User guide for LCAbyg 2023

Calculate the Buildings environmental profilel

LCAbyg

INTRODUCTION AN READING MANUAL

This section introduces LCAbyg, and how to get started by reading the user manual.
This section also describes which new updates and/or features are available in the program (version 5.3.1.0) and which have been discontinued

LCAbyg

NEW FUNCTIONS AND ERROR CORRECTION

LCAbyg is a nationally free accessible tool, developed by BUILD. The first version launched in 2015 and have since then had many changes to the user interface and the calculation core. LCAbyg is under constant development and there is always work being done, towards making existing functions better and adding new functions in close collaboration with the industry. LCAbyg 2023's development is based on earlier versions of LCAbyg and experience, furthermore adding a new calculation type, that is only addressed to the building regulations requirements to the climate impact of buildings, that is implementet January 1st 2023. LCAbyg will still be usable in other ways, since the tool is used in e.g. education or certification- and/or voluntary schemes.

What is new in v5.3 (launched in december 2023)

More area entries under 'Calculation prerequisites'
Under calculation prerequisites, it's now possible to input the area of integrated garages for singe-family houses, row houses and the like, where 50 pct. is included in the calculation, according to the upcoming requirement for buildings environmental impact, as well as an additional area, where 25 pct. gets included. The additional area covers outdoor ramps, stairs, fire escapes, access balconies and similar, integrated carports, outbuildings, protective covering, sheds and walk-om-ceilings and the like. See also §297(3) for area definition. Notice that LCAbyg calculates the percentage of the input areas and adds these to the total area, used to calculate the results per m^2.

Import of emission factors from local source of supply
It's now possible to import an EPD for supply sources, if there is an encrypted and 'locked' .lb5epd file for the EPD. At the release of LCAbyg 2023 EPD's from utilities have not yet been released. There will be more about this in the user manual, or on webinars, when this is available.

Biogas is replaced with pipeline gas
The emission factors for biogas has been replaced with new emission factors for pipeline gas. See more about data behind the operation in the included Excel sheet, that can be downloaded from the same place as LCAbyg. Emission factors for GWP is streamlined with annex 3 table 8 in the notice.

Service life table is updated
The service life table has been updated according to BUILD RAPPORT 2021:32 – BUILD levetidstabel – Version 2021 (revised in November 2022, as 2. edition), which can be found here.

Special building conditions
In case that a building has special building conditions, these can be added in the program, after which the given constructions within these special building conditions is chosen in the building model. Thereafter the additional impact due to special building conditions to which the building is justified is calculated (called additional climate impact).

Read more about special building conditions in the new BUILD report 2022:27 here. See §298(4) in the notice annex 2 table 9 for determination of the special building conditions.

New layout in the library
The layout of the components and products library has been updated and now gives the possibility to get more information about components and products within the library.

Stages can be added according to EN15804+A2
It is now possible to create stages according two different standards - EN15804+A1 and EN15804+A2. During input of stages according to EN15804+A2, only the GWP indicator is needed. Be aware, that if one or more stages is input according to EN15804+A2, the project will use environmental data from two different standards, and that the results of other indicators than GWP can not be compared or summed. There will be a warning, several places in the program, if EPD's from EN15804+A2 are used.

Scaling factor

All stages now have a scaling factor. The scaling factor can be used for e.g. input of insulation material, where the EPD includes a table for scaling of the wanted material. If the data set does not include a scaling factor, 1 is put in.

Display of result updates

There is now a possibility to turn of the visibility of the different environmental indicators and only show results of single indicators rather than them all. As a default LCAbyg only shows the results for the environmental indicator GWP, when the calculation prerequisites is set to 'Building regulation'.

New result display for the building regulation

If the calculation type 'Building regulation' is chosen, available is a new result page called 'Building regulation', which gives a simple over look of the main results about the buildings environmental impact, used as documentation for the upcoming requirements about buildings environmental impact in the building regulation.

English version

In settings the possibility to change the program interface to English has been added.

Report update

The LCAbyg report has been updated and can be used as documentation for the building regulations requirements to the climate impact of buildings.

Import of ILCD+EPD format

It is now possible to import EPD's on the digital format ILCD+EPD. Form January 1 2023 EPD"s from Norway can be imported, with few exceptions od material, if the digital file doesn't have the necessary information that is needed for the LCA calculation in LCAbyg.

LOG

LCAbyg's LOG is now updated så that it is more interactive, which means that you can double-click on any defects or errors in the log and thereby be led to where a lifetime or quantity is missing.

Opening of LCAbyg projects

It is now possible to open LCAbyg project by double-clicking the files. This only works as long as the project isn't destroyed. In this case LCAbyg must be opened first, and then the project can be opened from there.

Reperation of projects

LCAbyg can now reperate projects that have previosly been destroyed. This means that most projects from e.g. earlier versions, now can be opend in LCAbyg (not by double-clicking the file), and you will get a message here that you can repair the project. **Remember to save your original project**, since there may be information that LCAbyg removed, in connection with repairng the project.

Shortcut keys

It is now possible to use shortcut keys in LCAbyg, to acces different functions such as: rename, remove and so on. These shortcut functions can be seen in LCAbyg, by holding the mouse over the function

GENDK updates

Adapted regulation requirements

GenDk has been updates and adapted to "Bilag 2, tabel 7: Generisk datagrundlag 2023". This update includes replacement of generic data for concrete and wood products with industry data from EPD Danmark. The database can be downloaded from: `http://www.bygningsreglementet.dk`.
Further more attention is drawn to the fact that the GenDK library for components, is further updated for possible errors. Ur is therefore important to note that projects created in LCAbyg 5.2.1.0 or earlier versions, potentially will have significant variations in their results, since the database has been updated. Older project can be opened in LCAbyg 2023, and will be automatically updated to the latest

version of the database. However, the project file can afterwards not be converted back to older LCAbyg versions.

New components
The components library has been updates with more components. Among other things standard values have been added for installations, as BPST has developed in collaboration with the industry.

Functions that are no longer available

Import of LCAbyg 3.2 projects and building components
When publishing LCAbyg 2023, the possibility to import projects or building components (Elements, Components, Products or Stages) from LCAbyg 3.2. Should the need to do so appear, first open the LCAbyg 3.2 in LCAbyg 5.2.1.0, save it and hereafter, open the files in LCAbyg 2023. If there against expectations, will be issues with opening projects from LCAbyg 3.2 in LCAbyg 5.2.1.0, it is possible to write the LCAbyg mailbox.

DGNB as calculation type
As follows from the new DGNB manual valid from 2023, where the documentation requirement for life cycle assessment is streamlined with the building regulation, the calculation type DGNB is removed from LCAbyg 2023. This in turn means that the new DGNB certifications, must use the calculation type 'Building regulation' to document the LCA-criteria in DGNB. Scoring is done elsewhere. Information regarding DGNB-certification-types can be accessed here: `https://dk-gbc.dk/certificering?certificering=bygninger`

GLOSSARY

LCA	Life Cycle Assessment (livscyklusvurdering)
GWP	Global Warming Potential (klimapåvirkning)
VSC	Voluntary sustainability class (FBK - Frivillig bæredygtighed- sklasse)
BR18	Building regulation 2018 (Bygningsreglementet 2018)
EPD	Environmental Product Declaration (EPD) / Miljøvaredeklaration
EoL	End of Life (Endt levetid)
Building components	Building components refers to elements, components, prod- ucts, as well as stages
VCBK	Research center on the climate impacts of buildings (Viden- scenter om Bygningers Klimapåvirkninger)

MEANING OF ICONS AND COLORS

LCAbyg v5 is built around icons and colors. These icons and colors make it easy to get a quick overview throughout the program. The icons and colours recur through the programs tabs.

	DATABASE SOURCES			IN ACTIVE *	COMMENTS
	GENDK	USER	EPD		
GROUP		■		■	
SUBGROUP		▦		▦	
ELEMENTS	▮		▮	▮	
COMPONENTS	▦	▦	▦	▦	
PRODUCTS	₩	₩	₩	₩	
STAGES	🏭	🏭	🏭	🏭	
RENAME		✎		✎	
CHANGE GROUP		⧉		⧉	
ADD		+		+	
CREATE AND ADD		+⁺		+⁺	
IMPORT AND ADD		↓		↓	
EXPORT		↗		↗	
DUPLICATE		⧉		⧉	
DUPLICATE AND REPLACE		⧉		⧉	
DELETE		×		×	
DUPLICATE AND REMOVE IN CURENT SCENARIO		⧉		⧉	This is only active when scenarios are "on" in the project.
REPLACE ALL		⟲		⟲	Replaces all unlocked components.
WARNING		⚠			
ERROR		⊗			

*ATTENTION: If an icon is washed out and grey, it means that the function is inactive or deactivated.

FILE TYPES

LCAbyg 2023 is programmed to be able to handle many different file formats, see which in the table below.

		LCABYG 2023		
	ICONS	FILE FORMAT	JSON	EXCEL LITE
PROJECTS		.lb5		
ELEMENTS		.lb5elm		
COMPONENTS		.lb5cstr	.JSON	.CSV
PRODUCT		.lb5prd		
STAGES		.lb5stg		
EPD DK FILER		.lb5epd		

Shortcut keys

LCAbyg 2023 has a number of shortcut keys to access functions faster.

F1	Help function.
Delete	Delete selected items.
Ctrl. + S	Save project.
Ctrl. + Z	Undo quantity or naming entry. Can *not* be used to undo if a construction is deleted for example.
Ctrl. + N	Create and add a new element.
Ctrl. + R	Rename.
Ctrl. + K	Shift group/category for a construction.
Ctrl. + I	Import and add a component.
Ctrl. + E	Export a component.
Ctrl. + A	Add a component.
Ctrl. + D	Duplicate a component.
Ctrl. + Shift + R	Replace all throughout the project (of the chosen component).
Ctrl. + Shift + N	Add an element.
Ctrl. + Shift + A	Create and add a component.
Ctrl. + Shift + I	Import and add a component.
Ctrl. + Shift + D	Duplicate and replace a component.

INTRODUCTION

This is the user manual for LCAbyg v5.3.1. LCAbyg 2023 is a futher developemnt and update of LCAbyg version 5 and the previous updates, which is based on the upcomming LCA-requirements as of 1 January 2023. The program is a tool used for life cycle assessment (LCA), a method to calculate and determine a buildings environmental impact and resource use. LCAbyg can used for documentation in regard to the LCA requirement for the "Voluntary sustainability class", general comparison of buildings or as a goal for a certification.

On https://www.lcabyg.dk/ is the newest version of the tool, the user manual and usable information and literature about LCA for buildings. LCAbyg is developed by The Department of the Build Environment at Aalborg University Copenhagen.

It is beneficial to read from start to finish, if one has no previous experience with LCAbyg. From here comes background knowledge about the buildings life cycle and library, that includes many example construction, which can be used as a baseline. It is recommended to take a look at LCAbyg's YouTube channel, where short introduction videos about LCAbyg v5 is found. The manual can be used to find respective sections or searching for key words, when looking for specific procedures or definitions.

The contents of the user manual is split up into three main parts. The first part gives an overview of the underlying functions of the user interface, such as an explanation of the buildings life cycle and which stages are included in the program. Finally a description of the integrated library is given. The second part of the manual explains step-by-step, how to create a project with all its parts. The last part is about LCA's output of results and report as well as the built-in analysis options. There are also several appendices attached to the user guide that can be helpful e.g. when entering the energy consumption, EPDs and special conditions.

READING MANUAL

The user manual for LCAbyg is parted into multiple sections. The first two sections shortly introduces LCAbyg and how to create a new project. The remaining section is about results and analysis, as well as Excel-export and download of this in a pdf.

SECTION 1, About LCAbyg, shortly introduces LCAbyg, the build in library, building layers and modeling, as well as which modules and environmental impact categories is included in the model.

SECTION 2, Create a new project is a step by step guide that explains how to create a new project, as well as how to make changes in existing components. This includes all you need to know when modelling your building.

SECTION 3, Results describes how to set up this tab, as well as the information to be found here.

SECTION 4, Analysis and Report describes how to set up this tab as well as the information and graphs to be found here.

SECTION A-I, is Annex as well as Therms and conditions for using LCAbyg.

Chapter 1

ABOUT LCABYG

LCAbyg is a tool used for developing life cycle assessments for buildings.
Environmental impacts over the entire life cycle of the building are estimated and therefore include the procurement of raw material, production of building materials, energy and resource consumption during operation and maintenance, as well as disposal and id possible recycling of building components and building materials.

