Living Places

Active House Radar

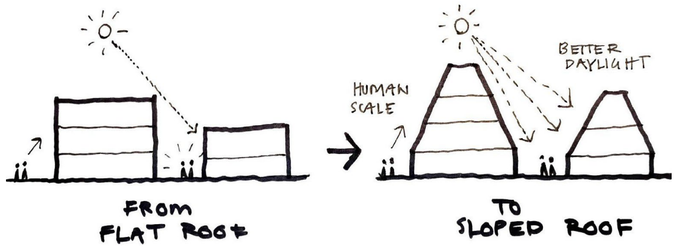
Evaluation of comfort, energy and environment

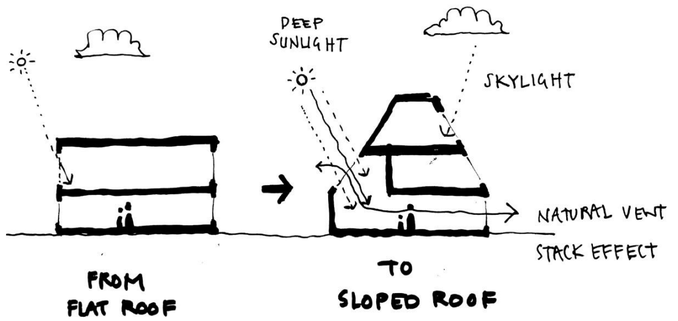
EFFEKT, Artelia, VELUX, and Enemærke & Petersen, Politecnico di Milano

Photo: Adam Mork

Living Places

As we spend 90% of our lives indoors, buildings directly affect our physical and mental health. We should focus on creating a better living environment for our planet and a path towards a future-oriented society that enhances living conditions for people and the planet. This article describes the Living Places project's process of creating its Active House radar. Living Places is a building that combines energy efficiency with a focus on user comfort in terms of well-being and health by optimising the indoor climate while respecting the environment. The application scope of the Active House 3.0 specification to this building aligns with Build for Life's ambitious goal to build a long-term legacy of pioneering healthy buildings of tomorrow. The building reflects the vision behind the Active House and stands as an innovative technical guideline while introducing objectives of architectural quality, environmental design, and energy efficiency. It is centred around regenerative design principles through carefully selecting materials, building techniques, utilities, and design configuration of indoor and outdoor spaces.





The project showcases a new way of thinking where all phases of the building development are considered for pioneering and experimentation, insight for cities, architects, and developers. Ideated and under continuous developments based on the Build for Life compass, Living Places in Copenhagen is a collaboration between EFFEKT, Artelia, VELUX, and Enemærke &Petersen, envisioning an open-source development model that enables a new holistic approach to sustainable construction by factoring in the entire life-cycle.

Living Places is based on five principles of healthy, shared, flexible, adaptive, and scalable to inspire and vehicle a new way of living, enabling people to understand their home as a frame for health and well-being.

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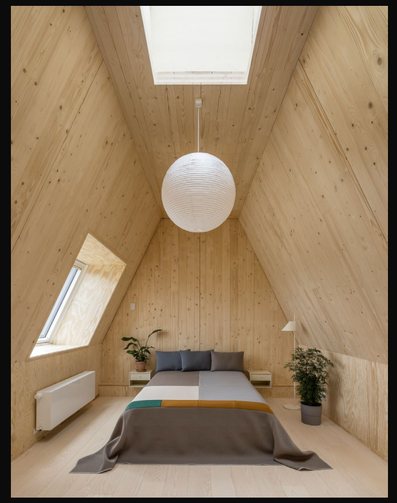
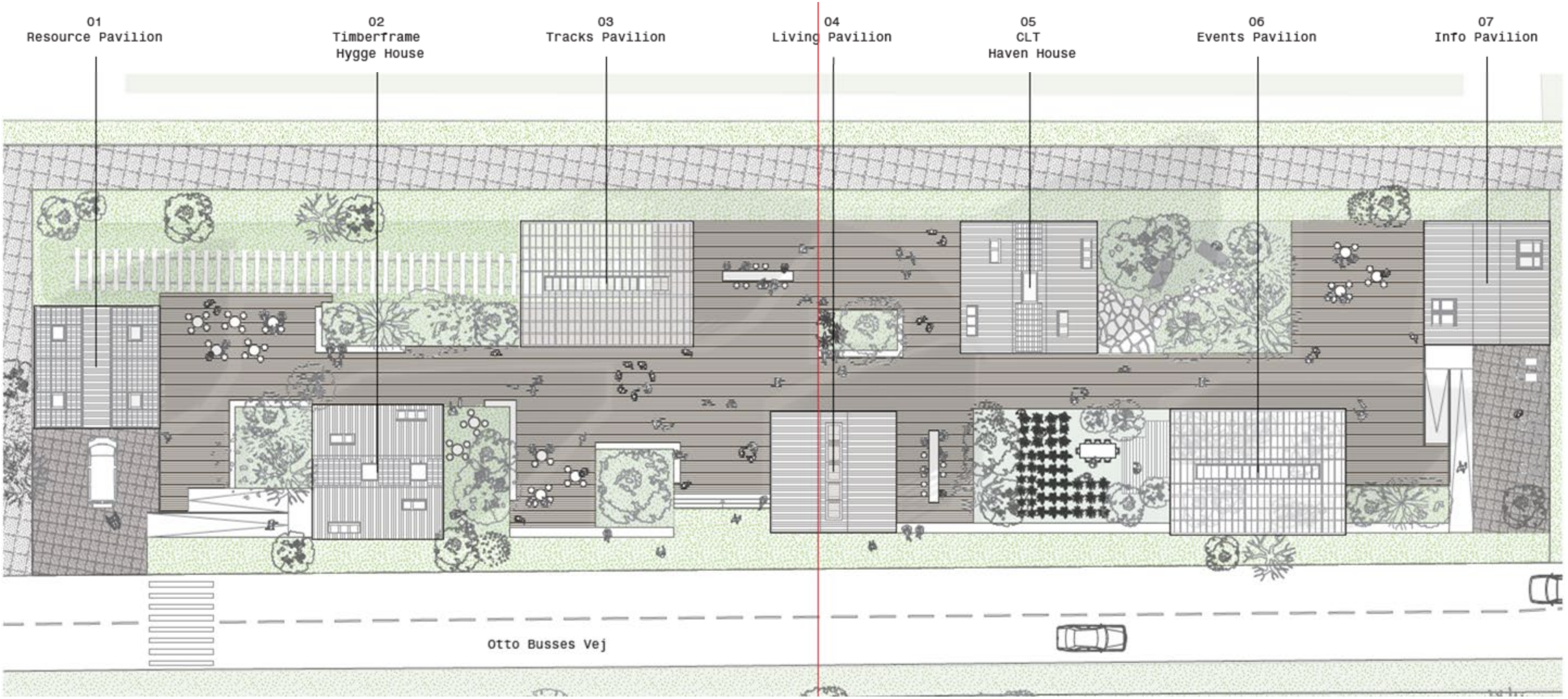
Project Concept

Project Site

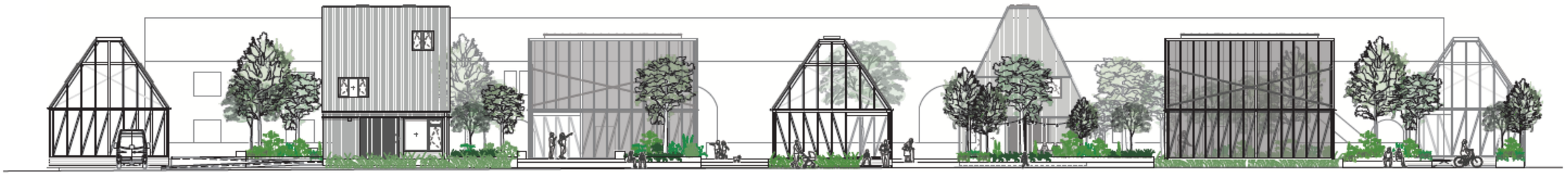
This report describes the design strategies and performances of the two Living Places built for test and inspirational purposes in the Jernbanebyen area in a plot size of 2230 m², where the outdoor area is 1690 m². They will be de-constructed after 3-5 years and placed somewhere else subsequently. Here, the showcases closed volumes occupy 260 m² and the open pavilions 420 m², while the built area is 680 m² in total.



