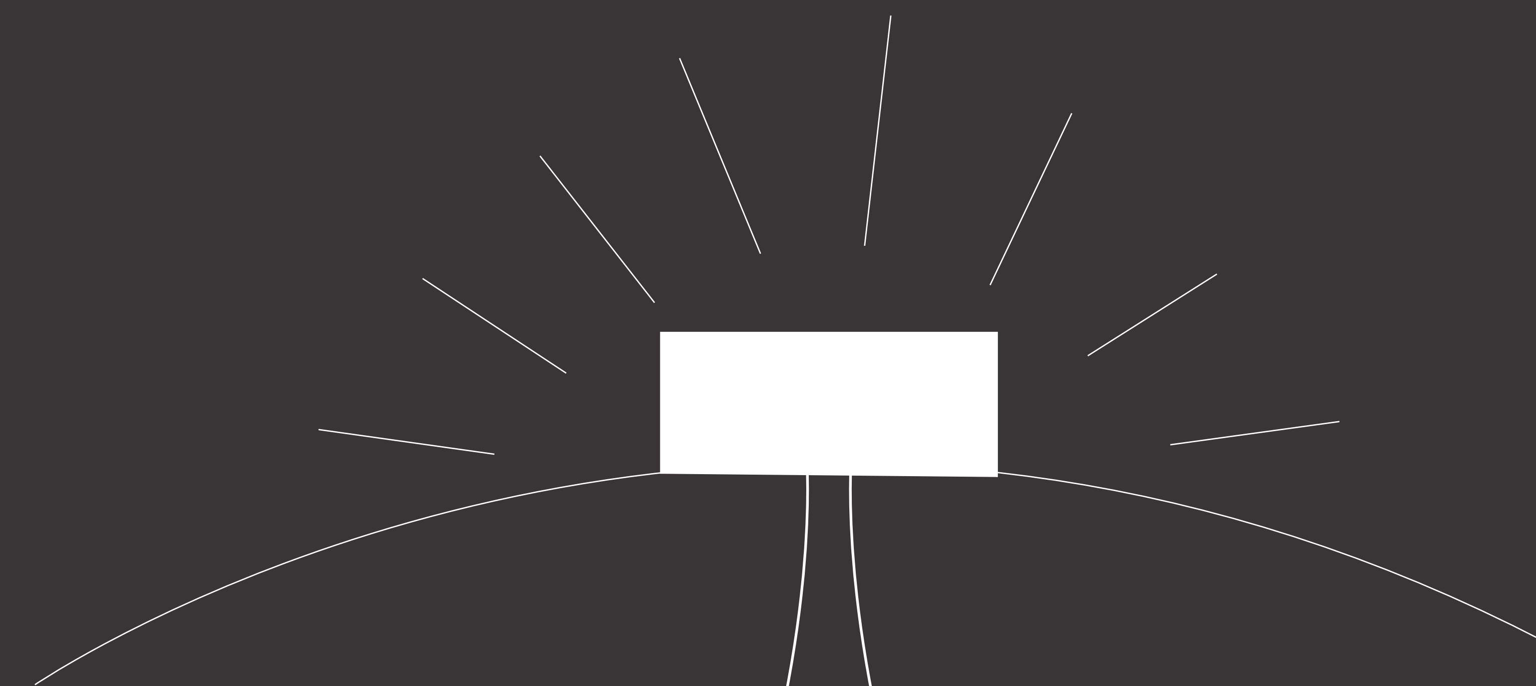

THE LIGHT EXPERIENCE

Architecture master thesis report

by
Amanda Østenkær & Jessika Kalstrup
Master Thesis, MSc04 Arch
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Architecture & Design
Group 11

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In great architecture spaces, there is a constant, deep breathing of shadow and light; shadow inhales and illumination exhales light.

[Pallasmaa, 2013, p. 51]

COLOPHON

Project Title: The Light Experience

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Aalborg University

Authors: Amanda Østenkær
Stud. MSc. Eng. Architecture

Jessika Kalstrup
Stud. MSc. Eng. Architecture

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Main Supervisor: Marie Frier Hvejsel, Associate Professor
Department of Architecture,
Design & Media Technology

Supervisor: Claus Topp, Part-time Lecturer
Department of Civil Engineering

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READER'S GUIDE

This rapport is divided into eight chapters; Themes, Iceland, The site, Case studies, Specifications, Studies, Presentation, Appendix. An introduction to each chapter is added on the first page of the chapter and has a part conclusion at the end of it. The introduction is made to give the reader a feeling of what the chapter is about and which texts it consists of, while the part conclusion sums up the different conclusions made in the given chapter.
All illustrations, including pictures and renders, are numbered and commented on, on the given spread. They are numbered by its page number and arrangement on the page, such as "Il. 37.2", where 37 is the page number the illustration is on, while 2 is the number of illustration on the specific page.
All references and illustrations are listed right after the conclusion in the end a reference list and illustration list.
The last chapter, appendix, consits of extra material from the design process documentation of calculations, simulations, etc.
On the diagrams and plans North is always staight up - unless it is stated othervise.
Diagrams marked with an green outline is the favored and chosen option.

PROLOGUE

This project is developed by group 11 for a master thesis in Architecture at Architecture and Design, Aalborg University. The project theme is light – daylight and the northern lights. The project is based on the requirements from a competition for seven cabins located in the Northern part of Iceland. The northern lights should be visible from their bed and during the day the natural light will influence and enhance the architecture and the human body in the human comfort zone. The holistic design method is with a sustainable and tectonic approach, evaluated and implemented throughout the design process, including studies of specific light solutions, to enhance the atmospheric sense and the environmental feeling for the experience of the rooms.

ABSTRACT

The aim of this project takes part in a competition brief of a proposal for a resort and guest houses located in the Northern part of Iceland, where the site is placed adjacent to the popular Mývatn Lake, near the town Reykjahlíð.
The focus of this project is light – daylight and northern lights. As stated in the competition brief, the guest must be able to explore the northern lights from their bed. At the main building will the daylight be the focus as well, and it will enlighten the view to the Icelandic nature. On the rooftop of the main building will a large terrace work as a viewing point for the northern lights.
The guest houses must be a space that benefits different types of users, with a good indoor environment in the rooms for the hard climate outside and with a varies use of daylight to enhance the experience of the rooms.
With a focus area on the daylight combined with different theories together with a sustainable approach will these be the foundation to enhance the experience of the architecture for this project.

MOTIVATION

Light is part of our everyday life. Every day of the year the sun shines brightly on one side of the earth and cast a shadow on the other side. The word day is used for a 24 hours period consisting of darkness and light. But the word day is also used for hours in the same period where the sun shines and make the nature, cities and everything in between visible for the human eye, whereas the time when the sun is on the opposite part of the world and darkness appears is named night [www.thesaurus.com, 2013]. As previously stated by Juhani Pallasmaa, light and shadow are part of great architecture [Pallasmaa, 2013, p. 51], but it is also what the human body needs.

Human beings thrive in the sunlight, they need it to be mentally healthy, while during the most part of the nighttime is used for sleeping and relaxing. The human body gets energy from the sun and calms down to a sleeping stage in the darkness - the body is biologically programmed to a 24 hours cycles [Volf and Johnsen, 2016].

From an architectural point of view, knowledge about light, and application thereof is a very important ingredient when designing a building - especially in a country like Iceland due to its northern location with 20 sun hours a day during the summertime and down to three sun hours a day in December [Island Tours, 2015]. We found light essential and interesting to work with for our master thesis - the variations and effects of daylight and shadows with its darkness. Iceland is located high up in the North, very close to the arctic circle, which means they have a special, and for us interesting, division of daylight and night - in the summertime the sun doesn't set, while in the winter period the sun is only up for a few hours [Timeanddate.com, 2018].
Another reason why we chose Iceland, is that is a remote piece of land in the middle of the ocean, where it is reliable on its own natural resources [Askja Energy, 2018]. We want to explore these resources to create a sustainable and self-sufficient project.

The human eye's' ability to perceive objects and colors are very low during the night time without any artificial light added. They need light to see the objects and colors clearly - it is essential to use light to get a visual understanding of a space and object. The eyesight is one of the most important senses of the human body, but it also connects to the other senses. By looking at a concrete pavement the body knows it is going to be hard to walk on, compared to walking in the grass. As Pallasmaa states:"Vision reveals what the touch already knows" [Pallasmaa, 2013, p. 46].
The eyesight is also a huge part of perceiving a specific atmosphere in a space. To see the sun slowly move on an object or the lack thereof. To set the right mood with how the daylight is filtered through the windows into the building and experienced by the building's user [Zumthor, 2015].

As mentioned, Iceland is a country with the low amount of daylight, and the competition's site is even on the northern part of Iceland in a remote part with only a few houses nearby, so minimal light pollution is present. Here the daylight in the winter period changes very fast and the sun is extremely low. The competitions focus on the northern lights which are most visible in the darkness of the night time, should be able to be experienced from the guest houses beds.

The island is made of volcanic eruptions and consists of several volcanoes, whereas some are active. Due to the island being very remote itself in the middle of the ocean and the villages placed with a large distance, the country has used sustainable solutions for a lot of years [Nørretranders and Eliasson, 2015]. All of these stats about the competition makes it well-suited for our master thesis with our interest in creating atmospheres by the use daylight and sustainable solutions.

▶ *Ill. 9.1: A hot water stream in the snow landscape at the geothermal area Hverir*

HOLISTIC ARCHITECTURE

During the design process of this project elected aspects of sustainable, tectonically and Nordic architectural theories has been used throughout the iterations. Even though they are from different theorists and different periods, they overlap and together benefits this project; together they are holistic architecture.
The meaning of the word 'holistic' describes the idea of using these different aspects into one whole project:

"A: Emphasizing the importance of the whole and the interdependence of its parts. B: Concerned with wholes rather than analysis or separation into parts" [Yourdictionary.com, 2018].

The aspects of sustainability, tectonics and nordic architecture will be in order of how they are linked together in our understanding of them. From the sustainable part its three parameters will be described as well as how and why to use passive strategies and then the cradle to cradle method will be shortly introduced – it is described further later in the report.
By the tectonically aspects a short history of how tectonics has enveloped through time will be explained, and the two theorists Sekler and Semper will described as well.
The last aspect is nordic architecture where Norberg-Schulz will be the main theorist with his view of nordic architecture and light.

SUSTAINABILITY

Sustainability is very important to implement in the architectural world for the present and future's sake; to use its aspects to design better building both for the people and the environment. For this project, sustainability is very important, and Iceland is a special country to be inspired by, since they are using their natural resources so well, that they basically don't need any other form for energy source [Askja Energy, 2018]. For architectural use sustainability can be separated into three aspects; economic, social and environmental.

For the social aspect of sustainability, the buildings must improve the living quality of the guest staying in the houses and the family living there all year around. Enhance the private atmosphere in the guest houses, but also gather the guests in the main house for them to socialize with other nationalities.

For the environmental aspect of sustainability, the buildings need to perform well, so that the energy consumption is low using passive strategies, which are design solutions that do not use electricity, but instead makes the building use less electricity. For instance, it can be used to place the windows to be able use them for heating by sunlight, but also for natural ventilation [Mason, 2018].
The environmental certification Cradle to Cradle will be implemented in the project to select and use sustainable materials. It focuses on how the material is produced, used and disposed to ensure that it can be recycled and, in that way, minimize the waste. This is part of protecting our nature and ecosystems [Braungart and McDonough, 2007].

The environmental and economical basically goes hand in hand by using passive strategies the energy consumption decreases and by careful considerations of the material the building can be designed with a low maintenance, so the household will be able to save a lot of money. The materials will be used in an efficient way, so that during its lifetime the economical aspect will be low [Mason, 2018].

TECTONIC

The word tectonics origins in the Greek word tekton, which means a carpenter or builder – an artisan that can use its handcraft abilities to design and produce. Through time tekton develops into master builder and architekton, where the aesthetics becomes a factor for designing buildings together with the knowledge of handcraft [Frampton, (1995) 2018]. This relationship bond between aesthetics and handcrafts, as in the different theories of tectonics in architecture, has been developed and discussed through time. And for this project we would like to integrate it in the design.

The Austrian architect Eduard Sekler describes tectonics as the relationship between structure and construction. He describes structure as the general system and principle of how the building's elements are arranged. Whereas construction is about the realization of the structure – the joint details, material's properties. The structure and construction implement each other, but if one of them is lacking in quality the overall architectural visual expression decreases in quality. They work together and are inseparable to be tectonics [Sekler, (1965) 2018].

▶ *Ill. 11.1: Sustainability diagram*
▶ *Ill. 11.2: Holistic and integrated design proces method*

METHODOLOGY

The integrated design process, as defined by Mary-Ann Knudstrup, will be used as a baseline for the methodology used in this project. It's a method to design holistic and sustainable using an iterative process [Knudstrup, 2005].
A holistic approach will be added to the IDP-methodology, by always using a holistic approach in each of the phases. The holistic architecture is referred to the combination of architectural and engineering knowledge – including the sustainable and tectonically aspects.

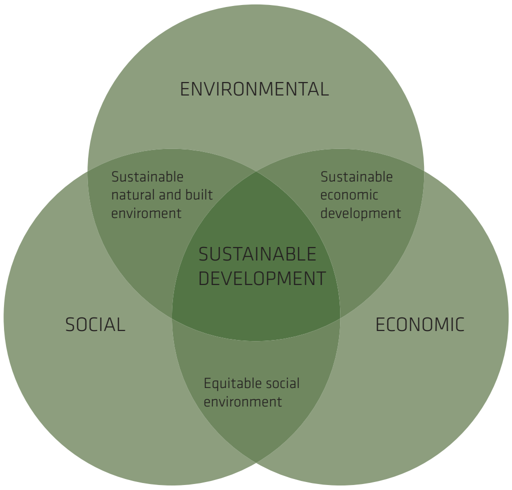
PROBLEM OR IDEA
The focus of this project is to explore the atmospheric and sustainable possibilities of daylight in the guest houses on an Icelandic site. This focus has been developed by studying the site on Iceland and reflection upon its possibilities; the hill overlooking the magnificent landscape.

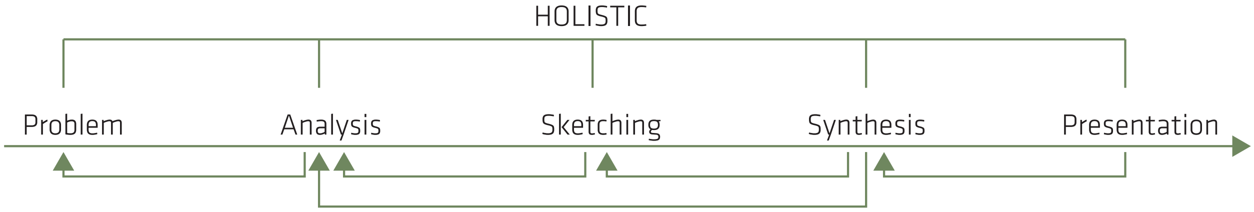
ANALYSIS
With the use of specific chosen theorists and themes, the analyses will be used as a base for the sketching phase. Detailed information about the site's landscape, climate, vegetation, sense of place is elaborated. Everything that the project is based on and the knowledge that was used further phases.

SKETCHING
Throughout this phase, the knowledge from the analysis phase will be used to base the concept. Ideas will be developed with different visual programs, model work, and sketches. Varies studies will be made according to the theme – such as light studies, plan studies, atmosphere studies, etc. Different sustainable and tectonic solutions are sketched on and implemented.

SYNTHESIS
The final concept and design will be worked on to meets the design and energy criteria, room program, etc. Iterations of the rooms will be made while calculating the temperature, daylight factor, etc.
The concept will be evaluated and further developed until the final design is found. The sustainable and tectonic ideas are finalized and calculated on to meet the energy criteria and the criteria for the human comfort zone. The final details will be finished.

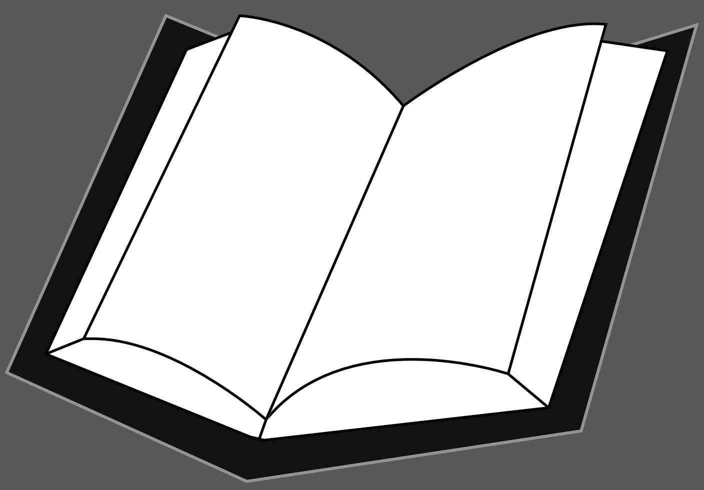
PRESENTATION
The final phase whereof the material and the final concept will be presented in a way that visualizes and highlights its qualities.
Several renders from the 3D programs, diagrams and elaborating texts will be used in this report and later posters and models will be created for the master thesis exam.





chapter one
themes

This chapter consists of the main themes and theories used for this project. The theories used, are the light effects based on Henry Plummer's theories, Marilyne Anderson's studies of calm and excitement and theories of shadows, colors, privacy, etc. The atmospheric theories are based on Peter Zumthor and Juhani Pallasmaa's theories of atmospheres and senses. The human comfort zone will be described with a combination of Marilyne Anderson's theories. The principle of Cradle to Cradle will be described as they are used as an evaluation tool for choosing the best material for this project, material amount, etc.



