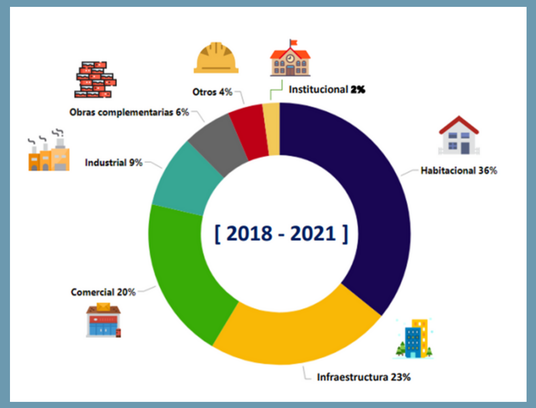
Analyses of the market in Costa rica



The construction sector plays an essential role in this task, as it is the main world consumer of raw materials, using 40% of global energy resources, and generating between 25% and 40% of the world's carbon emissions, according to data from the European Commission and the World Economic Forum. In Costa Rica the largest part of the totall construction is housing (36%). In 2018 before Covid the construction was 5.3% of the GDP (Gross domestic product) reaching 10.2 million. In the country, products based on cementitious materials have traditionally been used that allow a low initial cost and great speed of installation. However, these have historically presented problems to guarantee the fulfillment of the seismic requirements and their production represents a significant energy consumption and emissions.

Energy and Water

Energy supply

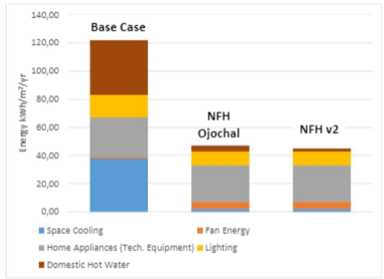
The energy supply system of the NFH Ojochal is based on electricity from the grid to powerelectrical demands and a 200L thermal collector to cover DHW demands. Electrical installations have been planned for future installation of photovoltaic arrays to generate on-site electrical energy.

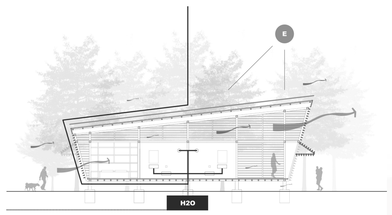
Water supply

The building is connected to the generall water network. The rain that falls on the roof is captured and transported to a tank underneeth the building. The rainwater is used for the toilet and other parts.

Space cooling

The building is for the most part beeing cooled with naturall ventilation. By making the building higher on the other side the air is being pushed togehter. There are also fans for extra ventillation and cooling.

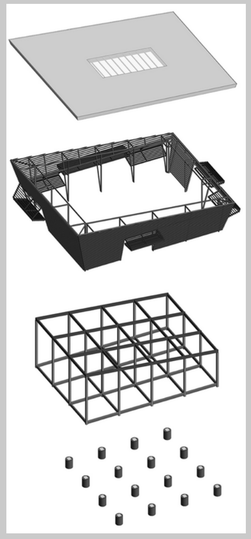




Material usage

- **Groundwork and Foundations: Isolated reinforced concrete foundations.**
- **Structure: Structural steel (cold formed) with anticorrosive finishes.**
- **Facade: Structural steel, steel plates, anticorrosive finish, radiata pine louvers and folding doors, windows with 6mm single-pane glass an aluminium cladding and plastic mesh for natural ventilation and mosquito-control.**
- **Inner Walls: steel framing with plastered drywall and melamine panels, windows and doors with 6mm single-pane glass an aluminum cladding and plastic mech for natural ventilation an mosquito-control.**
- **Floor Structure: structural steel (cold formed) with anticorrosive finish and radiata pine floor finish.**
- **Outer Roof: structural steel (cold formed), corrugated and coated steel sheets as a roofdeck and coated steel gutters and flashings, gypsumboard ceiling with aluminum-polyethylene foam insulation**
- **Fixed Inventory: plumbing fixtures, refrigerator, kitchen hob and oven, other.**
- **Stairs and Balconies: reinforced concrete strip foundation, structural steel (coldformed) with anticorrosive finish and radiata pine floor finish.**

The choice of the materials are based on availability on the local market and the enivromental impact. The climate also has a lot of impact on the choice of the materials for example the Pinewood and the flooring.