LCAbyg

LCAbyg is a digital tool, used to calculate environmental impacts and resource use, associated with a buildings over its life cycle. Information about the building and the building components, waste, transport, building process as well as the buildings energy use are entered. Based on that information LCAbyg will calculate a Life Cycle Assessment, and the results are compiled in a report, that can be downloaded as an pdf. The overall structure in LCAbyg is divided into different levels, for the entered information about the building. The levels are 'Elements', 'Components' and 'Products'. This means that the amount and the unit for a given element have to be entered at element and component level. This is described further, later in the manual. The purpose of the levels is therefore to define amounts, and also to link environmental impacts to exactly to their exact location. Overall, the calculation in LCAbyg consists of the following steps:

1. Files.

2. Enter information about the building and operation, as well as the operation on the construction site.

3. Enter information about building elements.

4. Enter information about waste and transport.

5. Evaluate the entered amounts and calculated results.

6. Look at the results in the analyses, and generate and download your result report.

1.1 User interface

The graphic user interface in LCAbyg is build around three main elements; **tabs** on the left side, a **menu bar** at the top and a **contents window**, which is the white surface in the middle, see Figure 1.1.
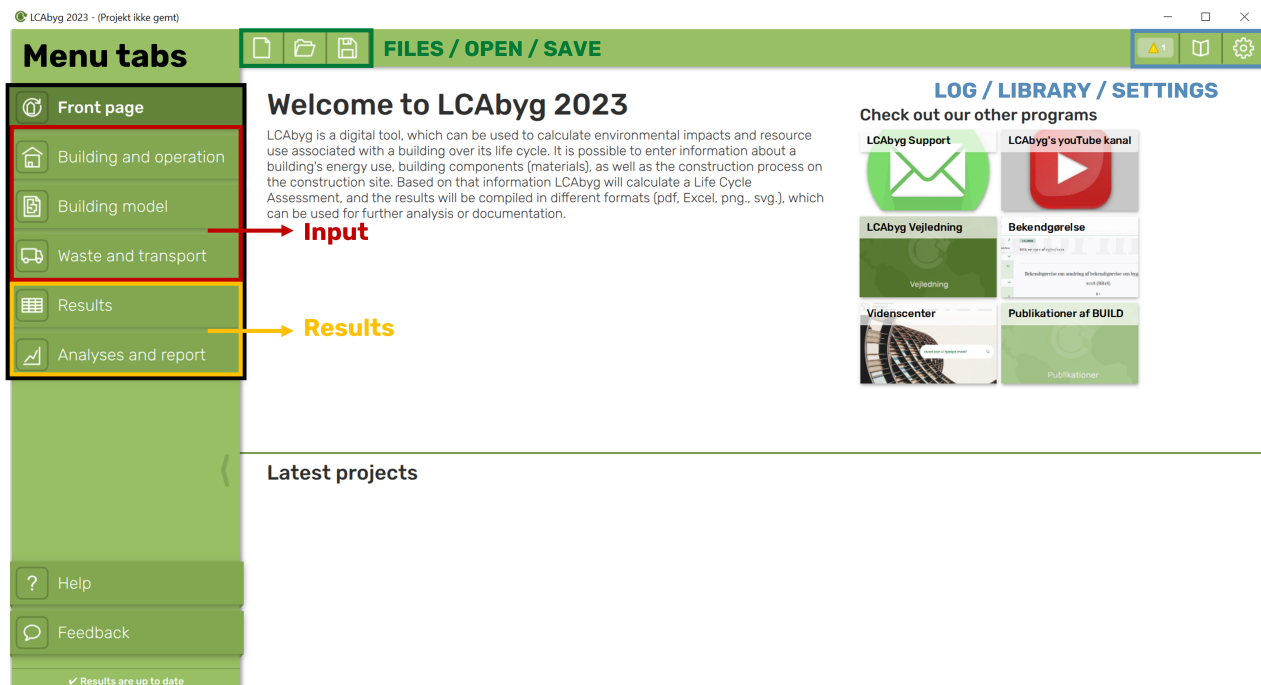
Figure 1.1: User interface in LCAbyg

The **tabs** in LCAbyg, is split into two overall groups: Entries and Results (see Figure 1.1). **Entries** includes three tabs **'Building and operation'**, **'Building model'** and **'Waste and transport'**. These tabs contains the building model it self, including material knowledge, energy use, transportation and so on. A further

description of the tabs, including usage, can be found in the following section, Create a new project. **Results** shows the final amounts and emissions, as well as an analysis of the modelling.

Other than the tabs, the figure 1.1), also shows what the buttons in the menu bar contains. The menu bar contains the functions, *'Files'*, *'Open'*, og *'Save'*. Under *'Files'* it is possible to create new projects from CSV-files generated with the Excel lite tool, import LCAbyg EPDs (from EPD Danmark) or JSON-components. Furthermore it is possible to export entire projects to a JSON-folder. *'Open'* gives the possibility to open an existing project and *'Save'* makes it possible to save new projects, as well as update existing ones.

1.2   Library

LCAbyg comes with a pre-generated library, that can be used to faster and easier create the building model. The library contain examples of components and pre-defined elements. Components that start with *"Ex."* are for existing elements when e.g. renovation of buildings and elements that start with *"Ren."* is elements with renovation measures. These examples are first of all made as temporary definition and as a help to model in the early design phase, before the construction is defined further over the course of the project. The library can also be used for making quick LCA estimate, in situations where it's too time consuming to define all the details in the projects current phase. When choosing components from the library, this shall happen based on a building professional assessment. In case a more accurate LCA is wanted or needed, the components can be customized or replaced in LCAbyg, so it matches the specific project. The full LCAbyg library can be found in the publication Example library for LCAbyg which can be downloaded her.

The libraries content is primarily used for newly build homes, school and institutions as well as offices, up to 5 stories tall. Components that is used directly form the library, has the source 'GenDk', which is the indicator for the LCAbyg database. Products in GenDK are according to 'BR18 annex 2 table 7: Generic data base 2023'.

A principle through out, is that everything assumed about the dimensions, layers and environmental data, follows conservative assumptions. This means that it is possible to achieve environmental improvements, by creating project specific, user generated elements.

1.2.1   Filtering options

LCAbyg 2023 allows for even more filtering options in connection with the component libraries. The different filtering options supported by LCAbyg 2023 are described below.

GenDk	Filter search after components in GenDK.
EPDDanmark	Filter search after components in EPDDanmark.
EPDNorway	Filter search after components in EPDNorway.
BPST (This name may change)	Filter search after components for Standardvalues for installations.
User	Filter search after components that are User created.
External Id	Filter search by the external Id the components have.
Free tekst	Freetext filter in the names of all components.
Group	Filter search after components that are part of the group (e.g. external wall).
Subgroup	Filter search after components that are part of the subgroup (e.g. load-bearing internal walls).

1.2.2   Detail level

The components are defined with a high level of detail, in regards to dimensions and the included products, as well as following requirements about completeness in relation to legislation regarding buildings

environmental impact. Materials missing from plane elements e.g. walls and decks is by default calculated for a normal section. This means that materials for edges, joints, flashings and the like, should be added.

1.2.3 Service life

All service lives in the component library, has been established acc. the service life table from BUILD RAPPORT 2021:32 – BUILD levetidstabel – Version 2021.

1.2.4 Graphs

In the library, whether the book in the right corner is used, or modeled under the tab *Building model*, there is an update with small graphs to give an overview of the structure and emission as well as the products composition of stages.

1.3 Buildings life cycle

Calculation wise, LCAbyg supports a big part of a buildings life cycle according to EN 15978:2012, european standard about LCA on buildings. According to the standard, a buildings life cycle should be modelled as illustrated on Figure 1.2. The figure consists of 5 life cycle stages (top row) and the associated life cycle modules from A-D (bottom row). The modules that are included in LCAbyg is highlighted - A1-5, B4, B6, C3-4 and D. It should be noted that LCAbyg uses other terms, so what the standard EN 15978:2012 describes as modules (A1-D), are refereed to as *Stages* in the program.
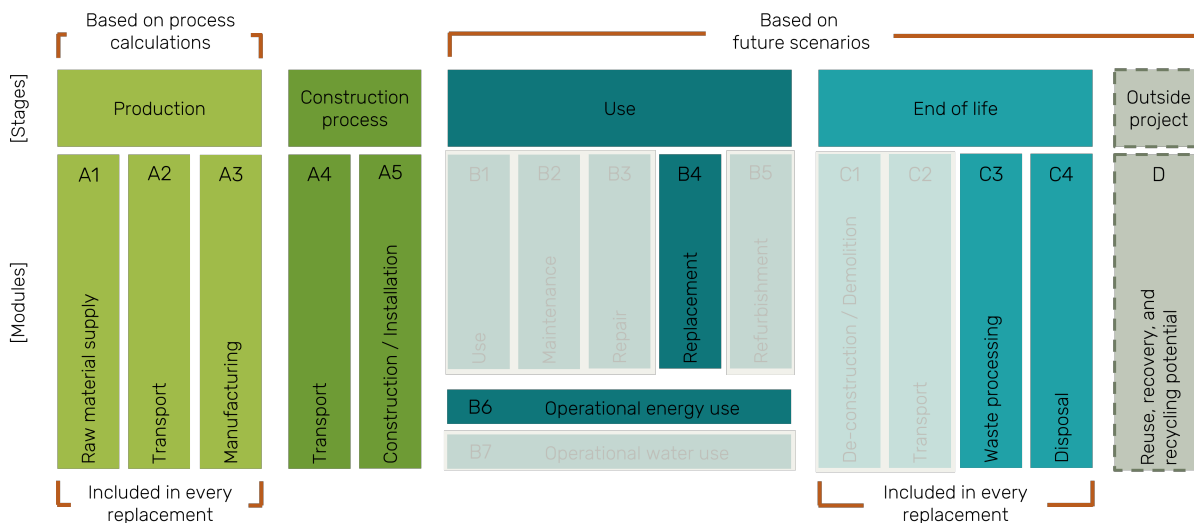
Figure 1.2: The buildings life cycle acc. EN 15978. The supported modules in LCAbyg is highlighted in blue.

1.3.1 Building materials

The modules A1-3, B4, C3-4 and D are all related to building materials. Impacts from modules **A1-3** and **C3-4**, is calculated, only based on type and amount of a given material. Impacts from replacement of products, **B4**, contributes to the results when a products service life is shorter than the reference study period. A replacement corresponds to the sum of A1-3 and C3-4 stages for the given product, since the used product gets processed as waste and a new gets produced. The reference study period and service

life is described further in Chapter 2 *Create a new project*.

Stage D, is seen as outside the project and on one side contains materials potential to be a part of a new life cycle and on the other side, contains the excess renewable energy production. Stage D is not part of the calculation for the final LCA results, since these are outside of the system boundary, it however shows a future potential for the building.

1.3.2   Transport to construction site

Transport of products and soil to/on/from the construction site is entered in relation to the individual product. The result is accounted for in a separate module **A4**.

1.3.3   Constrcution and installation process

Impacts from construction and installation, **A5**, includes material waste and energy use during the construction process. The energy use for the entire period is entered and split into energy types. Transport can be entered as energy use or as a chain of transportation analogue to A4.
Material waste is entered in relation to the products.

1.3.4   Energy use

Energy use for operation, **B6**, is entered i seperate energy types, electricity, district heating or pipeline gas, as well as if the calculation should be based on data from a single year or from progression.

In the progression scenarios, the energy uses environmental profile is calculated, based on the assumption that the environmental impact from electricity and heat producing technologies, is reduced with time, i.a. as a consequence of the phase out of fossil fuels. More detailed descriptions of the scenarios for electriciy and district heating, can be found in the report 'Opdaterede emissionsfaktorer for el og fjernvarme' made COWI for the traffic and building authorities. The progression scenarios for pipeline gas is made by BPST, in relation to the introduction of CO_2 requirements for the impact indicator GWP. The same method is used for the rest of the indicators, but instead of BPST the data comes from ökobaudat.

1.4   Impact categories

LCAbyg calculates results within a number of selected indicators, and hereby shows the environmental impact and resource use compared to the standard EN 15978. LCAbyg supports the indicators shown in Figure 1.3. It should be noted that there is more impact indicators than the program supports. Though many of them have not been included to make the results more manageable, they can i.a. be found in EPDs.

Category
Global warming potential (GWP)

Unit
kg CO_2-equivalent

Problem
When the amount of greenhouse gasses in the atmosphere increases, the ground-level layers of air are heated with climate change as a result

Category
Ozone depletion potential (ODP)

Unit
kg CFC11-equivalent

Problem
Depletion of the stratospheric ozone layer that protects flora and fauna from the harmful UVA-A and UV-B rays of the sun.

Category
Photochemical ozone creation (POCP)

Unit
kg Ethene-equivalent

Problem
In connection with UV-rays, contributes to the formation of ground-level ozone (summer smog) which, among other things are harmful for the respiratory passages.

Category
Acidification potential (AP)

Unit
kg SO_2-equivalent

Problem
Reacts with water and falls as "acid rain" that among other things contributes to depleting the root system and leaching the nutrients of plants.

Category
Eutrophication potential (EP)

Unit
kg PO_4-equivalent

Problem
Excessive nutrient additions promote unwanted plant growth in delicate ecosystems, e.g. algae growth resulting in fish death.

Category
Abiotic depletion potential for non fossil resources (ADPE)

Unit
kg Sb-equivalent

Problem
A high consumption of abiotic resources can contribute to depletion of available elements in the form of e.g. metals or minerals.

Category
Abiotic depletion for non fossil resources (ADPF)

Unit
MJ

Problem
A high consumption of abiotic resources can contribute to depletion of available energy in the form of fossil fuels.

Category
Total use of renewable primary energy (PERT)

Unit
MJ eller kWh

Problem
A high consumption of primary energy resources from fossil and renewable sources can contribute to depletion of natural resources.

Category
Use of non-renewable secondary fuels (NRSF)

Unit
MJ eller kWh

Problem
Secondary fuels (e.g. waste) are in principle a limited resource, and a high consumption of secondary fuels may indirectly lead to resource scarcity.

Figure 1.3: Indicators of environmental impact and resource use acc. EN 15978, supported by LCAbyg. Be aware of the fact that primary and secondary energy is split into renewable and fossil energy in LCAbyg and most EPDs.

Chapter 2

CREATE A NEW PROJECT

The following chapter will review the different steps there is to creating a project in LCAbyg:

1. Entering under the tab 'Building and operation'
2. Creation of building model under the tab 'Building model'
3. Adding waste and transport

LCAbyg

2.1 Front page

When starting a LCA calculation, you first have to create a project, see Figure 2.1. You can chose to either create an *'Empty project'*, *'Single family house, example'* or a *'Renovation project'*. You can also open an existing project. You also have the possibility to save a project by choosing *'save'* in the menu bar, naming your project and save it a place on your computer where you can find it.

The example project, *'Single family house, example'* includes a number of pre-entered elements that you can edit and add components to, by right clicking the element.
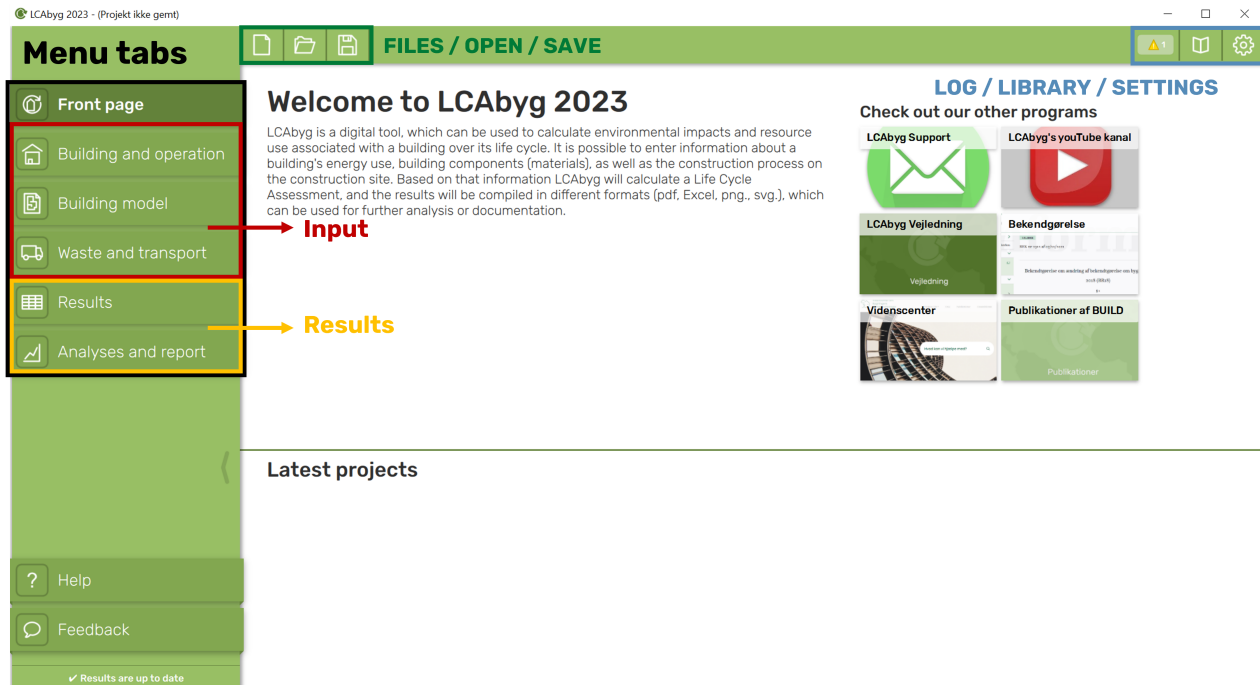
Figure 2.1: Illustrates the userface in LCAbyg, which is built upon three main element;the menu tab on the left, the menu bar on the top and the preview pane, which is the white surface.

