THE HOME THROUGH LIFE

The house that grows and shrinks with you

AESTHETICS OF SUSTAINABLE ARCHITECTURE

TU Delft Architecture and the Built Environment

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The contemporary architecture is often based on our usual methods of energy-focused sustainable buildings. These seem to strive toward excessive insulation and mechanical ventilation to create a sustainable building. It is driven by adding technical measures later in the project rather than creating sustainable architecture. I want to create a building that goes beyond the usual methods. A building that reduces the demand of energy in a less superficial way than most of the contemporary architecture (Japan, 2005).

To create this building I was inspired by the Japanese architecture. The Architectural Institute of Japan defines a sustainable building as a building that is designed (Japan, 2005):

"to save energy and resources, recycle materials and minimize the emission of toxic substances throughout its life cycle, to harmonize with the local climate, traditions, culture and the surrounding environment, and to be able to sustain and improve the quality of human life while maintaining the capacity of the ecosystem at the local and global levels."

Mainly the first part of the definition inspired me: minimalizing the energy demand, waste and material use. In Japan they do this through creating a design based on the material. Minna Sunikka-Blank calls this the "Material as the Concept" (Sunikka-Blank, 2011). The Japanese architecture is based on timber structures, passive solar strategies and adaptability.

The timber structures exists out of a platform timber frame and post-and-beam structure. They used the local wood, which reduces the embodied energy. The structure was based on the proportions of this local wood. There is a strong element of modular thinking connected to the Japanese architecture. The structure allows the plan to grow, according to the needs. This was made possible through the clear difference in load bearing and space dividing elements in the structure. The traditional Japanese home is practically an one-room house. They used small wooden fencelike partitions to divide spaces (Japan, 2005).

To make the design of the "Home through life" I used this principle as an inspiration. Minimalizing is the keyword in this project and I wanted to design this house based on the materials: "Material as the Concept".

The house is build up out of flexible and modular boxes, based on the minimal size of a room and the size of the material. These boxes are not only flexible in the interior, like the traditional Japanese houses, but also in the exterior element and even in de total shape of the building.
The boxes exist out of a timber structure with interior – and exterior walls which can be removed and replaced for windows or open spaces. Also the total box can be added or removed from the building.

The material, the timber structure, is made out of local wood. This wood comes from the organisation 'Hollands Hout' which is located in The Netherlands. The Dutch version of the Forestry Commission uses the wood from the Dutch Forests to produce structural timber.
The last part, which I haven't mentioned that much yet is the passive solar strategies that I applied. A horizontal louvre system is added on the East, South and West façades of the building. This prevents the building from overheating.

As long as the traditional Japanese architecture already exists, the way that they design sustainable architecture goes beyond most of the sustainable architecture nowadays. That is why I wanted to incorporate the Japanese way of architecture into my design.

LIFESTYLE

THE HOUSEHOLD

The household exists out of four persons. A mother, a father, child and a grandmother.

Father & mother

They both have a fulltime-job and work at an office nearby. The way of working at his office is changing. There are less workspaces which means that the they need to work at home very often. They need a space where they can work where they can receive guests.

Child

This child is still very young and is still on the elementary school. But when she grows up she needs some extra space to study.

Grandmother

The Duth healtcare is changing. The govern ment is giving less money for retirering homes and nursinghomes. That's why children of there elderly parents should take care of them. In this household the mother and father need to take care of fathers mother. She is still healty but can't live on her own anymore. The house should have a place where she can live. But this place should be able to change when she needs more care or when she moves to an nursing home.

The family is vegan. They only eat biological and do not eat any kind of meat. They want to eat as sustainable as possible so they want to know the possibilities to grow their own food. They not only want to grow food but they also want to get there own eggs, so there has to be a place for chickens.

LOCATION

The family lives in the West of The Netherlands near the coast. This means that there is a lot of wind, an average speed of 8.0-8,5 m/s. The irraditation (31,1 kWh/2), precipitation (1,3-20 mm) and temperature (15,6-17 °C) is the same as the average in The Netherlands.

www.zonnestroomnl.nl/nieuws/tel-de-zon-2016-zonnestroom-systemen-blijven-goed-presteren-in-nederland/

They live on the countryside, just outside The Hague. Despite that they are living on the countryside, they can go to there work and to the shops by bike. A car isn't necessary.

Living on the countryside gives a lot of possibilities for the family. They've got enough space to grow their own food and have chickens or other animals.