LIGHT THEORY

" The only thing we see is light" [Nørretranders and Eliasson, 2015, p21] stated by Olafur Eliasson and Tor Nørretranders. The natural light we see on Earth comes from our sun and shines upon our nature, building and each other. It makes it possible for us humans to perceive. A building without light cannot be seen and therefore is an essential aspect when designing a building [Nørretranders and Eliasson, 2015]. "The light is a factor to specific highlight a shape and the structure, and in a phycological meaning create an atmosphere or a personality" [Mathiasen, 2015, p31]. How the light touch a building, can change its expression and shape. It is therefore important to understand light when the light and shadows together create the expression of a building, its room, shapes, materiality and atmospheric feeling.

THE HUMAN AND LIGHT

Since the human birth has the light been a guideline for our behavior, well being and our life cycles [Fagerhult, 2018]. A phenomenon that always has been understood and acted out from experiences. "When we, as humans, move through light, we use our experience, intuition, and senses to orientate ourselves to. Our bodies detect how the light is coming before us, and our eyes detect how the light visually performs as brightness, contrasts, colors, and shadows. And it is in the sense that we are able to commit ourselves to the light world" [Mathiasen, 2015, p39].Before the human eye can see the light, the light has to hit a material, reflect from it and then it will be able to perceive. If one of those elements not been concluded in the situation, the light will not be able to be explored [Mathiasen, 2015].

TYPES OF LIGHT

There are three types of daylight; sunlight, skylight and reflected light.

The sunlight is direct light from the sun. Skylight is also light from the sun but is before it hits the ground it is being spread out in the atmosphere and creates light through the skies. Reflected light is when either sunlight or skylight hits its surroundings, it will create reflected light.The difference between the two light sources is that the sun is circular shaped, which creates a direct light source, that moves across the sky through the day, and creates various dynamic light.

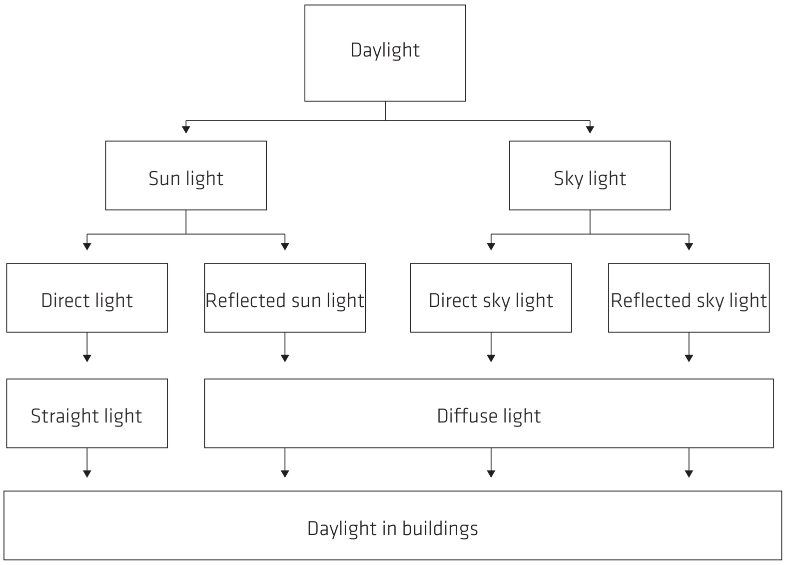
The skylight comes from a flat surface there surround the earth, which creates a more diffused light and is more stable and smooth [Mathiasen, 2015].

HENRY PLUMMER

Henry Plummer is an American architect, photographer, and a Professor Emeritus of Architecture and light at the University of Illinois at Urbana Champaign. He has very carefully made studies on the variety of light in the Nordic countries with the daylight phenomena. Amongst this, he is also an author of several books focusing on the experience of light, with an analytical perspective and poetic touch to an atmosphere. Plummer uses a variety of different architectural lighting cases to underline his own theory on the use of light and senses in architecture [Plummer, 2014]. Five following light effects will be reviewed later.

According to Plummer's view on daylight, is that he looks beyond the practical preference of using reflecting white rooms or elements to facilitate bright rooms, but instead, he is much more interest in the use of those light effects that play with the local beauty in nature and make the light and atmosphere touch the human soul.

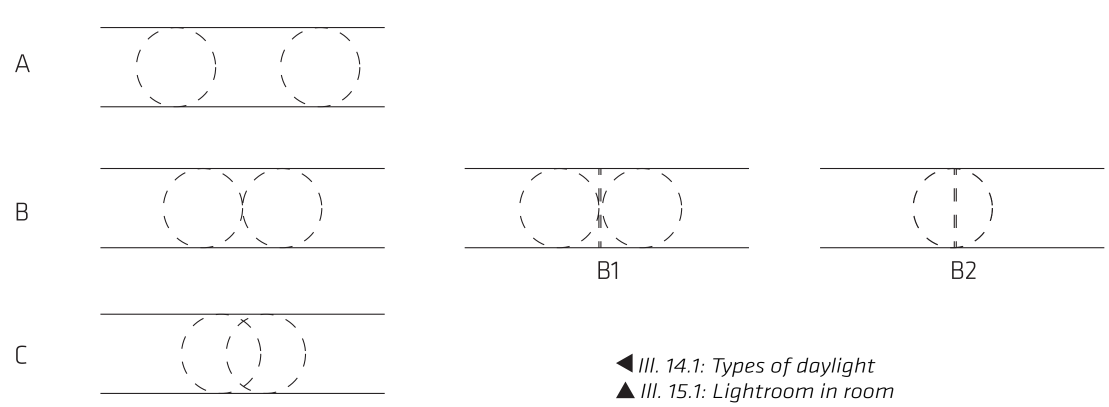
To Plummer, the continuous cycle of the solar event makes the experience of a building different. When the morning sun touches a building, makes one experience, by contrast to when the sun hits the building at noon



or in the evening a new experience will be formed. He states that something as simple as light can be used as a material or tool in architecture, to form and define an atmosphere or spirit of a place or a building. Daylight has a mood, and through this mood, it defines the atmosphere. Because it does not only illuminate the architectural form but also gives it an emotional depth, with a connection to the outside, the nature, the universe, as well as the world inside us. Plummer states that, without this atmospheric presence in the daylight, the buildings might shelter and support us, but they will never be able to sustain our spirits, a sustain of spirits we human beings require. Plummer states "[..] I found daylight to be an inexhaustible source of miracles. While lighting fixtures are something added to architecture, natural light is inherent to it since every built form is a form of light. It is always changing and moving, in a state of becoming, and its qualities at any moment are never quite the same as the moment before or the moment to follow" [ArchDaily, 2018]. Furthermore, Plummer states that the importance of the natural light is the variation and adjustments which please our minds, by contrast to the artificial light which senses dead. Even though with the new technology, that can move and change the movement of the artificial lights, it will still miss this spontaneity and unpredictability from natural light [Plummer, 2014].
The five light effects Plummer has made upon his theory through cases are the following:
Journey: is a light method to lead people from a to b.
Diffused light: to create a soft and smooth light, without any direct light
Tranquility: creates an atmosphere of silence and changes the experience of the materials tactility.
Darkness: can create a spiritual and mystery feeling, only with the help of a little light opening.
Whiteness: creates an atmosphere of cleans and are good to reflect the light [Plummer, 2014].

LIGHTROOM IN THE ROOM
With the right light opening, the daylight can create a shape or space called a light room in the room. This happens when a light source creates a lighted space in an already light or dark space and separates the sounding to only focus on what happens in the lightroom. This creates a more various lighting experience, with a hierarchy and intimacy. And creates a feeling of a room in a room without any boundary. Even touch, there are several types of lightrooms in room, depending on how the light opening is placed. Are the lightrooms creating a more various light experience with contrasts of light and shadows it will affect the way to move and creates different spatial formations. As if the lightroom fading together to one room, the light will be smooth and not excited [Madsen, 2004].
A: Lightrooms there, is with a certain or bigger distance, clearly highlights the rooms different types of room with lightroom in it. This creates a contrasting light level.
B: With this type the light room, the openings are must closer to each other, but without fading into each other's lightroom, and without space in between, there will create shadows and to separate them. This lightroom creates a relatively various lighting. This type of lightroom can further be divided into two types. B1: the lightroom is following the rooms division. B2: Here the lightroom spans over the room elements.
C: With these placement, the lightrooms fades a bit into each other's room. This will give an experience of one lightroom and not several, and instead creates a more smooth light.

CALM AND EXCITEMENT
From a seizes lab named LIPID lab, EPFL. Marilyne Andersen who is a full professor of sustainable construction technologies and the dean of the school of architecture[People.epfl.ch, 2018], with one of her Ph.D. students Kynthia Chamilothori has conducted on several studies and reaches a conclusion on how a window pattern gives a feeling of most calming, least calming, most exciting, least exciting [The Daylight Award, 2018].
As the picture of the results shows, is the most calm, then there is a relaxed pattern, with the same pattern



◀ *Ill. 14.1: Types of daylight*
▲ *Ill. 15.1: Lightroom in room*

continually filling the shading area. The least calm pattern is a wild and not being able to predict. The most exciting shading pattern is where the pattern not are predictable, but without being too wild. The least exciting, when there only are horizontal or vertical lines, an almost predictable pattern, as there often are in front of the windows to shade today.

PRIVATE VS PUBLIC

By creating a light opening, it creates a private or public connecting to the outside. By making a placement of the light opening underneath eye level, it will create atmosphere feeling around the opening like a cave or a fire in the night, cozy, intimate and private. It also creates a private atmosphere by placing the opening above eye level. Here the body naturally straightens up, but with a feeling of smaller in the room, like a basement. The light opening therein between is creating a public atmosphere and relation to the surroundings [Madsen, 2004].

THE DIRECTION AND USE OF LIGHT

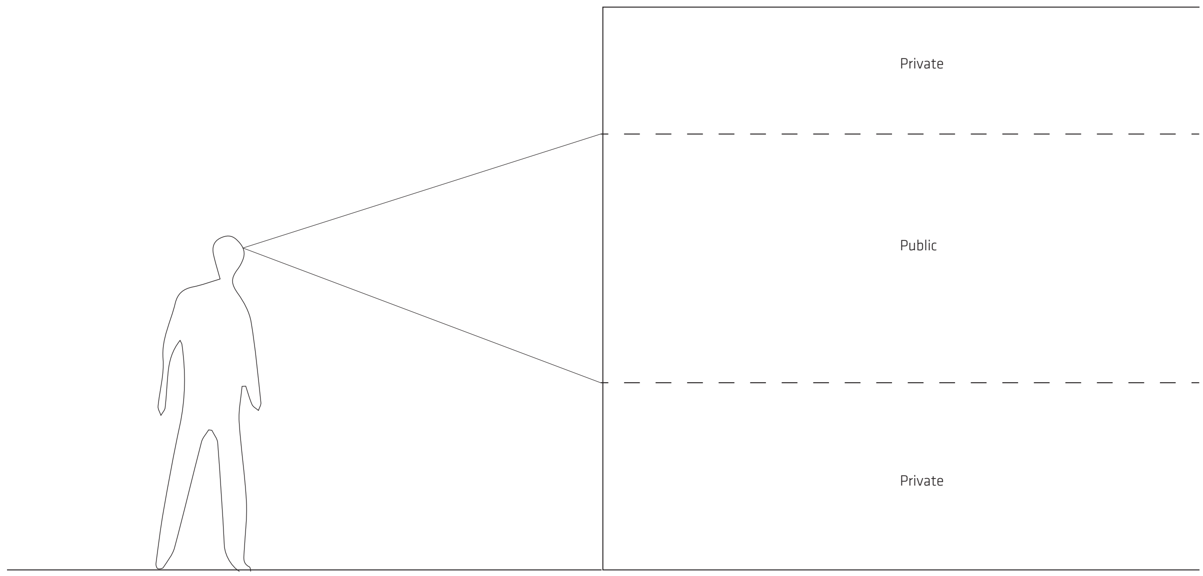
If the placement and direction of a light opening are either horizontal or vertical, it will create another atmospheric feeling there can be integrated. A vertical placement of the light opening creates a spiritual feeling because it will only be the light which will be visible and not the light source. The horizontal light opening created a connection to the everyday life, a connection to the surrounding and the place. [Madsen, 2004].

COLORS

"If the light disappears, disappears the colors. But also, if the darkness disappears, disappears the colors. It is the light and darkness there together create the colors and make the world recognizable [Boëtius, Lauridsen, and Lefèvre, (1998), p18].

The lights can be cold, warm and in different colors, which will change through the days, and influents how things get explored and affect the body. The lights color effects the atmosphere of a room, depending on how much light there comes through. If the light is clear and bright, an elements shape will be seen in a different way, then if the light is a bit dark or dark. If the room is a bit dark, it will be seen smaller than it is. It's a balance, too much light can be uncomfortable and too little can create a gloomy atmosphere [Dansk Arkitektur Center - DAC, 2018]. The light's color also affects how the human body behaves unconsciously. If the color of the light is cold bluish it will activate, and if the light is white warm it will create a calm atmosphere [Fagerhult, 2018]. This is because the yellow colors relate to the lights quality and are expired as warm and soft. The blue colors are connected to the darkness and are explored as cold and spacy [Boëtius, Lauridsen, and Lefèvre, (1998)]. In the dim light, the color will change. Ex if there are two different surfaces, a blue and a red, they will in normal daylight seem alike in the color, but become the light demi will the blue surface seem lighter and the red will become as grey or black. The same for a white surface, will in the daylight seem clean and bright, and in the demi-light becomes greenish [Voltelen, 1976].

If either the light or the material color is bright, it will move and lead the body quickly to the light source or element. But are they instead dark or black, it will slow the body down. By using the contrast of light and dark together, it can create a spatial experience of the room. Ex if a hallway is narrow and dark, which lead up to a bright room with many windows, will this enhance the experience of the room and the contrasts [Dansk Arkitektur Center - DAC, 2018]



ARTIFICIAL LIGHT

By optimal daylight in rooms, will it reduce the use of artificial lighting through the day. It is therefore important to integrate this part through a design process.

Using artificial lighting in an interior space, can either alter a way to perceive or move through a room, by placing the light in a uniform pattern in the ceiling. This will create a distributed smooth light over the room. Instead of placing the light lower and after the functions use, it will create artificial light rooms in rooms, which will alter an understanding of a hierarchy and placement in the room [Descottes and Ramos, 2013].

Through the height of the placement for the artificial light, it categories the light source to be either intimate or public. As the body inherently perceive the height from the artificial light source to a relationship with the body itself. As the closer, it is for the body, the more intimate the light is. The relationship between the light source and the creating atmosphere is illustrated in the section diagram.An intimate light is if the light source height is kept an arm's length away from the functions. For a more personal light, the light source is still close to the function but with a distance in the height, so the light will light more surrounds up and create a lightroom in the room. By placing a light source above the entrance of a house. The door will be shined on and creates a boundary for the private and public, interior, and exterior in the semipublic area. Afterward there will be a diversity between the height of the light source that changes the category from public local to public general [Descottes and Ramos, 2013].

NORDIC ARCHITECTS USE OF LIGHT

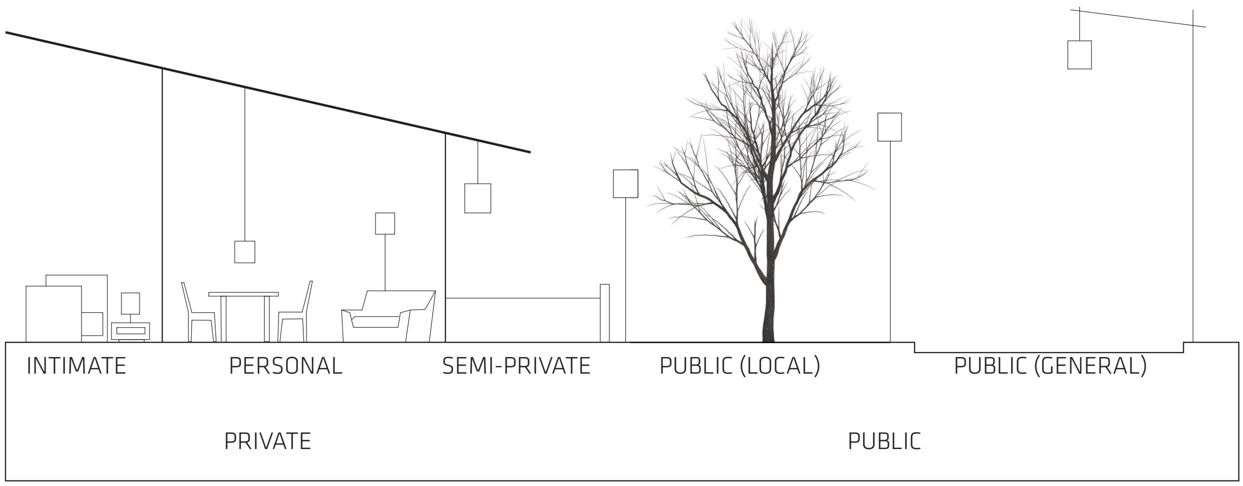
Nordic architects have through time made skylight to collect and drag the minimum amount of sunlight during the winter month into the building. This has been done in many projects by using the building profiles in the roof, to create openings towards south to let the low sun come in. During the summer the sun would be higher in the sky so that the incident light would not reach these windows and overheating is avoided.