2.2 Building and operation

Under the tab **'Building and operation'** (Figur 2.2), enter information about the building, the environmental profile is calculated for. It is under this menu pont that the buildings energy use (B6) is entered, as well as the energy use regarding the construction process, construction and installation (A5). Furthermore, documentation about the amount of soil moved by digger on the construction site and the amount of diesel used (A5), is also entered here. The tab contains multiple boxes, all described i the following tables. It is important to note that the boxes concerning *calculation prerequistics*, should ALL be filled out, since these forms the basis for the final results. Though most of the other boxes is mostly there to help remember information about the building, *Energy consumption and supply* is important to fill out, if the operation should be part of the final result. It is also under this tab that *'Scenarios'* and *'Special conditions'* is activated.
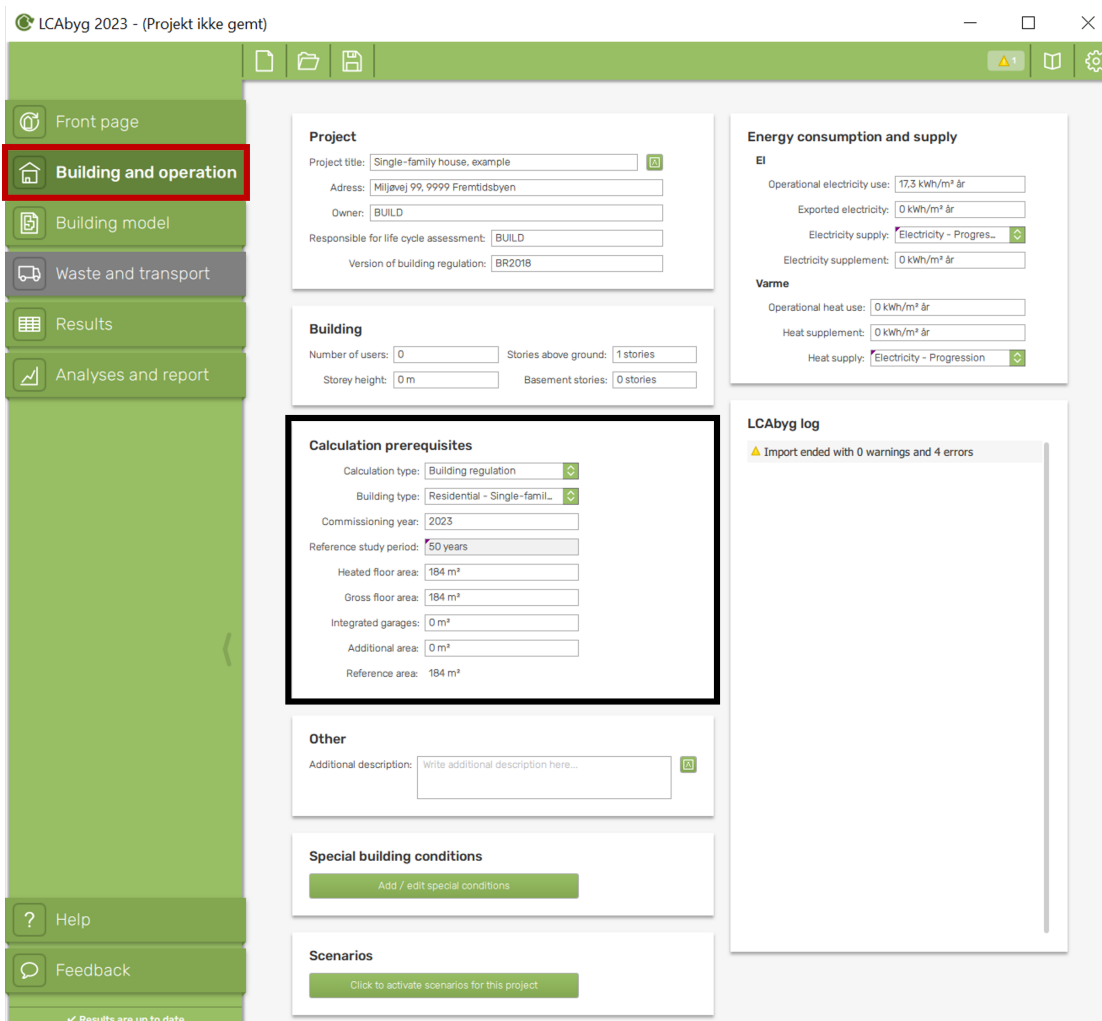
Figure 2.2: Illustrates the tab 'Building and operation'

2.2.1 Project

Project title	Add a title to the project, which that environmental profile is calculated for.
Address	Enter the buildings adress.
Owner	Enter name of the owner of the building
Responsible for life cycle assessment	Enter the name of the one that is responsible for the life cycle assessment.
Version of building regulation	Enter which version of the building regulation the project is subject to e.g. BR18.

2.2.2 Building

Number of users -	Number of expected users of the building
Storey height [m]	The buildings average storey height.
Stories above ground [number]	Number of stories above ground. Starts at 1 story (ground floor) and adds up.

Basement stories [number]	Number of basement stories (stories under ground). Definition of basement acc. BR18.

2.2.3 Calculation prerequisites

Is marked with black in Figure 2.2. These boxes <u>MUST</u> be filled out, since they make up the basis for which the results will be calculated upon. Is the heated floor area and gross floor area the same, the same value must be put into both boxes, since none of them can be 0. **Furthermore be aware of the fact that the *heated floor area* is used to calculate the operation pr. m^2 and the *reference area* is used to further calculations pr. m^2 at material level.**

Calculation type	Choose calculation type from drop down menu: *User specific LCA*, *Building regulation* or *Voulentary sustainability class*. In the report the value will indicate which system and rules the LCA follows
Building type	Choose building type from drop down menu. This does not affect the calculations.
Commissioning year	Enter the year the building is put into use after finishing of the construction.
Reference study period	Enter reference study period. This is locked to 50 years for VSC and Building regulation
Heated floor area [m^2]	Enter heated floor area according to the building
Gross floor area [m^2]	Enter gross floor area, including basement area, waste rooms at ground level and security rooms.
Integrated garages [m^2]	Enter reference area for integrated garages for single-family houses, row houses or the like.
Additional area [m^2]	Enter the reference area for outdoor ramps, stairs, fire escapes, access balconies and similar, integrated carports, outbuildings, protective covering, sheds and walk-om-ceilings and the like.

ATTENTION: For *Integrated garages*, 50 pct. of its area , and for *additional area*, 25 pct. of its area gets included in the calculation of the reference area.

2.2.4 Other

Additional description	Add any additional comments about the life cycle assessment, including regarding prerequisites, calculation method, references and the lik.

2.2.5 Energy consumption and supply

The data used in LCAbyg for calculating operation emissions, can be found i the Excel sheet, that can be downloaded from the same place as LCAbyg 2023. Here also lies the calculation method.

Operational heat use [kWh/m^2 year]	Enter heat use for building operation, see Appendix A with a guide about key numbers from the energy frame calculation.
perational electricity use [kWh/m^2 year]	Enter electricity use for building operation, see Appendix A with a guide about key numbers from the energy frame calculation.
Exported electricity [kWh/m^2 year]	Enter if any energy surplus of electricity from e.g. solar panels. This should not part of the energy frame calculation and is exported to the electricity network. See Appendix A.
Electricity supplement [kWh/m^2 year]	Enter if any supplement to the electricity use, see Appendix A with a guide about key numbers from the energy frame calculation.
Heat supplement [kWh/m^2 year]	Enter if any supplement to the heat use, see Appendix A with a guide about key numbers from the energy frame calculation.

Electricity supply	Choose scenario, for the calculation of electricity for the building operation, from the drop down menu.
Heat supply	Choose scenario, for the calculation of heat for the building operation, from the drop down menu.

NOTE: Calculations of the buildings collected environmental profile presumes information about the buildings energy use or need. A possibility is to use BE key numbers, see Appendix A. If the operational use is not entered, the results of the LCA will only reflect the embedded impacts related to materials.

Import of emission factors from local source of supply

This section is relevant if the district heating plant, supplying heat to the building which is the center of the calculation, has a specific EPD for emission factors for district heating. The EPD can be imported to the project, if there is an encrypted and 'locked' .lb5epd file for the EPD. The encrypted .lb5epd file can only be made as long as the EPD is third party verified. If such an EPD exists and there is no .lb5epd file, please contact BUILD.

STEP 1	Click files (paper icon) in the top left corner and choose *Import EPD Danmark EPDs*.
STEP 2	Choose the EPD, you want to import.
STEP 3	The imported EPD can now be found under *Heat supply*.

2.2.6 Energy consumption construction site

The data used in LCAbyg for calculating energy consumption construction site, can be found i the Excel sheet, that can be downloaded from the same place as LCAbyg 2023. Here also lies the calculation method.

Operational heat use [kWh]	Enter operational heat use during the construction process.
Operational electricity use [kWh]	Enter operational electricity use during the construction process.
Electricity supply	Choose scenario for calculation of electricity during the construction process from the drop down menu (Electricity - Progression is obligatory for VSC)
Heat supply	Choose scenario for calculation of heat during the construction process from the drop down menu (progression scenarios is obligatory for VSC)
Diesel (Machinery) [L]	Enter use of diesel oil during construction process.
Soil moved by digger [m^3]	Enter the moved soil volume during the construction process. This is an alternative entry, that is only used if the energy use from moving the soil can't be entered, based on measured energy or fuel.

2.2.7 Scenarios

See Appendix G for explanation about how to work with scenarios.

2.2.8 Special building conditions

Se Appendix E for a description of how to work with special building conditions.

2.2.9 LCAbyg log

The log in LCAbyg shows the different steps that has been made in the program, e.g. import or additions. The log is made to keep an overview and see if any enters is missing, or others. The log is interactive, which means that if an amount, service life or other things are missing, it will be marked with red. This can be clicked, and it will take you directly to the possible missing service life.

2.3 Building model

Under the tab 'Building model, the buildings materials are created and entered. The tab is split into 4 columns: Elements, Components, Products and Stages, that all together make up the entire building model. The tab is furthermore made up of a detail window to the right, that gives a quick overview over the chosen subjects, see Figure 2.3.

ATTENTION: To create, edit or add an Elements, Components, Products or Stages, right click on one of them e.g. an element, or you can use the buttons in right corner, nedt to the detail window„ marked with green on Figure 2.3. The buttons functions is further described later.

Structure: The 4 columns represent the levels and structure that LCAbyg is built up around. An element can consist of e.g. one or more components, that furthermore can consist of one or more products. E.g. can an element called 'External walls', consist of 124.47 m^2 external wall surface of bricks, middle layer of 100 mm aerated concrete and mineral wool, as well as an internal wall side, which is painted. The wall also consists further of possible fasteners like screws and plaster. Furthermore these components contains stages, that define the components environmental profile, see section Stages.

This means that while on component level, enters the amount and unit of the component, e.g. 325 m^2. On product level, the amount the different products uses per element unit is entered, e.g. 5 kg/m^2.
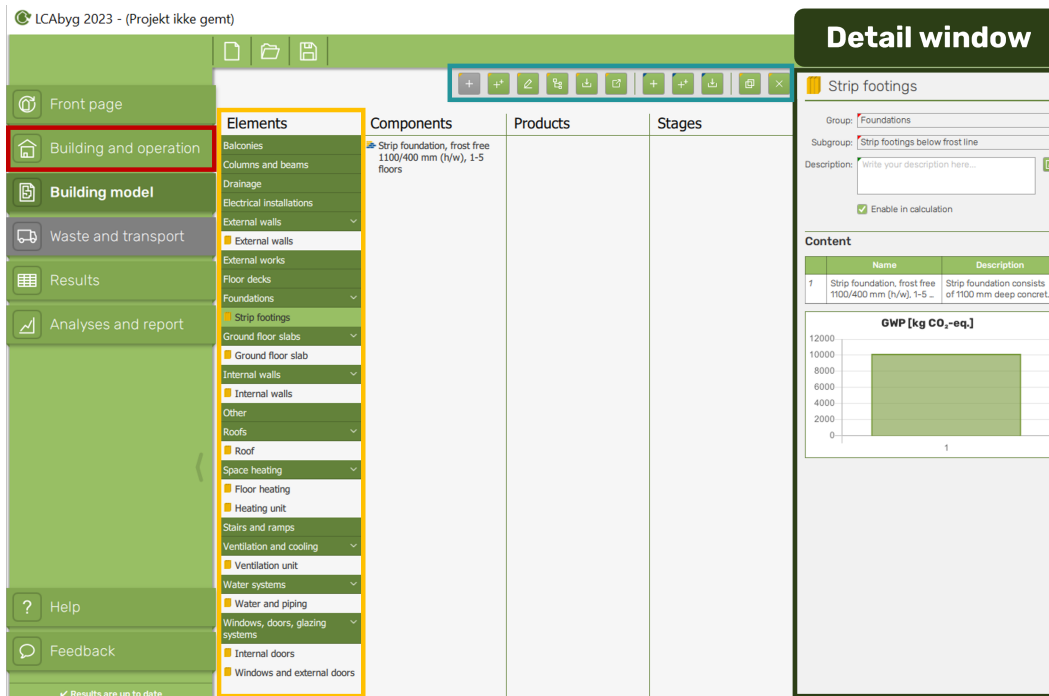

Figure 2.3: Illustrates the tab 'Building model'

2.3.1 Elements

The column 'Elements' is separated into 17 groups (*Balconies, Columns and beams, Drainage, Electrical installations, External walls, External work, Floor decks, Foundations, Ground floor slabs, Internal walls, Other, Roofs, Space heating, Stairs and ramps, Ventilation and cooling, Water systems, and Windows, doors, glazing systems*), that has the colour dark green in the program, see Figure 2.3. The groups are locked and can't be edited, but is used to keep track of entries or as a check list to obtain a complete building model. You can crate and name your own elements, though each element need to contain one of the pre-defined groups (e.g. *'Internal walls'*), as well as a subgroup (e.g. *'Load bearing walls'*). An elements usually consists of a number of underlying components. If you are working with a project with multiple scenarios, the element will be created in all other scenarios, even if a scenario is locked. When an element is created, which scenarios it should be included in can be chosen in the detail window.