Project Siteplan



Project Elevation

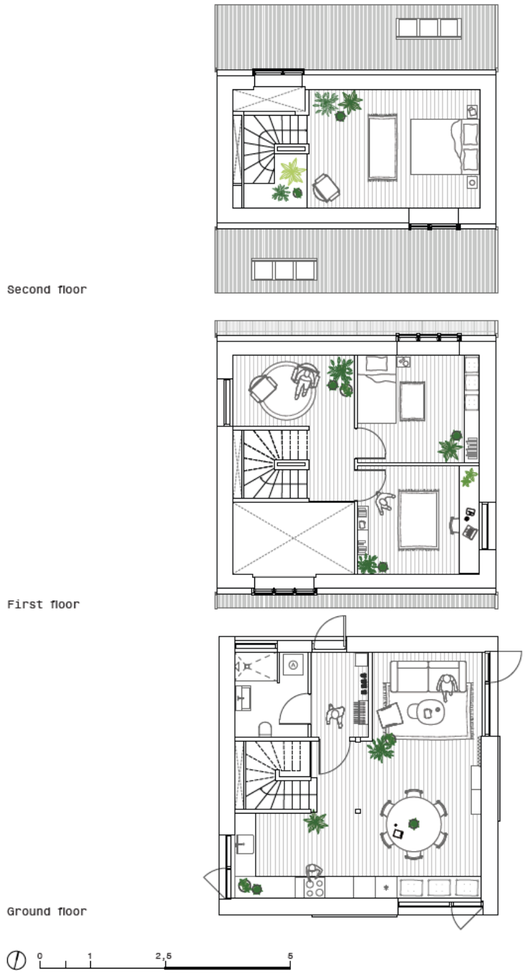


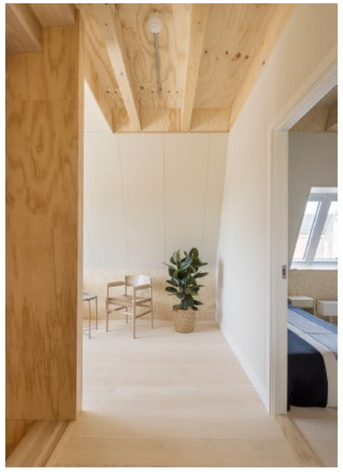
South elevation

North elevation

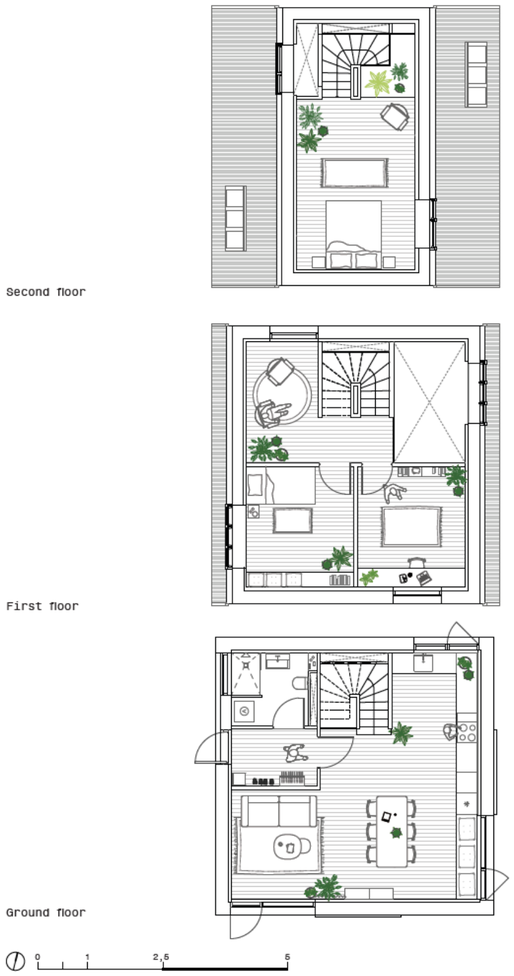
0 2 4 10 20

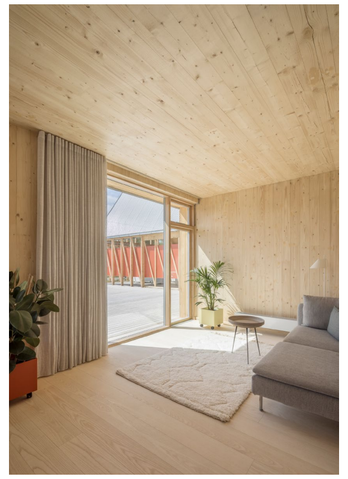
Hygge House

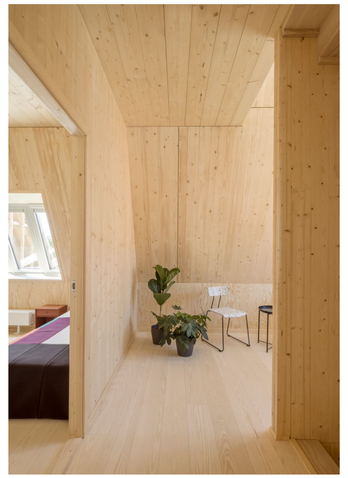




Haven House



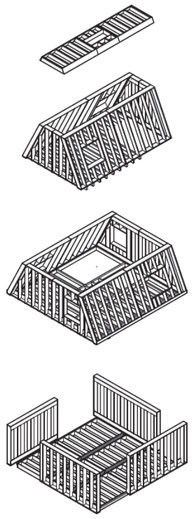




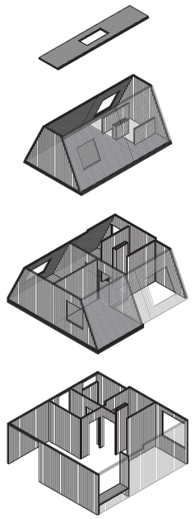
Technology

Photos: Adam Mork

Building systems



Timber Frame Construction



CLT Construction

The building typology is residential. The building technologies of the two Living Places buildings are timber frame construction and cross-laminated timber (CLT).

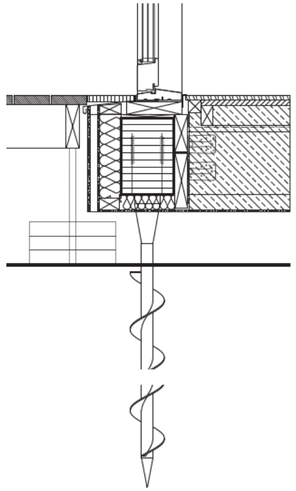
The buildings are developed in three levels for a net floor area of 147 m² and a room height of 2.6 m.

They comprise a kitchen, living room, cabinets, storage, three bedrooms, a studio room, and technical space.

The buildings are designed to create high-quality homes at a reduced price.

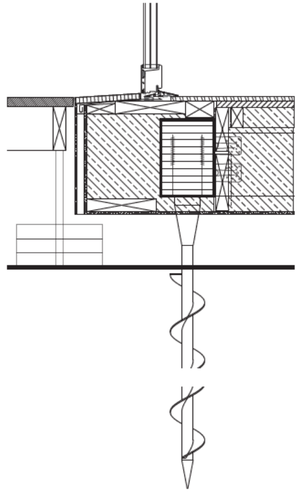
Foundation / Ground slab

Hygge House
Timber Frame construction



- Floor treatment with Indoor climate certified oil
- Ask plank floor with click system, 15x185 mm
- Spruce battens, 50x70 mm
- Vapor barrier, 0,20 mm
- Pine structural timber C18, 45x295 mm
- Cellulose insulation, 375mm. Fire class: B-s2, d0
- Hard wind barrier, 8 mm

Haven House
CLT construction



- Floor treatment with Indoor climate certified oil
- Ask plank floor with click system, 15x185 mm
- Spruce battens, 50x70 mm
- Vapor barrier, 0,20 mm
- Pine structural timber C18, 45x295 mm
- Cellulose insulation, 375mm. Fire class: B-s2, d0
- Hard wind barrier, 8 mm

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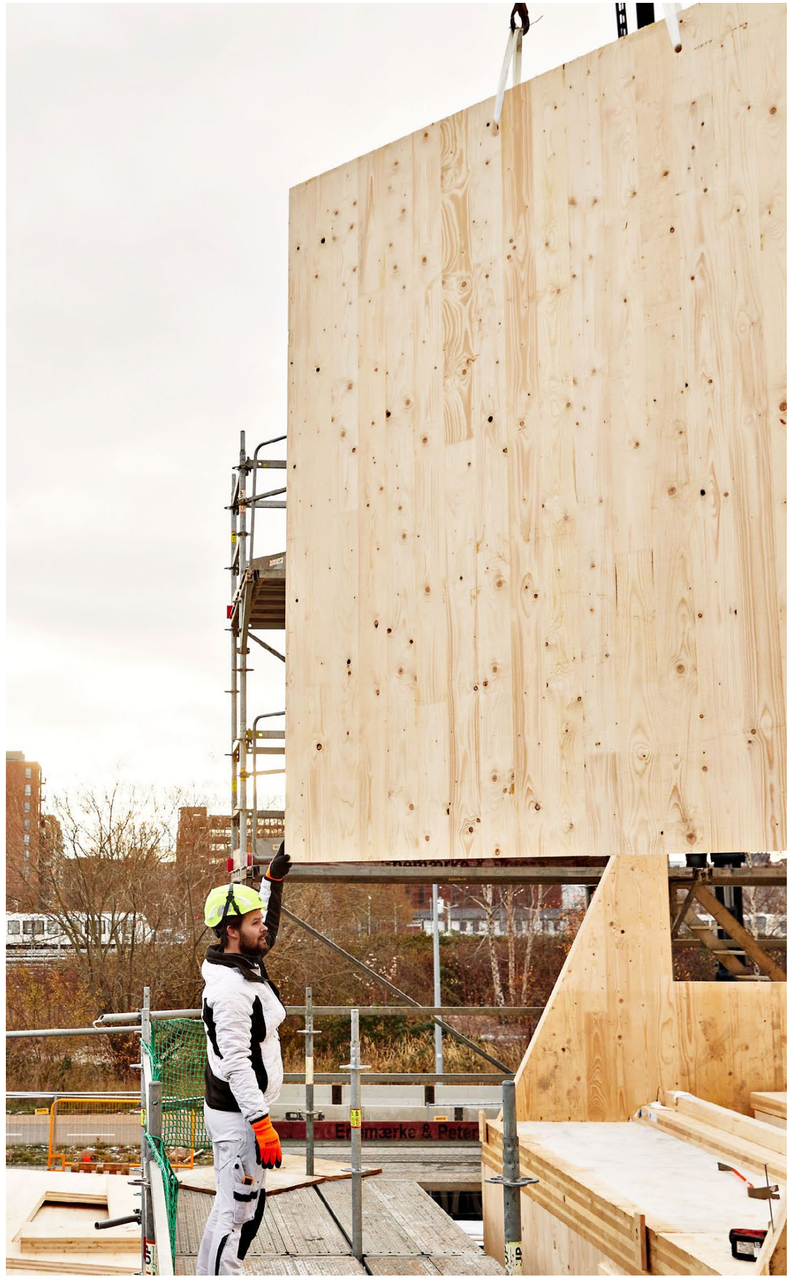
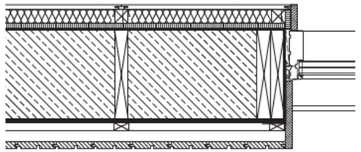
Technology



