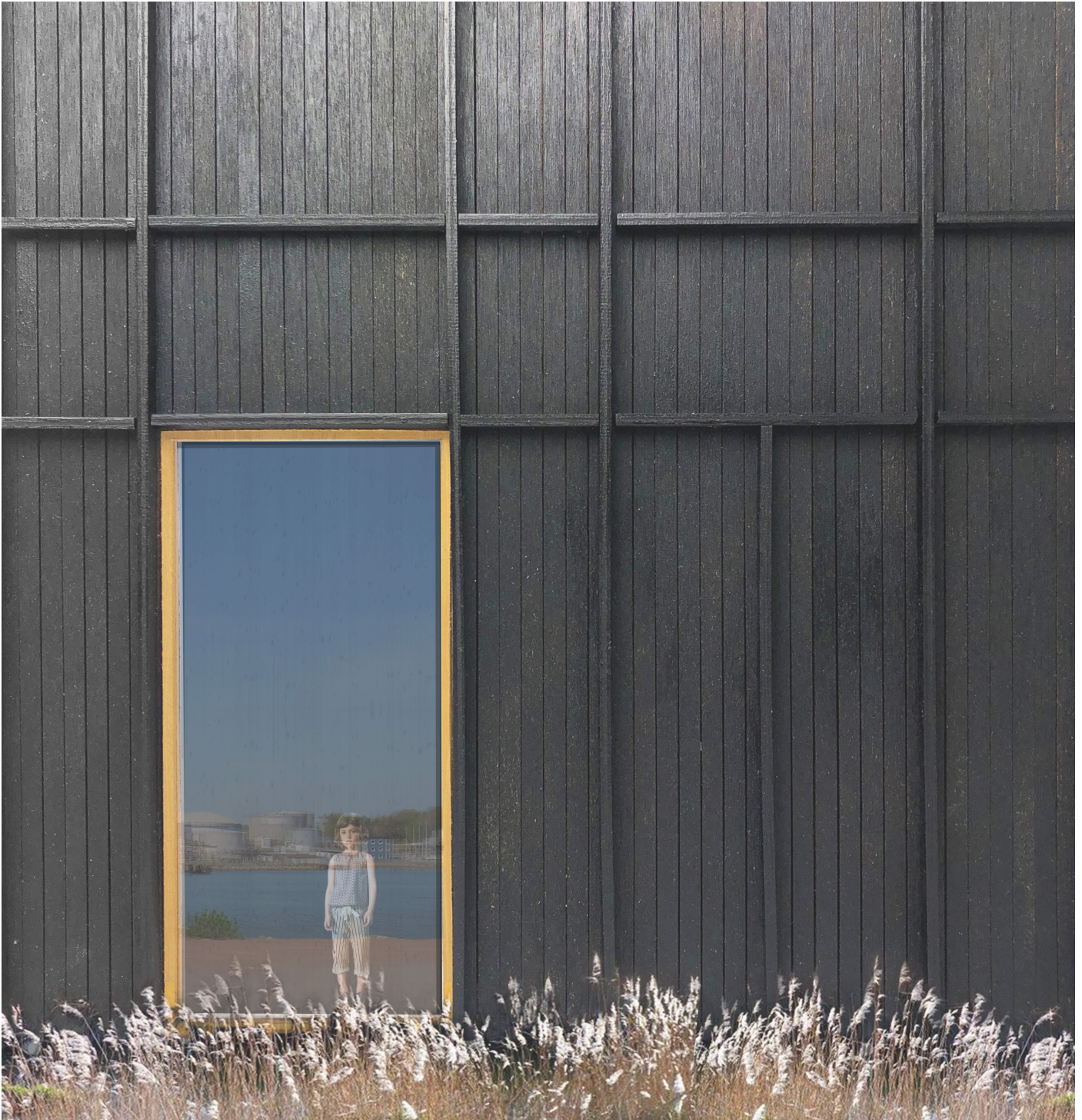


# CLIMATE CENTER OF SWEDEN

Master's Thesis by Linda Sköneskog



Climate Center of Sweden

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## ABSTRACT

Climate change is the challenge of our time. To be able to prevent this change and live more pro environmental we need to inform the society about why we have this situation and how we all together should act differently. Up to date information, inspiration and solutions need to be shown in an accessible way for everyone and to be able to address these problems, and to inspire innovative solutions, a public space would be relevant - a climate center.

Public spaces in Sweden, that inform about climate change is today lacking. A climate center in Gothenburg can contribute to a better understanding by showing both art and science while, simultaneously, the building itself can influence its visitors to act differently. Research in the field of human behavior is showing that people live more eco friendly while feeling connected to nature. When humans do not feel like they are a part of a larger eco system, they may be less inclined to protect the natural environment. The aim of this master's thesis was to explore how a climate center can improve its visitor's pro environmental behaviour through the built up architecture, using nature as inspiration.

To establish this connection to nature, theories of biophilic design was investigated and used. The research was divided into smaller investigations focusing on different elements within this design

theory. The used methods were hand sketching, both analogue and digital model making, renders and study visits to suitable reference projects.

The result was implemented in the design of the "Climate Center of Sweden", constructed with cross laminated timber, containing indoor and outdoor exhibitions and framed views of nature and climate culprits. The center will evoke gravitas but also give hope for a bright and sustainable future. It will contribute with eco aware citizens whom together will take a step in the right direction towards a sustainable future in Sweden as well as the world.

- Linda Sköneskog

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## AUTHORS BACKGROUND

Last year (during 2017-2018) I took the opportunity to study and live abroad for two semesters in Shanghai. Beyond China's amazing, breath taking mega cities and wonderful nature, you could see an obvious wear and tear culture, problems with smog and the phenomenon of so called *wasted cities*. These cities are newly built ones in new areas that are largely underpopulated or never became populated at all, just standing there empty waiting to be demolished (He, Mol, Lu, 2015). I would say that I cared about climate issues before, but experiencing the problems and seeing it with my own eyes made me care even more. This triggered me to create architecture that helps and informs people about sustainability.

The project I did my first semester in China was called *MycelSpace*. The assignment was to create a new experience for people within an existing public space, a shopping mall, using architecture. Me and my teammate designed four freestanding double curved walls, covered with mycelium and growing mushrooms, with the aim of bringing awareness of ecology and sustainability through this natural, edible and living material. The studio was focusing on producing proper drawings with details, finding a producer and calculating a budget. Why I now chose *Building and Tectonics* as direction for my master's thesis is because I really appreciated that way of learning and working.

Now, when designing a climate center, I want to develop the knowledge I gained from previous projects. This time I will not design something complementary in a public space but instead create it all myself in a more complex and bigger scale and create a project that will influence and bring awareness to a wider range of people.

### MASTER IN ARCHITECTURE AND URBAN DESIGN

Chalmers University of Technology, Gothenburg  
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Collage of Architecture and Urban Planning,  
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## **BACKGROUND**

This chapter contains the background of this master's thesis, including its discourse, theory and research questions followed by used methods and reference projects.

## DISCOURSE

### CLIMATE CHANGE

On October 8th 2018 Intergovernmental panel on climate change, reported that we have only a decade to prevent the global warming from going out of control (Leahy, 2018). "The decisions we make today are critical in ensuring a safe and sustainable world for everyone, both now and in the future" (IPCC, 2018). Climate change truly is the challenge of our time. To be able to prevent this change and live more sustainable we need to inform people how we all can act and live differently. Updated information, inspiration and solutions need to be shown in an accessible way for everyone and not only for already informed people within the area.

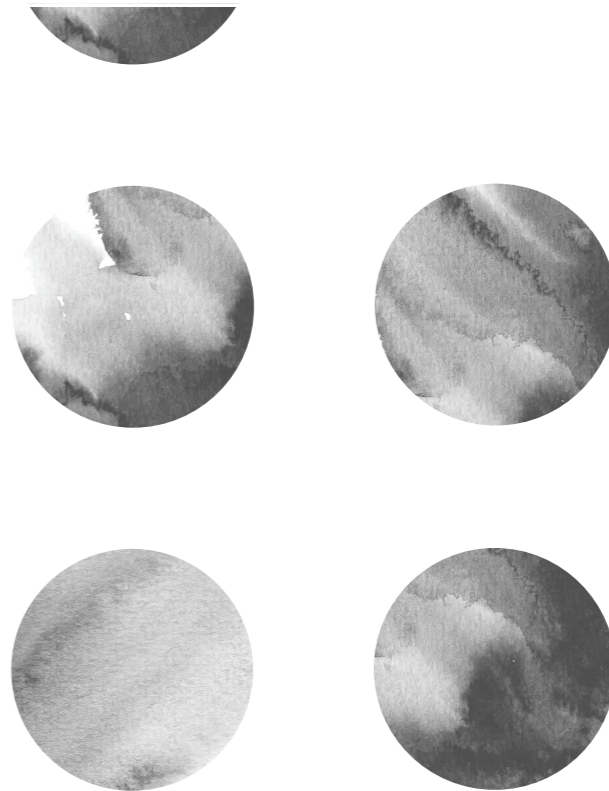
### SWEDEN

As of today, information about climate change in Sweden is mostly concentrated online, in newspapers or literature and less in public spaces. You can read about climate change on sites such as *Naturvårdsverket*, *Världsnaturfonden WWF*, *Naturskyddsföreningen* or *SMHI* (Sweden's focal point for IPCC) but you are in most cases not able to visit them in another way than through their website. The biggest permanent exhibition on the subject of *environment and sustainability* is on Ekocentrum, Gothenburg. Ekocentrum Foundation's

target groups are mostly companies who are interested in environmental and CSR training courses and less individuals. Another public permanent exhibition is *Mission: Climate Earth* located in Swedish Museum of Natural History, Stockholm. This exhibition's target group is families. Even though Sweden has a couple of exhibitions about the climate it would be benefit from having an even bigger one that is not permanent but constantly changing and updated with a wider range of people as target group and in a space that is more accessible. The need for change is urgent and the subject should be displayed and discussed more frequently in our public spaces.

### DEFINITION

The authors own definition of a Climate Center is a public space that shares knowledge and exhibits science and art on the topic of climate change in different and interesting ways.



**In Sweden we are consuming and living as if we had resources from 4.2 planets.**

– WWF, 2017

Figure 1. | Illustration of used planets. Author's own copyright

## EVIDENCE OF CLIMATE CHANGE

Throughout history, the climate on Earth has been constantly changing. Glacial cycles have come and gone in a relatively steady pace. The last cycle of ice age ended about 7000 years ago. This marked the beginning of the modern climate era as well as the start of human civilization. (NASA, 2019).

NASA argues that the global warming trend now present, is different than previously occurring climate shifts. The global warming we're currently experiencing is due to human activities that started about hundred years ago and the ensuing increase of average temperatures will likely affect the earth and its livability for years and years to come.

By using modern technology, such as satellites, scientists can collect data and information about the planet on a global scale and be able to see the signals of climate change during a longer period of time. Evidence of climate change is not only visible from a distance in space but also shown in ice cores, collected in for example Antarctica, that shows that our climate responds to greenhouse gas levels. Other evidence is also to be found in sedimentary rocks, coral reefs and tree rings, all revealing that the present global warming is occurring due to green gas emissions but also in a rate ten times faster than during any of the previous glacial cycles.

## CAUSES

NASA describes this warming as a result of our atmosphere working as a blanket. Sunlight is constantly crossing our atmosphere on its way to heating and lighten the surface of Earth. While at the surface it is radiated back again but captured by gas molecules trapped in the atmosphere. This leads to increased temperature on Earth. These blocking molecules are greenhouse gases, consisting of water vapor, H<sub>2</sub>O, methane, CH<sub>4</sub>, nitrous oxide, N<sub>2</sub>O and carbon dioxide, CO<sub>2</sub>.

NASA further describes that the natural greenhouse that our atmosphere used to have has changed into a more molecule dense one, absorbing more heat, due to human activities such as burning of fossil fuel, deforestation and agriculture. Even though carbon dioxide is naturally released into the atmosphere during volcanic eruptions and also from our own respiration, values of CO<sub>2</sub> is now increasing dramatically. This gas is one of the most important ones to take control over since it is a 'long lived' molecule that is more or less permanent while stuck in the atmosphere, in relation to water vapour which is not permanent.

## EFFECTS

The change is already visible and can be observed all over the world, glaciers are melting at this very moment, flooding is more commonly occurring and our wide animal and plant range have decreased. Scientist predict that in near future climate change will bring more extreme weather in terms of longer periods of drought, longer heat waves, more wildfires, intensified storms and heavy rainfall. Some areas are expecting to be covered with water due to rising sea levels and the Arctic is most likely completely free from ice within 30 years. Forecast over the temperature for the next century is an increase between 2.5 - 10 degrees (NASA, 2019).

## VITAL SIGNS

The latest measurement of carbon dioxide in the atmosphere, presented in April 2019, showed a concentration of 411 ppm (parts per million), the highest concentration ever measured in human history. Before the 1950's, the concentration had never been above 300 ppm with an average around 230 ppm, going back more than 400 000 years. See *figure 2* data diagram from reconstruction of ice cores by NOAA, *CO<sub>2</sub> levels throughout history*.

## SOLUTIONS

This global problem has a lot of dimensions and cannot be solved with a quick fix, even if we would stop all our emissions today, NASA reports that the climate change will be present for centuries to come and affect many future generations. The rising temperatures and levels of carbon dioxide takes a while for the planet to react on, and likewise to recover from. Carbon dioxide that once has been trapped in the atmosphere will stay there for hundreds of years, and for each day that goes the concentration increases, a sign of that change is about to come. Responding to the change contains two different actions. First and foremost, we need to reduce or stop our emissions of greenhouse gases. The second action includes adaption, we need to adapt to the current changes and prepare for the coming ones, which means for example that we need to work on our security and vulnerability towards extreme weather but at the same time also see them as an opportunity for new inventions (NASA, 2019).

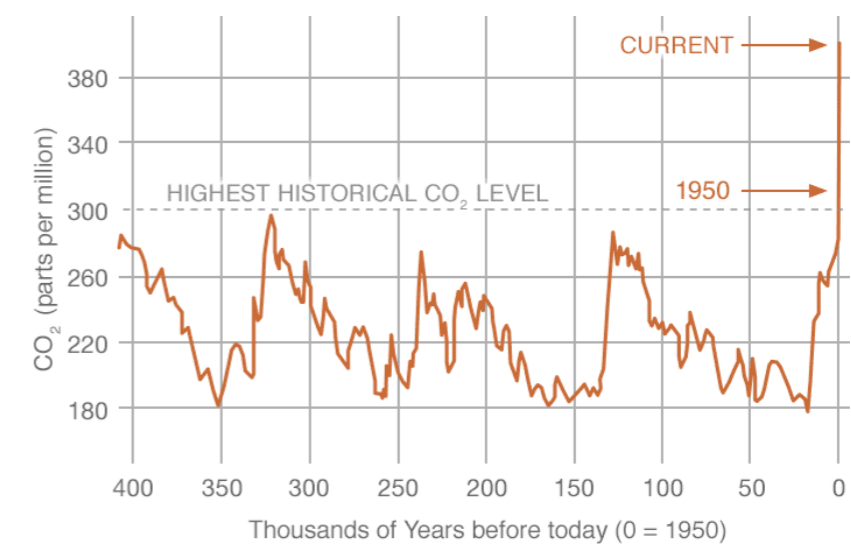


Figure 2. CO<sub>2</sub> levels throughout history (NASA via NOAA, 2019). Adapted with permission.

## THEORY

### PRO-ENVIRONMENTAL BEHAVIOUR

We have one earth and one earth only. To prevent climate change everyone needs to work toward the same goal, to live more sustainably. But how can we start acting more pro-environmental? Science in the field of human behaviour is showing that people live more pro-environmental while feeling connected to nature. When humans do not feel like they are a part of a larger eco-system, they may be less inclined to protect the natural environment (Lumber, Richardson & Sheffield, 2017). This theory is based on the *Biophilia Hypothesis*, which believes that we have "an affinity with nature" or "the love of all things natural." As we today live more in dense cities away from nature, we have lost our connection and therefore also care for it. To connect to nature again in our cities we can use *Biophilic Design* within the field of architecture (Kellert, 2008, pp 3-6).

### BIOPHILIC DESIGN

"The Architecture of Life". Biophilic Design is a design strategy that aims to reconnect people with nature and create good habitat for humans as biological organisms in the city. Design elements that can be used are following:

· *Environmental features*

Water, Color, Air, Sunlight, Plants, Animals, Fire, Natural materials, Views and Vistas, Façade greening, Geology and Landscape.

· *Natural shapes and forms*

Botanical Motifs, Tree and Columnar Supports, Animal Motifs, Shells and Spirals, Egg Oval and Tubular forms, Arches, Vaults, Domes.

· *Natural patterns and processes*

Age, Change and Patina of Time, Linked series and chains, complementary contrasts.

· *Light and space*

Natural Light, Filtered and diffused light, Light and Shadow, Reflected light, Light pools, Warm Light, Inside-Outside spaces.

· *Place based relationships*

Geographic, Historical, Ecological connection to place.

· *Evolved human-nature relationships*

Exploration and discovery, Attraction and beauty, Information and cognition (Kellert, 2008, pp 7-15).

**"People live more pro-environmental while feeling connected to nature."**

· Lumber et. al. 2017

## RESEARCH QUESTION

**How can a climate center improve its visitor's pro-environmental behaviour, through the built up architecture, using nature as inspiration?**

How can views and vistas be framed in a center placed in Röda Sten, to guide its visitors and remind about its climate?

How can wood be used as material in a center to create a good atmosphere to exhibit art and science?

How can inside-outside spaces be used in a center, in Gothenburg, while taking advantage of its surroundings?



## METHOD

This master's thesis explores how a climate center can be designed to influence its visitors' pro-environmental behaviours, by using biophilic design as primary research method.

Out of the list of possible design elements within biophilic design, shown on page 14, a few was chosen to be investigated. The chosen ones are listed below. During the separate investigations, research was done through sketching both analogue and digitally, by building models, 3D printing, painting, visits to the site and study trips to suitable references.

### ELEMENT 1: VIEWS AND VISTAS

*"People express a strong and consistent preference for exterior views, especially when the vistas contain natural features and vegetation. These views are often most satisfying when the scale is compatible with human experience."* (Kellert, 2008, pp 7).