STARTINGPOINTS

FAMILY SPECIFIC

(Urban) farming

As mentioned in the household description the family wants to live a vegan life. They want to know what the possibilities are to grow their own food. Which types of food are needed and how much space do they need to do this?

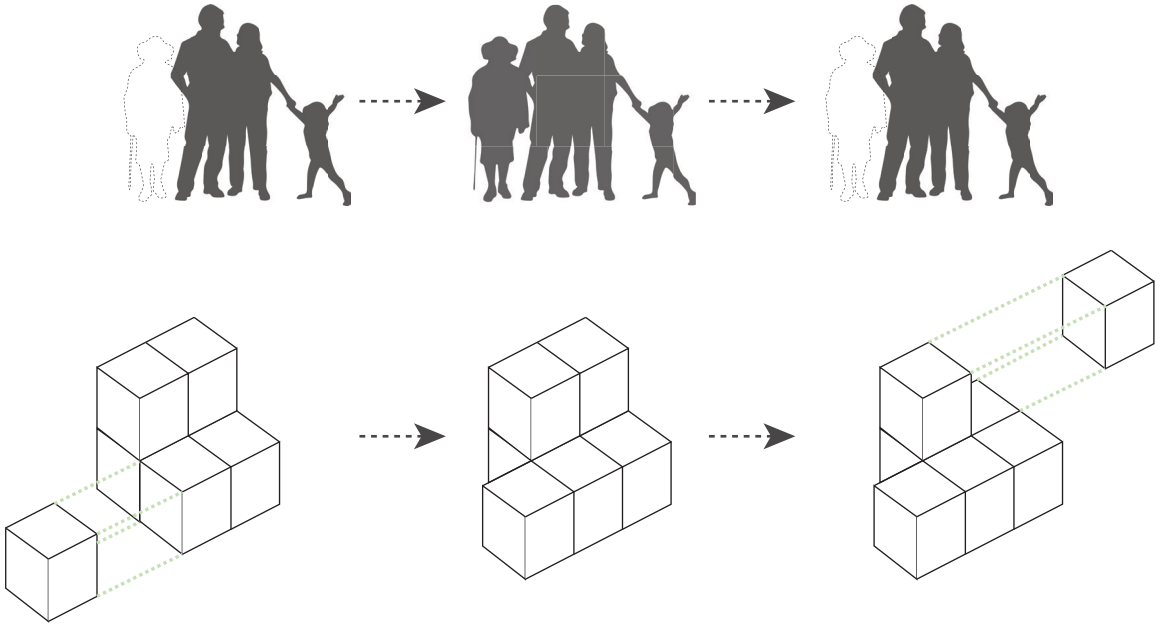
Modularity

The most important aspect of this family are the desires to let the house grow and shrink. It is important to create a house that gives the possiblitiy to adjust to the family.

If the grandmother needs more care and has to leave the house, the house should be able to change her room into another room. Or it should be able to remove this space.

The same counts for the workspaces for the parents and the child. It should be possibible to create more workspace or to remove the workspaces.

To meet all these whishes the house needs to be flexible, changeble. I choose to do this by designing a modular house which exists out of modular boxes that can be removed or added.



STARTINGPOINTS

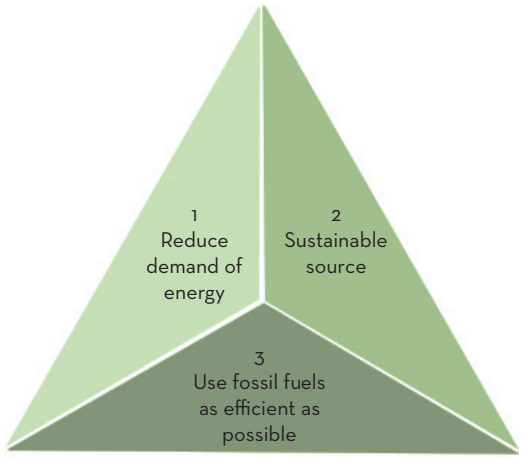
DURABILITY

To get a sustainable house I want to follow the three steps of the Trias Energetica. The Trias Energetica is a strategy to take energy-saving measures. This strategy was introduced in 1996 by the Netherlands Enterprise for Energy and Environment (Novem, one of the forerunners of NL Agency) under the name Trias Energica. Later, the Trias Energetica was developed by TU Delft (Energie leverend, sd). The strategy exists out of three stepts (image on the right):

1. Reduce the demand of energy
2. Use a sustainable source
3. Use fossil fuals al effeicient as possible

This design focusses on the first two steps:
Step 1: to reduce the demand of energy, the design of the house is designed in a way so there's less energy loss. To do so the design needs to be insulated very well, is should be protected from the sun and the surface should be as minimal as possible. With a minimal surface the building has a minimal energy loss to their surroundings. The solution where I came up with is to put a part of the house under the ground (image 1).