If the building needs to have a softer light, the incident sunlight can be reflected by striking a wall piece. The reflections would then be cast widely over the room and a softer light happens. Light from North also appears as a soft light, due the sun never moves on the northern façade. Where the incident light hits can also be used to control, what the person inside the building should look at or move towards to.

As winter and summer are opposite and contrast to one another, so is light and darkness. The light should not be considered to make the spaces bright and visual, but also to create shadows and, in contrast to light, darkness. Shadow and darkness are very much part of creating an atmosphere, to create different spaces within a room. The dark areas attribute to the enlighten spaces being more in focused, that can guide the user's attention to it. The user may also want to spend time in the less bright areas, due to in the shadows and darkness humans find intimacy. This can be created by implementing dark corner with an inviting bench to relax on. It makes the space calm and quiet [Plummer, 2016].

In the project, the light and darkness will be implemented in the design process, to create the wanted atmosphere in the guest houses and the main house. Different studies of window placements will be made in this matter to ensure the quality of the final design, and some initial studies are made here to give an understanding of the way light can enter a room in various ways.

◀ *Ill. 16.1: Private and public diagram*
▼ *Ill. 17.1: Artificial lighting*



NORDIC ARCHITECTURE

As well as the sun light affects the heat and daylight within the building it also is part of the definition of Nordic architecture. Nordic architecture is often defined and connected with nature and light, with a certain sense of the placement. In the Nordic design form the light, vegetation, topographic and the building environment goes hand in hand and defines a simplicity and sensitivity design form – the Nordic architecture.
Nordic architecture is representing Scandinavian and furthermore composed of several different Nordic countries. The name north itself describes some of the identity, that lays in the Nordic architecture form. The etymology of "south" is connected to "sun", where "north" is described as "below". Where below is defined as we in the north have a distance to the light that comes from the low sun.
Cause in the north, the sun doesn't rise high on the sky, but shines diagonally and dissolves in a variation between light, shadows and darkness. It is a place, where nights become days in the summer and have a midnight sun, and the winter days become so short, that darkness dominates [Norberg-Schulz, 1997].

As Christian Norberg Schulz states "As a point of departure for this comparison we can examine that which gives an environment its primary character – light. [...] For it is precisely light that defines the Nordic world and infuses all things with mood. Light informs us instantly that we are no longer in the south. [..] not that light creates things, but that it defines their manner of appearance." [Norberg-Schulz, 1997, p.2]. In the north, as Norberg Schulz states, the things and places are being defined and seen with a special mood of shifting nuance by the light and overcast sky.

The Nordic architecture is a simplicity and sensitivity culture that seeks its legitimacy in place and nature, where the parameters such as place, location, identity are important factors [Kjeldsen, 2012].
Norberg Schulz talks about the Nordic Gestalt. "We use the word "gestalt" to denote motifs that identity place, and that we recognize and recall" [Norberg-Schulz, 1997, p.17]. And by envision, place as a space with form, makes the environment and the relation to the location and to the user.

Gestalt also describes the ability to acquire and maintain some of the old building traditions, that have been formed through the time and where the construction is adjusted to the weather conditions and material resources.
One of the main keywords in Nordic architecture is "home". Where home is defined as intimacy and warmth. So, the sensitivity also lays in the sensible sense of using local materials, and the connection to the nature and use of light [Norberg-Schulz, 1997].

Christian Norberg-Schulz has also codified Nordic architecture as a product that springs from its native soil. He sees a relationship between the building, the native place, and location, while he mentioned that the new generation loses themselves from combining those factors, and instead designs a contrast to nature.
And through Michel Asgaard Andersen's sight, who is a Danish associate Professor in architecture at Aarhus school of Architecture [Arkitektskolen Aarhus, 2018]. He thinks at the new generation, has a new definition of the place, which has changed since the 1980's. It has moved from the topographic, where the place has a connection to the native soil and the surroundings as Norberg-Schulz' theory and instead moved to the social aspect, with a decreasing aspect on the landscape and the urban environment [Kjeldsen, 2012].

As Asgaard Andersen states, has a new vision enhanced the definition of Nordic architecture, where society, democratic, humanized and community are having a bigger influence than ever before [Kjeldsen, 2012]. "[....]Forms which do not threaten, but invite.[....] The entire modern tradition of Nordic architecture could be characterized by the intention to provide society with forms which invite." [Kjeldsen, 2012, p. 140].

Through this project, as described by Norberg Schulz, we will use his approach to Nordic architecture combined with the use of daylight, connection to place, materials and the society to create a strength for the architecture. We believe that these together can convey the local connection associated with the social and cultural values in a simple and sensitivity form.

From nordic architecture these six focus points will be intregrated in the design process:

- Local materials
- Connection to nature
- Simplicity
- Society
- Light
- Place

▶ *Ill. 19.1: Hot water stream at Hverir*

ATMOSPHERE

An atmosphere is a phenomenon to describe the rooms experience, where the light and the sense plays an important part to the definition of the spaciousness feeling, places perception and how they together create an experience of an elements shapes and size. An example how to use the light to enhance af atmospheric feeling of home.
The atmospheric experience of a building, room or a detail, will change along the daylight passes by on the sky. Some elements will have the same experience in a new various light, where other elements will be exceeded in a new way, which can enhance the element or the opposite.
In this following part, two important theorist Juhani Pallasmaa and Peter Zumthor will be used to describe an atmospheric and sensual definition to enhance the experience of a room.

PETER ZUMTHOR
Born 1943 in Basel, Switzerland.

He is one of the world leading architects in creating a specific atmosphere with architecture. He has taught at several schools of architecture, and has since 1996 been a professor at Accademia di Architettura di Mendrisio in Switzerland. After the success of his lectures, he decided to publish them into books, whereas Atmospheres is one of the most acknowledged and praised.
In this Atmospheres, he uses his own experience to describe his nine quality criteria for reaching a multi-sensory experience. These criteria are as follows;

THE BODY OF ARCHITECTURE
The body is the way materials can be assembled and create a space inside it. The anatomy of a building is formed with the exterior as a membrane, and every piece of the building together forms a body.

MATERIAL COMPATIBILITY
Each material behaves in its own way, but in a composition with another material, it behaves completely different. This relationship between them creates endless possibilities of which materials fit the space the most – sometimes the material itself doesn't fit the space, but in composition with another, they together fit perfectly.

THE SOUND OF SPACE
"Listen! Interiors are like large instruments, collecting sound, amplifying it, transmitting it elsewhere," [Zumthor, 2015, p. 28] This is probably the best way of describing, what he means about The Sound of Space. That each surface and shape affect how the sound, the reverberation time, is, which affect the hearing sensuous experience of the atmosphere.

THE TEMPERATURE OF SPACE
Feeling the atmosphere in relation to the temperature is not only physical but also psychological; "It's in what I see, what I feel, what I touch, even with my feet." [Zumthor, 2015, p. 34].

SURROUNDING OBJECTS
Surrounding Objects and the relationship between objects creates a sense of being at home. To personalize a space and defining the atmosphere.

THE COMPOSURE AND SEDUCTION
Make considerations of how the flow of people's movement is, and make it interesting for the person to move around inside the building.

THE TENSION BETWEEN INTERIOR AND EXTERIOR
What you see from the outside versus the inside. The tension and mystery of the two different experiences and how their boundaries are created and experienced.

THE LEVELS OF INTIMACY
How the rooms create different atmospheres of intimacy. It's a combination of various aspects; the size, dimension, scale, etc. Example, some spaces, inside and outside, allow making you feel calm while others intimidate you.

THE LIGHT OF THINGS
He describes his own design process as "hollowing out the darkness, as if the light were a new mass seeping in" [Zumthor, 2015, p. 58]. The movement of daylight can seem almost spiritual, as he says about daylight "it gives me the feeling there's something beyond me, something beyond all understanding" [Zumthor, 2015, p.60], which is always why according to him daylight is much better than artificial light [Zumthor, 2015].

Zumthor's nine qualification requirements will be used as a base for discussion during the design process, to ensure that the wanted atmosphere will be achieved.

JUHANI PALLASMAA
Born 1936 in Hämeenlinna, Finland.

The Finnish architect, who is a former professor and dean at the Aalto University, is well-known from his many inspirational buildings and books about architectural history and theory. His book the Eyes of the Skin – Architecture, and Senses are a masterpiece in the phenomenology of architecture theory, which has become a part of several schools of architecture's required reading.
In the mentioned book Pallasmaa explain his theory about the significant role of the senses in architecture and emphasize it with the use of other architects and theorists. He wants to inspire architects to carefully consider how the human senses perceive the architecture they design, to make them design sensual architecture – how each sense perceives it individually, but also in a collaboration with each other to gain a full sensual experience of the architecture.

According to Pallasmaa, the sense that has dominated most architecture in the western part of the world is the visual sense, which affects the quality of the design. When human beings experience a space, it uses all its sense one way or the other – as from all the senses are extensions of the tactile sense. "... the senses are specializations of skin tissue, and all sensory experiences are made of touching, and thus related to tactility" [Pallasmaa, 2013, p. 12]. With the lack of stimulating and consider all the sense, the architecture experience decreases in quality. The architects should use its own sensibility when designing to create a space for all the senses. He states that they should use a more analog approach when designing instead using modern computer-generated design, which prohibits the body of working with other senses than the visual sense.
In his book he refers to childhood memories and other moments in his life where he clearly remembers, how his senses were stimulated by architecture and nature. He uses these anecdotes as an attribute to his theory about senses. As he states; "We remember through our bodies as much as through our nervous system and brain,"[Pallasmaa, 2013, p. 49]. The body uses its experience to remember different sensual feeling. By only using the visual sense the body know by the look on a surface if it feels smooth or rough. Through time it gains more and more experience, which is what the architects it selves should use when they are designing [Pallasmaa, 2013].

During the design project of this project will his theories be used to gain a more phenomenological approach to a sensual design. All the senses will be influenced by the result of the design and be a careful consideration throughout the project.

HUMAN COMFORT ZONE

The human comfort zone is a place, with the optimal indoor conditions for heat radiation, wind, and moisture. A zone, where there should be no need to change the conditions of these three parameters. By combining the architectural qualities with the technical knowledge, the users will experience the atmosphere more comfortable and pleasant.

The human body has an incredible ability to adapt to the different climate, with temperatures from minus 20 °C to 40 °C, where the body still will be able to find comfort in the right conditions. The experience from the hot and cold climates are most affected by the humidity,

wind speed and heat radiation. A study shows through climatic conditions, that the human body is most comfortable while working or relaxing at 22 °C. While +/- 2 °C to it will be the operative comfort temperature in the surrounding air [Albjerg, 2008].

The Danish indoor climatologist, Ole Fanger, made a definition on the comfort concept in 1970, where he defined the six aspects for that time: air temperature, radiation temperature, relative humidity, air flow, metabolism, and the clothes' thermal properties. Today the

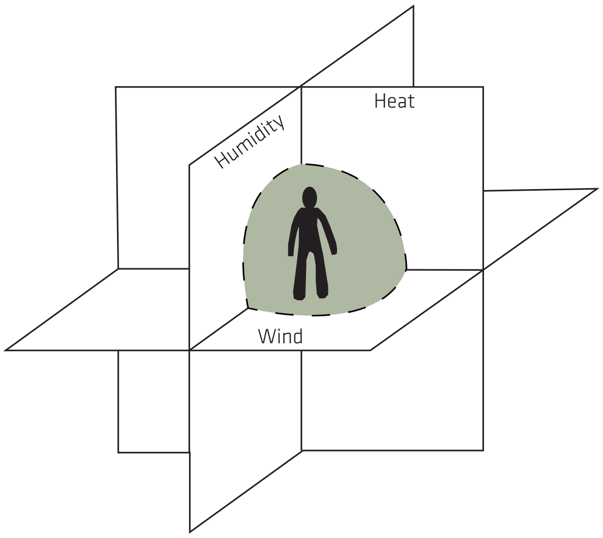
knowledge for the area have enhanced, and therefore the air pollution, amount of light and acoustic parameters is added on the list. All these parameters together define and describe the indoor climate.

Humidity, air flow and heat radiation are parameters that together with clothing and nutrition influence the inside and outside conditions and creates the human comfort zone. By having the optimal indoor climate, it can prevent diseases and genes, and enhance the experience of the comfort [Albjerg, 2008].

Already in 1963, Victor Olgyay made a graphic diagram to show the interdependence between the three comfort parameters. The purpose and goal of the diagram were to identify the human comfort zone, where there should be no need to change the conditions of the temperature, humidity, and air flow.

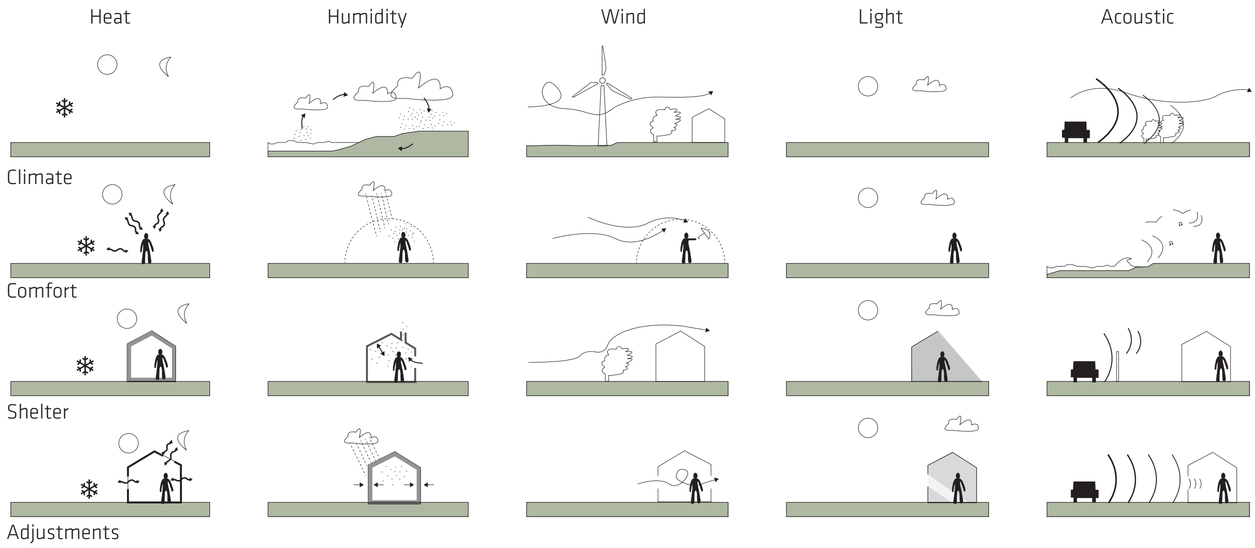
Shown in the diagram, is each of the three surfaces define as one of the parameters, where each parameter has its one comfort zone for the specific climate impact. When these three surfaces are put together, will each of their comfort zone create a "new zone"; a zone which defines the optimal comfort zone and describes the individual variations of tolerance from each parameter [Albjerg, 2008].

The swiss professor Marilyne Andersen, looks at three parameters there are affecting the human body health, behavior and perception regarding to light and together creates a dynamic of daylight. These three parameters are: Visual delight, Visual responsive comfort, and health



potential. The visual delight is about the sun's lighting in a room, which not only can be an issue for overheating, glare, but it can also be a satisfying condition, where these factors together should be a part of a selection in a process. The visual responsive comfort is all about comfort in the room, which will affect how the body behave in a space. The last one, health potential is about non-visual effect of light [The velux group, 2015]

The international standards for the indoor climate and the comfort demands try to achieve a stable homogeneous indoor climate - example with the same temperature in all rooms. These demands can almost only be achieved by implementing mechanical climate systems, where it is possible to get a stable comfort with no uncomfortable impacts. But these systems are often not enough, to satisfy the user's needs for achieving their comfort zone and a good indoor climatic environment, without any ability to change the conditions by opening a window or similar opportunities.



By forming the architectures after its climatic conditions, it can be able to protect, advantage and adjust some of the climate conditions with a minimal use of resources on the building, and it can enhance the elementary experience of the room. These climatic elements, such as light, acoustic, temperature, wind, humidity, and precipitation, also affect the human's five senses and the experience of the room. Through the diagram it is shown how these climate parameters interact
with the human body and the architecture [Albjerg, 2008].

"[..]the senses importance for our
experience of the close surroundings, is an important inspiration to the design of a room and architecture with a high comfort. A more varied comfort concept, must shift its focus from the view that climate variations and quantitative deviations from the norm imply the risk of physical discomfort to a more qualitative perception of human needs for a varied climate and that climate variation can be stimulation, can contain sensory qualities and can support the
experience of room, shape and fabric. [...] Variations in climatic experiences both inside and outside are often an essential part of life, and for some people, it is the very essence of living" [Albjerg, 2008, p29].