By framing *Views and Vistas* in the surroundings the center can take advantage of its nature and climate and use it as an effective tool to tell its story and guide its visitors. The chosen site has a lot of nature and quite rough climate with potential to use for this cause. The sub question that was investigated was: *How can views and vistas be framed in a center placed in Røda Sten, to guide its visitors and remind about its climate?* The outcome was implemented in the design focusing on guidance through the building and flow of the spaces.

### ELEMENT 2: NATURAL MATERIALS

*"People generally prefer natural over artificial materials, even the artificial forms are close or seeming exact copies of natural products. Part of the aversion is likely due to the inability of the artificial materials to reveal the organic processes of aging, weathering, or other dynamic features of natural materials, even inorganic forms like stone. The patina of time may provoke an intuitive*

*understanding among some people of the benefits flowing from the movement of nutrients and energies through natural systems."* (Kellert, 2008, pp 7).

Within the element *Natural materials*, the material wood was chosen and the technique of cross laminated timber, CLT, as the main material in the construction. Using wood as construction material is preferable since it is a renewable resource and has lower embodied energy compared to concrete and steel. Wood is further also one of few building materials that actually helps us tackle the climate change by binding carbon dioxide (Planet Ark, 2017). The sub question that was investigated within wood was: *How can wood be used as material in a center to create a good atmosphere to exhibit art and science?* The outcome was implemented in the design focusing on a visible construction that creates a good atmosphere.

### ELEMENT 3: INSIDE OUTSIDE SPACES

*"Appealing interior spaces in the built environment often appear connected to outside environment. These areas also mark the transition of nature with culture. Important design forms in the built environment that evoke this quality include colonnades, porches, foyers, atriums, and interior gardens."* (Kellert, 2008, pp 11).

The element *Inside-Outside spaces* was found to be suitable and interesting for this center due to its potential to connect indoor with the nature outside but also due to its possibilities to use spaces outdoor that has no need for heated covered spaces. Further, it had potential to involve with pedestrians outside of the center who just happens to walk by. The sub question for this element was: *How can inside-outside spaces be used in a center, in Gothenburg, while taking advantage of its surroundings?* The outcome was implemented in the design focusing on organizing and designing the program.

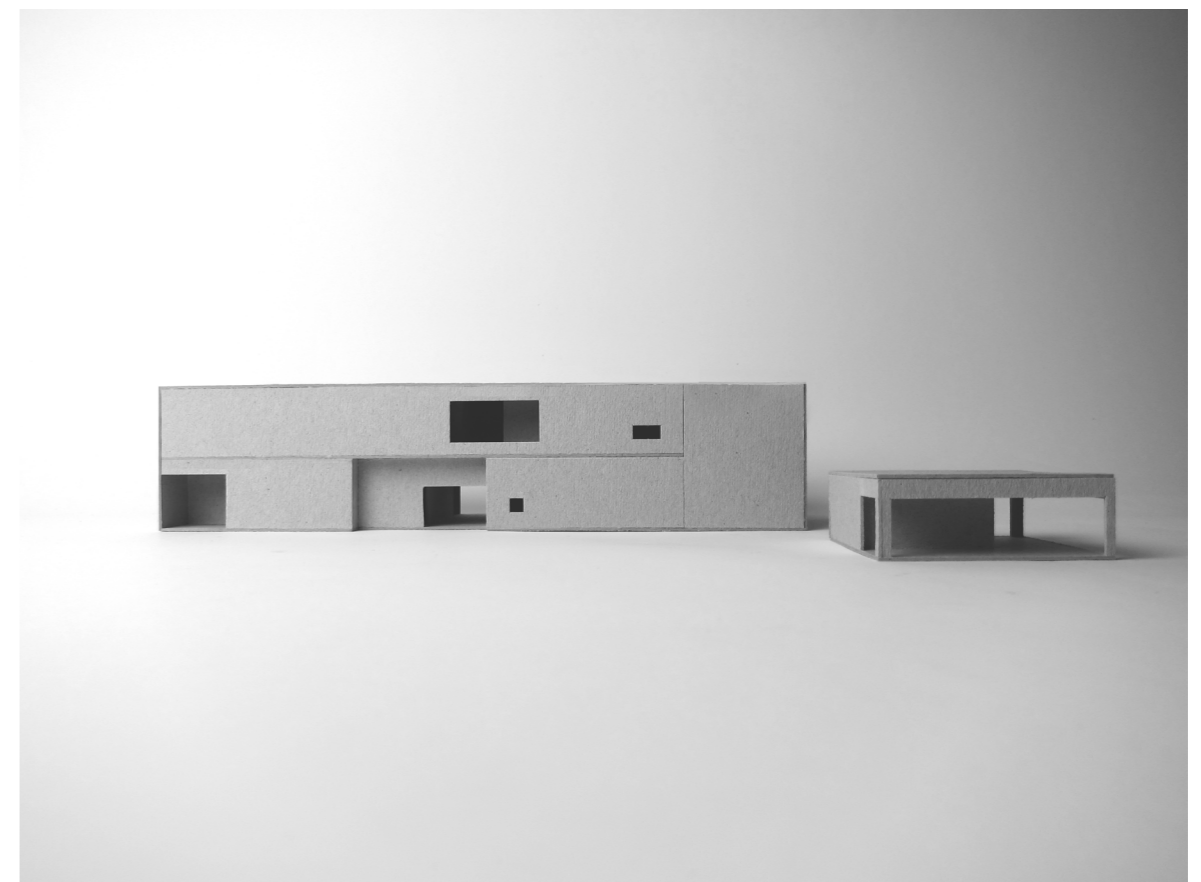


Figure 3. | Photo of early sketch model of the center.

## REFERENCE PROJECT

### THE CLIMATE MUSEUM

The most relevant reference of this thesis was the yet unbuilt *The Climate Museum* in New York. This museum is driven by a non-profit organization and is the first museum in the United States that is dedicated to climate change. This museum does not have any spaces yet on their own and for now they use different temporary spaces that they can use for free. This museum aims to be inspiring and be about learning and keeping up a dialogue, but also to build a broad community engagement around climate education and solutions.

The museum hosts events containing for example science education, workshops, seminars but also exhibitions on the theme with different artists work all around the city (The Climate Museum, 2019). To the right you see a picture of the exhibition *In Human Time*. An exploration of polar ice, humanity, and time, between December 2017-February 2018. This was their first exhibition that was a reproduction of drawings made by Zaria Forman (left) and photography and video installations made by Peggy Weil (right). The exhibition was presented at the Arnold and Sheila Aronson Galleries, Parson Schools of Design.



Figure 4. | Logotype of the museum (The Climate Museum, 2019)  
Adapted with permission



Figure 5. | Whale Bay, Antarctica, No. 4 by Zaria Forman (The Climate Museum, 2019)  
Adapted with permission

Figure 6. | 88 Cores by Peggy Weil (The Climate Museum, 2019)  
Adapted with permission

## THE WADDEN SEA CENTRE

The Wadden Sea center is located in the southern part of Jutland, in The Wadden Sea national Park, Denmark. This is a visitor center for the world heritage site, expanded with a new addition designed by Dorte Mandrup. As a visitor in this center you can either go on guided tours indoors or outdoors in the heritage, activities and trips are being held in a variety of spaces and is for both locals, tourists, young as elderly. Further, the center also hosts events for regional and international schools, the building contains both classrooms, exhibition halls and meeting rooms. As you can see on the images to the right there is a multi functional garden in the middle of the center where for example lectures can be held in front of the small scene or visitors can enjoy a coffee outside from the cafe.

The wadden sea center is a good example of a teaching center with a fine balance of inside- outside spaces. The center is using local natural materials as cladding in terms of thatched reeds, an old local roofing technique, and it frames its surroundings cleverly with windows out over the heritage (vadehavscenret, 2019).



Figure 7. | Thatched facade of local reeds.



Figure 8 9. | Wadden Sea Centre courtyard with outdoor seating and scene.

## SITE

This chapter contains an introduction to the chosen site, including its location in the city and a description of existing buildings and programme on the plot.

## RÖDA STEN, GOTHENBURG

### LOCATION

Since the center is about the climate and inspired by nature, it would be suitable to be built on a site both close to Gothenburg's nature and exposed to its climate.

The most characteristic nature and climate of Gothenburg, according to the authors own opinion, is Göta Älv river, the city's rainy days and the cliffs and hills all over the town. To be both close to this nature and climate, but still accessible in the city, the site of *Röda Sten, Klippan* was chosen. See page 26 for map.

Röda Sten is located on the southern side of Göta Älv river, to the west of the city center, just before the river flow into the ocean. This area is quite windy and exposed to the weather from the ocean, from here the water is truly present. To the east of the site there is the bridge Älvsborgsbron which is cutting of the area from the rest of the city with its massive ramp in south. Due to this ramp there is a large space of untouched hilly and rocky nature around the site.

### RÖDA STEN ART GALLERY

On the plot there is an old and very popular existing building, *Röda Sten art gallery*. This gallery hosts

exhibitions and performances from contemporary artist, but they also hold lectures, guided tours and creative workshops, with a lot of activities with target group kids and youths.

The building is an old renovated boilers house from the 1940's and it used to work as a heating plant. Within the building, chips of wood and coal where burnt in the big visible silos in the ceiling that visitors still can see today. The boilers house was a part of the industries producing sugar but was closed down 1957 when the industries was shut down.

Today the gallery is run by *Röda Sten Cultural Association*, a non profit organization that anyone can join and participate in (Röda Sten Konsthall, 2019).



Figure 10. Photo taken from east looking west over the Göta Älv river as it flows out into the ocean. The site is to the left behind the Röda Sten konsthall.



Figure 11. | Location Gothenburg | 1:150 000 (A1)

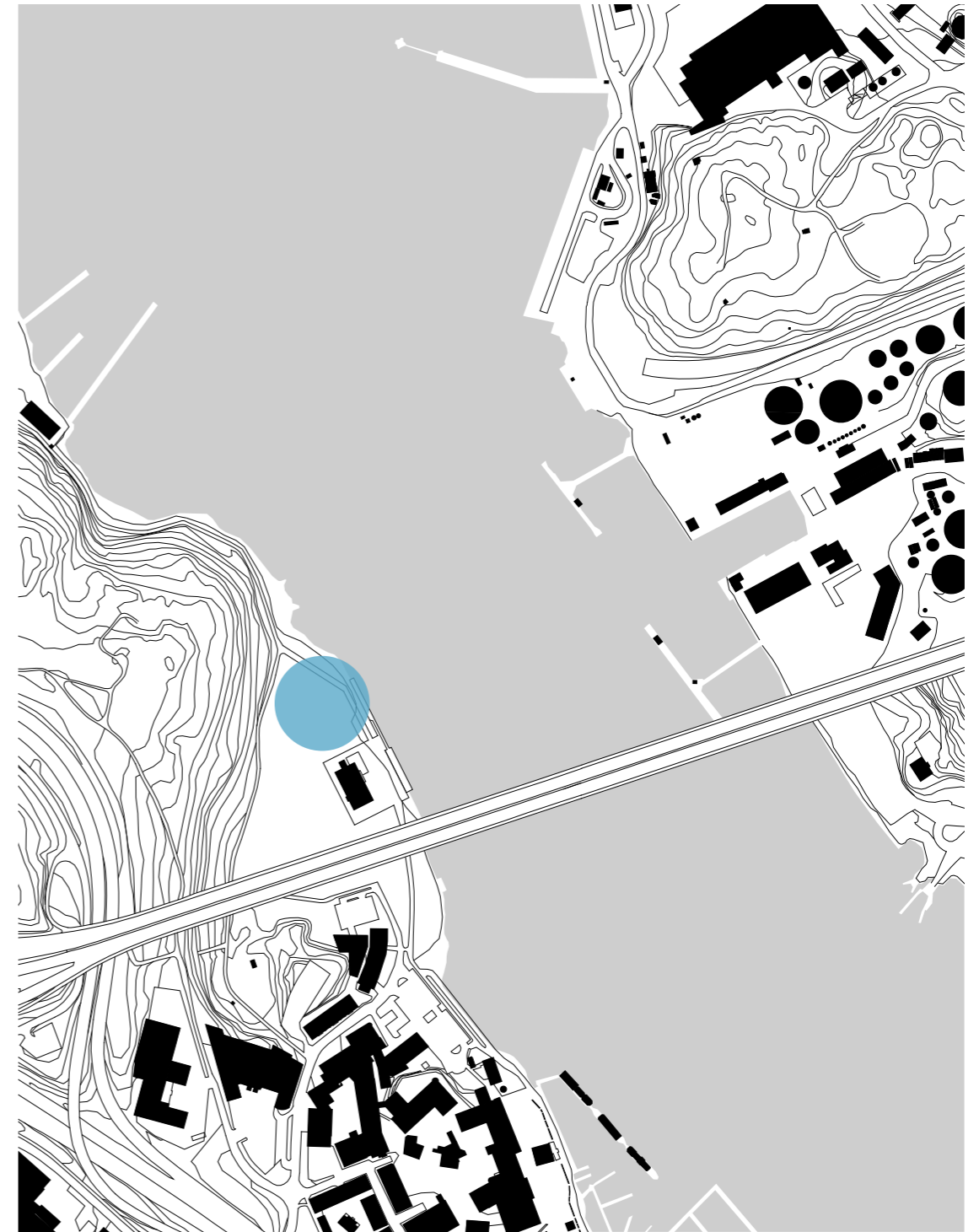


Figure 12. | Site plan | 1:6 000 (A1)



## PROCESS

This chapter contains a small part of the whole process from this thesis, showing different analyses of the site, early sketches of spaces and concept models.



### TRAFFIC FLOW ANALYSIS

The diagram above is showing the flow of people on the site. The majority of people are coming from the north eastern sidewalk, nr 1, and walks along the river or just stops by at Röda Sten konsthall. This way is the most common one if you go by foot, bike or public transport. People arriving by car is most likely to walk on sidewalk nr 2, coming from the parking area. The third alternative, is the southern entrance, a sidewalk that goes lengthwise with the hills and is less trafficked. The fourth option to reach the site is to come from the western sidewalk, this way is mostly used by people who are taking a longer walk along the river or by bike.

It would be wise to take advantage of this present flow of people on the northern part of the area and place the entrance of the center somewhere close to encourage spontaneous visits.

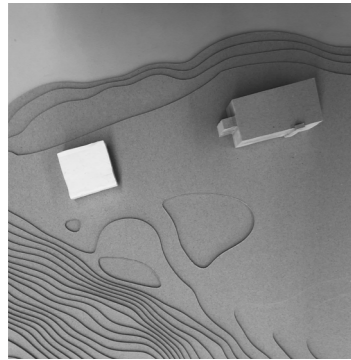


Figure 13.16. | Entrances to the site



PLACEMENT IN LANDSCAPE

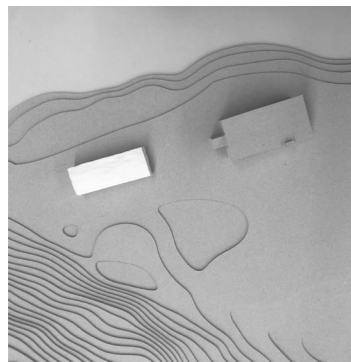
VOLUME STUDY



Simple geometry, two storeys.

Pros: The building does not cover the existing one from any point.

Cons: Looks small in relation to the existing building. No interesting spaces around it.

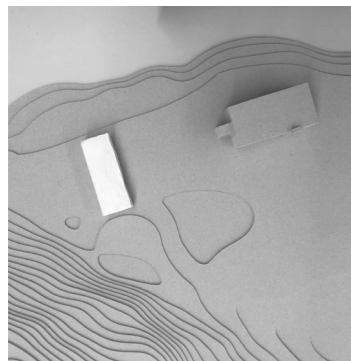


Longer rectangle, speaks with the existing building. Two storeys.

Pros: The size is recognizable since before on the site. Volume aligns the existing one. Creates little shadow on the other building and does not cover it from the different entrances to the site.

Cons: Slim volume that is hidden behind the existing building from the eastern entrances.

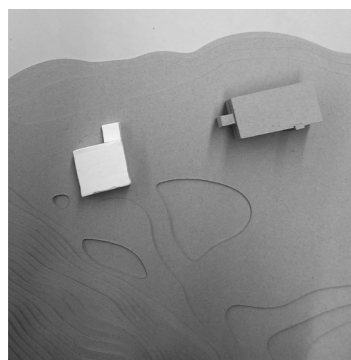
By adding an extra volume, the center will be more visible and the space more interesting.



Same volume as before, rotated 90 degrees.

Pros: The volume is well visible from all entrances to the site. Aligns with the existing building in north and does not cover the view over the river from south.

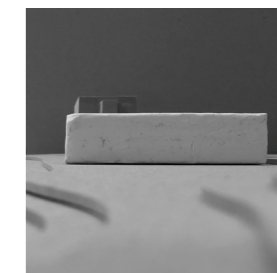
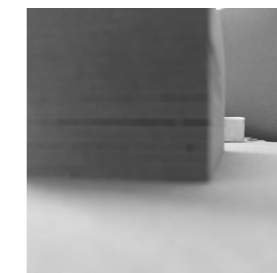
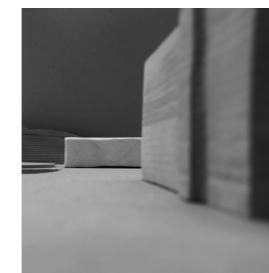
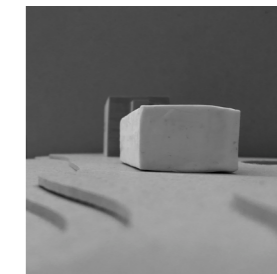
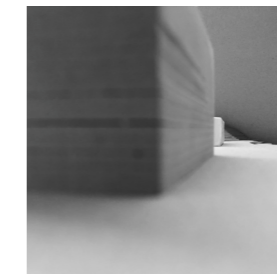
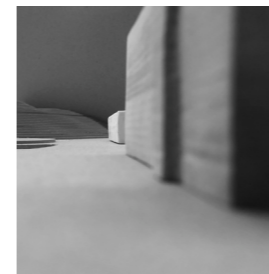
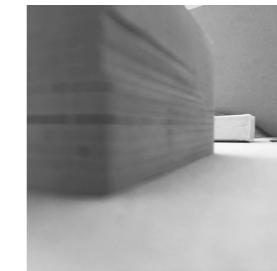
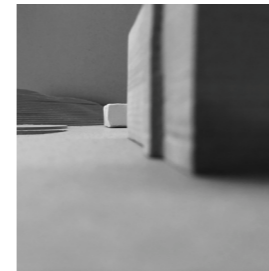
Cons: Breaks the building pattern a bit. Creates more shadow during the afternoon evening on the existing building.

