content

kadıovacık bíohouse

healthy buíldíng

relevant desígn

eco-fríendly

natural buíldíng materíal

Kadıovacık Biohouse was designed in accordance with the principles of building biology and ecology to set an example of building and construction that respects both people and the environment. The single-storey structure, that consists of three independent units, two of which are residences and one that is an office, sits on a site of 226m2. Due to its form, the building allows each independent unit to have its own inner garden.

Starting in April 2018, the construction was completed in March 2019. The building, which houses the Office of the Building Biology and Ecology Institute, is also used for educational purposes and research about construction methods that are focused on human and environmental health.

The architectural design of Biohouse aims at maximum energy savings. Thanks to the form and orientation of the building, the different exterior solutions that provide heat storage and insulation according to the location of the façades, and the window openings and roof applications, the building was designed to keep itself cool in the summer and maintain the heat inside with minimal artificial climate control in the winter.

location

human and environmental health

Along with making material choices regarding the creation of internal climatic conditions that support human health and the long-term durability of the structure, attention was also given to the creation of minimal waste in the case of demolition. Almost all of the elements used in the building were made from native or natural materials.

Construction methods and material choices were made in order to form internal climatic conditions that support human and environmental health along with the long-term durability of the structure. Priority was given to building materials that could mix with the soil without harming the natural ecosystem and would not create waste when the building completes its life.

INTERIOR WALL SURFACE APPLICATIONS

- Fine and decorative earth plasters *(Okil)*
- Clay paint *(Auro)*
- Compressed earth panels
- Adobe filling

STRUCTURAL COMPONENTS

- Cedar laminated structural system
- Cedar grill and wood flooring
- Wooden door and window joinery
- Cedar construction and paneling
- plywood roofing

INSULATION MATERIALS

Roof: Cellulose
Ground: Powder perlite
Façade: Reed cane insulation panels

FLOORING

- Natural wax, oil, and paints *(Auro)*

human and environmental health

Within the scope of the impact of the building on human health, the internal climate, acoustics, and worker health issues come to the forefront. The primary factors that enable the achievement of satisfactory results in these three fields are:

- **NATURAL BUILDING MATERIALS**
- **CRAFTSMANSHIP**

Natural building materials are used in the structural system and interior solutions of the Kadıovacık Biohouse. As it will be further detailed, wood and soil based building materials were heavily used in order to provide moisture balance in the indoor climate, clean the air, and promote good acoustic performances. Due to the fact that they do not release toxic gases and the size of the fibers they contain, the natural building materials used are not harmful to workers' health.

ROOF

Pitched Roof covering:
100% recyclable Rheinzink zinc titanium seam roofing
Hidden stream solution in roof covering

Flat Roof Waterproofing:
Bituminous membrane
Polyurethane root holder
Viols
6 cm Pumice

WALL

Outer Wall Surface:
Heraklith plates
Acrylic-based Baumit
Powerflex slab plaster
Granopor decor plaster

human and environmental health

When considering the environmental impact of the building; the energy spent in the construction and carbon emissions from logistics as well as the embedded energies of building materials and their transformations at the end of their life should be taken into account.

The building materials used in Biohouse do not create waste. Since they do not contain any chemicals and do not change their natural molecular structure, they can be easily reused and/or mixed directly with the soil.

- STRUCTURAL SYSTEM MADE OF CEDAR WOOD
- FLOOR AND COVERINGS MADE OF CEDAR WOOD
- PLASTERS PRODUCED WITH LOCAL CLAY AND SAND
- SUN-DRIED ADOBE BLOCKS
- COMPRESSED CLAY PANELS IN REPLACEMENT OF ROUGH PLASTER
- CELLULOSE INSULATION MATERIAL PRODUCED FROM PAPER WASTE
- REED CANE INSULATION PLATES
- HERAKLITH PANELS USED FOR INSULATION AND AS AN EXTERIOR PLASTER UNDERLAY
- POWDER PERLITE AND PUMICE INSULATION MATERIALS
- NATURAL OILS AND POLISHES

human and environmental health

The energy load and carbon emissions of the natural building materials used in Kadıovacık Biohouse are quite low.

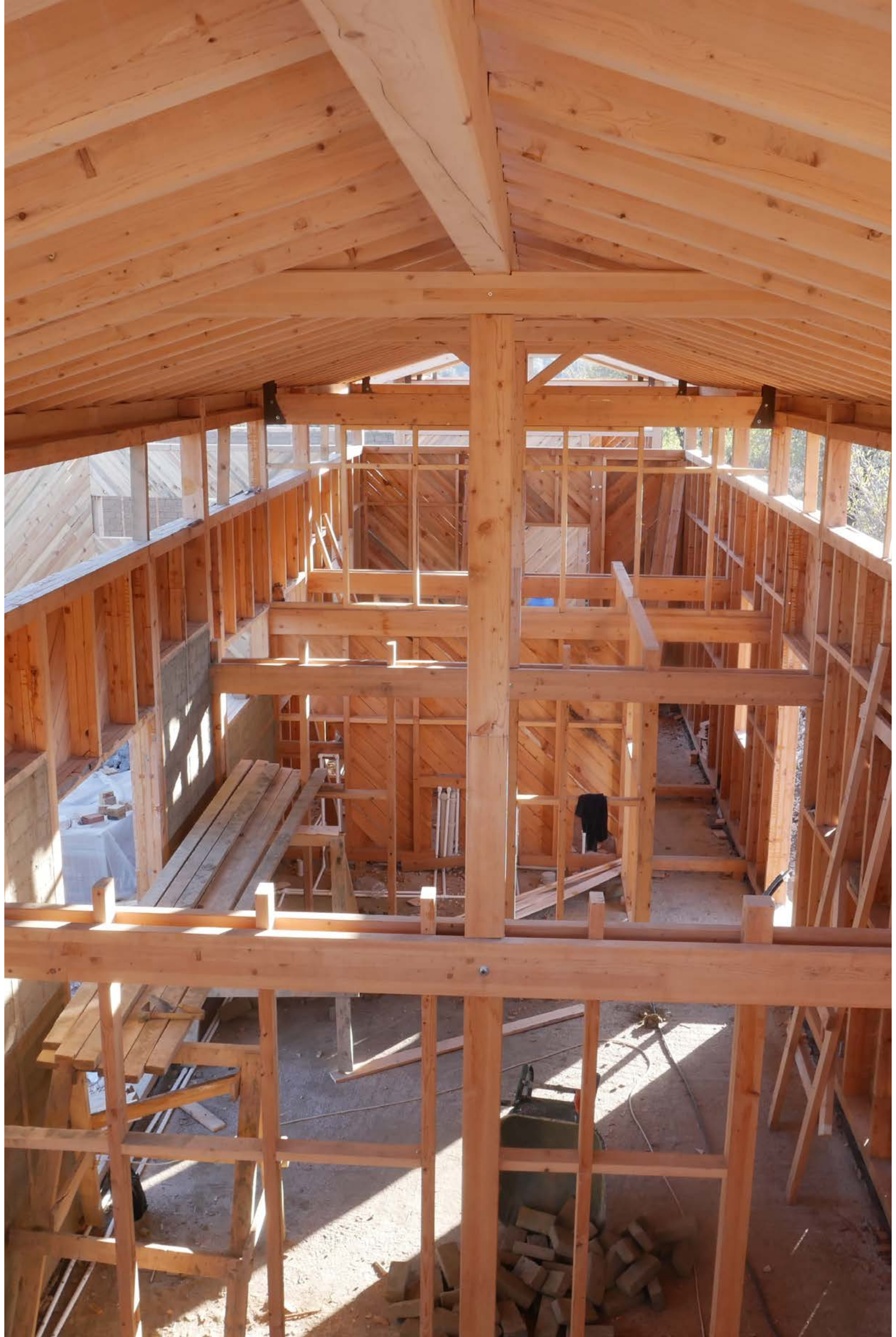
CLAY BASED NATURAL BUILDING MATERIALS

When used as wall filling and plaster of certain thicknesses;

- They bring the indoor humidity balance to ideal levels.
- The extraction-production-application processes involve low energy.
- With their heat storage capacities, they contribute to the energy efficiency of the building, especially in the summer.

Zero waste:

- Since they don't contain any chemicals and don't exhibit any molecular changes, they can be mixed directly with the soil.
- They don't release toxic gases from building materials and don't have radioactivity.



ecological footprint

The **natural building materials**' carbon and ecological footprints are low since they are sourced from low processed natural resources and they minimize production processes or the energy needed for them.

On the other hand, since the materials and the **labor were supplied locally**, awareness and support to the local economy were increased while the energy spent for the transportation of materials was minimized.

Kadıovacık Biohouse strives to keep its ecological footprint as low as possible in terms of both resource use and emissions. In order to illustrate the sensitivity shown to the environmental impact of the building, **a life cycle analysis** was carried out by providing all details regarding materials and construction processes.

5 cm thick reed cane thermal insulation

wood carcass

16 cm thick mudbrick blocks

carbon footprint

Most of the material-related carbon emissions during the construction of the Kadıovacık Biohouse originate from the concrete used in the foundation. The use of C30 concrete has led to an increased effect on the overall carbon footprint of the structure. The total carbon emissions of the house have been significantly reduced by choosing natural materials or materials with high natural content for the exterior and interior walls.

PERCENTAGE DISTRIBUTION OF CARBON FOOTPRINT BY CONSTRUCTION UNITS

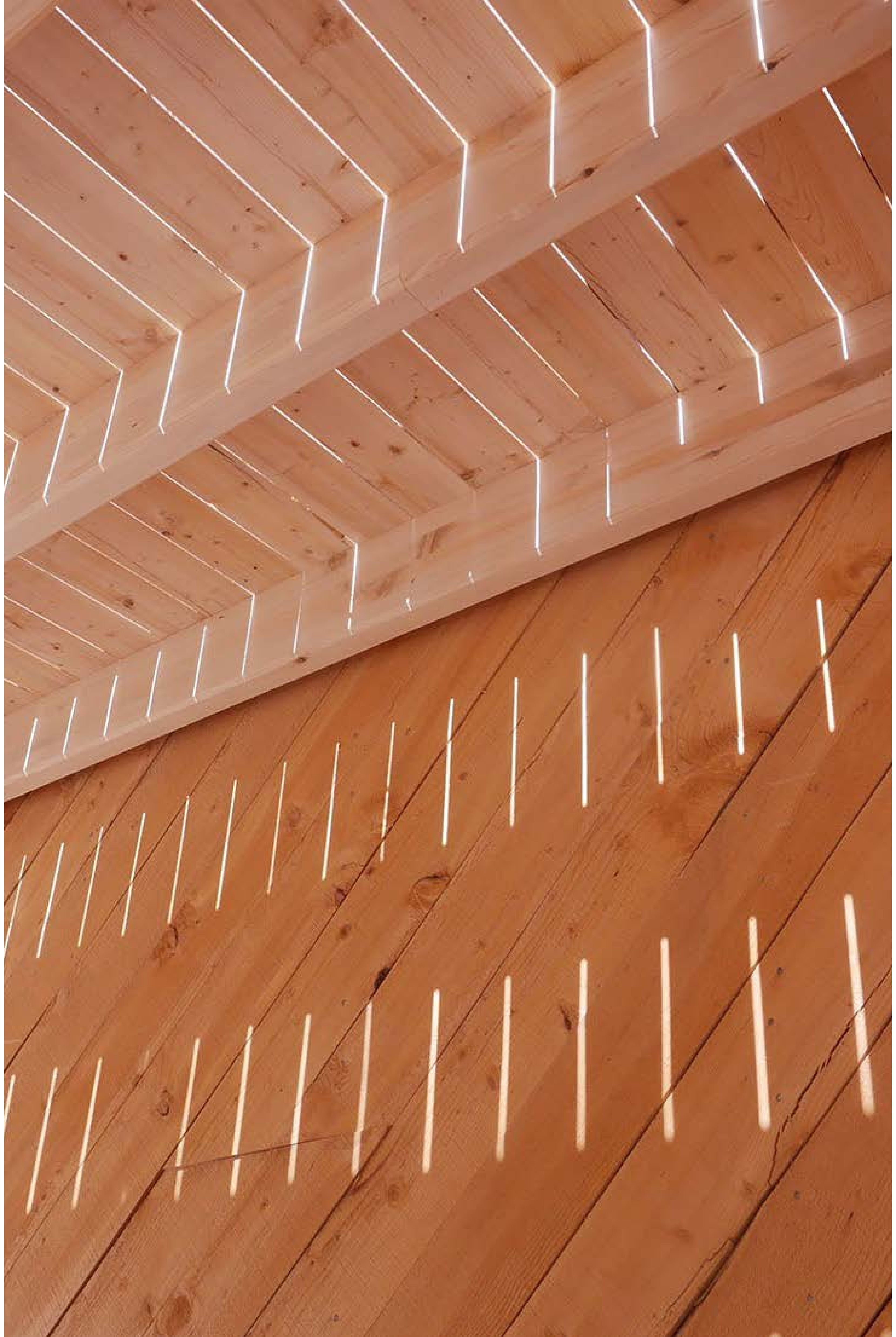
Interior walls	%3
Utilities/Energy	%4
Exterior Façade	%6
Roof	%8
Foundation	%79

carbon footprint

A carbon footprint is expressed in terms of the carbon equivalent (CO2 eq.) of the total greenhouse gases emitted by a product, system, or organization. Considered one of the most discussed issues today, a carbon footprint is an important concept in terms of measuring the contribution of said product, system, or organization to global warming.