◀ *Ill. 22.1: The comfort zone*
▲ *Ill. 23.2: Climatic conditions*

CRADLE TO CRADLE AND ECOLOGY

Cradle to Cradle is a holistic environmental certification tool. It is a revolutionary designing strategy, where the product is a part of a biological and technical circuits. The strategy is developed by the chemist Michael Braungart and the architect William McDonough in the 1990s.
The vision behind Cradle to Cradle is to transform the world into a place where production and consumption have a positive influence on society, economics and the environment with the same amount of consumption as now. All the materials should be healthy to its surroundings, by knowing all the ingredients in it, so it afterward can include in a repeating circuit.
Cause in the Cradle to Cradle concept, trash is no longer existing, only what is botanical, because everything should be recycled as it is, or transformed to a new resource for a new purpose in the healthy biological and technical circuits. The trash shall be seen as a nutrient to the future.
It all sums up to how we support the biosphere and the technosphere [Braungart and McDonough, 2007]. Cradle to Cradle is today the most ambitious environmental certification in the world, especially for those in the construction industry [Vugge til Vugge ApS, 2018].
The Cradle to Cradle concept, is made upon, that we today live in a world with the Cradle to Grave concept. Cradle to Grave concept were developed during the industrialization, and where the earth's resources were seen as inexhaustible. Today we know better, but we are still living after this concept, but are focused on, how to minimize the negative effects that affect our world and the environment by saving resources on earth and to poison less [Braungart and McDonough, 2007].

As William McDonough states "being less bad is not being good" [Guldager Jørgensen and Lyngsgaard, 2013, p81]. We are in a time, where we in some way try to be ecologic, but with a focus on the economies all the time. Cradle to Grave is the most dominate production type today, where statistics show that over 90 percent of the materials that are recovered to manufacture products, are they almost being thrown out in a short time " [Guldager Jørgensen and Lyngsgaard, 2013].
"In fact, many products are designed with a built-in obsolescence, so they only last for a while, and making it possible or even encouraging the customer to get rid of the thing and buy a new model" [Braungart and McDonough, 2007, p38].

The whole change from Cradle to Grave to, Cradle to Cradle is about benefits. The worst is to panic and destroy the resources, because these resources shall be handed over to our children and grandchildren for their future. Otherwise, there will not be much more future, if we continue in this way. As the way Michael Braungart and William McDonough describe our future goal - "Our goal is a delightfully diverse, safe, healthy and just world –with clean air, water, soil, and power – economically, equitably, ecologically and elegantly enjoyed" [Guldager Jørgensen and Lyngsgaard, 2013, p11]. The inspiration for the Cradle to Cradle strategy comes from the nature's system, where everything becomes nourishment for something new and everything are produced by renewable energy.

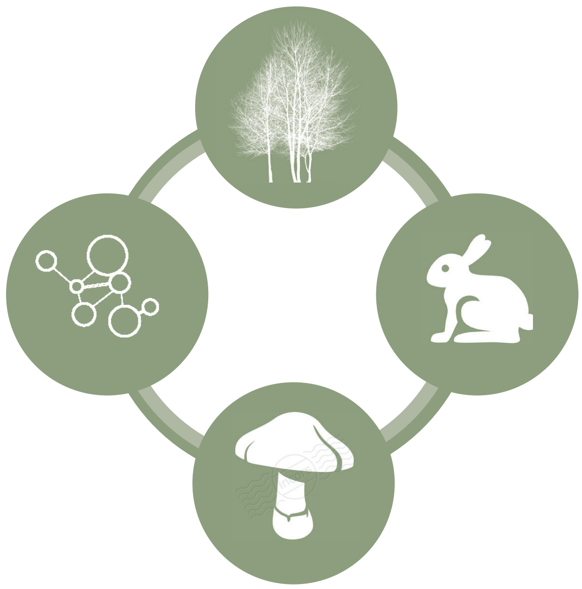
THE CRADLE TO CRADLE FOUNDATION
The foundation for the Cradle to Cradle strategy is based on these three principles: Waste = feed, renewable energy and appreciate the diversity, which together supports the biological and technical circuit.

THE THREE PRINCIPLES
Waste = feed:
This principle has focused upon, that there is no waste in nature because everything will be nutrition for thing else. Every material should therefore be chosen as a potential resource for either the biological or technical circuit.

RENEWABLE ENERGY
Everything in the biological circuit is powered by solar energy. The second principle has therefore focus upon basing production, buildings and consumptions energy from renewable sources as wind and the sun. Example produces the sun alone every day more energy than the entire world consume together - and this energy source is inexhaustible.

APPRECIATE THE DIVERSITY
The last principle has focused upon to appreciate the diversity of the natural species, the handcraft solutions and culture.

THE BIOLOGICAL AND TECHNICAL CIRCUIT
In the Cradle to Cradle strategy, is the two circuit as mentioned before very important for the strategy, where every material must be included in either the biological or technical circuit. Instead of considering materials as from production to destruction, Cradle to Cradle regards used materials as nutrients for something else in either the biological or technical circuit. The biological circuit is a process that only consists of materials that after used can be biodegradable without any pollution to nature or its surroundings. The technical circuit is a process that consists the used material which can be separated from each other and be recycled into something new without any loss in quality [Guldager Jørgensen and Lyngsgaard, 2013].



▲ *Ill. 25.1: Biological circuit*
▲ *Ill. 25.2: Techinical circuit*

CHAPTER CONCLUSION

To experience architecture the light, need to be present for the human eye to see it [Nørretranders and Eliasson, 2015]. The light simply has the hit the material and be reflected from it before the human eye can see it. The daylight can be divided into sunlight, skylight and reflected light. The sunlight is the light that comes directly from the sun, while the skylight is the light from the sun that is spread out in the atmosphere and creates light through the skies. The reflected lights are from these two other light types begin reflected on a surface [Mathiasen, 2015].

Henry Plummer's theories of the five light effects are the following; journey, diffused, tranquility, darkness, and whiteness. The journey effect can guide people with light, diffused light creates a soft light, tranquility can change the material's tactility, darkness can be achieved with a small window opening, while whiteness needs larger windows to get an atmosphere of cleanness [Plummer, 2014].

The light can divide a room into several spaces using its light area. For an example of the light not merging together this effect will be achieved [Madsen, 2004]. The light can also influence whether the atmosphere is calm or excited by the design of how the windows are placed and how the user will experience them [The Daylight Award, 2018].

By placing the window in different height, the room's atmosphere of being private and public can change. If the window is high or low the atmosphere of private would be created since no one can look through the windows. If the window is in between these heights then an atmosphere of beginning in the public is created. The atmosphere is also affected by whether it is horizontal or vertical light opening, where the horizontal connection to its surrounding while the vertical creates a spiritual atmosphere [Madsen, 2004].

The colors of the light by the sun, the material or the artificial lights also affect the atmosphere, for an example by if the light is bright is moves and leads the person [Dansk Arkitektur Center - DAC, 2018]. In the north the light often bright and soft and the shadows merge together due to the many days of the overcast sky [Plummer, 2016]. In the Nordic architecture, the buildings are simple and inviting, where the artificial lighting is warm [Norberg-Schulz, 1997].

The different factors, other than the mentioned light theories, are the sensuous experience of the space, as described by Peter Zumthor and Juhani Pallasmaa. The human body comfort was described to achieve that the building would be comfortable for the guests to be in, while the Cradle to Cradle principles was introduced with their waste = feed, renewable energy and the appreciation of diversity.

chapter two
iceland

In this chapter, Iceland is presented with its different aspects that are relevant to this project. The history and traditional building methods are explained, as well as how the natural resources of Iceland can be used as renewable energy and heat. As Iceland is rich in natural resources, their nature is beautiful and attracts a lot of tourists, especially to see the Northern lights, which are described in this chapter as well.

HISTORY AND BUILDING TRADITIONS

Iceland is a Nordic island, located in the middle of Atlantic Ocean, a few kilometers south of the Arctic Circle. Today Iceland has around 330.000 inhabitants on the 103.000 square kilometer island, which makes Iceland to the most barely populated country in Europe. Iceland has a unique wild landscape and topography, with both many volcano and lava fields, geothermal actives, high mountains, and glaciers, which is why the country is named – "The land of fire".

The first settled human arrived in Iceland in 874 AD was a Norwegian. The years afterward Iceland's population increased with other people from the Scandinavian countries. Before the humans arrived at Iceland, it was an extensively forested land. But after humans settled permanently, they used the resources and deforestation the countries forests.

From 1397 to 1918, Iceland was under the rules of Denmark, as a Danish colony until 1918 when it achieved independence and in 1944 became a republic [Iceland Northern Lights Rooms, 2017].

BUILDING TRADITIONS

One of Iceland's oldest building traditions is the turf houses, which have been built since the 9th century to the 19th. Because the first settlers were Norwegian and came from similar weather conditions, they used the same building traditions they were used to, and in the beginning build longhouses, which was the first form to be build on Iceland.

They used most of all the wood, and thereby destroyed the Icelandic forests. Those trees that were left, was either too short, because the trees grow very slowly, or they had too many twisted branches to be used. Therefore, became wood a poor building resource, unless they imported wood from Norway. A new building form were therefore used with other materials. Before concrete took over in 1900, was turf and stone the main construction materials. Turf is a material, which has some different qualities, that wood doesn't. For example, a turf house, would not collapse or overturn in a storm which Iceland often has. Another difference was the thick walls in a turf house, which were better insulated and could hold the moisture out, than the wood walls would.

The houses were constructed by heavy flat stone walls, were stone and turf were laid alternately above each other. To make an insulating wall, there was build an outer and inner wall, where the space between was filled with a combination of sand and mulch. Inside the house, large beams made from driftwood, probably found in the ocean, was placed.

Upon the beams other driftwood was laid across, to make a construction similar to a rafter, which was afterward total covered with turf to close off. When the times were good and Iceland imported wood from Norway, the houses were inside covered with wood or driftwood. But in the tough times, the inside wall was clean and showed the stone wall. If some of the beams got destroyed or rotten somewhere, it was not often the beams could be displaced, and instead stone were put in the bottom, to help to carry the construction.

Depending on the location on the island a house was built, the lifetime and durability of a turf house would vary. If a turf house is built in the southern Iceland, the lifetime of the house would be around 20-25 years, where in the northern Iceland, where the climate is drier, a lifetime would be around 50-70 years. These are some of the reasons combined with the hard weather conditions and volcano eruption why there only are a few left today [Museum Landnámssýningin].

◀ *Ill. 30.1: The turf houses seen together with its hugh rock at Drangurinn in Drangshlíð*
▼ *Ill. 31.1: A turf house at Rútshellir, Iceland, that is build far into the mountain side*
▼ *Ill. 31.2: Two joined turf houses at Drangurinn in Drangshlíð, Iceland*

NATURAL RESSOURCES

Iceland is the leading country in the world to produce most green electricity per capita, due to hydroelectric power and their unique energy source in geothermal power [Askja Energy, 2018 (1)]. They use almost 100 % renewable energy, except for less than 1 % which is, among others, fossil fuels. Hydropower is most used with its 73 % while geothermal power is 27 %, excluding the last less than 1 % [Askja Energy, 2018 (2)].

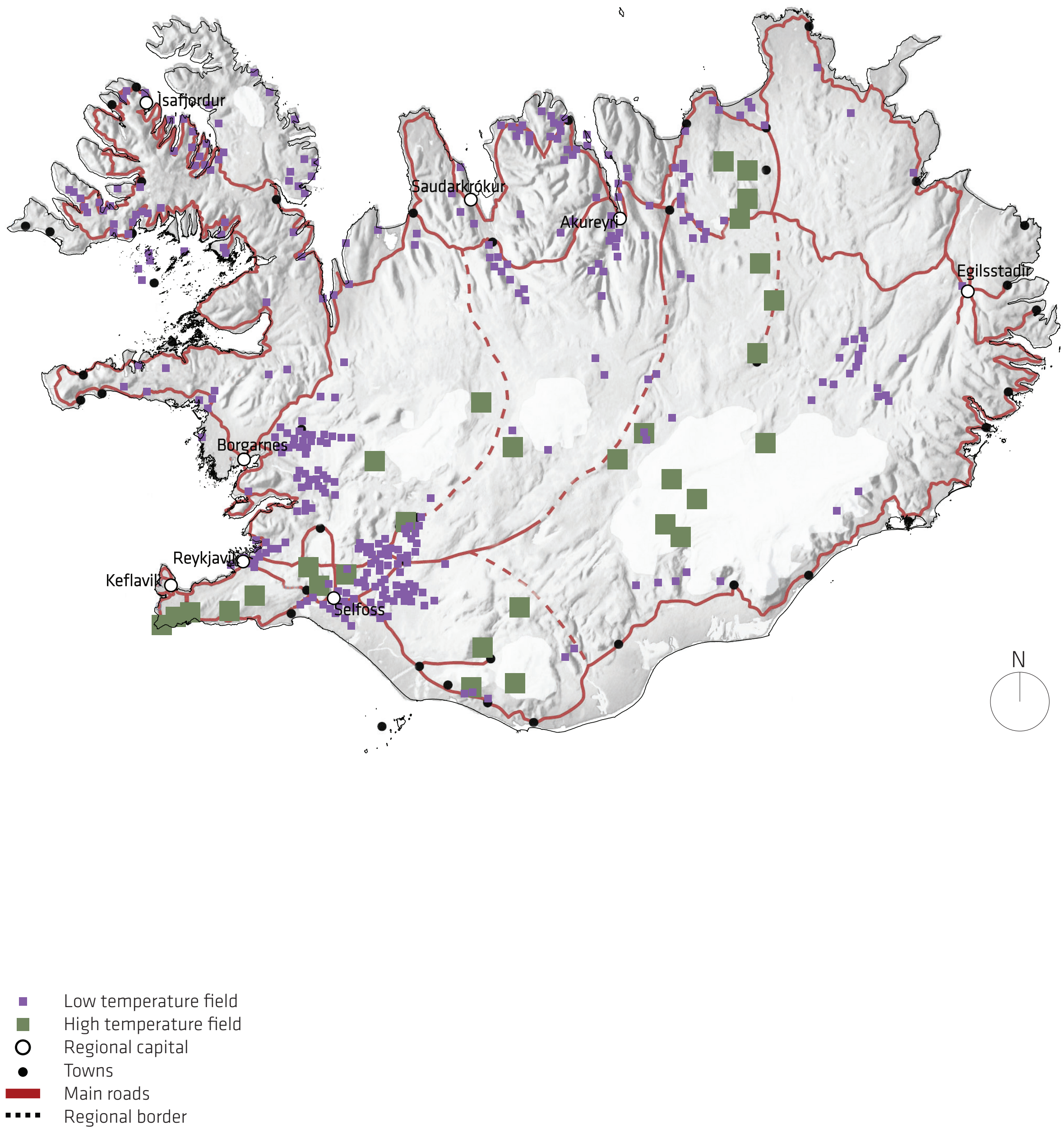
Iceland is a volcanic island, a hotspot in the middle of the Mid-Atlantic Ocean Ridge, where the continental plates of North America and Eurasia meet. Several places where water runs just below the surface, can be used for power and heat production. The hot water comes from the high amount of precipitation, that runs through hot bedrock and ends in hot springs [Landsvirkjun, 2018].
Even though Iceland began in the early 20th century to utilizing hydropower. It was first in the late 1960's the abundant amount of hydropower became attractive for foreign investment, and they really began to sell their green power to other countries. During the next couple of decades, Iceland added several hydropower stations to use their power from the streams and rivers.

Geothermal power had a slower process of becoming a noticeable energy source. It also began at the beginning of the 20th century. For centuries, had the Icelandic people used geothermal springs to take a bath or washing, but in 1908 a farmer started using it for heating up his house, and it soon applied to others. He lived close to a natural hot spring and led the hot water to his house using a pipe. The water's steam heated up the house and the family saved a lot of money on that renewable solution. This solution was also used in to heat up greenhouses. First, in 1930 the local authorities began to be interested in geothermal heating and wanted to use it as well. Due to the great depression and world war II, it was first in 1978 that the geothermal power source became a serious attribute to the power supply for the citizens of Iceland.

From the following years to the present the amount of power produced by renewable energy sources have only increased. Iceland is capable to sell their residue to other countries, that are interested in green energy, for a very low price, which gives them an advantage on the energy market [Askja Energy, 2018 (3)].

Less than 5 km away from the site, is a geothermal power station located, called Bjarnarflag Power Station, which is one of the smallest power stations on Iceland. It uses steam coming from the geothermal area close to Námafjall Mountain. It produces annually 18 GWh of electricity, which provides heating to the local district and for industrial use. The attraction Mývatn Nature Baths is filled with geothermal water from this power station [Landsvirkjun, 2018]. Energy and heat will come from this closeby renewable energy source to supply the houses on the site.