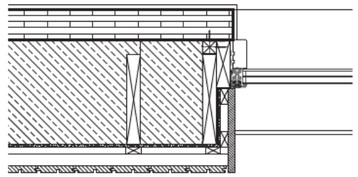
Facade

Timber Frame Construction (Hygge House)



- Spruce facade cladding boards, 21x124 mm. Vertical
- Spruce roofing battens, 38x73 mm. Horizontal
- Spruce roofing battens, 25x50mm. Vertical
- Wind panel with open diffusion, 8mm
- Pine structural timber C18, 45x295 mm
- Cellulose insulation, 295 mm. Fire class: B-s2, d0
- OSB plate G3, 18 mm
- Pinewood framing, 45x70 mm
- Wood fiber insulation, 45mm. Fire class: B-s2, d0
- Fiber gypsum boards, 15mm. Visible connections
- Interior linoleum paint

CLT construction (Haven House)

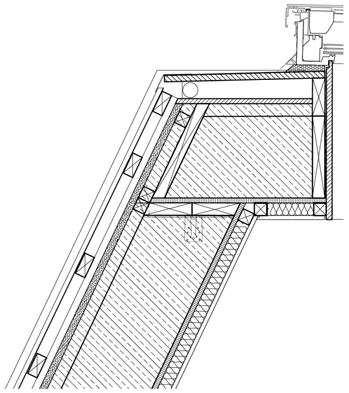


- Spruce facade cladding boards, 21x124 mm. Vertical
- Spruce roofing battens, 38x73 mm. Horizontal
- Spruce roofing battens, 25x50mm. Vertical
- Wind panel with open diffusion, 8mm
- Pine structural timber C18, 45x295 mm
- Cellulose insulation, 345 mm. Fire class: B-s2, d0
- CLT C5s, 100 mm. IVQ vertical elements
- Varnish with UV protection, Indoor climate certified

Technology

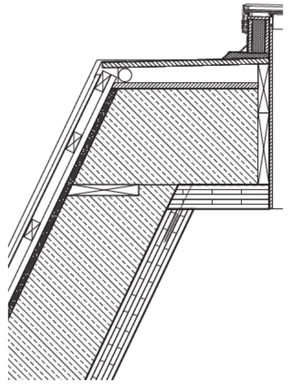
Roof construction

Timber Frame Construction (Hygge House)



- Steel sinus plate, 18 mm. Zink-Magnesium treatment
- Spruce roofing battens, 38x73 mm. H.
- Spruce roofing battens, 25x50mm. V.
- Wood fiber roofing plate, 25 mm
- Pine structural timber C18, 45x29mm
- Pine interior battens, 45x45 mm
- Cellulose insulation, 340 mm. Fire class: B-s2, d0
- OSB plate G3, 18 mm
- Pinewood framing, 45x70 mm
- Wood fiber insulation, 45mm. Fire class: B-s2, d0
- Fiber gypsum boards, 15mm. Visible connections
- Interior linoleum paint

CLT construction (Haven House)



- Steel sinus plate, 18 mm. Zink-Magnesium treatment
- Spruce roofing battens, 38x73 mm. Horizontal
- Spruce roofing battens, 25x50mm. Vertical
- Wood fiber roofing plate, 25 mm
- Pine structural timber C18, 45x295 mm
- Cellulose insulation, 395 mm. Fire class: B-s2, d0
- CLT C5s, 100 mm. IVQ vertical elements
- Varnish with UV protection, Indoor climate certified

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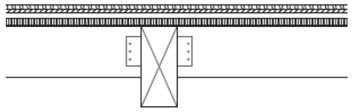
Technology

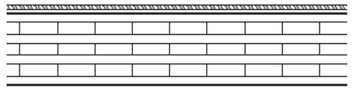
Slab

Timber Frame Construction (Hygge House)



- Floor treatment with Indoor climate certified oil
- Ask plank floor with click system, 15x185 mm
- Fiber gypsum floor boards, 13 mm
- Pine floor plywood, 18mm
- Pine roofing plywood, 25mm
- Pine structural timber K18, 270x120 mm

CLT construction (Haven House)



- Ask plank floor with click system, 15x185 mm
- CLT C7s, 240 mm. IVQ
- Varnish with UV protection, Indoor climate certified

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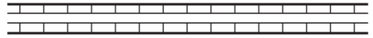
Technology

Interior wall

Timber Frame Construction (Hygge House)

- Interior linoleum paint
- Fiber gypsum boards, 15mm. Visible connections
- Pine wood framing, 45x70 mm
- Fiber gypsum boards, 15mm. Visible connections
- Interior linoleum paint

CLT construction (Haven House)

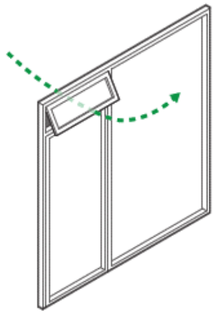


- Varnish with UV protection, Indoor climate certified
- CLT C3s, 90 mm. IVQ vertical elements
- Varnish with UV protection, Indoor climate certified

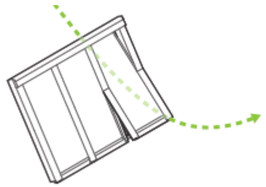
Technology

Windows

Timber Frame Construction (Hygge House)

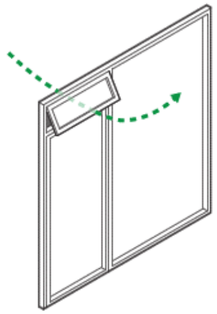


Facade
- Oiled oak frame
- Triple glass layer. 6+14+4+14+6

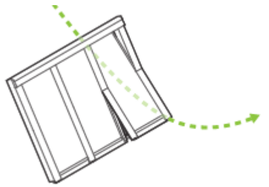


Roof
- VELUX Integra 2i1 - GGLS MMK08 206630
- VELUX Integra 3i1 - GGLS FFKF08 206630
- VELUX FRW - CVU 0325QA + ISU 2093 - 080080

CLT construction (Haven House)



Facade
- Aluminum - Pine frame
- Triple glass layer. 6+14+4+14+6



Roof
- VELUX Integra 2i1 - GGLS MMK08 206630
- VELUX Integra 3i1 - GGLS FFKF08 206630
- VELUX VMR - UVM 18000800 0030V 2301B

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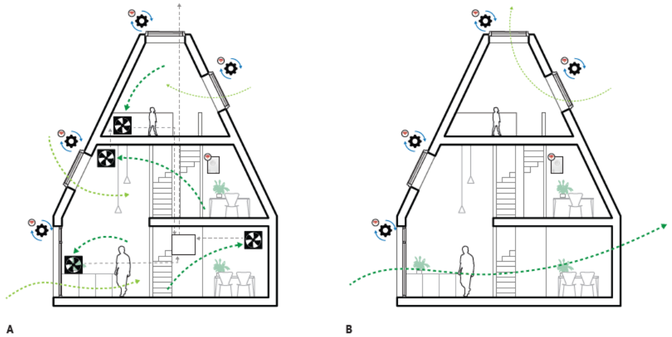
Technology

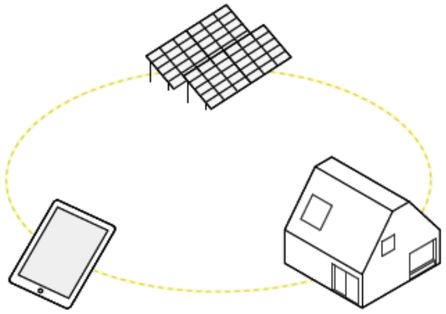
Technical System

The technical system consists of an air-to-water heat pump for heating and domestic hot water combined with 12 m2 of PV panels installed on the roof, which provide an energy supply to the system. In addition, passive strategies, such as the shape of the building and the orientation of the windows, were considered to optimise the building's performance and enable better airflow for natural ventilation.The VELUX ACTIVE system controls the ventilation to maximise the fresh air, and central mechanical ventilation with an enthalpy exchanger is used in the CLT house.