Step 2: The house uses the power of the wind and the sun (image 2) to gain energy. It also stores rainwater to use it later in the house and the farm (image 3). There should be a battery to safe the energy on sunny and windy days, so the house can use this energy on days when the sun isn't shining or when the wind isn't that strong (image 4).



Trias Energetica
http://www.energieleverend.nl/index.php?page=Ontwerp

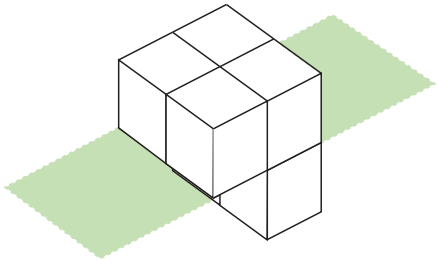


Image 1

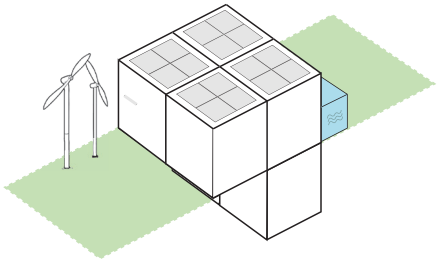


Image 3

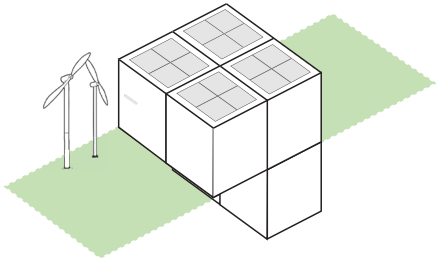


Image 2

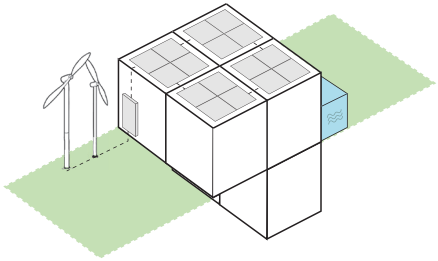


Image 4

LYFESTYLE

DESIGN

BUILDING UNDER THE GROUND

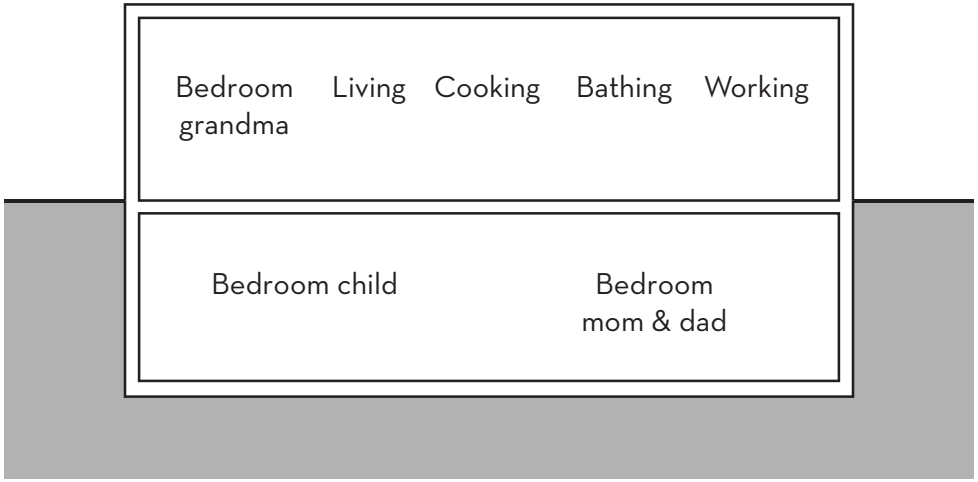
To get the minimal surface, as mentioned in the durability startingpoints, a part of the house should build under the ground.

Building under the ground means that the house loses less energy. Buildings are surrounded by a mass of earth, which ensures good insulation and therefore energy saving.
The temperature below ground is also more stable than above ground, which makes climate control a lot easier (Khaled, 2012).

Of course, there are also disadvantages to living under the ground. An important disadvantage is the lack of daylight. It is also not possible to build modular under the ground. But I found solutions for these problems.