The carbon footprint report has been created within the framework of the categories that make up the building. The categories in question have been determined in the light of data submitted to Metsims Sustainability Consulting and internationally accepted rules.

** This study was carried out with the life cycle assessment method in accordance with ISO 14040/44 standards. The environmental performance of the materials used in the design was calculated using the Turkish Lifecycle Inventory Database (TLCID) and Turkish Construction Materials Sustainability Database (TurCoMDaT) databases developed by Metsims Sustainability Consulting with the support of Ecoinvent and the Sustainable Production R&D and Design Center (SÜRATAM).



TOTAL GROSS AREA

226 m^2

TOTAL CARBON FOOTPRINT

121 ton CO_2 eq.

PRE GROSS SQUARE METER

535 kg CO_2 / m^2

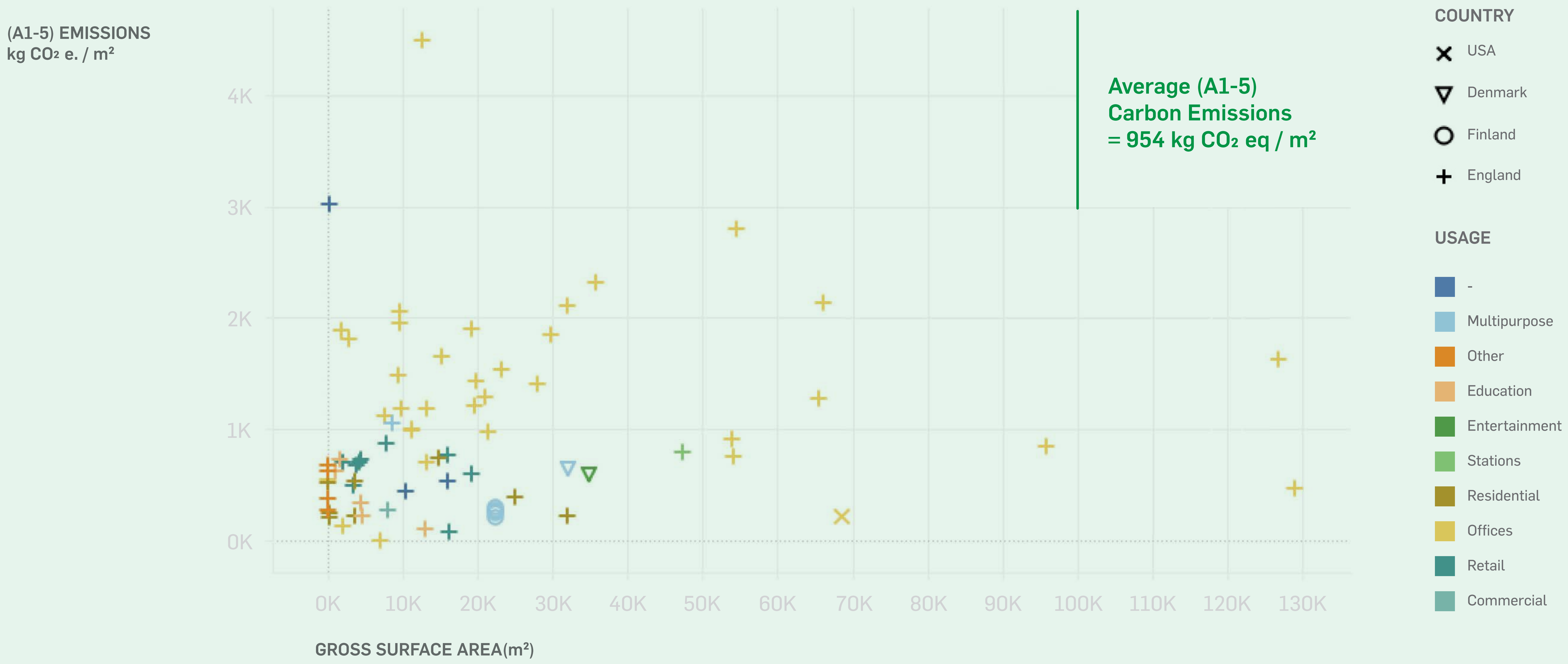
GROSS SQUARE METER PER YEAR *(50 YEARS)*

10.7 kg CO_2 / m^2 / year

carbon footprint

Based on it's life cycle analysis, Kadıovacık Biohouse's gross carbon emissions per square meter is almost half in comparison to residences selected from four different countries.

The graph shows the distribution of carbon footprints per square meter of building with different programmatic uses from four different countries. While the square meters, dimensions, and number of floors of the buildings may vary for different purposes, this graphic is presented in order to compare the Kadıovacık Biohouse, which has 535 kg CO_2 /m2 of carbon emissions, to these buildings.



structural system

A wooden frame structural system was designed due to its longevity and high performance against earthquakes. Due to carbon footprint concerns, the timber used in the wooden structural system were acquired from forests in Mersin instead of the countries such as Ukraine and Romania that generally supply wood to Türkiye.

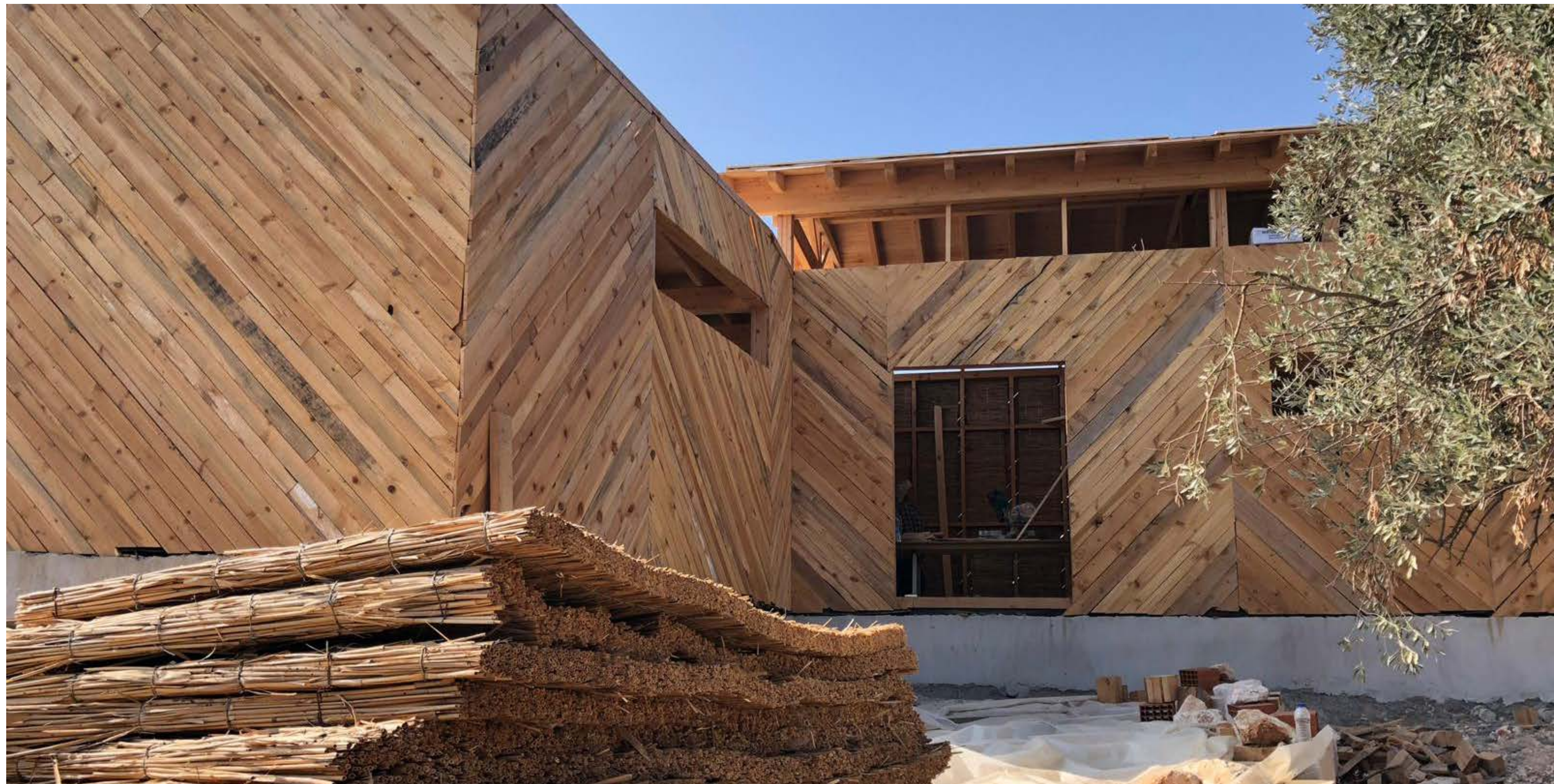
Cedar wood in the form of 70 m3 logs were purchased from Andırın forest management. The initial cuts were made in a local sawmill. The logs were cut into planks according to the quantities and needs of the wooden structure of the building, and were taken to a carpenter's workshop in Güzelbahçe, a neighboring district of Urla, to be processed.

The planks were processed after being stacked and covered for about 9 months. At this stage, all columns, beams, purlins, rafters, and buttresses were produced through laminating and pressing. In addition to this, flooring and covering boards were produced, and the threads were opened.

structural system / on-site production

structural system / on-site application

structural system / on-site application



foundation to ground

Through the reinforced concrete strip foundation method the amount of cement and iron used in the construction of the foundation has been limited. Concrete use was kept to a minimum with the use of a frame formed from reinforced concrete strip foundations. Precautions were taken against capillary water coming from the ground through gravel filling. Perlite was applied on the floor for thermal insulation between the wooden gratings, and the wooden flooring was applied on top as the final surface.

THICKNESS

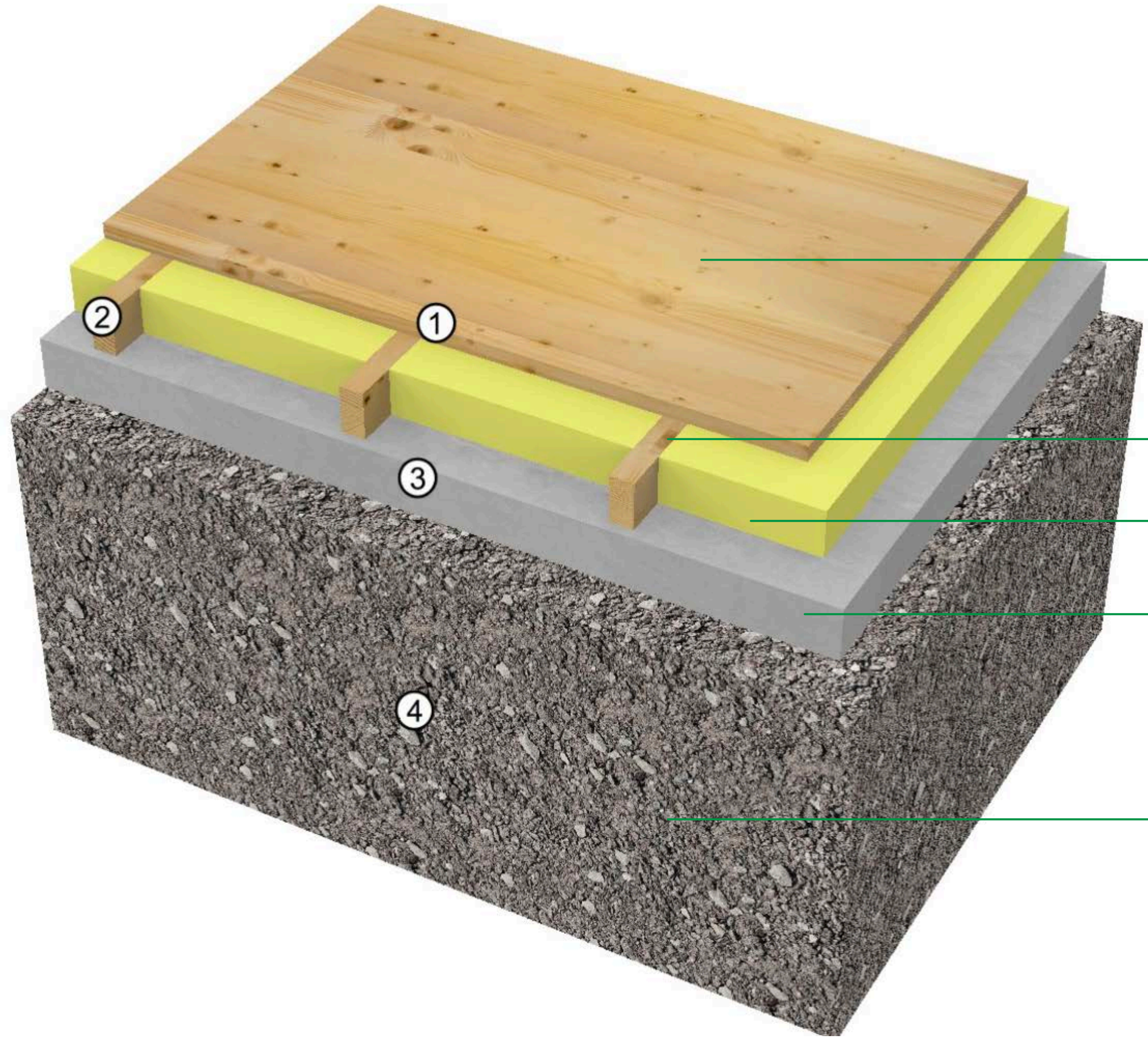
70 cm *(gravel thickness)*

U VALUE

0,091 W / m²K

HEAT STORAGE CAPACITY

191 KJ / m²K



REINFORCED CONCRETE STRIP FOUNDATION

EXCAVATION SOIL

GRAVEL

WOOD FLOORING

floor coverings

Excluding the wet spaces, wooden floor coverings were used inside the building.