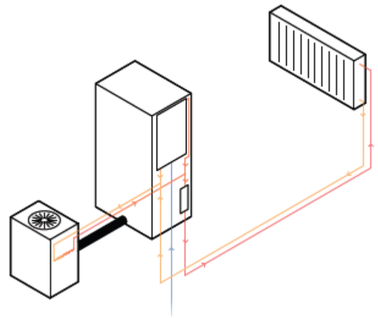
Ventilation system



Heating



Energy



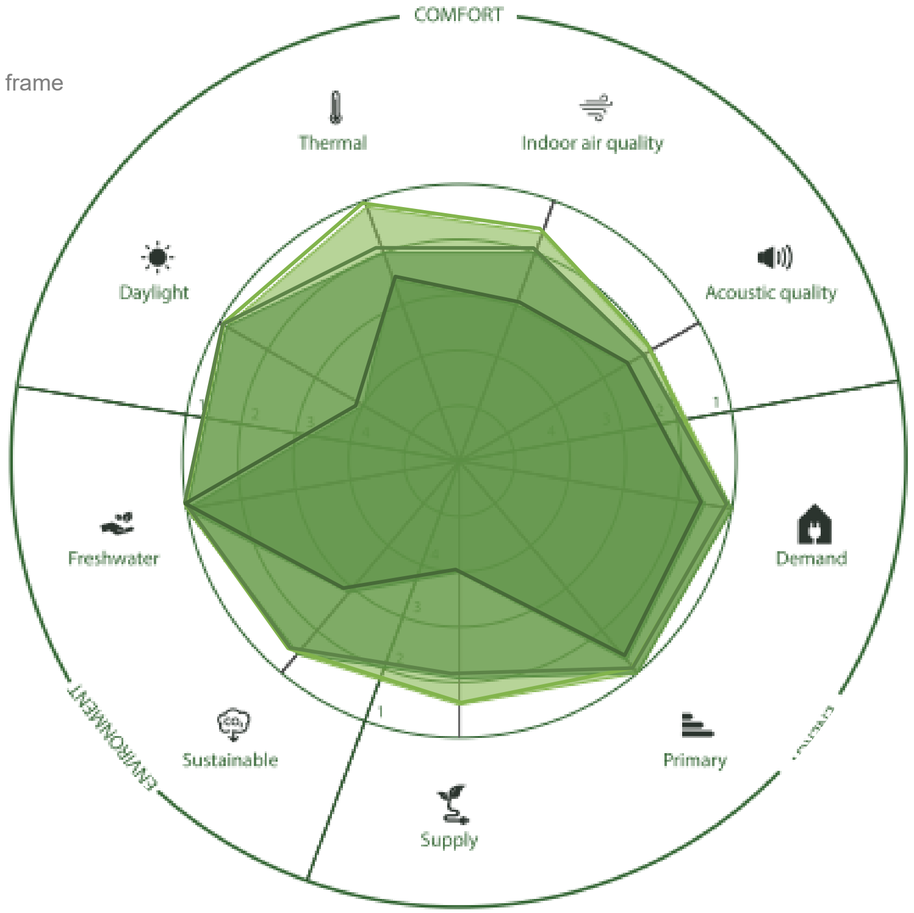
	Ventilation	Exhaust	Electricity	Heat source	Heat distribution
Timber Frame Construction (Hygge House)	Natural ventilation (VELUX ACTIVE)	Exhaust through wall	Wireless switch for light Solar Panels: SPR-MAX3-375 (Sunpower)	Air to water heat pump	Radiators
CLT Construction (Haven House)	Hybrid ventilation (VELUX ACTIVE + central Mechanical system)	Exhaust through wall	Wireless switch for light Solar Panels: SPR-MAX3-375 (Sunpower)	Air to water heat pump	Radiators

Living Places

New buildings - Residential

Shown cases

- [x] Hygge – timber frame
- [x] Heaven – CLT
- [x] 2022 Benchmark Danish House



The **Overall Score for Hygge House**

1.5

& for Haven House

1.3

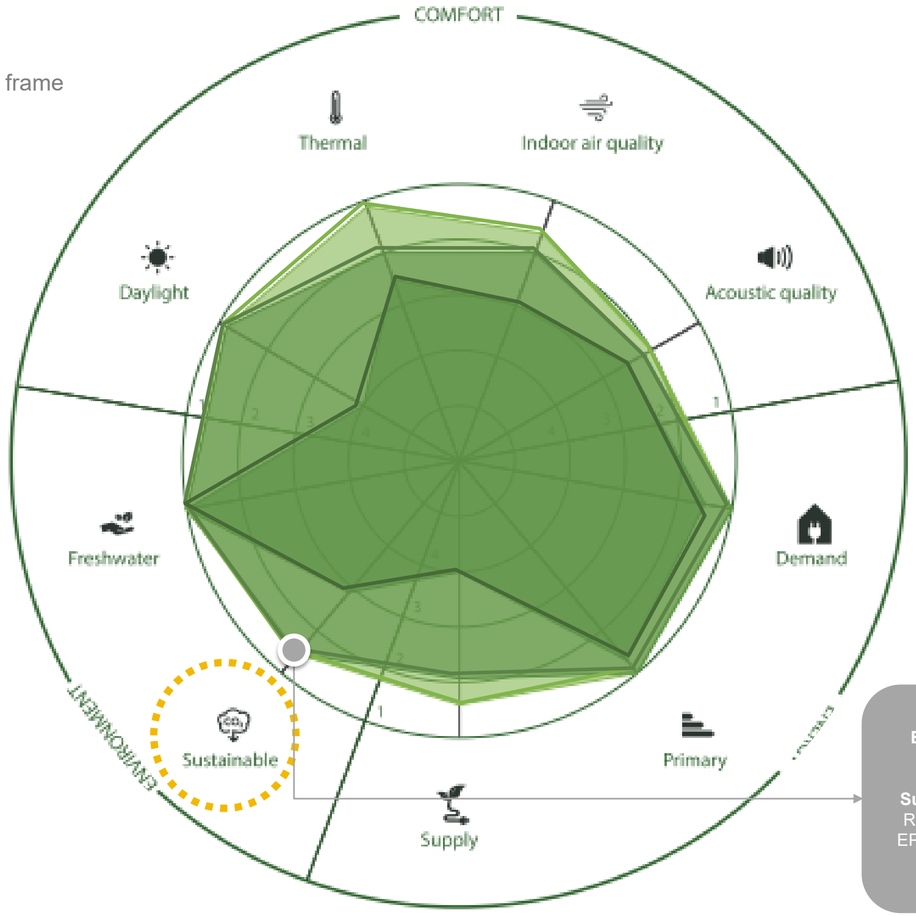
	Hygge	Haven
Daylight	1.1	1.1
Thermal environment	2	1.1
Indoor air quality	2	1.6
Acoustic quality	2.2	2
Energy demand	1	1
Energy supply	2.1	1.6
Primary energy performance	1	1
Sustainable construction	1.5	1.5
Freshwater consumption	1	1

Living Places

New buildings - Residential

Shown cases

- ☑ Hygge – timber frame
- ☑ Heaven – CLT
- ☑ 2022 Benchmark Danish House



Environmental impact (e.g., GWP, etc.)
+
Sustainable construction (e.g., Recyclable & reusable content, EPD declared, responsible wood sources)

The **Overall Score for Hygge House**

1.5

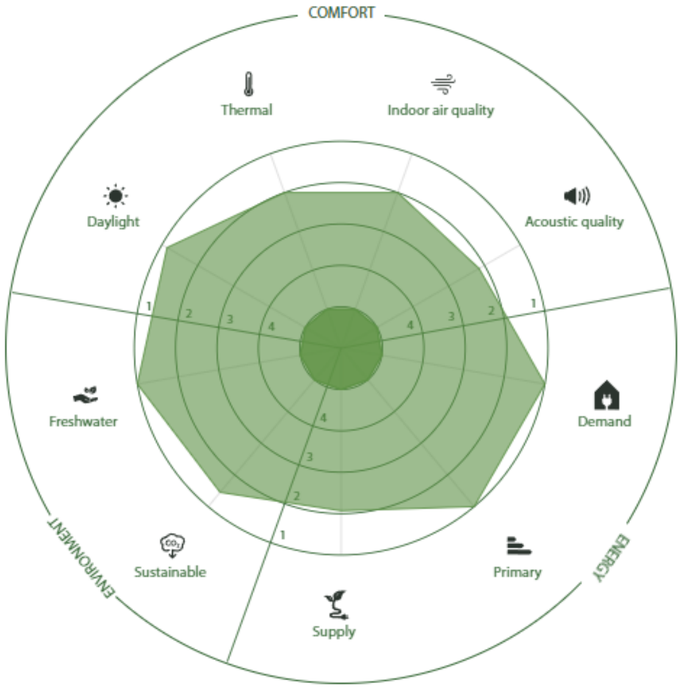
& for Haven House

1.3

	Hygge	Haven
Daylight	1.1	1.1
Thermal environment	2	1.1
Indoor air quality	2	1.6
Acoustic quality	2.2	2
Energy demand	1	1
Energy supply	2.1	1.6
Primary energy performance	1	1
Sustainable construction	1.5	1.5
Freshwater consumption	1	1

AH Radar

as built



1.5 Overall Score

https://radar.activehouse.info/

VELUX

Hygge House

Timber Frame Construction

The Active House specifications 3.0 include the vision and knowledge needed to meet the technical requirements for achieving the design concept's performance levels and a holistic approach (biodiversity, local culture, and location).

An Active House is evaluated by integrating the three main principles of Comfort, Energy and Environment, synthetizing the performance of the Active House Radar, and showing the level of ambition of each of the three main criteria and their sub-parameters.

Each parameter describes the level of ambition of how 'active' the building has become. For a building to be considered an Active House, the level of ambition can be quantified into four levels, where 1 is the highest, and 4 is the lowest and should be equal to or higher than 4.

The project includes all nine parameters of Active House and recommends almost the best level for each, as shown in the figure. All the analyses were performed with different tools, and simulations were performed dinamically.

According to the third edition of the Active House Specifications, the overall score for the Hygge House with timber frame construction is 1.5.