▶ *Ill. 33.1: High and low temperature fields on Iceland*


Ísafjörður
Saudarkrókur
Akureyri
Egilsstaðir
Borgarnes
Reykjavík
Keflavík
Selfoss
N
Low temperature field
High temperature field
Regional capital
Towns
Main roads
Regional border

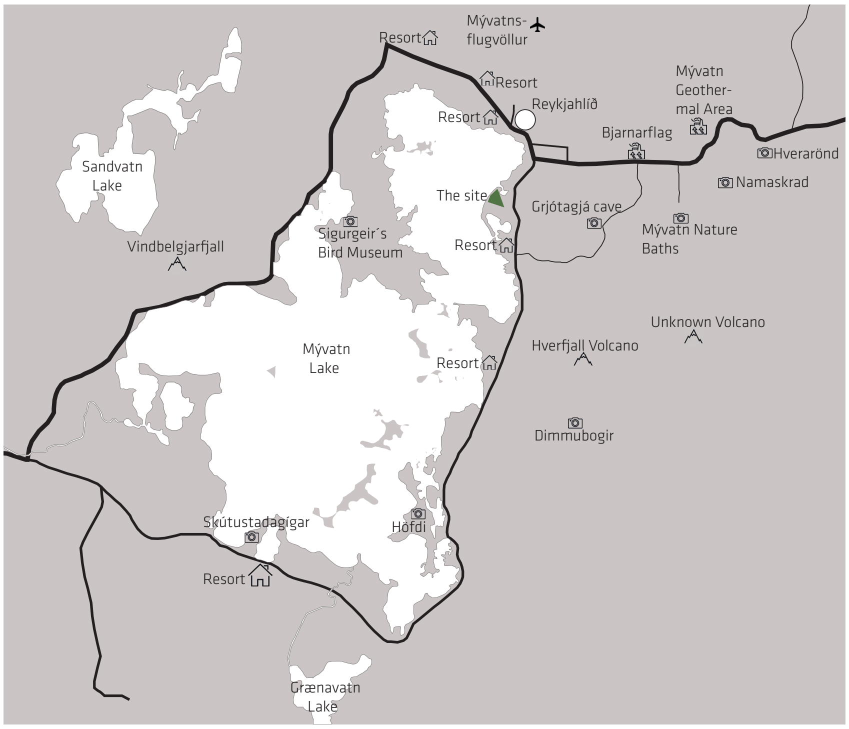
TOURISM

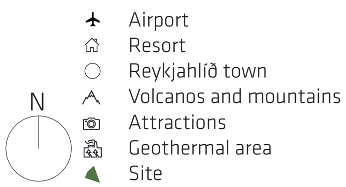
Iceland is a much more expensive tourist destination to visit, than many other charter hotels lying on a strip around the world. Since the county has a big focus on protecting the untouched nature, it deliberately chooses not to overpassed the whole country with hotels that would destroy the nature, but make Iceland a cheaper travel destination [Islandsrejser.dk, 2018]. Therefore Iceland was most often visited with stopover tourists, traveling between the US and Europe, where they had two to three nights in Reykjavik, before they continued their travel to the final destination. Or tourists just traveled to Reykjavik and stayed in the area around during their stay. After the crisis in 2008, Iceland has become the second richest country in the North, just after the oil-rich Norway according to GDP.

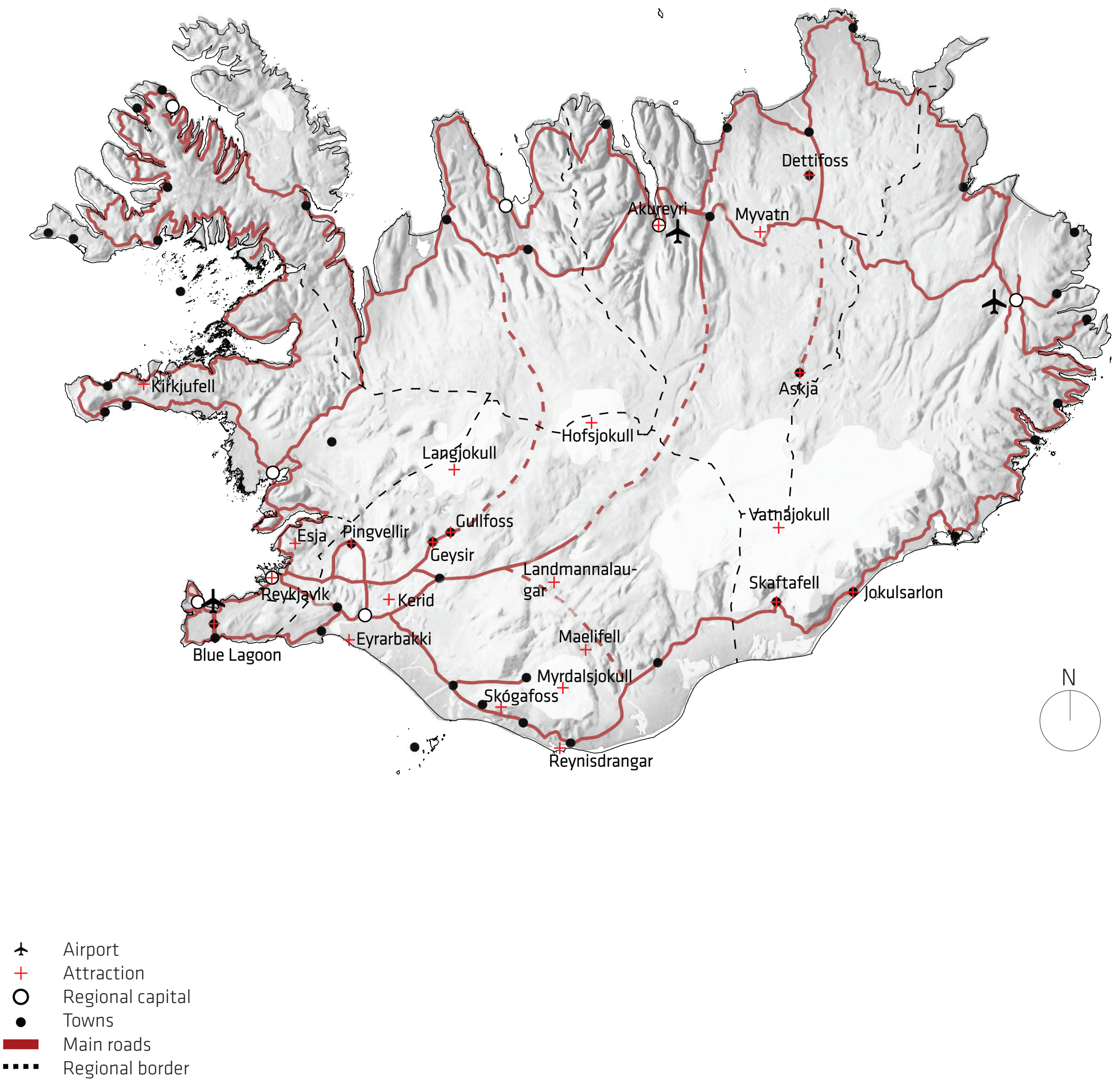
The richness of the country, and with the curiosity and request from the Icelandic people, have caused major changes in a more modern society characterized by mobility, openness and innovation.

In the last few years, the number of tourists has increased. In a country with a small community of almost 330.00 inhabitants, had Iceland approximately in 2015 1.26 million tourists. The following year, the number increased by 40 % to almost 1.8 million.
Iceland is today, therefore, more than just the old industrial fishing town Reykjavik, and the Golden Circle. According to the statistics, it shows that the north has become much more attractive both in the summer and winter because the north is one of the most beautiful places in Iceland [Ferdamalastofa.is, 2018].

With all of the unique nature, high mountains, lots of volcano fields, gigantic and tumbling waterfalls, geothermal activities, rich life of birds and animals, and with the higher possibility to explore the northern lights [kulturretur.dk, 2018]. Either they travel to the second biggest city Akureyri or near the popular lake Mývatn to explore the nature in this area [Ferdamalastofa.is, 2018].







◀ *Ill. 34.1: Attractions near the site*
▲ *Ill. 35.1: The largest attractions on Iceland*

NORTHERN LIGHTS

For this competition, the northern lights are very much in focus, since the user should be able to see it from their bed in the guest houses [Iceland Northern Lights Rooms, 2017] but also due to the magical experience of seeing these lights are one of the biggest reasons for tourist to visit Iceland.

Northern lights or Aurora Borealis as it also is called is a natural phenomenon that only occurs in near the North pole, whereas the Southern lights only occur near the South pole. The reason why the lights come into existence begins on the sun. Inside the sun's core is the temperature over 14 million °C which creates a very high pressure that force hydrogen atoms into helium.
The reaction creates energy that radiates outward of the outermost layers of the sun, where the heat travels to the surface are huge swirls. These swirls are electrical currents filled with charged gas, which are called plasma, that makes magnetic fields inside the sun.

Some of the strong magnetic fields push through the surface slowing the swirls down. The plasma pushes its magnetic fields outside the sun until it breaks away from the sun into space, creating solar winds. The solar wind travels through space with 400 km per second. During it passes several planets before hitting Earth after 18 hours, and the solar wind has now traveled 150 million km from the sun.

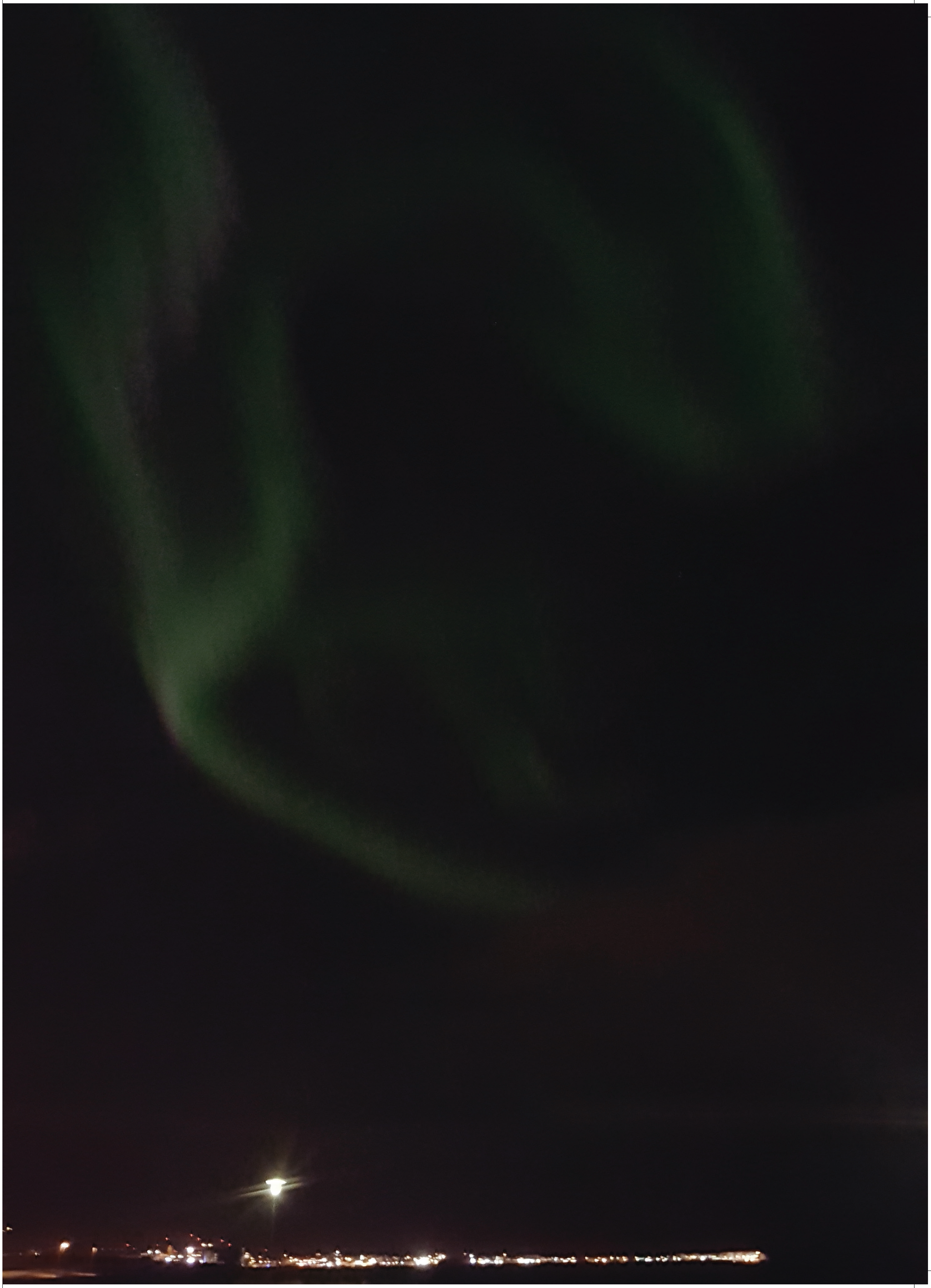
The solar wind hits Earth, and it is being deflected by Earth's magnetic field and moves further through space. But due to the plasma within the solar wind is charged with particles, some of them get directed to Earth's two poles. Some of the spots in Earth's magnetic field are weak and lets a small amount of plasma into the ionosphere, which is at an altitude of 85-600 km. Here the particles inside the plasma, made of electrons and protons, stimulate oxygen and nitrogen.
On the poles, these charged particles strike atoms, that causes the electrons to move to a higher-energy state, and when they drop back to a lower energy state a photon is released. A photon is light, which can be seen in the sky as northern or southern lights [Aurora Reykjavík]. The light varies in color; the most common is bright yellow and green, then blue and purple whereas the red color is the rarest [The Icelandic Web of Science, 2005]

In Iceland, the northern lights can be seen from the end of August through April. Since the lights appear high above the ground, even higher than the skies, the weather plays a huge impact on, if the northern lights will be visible or not. If there is a cloudy sky, then it will not be possible to see them from the ground.
Another huge factor is the light from the moon and the light pollution from the cities. A full moon can make it more difficult for the human eye to see the lights because, the moon's lights intervene the lights from the northern lights.
Due to the high amount of street lights and other forms of artificial lighting, the sky becomes brighter near cities – it also affects how many stars and satellites, that can be seen. If these factors are in order, then the best time to see the northern lights is between 9 pm to 2 am [Andrèsson, 2010].

Long before scientists made it clear why the northern lights happen, a lot of different tales was told through time. Some of the Icelandic tales involves that if several colors appear in the northern lights, then a storm is coming, while others are about childbirth such as;
"Our Icelandic ancestors also associated the lights with childbirth and held that they would relieve the pain of delivery. Maybe that's the reason why statistically most babies are born during the northern lights season.... However, the expectant mum should not look at the aurora because the child would be born cross-eyed!" [Aurora Reykjavík].

At our study trip to Iceland at the end of January 2018, we experienced the Northern lights several times. The most amazing time was when the lights danced in their green colors across the sky of Reykjavik. It was our last night to see them and they certainly did not disappoint. They felt so close to us, but when a cloud passed the sky we realized how high the lights actually were. It was a magical experience and the primary word we used was wow. And this experience of the Northern Lights is definitely amazing, magical and surreal. It seems so close, even though it is very far away. It makes you turn to the dark sky, filled with the wonder of them, space and cosmos. Our Earth seems so small compared the entire universe that lies behind the Northern Lights.

▶ *Ill. 36.1: Green Northern lights over Reykjavik*



CHAPTER CONCLUSION

Iceland is placed in the Atlantic Ocean near the Arctic Circle. With its 330.000 inhabitants, the island has through time learned to live in and of its resources. Their oldest building traditions are their turf house, that has been built since the 9th century, is made of turf and stones and was built to survive storms through the years. Later concrete became their most used material and are still being produced and used as a building material [Museum Landnámssýningin].

To provide the island with electricity and heat their huge geothermal areas are used to pump the hot water up and provide them. Together with their hydroelectric power, the island is provided with almost 100 % of renewable energy and heat sources – and even producing enough to sell it to other countries [Askja Energy, 2018 (2)].

Other than using their nature for buildings material, electricity, and heat, it also attracts a lot of tourists each year. The tourist visits Iceland to explorer their nature of mountains, volcanos, glaciers, and much more. Near the site, several nature attractions are located such as Hverfjall volcano and the geothermal field of Hverir [Ferdamalastofa.is, 2018].

Another huge attraction for the tourists is the possibility to explore the northern lights, which origins in solar winds hitting Earth and becoming northern lights near the north and the south pole [Aurora Reykjavík]. From the end of August through April the northern lights can be seen on the site, for the guests to enjoy the natural phenomenon [Andrèsson,2010].

chapter three
the site

This chapter focus on the site in the Northern part of Iceland as well as suitable analyses. An explanation of the competition is described, including what is not going to be part of this project from the competition. The site's typography is shown through two sections and photos of the site shows its vegetation. An analysis of the microclimate is made to give an understanding of how the climate behaves on the site. This was explored during a study trip, where an analysis is based on what we experienced with our senses.

COMPETITION

This project is based on the Iceland Northern Lights Rooms competition issued by Bee Breeders Architecture Competition Organisers with the deadline for submission May 15th of 2018. The task is to design a concept for guest houses and a home for the hosts family, whereas the guest houses must be comfortable during all weather conditions; must be resistant to heat, cold, rain, snow and wind. It is focusing on experiencing northern lights from each bedroom through a skylight to give the user a unique stay.

The site is located remotely in the northern part of Iceland. All of the buildings must be environmentally responsible and energy efficient, including generating power on its own and provide drinking water. The buildings must be low maintenance, both in terms of costs and effort [Iceland Northern Lights Rooms, 2017].

This project is not going to be submitted for the competition due to four of its requirements, do we not see as relevant for this project as a master thesis, but the rest will be used and mentioned in the room program.