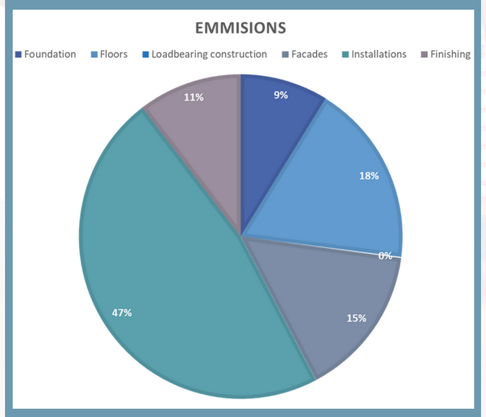
Transport

The transport to the construction site has been done with 2 trucks (1 for the foundation and 1 for the other materials). This has been done to minimise emissions during the transport. By doing this all of the porducts are on the site on time so there won´t be any delay on site.

NFH

The realisation of the NFH (No Footprint House) in the Netherlands.

Dividing of the emissions of a bungalow in the Netherlands



This pie-chart shows the emmisions for each category for a typical Dutch bungalow. It's build traditionaly with a concrete foundation, sand-lime brick as loadbearing walls, concrete floors, wooden window frames and bricks. As shown in the picture the installations take a big part of the totall, therefore we are going to lay our focus on this part.

Building regulations in the Netherlands

The Netherlands has a lot of building regulations which you can find in the Building decree (2012) these are from the Dutch goverment. We also have European regulations and laws to protect workers. In this documentation almost all of the rules linked to construction are visable. For our design there are a lot of important points amongst other things;

- **Structure**
- **Accesability**
- **Installations**
- **Daylight**
- **Fireproofing**
- **8**
- **etc.**

Bouwbesluit

Target audience

The Netherlands has a residence shortage of almost 300.000. 55% of municipalities call the shortage of senior housing the cause of this crisis. The shortage of senior housing was estimated at 80,000 in 2021. Annually this shortage grows by 20,000. The older people have in generall bigger houses because they worked their entire life. They want to move because their houses are too big only they have no place to move. Research has shown that among more than 82,500 homeowners aged 55 and older, 40% are thinking of moving to a smaller home.
That is why we are going to focus this project on the older people so they can make space for the younger people. To make this possible we need to take in account that a wheelchair has to be able to turn in the design. That's why we are going to make a larger bathroom combined with a toilet and a accessable frontdoor.

Building the NFH in the Netherlands

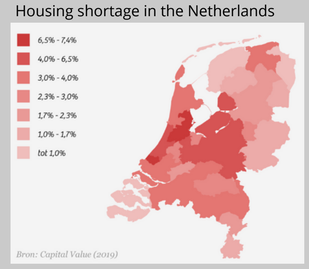
In the Netherlands, individual homeowners are experimenting with houses with a low footprint. The design in Costa Rica is made for a very different climate. To be able to place it in the Netherlands, many parts have to be machined. That makes it very difficult, so we're going to look at what the homeowners have done with these houses. we hope to get a lot of information by comparing them.

Residence shortage

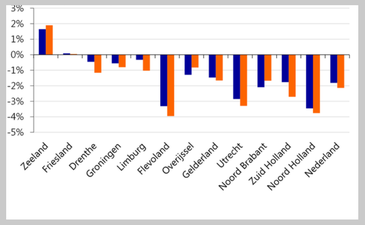
The Netherlands has a housing shortage of almost 300,000. It is especially difficult for first-time buyers on the housing market. The average age of someone leaving the parental home is 23.7 (2020) years, which is lower than the average age of 26 in Europe. Because there are not enough houses, the prices of an average house rise to € 419,000 (before the war in Ukraine). This is a lot of money that a normal young person cannot afford.

map of housing shortage

Housing shortage in the Netherlands



Housing shortage as a percentage of the housing stock per province



Instalations

Ventilation system with heat recovery:

We use a ventilation system with heat recovery. Balanced ventilation is an installation in which as much freshly filtered outside air is blown into the house as polluted air is removed from the house. The energy of the outgoing air (warmth in winter, coolness in summer) is transferred to the incoming air. In this way, balanced ventilation reduces the energy bill. In addition to the cold recovery, the ventilation system can be used to bring extra cold air into the house on a cool summer night.

Solar boiler/heat pump:

A solar water heater provides hot water with energy from the sun. In the summer, a solar water heater supplies almost all your hot water. This is not possible in winter, so we also install a heat pump. So that there is hot water on solar energy all year round.