AH Radar

as built

1.3 Overall Score

👉 https://radar.activehouse.info/

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Haven House

CLT Construction

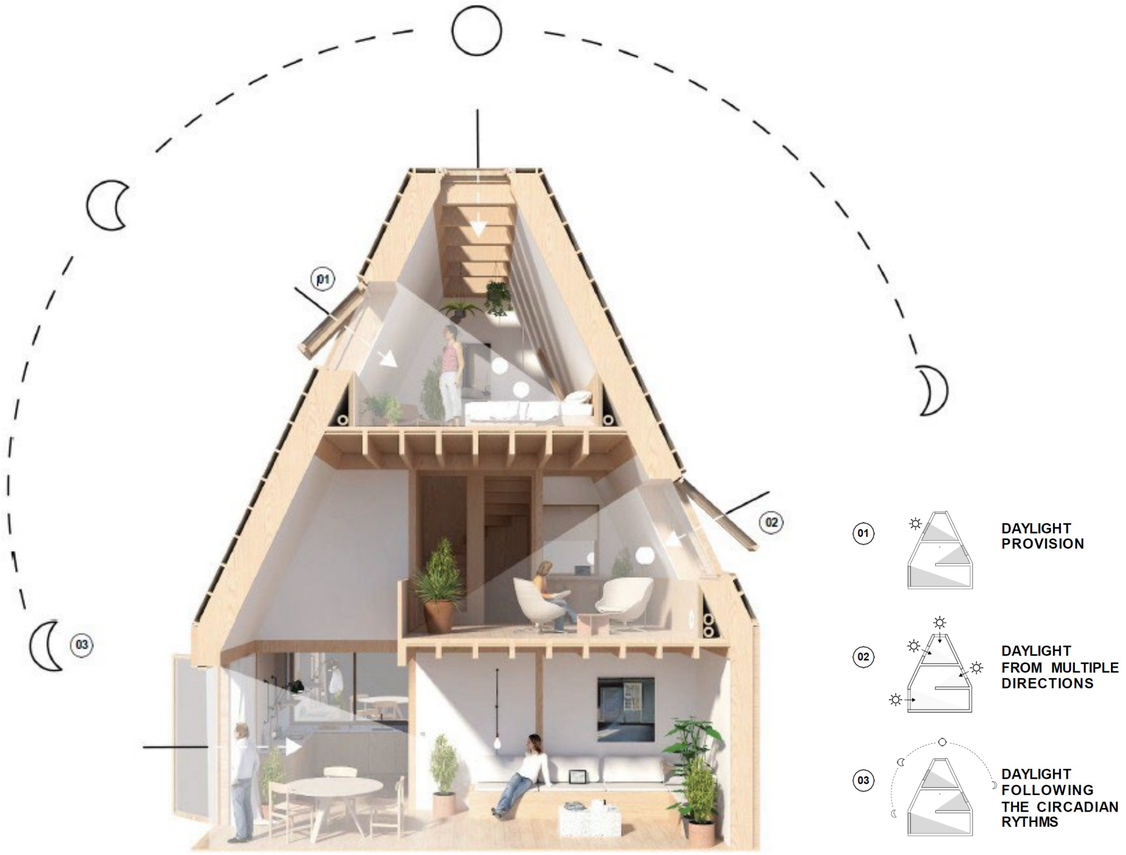
On the other hand, according to the third edition of the Active House Specifications, the overall score for the Haven House with CLT construction is 1.3. The Heaven House has hybrid ventilation, and the energy needs include the energy for mechanical ventilation with heat recovery, which impact the performance for indoor air quality levels, thermal environment and energy demand.

Shown cases

- ☑ Hygge – timber frame
- ☑ Heaven – CLT
- ☑ 2022 Benchmark Danish House

Comfort

According to the Active House specifications, Living Places satisfy the four main parameters of the comfort criteria: Daylight, Thermal Comfort, Indoor Air Quality and Acoustic Quality. It is a building that allows abundant daylight and fresh air, enhancing indoor climate quality. Inside the buildings, the sloped roof enables better daylight conditions with light from roof windows (i.e., VELUX type) reaching deeper into the plan, ensuring a good lighting condition for the lower floors where daylight is most scarce and high levels of daylight in the house all year round according to the Active House specification 3.0.

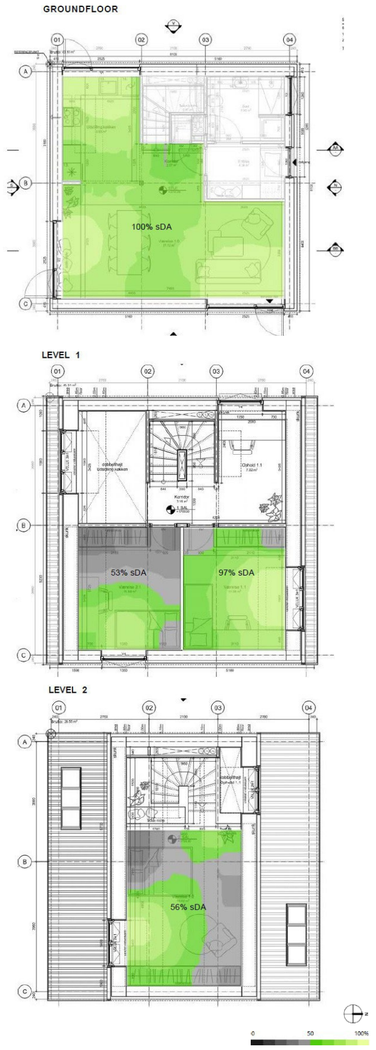


Daylight

On average, the climate-based daylight autonomy calculations, DA300lux [50%], above target illuminance for main rooms is 83% unless a room remains with less exposure.

Further, the presence of shadings for the roof windows mainly protects them from the summer heat and avoids glare, using composed materials that do not constitute significant luminance contrasts (surface reflectance). Also, the electric lighting sources should protect against flicker (i.e., CRI values and colour temperature must be of high quality – focus on CRI9). Outside the building, the sloped roof enables direct sunlight to reach surrounding urban spaces and the façades of neighbouring buildings, allowing higher density while maintaining a human scale and enhancing daylight conditions.

The score obtained is 1.1 for both Hygge and Haven Houses.



Daylight 1.1

Have you made daylight factor calculation with a validated simulation program?

Yes

Used method

Option 2: daylight autonomy

ET0 - LIVING ROOM / DINING ROOM 1

Amount of daylight above target illuminance

> 70% of occupied space

ET0 - KITCHEN 1

Amount of daylight above target illuminance

> 70% of occupied space

ET1 - BEDROOM 1 1

Amount of daylight above target illuminance

> 70% of occupied space

ET1 - BEDROOM 2 3

Amount of daylight above target illuminance

> 50% of occupied space

ET1 - OFFICE 1

Amount of daylight above target illuminance

> 70% of occupied space

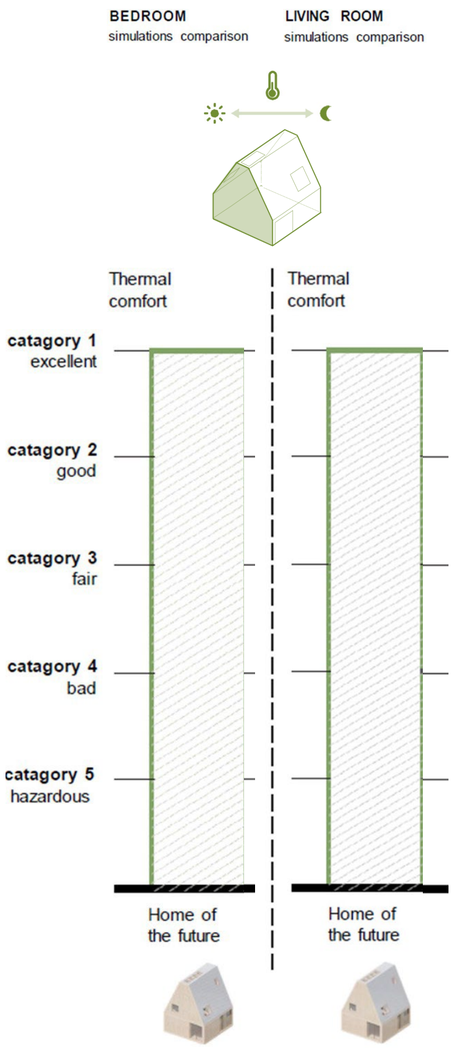
ET2 - BEDROOM 3 1

Amount of daylight above target illuminance

> 70% of occupied space

Thermal Comfort

Living Places follows the Active House requirements, having adequate thermal comfort, both in summer and winter, with an inside temperature score at the better level category for the analysed locals, such as The kitchen and bedrooms are about 20°C during heating and less than 26°C in summer, minimising overheating. Double-high spaces and ceiling height enable stack effects of air for natural ventilation through overhead windows. The calculations were performed dynamically considering, as background information: a heat pump air-water, skylights and small windows at the ground level fitted with motors for automatic opening (e.g., Velux Active control system), the presence of roof insulation, nr. 2 occupants in the bedroom and nr. 4 in the living room. Additionally, the Hygge House only runs with natural ventilation while the Haven House, hybrid ventilation. In the latest one, mechanical ventilation is used during the heating season, while during the rest of the year, the house is naturally ventilated. The score for the Hygge House with timber frame construction is 2, and for the Haven House with CLT construction, it is 1.1.



VELUX®

Hygge House with timber frame construction

Thermal environment 2

Has a dynamic simulation been performed to evaluate the CO2 concentration for different rooms?

No

ET0 - KITCHEN 2

Room with air conditioning?	Summer category	Winter category	Summer score	Winter score
yes	Better level	Better level	2	2

ET1 - BEDROOM 1 1

Room with air conditioning?	Summer category	Winter category	Summer score	Winter score
yes	Best level	Best level	1	1

ET2 - BEDROOM 3 1

Room with air conditioning?	Summer category	Winter category	Summer score	Winter score
yes	Best level	Best level	1	1

Haven House with CLT construction

Thermal environment 1.1

Has a dynamic simulation been performed to evaluate the CO2 concentration for different rooms?