The first requirement that is not going to be part of this project, is the guest houses must be moveable without any permanent foundation. It would take time and effort to design this in a sustainable way and still create a good movement flow on site, whereas we would rather spend time on creating a great atmosphere in the guest house and home with sustainable solutions.

The solution to make it moveable will be designed with a more industrial approach, which is not part of this project.

The second requirement that is not going to be used is there must be single room guest houses. The reason why this is not part of the project is that most people traveling around Iceland in small groups, as a family or a couple [Ferdamalastofa.is, 2018]. Only a very few travels alone, so to make more guest houses for a couple will probably be more used.

The third requirement is that the buildings should be 200 m from the Mývatn Lake's edge. The 200 m include the part of the site that has the best view, where the cabins can be located. When we visited the site, the view from the site's peak impressed us, and that view is something we want to be able to offer to the cabins.

By looking at the surrounding houses and resorts near the lake, most of them do not meet this requirement. With careful consideration of how the buildings are made and placed on the site with a sustainable aspect, the lake should not be affected by it.

The fourth and last requirement is that the main house should offer a terrace with a roof. Due to the shape and concept of the main house, where the roof itself is a large terrace, a roof on the terrace would not follow the clean shape of an cylinder to match the concept.

▶ *Ill. 43.1: The view towards South seen from the site*

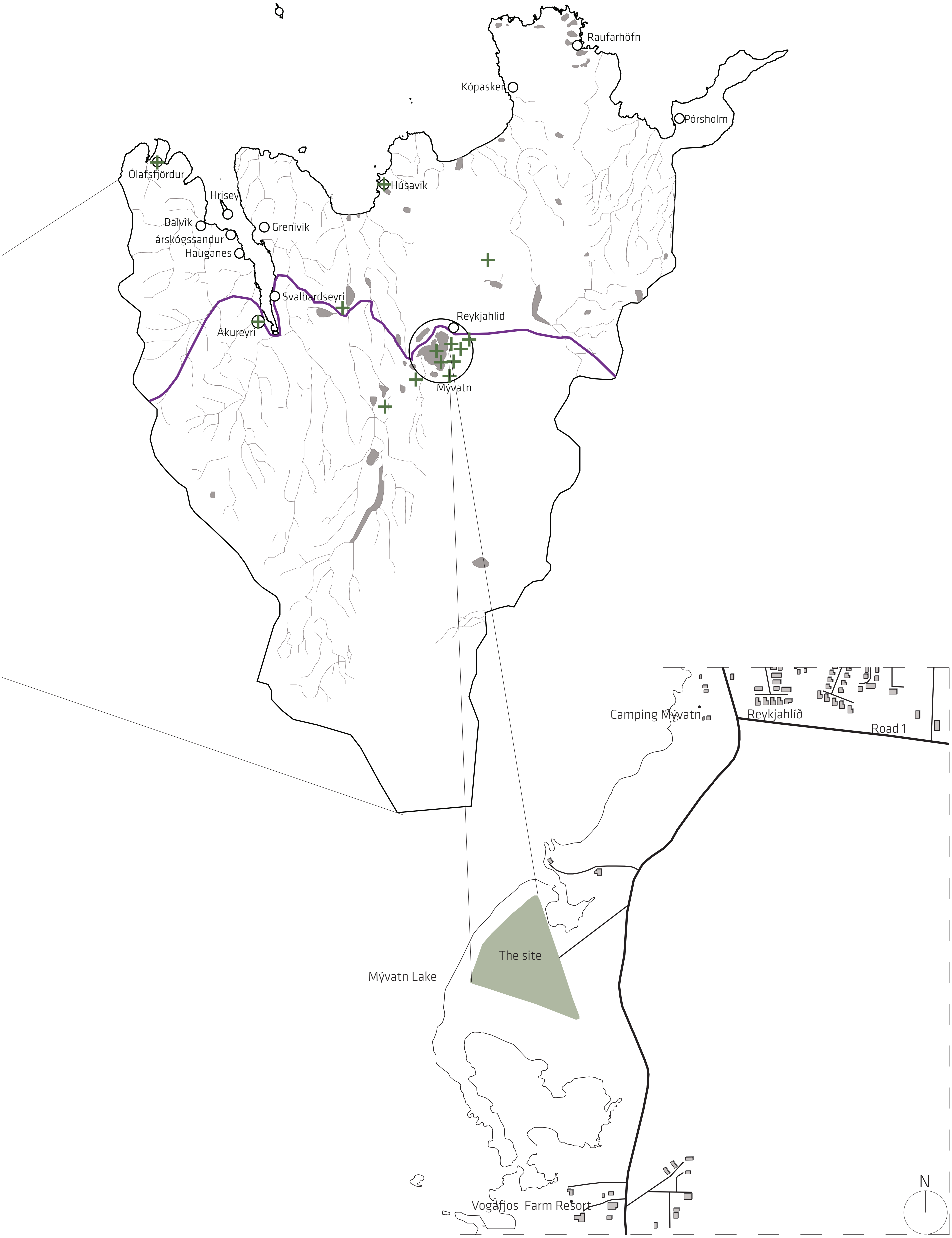
LOCATION

The site is located in the northeast region called Norðurland Eyestra, which is on the opposite side of the capital of Iceland, Reykjavik [Iceland Northern Lights Rooms, 2017].
The site is 92548.9 m2 (9.25 hectares) and is located just 105 kilometers south of the Arctic Circle. The site is placed adjacent to the popular Mývatn Lake, which are with the surroundings one of Europe's greatest natural treasures. The lake has around 40 islands in it and many bays on the coast, where the site is located in one of the bays [Iceland, 2018].
The nutritious lake and the wetland surroundings, which also are an active volcano area, are a very popular area for fish, water birds, especially ducks - but also mosquitos, which the lake is named by [Iceland Northern Lights Rooms, 2017].

On the southern side of the site, is the big old Krafla volcano, which was created for 2300 years ago by large lava eruption and had its the last eruption in 1984. Near Krafla lays the geothermal power plant Kröflustöð, and the Bjarnarflag Geothermal station. Even though the site is located in the northern highlands, has there always around Mývatn been a relatively high inhabitant, cause the high wildlife to the lake. Just north of the site, around 1.5 kilometers, is the city Reykjahlíð, which are a small town, where they have recovered minor [Iceland, 2018].

One of the major tourist attractions in the area is Dimmuborgir, which is an area of huge lava formations, is located 5 km southeast of the site [Ferdamalastofa.is, 2018]. When arriving at the site from Akureyri, the biggest city in this part of Iceland, the main road takes the tourist pass Dimmuborgir, where the dark lava stones are on each side of the road. Dimmuborgir means dark fortress [Mývatn, 2018].
In the Dimmuborgir area the lava stones are several meters tall and by walking on the paths in this area, our experience is that we felt small and amazed by these dark, almost black, lava formations. After having walked in this area for a while, then we walked back to the car that was parked on a hill, where the horizon with its volcanos and mountains was visible again.

▲ *Ill. 44.1: The regions of Iceland*
▶ *Ill. 45.1: Nordurland Eystra*
▶ *Ill. 45.2: The site and its nearby city, Reykjahlíð*

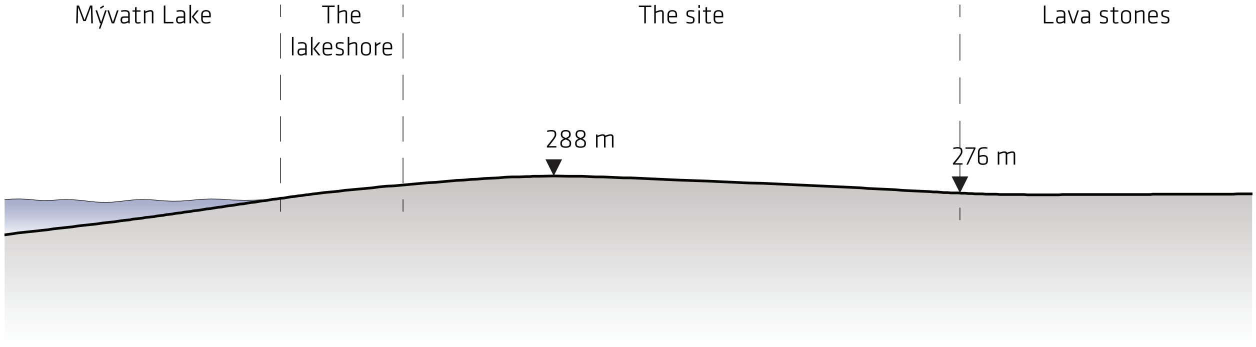

Raufarhöfn
Kópasker
Þórsholm
Ólafsfjördur
Húsavík
Hrisey
Dalvík
Grenivík
árskógssandur
Hauganes
Svalbardseyri
Reykjahlid
Akureyri
Mývatn
Camping Mývatn
Reykjahlíð
Road 1
The site
Mývatn Lake
Vogafjos Farm Resort
N

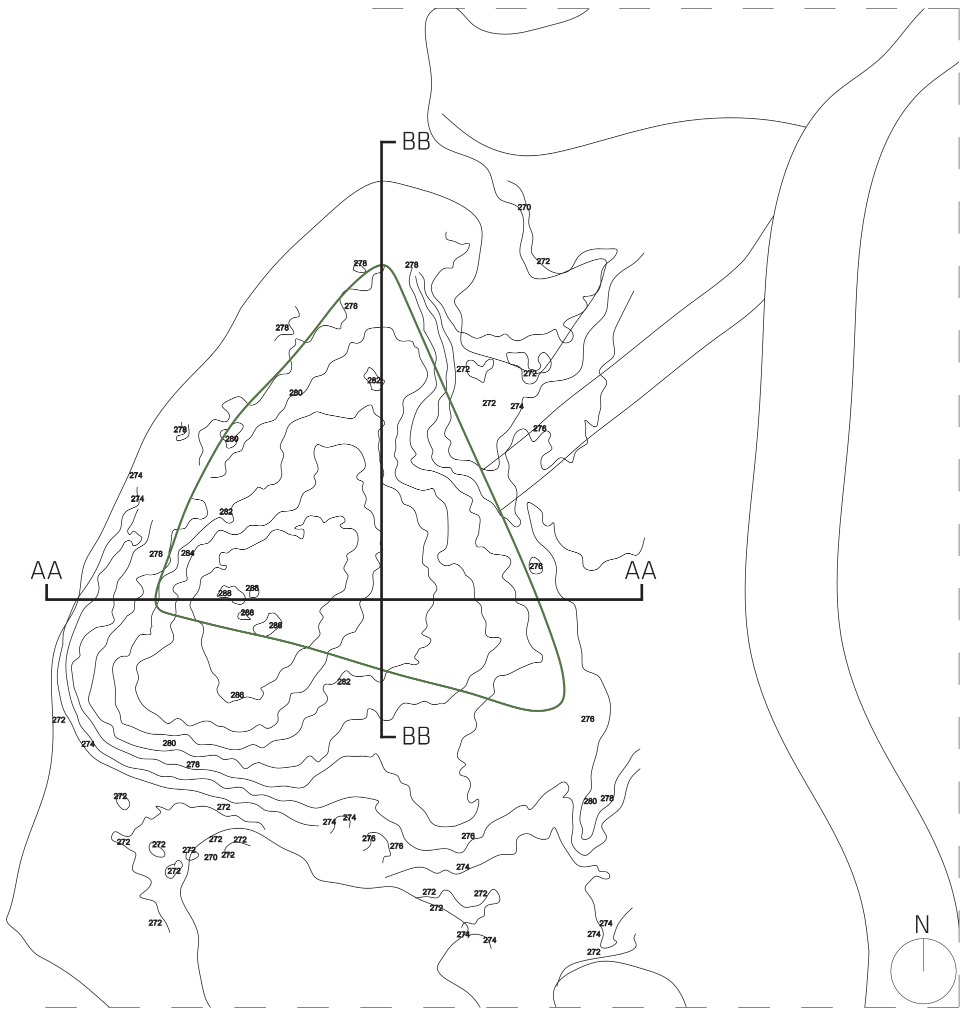
TERRAIN

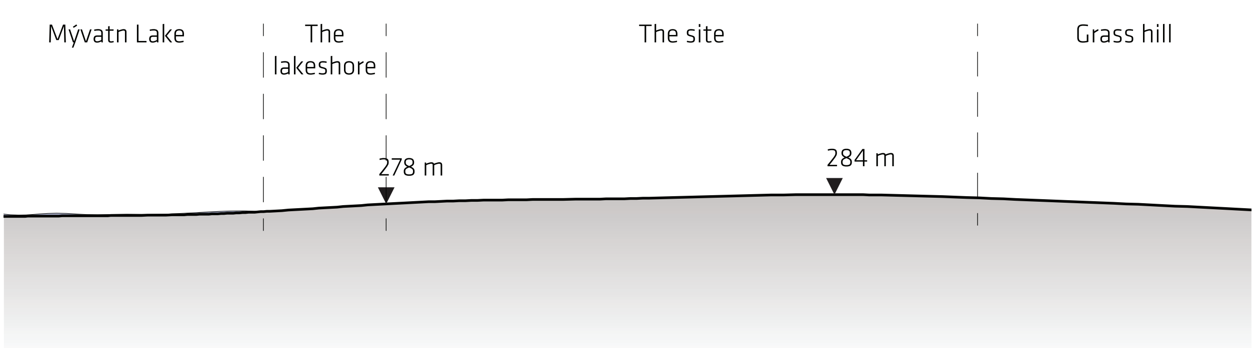
The site's terrain is shaped like a smaller hill, where the lowest point is at the northwestern corner and follows the edge of the site around to the southeastern side. From this side of the edge, the hill creates its slope, and are peaking at the southern side of the site.
From the lowest point, the height quota is 272 meters above the ocean. The highest point is at quota 288 meters above the ocean. That makes a height difference of 16 meters at the site, but in most cases, the difference is at 12 meters.

The site's driveway consists of 1100-2800 year old lava, while the site it self is made of tuff. Tuff is combined and hardened volcanic ashes, so it is a solid mass. The area with tuff begins when the hill begins to increase in height - so a bit larger that the site's area [Thordarson and Hoskuldsson, 2002]

▼*Ill. 46.1: Section AA-AA from West to East, 1:5000*
▶ *Ill. 47.1: The site with its typography*
▼ *Ill. 47.2: Section BB-BB from North to South, 1:5000*




BB
AA
AA
BB
N


Mývatn Lake
The lakeshore
The site
Grass hill
278 m
284 m

OUR EXPERIENCE

In the end of January, we went to Iceland to experience what the users' of the guest houses would and to study the site and its surrounding nature. The site was visited a day with -20 degrees Celsius and almost a clear sky with a low wind rate. The site was covered in almost knee high untouched snow.
We used our own senses to make a phenomenological analyze on the site during our stay, based on inspiration from Pallasmaa - how he describes experiencing architecture with the human's senses [Pallasmaa, 2013]. This analysis will be used when designing the buildings and their placement and orientation on the site.

SIGHT
At first, it was very difficult to find the entrance to the site due to the tall trees along the road, where the entrance was a bit hidden. A morning fog hovered over the site making it almost invisible from the road. On the other side of the entrance were shelters for sheep in a fenced area.
The first meeting with the site, was the long driveway which has big lava stones on each side in different shapes and sizes, due to the site is located in the Dimmuborgir area. The driveway itself is in contrast to the lava stones by being the surface is even as it is made of grass. Along the driveway is part of Lake Mývatn visible in a small inlet, and due to the cold, the water created a steam on top of it.
The building site is located at the end of the driveway as a smoothly curved hill and seems tall from the driveway. During a walk along the building site's boundaries, a more and more beautiful landscape was revealed. Due to its direct location to Lake Mývatn the view is broad and many mountains and volcanoes are visible. It was difficult to choose the best view spot on the site because the view was amazing from all directions. You could see the steam from the hot nature bath several km away and the many resorts laying near the lake on the other side. Around in the landscape, the locals were out and enjoying the weather on their snowmobile and cross-country skiing.

HEARING
When standing on the site in the snow, almost no sound was to hear. The closest city is very small and a bit away. A few birds played in the lake's inlet, but no other animals were present that day. On the road, tourist buses drove their passengers to the different nature attractions in this northern part of Island, but the many trees functioned as a shelter of their sounds.
During the warmer periods of the year, more birds will probably be hearable and maybe also the sheep from the other side of the road.

TASTE
When breathing in this cold weather, all you could taste was the cold and humid weather. It could be hard to take a deep breath because of the cold temperature, especially if you were facing the wind direction.

SMELL
Along the driveway, the smell of seawater and seaweed was mild and fresh. On the Northern part of the site towards the coastline of Lake Mývatn, no specific smell was present, not even from the lake due to this part of it was completely frozen.
On the Southern part, the smell of sulfur is very strong. It smells like rotten eggs. It comes from the openings in the ground which this area is rich of.

TOUCH
The driveway was placed in the shelter of the wind and the closer and the more we walked up on the site's hill, the wind grew stronger. Even though the wind rate was very low that day, the wind became stronger on the site. Nothing gives it shelter, which makes the -20 degrees Celsius colder.
The terrain on the site's hill was a bit more uneven than the plane driveway, but nothing to compare with the lava stones next to it. The ground was hard and frozen. In general, on Iceland at not of sites and areas make use of horizontally placed pipes laid on the ground with a bit space between to prevent the animals from entering the area. This was also used on the neighbor's driveway.