First to get the sunlight in the basement, one of the façades need to open up. The design includes a ramp on the North side of the house.

Second, the functions that don't need to be modular should me placed under the ground. These functions are the bedroom for the child, mother and father.



MODULAR BOXES

REQUIREMENTS

To make the house work and to meet the way the family lives, it needs to be modular. The house should exis out of boxes which can be taken in and out. I made a set of requirements for those boxes:

Rollator/weelchair friendly, so grandmother can stay in the house when she can't walk on her own anymore.

One box needs to be big enough for a toilet and a bathroom (1,65 x 2,2 m), because this is the biggest room that is needed for this family, based on the Bouwbesluit requirements (image 5).

Dimentions based on less material waste, the box need to have a dimention that fits with the size of the material (multiple of 0,6 m).

The boxes need te be relatively easy to change and to be multiplied, the form of a square gives the most potential for this. This also counts for the additions.

All these requirements together makes a box with a size of 2,4 x 2,4 meters.

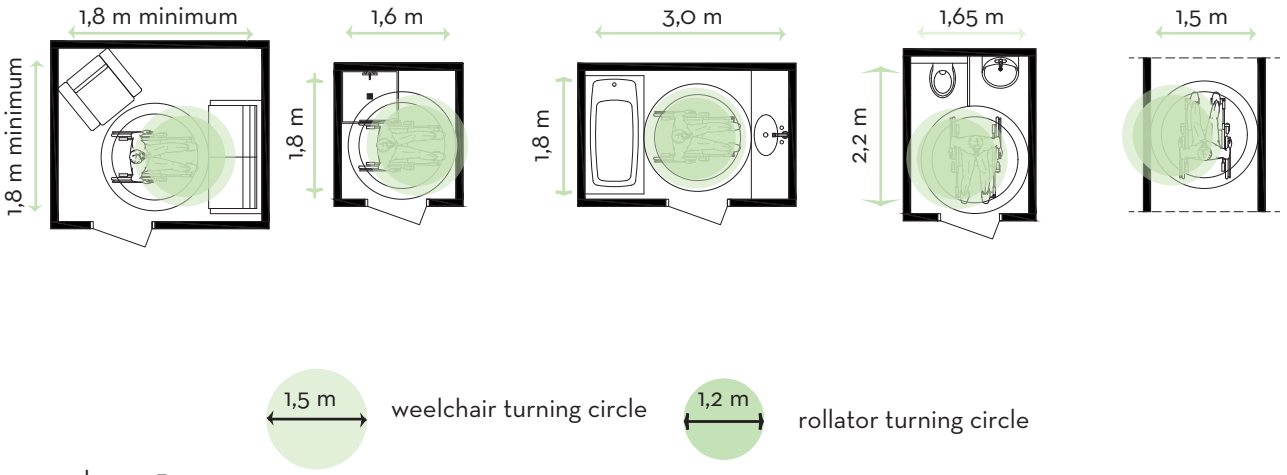


Image 5
https://www.bouwbesluitonline.nl/Inhoud/docs/wet/bb2012/hfd4

MODULAR BOXES

The modular boxes exists out of a wooden structure. This structure is build up out of wooden beams and collumns.

The boxes can have endless configurations, but they all have a bottom and a top, a floor and a roof. This means that they can be build on top of eachother, but that this would not be that easy to do as putting the boxes next to eachtother (image 6).

As said, every box exists out of a floor and a roof, but they ofcourse also have an interior- and exterior wall. There are four types of walls that can be put in to the boxes:

1. Exterior closed wall, timber;
2. Exterior open wall, totally made of glass;
3. Interior closed wall, timber;
4. Interior open wall, a totally open side of the box.

With those boxes and those types of walls I have made my design.