Auro's natural oil and varnish were applied respectively onto the wooden joinery and wooden flooring. Thus, toxic gas emissions in the indoor climate are decreased.

Ceramic tiles were used in the wet spaces.

The ground located at the rear entrance of the building is made of compacted soil.

Composite stone slabs on compacted gravel were placed in order to reduce the use of cement on the terraces.

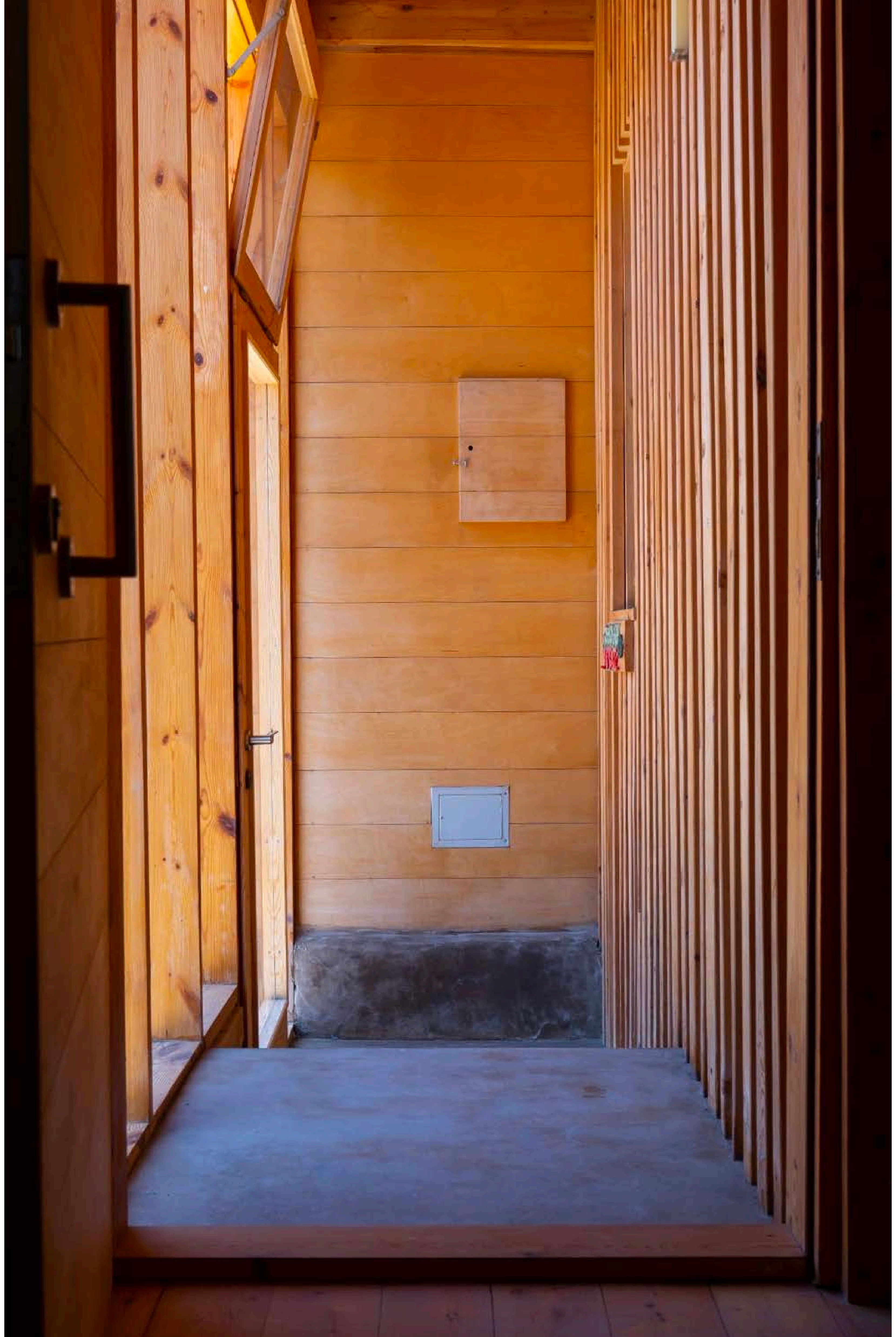
floor coverings

The earthen floor in the windbreaker section of the main entrance was applied by the building owners.

The lowest layer was prepared by ramming together local soil, gravel, and sand.

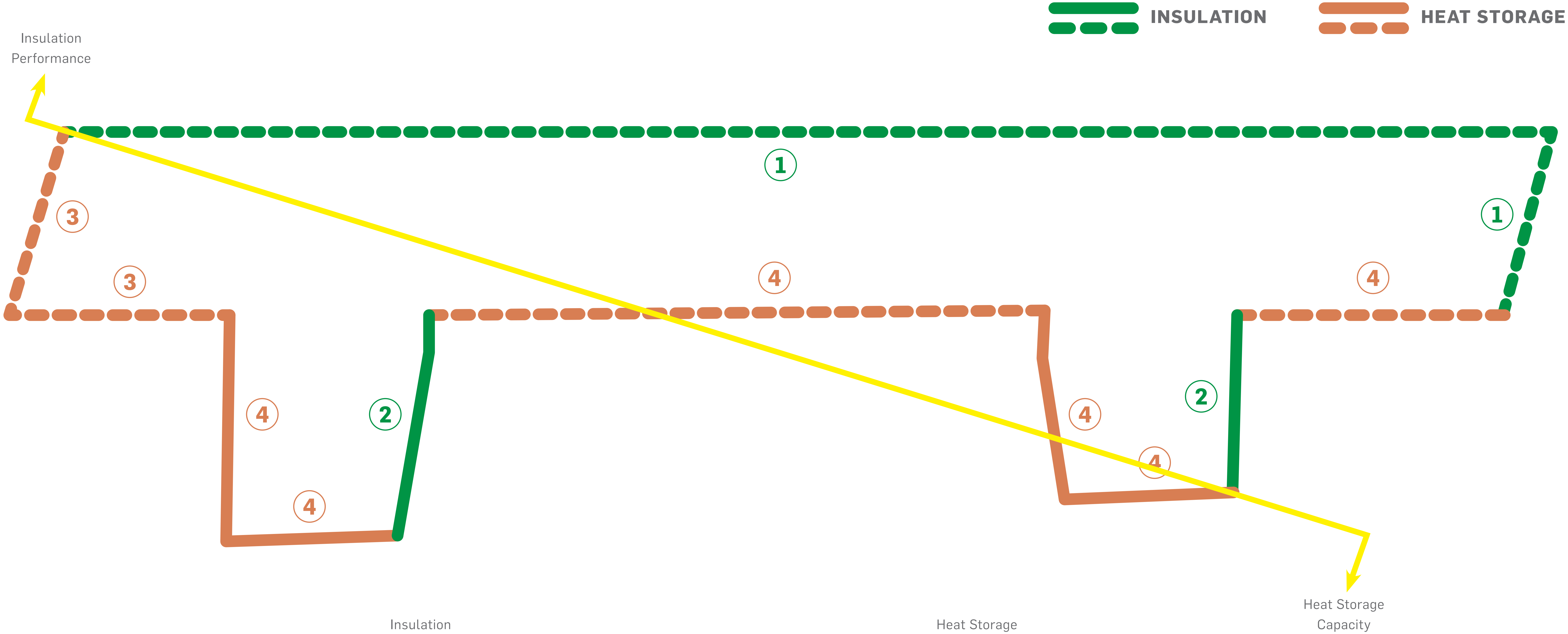
On the top 2 layers, a thinner and sifted soil mixture was applied through plastering.

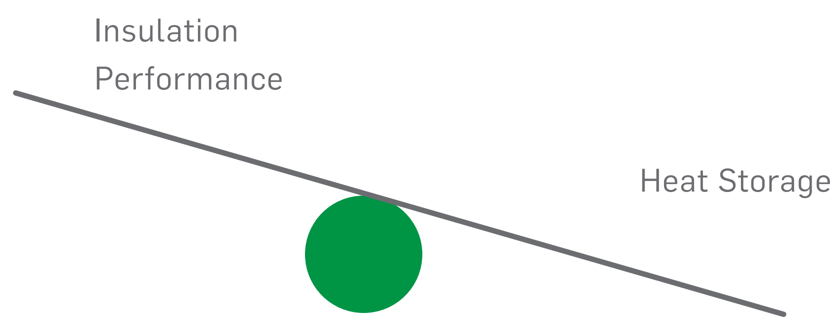
Finally, the covering was made more water resistant by applying linseed oil and Auro's natural lacquer.

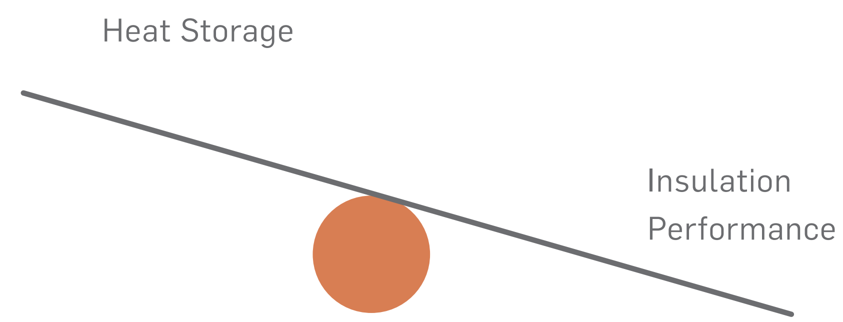


façade details

Two different parameters were considered in the façade design:
Thermal insulation performance and heat storage capacity.