No

ET0 - KITCHEN 2

Room with air conditioning?	Summer category	Winter category	Summer score	Winter score
no	Better level	Better level	2	2

ET1 - BEDROOM 1 2

Room with air conditioning?	Summer category	Winter category	Summer score	Winter score
no	Better level	Better level	2	2

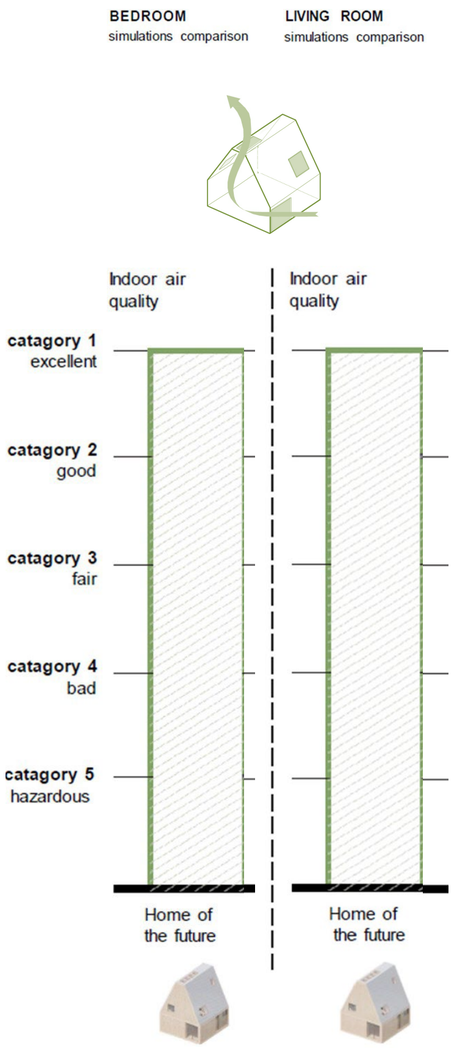
ET2 - BEDROOM 3 2

Room with air conditioning?	Summer category	Winter category	Summer score	Winter score
no	Better level	Better level	2	2

Indoor Air Quality

For Living Places, certified materials off-gassing were selected, favoring low levels of IAQ and easing maintenance. The houses employ only natural ventilation in the Hygge House, while the Haven one has hybrid ventilation. With hybrid ventilation, the maximum level of CO2 indoors increases between 380 to 570 ppm above outdoor concentration, which is also guaranteed by providing sufficient exhaust ventilation in periods of high humidity loads. Mechanical ventilation is 10 l/s per person (i.e., bedrooms), making the CO2 level below 1000 ppm. The calculations performed were static, as the airflow was registered high enough to secure acceptable CO2 levels, considering an activity level in the room between 0.8 and 12 MET. Therefore, the data were inserted manually and without a simulation file into the Active House tool.

The score for the Hygge House with timber frame construction is 2, and for the Haven House with CLT construction, it is 1.6.



Hygge House with timber frame construction

Indoor air quality 2

Has a dynamic simulation been performed to evaluate the CO2 concentration for different rooms?

No

ET0 - LIVING ROOM / DINING ROOM 2

CO2 concentration above outdoor

< 550 ppm

ET0 - KITCHEN 2

CO2 concentration above outdoor

< 550 ppm

ET1 - BEDROOM 1 2

CO2 concentration above outdoor

< 550 ppm

ET1 - BEDROOM 2 2

Haven House with CLT construction

Indoor air quality 1.6

Has a dynamic simulation been performed to evaluate the CO2 concentration for different rooms?

No

ET0 - LIVING ROOM / DINING ROOM 1

CO2 concentration above outdoor

< 400 ppm

ET0 - KITCHEN 1

CO2 concentration above outdoor

< 400 ppm

ET1 - BEDROOM 1 2

CO2 concentration above outdoor

< 550 ppm

ET1 - BEDROOM 2 2

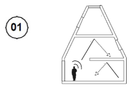
Acoustic Quality

According to Active House specification 3.0, the acoustic quality parameter contributes to the determination of the overall comfort condition of the building.

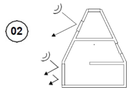
The building has a low reverberation time in all living rooms thanks to the extended focus on ventilation ducts and diffusers to reduce noise. To minimize technical noise and sound transmission between beds and living rooms shafts with the slightest contact with bedrooms and sound-absorbing walls and doors were conceived and placed.

Evaluations were performed without simulations but by a calculation considering the material sound absorption.

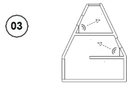
The results were then inserted in the Active House tool. The score for the Hygge House with timber frame construction is 2.2, and for the Haven House with CLT construction, it is 2.



NOISE INSULATION



CONTROLLED SOUND TRANSMISSION



SYSTEM NOISE

Hygge House with timber frame construction

Acoustic quality 2.2

Acoustic privacy

Without acoustic privacy

ET0 - LIVING ROOM / DINING ROOM 2.5

Inside system noise	Outside noise
< 30 dB	< 35 dB

ET0 - KITCHEN 2

Inside system noise	Outside noise
< 25 dB, or below background noise	< 35 dB

ET1 - BEDROOM 1 2

Inside system noise	Outside noise
< 25 dB, or below background noise	< 35 dB

ET1 - BEDROOM 2 2

Inside system noise	Outside noise
< 25 dB, or below background noise	< 35 dB

ET1 - OFFICE 2

Inside system noise	Outside noise
< 25 dB, or below background noise	< 35 dB

ET2 - BEDROOM 3 2

Inside system noise	Outside noise
< 25 dB, or below background noise	< 35 dB

Acoustic Quality

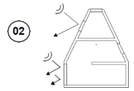
According to Active House specification 3.0, the acoustic quality parameter contributes to the determination of the overall comfort condition of the building.

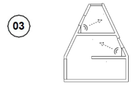
The building has a low reverberation time in all living rooms thanks to the extended focus on ventilation ducts and diffusers to reduce noise. To minimize technical noise and sound transmission between beds and living rooms shafts with the slightest contact with bedrooms and sound-absorbing walls and doors were conceived and placed.

Evaluations were performed without simulations but by a calculation considering the material sound absorption.

The results were then inserted in the Active House tool. The score for the Hygge House with timber frame construction is 2.2, and for the Haven House with CLT construction, it is 2.


01 NOISE INSULATION


02 CONTROLLED SOUND TRANSMISSION


03 SYSTEM NOISE

Haven House with CLT construction

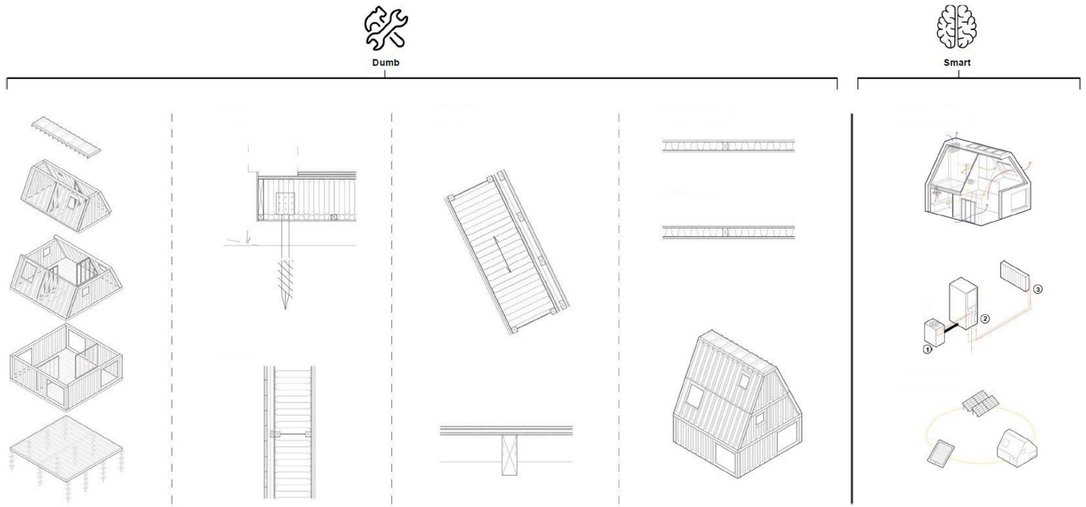
Acoustic quality 2

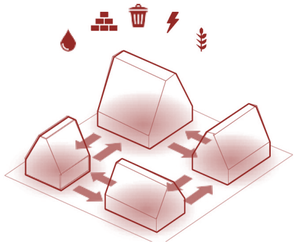
Acoustic privacy: Without acoustic privacy

	Inside system noise	Outside noise
ET0 - LIVING ROOM / DINING ROOM 2	< 25 dB, or below background noise	< 35 dB
ET0 - KITCHEN 2	< 25 dB, or below background noise	< 35 dB
ET1 - BEDROOM 1 2	< 25 dB, or below background noise	< 35 dB
ET1 - BEDROOM 2 2	< 25 dB, or below background noise	< 35 dB
ET1 - OFFICE 2	< 25 dB, or below background noise	< 35 dB
ET2 - BEDROOM 3 2	< 25 dB, or below background noise	< 35 dB

Energy

During the whole lifecycle of the building, the design of an Active House must be based on the Trias Energetica approach to sustainable design, focusing on the energy demand, integration of renewable energy and primary energy performance system. The buildings were designed to accommodate appliances without affecting their systems. Using non-energy-intensive solutions, such as solar gain, daylight, natural ventilation, and ventilative cooling, is crucial for energy conservation in the building. By separating the technical system from the building, constructive solutions can be implemented more efficiently.





RESOURCE LOOPS

Energy

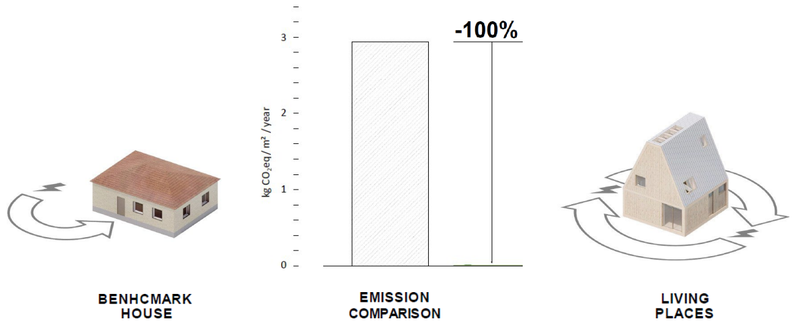
In Living Places, the annual energy demand is minimised thanks to adopting a holistic approach to energy use. Using the passive strategies of optimising the orientation of the windows, shading systems, shape, and location of the building combined with solutions such as an energy-effective system with a heat pump air to water efficiently utilises the energy in the outdoor air to heat water for heating and domestic hot water. In addition, the installation of lighting with power of 5-6 W/m^2 depending on the lux level in each zone, extractors, and other services were also selected.