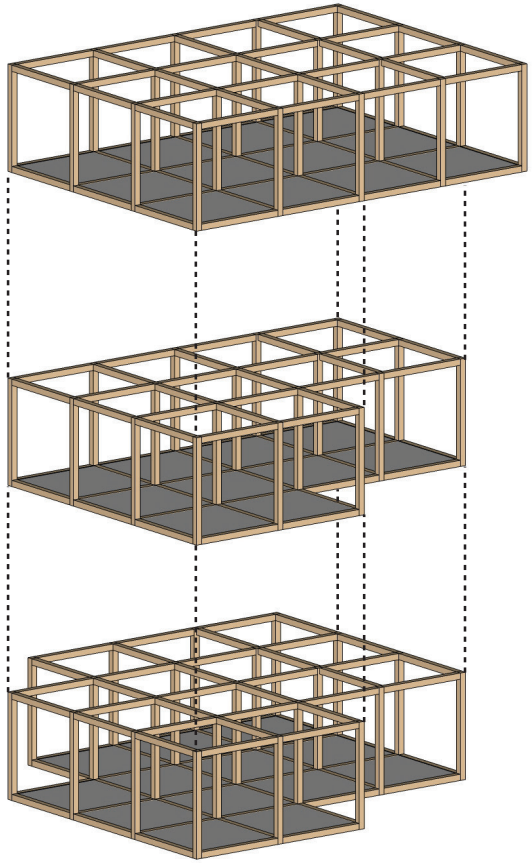
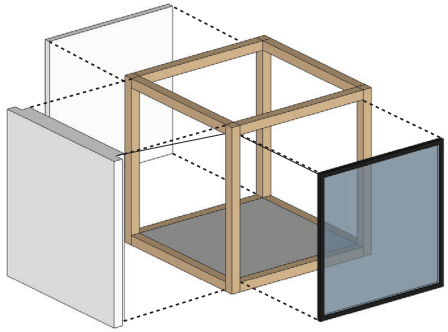


Image 6

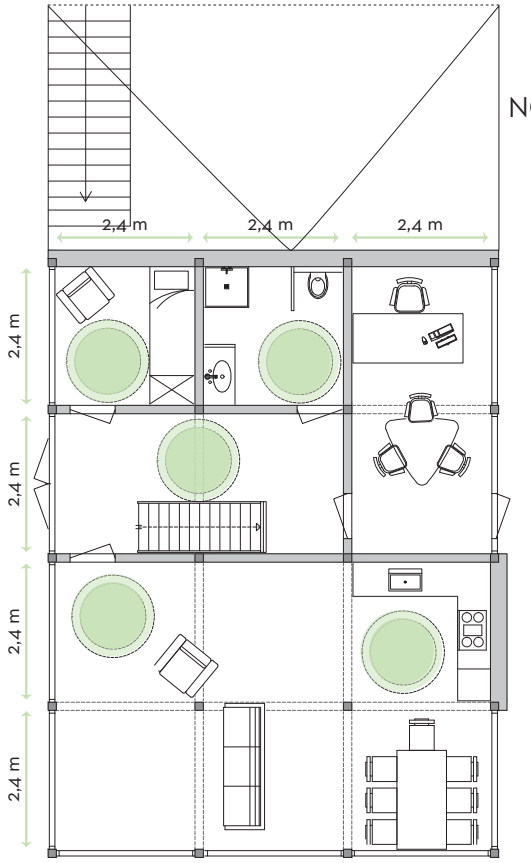


FLOORPLAN

The floorplan is based on the boxes, mentioned before, and the loop of the sun (image 8). A part of the building is under the ground, the bedroom of the child, mother and father. The other functions: the bedroom of the grandmother, the bathroom, the kitchen, livingroom and workspace are located on the ground floor.

The rooms on the ground floor have the dimentions of the boxes. The location is based on the loop of the sun. The spaces in which sunlight is wanted are located on the South side, these are the cooking and living spaces.
The other function are located on the North side of the house.

The house can be entered through three doors. One at the West side of the house, this is the entrance for the private part of the house. One at the East side, this the entrance of the public part. This is the entrance for the workspaces. The parents can receive guests here. The thrid entrance is an entrance to the basement. This entrance makes it possible to enter the basement without using the ground floor. I wanted to design a house where the family can live their whole lifes. But what if, at some point, they move or if they don't need the basement anymore. To make the house even more flexible I added the entrance to the basement. So the basement can be used by a different owner than the ground floor.