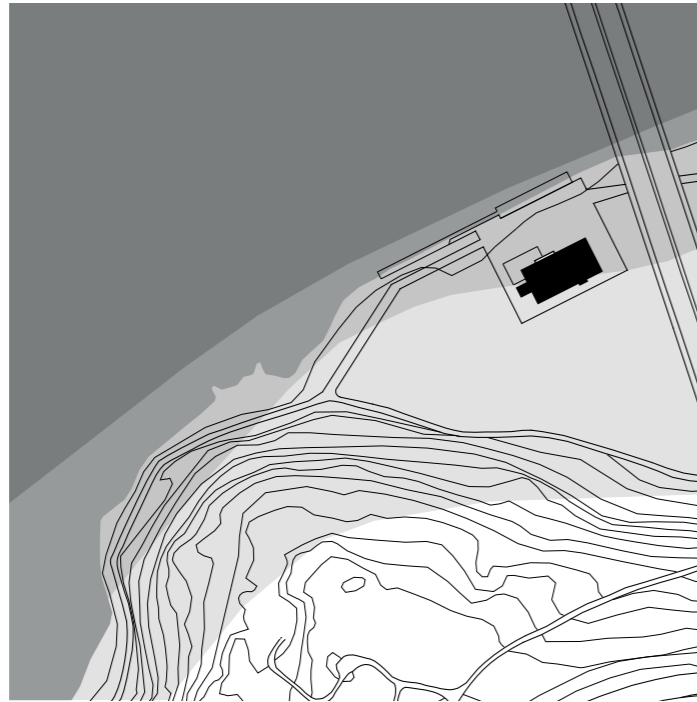


Same rectangle as before, added one smaller volume with one storey in north.

Pros: More exciting spaces between the volumes and existing building. The extra widths make the center more visible from the entrances in east. A lower volume in the front is covering the existing building less, seen from the western entrance.

Cons: Not that attractive composition.

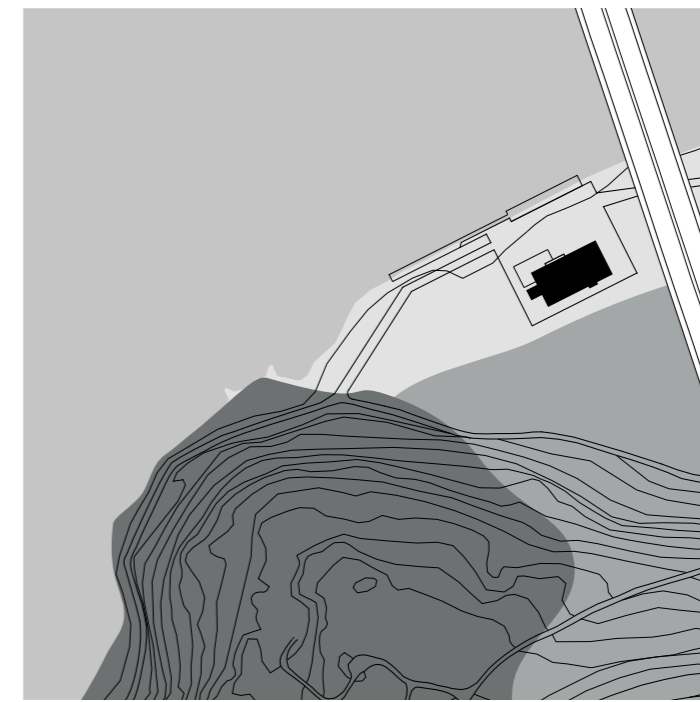




-1000 years
  present time
  1000 years
  5000 years

### SEA LEVEL MAP

Due to present global warming that causes flooding and rising seas we need to pick our future sites close to waterfronts carefully. The diagram above is showing four different sea levels regarding the river of Göta älv that goes along the site. The area of light grey is showing where the sea level was 5000 years ago, next level shows 1000 years ago. The third level is the sea level as it is today. Fourth level is showing the future level in 1000 years from now. Apparently, the sea level of the river is decreasing in Gothenburg, opposite of what one might expect. The sea level will continue to decrease and this thanks to the ice sheet that once covered the area long time ago. The land is still rising where the ice once pushed it down, and in a faster pace than the sea level is rising. In terms of rising sea levels, the area will be suitable for a new center (Sveriges Geologiska Undersökning, 2019).



Artificial filling
  Fluvio glacial sediment
  Parent rock

### EARTH DEPOSIT MAP

The site contains half of artificial landfill and half of Fluvio glacial sediment. Fluvio glacial sediment is rated as steady ground by SGU (Sveriges Geologiska Undersökning) and thereby alright to build upon, just like the parental rock that is adjacent. Compared to the previous diagram one can see that the landfill starts where the sea level was 1000 years ago (Sveriges Geologiska Undersökning, 2019).



### WIND ANALYSIS

The wind on the site is quite strong and shifts during the seasons of the year. see diagram to the right. During the winter there is strong wind coming from south west and a bit weaker but greater amount from the north east. During the spring the wind direction change and the strongest wind blows from west and north. When it comes to the season of summer the wind speed decreases breezes blow from south west. Later towards autumn the winds speed increase again this time from south, south west and west.

During the whole year most of the wind blow from south to west. in this area on the site it will be suitable to have seating during the summer and maybe use the wind all year around to enhance the presence of the local climate. The northern to eastern part of the area is more suitable for activities in leeward. Weather data collected from energyplus.net (2019).

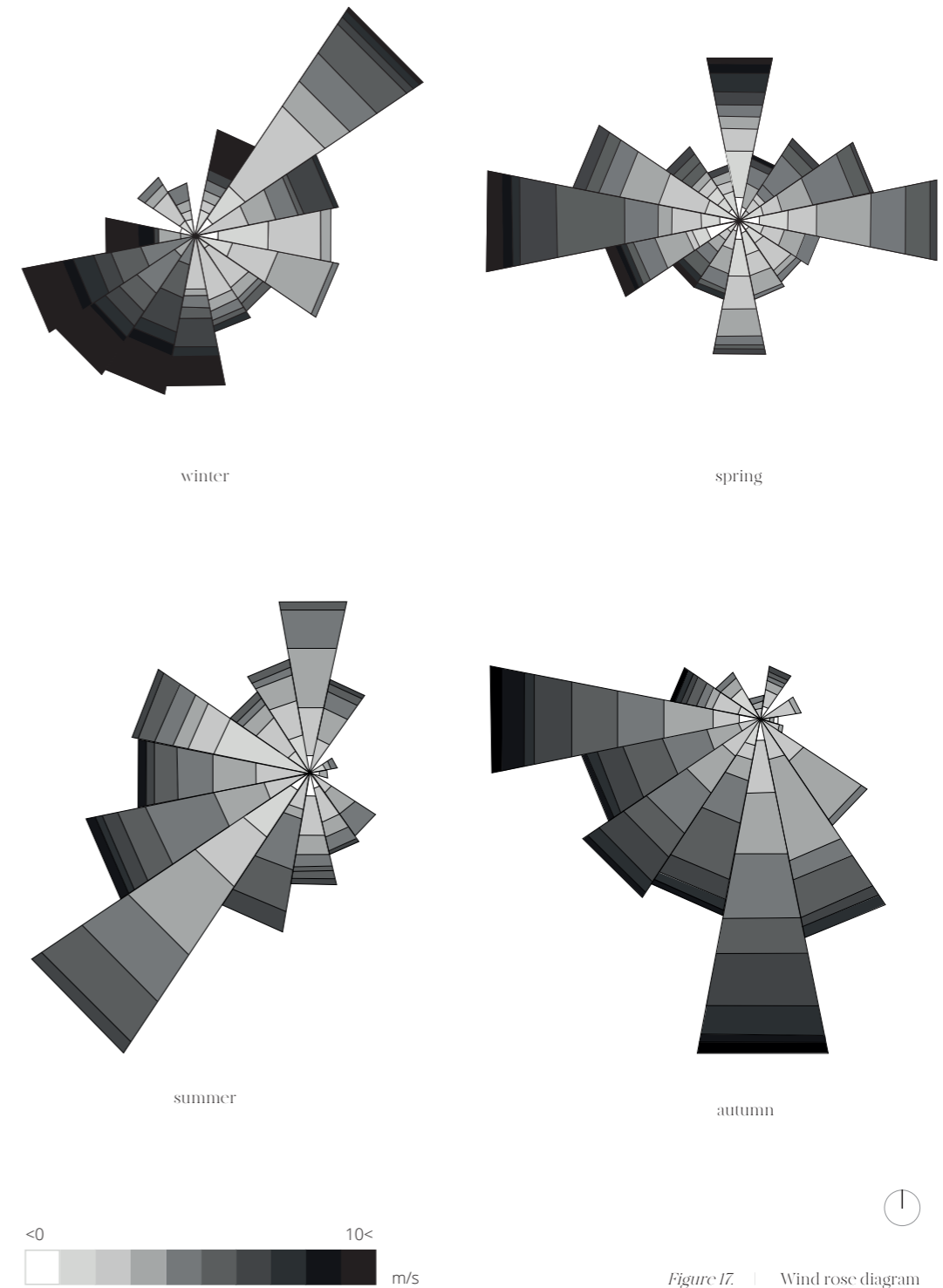
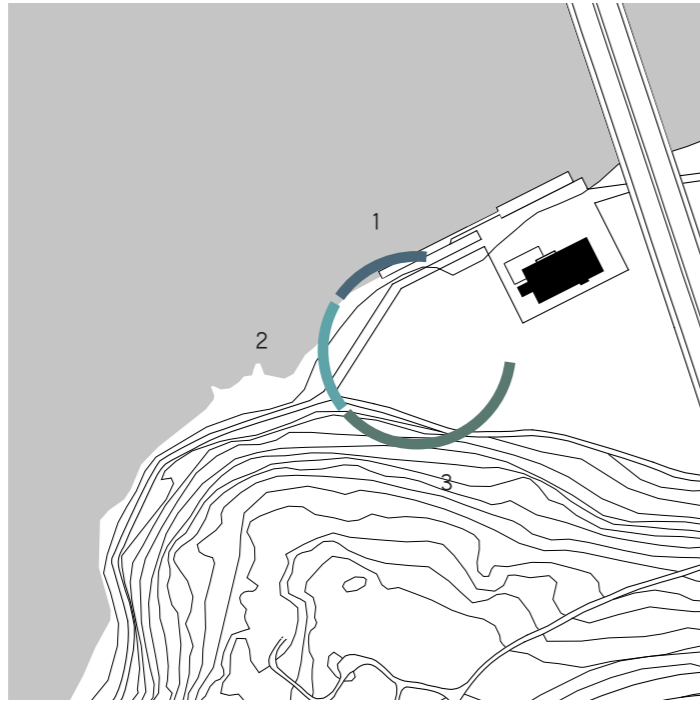


Figure 17. | Wind rose diagram

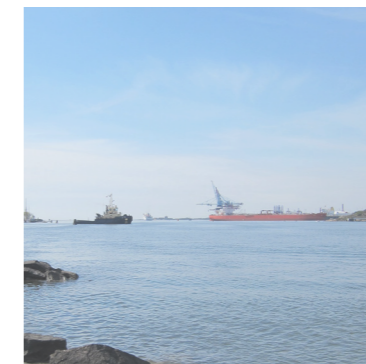


### VIEW ANALYSIS

Identified potential views and vistas of nature on the site can be divided into four spans. First one is the view out over the river, looking at the hills on the opposite side on Hisingen. In this view you also can see the company *OljOla*, an oil tank supplying company that fits dramatically in to the discourse about climate change and carbon dioxide emissions. The second view, which might be the most impressive one, is the view out over the river as it flows along the hills into the ocean. This view also frames *Skandiahamnen*, the biggest shipping port of containers in Sweden with a wharf length of 2.2 km, enrichen this view with possibilities to raise questions regarding our consumption habits. Third view is a view that frames the hills and its greenery looking south on the site, a calmer and more peaceful vista. A fourth view is of course the sky that can be framed through skylights, atriums and courtyards.



1. Göta Älv - oil tank supplying company

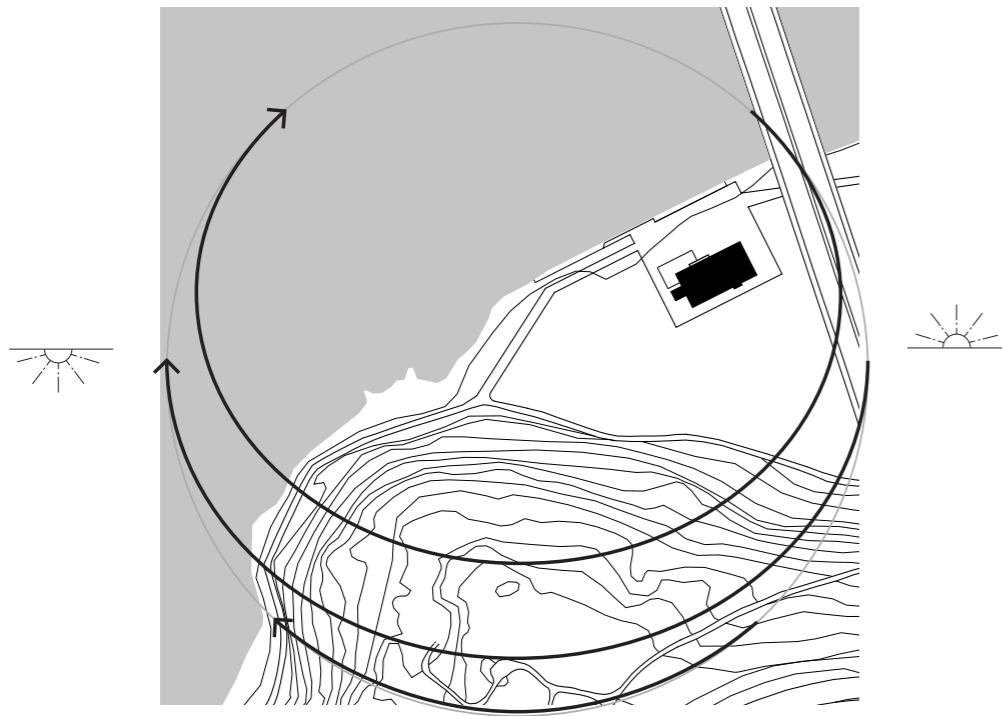


2. Ocean - shipping port



3. Hills with greenery

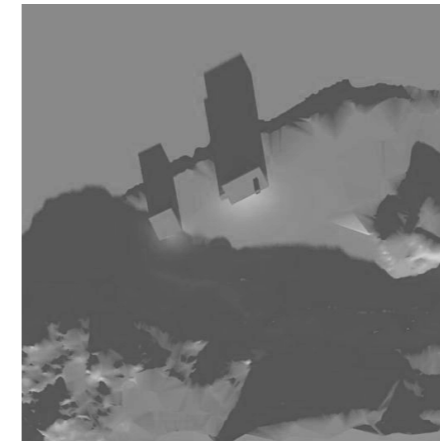
Figure 18.20. | Views to frame



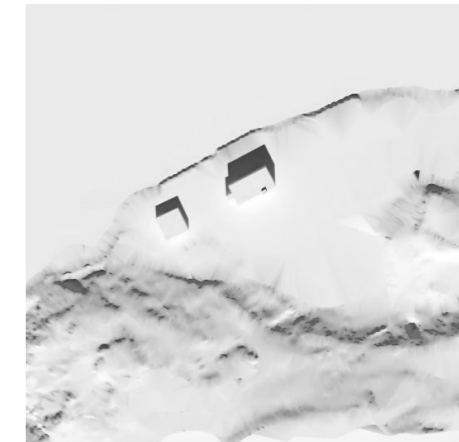
### SUN PATH ANALYSIS

The sun diagram above is showing three different sun paths during the year. The first arrow (topmost) shows the path during summer solstice 21st of June. During this time and nearby months, the sun will reach the site very well from several directions due to its steep angle position on the sky. The second arrow (middle) shows autumn and spring equinox 21st of September / 21st of March when day and night are equally long. During these dates the sun still reaches the site well from east to west during the day. The third arrow (bottommost) shows the sun path during winter solstice 21st of December. during these months the sun will have more trouble with reaching the site, due to its low angle but also due to the hill in south covering the sunrays.

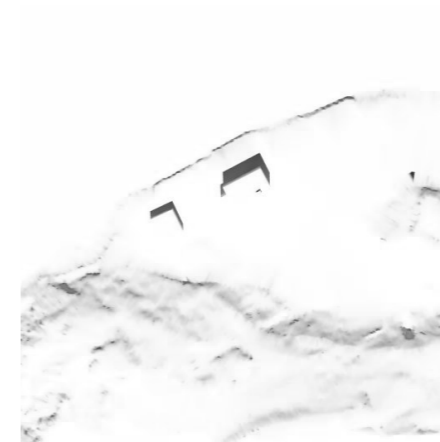
The sun study to the right is showing how a new two-story building is shadowing the site during the year. To not destroy the present sunny café terrace of Rôda Sten konsthall it was interesting to see when a new building would throw its shadow there or not. The shadow of the new building will only hit the existing building after 5 pm during March and late parts of September when the sun is standing very low. Similarly, the existing building will only throw a shadow on the new building early mornings between 6 am - 8 am during April to September.