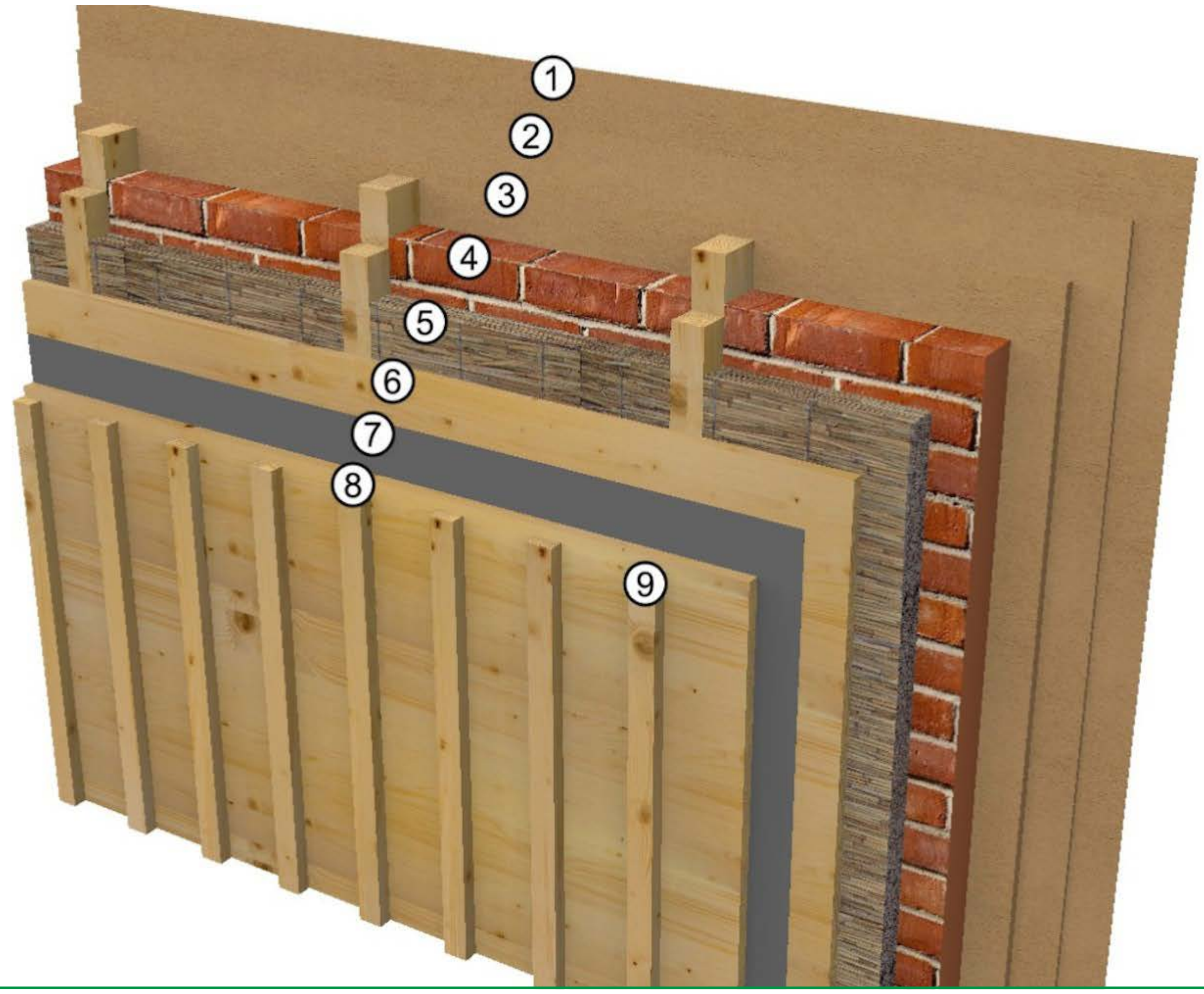




1) North Façade / plaster
2) East Façade / wood veneer
3) South and West Façades / plaster
4) South and West Façades / wood veneer

east façade / thermal insulation

1) Okil decorative plaster *(3 mm)*
2) Okil thin plaster layer *(1 cm)*
3) Lemix clay panels *(22 cm)*
4) Adobe filling between wood carcass *(10 cm)*
5) Reed cane insulation plate *(5 cm)*
6) Windbreaker, impermeable separation layer open to diffusion
7) Diagonal wood veneer with a cross section of 2 x 17cm
8) Vertical wooden boards with a cross section of 2 x 17cm
9) Vertical wooden slats with a cross section of 3 x 5 cm



THICKNESS
24 cm

EMBEDDED ENERGY
> 66 kW / m^2

U VALUE
0,51 W / m^2K

HEAT STORAGE CAPACITY
128 KJ / m^2K

4

5

6

west façade / heat storage

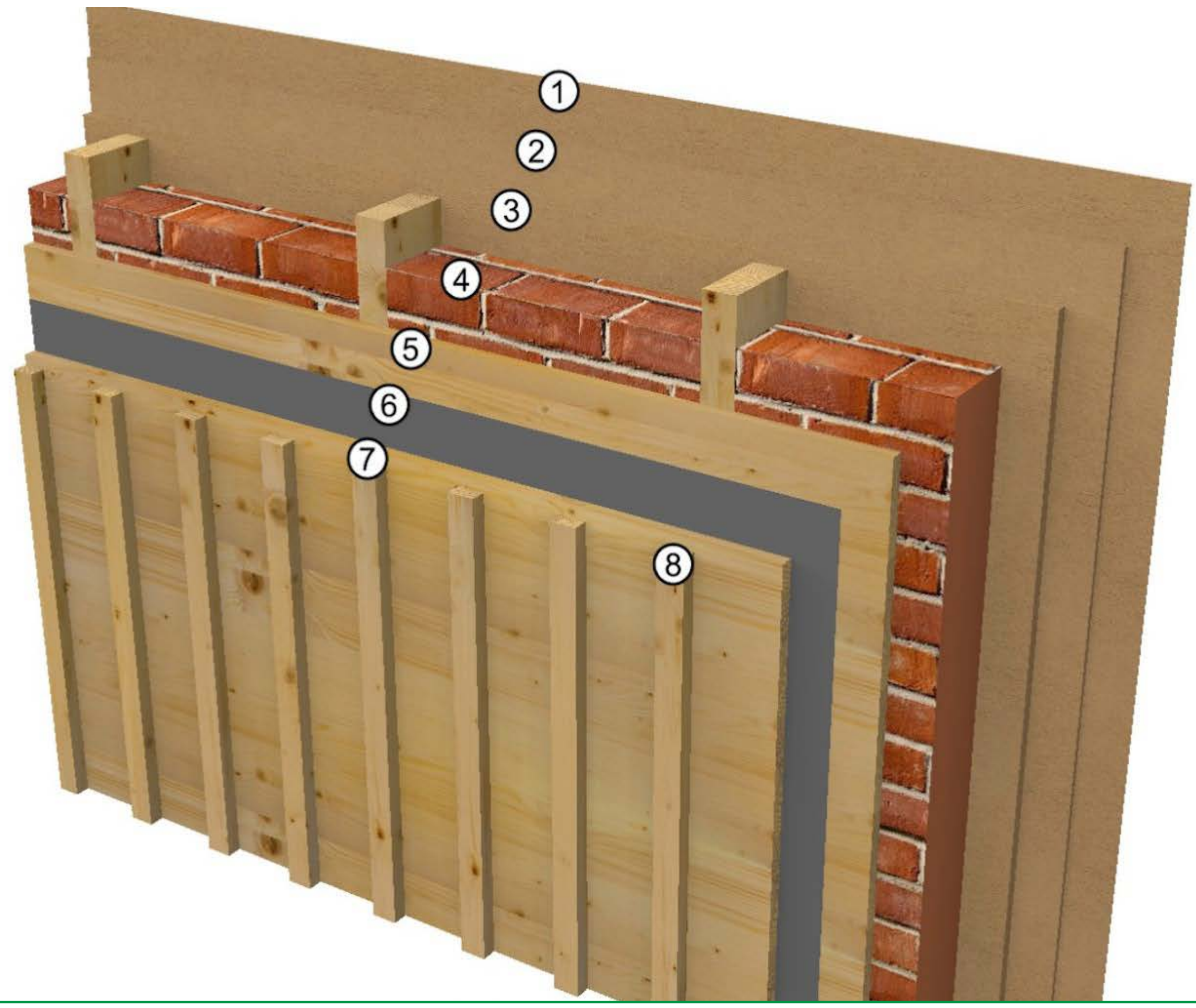
1) Okil decorative plaster *(3 mm)*
2) Okil thin plaster layer *(1 cm)*
3) Lemix clay panels *(22 cm)*
4) Adobe filling between wood carcass*(16 cm)*
5) Windbreaker, impermeable separation layer open to diffusion
6) Diagonal wood veneer with a cross section of 2 x 17cm
7) Vertical wooden boards with a cross section of 2 x 17cm
8) Vertical wooden slats with a cross section of 3 x 5 cm

THICKNESS
24 cm

EMBEDDED ENERGY
> 76 kW / m^2

U VALUE
0,81 W / m^{2}K

HEAT STORAGE CAPACITY
138 KJ / m^{2}K



3

4

5

south façade / heat storage

1) Okil decorative plaster *(3 mm)*

2) Okil thin plaster layer *(1 cm)*

3) Lemix clay panels *(22 cm)*

4) Adobe filling between wood carcass*(16 cm)*

5) Diagonal wood veneer with a cross section of 2 x 17cm

6) Windbreaker, impermeable separation layer open to diffusion

7) Heraklith insulation and plaster holding panel (25 mm)

8) Baumit powerflex filler plaster

9) Baumit Granopor decorative plaster

THICKNESS

24 cm

EMBEDDED ENERGY

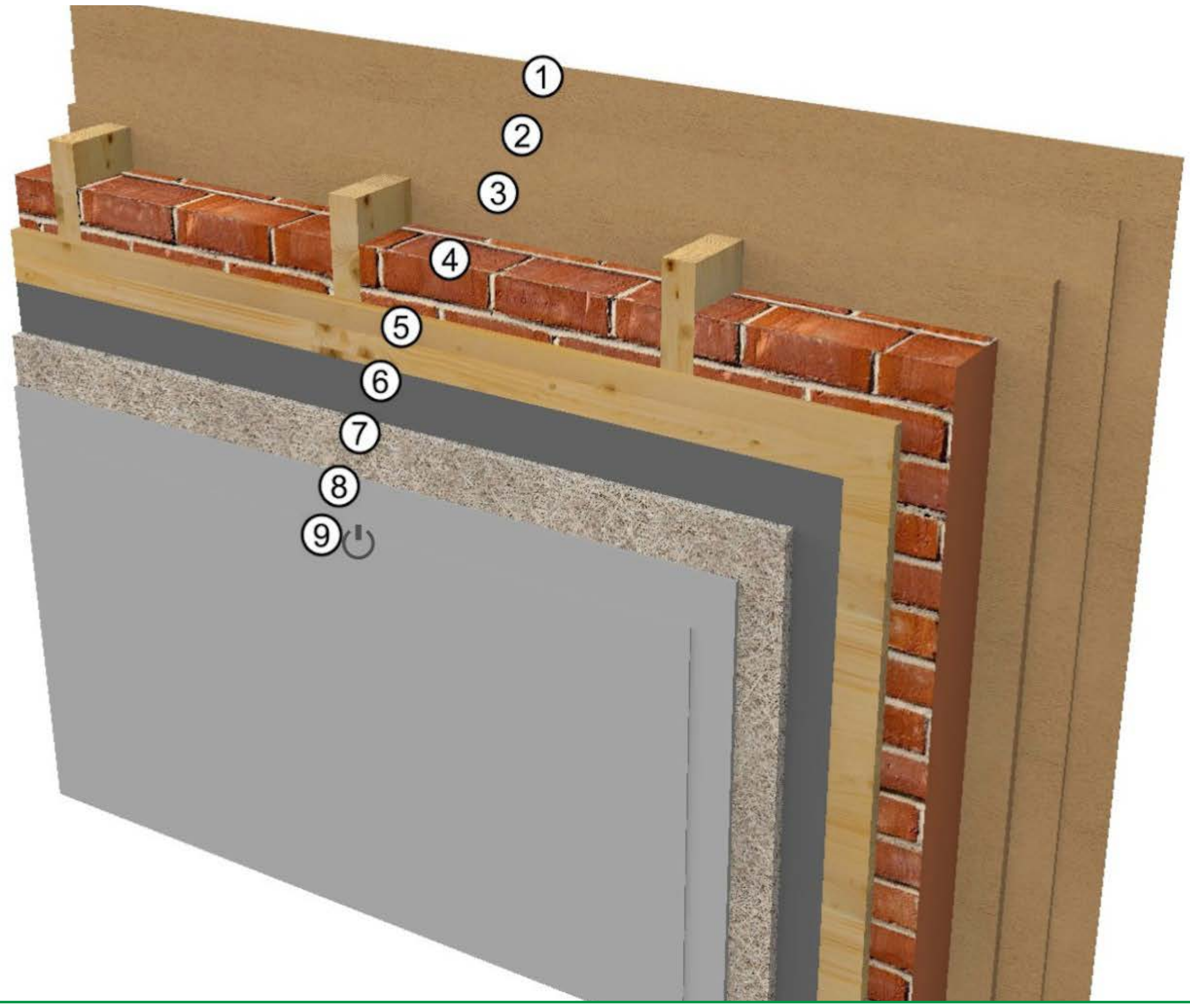
> 86 kW / m²

U VALUE

0,53 W / m²K

HEAT STORAGE CAPACITY

189 KJ / m²K



2

4

5

north façade / thermal insulation

1) Okil decorative plaster *(3 mm)*

2) Okil thin plaster layer *(1 cm)*

3) Lemix clay panels *(22 cm)*

4) Adobe filling between wood carcass *(10 cm)*

5) Reed cane insulation plate *(5 cm)*

6) Diagonal wood veneer with a cross section of 2 x 17cm

7) Windbreaker, impermeable separation layer open to diffusion

8) Heraklith insulation and plaster holding panel (25 mm)