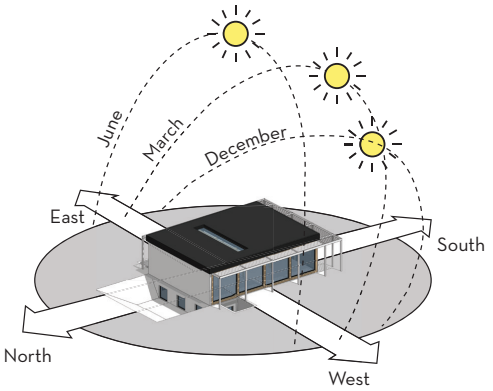


Image 8

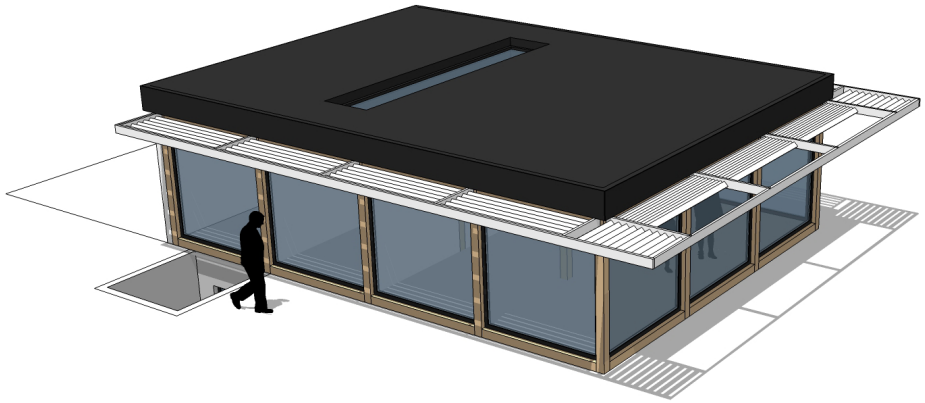
THE DESIGN

A lot of the design issues, which are visible in the 3D visualisations on the right, are already explained. I am not going to repeat them. But there are also some parts of the design that are visible now, and weren't before.

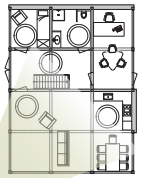
The first thing are the louvres. The house is very open towards the South, which creates a very light kitchen and living, but it also gives the sun the chance to warm up the building. To protect the house from heating up I designed a louvresystem. This system exists out of louvrepanels which can change from position. They can open en close in two ways. The first one is is the angle of the louvres. But they can also open and close in total, which is visualized in the 3D image. In this way the family can control the amount of sunlight which comes into their house.

The other thing which I didn't mentioned yet is the vent in the roof. This vent provides not only extra sunlight but is is also part of the climate system. This vent makes it possible that the polluted air will be sucked out of the rooms. I will explain this in the pharagraph "Energy system".

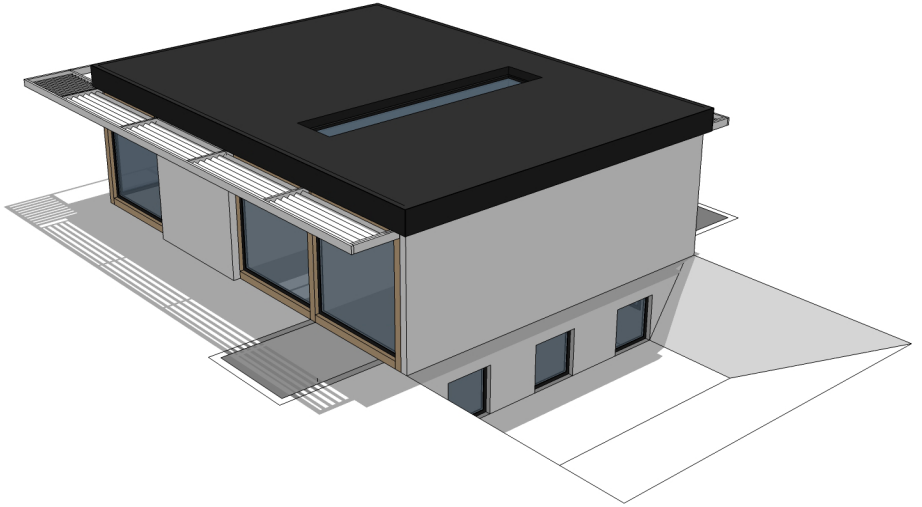
The last thing is the colour of the roof. The roof is black so the roof will become very warm in the summer. This is neccesery to create a big difference in temperature between the air in- and outside the building which makes the natural ventilation (as described above). It also increases the results of the PVT panels, which will be put on the roof. This will also explained in the paragraph "Energy system".



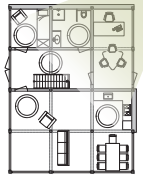
North



South



North



South

GREEN (HOUSE)

The familiy lives on the countryside, so they have a lot of space to grow their own food. But how much space do they actually need? In the image on the next page you can see the surface of the lot which is needed for farming in comparison with the surface that is needed for the house.

These dimentions are based on the calculations below.