It is possible to add and edit elements, either by right clicking or by using the buttons marked with green on Figure 2.3. The meaning of the different buttons can be seen in the section **Meaning of icons and colors**. It is possible to exclude an element from the calculation by clicking 'Enable in calculation' off. Furthermore it is possible to "collapse" elements.

It is possible to find deleted elements, by right clicking elements under the tab building model, and press "Add element". This function only works in case you have deleted an element.

Create a new element
When creating a new element, a group and subgroup has to be chosen.

STEP 1	Right click one of the groups (*dark green*) in the element columns and press 'create and add element', or use buttons.
STEP 2	Enter name of element, e.g. **Internal wall, type 1**
STEP 3	Chose a *Group* for the element via the drop down menu
STEP 4	Chose a related *Subgroup* via the drop down menu.
STEP 5	Press Create Now you can either chose to add one or more components from the library, by choosing *'Add component'* or create and name own components, by choosing *'Create and add component'*, see step by step guide in upcoming section.

2.3.2 Components

An element consists of one or more **components**, see Figure 2.4, that can created two ways: Either by adding a component from LCAbygs library (with the source name GENDK) or by creating a new component, that can be specified. It is also possible to edit components from the library. It is possible to exclude a component from the calculation, by clicking 'enable in calculation' off. If working with multiple scenarios, be aware of when adding components to an element that exist throughout the scenarios, the element in other scenarios will also be changed.

It is possible to add and edit in components, either by right clicking or by using the buttons marked with green at Figure 2.4. The meaning of the different buttons can be seen in the section *Meaning of icons and colors*
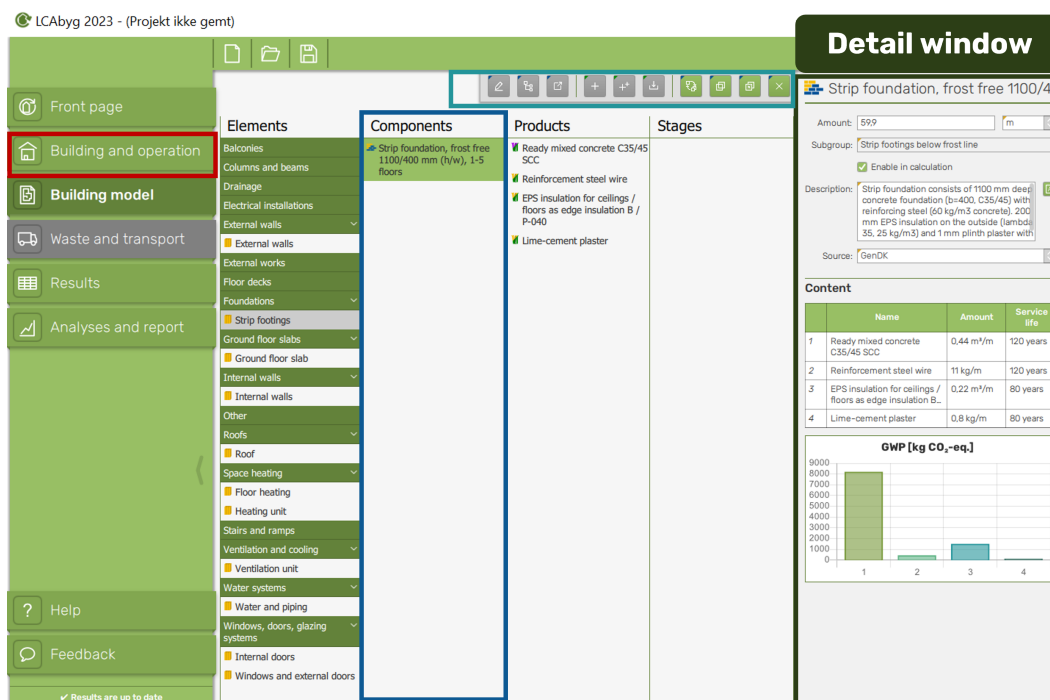

Figure 2.4: Illustrates the 'component' level

Add component

When choosing **'Add component'**, a pop up window will come and show LCAbygs component library to the left, as well as a detail window to the right, that shows the belonging products (see section Products for further description).

STEP 1	Right click on the specific element that you want to add a component to and click 'Add component' or use the buttons.
STEP 2	Search or scroll after the component you want to add.
STEP 3	Click the conponent.
STEP 4	Afterwards click Add.
STEP 5	Mark the component to enter amount. *The amount is typically given in the unit m^2, but the specific amount can be different, depending on the type of element and the belonging component that has been chosen. E.g. is the foundation by deafult specified in m and ventilation in pcs.*

ATTENTION: if you can not find the wanted component in the list, you can to two things:

1. Do you wish to edit an existing component from the list, first chose the component as described in

the 5 steps above. Hereafter, right click the component and choose **'Duplicate** or **'Duplicate and replace** - now you can remove and/or create a suitable product to the component.

2. You can also create a new component from scratch by right clicking the element and choosing **'Create and add component'** and follow the guide below **'Create and add component'**.

Create and add component

When adding a new **component**, you must choose **Unit** and define a **Group**, as well as a **Subgroup**.

STEP 1	Right click the specific element that you want to add a component to an click *'Create and add component'* or use the buttons.
STEP 2	Enter name of component.
STEP 3	Choose a *Group* for the component via the drop down list.
STEP 4	Choose a additional *Subgroup* for the component via the drop down menu.
STEP 5	Choose a *Unit* for the component via the drop down list.
STEP 6	Click *Duplicate and add*.
STEP 7	Mark the component to enter amount. *The amount is typically given in the unit m^2, the specific amount can be different, depending on the type of element and the belonging component that has been chosen. E.g. is the foundation by default specified in m and ventilation in pcs.*

A new component can also be created by using the construction of an existing component. This is done by using the *Duplicate*-function:

'**Duplicate**' means that you create a clone of a component, as well as keep the 'old' component.

'**Duplicate and replace**' means that you create a clone of a component and at the same time replaces the 'old' component.

2.3.3 Products

There can be found a large number of **products** in the programs library, which covers a wide range of materials and products. The product library is updated to follow annex 2, table 7 in the notice for the LCA-requirement from 1 January 2023 It is also possible to create a name your own products. A product contains information about environmental impacts and resource use throughout the products life cycle, that can be seen in Figure 2.5. A product from the LCAbyg library will always contain the stages: Manufacturing (A1-3), as well as Waste processing (C3) and/or Disposal (C4). Potential for reuse, recovery and recycling (D), will only be added when the information is accessible.

It is possible to add to and edit products, either by right clicking or using the buttons marked with red at Figure 2.5. The meaning of the buttons can be seen under the section Meaning of icons and colors.
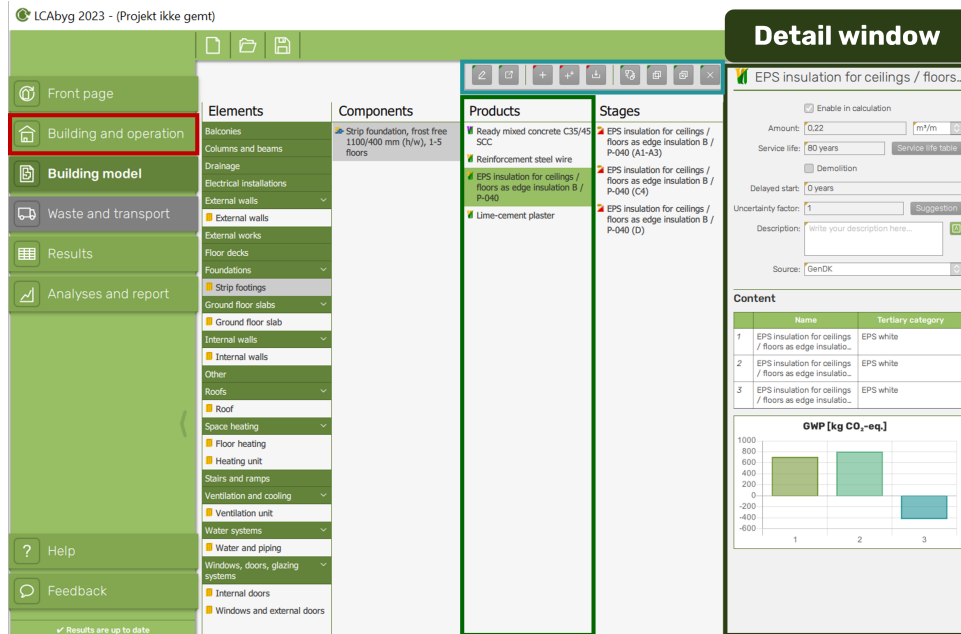
Figure 2.5: Illustrates the 'Product' level

A **product** can be created two ways, either by choosing and adding a product from the LCAbyg library (with the source name GENDK) or by creating a new product, that can be specified. You would typically create a new product based on environmental product declaration (EPD) and its belongong stages, see how to do this under the section Stages.

Add a product

When choosing *'Add product...'* a pop up window will come and show LCAbygs product library to the left, as well as a detail window to the right, that shows the belonging stages (*see section Stages for further description*).

STEP 1	Right click the component you want to add a product to and click 'Add product...', or use the buttons.
STEP 2	Search for the product you want to add. **ATTENTION**: if you can not find the wanted product in the LCAbyg library, you can add one yourself by right clicking and choosing *'Create and add product...'*, and follow the guide down below. You can not edit a product, unless the *component* is also editable, as described earlier. It is also possible to import LCAbyg files from EPD Denmarks database, this is described in Appendix C.
STEP 3	Click a product.
STEP 4	Afterwards click *Add*.
STEP 5	Mark the product and enter *amount*, *unit*, *service life*, as well choose if there is *delayed start* and/or if it is a *demolition*.

Amount of a product is per component unit, which means that e.g. a 124 m^2 wall side, uses 0,19 kg of primer per m^2, 0,38 kg of acrylic paint per m^2 and 8 kg of plaster per m^2.

Service life of a product refers further back to the specific reference study period, meaning how many times a product needs to be replaced during the reference study period. E.g. acrylic paint as interior surface, has a service life of 15 years and therefore need to be replaced 2 times after construction of the building over the 50 year reference study period.

Delayed start is chosen when i calculating remaining service life. This means, when you have a product that gets demolished/added later in the future. This can e.g. be a windows that got replaced a few years ago, and therefore don not need to be replaced for another 5 or 10 years in the future.

Demolition refers to disposal for the product in question, at the start of construction. During re building or renovation, it can be relevant to enter existing products i the building, that is getting torn down now (or after a number of years if also using 'delayed start') - in theses cases, demolition is switched on.

Create and add product

When creating a new **product**, a **name** must be entered, furthermore it is important that the product gets one or more stages added to function properly. You can either add an existing stage from the LCAbyg library or create one yourself from a environmental product declaration (EPD), see how i the section Stages.

STEP 1	Right click the specific component you want to add a product to and click *'Create and add product...'*, or use buttons.
STEP 2	Enter name of the product.
STEP 3	Afterwards click *Create*.
STEP 4	Mark the product and enter *amount*, *unit*, *service life*, as well choose if there is *delayed start* and/or if it is a *demolition*. *Note*, that the import part is that the product includes a A1-3 and at least one C stage, before it gets included in the final environmental calculation.

2.3.4 Stages

The library in LCAbyg contains a number of stages that <u>MUST</u> be included in the created products. It is in the stages that the data about environmental impact i placed. A product must contain a A1-3 stage as well as at least one C stage, before it gets included in the final environmental calculation.

It is recommended not to make changes in the library, and hereby the composition of the products stage. It is though possible to create product specific or industry specific products, by creating and adding stages e.g. from an EPD. Since EPDs are third party verified, it is recommended not to make changes in this data. Some older EPDs is missing EoL (end-of-life) stages, and therefore be necessary to add this stage, based on a building professionals assessment. The generic library in LCAbyg can in this case be helpful.

You have the possibility to create the following stages: Manufacturing (A1-3), Waste processing (C3), Disposal (C4), as well as Potential for reuse, recovery and recycling (D). The manufacturing stages contain data about the environmental impact during the manufacturing of the product, while the products EoL (C3-4) refers to what happens at a product ended service life, e.g. disposal, recycling.

It is possible to add to and edit products, either by right clicking or using the buttons marked with green at Figure 2.6. The meaning of the buttons can be seen under the section Meaning of icons and colors.
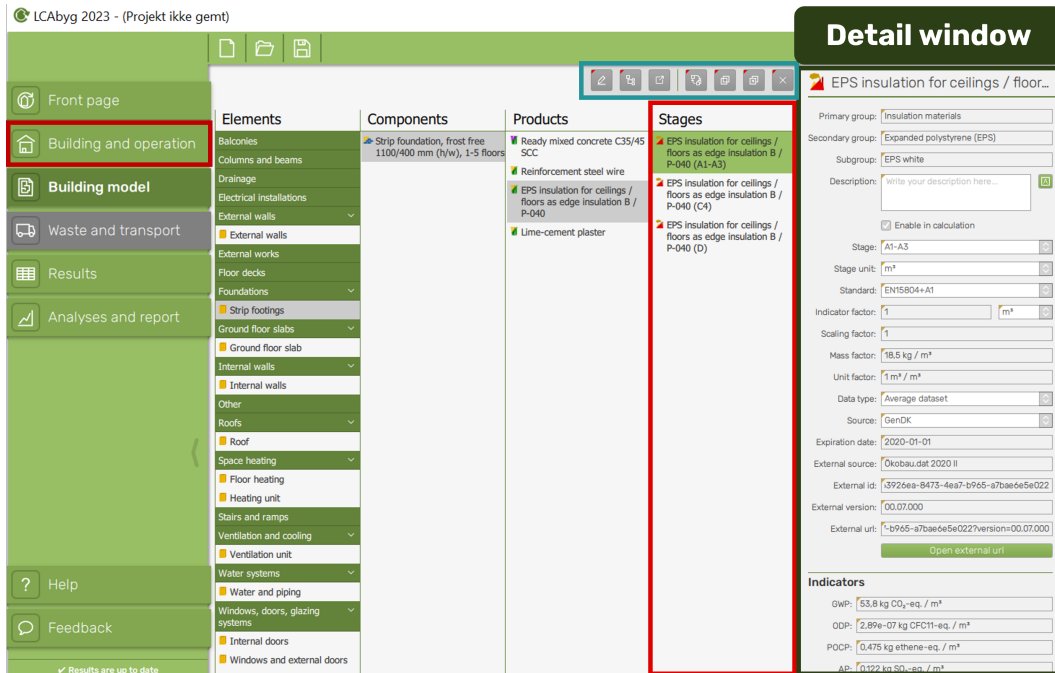
Figure 2.6: Illustrates the level 'Stages'

Add stage

When choosing **'Add stage...'** a pop up window will come and show LCAbygs product library to the left, as well as a detail window to the right, that shows the specific details belonging to the stage.