9) Baumit powerflex filler plaster

10) Baumit Granopor decorative plaster

THICKNESS

24 cm

EMBEDDED ENERGY

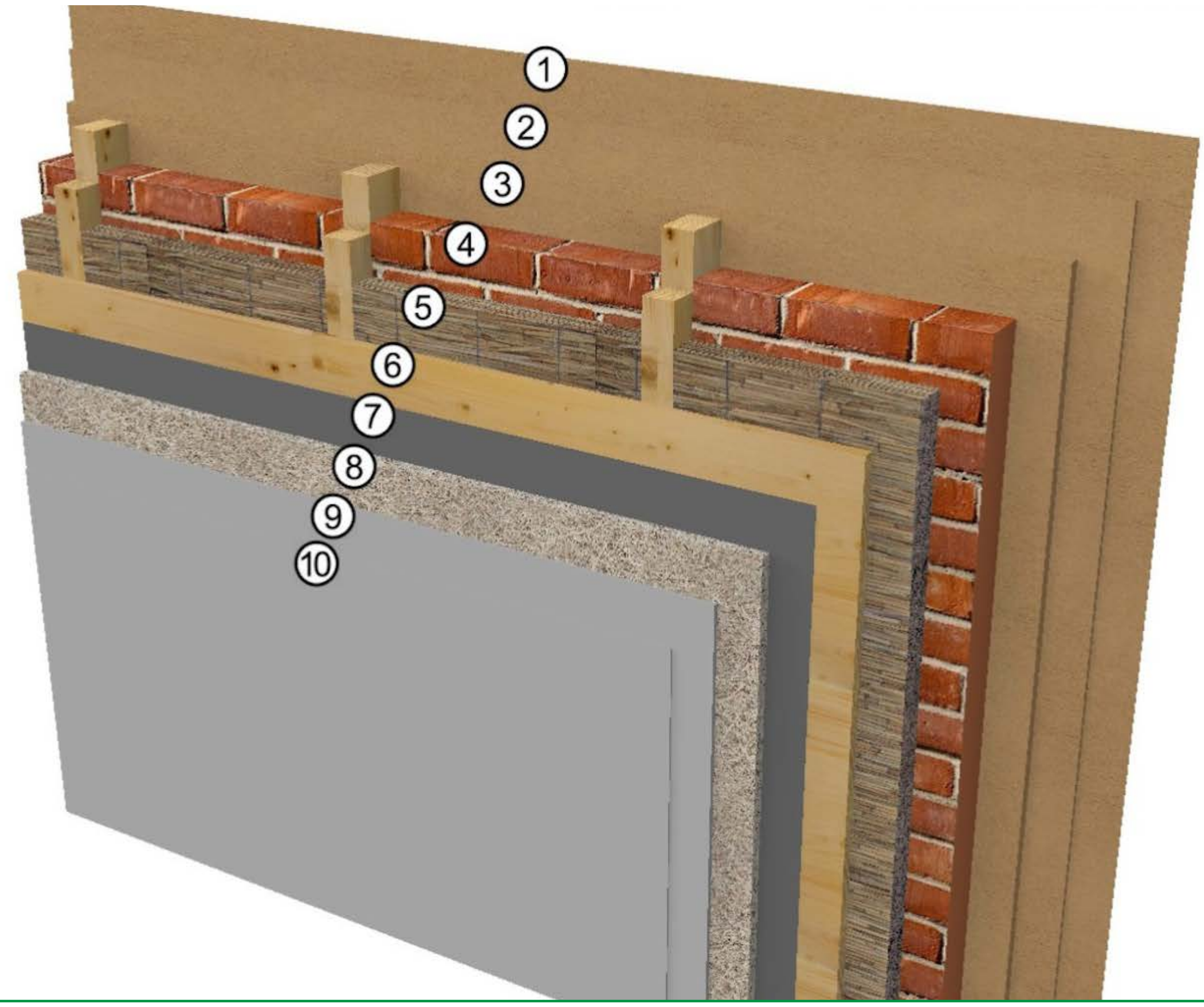
> 75 kW / m²

U VALUE

0,49 W / m²K

HEAT STORAGE CAPACITY

131 KJ / m²K



4

5

6

interior wall structure

In order to maintain the temperature inside the building in the winter, some of the walls are heated by creating radiation heat.

Radiation heat allows for the heating of large surfaces with low temperatures, and also minimizes dust circulation in the interior while contributing to thermal comfort.

Two local masons built the walls with 23,000 adobe mudbricks. These mudbricks that were built inside all of the walls and partition walls of the south and west façades were placed in rows of two. Using clay mortar, which is the raw material of the adobe mudbricks, the wall fillings were completed in 2 months. Instead of rough earth plaster, Lemix clay panels were installed. For the first time in Turkey, clay panels were used as a material and technology in construction. Afterwards, while Okil fine and decorative plasters were applied to some parts of the building, Auro's clay paints were applied on the soil plaster in other parts. The use of clay paint in the building broke new ground in our country as well.

The structural strength of the wooden frame against lateral loads was provided through cross bracing wooden boards mounted on one side of the entire carcass. In order to ensure the adhesion of the outer plaster and to add extra heat insulation, heraklith panels made of wood fiber were mounted on the cross boards. These panels were covered with Baumit powerflex fine plaster and granopor decor plaster. When choosing the exterior plaster, the flexibility offered by the product, its diffusion value, and low environmental impact after use were taken into account.

interior wall structure

Fine and decorative earth plasters were applied on the clay panels throughout the living spaces of Biohouse.

CLAY PANEL FEATURES

100% recyclable
Produced with completely natural and raw materials and throughout sustainable processes.

Indoor climate
With its high heat storage capacity and humidity balancing feature, it **regulates the room temperature and humidity exchange**, thus providing an ideal indoor climate.

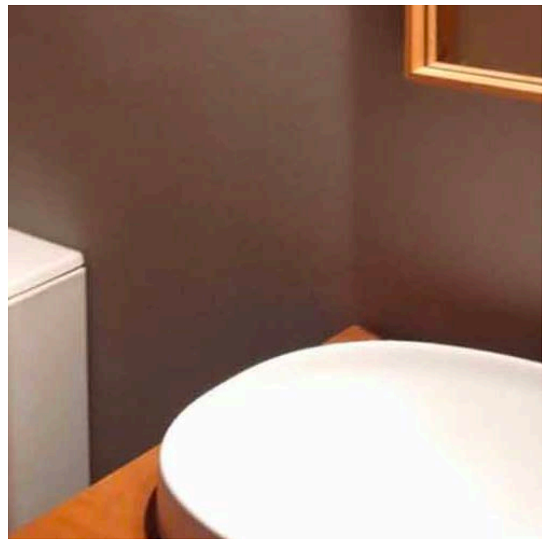
Dirt and Odor
Neutralizes indoor air pollutants and **prevents mold**. It also absorbs odors while neutralizing the air.

Sound insulation
By using 22 mm clay panels, an 11 cm wall was created with appropriate wall layers. As a result of a test carried out in accordance with the DIN EN ISO 10140-2 standard; the sound insulation of the walls was valued at **51 dB**.

Non-flammability
Since its expansion density is 1450 kg/m3, the panels are categorized as **A1 class fireproof.**

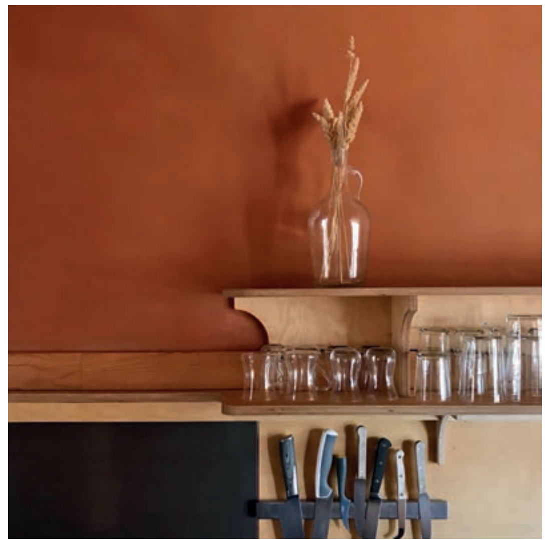
interior wall structure

Fine earth plaster was applied on the clay panels in the living areas of the Biohouse.



WET AREAS

In the wet areas, ceramic tiles were only used in the shower and for the sink backsplashes, and earthen plaster was applied to the remaining walls.