WHAT ONE PERSON NEEDS:

Vegetables Fruits	35 m2
Legumes Potatoes Grain	100 m2
Oilseeds	30 m2 +
	165 m2

WHAT THE WHOLE FAMILY NEEDS:

Vegetables Fruits	140 m2
Legumes Potatoes Grain	400 m2
Oilseeds	120 m2 +
	660 m2

Milk	2 goats - 50 m2 per goat
	100 m2
Eggs	1-2 chicken per person
	1,35 m2 per chicken
	6 chickens x 1,35 m2
	8,1 m2 +
	108,1 m2

A total of 933,1 m2

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MATERIALIZATION

MATERIALIZATION

The house can be seperated into two parts: above ground and under the ground. This seperation is also visible in the materials (image 9).

The part above ground is build up out of a wooden structure. I chose for this material because it has a low embodied energy, is flexible dismountable and recycleble. The wood comes from The Netrhelands itself, wich minimalizes the embodied energy even more. The institute Hollands Hout uses larch wood to create wooden structures.

The part under the ground is made of Reduton®. This is a type of concrete which has a low CO_2 footprint because it uses geopolymers instead of cement. With Reduton® a CO_2 reduction of approx. 80% can be realized (van den Bosch beton, sd).

The materials under and above the ground differ from eachother because of the different conditions. It is not possible to create a wooden structure under the ground and it is very hard to make a concrete, flexible and modular box.

The louvres are made out of aluminium, because of the high durability and the low weight.

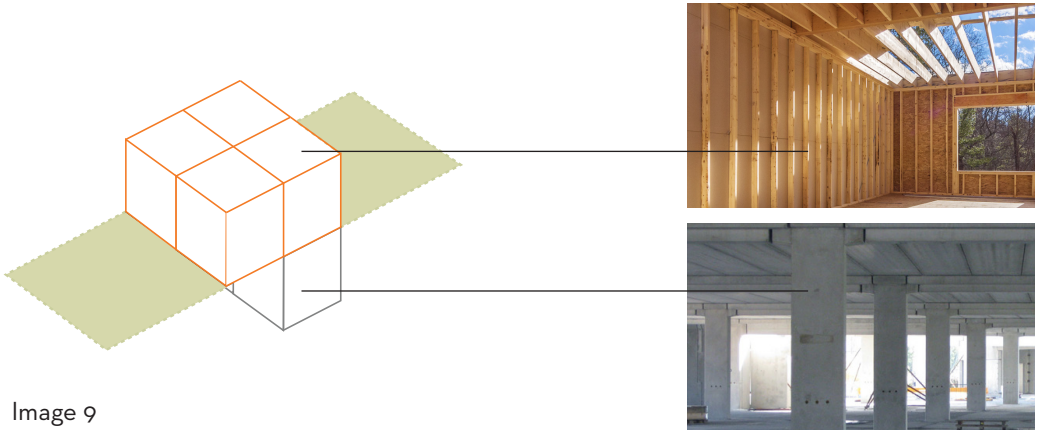
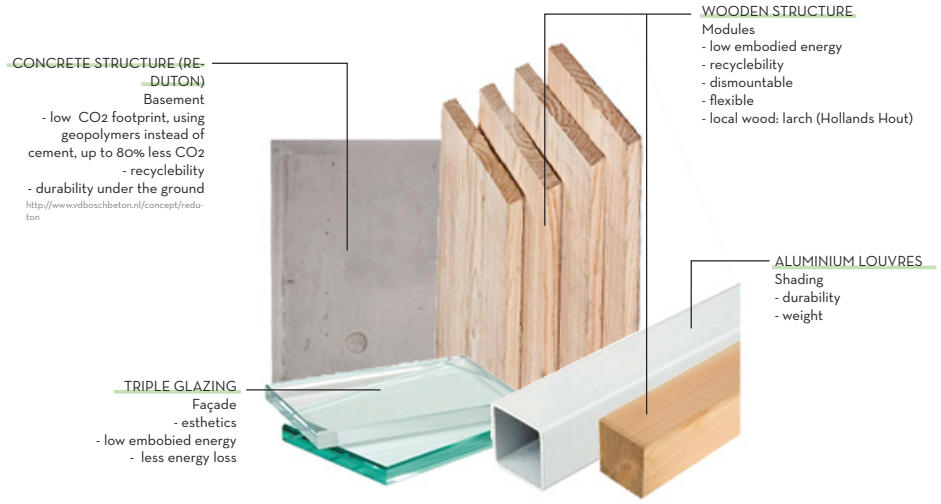