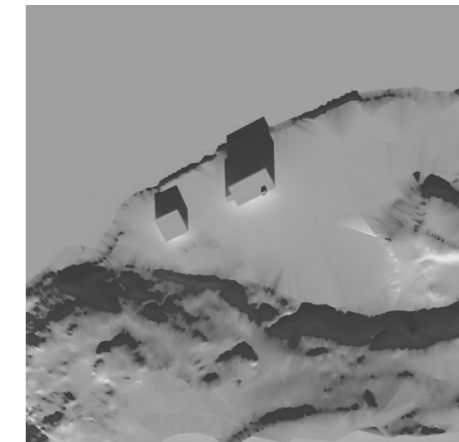
january 02:00 pm



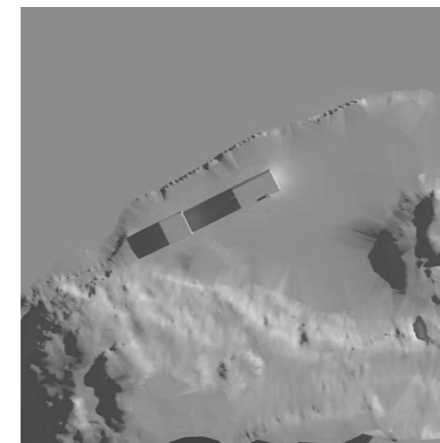
july 02:00 pm



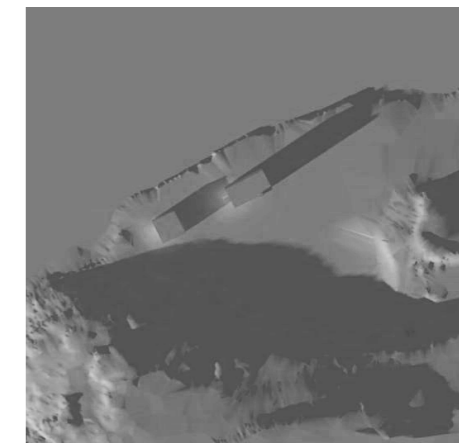
april 02:00 pm



october 02:00 pm



july 07:00 am



september 06:00 pm

Figure 21.26 | Sun studies

## SKETCHES OF SPACES

### EXHIBITION HALL L

Sketches of the biggest exhibition hall on 200 m<sup>2</sup> with double ceiling height. Big window that frames one of the views on site. The first series has the dimensions of 14 x 14 meters, series 2 has 10 x 20 meters and a ceiling height of 8 meter.

A. Entrance through big opening on opposite side of the framed view. Low windows at the bottom lets little gentle light in and enable the visitor to see the vegetation on the outside.

B. View around the corner that lets a tempting light in that makes the visitor wants to continue further in. Small space next to it to enhance the bigger space.

C. At the entrance the visitor faces a wall suitable to put information on about the exhibition. The wall enables two new possible ways. At the end of those ways the visitor faces to framed views with light that guides you further in to the big hall.

### EXHIBITION HALL S

Sketches of the smallest exhibition hall on 40 m<sup>2</sup>, 6 x 7 meters. These sketches investigate flow, light, views and exhibition possibilities, see next spread.

A. One flow where the visitor walks straight along the long side. Window framing a view along the other creates a light room.

B. One flow where the visitor walks through the space centred. This alternative enables more space for exhibition when the light comes from the ceiling and the view in the room is towards the sky. Openings and window aligned.

C. Openings from one short side and one long side, flow along one corner. View that leads from the short side.

D. One opening and window at the bottom with a view of the vegetation. A lot of exhibition space.

E. Two openings from the same long side. View through skylight. Two different sectional sketches that shows on different light through different shaping of the ceiling.

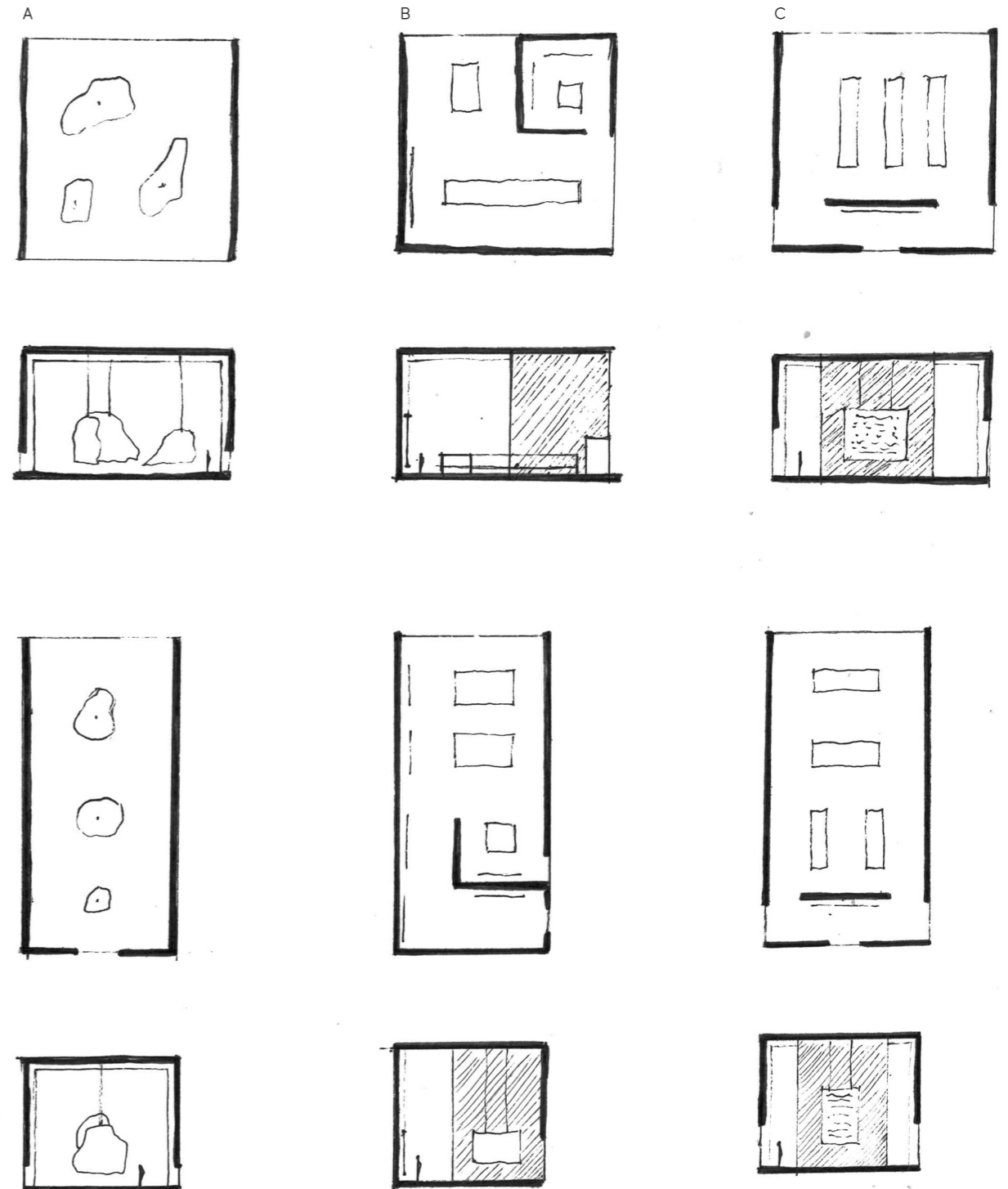


Figure 27. | Exhibition hall L. | 1:400 (A1)

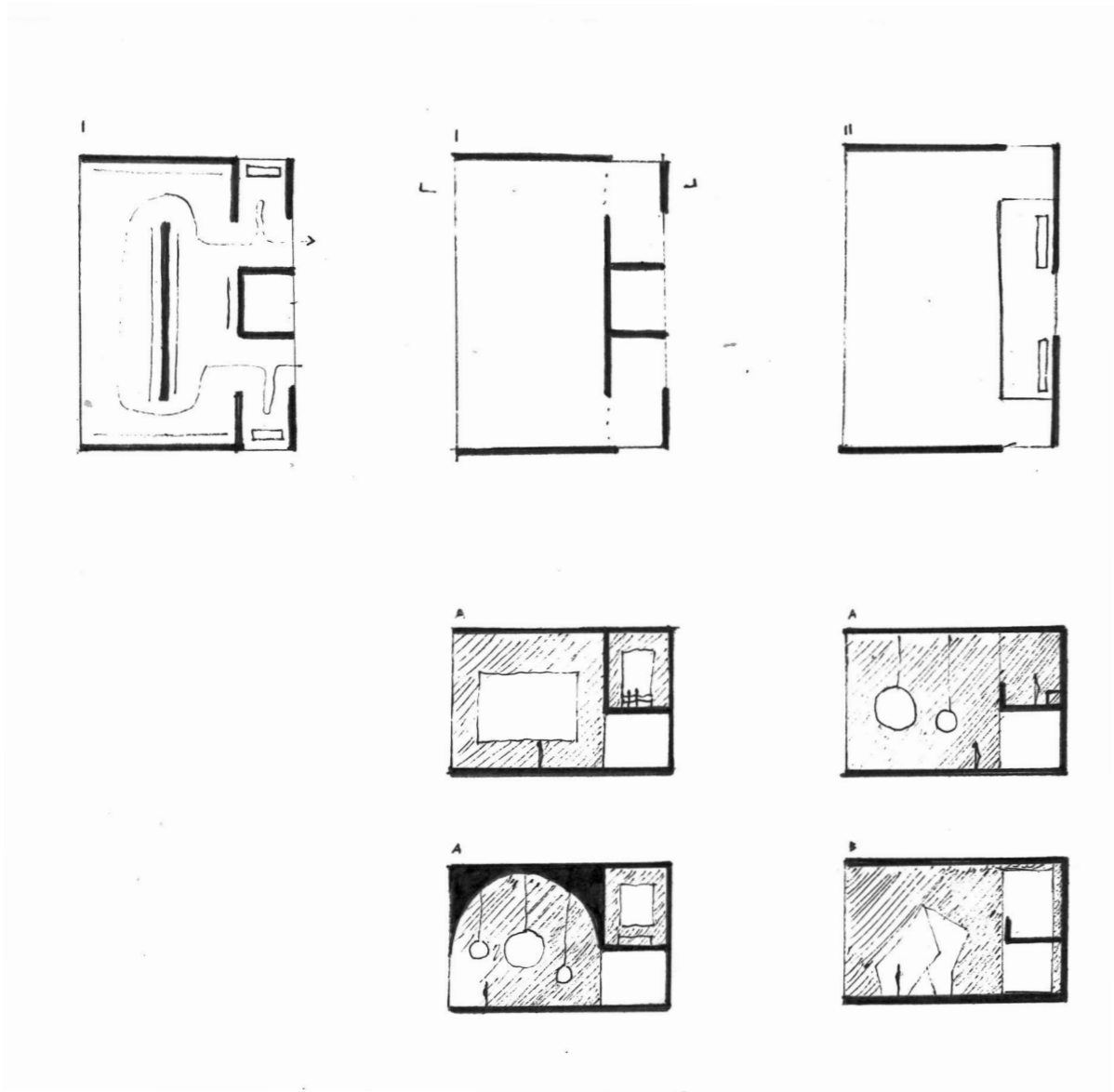


Figure 28 | Exhibition hall L | E: 400 (A1)

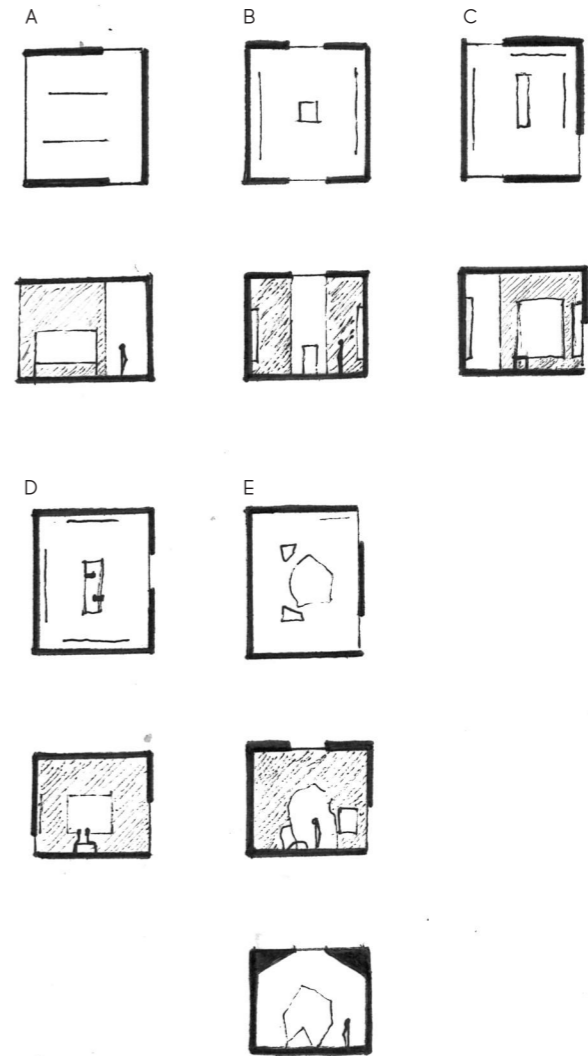
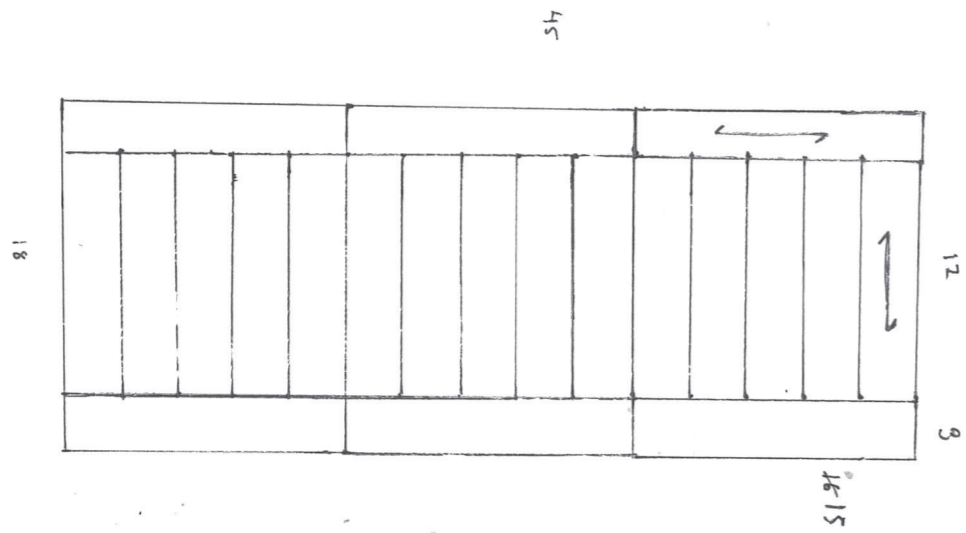


Figure 29 | Exhibition hall S | E: 400 (A1)



**CONSTRUCTION SKETCHES**

Sketches on CLT construction and how the elements can be put together according to a grid based on its element's dimensions. Sketches in the right corner shows on different amounts of glulam beams holding up the ceiling in the bigger exhibition hall.

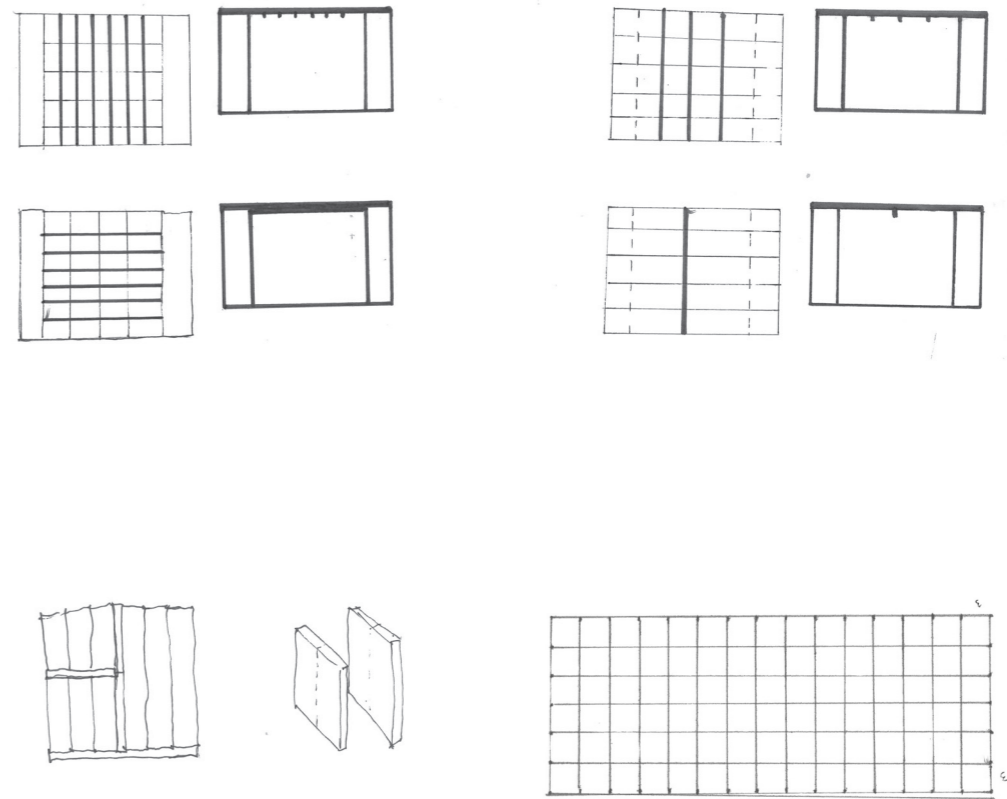
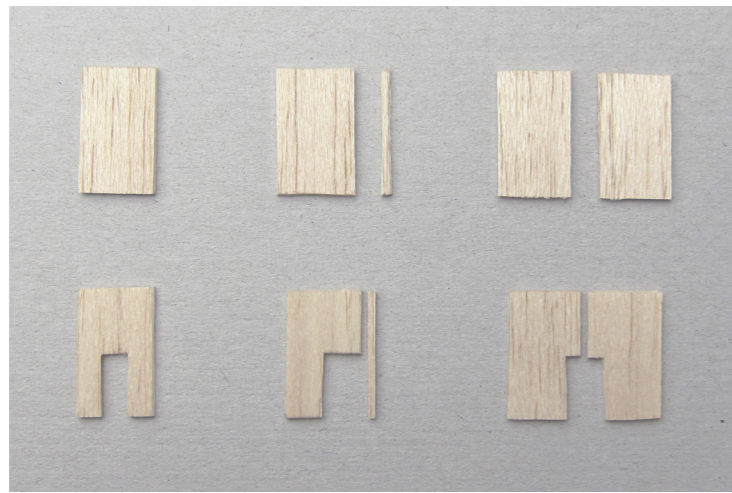


Figure 30.31 | construction sketches CLT grid





CONCEPT MODELS | CLT OPENINGS

Concept models of how to handle openings in the CLT construction. The models first row above shows whole CLT elements of 3 x 5 m, if they are put together with a distance that distance can become the opening to next space behind. The second row shows how openings can be cut out from the element, either from one single element or from two together. The pictures on the right side shows how these different openings looks like in a space.