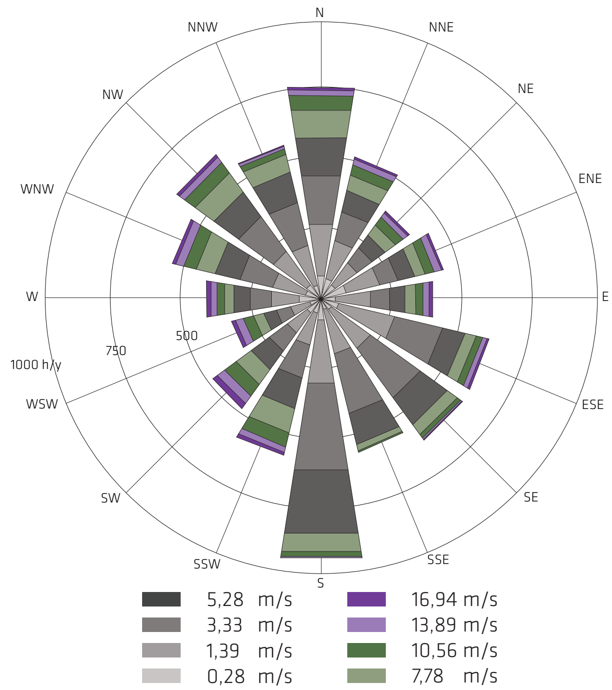
▶Ill. 49.1: Standing on the hill looking South, where a small resort and private homes are located
▶ Ill. 49.2: View to East of two volcanoes including Hverfjall opening up towards the site
▶ Ill. 49.3: The view from the drive way towards the site's hill
▶ Ill. 49.4: The beginning of the drive way looking at the site at the end, surrounded by lava stones and birch trees.




MICRO CLIMATE

The microclimate for this site is very extreme. The temperatures are low, and has primarily over casted weather with strong winds. The data for this analysis is made for the closest village, Reykjahlíð.
Since the site is placed on a hill with a minimal amount of shelter from the wind, it is highly affected by it. The wind comes primarily from South and second most from North. The strongest winds come from South West and in general, the most winds come from West. The mildest winds come from South South East.
It rains in every single month of the year on the site with more than 40 mm precipitation, except for June with it's 30 mm rain. The rainiest month is October with 84 mm.
If only looking at the mean temperature for every month, the lowest is -7 °C in January and the highest is 14 °C in July. The hottest day is also in July with 21 °C and the coldest night is -17 °C in January [meteoblue, 2018].
In Reykjahlíð the amount of daylight during the summer and winter time is very different from one another. June has less than 30 minutes of civil twilight [Timeanddate.com (2), 2018], which is where it's the beginning of becoming dark, but you can still see and navigate, so artificial lights are not yet required on vehicles [Timeanddate.com (1), 2018]. In December only three hours of daylight and two hours of civil twilight, whereas the rest of the twilight is so dark, that artificial lights are required on vehicles [Timeanddate.com (1), 2018] and 13 hours of the night in total darkness [Timeanddate.com (2), 2018].
More than of half of each month is overcast – except for June where 12,5 days are overcast. In average 14 days per month precipitation happens, whereas most of it in November to February is snow. It can start snowing in August and primarily ends in June. The most amount of snow occurs in March [meteoblue, 2018].

This analysis will be used to make careful consideration, of how the guest houses and the main house can achieve the wanted atmosphere, with the very different amount of daylight in the summer and winter time. The wind speed also needs to be taking into account, to avoid making the wind speed even stronger with wind tunnels, and to make sure that the users can get in and out of their house easily.



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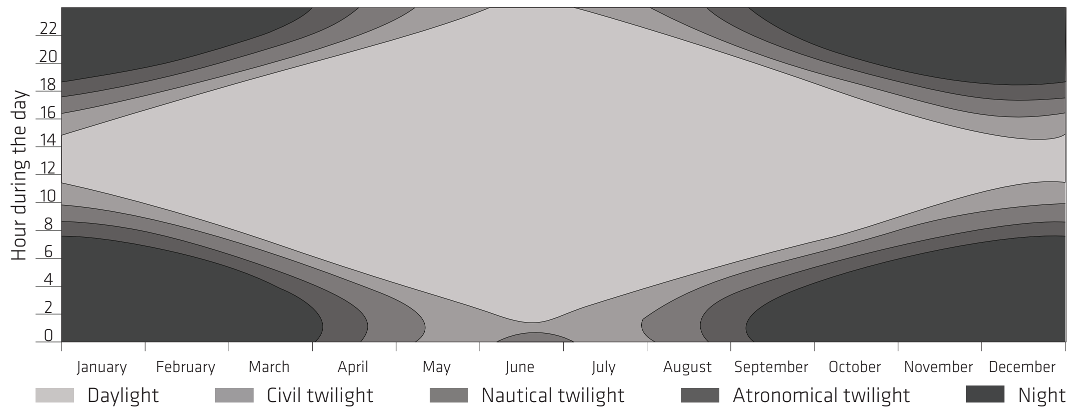
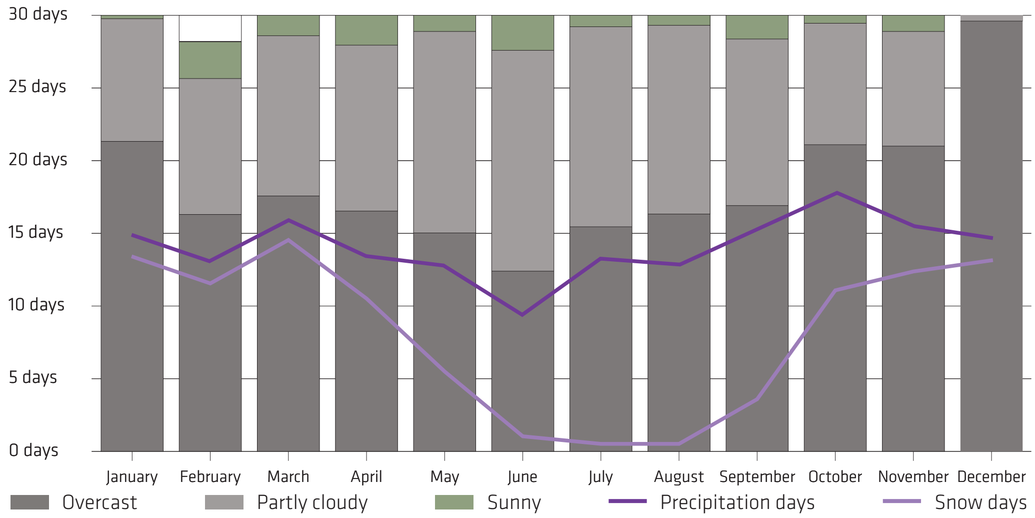
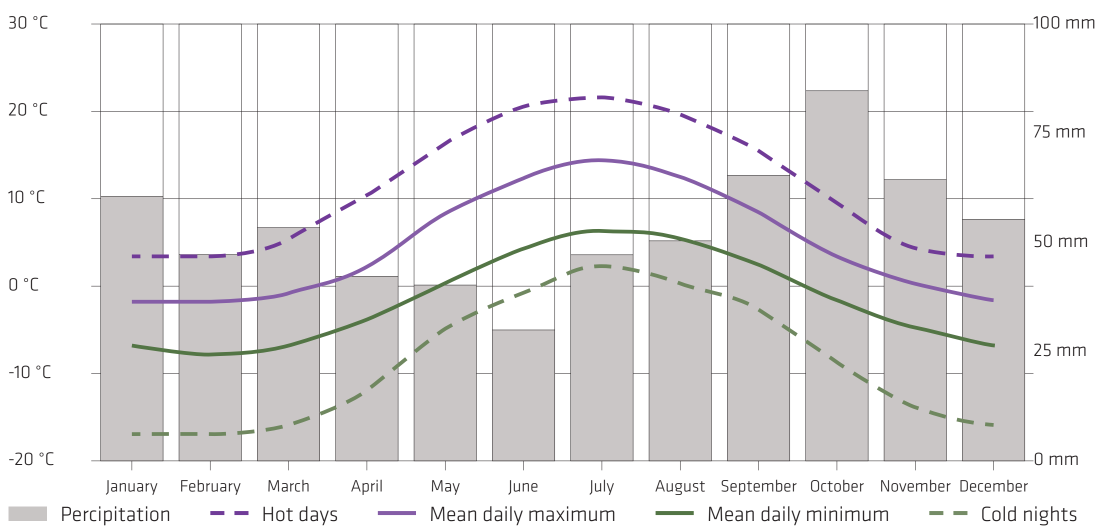






◀ *Ill. 50.1: Windrose for Reykjahlíð*
▲ *Ill. 51.1: Daylenght diagram for Reykjahlíð*
▲ *Ill. 51.2: Sky and precipitation diagram for Reykjahlíð*
▲ *Ill. 51.3: Temperatures during a year in Reykjahlíð*

LIGHT AND ICELAND

Iceland has a huge contrast in the amount of daylight during the summer period versus winter; almost no darkness in the summer period and only a few hours of sun in the winter [Timeanddate.com (2), 2018]. Since the site is located in the northern part of Iceland, the sun is very low during the winter where the lowest altitude of the sun is 1° on the 21st of December [Timeanddate.com, 2018 (3)]. In the summertime, the sun is higher in the sky, where the altitude is 48° on the 21st of June [Timeanddate.com, 2018 (4)].

The way the sun moves high on the sky with a midnight sun during the summer and very low sun in the winter, create two very different kinds of shadows of the surroundings and buildings.

During the winter months, the low sun creates long and dark shadows – together with the white snow the low sun's light is reflected from the ground to the building, creating shadows above the object rather than under as usual. The snow also attributes to creating more light during the dark months [Plummer, 2016]. In the summer the midnight sun appears creating an "unreal haze that bathes the land in a fairy-like glow, its colors strangely muted and blurred" [Plummer, 2016, p. 6].

▶ *Ill. 53.1: Light hitting mountains*

VEGETATION

As mentioned early, the entrance to the site is a long driveway made of grass where both sides of it are covered by huge dark lava stones, as the ones in the Dimmuborgir area. The site itself is covered by tall grass growing wildly. On the site no flowers or trees are growing, but along the driveway some birch trees grows [Iceland Northern Lights Rooms, 2017].

▶ *Ill. 54.1: Tall grass is the only type of plant growing on the site*
▼ *Ill. 54.2: View from the drive way covered in snow, where the dark lavas tones still peeks out here and there*
▶ *Ill. 55.1: At the boundaries of the site the lava stones meet the grass field*
▶ *Ill. 55.2: Birch trees and lava stones near the drive way*

MATERIAL RESSOURCES

One of the main factors to find the most sustainable Cradle to Cradle certificated materials for this project, is that the site is located on Iceland. This limited some of the options because Iceland doesn't produce or have the natural material and are instead needed to transport to the island.

For the structural systems the following tree materials have been studied: Wood, steel, and concrete, through local materiality and according to LCA.

STRUCTURAL MATERIALS

WOOD

Wood is one of the oldest building materials in Iceland and has once covered the island with 25 – 40 percent of willow and birch. This was before the settlers arrived and some of the main lava eruptions. Today there is just around two percent left, and Iceland has therefore planted new areas for the future, so the percentage can increase. So even though, that wood normally is the most sustainable material, by having the lowest CO2 emission and long lifetime, it would not be very sustainable to use some of the wood that is left, or even worse, to get it transported with a ship or airplane, since the sustainable solution kind of disappears [Vidste du at, 2018].

STEEL

One of the biggest material resources in Iceland is steel ore. The production of steel and digging after ore, has become so big, that it is the country's next biggest export material, right after aluminum [Karlsson.dk, 2018]. But according to the economics aspect in the sustainable circle, and the need of extra material for cladding the structure, and the total CO2 release for the buildings lifetime, the material has been down priorities.

CONCRETE

Today one of Iceland most used and locally produced building material is concrete. Concrete is compared to the two other materials, the one with the highest CO2 emissions for the production. By looking on the material through a sustainable aspect, compared to steel and wood, concrete is for this project the most sustainable solutions by looking at the social impact by using a local material, the lifetime, and the economics. According to the environmental effect, concrete has tried to be improved, because the half of all the CO2 emission comes from the cement production.

So, by using less cement, and instead use some material waste such as ashes from lava or example wastewater sludge with the same durability, the concrete can be even more sustainable [Teknologisk.dk, 2018].
The life cycle for concrete has a positive influence on the environment, because the material through its lifetime and especially when it is going to be demolished, decreases CO2 from the air [Gronbeton.dk, 2018]. Through the Cradle to Cradle studies it has shown that the decreasing of the CO2 is so big, that by recycling concrete as for example for roads or other elements, the new elements production will have a lower CO2 emission, but especially in the recycling process, a lot of CO2 is engulfed. [Gronbeton.dk, 2018].
That means that even though normally concrete has the biggest CO2 level release through the production, will the concrete through its lifetime have a positive impact on the CO2 level. Therefore, when the CO2 emission is calculated for concrete, the number is too high [Gronbeton.dk, 2018].

INSULATIONS TYPES

Instead of just using mineral or glass wool which is common, more sustainable solutions have appeared, like wood fiber, flax, paper wool or seaweed. But the materials' insulations ability, moisture holding, the shapes durability and the treatment has a big effect on how sustainable the materials are [Grønforskel.dk, 2018].
With inspiration from one of the following case study, The modern Tanghus, where seaweed is used as an insulation material, seaweed will be used in this project.
Eelgrass or seaweed is natural good insulated and sustainable material, with a long lifetime. It has just given the gold certification Cradle to Cradle materials [Vugge til Vugge ApS, 2018].
It grows on the sand in the ocean, where there is low tide. It is most able to be found in the Atlantic Ocean, between Northern America and Scandinavia and down to the middle east.

Instead of letting the seaweed lay along the coast to rot, which release CO2, the seaweed will be sampled by hand to dry, where it afterward is stuffed into thin fykes made of strong wool yarn and are afterward ready to be used as insulation. This new life cycle for the seaweed makes the emission decrease in its CO2.
The salt from the ocean naturally impregnates the seaweed against sponges. This gives the material a good fire resistance [Nielsen, Klebak and Søndermark, 2013].
Using seaweed as a building material, is an old tradition in Læsø in Denmark, and are for now still only being produced in Denmark. Using the seaweed as an insulation material is still so new it will recourse for this project, that few people from Denmark with the knowledge about the process and the skills are flown to Iceland to teach and pass their knowledge on to the icelandic builders.
As Real Dania say, which have been part of the process for The modern Tanghus; "It wood be amazing, if we

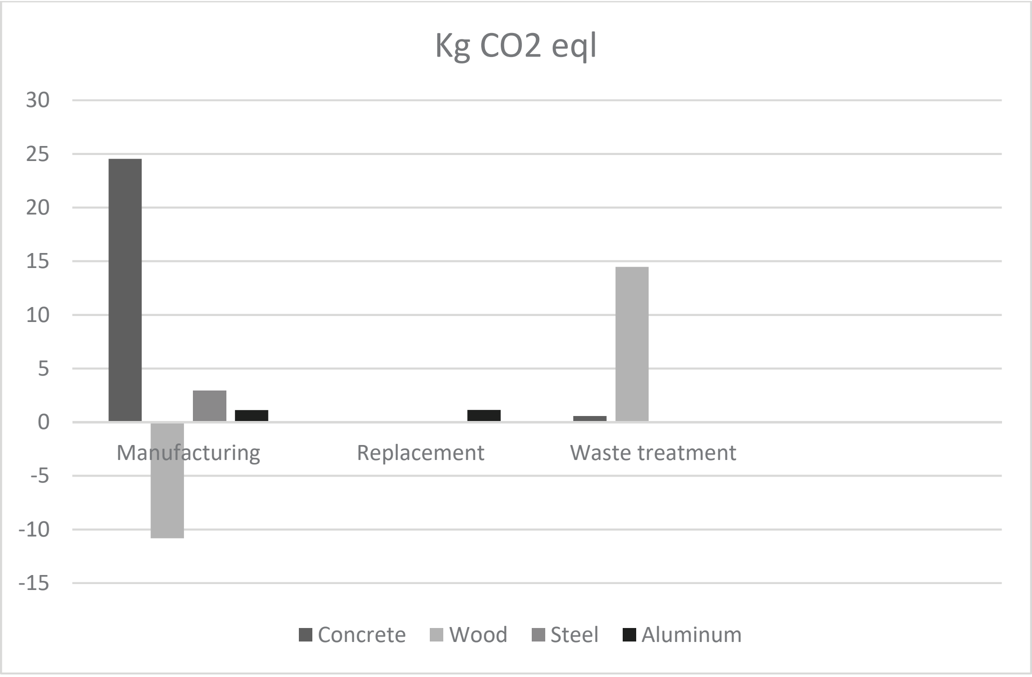
could get the seaweed insulation out on the worldwide marked as mineral and glass wool"[Realdania.dk, (2018)]

FACADE CLATTERING
CORRUGATED ALUMINUM
Through the study trip to Iceland, it was noted that many houses were using corrugated aluminum as a facade clattering, and therefore to the upcoming façade studies, corrugated aluminum is being looked at according to the resources and the weather conditions.
Aluminum is Iceland's biggest export, and there are now several factories on the island, where one of them is very near the site, they are producing aluminum with a sustainable approach [Alcoa.com, 2018]. Because of Iceland's renewable resources for the production of aluminum, the energy consumption for one-ton aluminum is the same energy amount that one 60 watt light bulb uses in 60 years [Fysik-kemi.gyldendal.dk, 2018].
Aluminum has a good durability, as it creates a thin transparent surface, that prevents a direct contact with water. Should this surface get any scratch, a new surface will immediately be created [Brixgaard.dk, 2018].