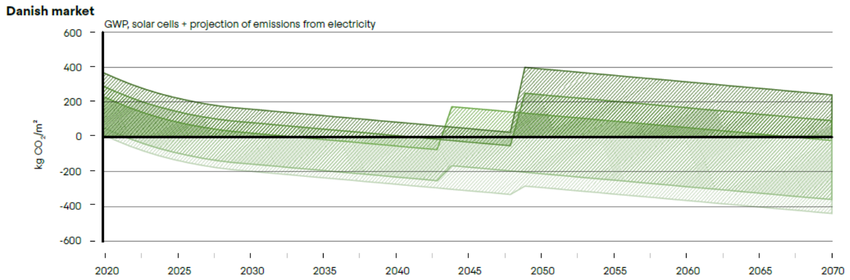
The total energy demand for electricity in the Hygge House with timber frame construction is 5.6 kWh/m² yr for the heat pump (heating and hot water), and for the Haven House with CLT construction is 5.1 kWh/m² yr, where 2,2 kWh/m² yr goes to ventilation (exhaust hood); considering a primary energy factor of 1.9 for the energy frame calculation and a COP of the heat pump for heating equal to 3.8 and 4.5 for hot water.

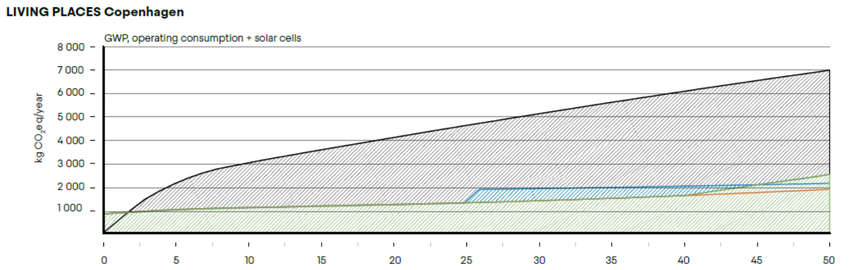
The energy supply of Living Places is produced by PV panels of 9.5 m², providing 2050 kWh per year to the system.

The PV cells study considered them to sit for the entire building life and accept less production as replacement is essential for the total CO2 footprint from the building's operating consumption. The score for the Hygge House with timber frame construction is 2.1, and for the Haven House with CLT construction, it is 1.6.

Living Place's annual primary energy performance was calculated by multiplying the difference between the total energy need and the amount of renewable energy by the national primary energy factor. The score obtained for both houses is 1.

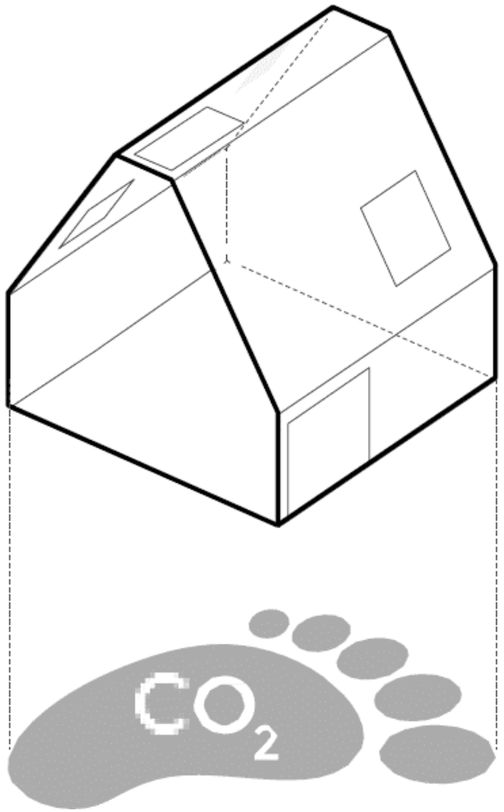






Environment

The environmental performance is given by the weighted average of sustainable construction and freshwater consumption. Living Places is designed for longevity, using aesthetics and functional design to enable caretaking and durability. Individual components are chosen based on the intended use of the balance between sustainable materials and their life span and design for disassembly. Understanding the building's environmental interaction means the inclusion of LCA evaluations.

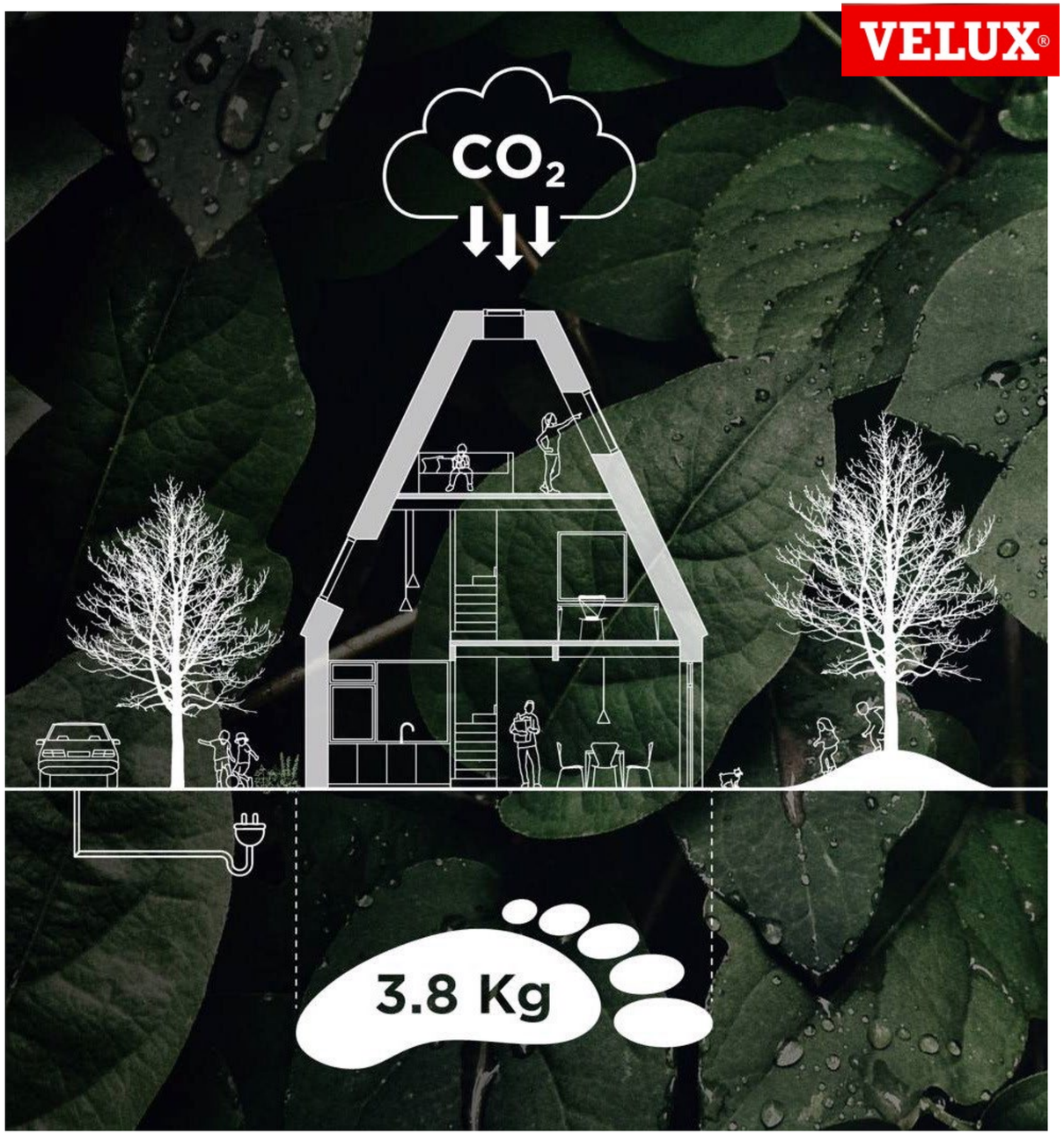


CO2
FOOTPRINT

Sustainable Construction

With an experimental mindset, VELUX, Artelia Engineers and EFFEKT Architects have carefully considered each material, design and building technique for Living Places and mapped their projection for emissions against the typical Danish reference house.

The sustainability assessment of the construction is based on the analysis of environmental loads and the life cycle analysis of the building, quantifying its emissions to air, soil and water. The Life Cycle Assessments (LCA) of Living Places allowed the focus on reducing emissions and benchmarking materials and systems to select the best option according to what strategies best suited the project goal and scope, previewing the end of life of the building for the different components and materials.



v

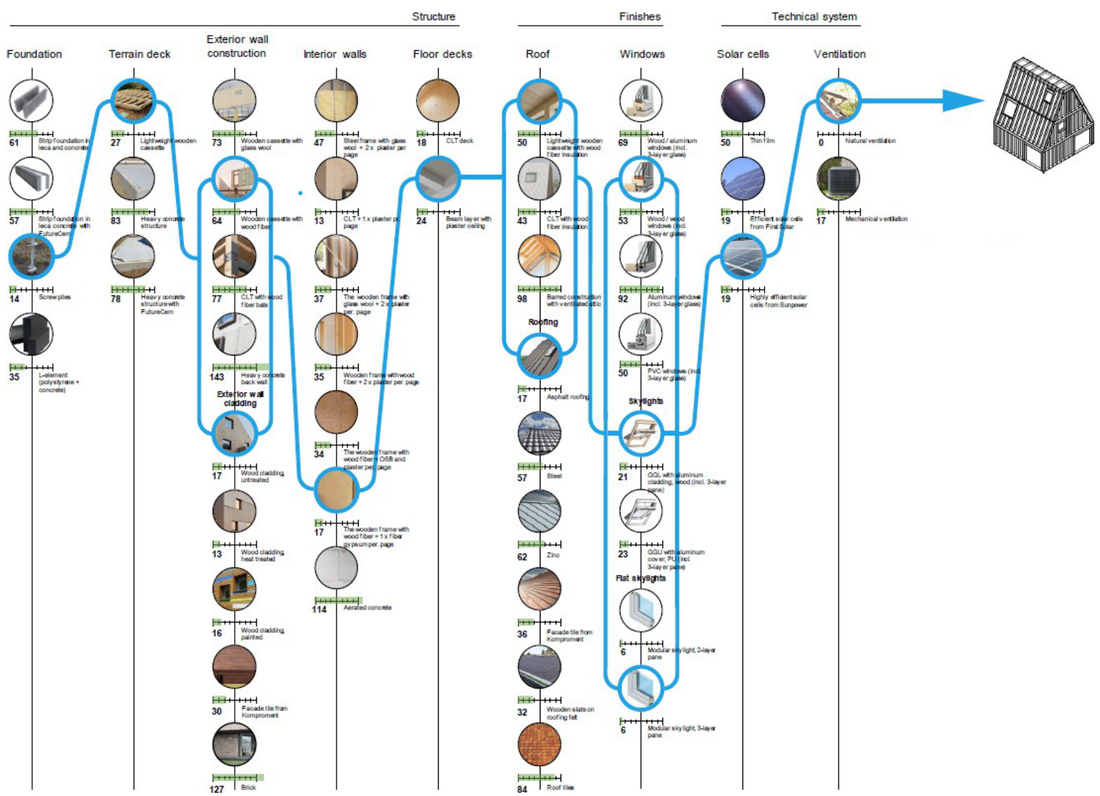
Project DO

In order to design and construct a building that could satisfy the LCA requirement for the entire life cycle, a Design Optioneeting (DO) approach was applied to define the best solution to be selected according to three main point criteria for the structure, the finishes and the technical system.