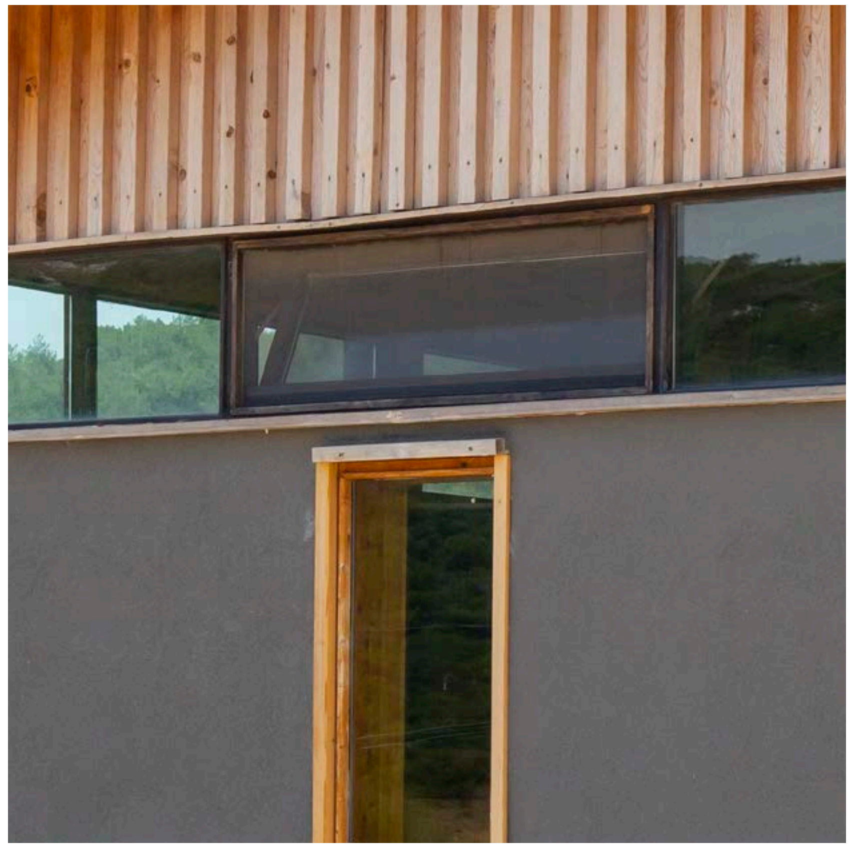


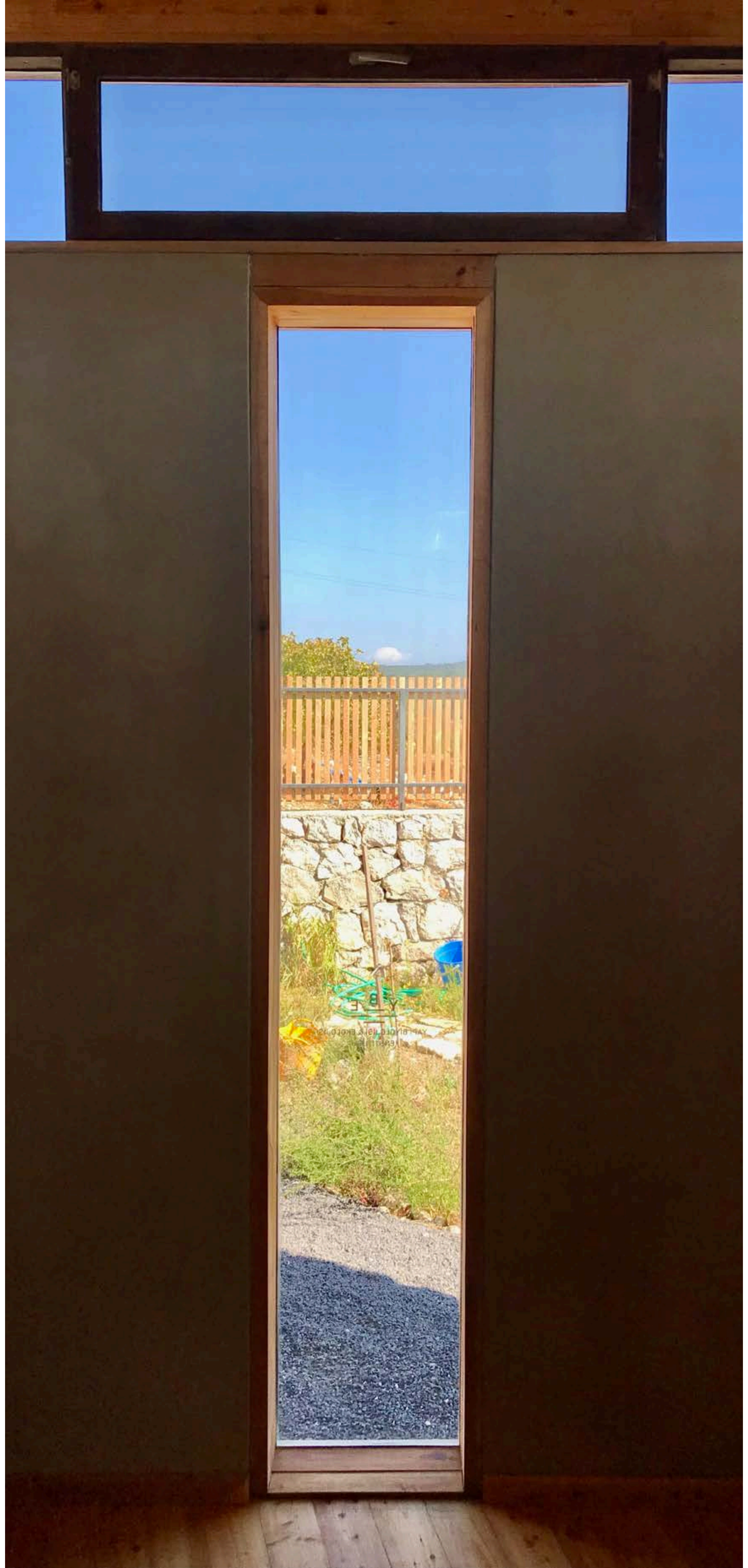
KITCHEN

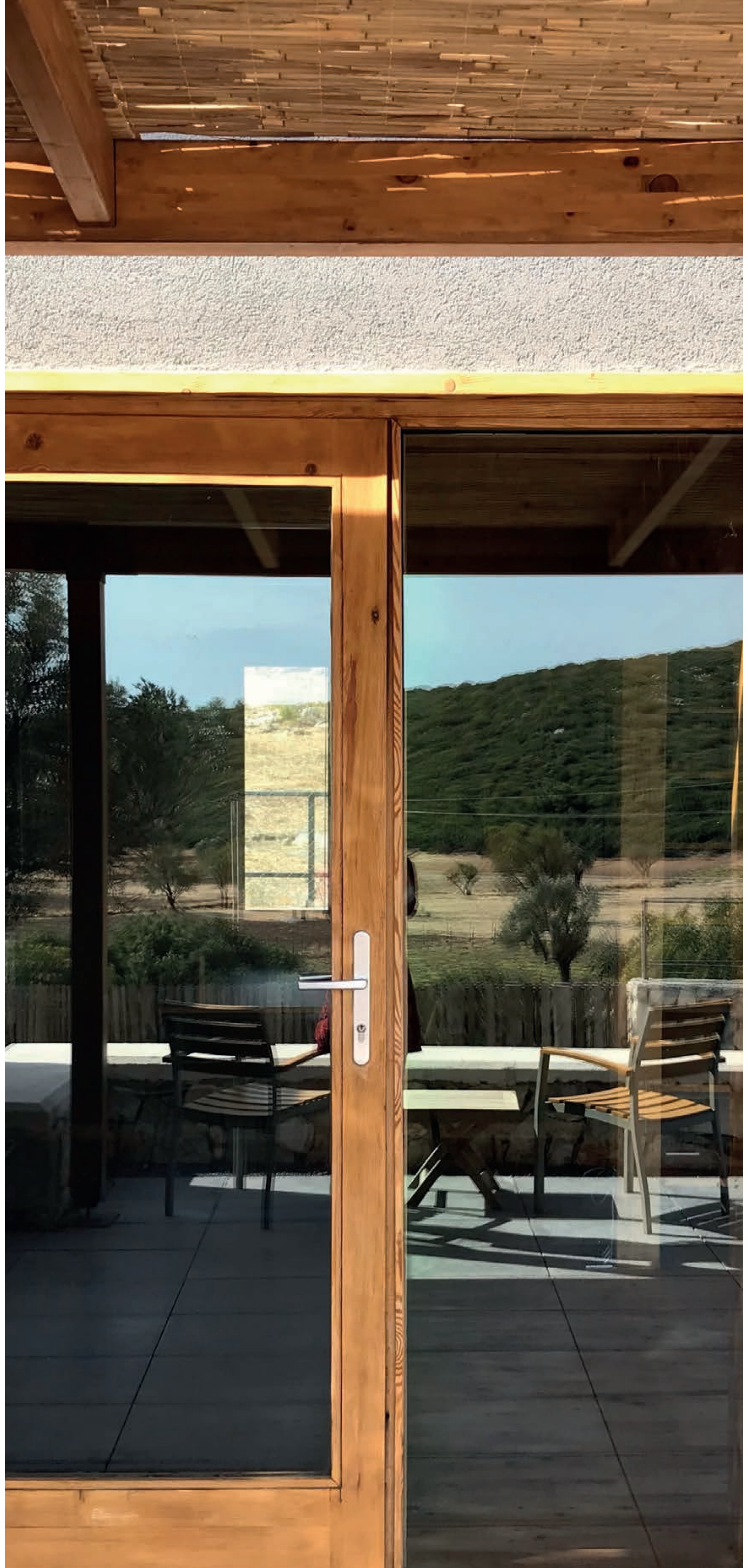
The colored wall in the kitchen area was obtained by mixing plant-based paints.

windows + joinery

All door and window joinery was produced in a local carpenter's workshop. The joinery used in the building is made of solid laminated wood and treated with natural oils to protect from external conditions. The windows that are placed horizontally at +3.50m throughout the whole building elevation serve for both ventilation and as skylights. Black natural paint was used on the upper windows, while Auro oak natural paint was used on the lower windows and doors. The windows are double glazed and are composed of two different glass thicknesses in order to provide heat and sound insulation.







roof solutions

Due to the form of the building, two roof systems are used. Titanium zinc was chosen for the pitched roof. Metal roofing was preferred due to its longevity and quality of workmanship. For flat roofs, a method close to a green roof system was preferred for its thermal insulation and thermal storage properties.