ATTENTION: A product must contain a A1-3 stage as well as at least one C stage, before it gets included in the calculation. A product can only contain one of each type of stage. If you wish to not include the manufacturing stage of a product, "demolition" must be used.

STEP 1	Right click the product you want to add a stage to and click 'Add stage...', or use the buttons.
STEP 2	Search or scroll after the stage you want to add.
STEP 3	Click a stage.
STEP 4	Afterwards click **Add**.

If you choose to create a new stage, you need a number of information's about the products environmental attributes. These information can be found in LCA-databases or for specific products in the product environmental product declaration (EPD). You can look for EPD-data for products or building components at manufactures or finding them on different national program operators websites. Be aware of, if the found data fulfills the current European standards, i.e. EN 15804 about environmental product declarations. If in doubt, about how enter an EPD and what information is entered where, you can find a step by step guide in Appendix B, or on LCAbygs YouTube channel. Be aware of the fact that most of the EPDs from EPD Denmark, can be found as LCAbyg files and can therefore be loaded as product and/or stages. Import of these is described in Appendix C.

Create and add stage

When creating a new **stage**, if data comes from an environmental product declaration (EPD), a number of information must be entered. The information can be found in the EPD's and are specified in the table below, Table 2.7.

STEP 1	Right click the specific product you want to add a stage to and click *'Create and add stage...'*, or use buttons.
STEP 2	Enter the information specified in Table 2.7.
STEP 3	Afterwards click *Create*.

GENERAL	
Name	Enter name of the stage. Feel free to add which stage it is about. E.g. (A1-3)
Primary group	*Select a primary group.
Secondary group	*Select an associated secondary group.
Subgroup	*Select an associated subgroup.
Stage	Select the stage specified in the products EPD. The stage indication, e.g. A1-A3, is according to the European standard EN 15804 about environmental product declaration for products. Be aware of the fact that, for every product there must be separately entered the manufacturing stage and EoL, respectively.
Stage unit	Select the unit you wish the material entered in, in future use of the material. **As a starting point, use the declared unit or the functional unit** from the environmental product declaration, that is usually given, per kg, per m^3, or per m^2 material or per pcs.
Standard	Select the EPD standard the data set is made after. EN15804+A1 or EN15804+A2.
Indicator unit	<u>ALWAYS</u> select the unit given in the environmental product declaration as the declared unit. If the declared unit e.g. is 1 kg, the Indicator unit should thereby be kg.
Indicator factor	Indicator factor the amount given together with the declared unit. If the declared unit e.g. is 1 kg, the Indicator unit should thereby be 1.
Scaling factor	Enter a possible scaling factor, if the environmental impacts in the EPD should be scaled to correspond to a specific product. If there is no given scaling factor in the EPD, 1 should be entered.
Mass factor	Here the weight (in kg) in entered per Indicator unit. Is the data set e.g. about a plasterboard with the indicator unit m^2, the mass factor could be 10, meaning the plasterboard weighs 10 kg/m^2.
Unit factor	The Unit factor describes the relation between the Indicator unit and Stage unit. In cases where the Indicator unit and Stage unit is the same, e.g. if both is given per m^3, the entered Unit factor be 1 (m^3/m^3).

INDICATORS	
GWP [kg CO$_2$-eq]	Global Warming Potential (GWP). **ATTENTION:** When entering an EPD according to standard EN15804+A2, enter GWP- (total).
ODP [kg CFC11-eq]	Ozone Depletion Potential (ODP)
POCP [kg SO$_2$-eq]	Photochemical Ozone Creation Potential (POCP)
AP [kg PO$_4^3$-eq]	Acidification Potential (AP)
EP [kg ethene-eq]	Eutrophication Potential (EP)
ADPE [kg Sb-eq]	Abiotic Depletion Potential, Elements (ADPE)
ADPF [MJ]	Abiotic Depletion Potential, Fossil fuel (ADPF)
PERT [MJ]	Total Primary Energy, renewable (PERT)
PENRT [MJ]	Total Primary Energy, non-renewable (PENRT)
RSF [MJ]	Use of renewable secondary fuels (SE-R)
NRSF [MJ]	Use of non-renewable secondary fuels (SE-NR)

Table 2.7: Description of the necessary boxes to fill out when creating and adding of a new stage.

*The structure of the stage categories (Primary group, Secondary group and Subgroup) can be found in the Excel sheet, that can be downloaded from the same place as LCAbyg.

ATTENTION: *Be aware of, when using environmental data from standard EN15804+A2, the project will be based on data from to different standards (EN15804+A1 and EN15804+A2), and the results for other indicators than GWP, can not be compared or summed.*

2.3.5 Building component files

It is possible to export and import building components (elements, components, products, and stages) from earlier LCAbyg 5 versions. A building component can be exported by clicking the building component and use the button '*Export...*', where it afterwards can be saved to your computer. You import the building component either by right clicking and selecting '*Import and add...*', or use the buttons shown in Table 2.8.

	LCABYG 2023			
	ICONS	**FILE FORMAT**		
ELEMENTS		.lb5elm	**EKSPORTER**	
COMPONENTS		.lb5cstr		
PRODUCT		.lb5prd	**IMPORTER AND ADD**	
STAGES		.lb5stg		

Table 2.8: Shows the file types that can be exported and imported i LCAbyg 5

When a building component and its associated levels is added, it can be found in the library. I.e. that if an element is imported with its associated components, products and stages, all of these will be added to the library, and be accessible in the entire project. Therefore if your try to import a component e.g. that was part of an earlier import, an error message will come up, since the building component is already in the project.

STEP 1	Right click or choose the icon *'Import and add…'* to add components to your library.
STEP 2	Search you computer and choose the building component you want to add. When you press *'Import and add…'* you will see which building component you can add. This depends on where in the building model you are. You can add components, when you have chosen that it's components you want to add, and so on.
STEP 3	Click on the associated component.
STEP 4	Afterwards click Open.
STEP 5	The building component will now show up in the model as well as the under-lying library.
STEP 6	Select the component and enter/check through **amount, unit, service of life,** as well as choose if there is a **delayed start** and/or if there is a **demolition**.

2.4 Waste and transport

Notice that entry of waste and transport isn't relevant for life cycle assessments in accordance with BR18 (2023)

Under the tab *'Waste and transport'*, see Figure 2.7, enter information about waste and transport for the building the environmental profile is calculated for. In the menu bar under the item a drop-down menu is located, where it's possible to change between *'Product'*, *'To construction site'* and *'On/from construction site'* This tab is compatible with calculation cf. VSC (Voluntary sustainability class).

Figure 2.7: Illustrates the 'Waste and transport' level

2.4.1 Product

When 'Product' is chosen in the drop-down menu, will the workspace appear as in Figure 2.7. Here are all entered products under the tab *'Building model'* listed. The workspace is furthermore divided into columns, where **waste** refers to the percentage waste of products, that happen on the building site (A5). This can for example be products that have been damaged under the construction process or by improper storage, and thus not be able to be used for the actual purpose.

To/from construction site

At unknown amount of waste all materials in the building model has to have added 10 percent waste. The documentation of waste of materials contains both a description of what type of wasted product in question and a quantity inventory.

The remaining columns **truck**, **train**, **pram** and so on, in Figure 2.7, refers to the transport of products to the construction site, where transport in regards to the construction process of products, soil and construction waste has to be documented in regards to the LCA-requirement for VSC.

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To/from construction site

The entry must include the distance and transportation mode. The type of product happens automatically, but the transport of the product to the construction site has to be connected to the products.

Note, if the function 'Change all' is selected in Figure 2.7 a window pops up, where it's possible to define/change all products waste and transportation distances to the same. Even if you work with multiple scenarios, waste and transport is only changed in the active scenario.

2.4.2 'To construction site'

When **'to construction site'** is selected from the drop-sown menu, it's possible to add transportation type and amount of other products, that otherwise isn't in the building model e.g. soil. You can add a new line by pressing '+' (red marking on Figure2.8). Once you have created and named which product it is, the **weight** and **transportation type** can be entered.

It is possible to add and edit in the product, either by right clicking or use the function buttons marked with red on Figure 2.8. *Note that buttons 2-3 can't be used until a product is added to the construction site.*

1. *Add* product to construction site.

2. *Rename* product to construction site.

3. *Remove* a product.

Figure 2.8: Shows 'To construction site' and how to add transportation types

2.4.3 'On/from construction site'

When **'On/from construction site'** is selected from the drop-down menu, it's possible to add transportation of construction waste in the construction period, as well as construction waste in other locations, than the actual construction site, that is related to the construction process. Transport between construction site and other locations in connection with construction processes, including storage, prefabrication or reprocessing. Construction waste from prior demolition isn't covered.

It is possible to add and edit in the product, either by right clicking or use the function buttons. *Note that function buttons 2-3 can't be used until a product is added to the construction site.*

1. *Add* product to construction site.

2. *Rename* product to construction site.

3. *Remove* a product.

To/from construction site

The entry of construction waste must include type of construction waste and a quantity storage, as well as transportation type and distance.

You can add e.g. the type of waste that has to be transported by clicking '+' (red marking on Figure 2.9). Once you have created and named the type of waste in question, the **weight** and **transportation type** can be defined, which can then automatically be seen in results.

Figure 2.9: Shows 'To/from construction site' and how to add transportation types

Chapter 3

RESULTS

The **Results** tab provides an overview of all quantities and results from your project.

You can export all amounts and results from your project to Excel or JSON. Based on exports it is easier to see all the entered quantities and results, and use these to prepare your own graphs.

LCAbyg

3.1 Results

Under the tab **Results** a drop-down menu can be found which allows to shift between two/three 'tabs'/functions **'Quantities'** and **'Results'** can always be accessed, where the third option **'Building regulation'** only appears if the calculation type *Building regulation* is chosen.

The results are based on the data you entered within the first three tabs: **'Building and operation'**, **'Building model'** and **'Waste and transport'**, see Figure 3.1. Additionally you can **'Export'** your results and quantities to **Excel** or **JSON**, so that you can continue work in your desired format. Furthermore the **Detail window** shows the general data related to the chosen building component. In addition you can choose if you want to see the results in a 'Total' statement, or a statement 'per m^2', ' per m^2 per year' or the 'Normalized'.

The normalized results tells us, how big a share of an average world citizen's annual environmental impact on the building's total impact corresponds to. A normalized result of e.g. 604 person-equivalent GWP means, that the building's total potential greenhouse gas emissions over the total lifetime, corresponds to 604 peoples annual emission of green house gas. The normalization reference used is the CML 200, World 200 (Update April 2015). Conversion to person-equivalent is made on the basis of the world population for 2000 from data.worldbank.org.

Figure 3.1: Illustrates the tab 'Results'

In order to clarify the results page it is possible to open and close different rows in results, this is done by:

- By **left-clicking** the green boxes to the left, the individual elements, components and products are opened and closed representative as clicked on.

- By **right-clicking** the green boxes to the left all rows within the same category opens and closes.

3.1.1 The tab 'quantities'

The tab *'quantities'* displays both the entered quantity, the total quantity as well as the total weight of all the entered products production stages (A1-3). Furthermore the tab displays the lifetime for each product, uncertainty factor, and number of replacements for the product over the reference study period, see Figure 3.2.
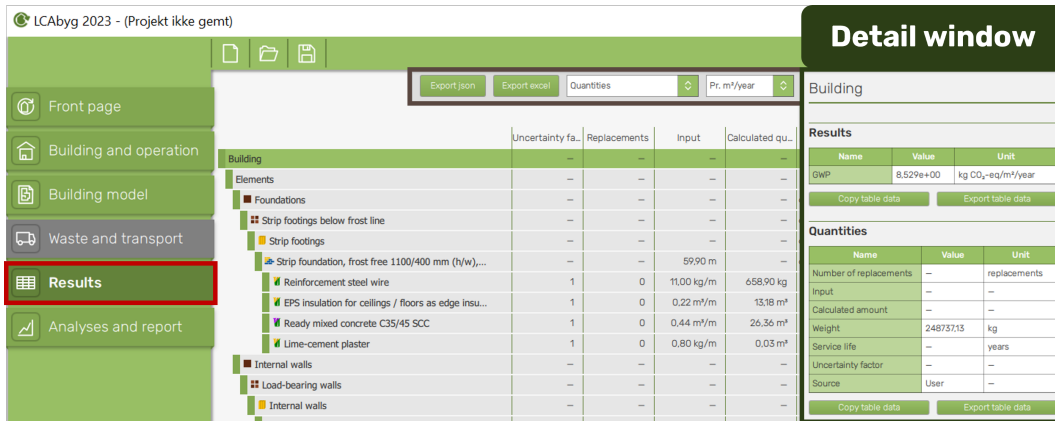

Figure 3.2: Illustrates the tab 'Results'

3.1.2 The tab 'results'

The tab *'Results'* displays the buildings total environmental profile. Since the requirement from 1 January 2023 exclusively focuses on GWP, this tab shows the result for GWP, with the option to see the other eight environmental impact categories LCAbyg supports, see Figure 3.3.
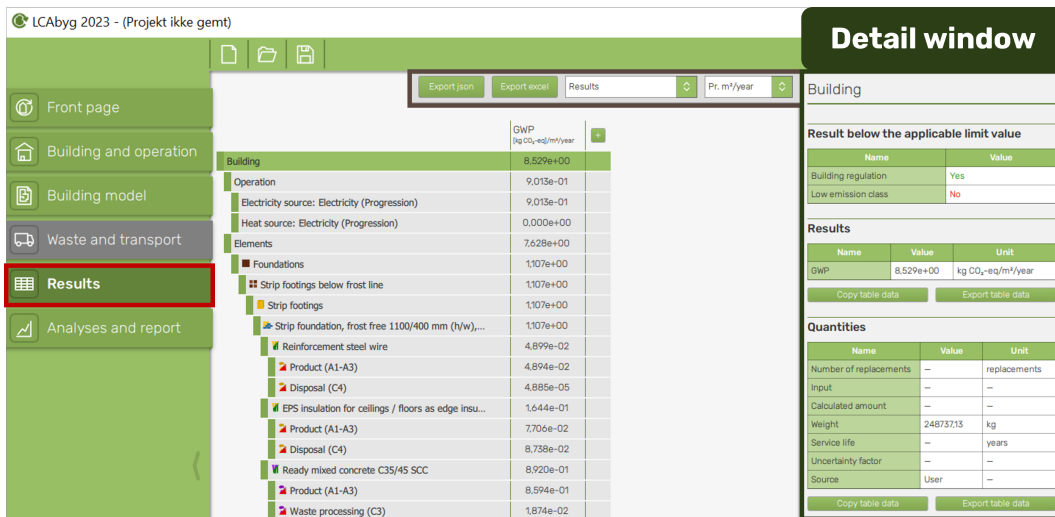
Figure 3.3: Illustrates the tab 'Results'

ATTENTION: When per m^2 is selected, the heated floor are is used for the calculation of the operation and the reference area is used for the actual products. Per year will always refer back to the reference study period for the building, that is entered under calculation prerequisites in the tab *'Building and operation'*.