Solar panels:

We use solar panels as much as possible, because solar panels save the most on CO2 emissions and on energy bills. However, a solar water heater is also used, because almost all power consumption is covered with the solar panels, so it is more economical to also install a solar water heater.

Conclusion:

We hope to be energy neutral by using these four systems. The systems work well together. The solar boiler works on solar energy, but cannot provide enough hot water all year round, in combination with the heat pump this is possible. The heat pump works on electricity, which is provided by the solar panels.

Spatial program

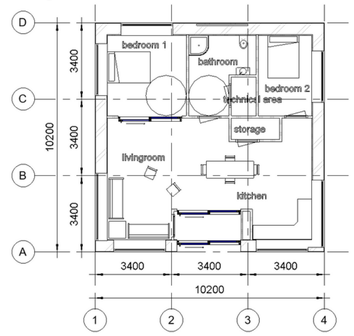
Room:	Surface in m2:
livingroom	35
kitchen	18
dinningroom	18
bedroom	21
bathroom	9
tecnical area	3
hall	7
fusebox	0,3
Total:	**111,3**

Schedule of Requirements.

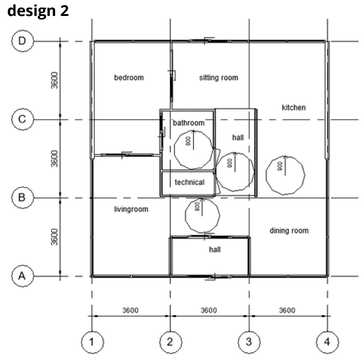
- **the house must have one storey**
- **the house has light colors (wood + white)**
- **the bedroom must be at least 3.2 by 3.5 meters**
- **in the bedroom there is a free space of 1.5 meters by 1.5 meters available for the turning circle**
- **The toilet should be raised so that it is easier to get up (between 46-50 cm)**
- **brackets for support points in the shower**
- **The floor is as high as the ground level so you can easily acces the building**
- **glass sliding doors are widely used within the house (for easy acces)**
- **in the bathroom there is a free space of 1.5 meters by 1.5 meters available for the turning circle**
- **the hall must be at least 1.5 meters wide**
- **in the bathroom, naturall daylight it's created by using a solar tube**
- **the house has to be as energy neutral as possible**

4 Design options

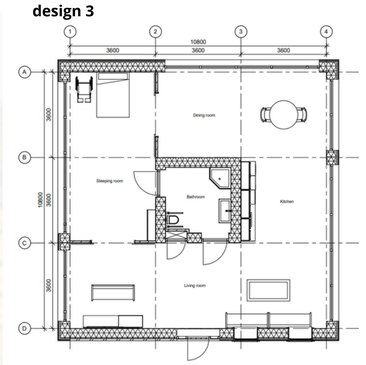
design 1



design 2



design 3

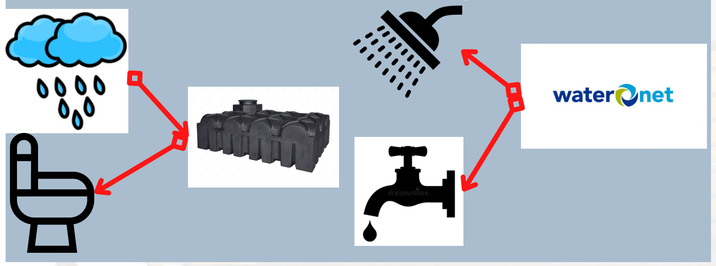


design 4

Watersupply

To make the home water energy neutral, it will only need a system to collect rainwater and filter it to use it in the shower and toilet. The dirnking water will be gained from the water network.

The way this will work is: Rainwater is collected from the roof and goes into the rainwater tank. This water will be filtered for use in the shower and toilet. Drinking water is coming from the water network.



NFH

The realisation of the NFH (No Footprint House) in the Netherlands.

Solar tube

This is Solar Tube. It provides light during daytime by the sunlight that enters the tube and strengthen the light while the sunlight passes trought the tube into the desired room. It's possible to use this in the roof to save space for solar panels. It is also possible to keep the skylight in the current shape (a big rectangle above the middle of the house).

Structural

The structure of the building consists of a concrete foundation which lay on a sand bed. In the Netherlands this is needed to prevent prolapse. On top of the foundation come wooden I-profiled beams (89x400mm, Distance between track centers 600mm) for the ground floor. On top of the beams (on the outside) which span 9 meters comes a structural timber-straw panel of around 3,6 meters high. As roof we also use the I profiled beams (58x400mm Distance between track centers 600mm) this because we can combine the freight with the beams used in the groundfloor.