roof solutions
flat roof layers

INSIDE OUT

1 Wood Structural System

2 Wood Paneling *(24 mm)*

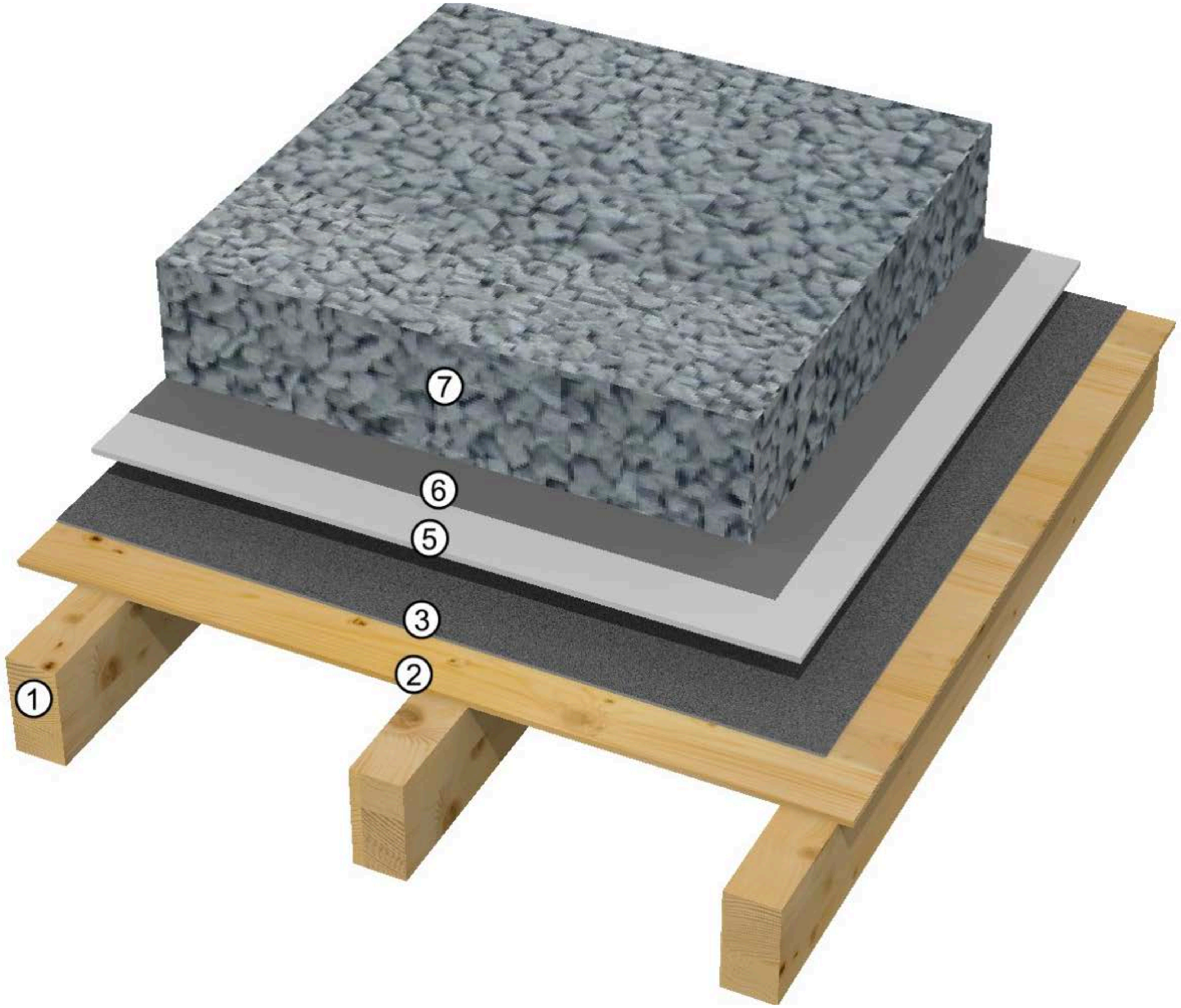
3 Bituminous waterproofing membrane

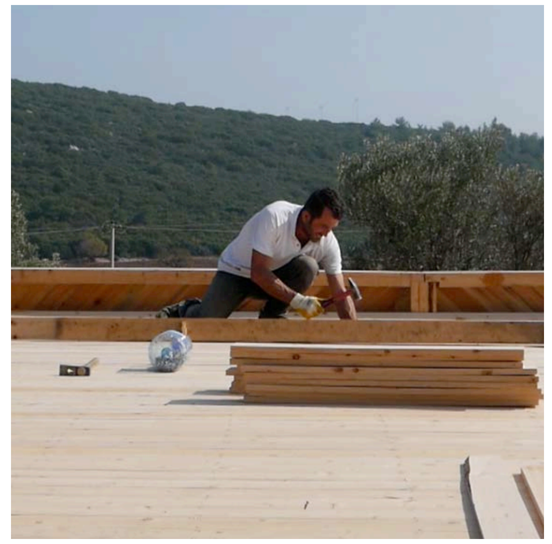
4 Liquid waterproofing

5 Root holder membrane

6 Viol

7 Pumice *(10 cm)*

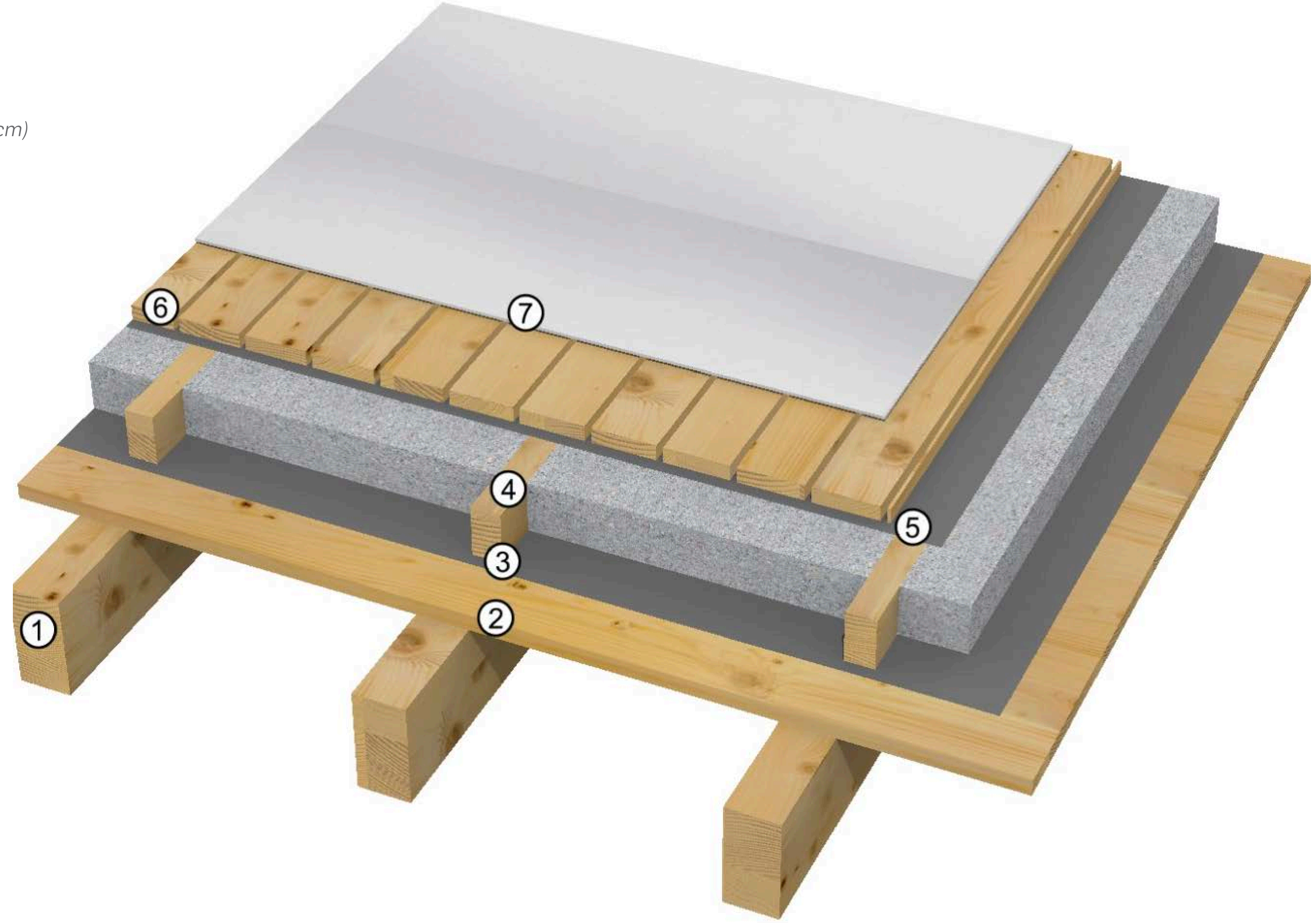




roof solutions
pitched roof layers

INSIDE OUT

1. Wood Structural System
2. Wood Paneling *(24 mm)*
3. Cellulose thermal insulation between roof beams *(7 cm)*
4. Moisture barrier *(3 mm)*
5. Poplar plywood veneer *(25 mm)*
6. Moisture diffusion cover with separator *(5 mm)*
7. Rheinzink zinc roof system



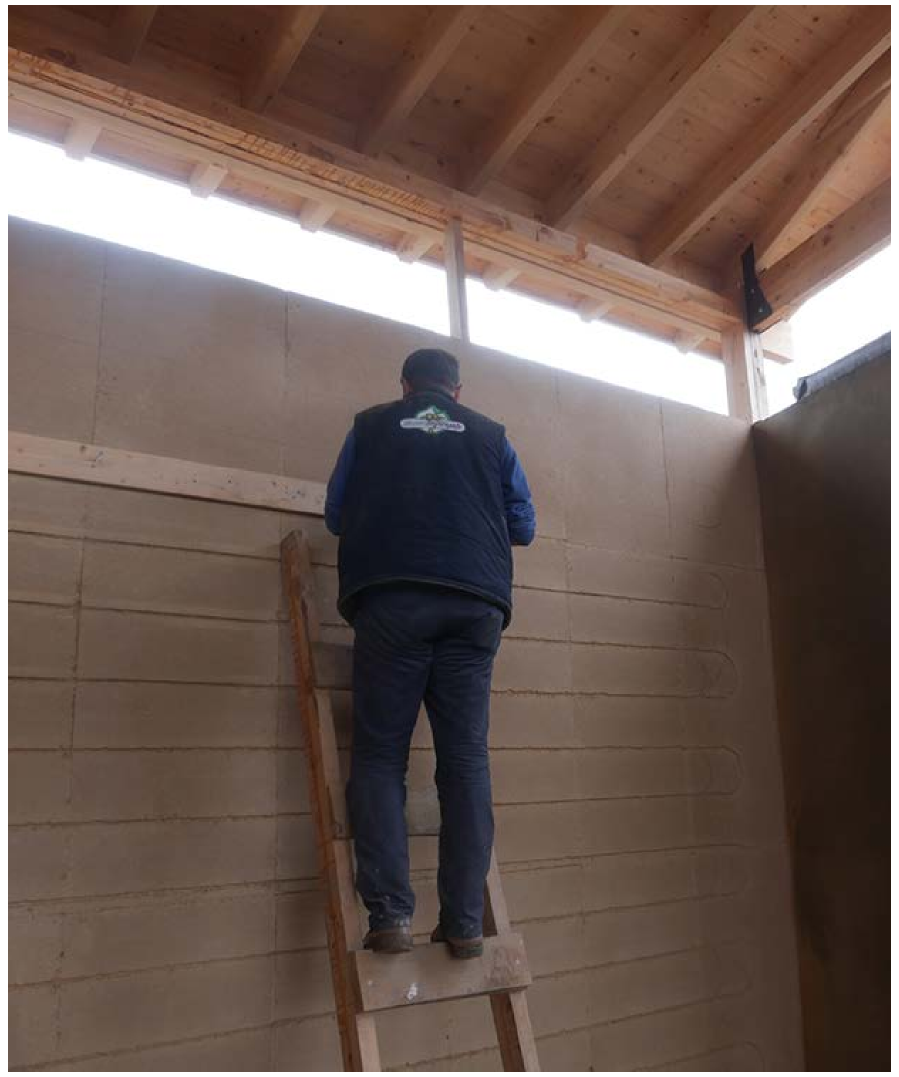
passive
climate control

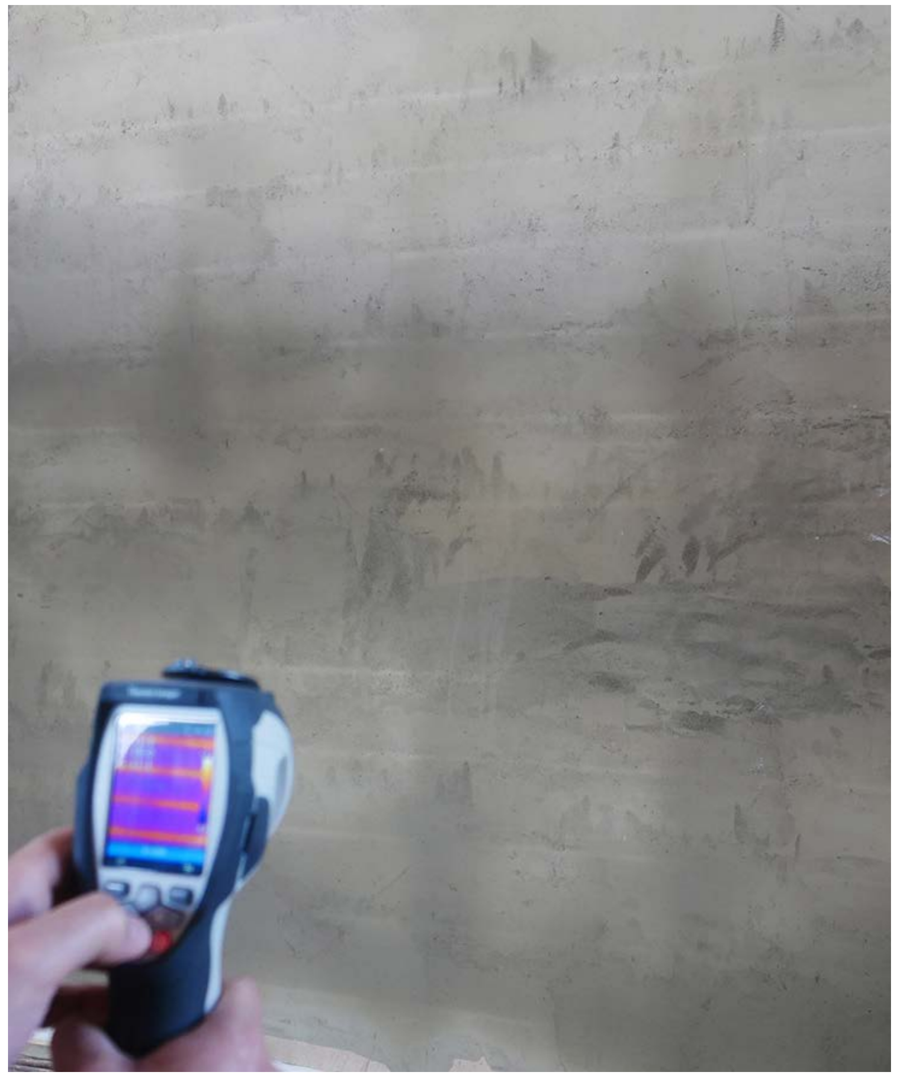
Transom windows at appropriate heights were placed on the façades in order to provide passive climate control during the summer season. Window openings and heights on each façade were determined accordingly. With the high heat storage capacity of the south, south-east and south-west walls and the greenhouse effect originating from the windows, the ideal indoor comfort temperature is achieved by taking advantage of the multitude of sunny days during the winter months. The aim is to minimize the energy need for heating and cooling of the building with passive architectural solutions.

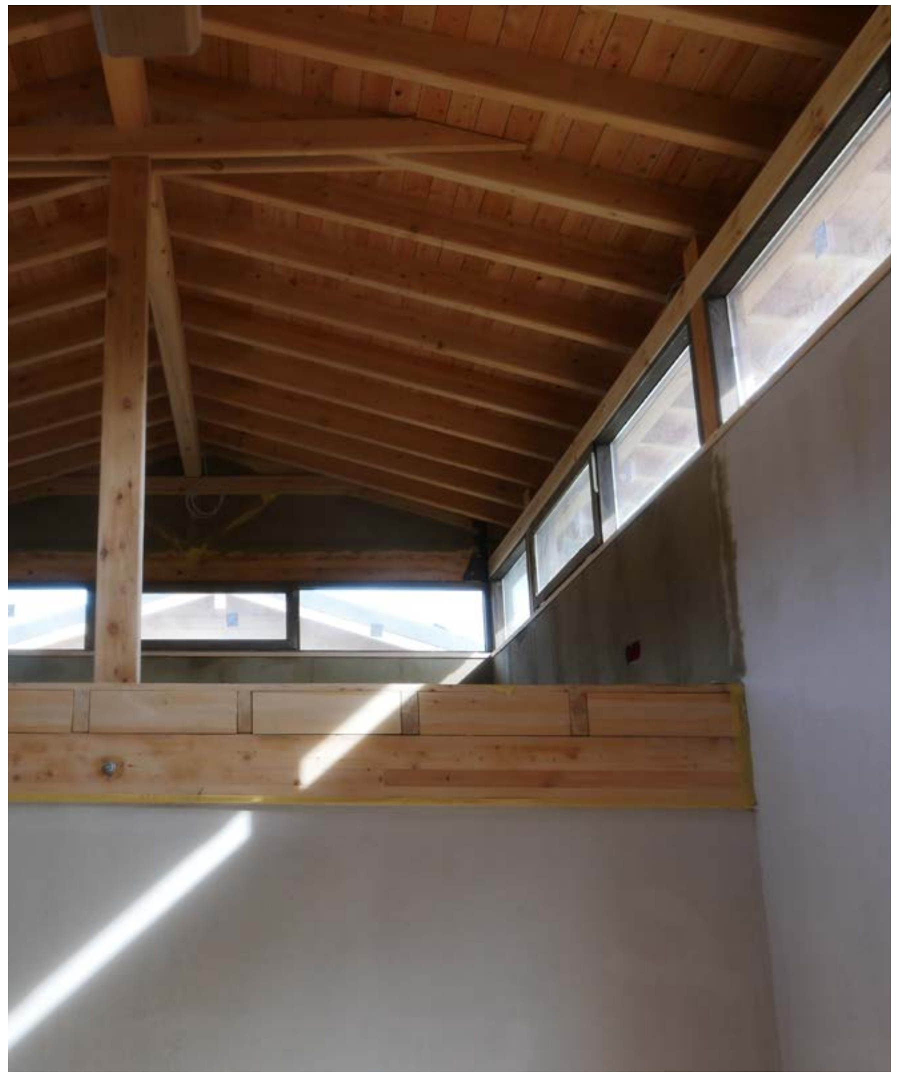
active
climate control

active climate control

Active climate control in the building is provided by the wall heating system in winter and transom windows in summer. For the wall heating system, low-voltage electrical resistance wires are laid out on the inner surfaces of the east and north wall facades and covered with fine and decorative earth plaster. The heat given by these low-current wires spreads over the entire surface of the wall and with the storage capacıty of the clay based materials, is maintained for a certain amount of time. With special sensors placed on the panels and the automation system installed, the system works in line with the desired values.