The results in LCAbyg is rounded-off using the method *"Banker's rounding"*, that is the most stable numerical method used to rounding-off numbers, where *x,5* is rounded to the nearest even number. *Therefore it may happen that the result may vary due to this rounding method.*

Example 8,15 is rounded UP to 8,2 (since 2 is an equal number)

but 8,45 is rounded DOWN to 8,4 (since 4 is an equal number)

3.1.3 The tab 'Building regulation'

See annex H for description thereof.

3.2 Export to Excel and JSON

You can export all quantities and results from your project to Excel. Based on the export it's easier to see the full range of entered quantities and results and use these to prepare your own graphs. The same applies for exporting to JSON. You can read more about the JSON format in the LCAbyg's JSON guides, that can be downloaded from the same place as LCAbyg

ATTENTION: When changing the language, certain fields in the user created components may appear empty in the Excel extraction, this is because the components and products don't have naming in the language selected. When renaming components and products, names can be added to the construction in multiple languages. This is done by pressing the translation button.

3.3 3. Party integration

LCAbyg 2023 supports a number of integration flows, that the user can use, whether it's as a new user to LCAbyg 2023 or for the development of their own third-party integration to the program.

3.3.1 Excel lite

This is a tool that can help with quick entry of quantity to transfer into LCAbyg 2023.This makes it possible more quickly build a building model from GenDK component library. Excel Lite can be downloaded from the same place as LCAbyg 2023.

3.3.2 Json

It is possible to use the JSON-form as a third-party integration into LCAbyg 2023. This can be read about in a seperate guide, that helps to understand how the JSON format is used in LCAbyg 2023. The guide is in english. https://www.lcabyg.dk/da/bim-integration-da/

Chapter 4

ANALYSIS AND REPORT

In the 'Analysis and report' tab, it's possible to see the results of your LCA-environmental profile in pre-defined graphs, as well as save the results as a report, *'Export to Excel*, and *'Export to json'*, according to your preferred format.

4.1 Analysis and report

The last tab is the 'Analysis and report', here its possible to see your results in predefined graphs, as well as save to results as a report, *'export to Excel*, and *'export to Json'* according to your preferred format, see Figure 4.1. All results are based on the data entered in the firs three tabs: *'Building and operation', 'Building model' and 'Waste and transport'*.

NOTE: the graphs do not show the correct results, before clicking the individual graphs.

Figure 4.1: Illustrates the tab 'Analysis and report', accumulated graph

Under the tab *'Analysis and report'* many different types of diagrams is displayed, these can be used to get an overview of the model. The diagrams shows a number of predefined analysis. The analysis shows e.g. the *Accumulated results*, the ratio of *embedded and operation*, hotspot-anlaysis shown for the different stages, elements and material groups. Furthermore if the calculation type 'Building regulation' is used, the ratio between elements and the buildings environmental impact (CO_2-eq/m^2/year) is shown as well as the limit value requirement with reference to the building regulation (BR18), that were implemented from 1 January 2023, as well as the limit value for the low emission class.

For all the analysis, except the ones regarding the limit values, its possible to decide which of the nine environmental impact categories the diagram should show. By default the graphs will show the results for global warming (GWP).

For the Hotspot-analysis, it's possible to choose which level the diagram should sort after. The levels that can be selected is, *group, subgroup, elements, components, products,* and *stages*.

It is possible to export all graphs to .svg and .png as well as copy or export the underlying table data, so you can continue working with these, when clicking the different graphs.

4.2   Download report

You can export all quantities and results from your project to a predefined final report. The report provides an overview over the most significant information from the tab **Building and operation**, as well as the final results for the environmental impact shown throughout the tables. The report allows to document the environmental impact for a building and can be used as documentation in accordance to the new LCA-requirements from 1 January 2023.

Appendix A

BE18 KEY NUMBERS

A.1 KEY NUMBERS FROM BE18 TO ENTER FOR ENERGY INPUT FOR BUILD-ING OPERATIONS. (B6, D)

The annex explains how to enter results from the energy framework calculator (BE18) in LCAbyg.

Be18 key numbers for module B6
If module B6 is based on the theoretical energy calculation from BE18, results for the buildings energy requirements must be used. This requirement shouldn't be multiplied with the factor for primary energy, that is used to comply with energy demands in compliance with the building regulations. Therefore contributions to the energy demand for heat (1) and electricity to building operation (2) is enterd in the corresponding fields in LCAbyg.

Figure A.1: Key numbers from energy framework calculation (Be18) as a source for entering energy in LCAbyg

BE18 automatically subtracts any renewable energy production from these contributions to the energy demand. The energy production from e.g. solar cells or geothermal heating therefore doesn't need to be entered seperately in LCAbyg. However this only applies for the amount of energy production, that can be included in the energy frame in regard to SBi-instruction 213.

Exported electricity

Exported electricity must be entered separately, if the electricity production from solar cells exceeds the share, that can be factored in the energy framework according to the SBi–instruction 213 and that can be exported to the collective energy supply. This share is not directly reflected from Be18 results and should therefore be calculated as follows.

According to the building regulations guidance of the energy use 1.12, renewable energy production may only be included in the energy frame work with a maximum of 25kWh. This figure is covered with the factor of 1,9 for the electricity production cf. § 252, BR18. Since we need to calculate without energy factors, we must first calculate

---

The peritted amount of renewale energy production in the energy frame: $\frac{25}{1,9}$ *= 13,2 kWh/m^2/year*

Now we can find out whether the electricity production from solar cells is within or over the threshold by calculating:

Performance from solar cells (3) - 13,1 kWh/m^2/year

Any positive result constitutes the value entered in the field **Exported electricity** in LCAbyg.

Appendix B

ENTER EPD

B.1   EXAMPLE OF EPD ENTRY

It is important to have read the section Stages carefully before reviewing the entry. Furthermore it's important to have added a new construction or made an existing construction from the library editable you can see how this is done in the section Create a new project.

When entering an EPD, you mostly enter a product specific product that contains some stages, e.g. A1–A2 as well as C3 and C4. You therefore have to create a product where you can add the stages to. Make sure you give the product a name, so you know what EPD and what product from the EPD it is, so you can find the product again, and use it in the same project or export it and use in other projects.

In the following an EPD from EPD Denmark's website, that is an industry EPD for concrete elements reviewed. The EPD has the number MD–20015–DA and can be found here:
`http://www.epddanmark.dk/media/1261/md-20015-da.pdf`.

As can be seen from the chosen EPD and from figure 19, it consist of several product variations. When this is the case, it's important to figure out, which variation is the best match to the desired purpose, since this is crucial for following entries for the stages. Here the product variation '**15 cm tyk væg, 11% udsparinger, med 5–15 kg armering**' is chosen for further entry

Now open the window with create a new stage, see how in the section 2.2.4 Stages, to enter the information from the EPD

Deklareret produkt
1 m^2 vægelement, med 11% udsparinger.

EPD'en er udarbejdet på baggrund af vægtede gennemsnitsdata fra flere producenter (average product, Industry level). Producenterne som leverer data til EPD'en dækker ca. 84% af den samlede danske produktion af vægelementer.

Antal deklarerede datasæt/produktvariationer: 3
15 cm tyk væg, 11% udsparinger, med 5-15 kg armering
20 cm tyk væg, 11% udsparinger, med 5-15 kg armering
20 cm tyk væg, 11% udsparinger, med 16-25 kg armering

Figure B.1: Illustrates that there can be several declared products, ad for the industry EPD, chosen from the review of EPD entry

B.1.1 STEP-BY-STEP GUIDE FOR EPD ENTRY

When entering an EPD, you enter what in the program is called stages. The entry of stages is divided into 2 information levels, if you can call it that. The first part is a more general entry, this is where information such as FU (functional unit) is entered, and other information such as the EPD's calculations and what the benchmark is based on. This information is also explained in the table below. The last part of the entry, is the indicators, which LCAbyg's further calculations are based on. The indicators are the results of the EPD, and is often found in the end of an EPD. What to enter where, can bee found in the end of section Stages.

GENERAL	
Make sure that the entry of the name of the phase allows you to quickly know which phase it is, and possibly which EPDD it belongs to. The groups are indicated according to construction knowledge. If there is no matching group, select the closest one	
Name	15 cm thick concrete element (A1-A3) branch EPD MD-20015-DA
Main group	Mineral building materials
Middle group	Mortar and concrete
Subgroup	Concrete
Fase*	A1-A3

For the entry in the last fields of *'general'* use the following table from the EPD (page 4). It is extremely important that the indicator unit, indicator factor and mass factor are the same as defined in the EPD.

Name	Value			Unit
	15cm, 5-15	20cm, 5-15	20cm, 16-25	
Declared unit	1	1	1	m^2
Mass	320,9	426,4	433,9	kg/m^2
Conversion factor to 1 kg.	0,003116	0,002345	0,002305	-

Phase unit	m^2	Selected from a future entry perspective
Indicator unit	m^2	Blue highlighting of the above table/image from the EPD page 4.
Indicator factor	1	
Masd factor	320,9	Purple highlighting of the above table/image from the EPD page 4
Unit factor	1	-

* If there are several stages, a new entry is made per stage. The information entered in general MUST be the same for each EPD regardless of stage. However, remember that no two stages in a construction product must be the same, e.g. there must not be two C3 stages.

Appendix C

IMPORT OF LB5EPD files (EPD Denmark)

C.1   IMPORT OF EPD'S

In 2020 and 2021 BUILD and EPD Denmark started a collaboration under the project name *'Faktabaseret valg af materialer til fremtidens byggeri - Kvalificering af miljødata i byggeriet'*. The purpose of the project were mainly to make it easier for the users to use specific environmental data instead of generic environmental calculations. Based on one of the work packages it's now possible to download -lb5epd files from EPD Denmark website and import them into LCAbyg. This applies for LCAbyg 5.1.0 and newer, although older versions may not work as well as the latest.

In the latest version of LCAbyg, LCAbyg (v5.3.1.0) it's now also possible to import EPD's from other providers via the ILCD+EPD format, as well as import EPD's from local utilities. See how to obtain EPD's from the ILCD+EPD format under section D.

C.1.1   PROCEDURE DESCRIPTION

The collaboration between BUILD and EPD Denmark makes it possible to import EPD's from EPD Denmark and thereby avoiding many uncertainties and human errors that can occur by manual entering. Additionally EPD entering can be time consuming, which is expensive. All these factors are remedied through this project. It's only EPD's at EPD Denmark that are of the format .lb5epd format that kan be imported that is illustrated in figure C.1.

As visualised in Figure C.1, the EPD's from EPD Denmarks is converted to a .lb5epd file. The file is encrypted the same way as the generic (GenDK) database in LCAbyg, which means all files are locked with the source e.g. EPD Denmark and must be handled the same way as GenDK components when editing. The encryption means that the EPD's data is verified by the provider exactly as when using their PDF files, however neither the provider nor BUILD is responsible for the use of data and thereby sources of error. The LCAbyg user is responsible for using valid and correct data.

STEP 1	Make sure you have an open project, since the EPD's are project dependant and must be imported every time you open/create a new project.
STEP 2	Click on files (paper icon) in the top left corker, and choose *Import EPD Denamrk EPD's*. see Figure C.1.
STEP 3	Choose the EPD to import.
STEP 4	Find/ass the EPD to the library, under product or stages, or as source of supply '*Energy consumption and supply*' dependent of the EPD's system boundary. See the section Building model for further description about adding products and stages.