Transport

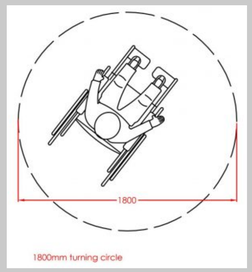
Not all of the materialls we are going to use come from the Netherlands for example the façade comes from Latvia. We are trying to get as much as possible materialls from the local market. Our goal for the tranportation of the materialls is to combine as many frights as possible and use electric trucks to reduce the emmisions.

Construction

The foundation is from concrete beams there and are prefabricated at a company in Lemmer. By doing this we save time on construction and there is no truck needed for the concrete. We also did research on other options used in the Netherlands but there wasn't enough information available. Normally in the Netherlands we insulate the foundation with an EPS-formwork (bad for the environment), this is not needed in our case because the thermal peel is closed. The floor consists of wooden I-beams and is put together on the construction site. This takes a longer time during construction, but a pro is that more materials fit on the trucks. Then the prefabricated walls (including window and door frames) are placed. All the walls fit on a single truck which comes from Latvia. The I-beams for the roof are pinned to the side of the wall with metal angels and screws, this makes it dismountable. The roof is put together on site so the installations can be hidden in the ceiling.

Grid size

We are building this house for older people so they may be in a wheelchair. That's why we base our grid size on the size of the turning circle of a wheelchair which is 1700mm. A grid size which is a multiple of 1700mm is not a standard size that's why we up it to 1800mm. 3600mm is going to be our grid size this is a multiple of 1800mm and is much more common.

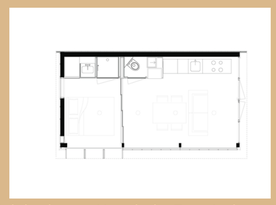


Inspiration on design

Our main source of inspiration is the NFH itself, since we're planning on building with the same concept, but then in the Netherlands. Aside of that we have found couple of other interesting projects that have low footprint and are sustainable. One of our sketches was inspired by a project by Zecc Architecten. The project can be seen on the right. It has a foldable facade, which are not just foldable, but also movable, so the resident can decide what amount of daylight they want or the resident can expand the facade if they want privacy.

Holiday home, Utrecht by Zecc Architecten

The garden house has replaced a holiday home, the foundation of which has been reused and the existing contours formed the starting point. The refinement of this house is in the asymmetrical main layout, the detailing and the interior. The house is completely closed on one side by continuing the slate covering in the vertical facade surface. The other side opens to the green and features movable shutters. The horizontal slats of the shutters merge into the facade cladding, giving the house with closed shutters a closed character.



Holiday home, Utrecht by Zecc Architecten

Materialization

Goals:
- Circular
- Economic
- Light
- Dismountable
- Reusable

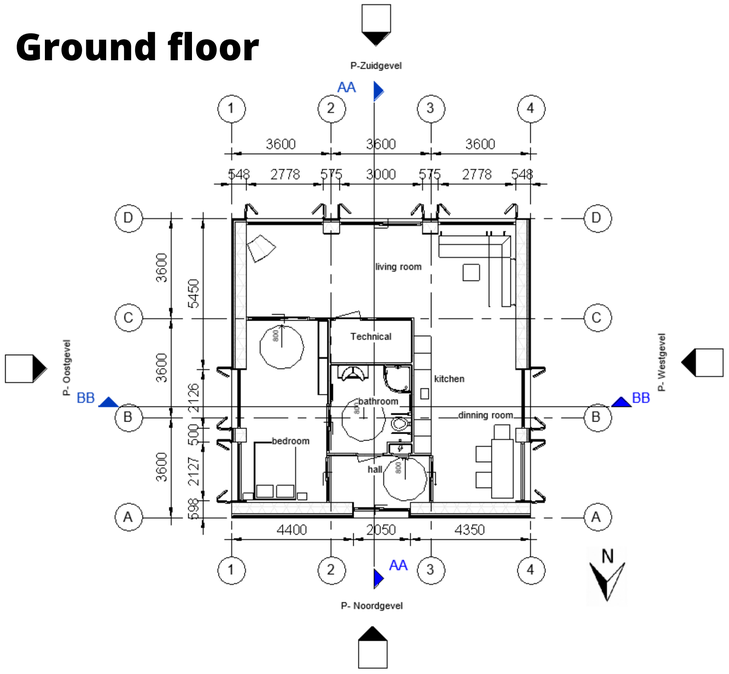
We have chosen to not use second hand materialls because we don't know wich materials will be available during construction

Dismountable

Our main goal is to make a building with an as low as possible footprint that's why we are trying to make the entire building dismoutable. The complete building can be disassembeld (including the foundation) and can be put together somewhere else.