By analysing the graph, the structure selections are strip foundation in concrete with FutureCem, lightweight wooden cassette terrain deck, Wooden cassette with wood fiber and Wood cladding, untreated for the exterior walls, the wooden frame with wood fiber 1x fiber gypsum for the interior walls, and a beam layer with plaster ceiling for the floor deck.

The finishes selections are lightweight wooden cassette with wood fiber insulation and asphalt roofing for the roof, wood windows (3-layer glass), GGL with aluminium cladding, wood (3-layer pane) of a skylight, modular skylight, 3-layer pane for windows.

The technical system selections are highly efficient solar cells from SunPower for photovoltaic panels and natural/hybrid ventilation.

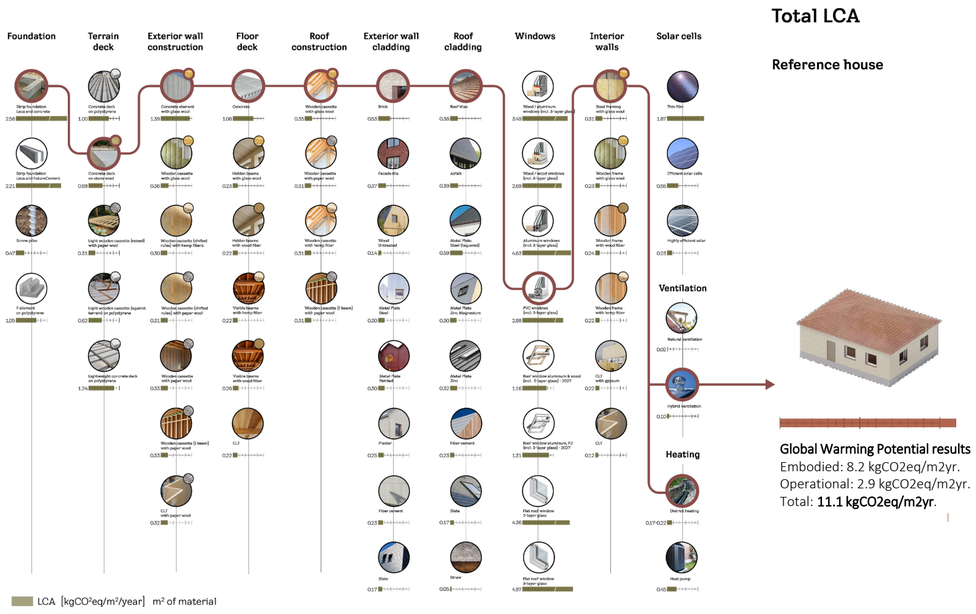


Sustainable Construction

In Living Places, prioritization was given to selecting the material with documented environmental product declaration (EPD) and setting a target for the material's travel distance until the construction site. This approach was combined with a digital & up-to-date record of information on the building throughout its lifecycle, ensuring the pursuit of the Active House to impact the environment positively. Sets of analyses on the building materials and resources used, the local building culture and behaviour in and around highlighted that there are no influential impact categories as all have been carefully studied to be as less possible. The last parameter evaluated to complete the performance assessment is the content of recyclable materials, considered equal to 80% obtained by evaluating the building material utilised.

TYPICAL DANISH SINGLE-FAMILY HOUSE
(2022, Artelia Danmark)

Size:	184
Floors:	1
Building principle:	Brick
Foundation:	Concrete
Floor height:	2.7 m
Room height:	2.4 m
Heating application:	District heating
Heating source:	Floor heating
Ventilation:	Mechanical
Solar panels:	7 m²



Total LCA

Reference house

Global Warming Potential results
Embodied: 8.2 kgCO2eq/m2yr.
Operational: 2.9 kgCO2eq/m2yr.
Total: **11.1 kgCO2eq/m2yr**.

Sustainable Construction

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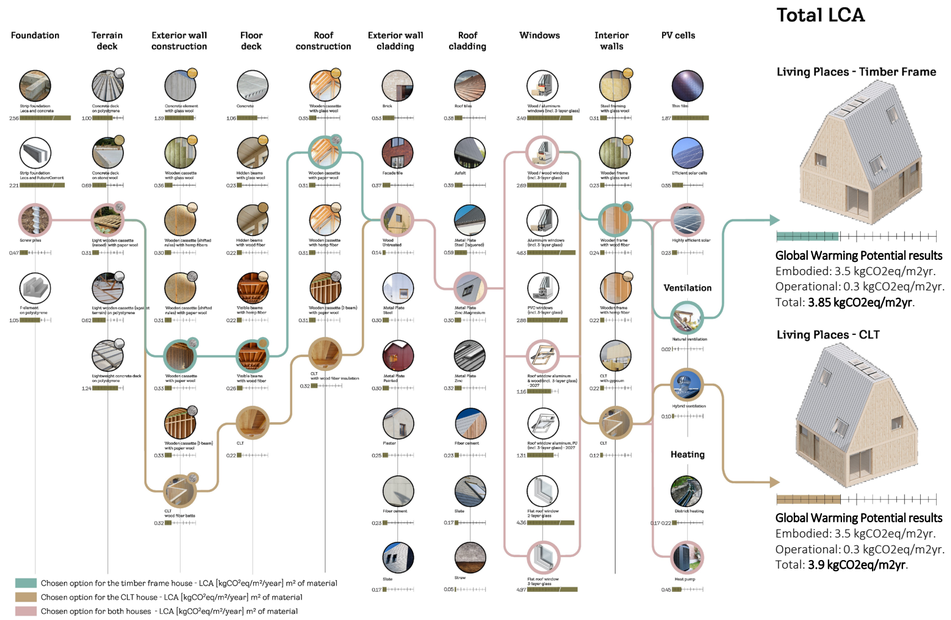
LIVING PLACES HOUSES

Size:	147
Floors:	3
Building principle:	Timber frame / CLT construction
Foundation:	Screw pile foundation
Floor height:	3 m
Room height:	2.6 m
Heating application:	Air to water heat pump
Heating source:	Radiators
Ventilation:	Natural or hybrid (CLT)
Solar panels:	11 m^2



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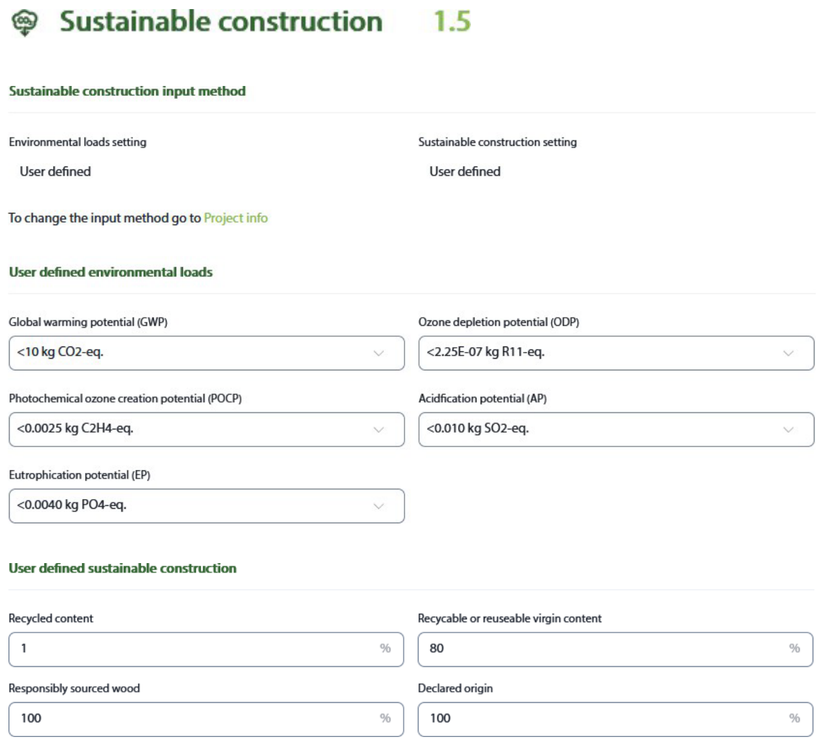

Fresh Water Consumption

Consideration of the water consumption and treatment during the lifetime of the building was done by assigning each sanitary appliance according to its “water use” value.

The score obtained is 1 for both buildings

Freshwater 1

Toilet water usage

Toilet water usage: < 4 litre per flush — Score: 1

Shower water use

Flowrate of showerhead: < 6 litre per minute — Score: 1

Tap water use

Tap flow rate: < 3 litre per minute — Score: 1

EFFEKT, Artelia, VELUX, and Enemærke & Petersen, Politecnico di Milano

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