ATTENTION: When **importing** product EPD's, they are placed under library in LCAbyg. You can find the imported EPD's by searching for the source of the given provider e.g. EPD Denmark. Furthermore, please note that the EPD'S are either transferred as product or stages, this depend on the system boundary and content of the EPD's.
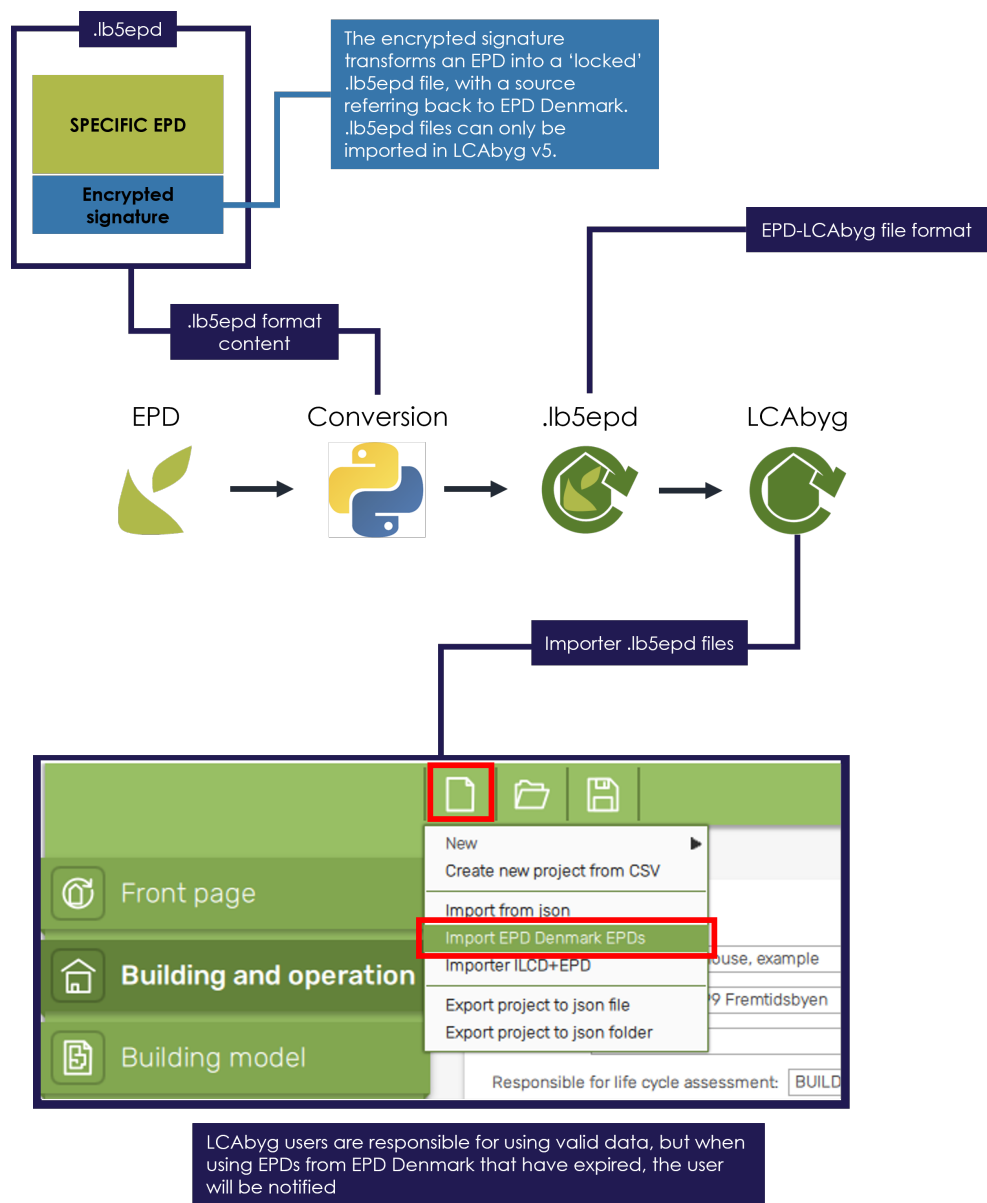
.lb5epd

SPECIFIC EPD

Encrypted signature

The encrypted signature transforms an EPD into a 'locked' .lb5epd file, with a source referring back to EPD Denmark. .lb5epd files can only be imported in LCAbyg v5.

EPD-LCAbyg file format

.lb5epd format content

EPD   Conversion   .lb5epd   LCAbyg

Importer .lb5epd files

Front page

Building and operation

Building model

New
Create new project from CSV
Import from json
Import EPD Denmark EPDs
Importer ILCD+EPD
Export project to json file
Export project to json folder

ouse, example

9 Fremtidsbyen

Responsible for life cycle assessment: BUILD

LCAbyg users are responsible for using valid data, but when using EPDs from EPD Denmark that have expired, the user will be notified

Figure C.1: Procedure desription of import of EPD's from EPD Denmark intro LCAbyg v5

Appendix D

IMPORT OF ILCD+EPD FILES

D.1   IMPORT OF ILCD+EPD FILES

It is now possible to import Environmental Product Declarations, also know as EPD's published in ILCD+EPD format. The option is available from the LCAbyg 2023 (5.3.1.0) version.

EPD's published in ILCD+EPD format, can be found with the program operators such as EPD Norway, or through common databases, such as ECP platform - ECO Portal. From the 23 december 2023 it's possible to load EPD's in ILCD+EPD format. *The available program operators are regularly updated, see section D.1.3*.

D.1.1   BEFORE YOU START

LCAbyg "reads" the ILCD+EPD format by checking for necessary information, set by the requirements for the program, i.e. in the same way, as if the EPD were to be entered manually. Since the ILCD+EPD format, is a digital format, users of LCA will experience that EPD's from an otherwise available program operator, that is defined under section D.1.3 can't load in LCAbyg. This occurs, since the file is discarded due to lack of data. As a user of LCAbyg it may be necessary to manually enter these EPD's.

EPD's loaded through the ILCD+EPD format is encrypted in the same way, as the generic (GenDK) database in LCAbyg, which means the files are locked with the source of the program operator it originated from, e.g. EPD Norway and therefore needs to be handled the same way as GenDK components when editing. The encryption means that the EPD's data is in some way verified by the provider exactly as when using the pdf files, however, neither the program operator nor BUILD is responsible for the use of data and thus any sources of error that may exist when using the files in the ILC+EPD format. The LCAbyg user is responsible for using valid and correct data, so just for the record, it is advised to check the data used.

D.1.2   PROCEDURE DESCRIPTION

It is possible to import EPD's in the ILCD+EPD format by following the step-by-step guide below and Figure D.1, or by watching the short LCAbyg tutorial on LCAbygs YouTube canal, Import of ILCD+EPD files.

Figure D.1: How ILCD+EPD files (XML) are found and copied

STEP 1	Make sure you have a project open, since the EPD's are project dependant and have to be imported every time you open/creates a new project.
STEP 2	Click on files (paper icon) in the top left corner, and choose *"Import ILCD+EPD"*.
STEP 3	Find the EPD you want to import and check to see if the XML format exists.
STEP 4	Hover your mouse over the XML format and right-click. Then choose **Copy link**. See Figure D.1.
STEP 5	Insert the link ind the box available in LCAbyg, by selecting **Import ILCD+EPD's** and press **Import**.
STEP 6	LCAbyg will inform the user if the file was imported o if there was a problem. *If LCAbyg gives an error message, the EPD must be entered manually.*
STEP 7	EPD's can now be found in the library. **ATTENTION.** Depending on the system boundary of the EPD, the EPD is found either with the source **User** or **program operator source** e.g. EPD Norway. See under the section F.2 for further description on adding products and stages.

ATTENTION: The digital EPD format, ILCD+EPD, is found under the filename XML.

D.1.3   AVAILABLE PROGRAM OPERATORS IN THE ILCD+EPD FORMAT

It is continuously updated with the program operators that can be imported into LCAbyg via the ILCD+EPD format.

EPD-Norway Digi	Available from 23. December 2022

OBS: All digital EPD's from the list above can also be imported from ECO Platform - ECO Portal.

Appendix E

SPECIAL BUILDING CONDITIONS

E.1 SPECIAL BUILDING CONDITIONS

With LCAbyg 2023 version 5.3.0.0 and later versions it is now possible to add special building conditions, when working under the calculation type 'Building regulation'. If you want to model a LCA for documentation to the building regulations, you must choose **Building regulation** under calculation type, that is placed in the tab *Building and operation*. When this mode is selected, some features will be locked and new ones will appear.

In the calculation type 'Building regulation' it's possible to add special condition for constructions in the building, which entail an increased climate impact due to documentable special building conditions. The definition of a documentable special condition and the calculation model to determine the increased climate impact appears from §298(4) in the building regulation (BR2018).

E.1.1 ADD SPECIAL BUILDING CONDITIONS

Specialconditions is added to a project under 'Building and opreation' with the button *Add/edit special building conditions* see Figure E.1.
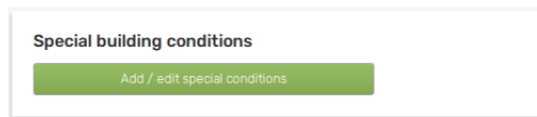
Figure E.1: Shows how special building conditions are added or edited in a LCAbyg project.

When the green button is pressed, a pop-up window occurs, where information regarding the construction special building conditions can be entered, see Figure E.2.

Figure E.2: Shows pop-up window for entry of information regarding the constructions special building conditions.

To identify what constructions are subject to special condition, the field *special condition* is activated for the construction, see Figure E.3.

ATTENTION: Constructions **MUST** be added under a product, that is connected to the correct group and subgroup
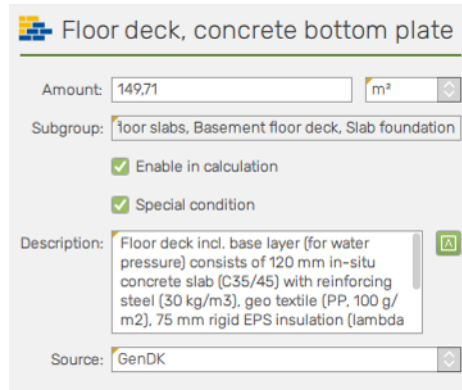
Figure E.3: Shows where special condition is activated for a given construction.

STEP 1	Go to the menu tab *Building and operation* and add special conditions with the green button, see Figure E.1.
STEP 2	Choose the group and subgroup that the construction with special building conditions belong to, enter the amount of the construction, and write documentation that the construction has special building conditions that justifies, that the buildings climate impact exceeds the limit value in the pop-up window.
STEP 3	Ceck if the enterd quantity for the construction in Step 2, matches what is entered in 'Building and operation'. If the amount isn't entered correctly both places, the result for the additional climate impact deviate from the real result.
STEP 4	Go to menu tab *Building model*, click on the given construction og turn on *special building conditions*, see Figure E.3.

E.1.2   CALCULATION OF ADDITIONAL CLIMATE IMPACT

When special building conditions are added to a project, LCAbyg calculates an additional climate impact, that appears in results. The additional climate impact that the special condition may cause, is calculated as the difference between the actual calculated climate impact from the construction and a reference value for the given construction. The reference vales can be seen in Table E.1. The report behind the preparation of reference values and the calculation model used to determine the additional climapte impact can be read here: https://vbn.aau.dk/da/publications/co2-krav-og-s%C3%A6rlige-bygningsforuds%C3%A6tninger-udformning-af-model-ti

CONSTRUCTION	UNIT	REFERENCE
Floor decks	kg CO_2-eq/m^2 construction/year	1,30
Floor	kg CO_2-eq/m^2 construction/year	0,65
Ceiling	kg CO_2-eq/m^2 construction/year	0,45
Internal wall	kg CO_2-eq/m^2 construction/year	1,03
Roof	kg CO_2-eq/m^2 construction/year	3,00
Ground floor slab	kg CO_2-eq/m^2 construction/year	2,27

External walls	kg CO_2-eq/m² construction/year	2,85
Columns and beams	kg CO_2-eq/m columns/beam/year	0,47
Foundation	kg CO_2-eq/m² gross floor area/year	1,06

Table E.1: List of reference values, that is used to calculate the justified additional climate impact under special building conditions.

The additional climate impact is calculated with the same unit as the limit value, which is kg CO_2-equivalent per square meter gross floor area, if this is valid for the construction, per year seen over a 50 year consideration period. Thus the calculation depends on the buildings total gross floor area or reference area. The additional climate impact is calculated as follows:

$$\frac{x/50 \text{ year} - r \times m}{e} > 0 \qquad \text{(E.1)}$$

where:

x = CO_2-equivalent from the building construction in mind with documentable special building conditions in kg CO_2-eq

r = reference value for the given construction in kg CO_2-eq/m² construction/year

m = quantity of building construction in m² construction or m² gross floor area

e = gross floor area or reference area in the building in m²

ATTENTION: If the result of equation E.1 is less than 0, it indicates that the construction in question isn't problematic, and the additional climate impact cant be determined. In this case a result won't appear under the tab 'Results' for the group, that the construction is placed under.

The additional climate impact for columns and beams with documentable special building conditions, is determined differently than the remaining building constructions. The additional climate impact for columns and beams can be determined as follows:

$$\frac{r \times m}{e} \qquad \text{(E.2)}$$

where:

r = reference value for columns and beams in kg CO_2-eq/m construction/year

m = quantity of columns and beams in m columns or beam

e = gross floor area or reference area in the building in m²

E.1.3   DISPLAY OF INCREASED ADDITIONAL CLIMATE IMPACT

Under **'Results'** the additional climate impact will appear for each element group, where there is special building conditions (brown marking on Figure E.4). If there are multiple special building conditions in the project where additional climate impacts can be calculated, will these be summed for all the elements (blue marking on Figure E.4).

	GWP [kg CO$_2$-eq]/m²/year	+
Building	1,229e+01	
∟ *Additional climate impact cf. § 298*	1,915e+00	
Operation	9,013e-01	
Electricity source: Electricity (Progression)	9,013e-01	
Heat source: Electricity (Progression)	0,000e+00	
Elements	1,139e+01	
∟ *Additional climate impact cf. § 298*	1,915e+00	
■ Foundations	4,869e+00	
∟ *Additional climate impact cf. § 298*	1,915e+00	
▦ Slab foundation	3,762e+00	
∟ *Additional climate impact cf. § 298*	1,915e+00	

Figure E.4: Display of results for special building conditions 'additional climate impact' in accordance to §298 (4)

Appendix F

SCENARIOS IN LCABYG

F.1 CREATE SCENARIOS

It is now possible in the new LCAbyg to work with several scenarios in a project. It is thus possible to work with different calculation assumptions for each scenario. Implying that the buildings dimensions, calculation type, commisioning year, amount of soil excavated and energy needs for operation and on construction site, building model, waste and transport can be changed independently of the different scenarios.

F.1.1 CREATION OF SCENARIO

Scenarios is activated under "Building and operation" with the button *Click to activate scenarios for this project* see Figure F.1.

Scenarios

Click to activate scenarios for this project
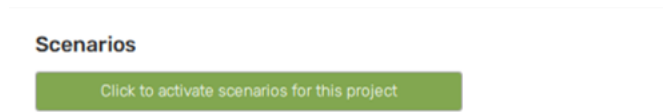
Figure F.1: Shows how scenarios is activated in a LCAbyg project.

When scenarios is activated, a tab will bee added in the bottom of LCAbyg (like you see in Excel). It is through these tabs that you can browse through the scenatios. When scenarios is activested, an exact clone of the orgiginal project is made. Blank scenarios can then be added and renamed.

ACTIVATE SCENARIOS
ATTENTION: When scenarios is activated in LCAbyg, an exact clone of the project is created, so make sure all essential information is already in the project. Of course there can always be added to the scenarios afterwards. Scenarios can be deactivated by deleting the created scenarios.