Foundation: The foundation is prefabricated and is without piles. Cause they are prefabricated they can be lifted up at the lifting eyes.
Groundfloor: The beams of the floor are pinned with screws to the foundation. Underneath the beams are OSB plates mounted to the beams to prevent that the insulation between the beams falls down. On top of the beams comes another OSB plate with a wooden fibre board, a metalic plating and wooden flooring. This is a special structure where no glue or cement is being used this makes it good for the environment and also dismountable.
Façade: The timber frame construction is placed on top of the groundfloor and is pinned with screws. The window en door frames are in the factory placed in the prefabricated walls. The other parts of the facade is also pinned with screws
Roof: The roof beams are pinned to the timber frame construction in between the beams comes the cellulose insulation. Underneath the beams come wooden battens where the plasterboard is mounted on. On top of the beams comes an OSB plate, BIO-foam insulation (slope layer) and EPDM. As ballast we use gravel so the slope layer doesn't blow away. The roof can also be completely dimounted.

Ground floor



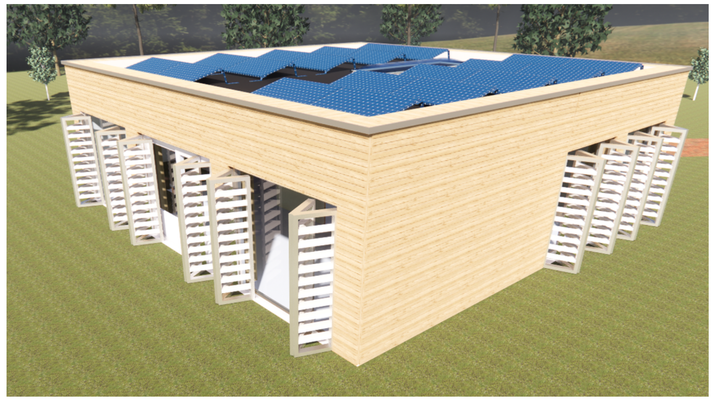
Explanation design choice

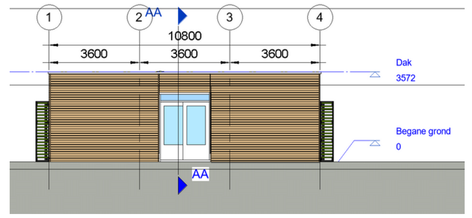
We have chosen for the second design because the second design complied the best with the demands of the target audience. The second design has the least square meters of hallway. In the final design we also took elements of the other designs to create the optimal layout.

In the second design the heart/core of the building is clearly visible with a bathroom and a technical space. This heart of the building is also visible in the design of the NFH. In our final design we added a fuse box and a kitchen to the core of the building so all the installations are close to each other.

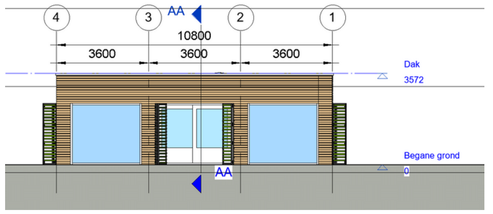
During the process of optimizing the design we enlarged the bathroom so there is enough space for a wheelchair. We also moved the door that went from the bathroom so the second hallway could be converted in more usable space. Our goal is to create a house which is easily accessible for disabled persons, so we chose to make large open spaces, so they don't have to go through a lot of doors.