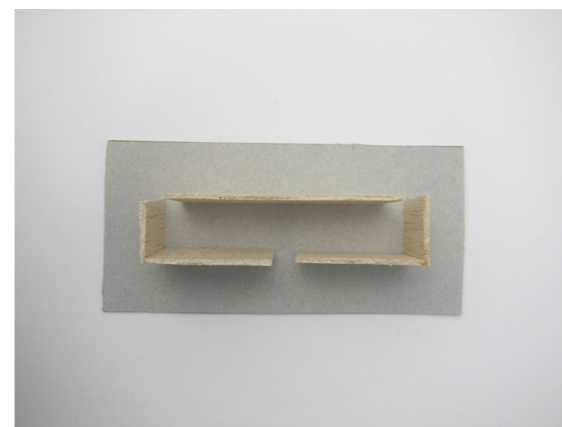
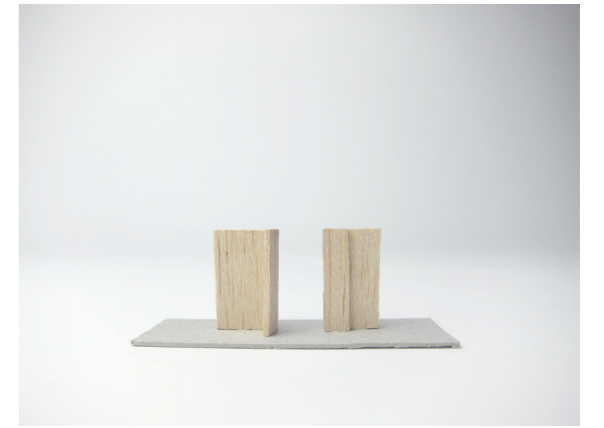
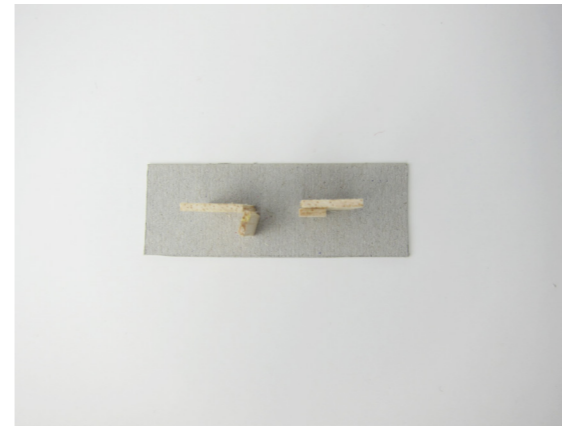
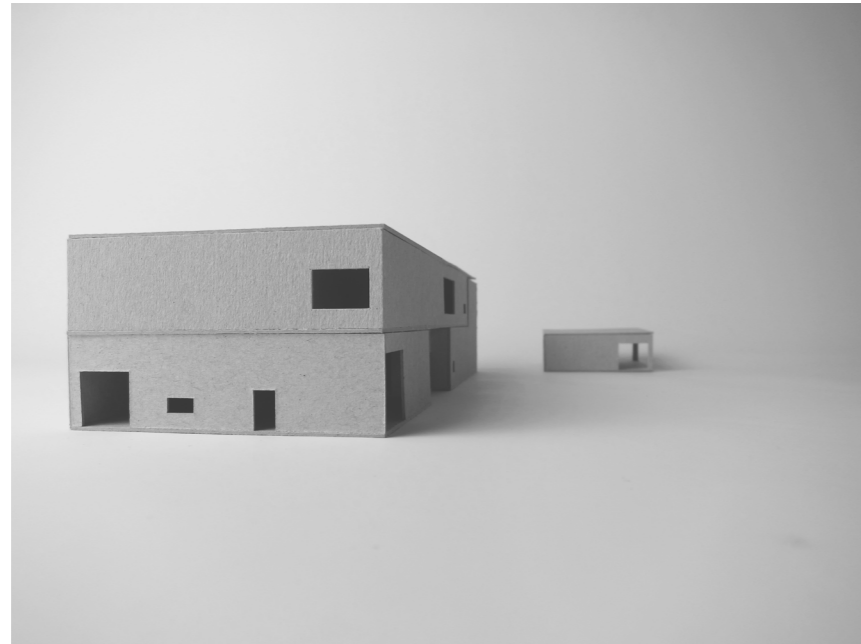


Figure 32.39. | Sketch models - CLT elements



### BUILDING PROTOTYPE

Photos of a building prototype built in the beginning of the thesis. The focus with the model was to see the relationship between the different storeys and start working with the facades and windows. It was good to get a feeling of how the two buildings can come together as a whole.

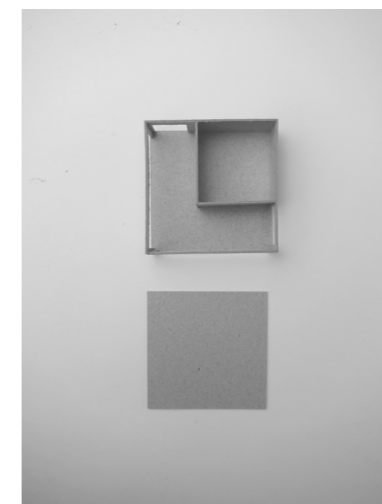
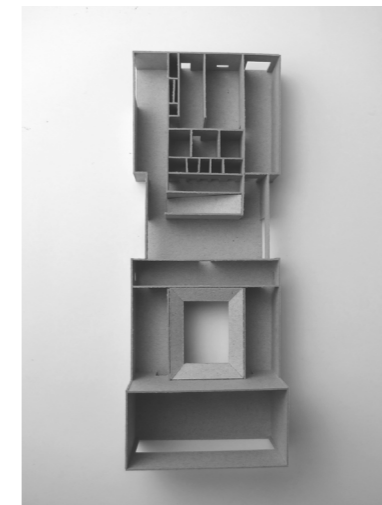
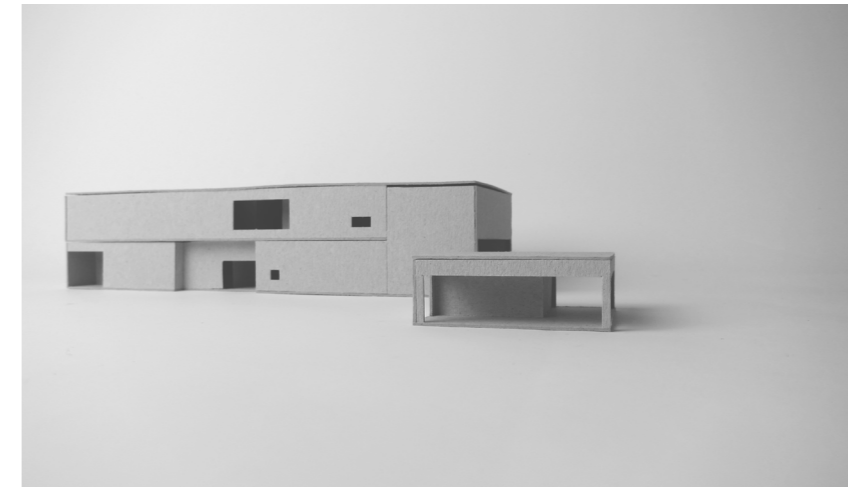
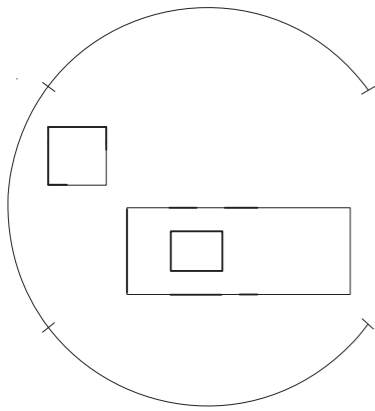


Figure 10-15 | Sketch models - early prototype

## PROPOSAL

This chapter contains this master's thesis final proposal for a climate center in Gothenburg, including design concepts, plans, sections, facades, views, details, program, photos of models and conclusion.

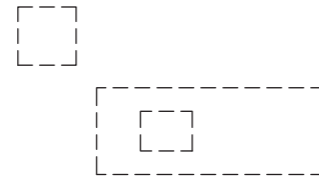
## DESIGN CONCEPT



### VIEWS AND VISTAS

*How can views and vistas be framed in a center placed in Röda Sten, to guide its visitors and remind about its climate?*

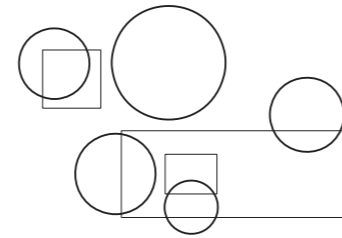
By framing the hills in south, the river in north and the ocean in west, the views will guide the visitor through the building by its windows. These views can simultaneously evoke questions regarding fossil fuels, carbon dioxide emissions and our consumption habits since they also frame the big container wharf *Skandiahamnen* and an oil tank supplying company *OljOla* on Hisingen.



### WOOD

*How can wood be used as material in a center to create a good atmosphere to exhibit art and science?*

By using exposed CLT elements as construction material and use them as the final interior finish, the atmosphere will be both calm, warm and light, suitable for exhibitions. The dimensions of the CLT elements are used as a grid to construct the center. Cobble wood with end grain are used as flooring and Shou sugi ban treated pine will be used as exterior cladding.



### INSIDE OUTSIDE SPACES

*How can inside-outside spaces be used in a center, in Gothenburg, while taking advantage of its surroundings?*

By using spaces such as: a courtyard for exhibitions and lectures that collects rainwater to the building, an outdoor learning area under roof in front of the river with display windows and a sculpture park between the trees and greenery. All spaces are using its surrounding nature to improve its function and are somehow connected to the different loops that the visitors will be walking in and around the climate center.



Figure 16. | view in front of the center

## SITE PLAN

Based on the vistas that are being framed and used as guidance, plus the flow of people on the site, the placement of the center landed on the northern part of the plot. In this location the center will reach all views and connect to the heaviest trafficked pathway, with the main entrance facing the path. By dividing the program into two buildings, a more framed and protected space could be created between them, together with the existing building in east. Here they have a space to share and use together.

The northern part of the plot is more organized with hard surfaces suitable for gatherings and happenings. Trees are planted in rows with benches underneath. The southern part is softer with greenery and vegetation. Here is a new sculpture park that will exhibit sculptures on the topic of climate change.



Figure 17. | Site plan | 1:1000 (A4)

- 1. café
- 2. trees with benches
- 3. climate center
- 4. event / exhibition space
- 5. röda sten konsthall
- 6. sculpture park

## PLANS

### FIRST FLOOR

#### Foyer / Reception

As you enter the entrance, under a welcoming porched roof, and walk in to the foyer, you will be faced by a view out over the green sculpture park on the southern part of the center. The reception is located in the middle accessible from both sides with the main entrance from north, creating a nice connection between the sculpture park and the river. To your left you find the reception desk where you can purchase your ticket or check in at one of the center's different seminars and workshops. If you want to hang of your coat you can just continue to the left around the corner where you will find the cloak room and restrooms. On the opposite side of the counter you find the exhibition entrance, a big opening from floor to ceiling with daylight coming from the right.

#### Exhibition

The exhibition contains five different halls and one courtyard outside; all spaces is organised in a loop for you to just follow without doubting to miss anything. The material of the walls and ceiling is pure wood that enhances the center's message about caring for nature. The exhibition starts from the reception and frames the view of the oil tank company in north, this sets the tone of the centers topic. The light guides the visitor further in around the corner in to smaller exhibition halls until you find the biggest hall, framing the ocean and the shipping port. The final exhibition hall that can be used to showcase solutions as the visitor can look out over the last and third view of greenery in south. From here you can walk out into the courtyard, an extension of the sculpture pare, where during rainy days you can sit under the porched roof as the rain falls like a curtain in front of you. The indoor rout ends where it begins, where you get your last reminder through the window before you walk out.

#### Staff area

In the eastern part of the building there is an art storage, service lift, office, break room and changing room.

#### Outdoor learning area / Workshop

Separated from the exhibition spaces but connected to the reception are the center's outdoor learning area, a multifunctional area suitable for different activities such as workshops with school classes, small seminars or lectures. Behind sliding doors, the space has a sink and along the exterior wall there is display windows that can exhibit information to the public. The space is always open and can be used extended out in the front yard, a possible shared space for collaboration with the Rôda sten art gallery.

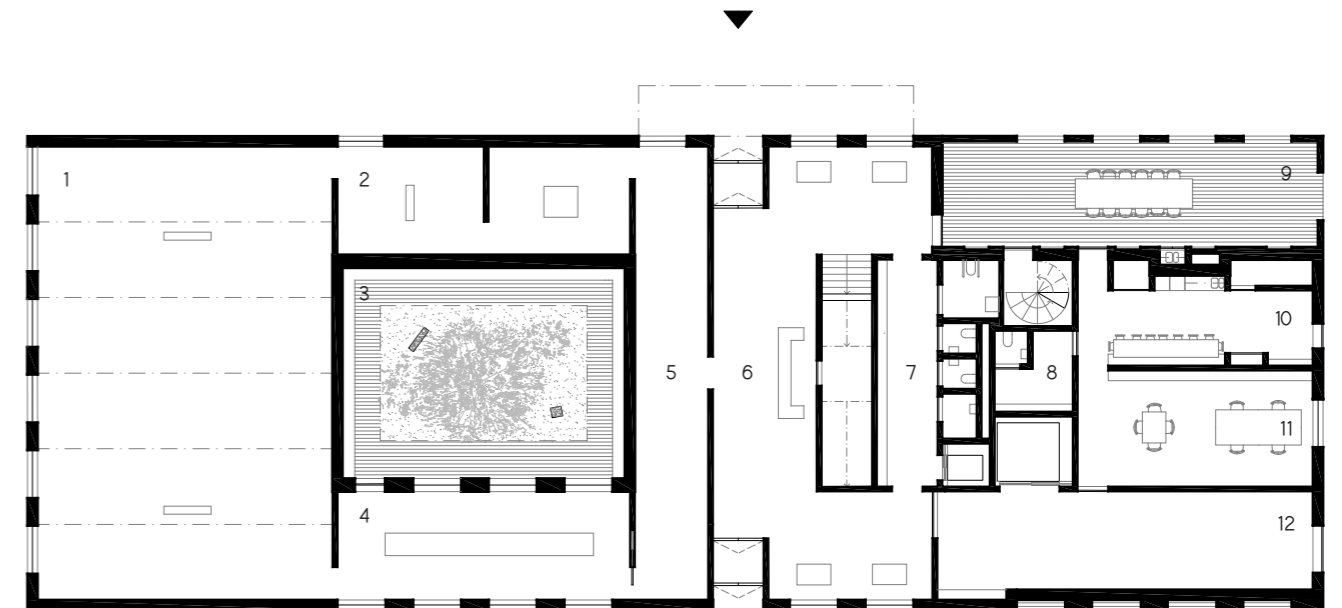


Figure 18 | Plan First Floor 1:300 (A1)

- |                          |                      |                          |
|--------------------------|----------------------|--------------------------|
| 1. large exhibition hall | 5. introduction hall | 9. outdoor learning area |
| 2. small exhibition hall | 6. foyer / reception | 10. break room           |
| 3. courtyard exhibition  | 7. cloakroom         | 11. office               |
| 4. final exhibition hall | 8. changing room     | 12. art storage          |

## SECOND FLOOR

### Conference | Foyer

The conference is located on the second floor and is reached by taking the stair from the reception. At the end of the stair there are big windows with a view over the hill that guides you up. As you reach the top you find the foyer of the conference, a space for smaller exhibitions but also a space where conference attendances can gather during a mingle before a lecture or a break. In connection to this the conference has its own cloakroom and restrooms just around the corner.

### Conference | Lecture hall

The entrance of the lecture hall is situated on the right side of the conference foyer. Entering through generous big doors the lecture hall opens up with a capacity of hosting 100 people. Due to the wide span of the hall, the CLT elements are complimented with glulam beams holding the ceiling cross the room, creating a soft depth to the wooden atmosphere. In here can for example schools and private individuals participate in seminars and lectures about climate change.

### Atelier

As a private person or professional artist, you can rent one of the centres two atelier to use as your workspace. In the hallway leading to the library it is possible to exhibit the art produced on the topic there. The ateliers have different sizes suitable for different kind of projects and creativity.

### Library

The center's library is located to the right of the stairs. Walking around the corner, through the hallway, you face big windows that are framing the river Göta Älv as you enter the library. Standing in the room, the space opens up at both left and right,

creating a long space that aligns the façade. In front of the window there is a seating area suitable for reading. Tall bookshelves from floor to ceiling is covering the whole back wall. In each end there is a smaller room, one is office and storage and the second one is a seminar room, possible to book both for conference and library visitors. The final space for the library is the research room, located along the hallway. The research room is a smaller and quieter space for research or for situations when you want to sit more private. A window is framing the view of the courtyard as you sit in front of the reading table.