utilities

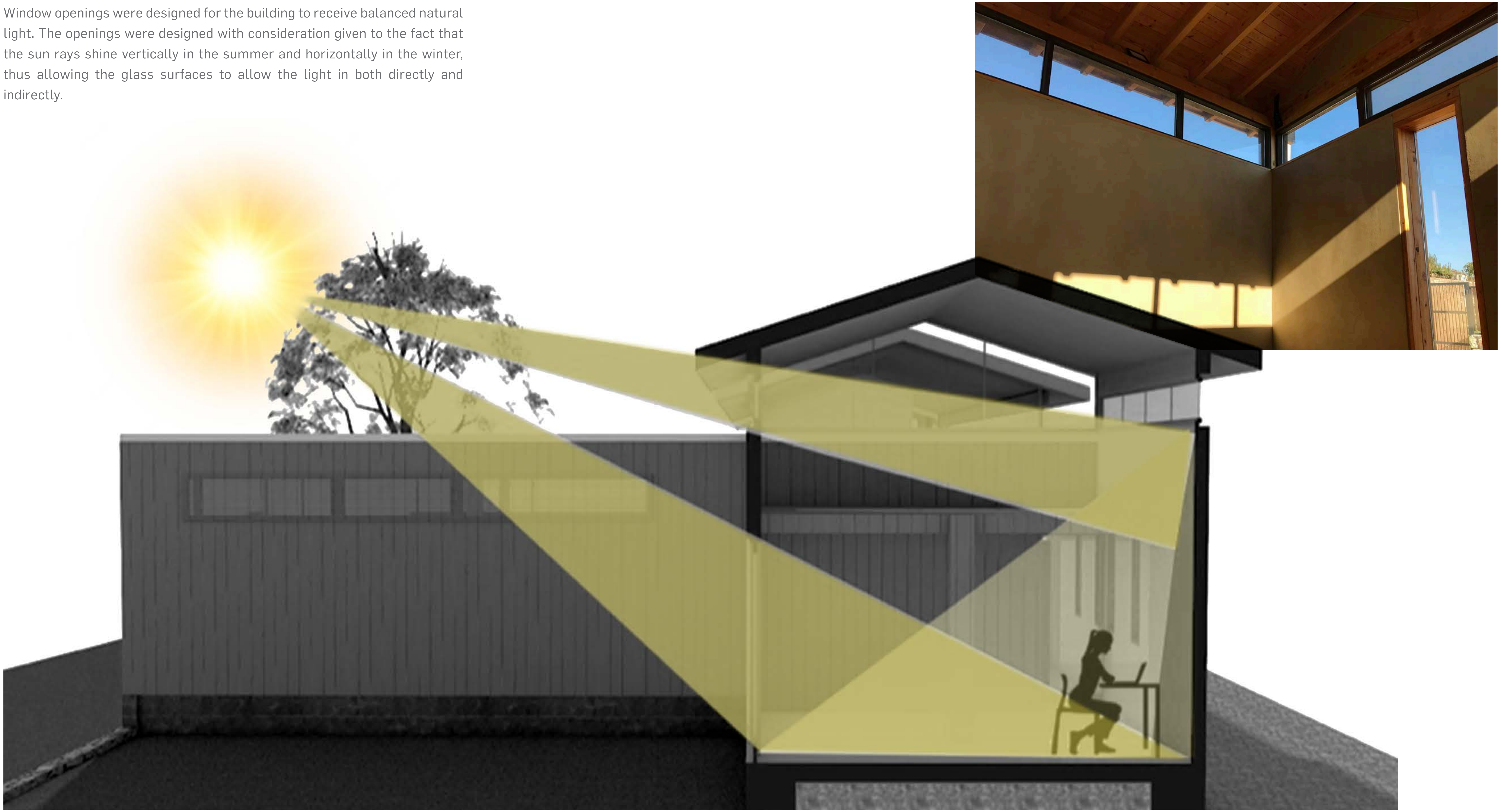
In order to reduce the dependence on the grid and against the frequent power cuts in the region, a solar panel with a capacity of 10 kW is planned to be installed.

In addition, with the 4 thermal panels that are located on the roofs and the double serpentine boilers they are connected to, the need for water heating in summer and winter months are met.

The optimization and management of the technical systems of the building are combined in a specially designed and acoustically insulated technical room.

natural lighting

Window openings were designed for the building to receive balanced natural light. The openings were designed with consideration given to the fact that the sun rays shine vertically in the summer and horizontally in the winter, thus allowing the glass surfaces to allow the light in both directly and indirectly.

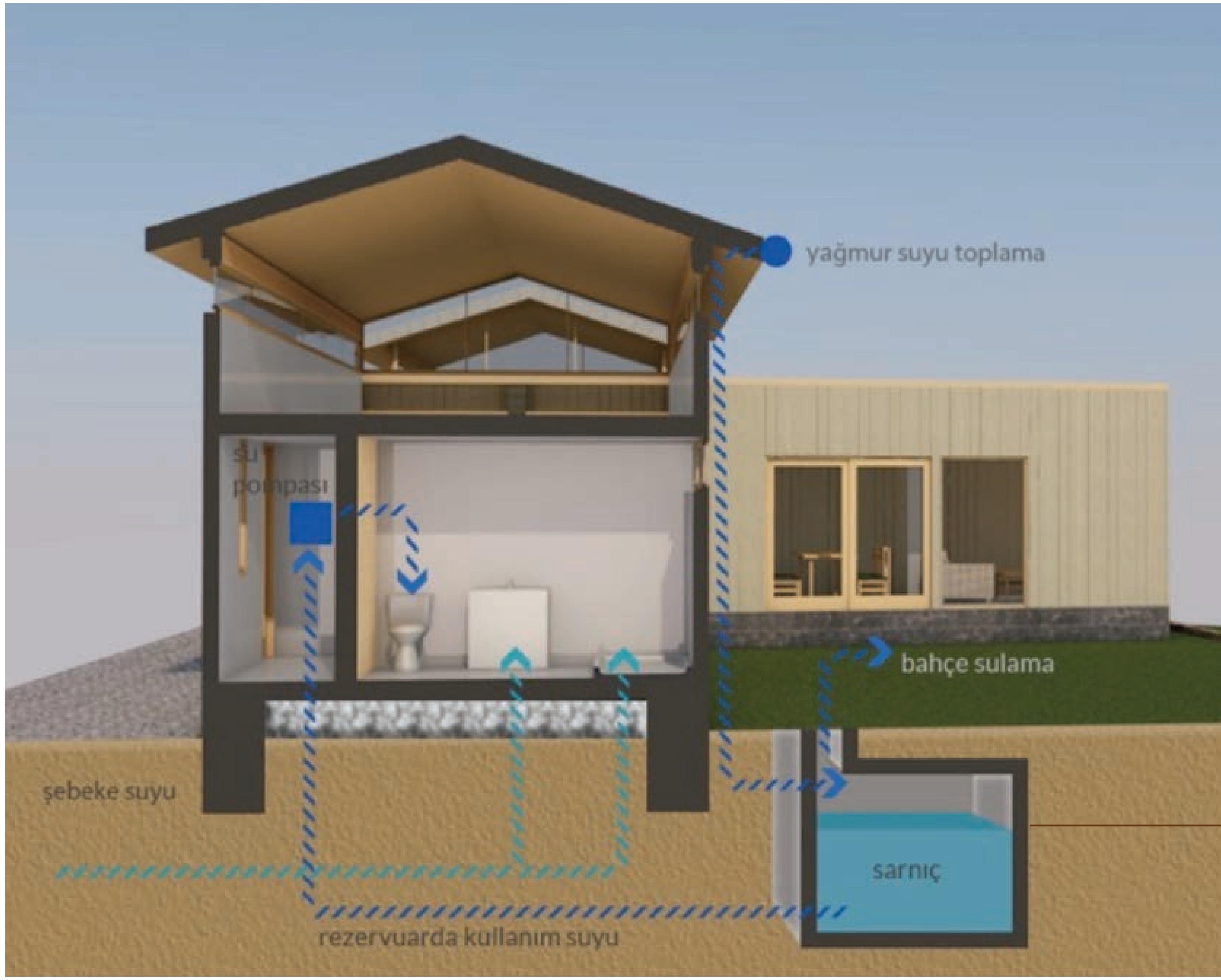


artificial lighting

In order for the metabolic melatonin hormone to be secreted in the evenings, it is necessary to provide appropriate lighting that does not contain blue color. For this reason, an artificial lighting system was created at different wavelengths (according to yellow and blue wavelengths) for the different times of the day. In addition to this, the overall lighting design of the building was made by taking into consideration criteria such as the level of illumination required by indoor activities, the correct selection of lighting elements, and their location.

water use

A 2-line plumbing system was designed in order to reduce the external dependency for water use. Rain water is collected in cisterns via hidden streams and drainpipe systems that are located on the roof. Due to the dry summer climate, the collected rain water is primarily used for garden irrigation and, if necessary, inside the building. Indoors the collected water is mainly used in the sinks, showers, and laundry.



GARDEN CISTERN

AND AKMAN & MERVE TİTİZ AKMAN

bíohouse actors

BUILDING BIOLOGY & ECOLOGY INSTITUTE OFFICE


AURO
AURO
HAGA
LEHMCOLOR
FARBKOLLEKTION
bauhaus
urban style


SANATIN YENİ TARİHİ
Fernlehrgang Baubiologie
Teil 1
Fernlehrgang Baubiologie
Teil 2

life in biohouse

life in biohouse


dy
md
DOĞAL YAPI
MALZEMELERİ
VE YÖNTEMLERİ
DERNEĞİ
dy
md
DOĞAL YAPI
MALZEMELERİ
VE YÖNTEMLERİ
DERNEĞİ

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BUILDING BIOLOGY & ECOLOGY INSTITUTE TRAINING

life in biohouse

OVADA APPLIED BUILDING WORKSHOPS

OSMANGAZİ UNIVERSITY VISIT

YAŞAR UNIVERSITY VISIT

SPONSORS

All of our sponsors readily offered their support as Biohouse is the first building in Turkey to be designed and implemented with the building biology approach and hosts the Building Biology and Ecological Institute.

AURO's wood paint, oil, and lacquer products were primarily preferred because of their natural ingredients, chemical-free composition, human and environmental friendliness. Auro provided the black paint of the upper window joinery, the oil and varnish of the floor joints, and the clay paints for the wall free of charge.

LEMIX panels consist of compacted earth and binder sawdust fibers. Due to its suitability and practicality for the dry construction system, it was preferred for demonstration purposes instead of coarse earth plaster. Thanks to the support provided by the Lemix brand, the panels were provided free of charge.

RHEINZINK provided the entire zinc roofing material free of charge and directed its expert team to the construction of Biohouse.

With the support of **OKİL** Natural Building Materials brand, Okil ready-made fine and decorative clay plasters were applied on most of the interior wall surfaces of the building. These ready-made clay plasters, which started to be produced for the first time in Turkey by Okil, were preferred because of their clay-based, completely natural content, and standardized product quality.

BAUMIT executed the necessary tests to find the right products for the exterior of the building and provided discounted purchase of materials in the construction of Biohouse. It also provided material support for the application of Klima brand lime-based indoor plaster for testing purposes.

With the material support of **FORBO,** veneer sheets produced from natural raw materials such as linseed oil and wood flour in the Furniture Marmoleum series were applied for the first time to the Building Biology and Ecological Institute head office desks in Kadıovacık Biohouse.

With the material support of **ÇİMSTONE,** the sets of 3 different kitchen counters of Biohouse were covered. Çimstone products were preferred due to their high level of natural quartz content and environmental approach.

With the support of **METSIMS,** Kadıovacık Biohouse became the first building in Turkey where a building life cycle analysis was carried out. In order to carry out a comprehensive analysis, all necessary information about the construction stages and materials used was shared objectively and included in the analysis by Metsims.

TEKNİK TESİSAT ENGINEERING has executed the heat loss calculations of the building.

OĞUZ YASARGİL, with his environmental awareness, ethical values and years of design experience, has enabled the Building Biology and Ecology Institute (YBE) to represent itself with the most appropriate design language. He carried out the corporate identity work of YBE in 2015, and since then, the design elements of the YBE identity continue to be used with pleasure. For the graphic works needed for the identity and contents of the Biohouse, he has captured the expression and order that is both original and consistent with the stated approach. His sensitivities and knowledge are also a great wealth for the YBE team.

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