Image 9

MATERIALS



ENERGY

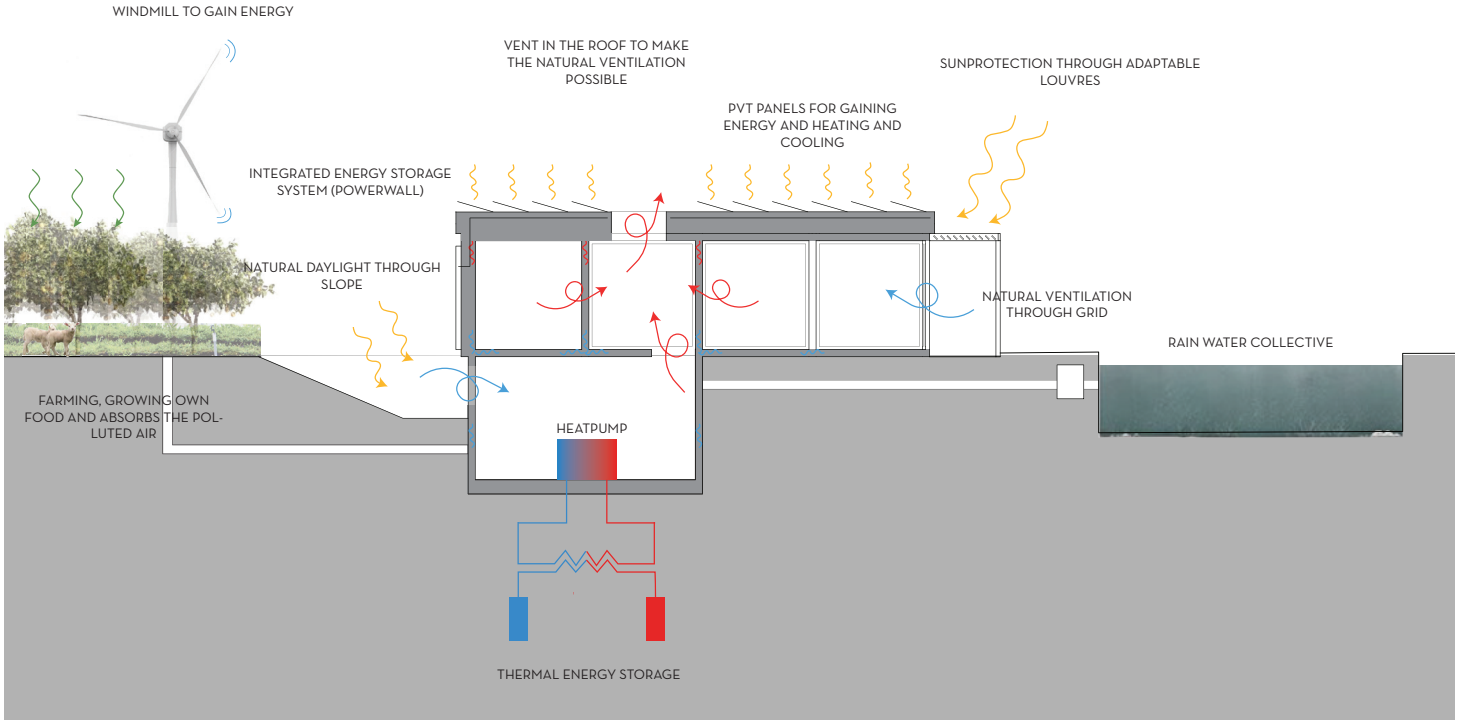
ENERGY SYSTEM

The scheme on the right explaines the way the house works. This scheme can be divided in: ventilation, heating and cooling and energy. I will explain the scheme through these components seperately.

Ventilation
The house will be ventilated in a natural way. I allready explained this quickly. Fresh air will enter the house through air vents in the windows. The fresh air will be tranfered to the other rooms through the difference between the cool air in the basement and the warm air on the roof. The air wants to move to the warmer place, which is the vent in the roof. In this way the house will be ventilated in a natural way.

Energy
The energy will be provided through sustainable sources: the sun (PVT panels) and wind (a windturbine). On sunny and windy days the extra generated energy will be stored in the integrated powerwall.

Heating and cooling
The building will be heated and cooled through a thermal energy storage, PVT panels and a heatpump. With this system the groundwater is used in the deeper soil as an energy buffer. Part of a thermal storage system is a heat exchanger with which cold water is injected in the cold source in the winter and the heated water in a hot spring in the summer. In the summer, a building can be cooled by pumping up the cold water. In the winter, a building is heated by pumping up the hot water.
The PVT panels do not only gain energy but they can also be connected with the heatpump.



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