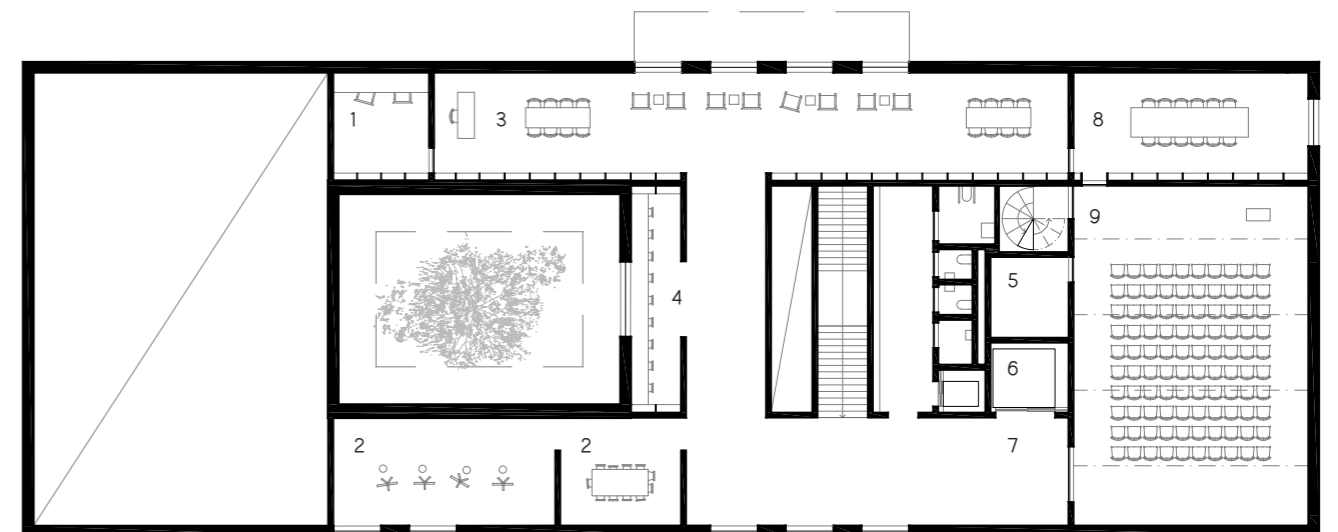


Figure 19. | Plan Second Floor 1:300 (A1)

- |                   |                   |                        |
|-------------------|-------------------|------------------------|
| 1. library office | 4. research room  | 7. conference foyer    |
| 2. atelier        | 5. technical room | 8. seminar room        |
| 3. library        | 6. service lift   | 9. lecture hall 100 p. |

## CAFÉ

A small café that can host 50 people is positioned next to the walking path along the river, suitable for a spontaneous coffee in the sun or a break for school classes who are visiting the center together. The café is a space that can attract pedestrians out on a stroll to the center and work as a compliment building to the main building. The building contains a seating area that frames the river, a small preparation kitchen, a counter area, storage and restrooms.

On the western side you will find the sun and the windiest area, on the eastern side you will find shadow and leeward, both with a great view. In front of the building there is a small wooden terrace that its visitors can enjoy during the warmer seasons.

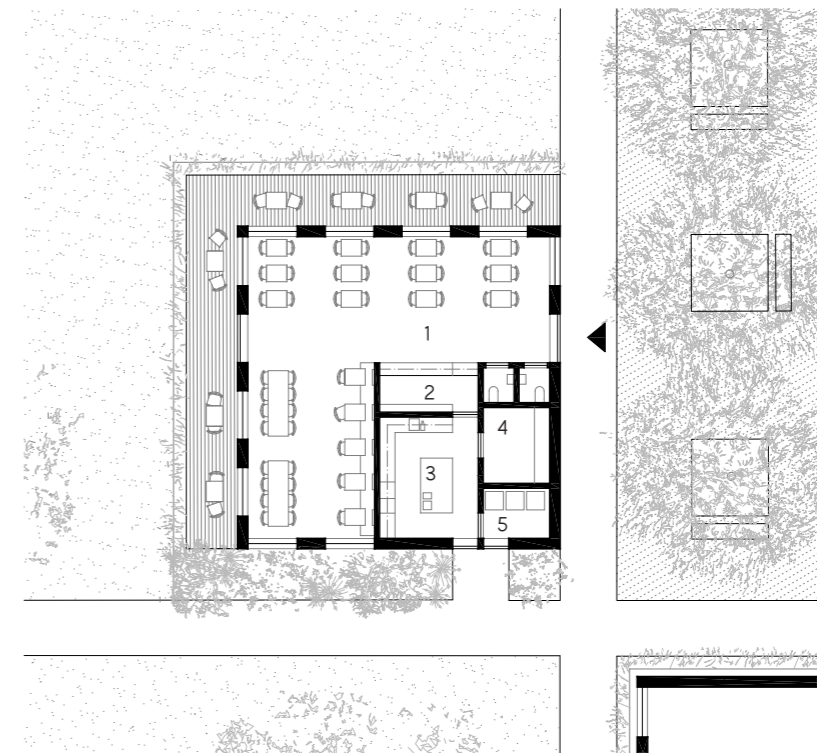


Figure 50. | Plan Café E 300 (A1)

1. café  
2. counter  
3. kitchen

4. food storage  
5. garbage room



## SECTIONS

A  
Section through the final exhibition hall, the courtyard and the smaller exhibition hall on first floor, atelier and library on the second floor.

B  
Section through the introduction hall on the first floor, atelier, research room and library on the second floor.

C  
Section through the reception foyer, storage below stair and beginning of stair on the first floor, conference foyer, ventilation space and library on the second floor.

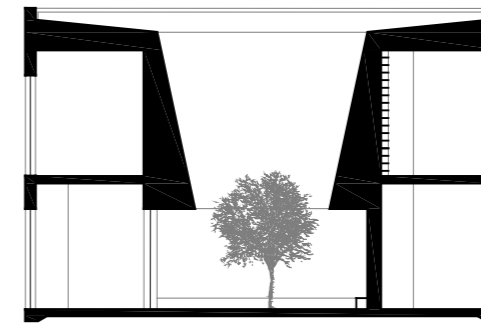


Figure 51 | Section A 1:300 (A1)

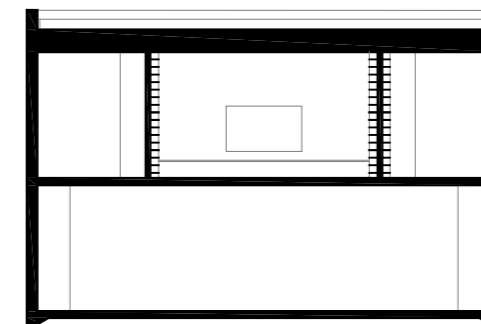


Figure 52 | Section B 1:300 (A1)

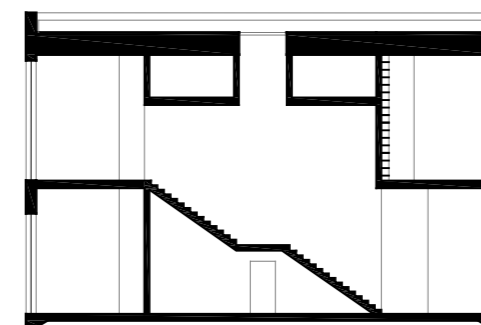
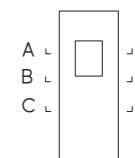


Figure 53 | Section C 1:300 (A1)



## FACADES

The center's design is based on a grid made out of 3 x 3 m. dimensions related to the elements of its cross laminated timber construction. This grid is also visible in the façade, as a wish to express the wooden construction on the exterior. The window sizes are adjusted to the grid, placed within it, to establish a rhythm and balance. The actual construction is not what is seen on the façade, instead there are glulam bars above the panel every meter that creates shadowing and division.

At the main entrance, on the northern façade, there is a porched roof that enables weather protection and offers a welcoming gesture towards the visitors.

All wood is treated with *Shou sugi ban*, an ancient Japanese wood preserving technique where the surface of the wood burns to different stages of coalification. The charred surface can, after being burnt, either be left as it is or be brushed and sealed with for example linseed oil. This charred surface makes both the wood more resistant against rot, mould, sunlight, erosion and fire, without extra impregnation agent, making this kind of façade environmental friendly and maintenance free (tree, nu, 2019). This is a cladding that will strengthen the connection with nature but simultaneously remind us about the forest fires that climate change has brought. Which is the theme of the exhibition here that I have suggested. See next page for image.

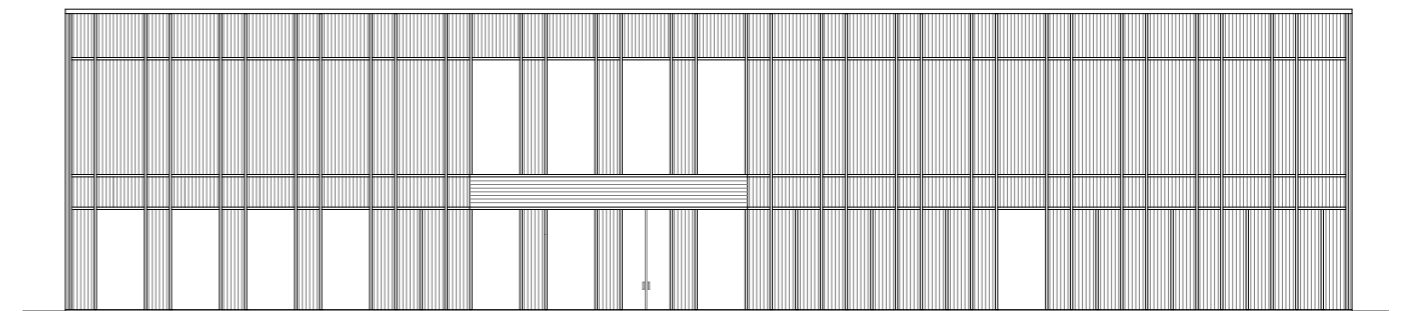


Figure 54. | Elevation North Climate Center 1: 300 (A4)

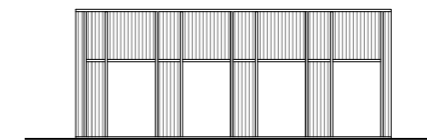


Figure 55. | Elevation North Café 1: 300 (A4)



Figure 56. | Photo of chosen cladding material. Shou sugi ban named "Kärnfuru, Kraftigt bränd. Linoljad" from the Swedish company *Tree*.

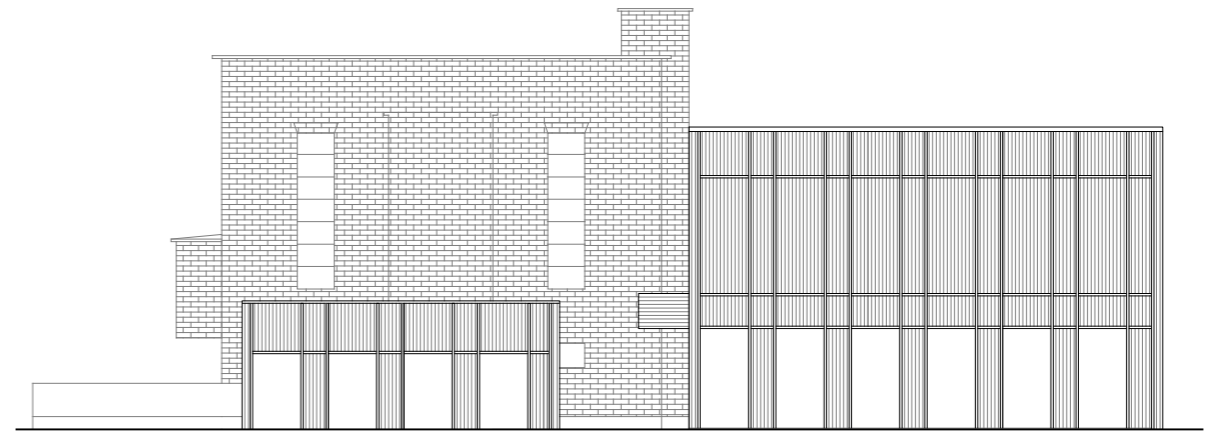


Figure 57. | Elevation West E 300 (A1)

## VIEWS AND VISTAS

### ELEMENT 1

From site visits three good potential views were identified that the center now is framing, see photos in the chapter *process*.

First one is the view out over the river, looking at the hills on the opposite side on Hisingen. In this view you also can see the company *OljOla*, an oil tank supplying company that fits dramatically in to the discourse about climate change and carbon dioxide emissions.

The second view, which might be the most impressive one, is the view out over the river as it flows along the hills into the ocean. This view also frames *Skandiahavnen*, the biggest shipping port of containers in Sweden with a wharf length of 2.2 km, enrichen this view with possibilities to raise questions regarding our consumption habits.

Third view is a view that frames the hills and its greenery looking south on the site, a calmer and more peaceful vista.

The view framed in the image to the right is the oil tank supplying company, which is the first framed view that the visitor will see while walking along the exhibition path. The view and light guide the visitor further in to find the next hall around the corner to the left.

The views are framed with wooden window frames, which are placed within a bare CLT opening, see detail on next page.

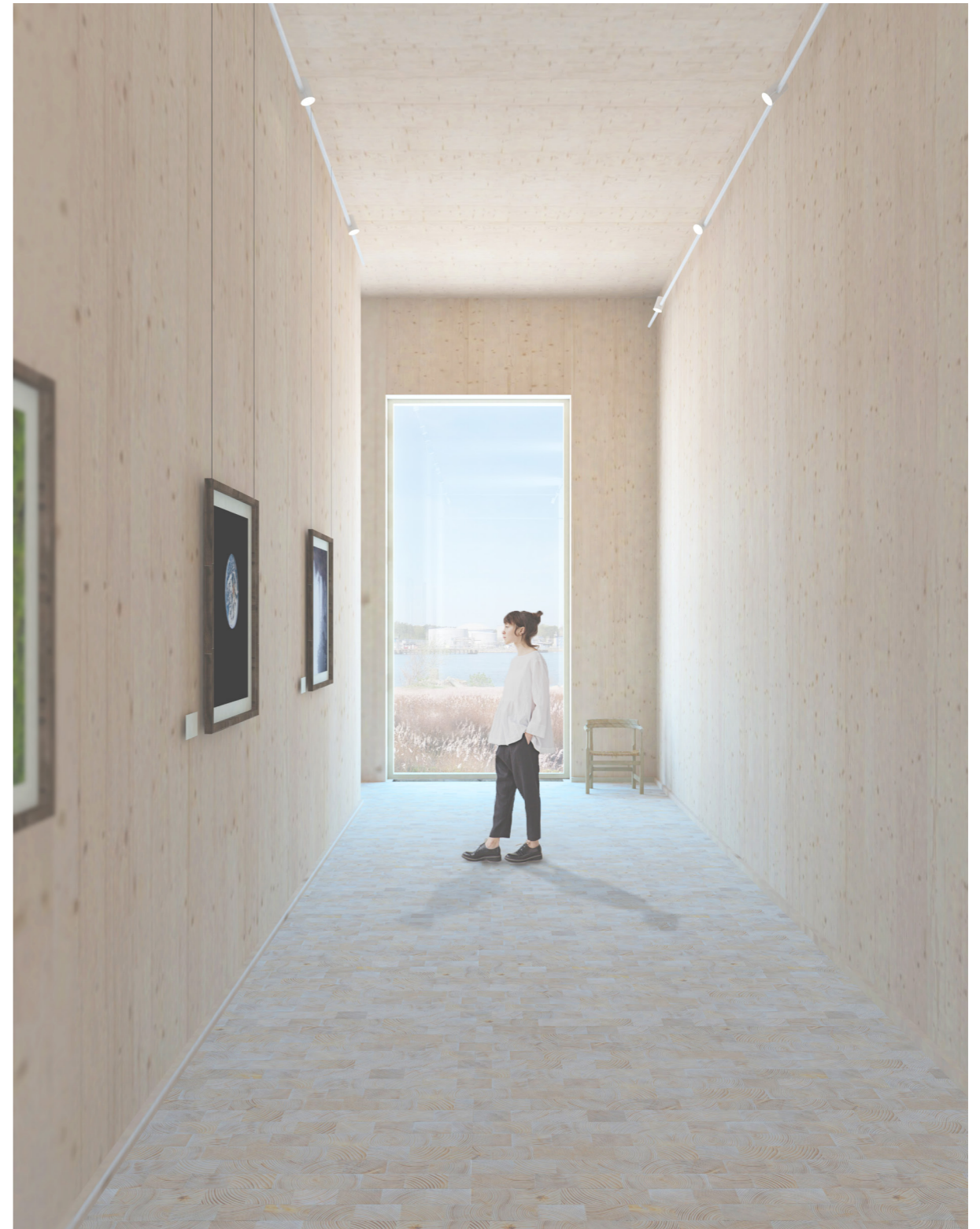


Figure 61. | View from the introduction hall

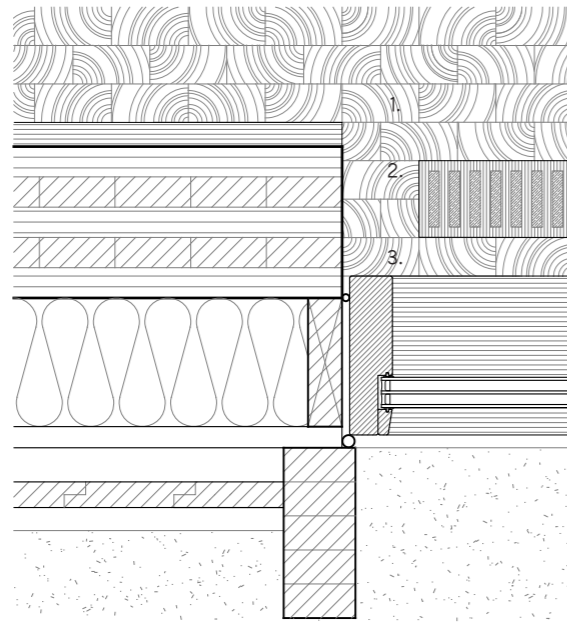


Figure 62 | Detail of window 1:10 (A1)