Renders

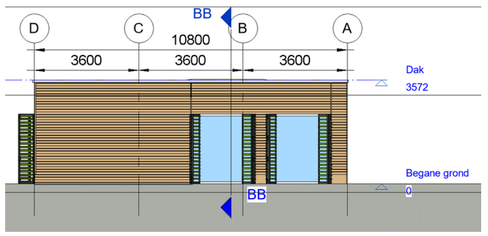




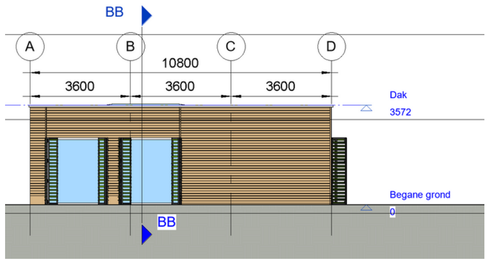
North elevation



South elevation



East elevation



West elevation

Description of design

We chose to place the front door in the north façade because there doesn't have to be much glass at an entrance. In the Netherlands the north is the side with the least sun so it's less profitable to place large windows there. The bedroom is at the east façade we chose to place it here because it has sun in the morning. The living room is on the south so there is a lot of sun. We chose to place the kitchen and dinning room on the west, so you have the evening sun during dinner. The living room, kitchen and dining room are one big space so it's easily accessible. The bedroom had a large glass sliding door to the living room this so when the resident can't get out of bed anymore, they can still be included in a conversation held in the living room. From the bedroom it's possible to go directly to the bathroom this so fewer mobile persons only have to go through a single door. In every room you can rotate in a wheelchair.

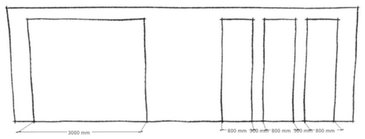
Facade Finish material
RED CEDAR WOOD

This is one of the most sustainable wood types in the world.
It lasts 25 years and doesn't require a lot of maintenance

To save the costs and use of materials we decided to place the panels horizontally.
This also respresent the similiraty to the NFH in Costa Rica.

Wall openings
Unlike Costa Rica The Netherlands has cold weather. To take advantage of the sunlight a we added big windows on the south, east and est side. The north evelation is mostly close due to the fact that the sun doesn't shine much on that side. The facade has comibation closed and transparent parts to achieve a proper insulation.
For natural daylight in the bathroom we added a sunroof.
We chose for the left option so we have more daylight inside.

Louvers
For more privacy and protection from the sunlight during sunny days, we applied some vertical folding louvers for the wall openings.
We chose foldable louvers instead of sliding ones. By doing this we reduced the daylight limit for when the louvers are open. Also sliding louvers require more maintenance and take more space in the facade.



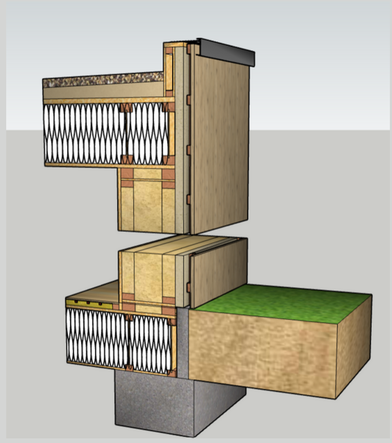
NFH

Detail

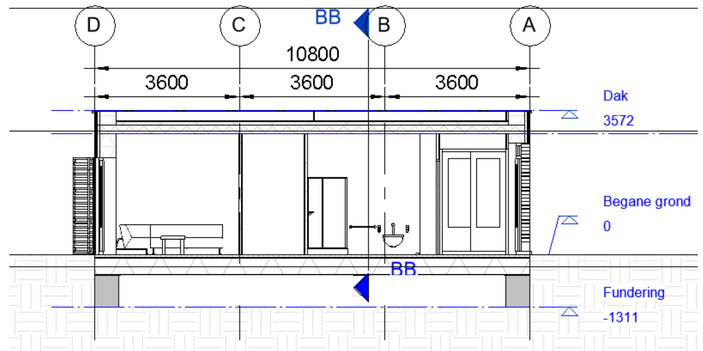
Roof:
-EPDM
-Slope layer Biofoam® 150mm
-Airthight foil 2mm
-OSB 22mm (compressed wood)
-I-beam + cellolose insulation 58x400mm
Distance between track centers 600mm
-Wooden batten 25mm
-Plasterboard 12,5mm

Facade:
-Plaster
-Plasterboard
-Timber-straw panel (300-400mm)
-Airtight membrane
-Insulating fibre board
-Wooden batten
-Wooden facade finish

Groundfloor:
-Wooden flooring (top layer) 15mm
-Wooden fibre board with floorheating
-Metal plating thermally conductive
-OSB 22mm (compressed wood)
- I-beam + cellulose insulation 89x400mm
Distance between track centers 600mm
-OSB 22mm (compressed wood)



Section A-A



Section B-B