STEP 1	Create or open an already existing project.
STEP 2	Go to the tab *Building and operation* and activate scenarios with the green button, see Figure F.1.
STEP 3	Tabs are created with the original building model, as well as an exact clone in the bottom of LCAbyg. The tabs and thus the scenarios will alway be available/visible no matter what tab you are in.

CREATE AN EMPTY SCENARIO
ATTENTION: This function is only available when scenarios are activated, and more than one scenario exists.

STEP 1	Make sure scenarios are activated.
STEP 2	Right click on an arbritrary scenario (these tabs) in the bottom of the screen og press *Create new scenario*.

F.2 BUILDINGMODEL

When scenarios are activated, will there in the tab *Building model* be added a pane to the detail window to the right, see Figure F.2 and F.3. This "scenario-pane" will be available on all component levels, and will first be deactivated when the scenarios is deleted. In the "scenario-pane" it's possible to remove or add components to a new scenario, it's here you can start creating e.g. renovation scenarios. It is possible to independently activate or deactivate components in each scenario. If a component is deactivated in a scenario, it will disappear from the building model in this scenario. It can be activated again with the function buttons or y activating it for the scenarios for which you want it to active.
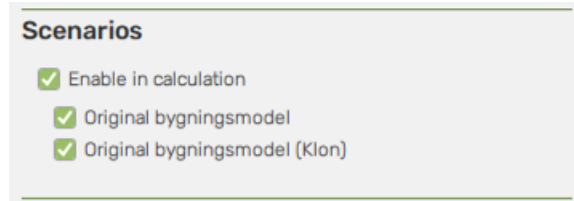
Figure F.2: Scenario-pane that is activated with scenarios.

For GenDK components, the same as always applies for "locked" components, that you cant change the product, if e.g. the construction is locked. This is illustrated by the "scenario-pane" is grey instead of green, see Figure F.3. However you are free to "include" component that are "user-created" for all scenarios.
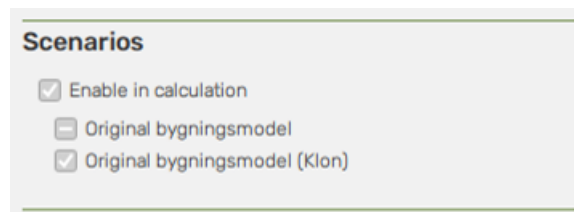
Figure F.3: When the scenario-pane is grey, it's because e.g. the product belong to a GenDK ('locked') construction. The construction must be cloned, before it can be changed in the products that is in the scenarios

F.3 RESULTS, ANALYSES AND REPORT

In the tab *Results* and *Analyses and report* it is possible to change between the scenarios that have been created in the project, and see their quantities, results and associated graphs. When scenarios are activated an extra diagram is shown in "Analyses and report", in this it's possible to see the difference in environmental impact from the scenarios that have been created, and for all nine environmental impact categories. This diagram can be sorted after stages as well as operation and so on. If you choose to export to JSON, Excel or generate a report, the files will be created based on the scenario that is open. If you want a result extract from all scenarios as a part of a project, you have to generate Excel files for each scenario.

Figure F.4: By activation of scenarios, a pane is added to the detailwindows under the tab building model.

Appendix G

RENOVATION PROJECT

G.1   CREATION OF RENOVATION PROJECT

LCAbyg 2023 gives the opportunity to work with existing buildings volumes in e.g. renovation of buildings. In its current state LCAbyg can generate case buildings for EB1. Older brick apartment building (1850-1920). When creating a new project with case EB1, you are asked to enter 8 parameters so that LCAbyg can generate aa accurate a model as possible for calculation and comparison. See Figure G.1.

Footprint [m^2]	Footprint of the building.
Number of stairways [pcs]	Number of stairways in the building.
Storeys above ground [pcs]	Number of floors above ground.
Roof type pitched roof	roof type pitched roof, mansard rood or Københavner roof.
Rood cladding	Non-glazed tile, slate or zink.
Utilised roof	If the roof is utilised as living area
Basement	Is there a basement in the building.

Figure G.1: Shows how Renovation projects are created.

G.1.1 CASE BUILDING

The generic case is determined from a study of 6 representative brick apartment buildings from four neigh-borhoods in the greater Copenhagen area (Amager, Vesterbro, Nørrebro, Østerbro) as well as knowledge from Engelmark, J. (1983) "Københavns etageboligbyggeri 1850-1900. En byggeteknisk undersøgelse" a SBI-report 142. The six cases where first studied in drawing and then used to calculate a median of pa-rameters. To calculate interior volumes a module is defined as a living space, a main stair and a back stair. The mean values is then cross-checked with the mapping in the literature. For the existing construction the function of demolition i deactivated, to remove the production stage from the calculations. Products in the existing constructions are pre-defined with delayed stat, it is set to the same amount of years as the products service of life, so that replacement of existing buildings doesn't happen automatically. If parts of the existing building has to be changed in the renovation, delayed start can be changed.

G.1.2 CASE ENTRY

Based on mapping of the building type, the following are defined: - Building depth - Storey height - Base-ment, storey height - Wall thicknesses - Roof quantity - Quantity per stairwell - Floor seperators - Doors and windows - Inner walls

Further information on the structure of the model generation can be read: https://vbn.aau.dk/da/publications/automated-life-cycle-inventories-for-existing-buildings-a-paramet

G.1.3 CONSTRUCTION EXISTING BUILDINGS

In order to work with renovations, in the constructions library, is existing constructions added with the naming Ex e.g. Ex. Teglmur 110 mm (1/2 sten). For existing constructions, the function demolition is activated to remove the production stage from the calculations. Products in the existing constructions are pre-defined with delayed stat, it is set to the same amount of years as the products service of life, so that replacement of existing buildings doesn't happen automatically. If parts of the existing building has to be changed in the renovation, delayed start can be changed to 0 years.
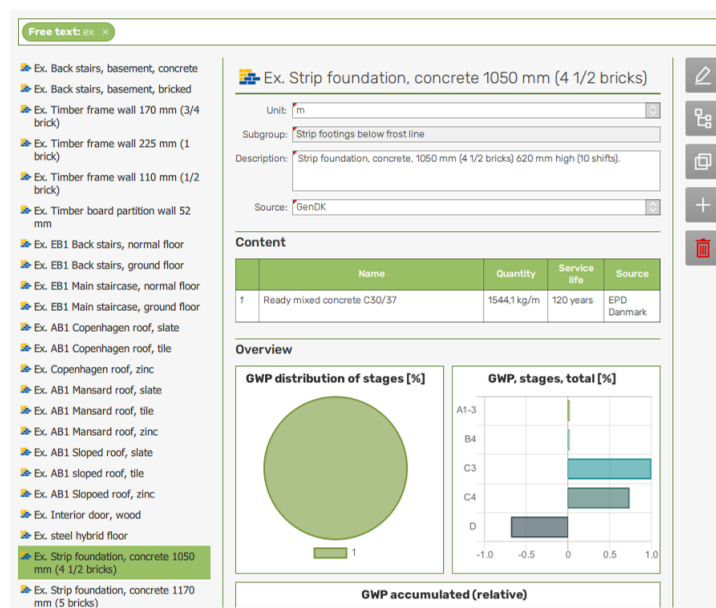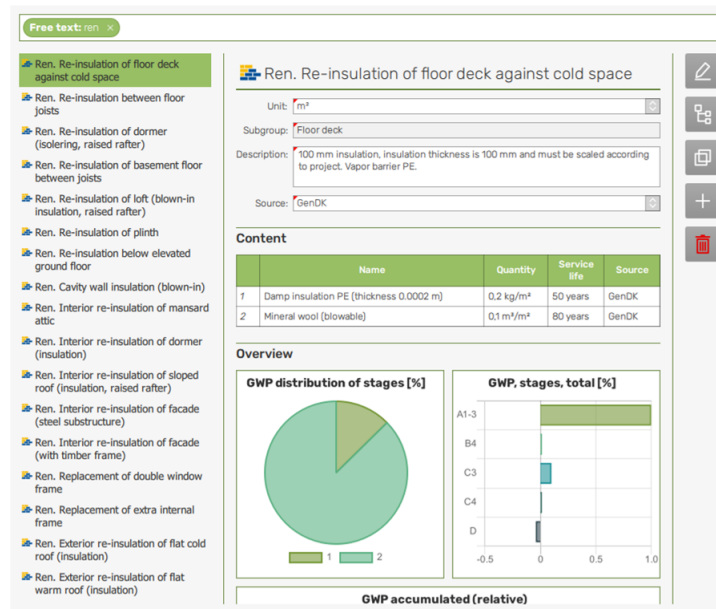

Figure G.2: Shows how existing constructions can be found.

G.1.4 CONSTRUCTION RENOVATION

The library for renovation contains examples of typical renovation measures for existing buildings. The initiative must be scaled according to the project and can be adapted to project specific wishes. These constructions start with Ren. e.g. Ren. Udvendig efterisolering af ydervæg med ventileret facade (træskelet).
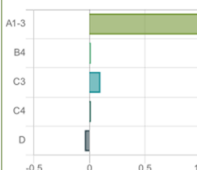
Figure G.3: Shows how renovation constructions can be found.

Appendix H

BUILDING REGULATION RESULTS

H.1 THE BUILDING REGULATION RESULTS PAGE

When the calculation type 'Building regulation' is chosen, placed under the tab **Building and operation**, it's possible to chose "buildings regulation" in the drop-down menu under the tab **Results**. Here relevant results for documentation to the buildings regulation will be shown.

Here results are shown for the actual building, the buildings resutls regarding the building regulation and the current limit values, see Figure H.2 and Figure H.1. Here information regarding any special building conditions in the project will be shown as well (see more in section E). (Figure H.2)
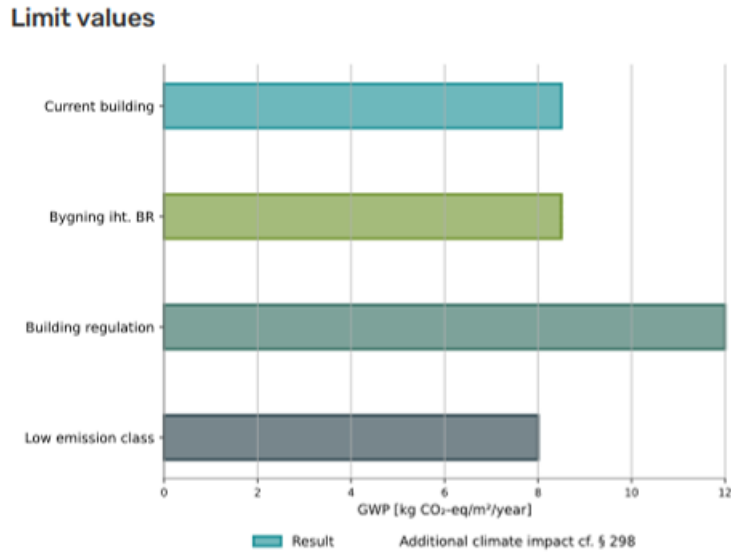

Figure H.1: Illustrates diagram for limit values

Figure H.2: Illustrates the results compared to the building regulation, as well as results divided into modules

In the table below H.1 the results shown in the result display in LCAbyg is described, which can be used as documentation in connection with the building regulations requirements for the climate impact of buildings.

Total climate impact (A1-3, B4, B6, C3-4)	The actual result for the current building. The result is the sum of all life cycle modules A1-3, B4, B6 and C3-4 per square meter reference area per year from a consideration period of 50 years. This result includes the additional climate impact from any special building conditions. The result appear on the bar chart as 'Current building'.
Increased climate impact	Here the sum of the increased climate impact for the total project is shown. This results is determined in accordance with §298 (3) and (4) in the building regulation and summed. The increased climate impact appear on the bar chart as dotted marking.
Total climate impact excl. additional climate impact	Here is the results for the building, without the additional climate impact. This result is used to evaluate if the buildings climate impact is above or below the limit values in §298 (1) and §297 (2)
Life cycle modules A-D	Here the results for the building is calculated by life cycle modules. This results is documented in accordance with §297 (2)

Table H.1: The table describes results relevant to the building regulations documentation requirements.

H.2   REPORT EXTRACT AS DOCUMENTATION

In the tab **Analyses and report** its possible to export the project to a PDF file. In the PDF file there's an overview of the projects results 'Overview', that can be used as documentation according with the building regulations requirements. From the overview the following information will appear: General information about the project, current calculation assumptions, limit values according to BR18 (results), relevant areas according to BR18, building operation, any special building conditions according to BR18, results per life cycle module according to BR18 as well as technical information regarding LCAbyg.

Appendix I

THERMS AND CONDITIONS FOR USING LCABYG

I.1 TERMS AND CONDITIONS FOR USING LCABYG

The LCA-tool and associated documentation is developed by BUILD - *Institut for Byggeri, By og Miljø*, at Aalborg University. The LCA-toll is for use for consulting engineers, architects, contractors and other consultants, that work with design of buildings. It is presumed that users of the LCA-tool has the necessary knowledge of LCA as well as construction, including building technical knowledge of the rules and legislation for buildings, including relevant regulations in the building regulation and in standards.

The LCA-tool has been developed on the basis of knowledge and technology available for BUILD at the time of carrying out the work. BUILD is without any liability, if later development should show that BUILDs knowledge and technology was deficient or incorrect at the time of the work. The LCA-tool is continuously being updated with new versions. It is always the individual user that has the responsibility of using the latest version.

BUILD is not responsible for errors and omission in the LCA-tool, except for errors and omission that may be due to gross negligence or wilful misconduct on the part of BUILD. BUILD assumes no liability for calculations, that is made with the LCA-tool or the results thereof, and BUILD can not be held liable for direct or indirect losses, consequential damage, lost earnings or other consequential losses as a result of calculations made with the LCA-tool. Operating losses, loss of data, disabling of software or other indirect losses, as well as consequential damage that may result from the use of the LCA-tool, are not compensated.

In relation to third parties BUILD is free from liability, and you as a user are obliged to, in all respects to indemnify BUILD for claims against the user from third parties in connection with the use of the LCA-tool.

As a user you may only copy the LCA-tool, in the extent necessary for the operation and security of the program. The LCA-tool may not be redistributed to third parties.

When publishing the results of the calculation made with the tool, as well as by written or oral reference to the LCA-tool, the user is obliged to refer to BUILD. The user also commits to refer interested third parties to the LCA-tool and to BUILD.

As a user by using the LCA-tool you accept the above terms and commit to comply with them.