- 1. end grain floor of oak
- 2. convector
- 3. wooden window frame

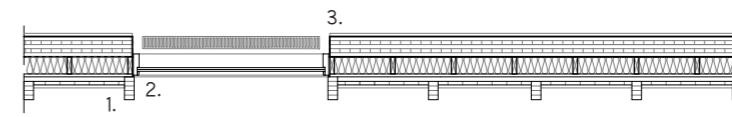
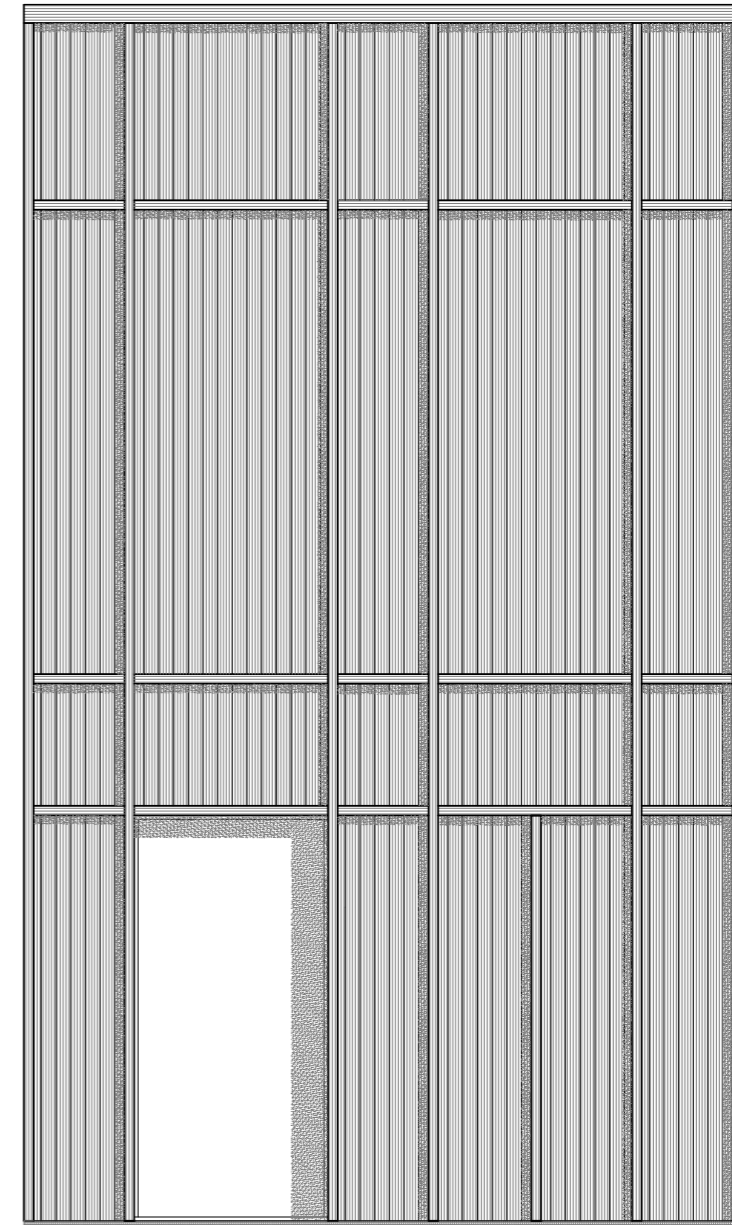


Figure 63 | Elevation and section 1:75 (A1)

- 1. glulam bars that divides the facade vertically
- 2. window aligned within the bar system
- 3. bare end of the CLT element

## NATURAL MATERIAL - WOOD

### ELEMENT 2

Wood was chosen early in the project as the element of *natural material* and cross laminated timber as the main material in the construction. Wood is a preferable material since it is a renewable resource and has lower embodied energy compared to concrete and steel. Wood is further also one of few building materials that actually helps us tackle the climate change by binding carbon dioxide.

CLT elements are prefabricated and has certain maximum size in dimensions of 3 x 16 m. To be able to use the elements as construction in a space higher than three meters, in this center's case five and ten meters, the elements needs to flip 90 degrees and be attached to each other on the long sides. This generated a grid to work within based on 3 x 3 meters. On top of the walls the cross laminated timber slabs lies. In bigger spaces, such as the lecture hall and the big exhibition hall, it will be needed extra support to handle the long spans in form of glulam beams.

To create openings between spaces, either you simply take a hole in the element or you just leave one element out, creating a gap, between two loose ends, from the floor to the ceiling. The last mentioned example better emphasizes the feeling of a board material that it is, when you walk around the actual edge. The beautiful wooden texture is visible from the interior and enrichen the atmosphere.

By using exposed cross laminated timber elements as construction material and have them as the final interior finish, the atmosphere will be both calm, warm and light, suitable for exhibitions. Cobble wood with end grain made of fir is used as flooring.



Figure 58. | View from large exhibition hall

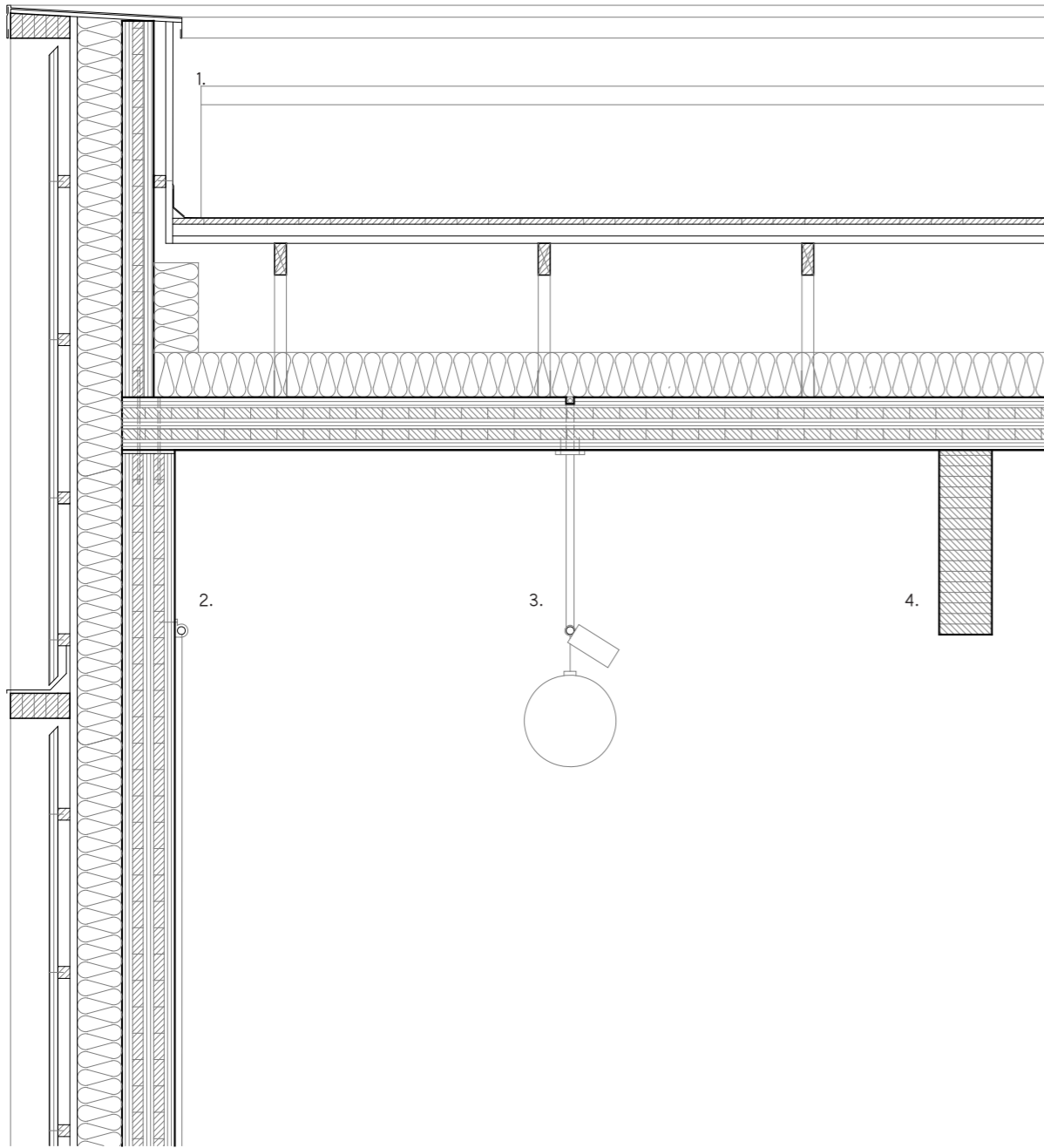


Figure 59. | Detail of ceiling in the large exhibition hall I: 25 (A1)

- 1. solar panels
- 2. suspension attachment
- 3. armature rail
- 4. load bearing glulam beam

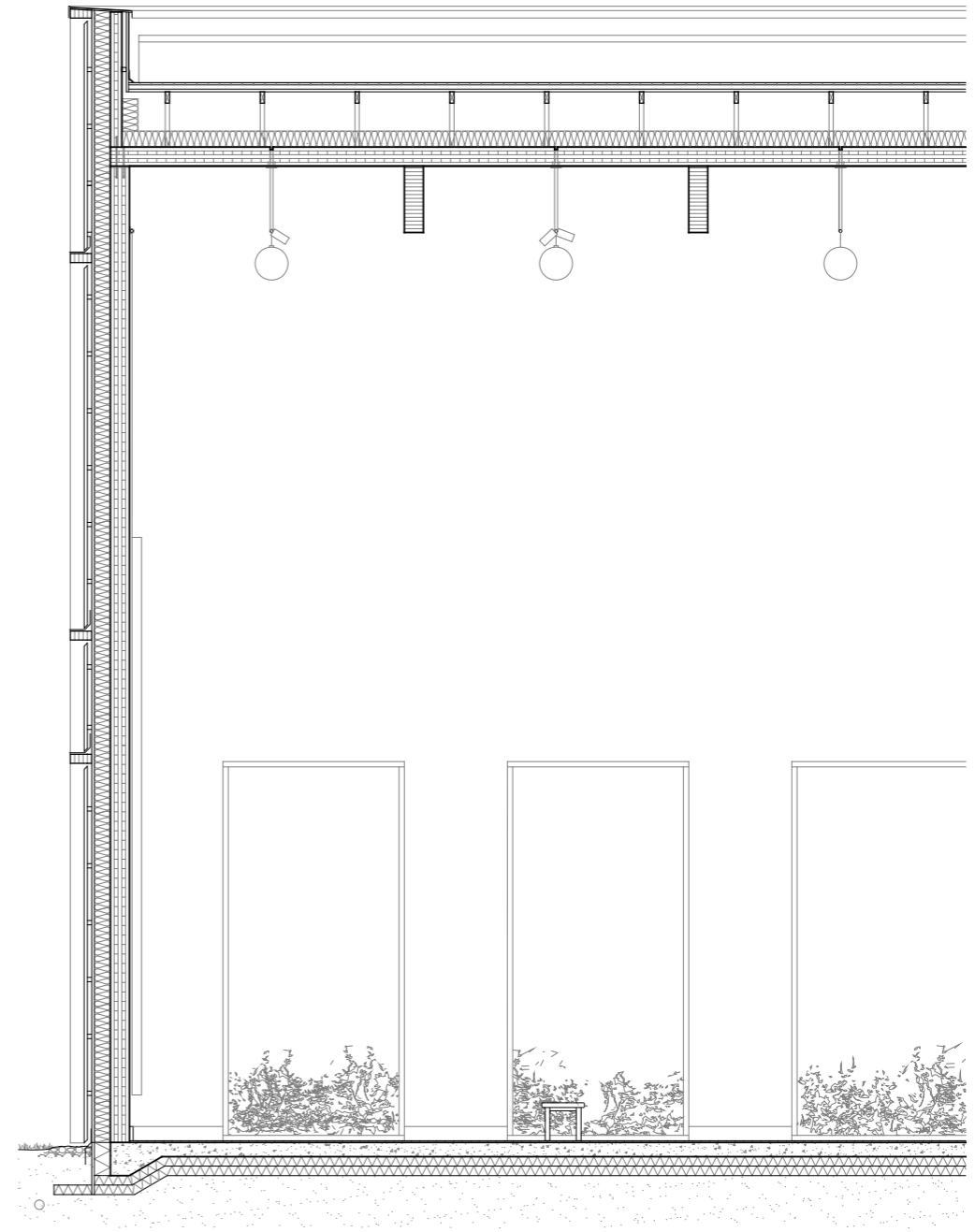


Figure 60. | Section of wall in the large exhibition hall I: 75 (A1)

- Wall structure:
- 31 charred wood
- 45 x 45 horizontal battens
- 28 bargeboard
- 170 wood fibre insulation
- 170 vertical wooden joists
- vapour barrier
- 200 cross laminated timber

## INSIDE OUTSIDE SPACES

### ELEMENT 3

Inside-outside spaces are spaces in the built environment that connects the inside with the outside, such as porches, atriums and colonnades.

From this investigation one exhibition hall turned into a green courtyard. The courtyard is suitable for outdoor lectures and sculptures, furnished with an integrated bench that runs along the walls where school classes or groups can sit together. From here the visitor can look at the sky in the opening between the sloping roof that collects all the rainwater. The ground has a light inclination towards the sides where the rain collects in a rainwater pipe that leads it out. The porch roof is ventilated and the moisture barrier is located between the CLT and the insulation. See section on page 82.

The southern part of the plot is being transformed into a sculpture park that the visitors as well as the public can stroll in and enjoy. On the southern facade you will find built-in benches to sit on and contemplate the park.

Another inside-outside space is an outdoor learning area on the first floor in the north-eastern corner, this space can be used for lectures, exhibitions, fika-breaks etc and offers protection from wind and rain under a roof. The space contains display windows that can show parts of different exhibitions to the public.

The last example of inside-outside space is the final exhibition hall on the southern part of first floor. This space is connected to both the sculpture park and the courtyard by its windows in both directions, creating a calm and bright atmosphere to display a more solution-oriented exhibition.



Figure 61. | View from courtyard



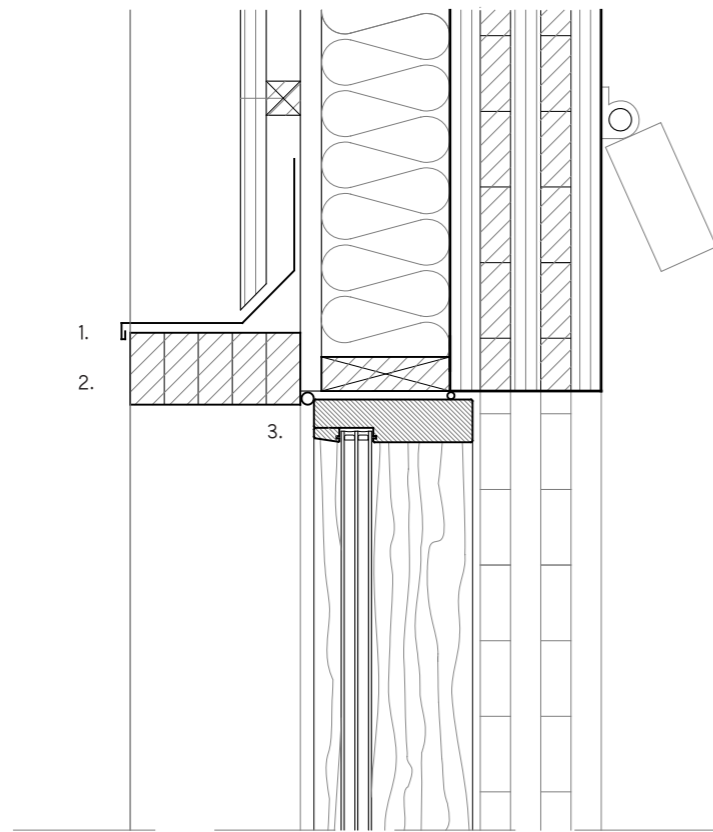


Figure 65. | Detail of window 1:10 (A1)

- 1. aluminium drip edge
- 2. glulam bars that divides the facade horizontally
- 3. three glassed fixed windows with wooden frame

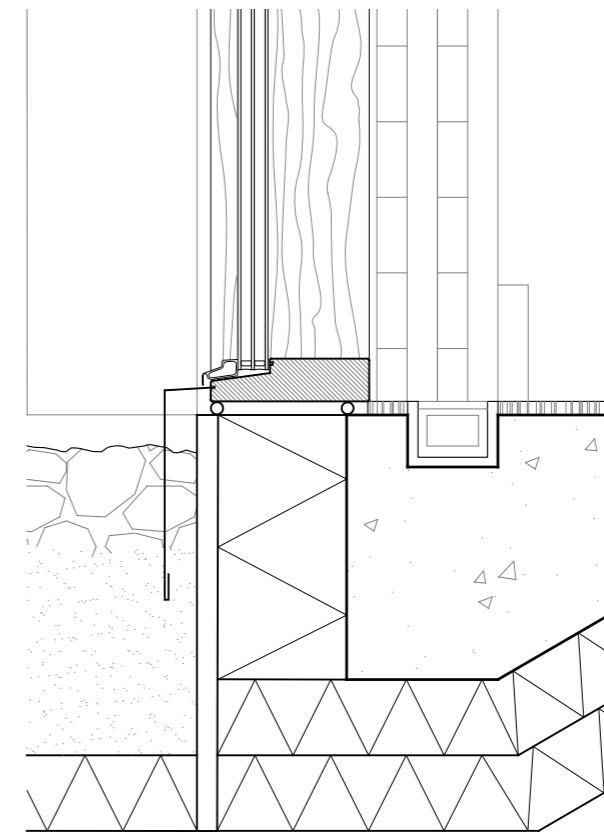


Figure 66. | Detail of window 1:10 (A1)

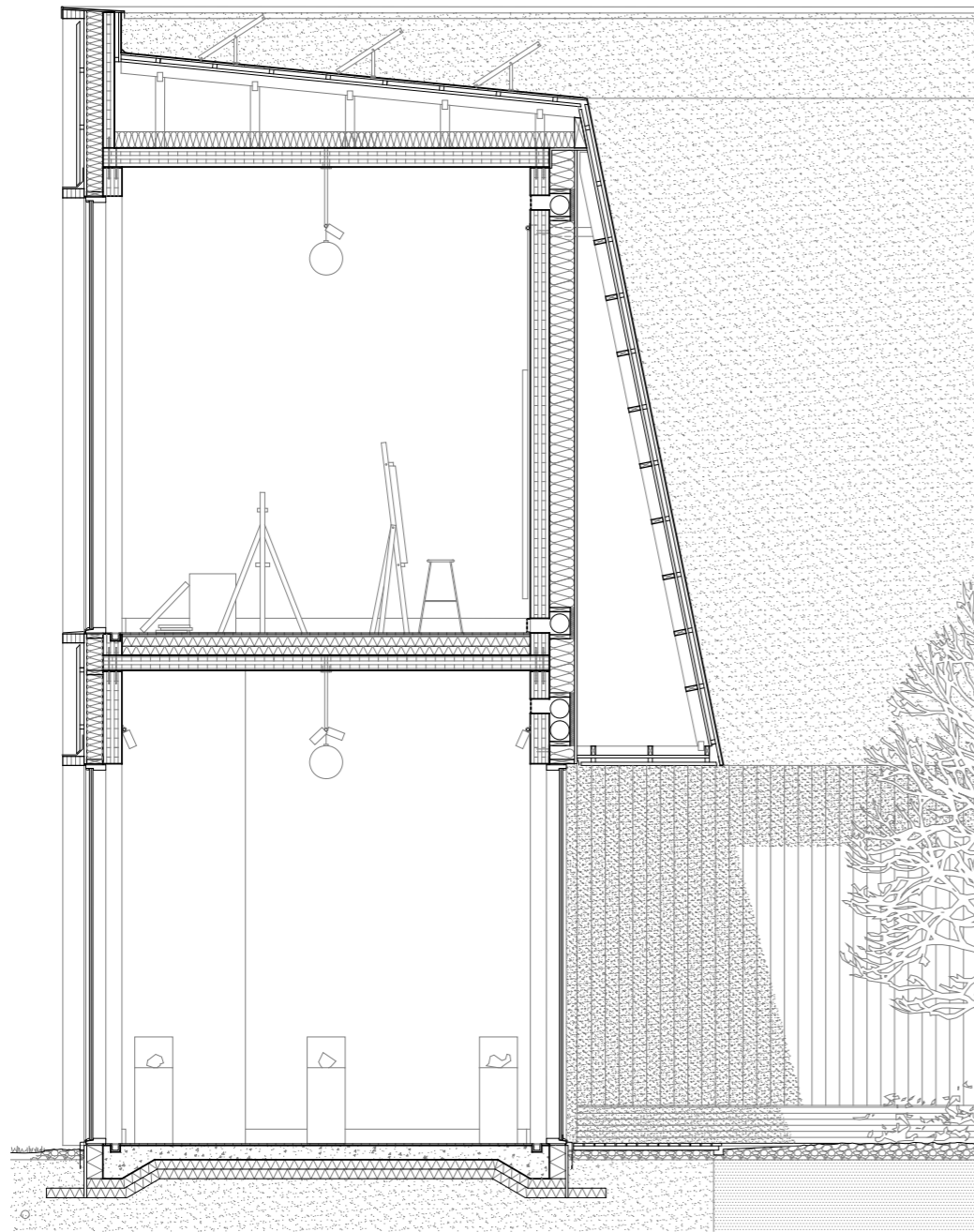


Figure 67. | Section of courtyard 1:75 (A1)

Roof structure:  
 roofing felt  
 20 tongue in groove wood  
 45 x 45 horizontal battens  
 28 bargeboard  
 45x120 bars lying on 45x95 pillars  
 170 wood fibre insulation  
 vapour barrier  
 200 cross laminated timber

ROOM PROGRAMME	NUMBER	m <sup>2</sup>	m <sup>2</sup> (NET)	NOTES
<b>Foyer facilities</b>				
Reception	1	100	100	
Reception storage	1	15	15	
Cloakroom	1	22	22	
WC	2	1.5	3	
Accessible WC	1	5	5	
<b>Exhibition facilities</b>				
Exhibition hall - s	2	25	50	
Exhibition hall - m	2	50	100	
Exhibition hall - l	1	210	210	
Exhibition courtyard	1	94	94	built in bench.
Introduction hall	1	50	50	
Outdoor learning area	1	62	62	workshop space, incl. sink, possibility to extend out in the garden.
<b>Conference facilities</b>				
Foyer	1	65	65	
Lecture hall 100 p.	1	125	125	
Seminar room	1	40	40	
Cloakroom	1	22	22	
WC	2	1.5	3	
Accessible WC	1	5	5	
<b>Library facilities</b>				
Atelier	2	20/38	58	
Library	1	110	110	
Office / Storage	1	16	16	
Research room	1	20	20	
<b>Office facilities</b>				
Break room	1	30	30	
Changing room	1	8	8	
Office	1	45	45	
Storage	2	2	4	
WC	1	1.5	1.5	
<b>Café facilities</b>				
Café seating 50 p.	1	90	90	
Counter / Serving area	1	8	8	
Garbage room	1	5	5	
Kitchen	1	20	20	
Storage	1	8	8	
WC	2	1.5	3	
<b>Other facilities</b>				
Cleaning storage	2	2.5	5	one on each floor with sink.
Control room	1	10	10	
Service lift	1	9	9	
Staircases - elevator	2	30	60	
Storage	1	60	60	close to facade and access to service lift.
Ventilation room	1	75	75	above cloak wc on second floor.
<b>Total area LOA</b>		1552 m <sup>2</sup>		
<b>Total area BTA</b>		1673 m <sup>2</sup>		



Figure 68. | Model part of northern facade E:25



Figure 69. | Landscape model E:100

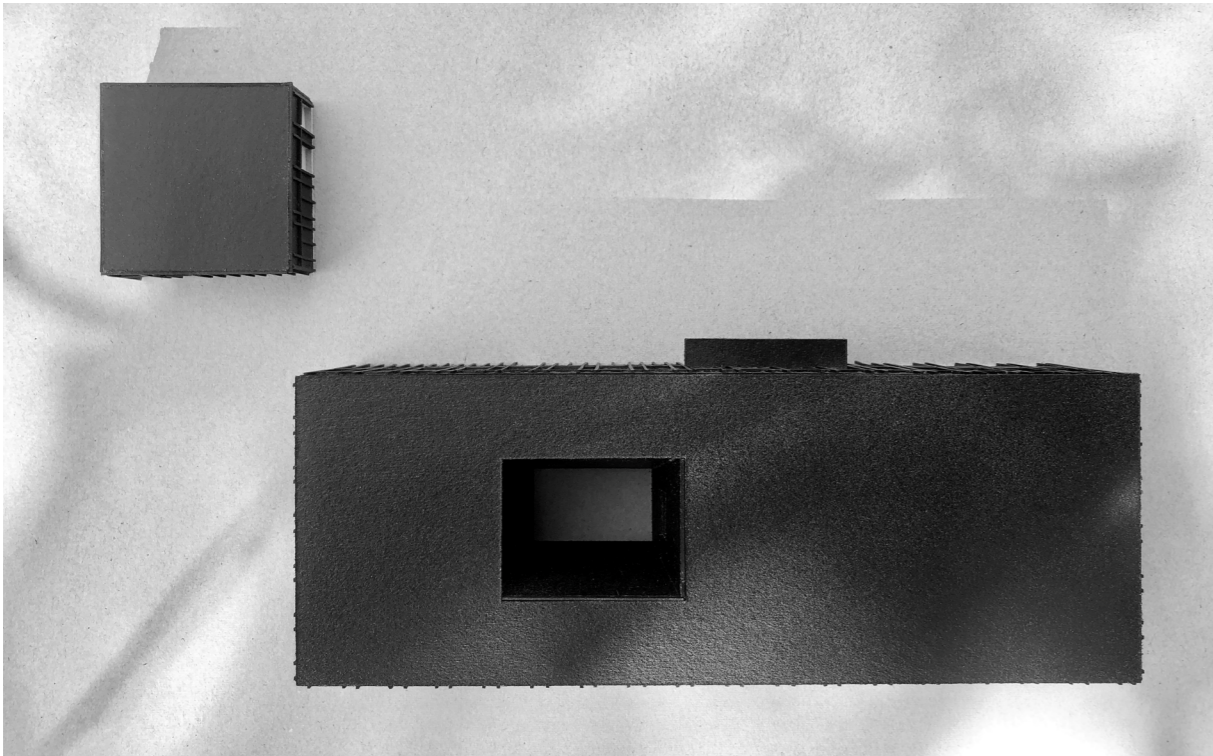


Figure 70 71 | Model 1:200

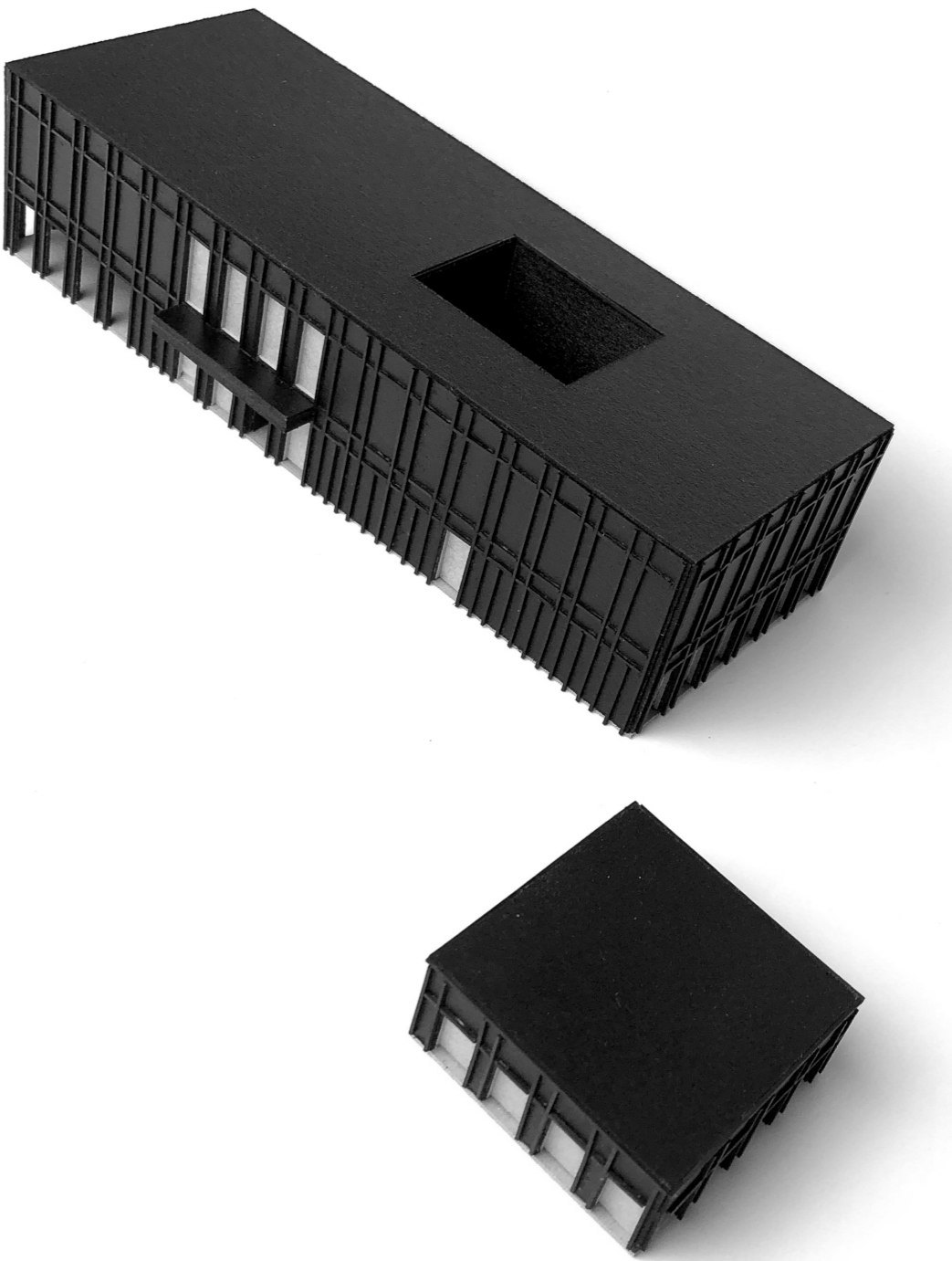


Figure 72 | Model 1:200

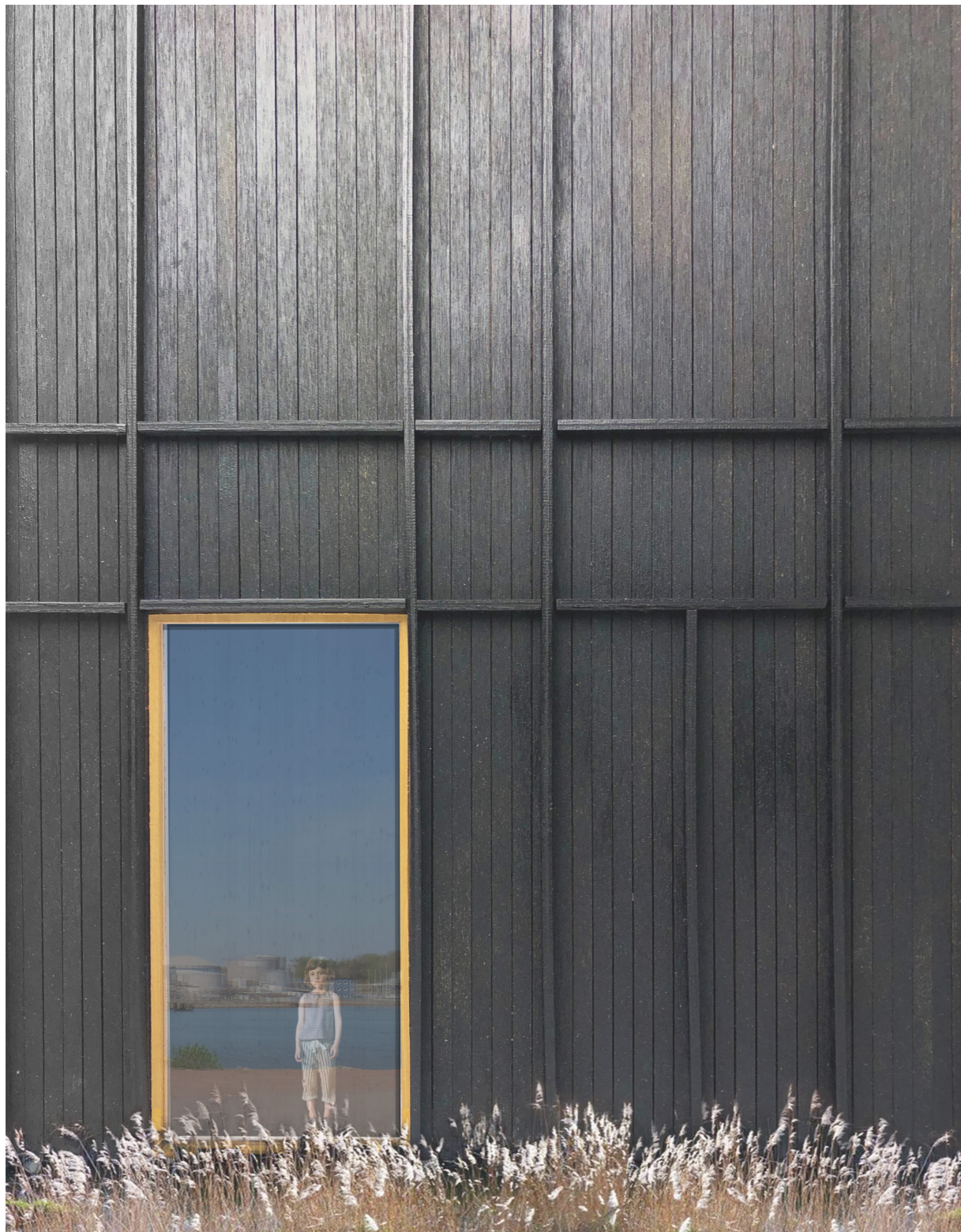


Figure 73 | View of northern facade

## CONCLUSION

Designing a new type of public building have been both challenging and exciting. With no yet built reference buildings to compare with, I designed the programme myself, based on what I thought would be relevant in this center. I ended up with focusing on exhibition areas, a conference and a library as the core of the project.

Now when I have tried to answer this research question *"How can a climate center improve its visitor's pro environmental behaviour, through the built up architecture, using nature as inspiration?"* I have come to a certain outcome depending on the three elements that I chose within the theory of biophilic design. Other elements would of course have given another outcome.

By framing views of nature present on the site, I would argue that the center contributes to a better understanding and will encourage visitors to behave differently as they affect with messages, especially since these views of nature have been strengthened by also framing existing climate culprits such as the oil tank company. These messages will though need some kind of explanation in terms of texts or signs to be more clarified.

By working with the material wood not only as a visible interior finish but simultaneously also use it as construction for the center by CLT elements. I believe it will strengthen the visitors experience within the center. A good atmosphere is achieved as the research question asked for and by combining it with more purposes in terms of structure, I would say it is a suitable sustainable option.

Regarding the inside outside spaces around the center, I believe they really add an extra layer to the centre's program as they use their surroundings in a good way. It would be interesting to see what the center would look like if all spaces where of this kind. The spaces connect the visitors better to nature than ordinary indoor rooms, but it is hard to say whether the visitor will become more pro environmental or not. Hopefully.

While working with a project related to such a complex and global problem as climate change is, other questions in addition to the research questions have been hard to not consider regarding this center, such as *"How will people feel in this kind of space?"*, *"Will visitors be encouraged or scared?"* and *"Should the center be prepared for the disasters or will the problems be solved until then?"* I have thought of them but decided to stay focused on the thesis question. Those questions would be suitable to work with as a next step.

This was an attempt to design a center based on theories which were new to me but that I found very inspiring, see this project as a manifestation on these theories. It has been a pleasure to do this project and I hope that whoever is reading this thesis in the future can get a little bit inspired, or even decide to design another building on the topic. A change is needed.

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## REFERENCES

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### IMAGES | FIGURES | TABLES

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*Figure 2.* NASA via NOAA (2019). *CO<sub>2</sub> levels throughout history* [Online Image]. Retrieved from <https://climate.nasa.gov/vital-signs/carbon-dioxide/>

*Figure 4.* The Climate Museum (2019). *Logotype for The Climate Museum* [Online Image]. Retrieved from <https://climatemuseum.org>

*Figure 5.* The Climate Museum (2019). *Photography of Whale Bay, Antarctica. No. 4* by Zaria Forman [Online Image]. Retrieved from <https://www.inhumantime.org/exhibition>

*Figure 6.* The Climate Museum (2019). *Photography of 88 Corcs* by Peggy Weil [Online Image]. Retrieved from <https://www.inhumantime.org/exhibition>