The difference on a flat aluminum clattering vs. corrugated aluminum is that the durability through the waved structure of the corrugated aluminum is stronger. The lifetime is around 50 years without any maintenance and only one coating, and is designed to resist many extreme types of weather conditions, that normally will destroy other materials [Sidabarn.com, 2018]. With the close connection to Mývatn Lake and the placement in Northern Iceland, the aluminum will not be affected more than in normal condition, because there is no salt in the water or nearby, which will affect the materials correction speed [AMU VEST]

Aluminum is a very good material to recycle and with the materials properties it can be recycled over and over again, which match to the Cradle to Cradle principle. Calculations show that 75 percent of al aluminum there ever have been produced, is still in use today [Alumeco.dk, 2018]. In the recycling process, the energy consumption is only 5 percent for the melting process than normal. This decrease 95 percent CO2 emission [Triplan.dk, 2018].

▼ *Ill. 57.1: LCA of materials thorugh CO2*



SUPPLY

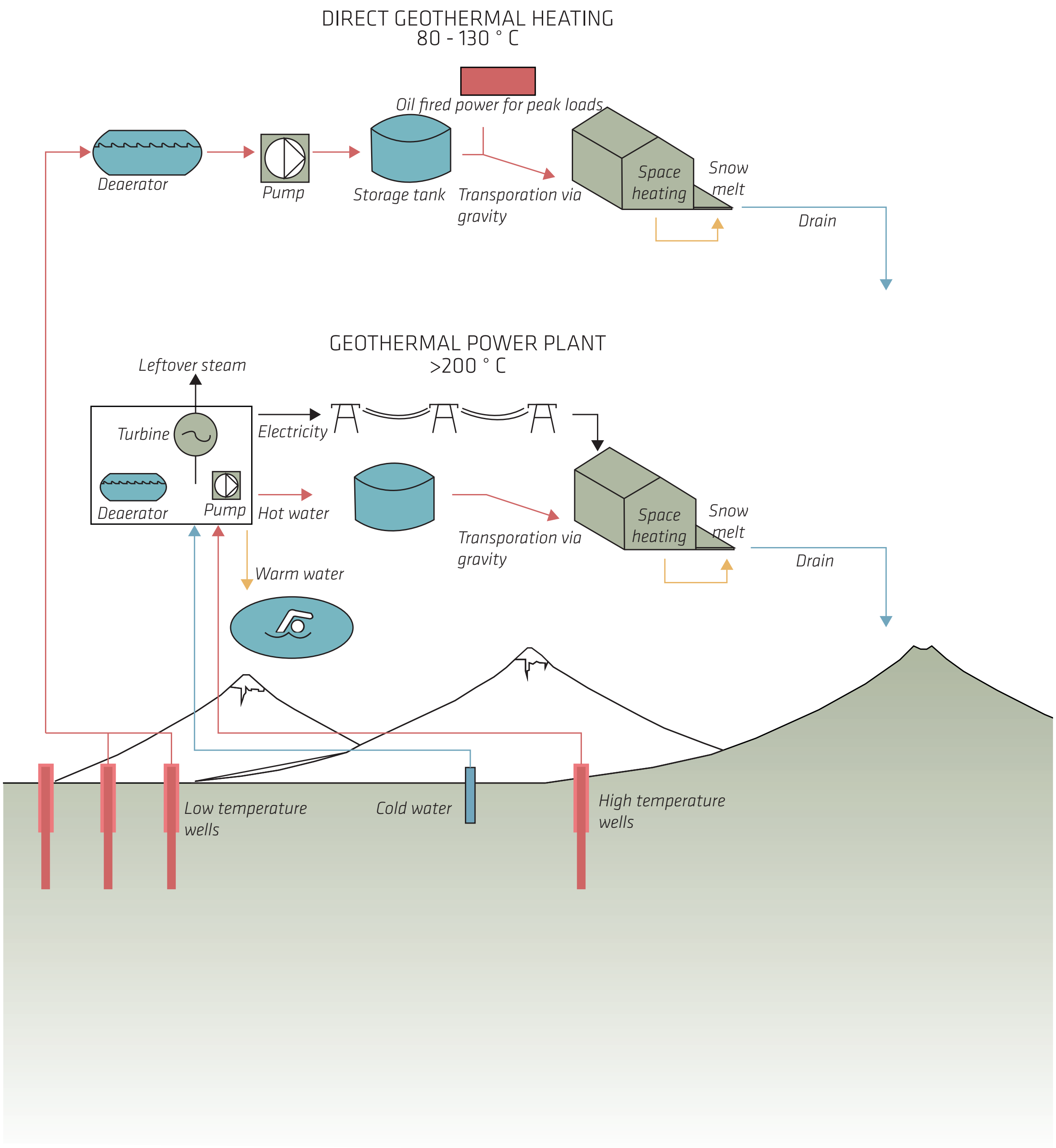
One of the themes for this project is sustainability including the Cradle to Cradle principles, so therefore it is important to know how the buildings on the site are going to be supplied. Since Iceland is being supplied with electricity and heat from renewable resources using geothermal power stations and hydropower plants, they make enough to sell without harming the nature, that is the choice for this project.

The electricity will come from the local geothermal power station, Bjarnarflag Power Station, which is in a geothermal area, 1,5 km from the site. At this power plant, electricity, heat and hot water are produced in different ways, but they are all started by pumping hot water up from the ground.
The water is groundwater, that comes from the high amount of rain and melted snow that slowly runs through the many layers of lava stones and are being filtered, which makes the groundwater clean. The hot geothermal heat makes the water very hot, and after it has been pumped up, the stream runs through a turbine, that produces energy and is sent to the consumers through wires [Mmillericeland.wordpress.com, 2011].
The cold drinking water comes from clean groundwater, which supplies 96 percent of the Icelandic population. The groundwater comes from non-geothermal areas and do not smell of rotten eggs, but should instead be one of the cleanest and delicious kinds of water in the world. The water supplies the nearby city Reykjahlíð and the water pipes run under the pavement, which can be lead to this site as well [Ibcbeverage.com, 2014]. The water comes from old glaciers that have been filtered through many layers of soil, then pumped up and sent directly to the user [Interview, see appendix].

The hot water will be sent out to the consumer, where it will heat the radiators first and then used as the hot water in the water tap [Interview, see appendix]. It will also be used for showering, which is why many of the showers' water in Iceland smells like rotten eggs, due to the high amount of sulfur in the geothermal water. Near this geothermal power station is Mývatn Nature Baths located, where the leftover of hot water fills up the pools [Mmillericeland.wordpress.com, 2011].

For toilet flushes different sustainable solutions can be possible for this project. Due to the high amount of rain, the rain can be collected and stored, and used for toilet flushes when needed – so can defrosted snow. Another solution can be to use grey water, which is the leftovers of water from showers and sinks. The building's site will be connected to the sewage system that runs under the pavement of the streets [Mmillericeland.wordpress.com, 2011].

▶ *Ill. 59.1: The production from geothermal areas*


DIRECT GEOTHERMAL HEATING
80 - 130 ° C
Oil fired power for peak loads
Deaerator
Pump
Storage tank
Transporation via gravity
Space heating
Snow melt
Drain
GEOTHERMAL POWER PLANT
>200 ° C
Leftover steam
Turbine
Electricity
Deaerator
Pump
Hot water
Transporation via gravity
Space heating
Snow melt
Drain
Warm water
Low temperature wells
Cold water
High temperature wells

CHAPTER CONCLUSION

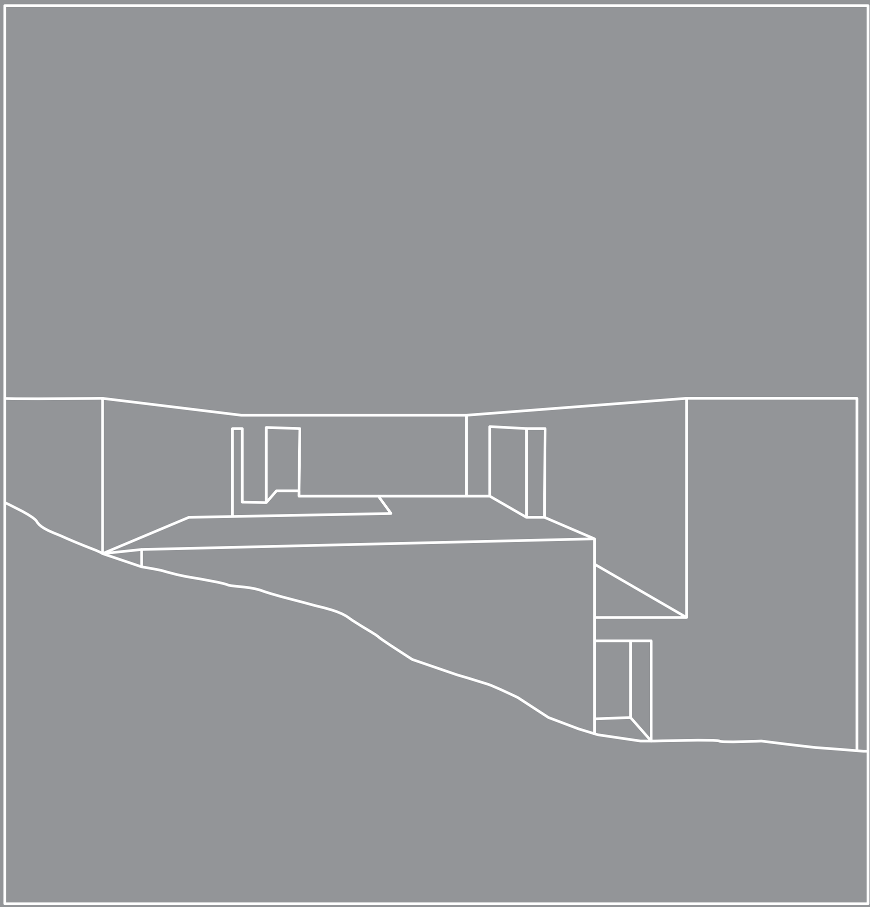
The site is in the northern part of Iceland near the Akureyri, one of the bigger cities in Iceland. Near the area is a geothermal area with its own power station, Bjarnarflag [Iceland, 2018]. These power stations use the hot water from the ground to create electricity through a turbine. After been through the turbine, the water will be used for heating in houses and industries [Mmillericeland.wordpress.com, 2011].

Arriving at the site from Akureyri, the guest will pass the area of Dimmuborgir, which is an area of old lava formations. The stones are dark and full of curves, and they cover both sides of the driveway to the site [Mývatn, 2018]. The site is not covered by these lava stones, but of grass. The site is a hill with a 16 m height difference. By being on the site ourselves, from when we went on a study tour in January, we experienced the amazing view from the top of the site. The site is located near Mývatn Lake, so to the west of the site, the lake is visible. In the horizon mountain and volcanos are located. We used our senses to explore the site to get an understanding of what the guests of the cabins would experience. The day we went there was the temperature -20 °C with a very low wind velocity. During a year the average temperature is between -7 to 14 °C. The wind can come from all directions, but mainly from the south and north. More than half of each month is the sky overcast, and which creates a grey-ish diffused daylight.

A Life Cycle Assessment analysis of wood, steel, aluminum and concrete was made in relation to the factor of where the material will be produced. Transporting materials to Iceland is very hard for the environment due to the CO_2 emissions of ships and airplanes. For insulation seaweed and examined as well.

chapter four
case studies

These following case studies are used as an inspiration for our project. To get acknowledgment and tools to enhance
the final project. The following case will be Thermal Vals, represent as a case, with focus on the use of light, material to enhance an atmosphere. The Kakslauttanen Arctic Resort is a case, to get inspired by another resort with the focus to experience the Northern light from the bed. The last three cases are how the Cradle to Cradle strategy is used in building certification on materials and the use of the principles.



THE CASE

THERME VALS

By Peter Zumthor
Location: Graubünden, Switzerland
Year built: 1996
Type: Spa

When Zumthor designed the project, he was inspired by the surrounding nature; Vals is in a valley with mountains on each side and has a minor river runs through. The spa is located on a steep site on the beginning of a mountain, where Zumthor designed the building half-buried in the hill with grass on the roof.
The concept for this project, was to make the spa's structure look like a cave or quarry in relation to the local quarry Valser Quartzite. Its structure is made of solid concrete walls, whereas the cladding is made of long, horizontal cuts of the quartzite stone from the before-mentioned quarry. These stones are placed as if they were formed on the wall by the nature. Zumthor design the pattern of the stone walls in a regular order of three different heights, but initially looks random stacked. This system is used on all the walls in the building.

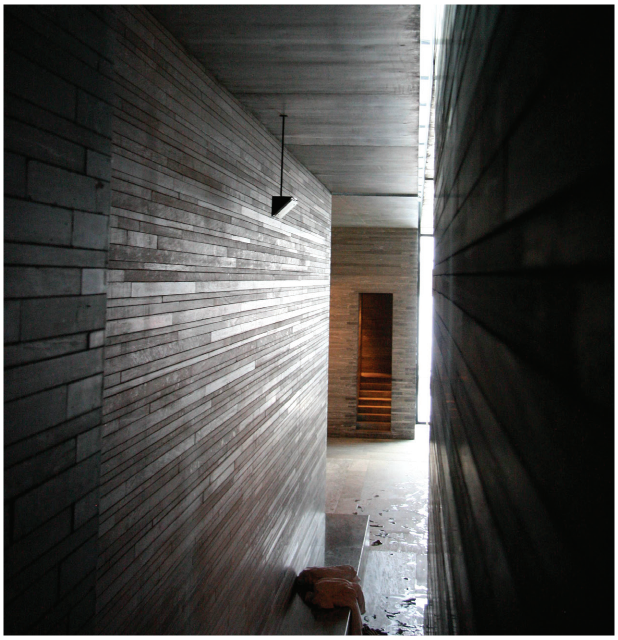
"Mountain, stone, water – building in the stone, building with stone, into the mountain, building out of the mountain, being inside the mountain – how can the implications and the sensuality in the association of these words be interpreted, architecturally?
The whole concept was designed by following up these questions; so that it all took form step by step" - Peter Zumthor [ArchDaily (1), 2009]

The building is 58 m wide and cuts 34 m into the mountain's hill side, but is barely noticeable from the hotel that the spa is made to. Since it is built into the hill side, the view from the hotel is only the roof and part of one the many stone wall, that looks natural in this context due to the local materials [WikiArquitectura, n.d.].
The roof is covered by grass, except for where the skylight windows are placed. These windows refer to the long, horizontal stones used for cladding, but also make a resemble to an archaeological site by the windows looking like a foundation. The windows are placed along the walls of the various baths, so by the view of the roof is the plan layout of the spa indicated [Archello, n.d.].

The plan layout of the building was made with careful considerations, of how the light enter the building and where it creates shadows and darker areas. Along the façade is floor to ceiling windows, where the visitor can enjoy the view of the valley from loungers. To create this sensuous experience, Zumthor stops the light from entering to far into the building, by placing the bath's walls opposite the windows. This creates a variation of shadows and lights when walking through the spa.

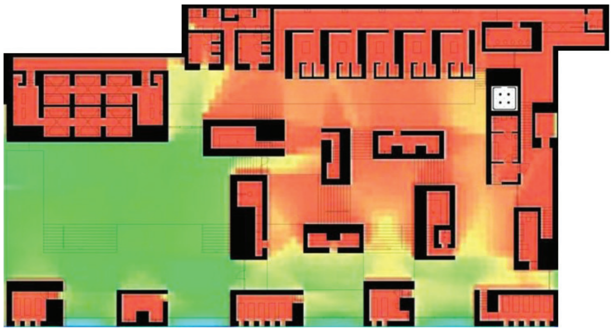
The skylights in the ceiling creates a small amount of light along the stone wall, where their texture is highlighted, but they also guide the visitor through the spa and creates movement.
Zumthor wanted the visitor to be moved and have a sensuous experience, which is the reason why he wanted to visualize as little technology as possible, except for a few soft-lighted hanging lamps and lights in the pool. To rediscover the ancient way of bathing, and being surrounded by the stones, the water, the light and the beautiful nature of Vals [WikiArquitectura, n.d.].

▼ *Ill. 64.1: The light from the large windows attract the visitor to move towards it*
▶ *Ill. 65.1: The narrow sky lights guide the visitor*
▶ *Ill. 65.2: The large windows give a nice view but also a lot of light on the hall ways, where entry to the various baths are possible*
▶ *Ill. 65.3: The building is half buried into the hill side*
▶ *Ill. 65.4: The green roof with its skylights that mimic the plan layout*
▶ *Ill. 65.5: An illustration of the amount of daylight in the building*









KAKSLAUTTANEN ARCTIC RESORT

By: Jussi Eiramo
Location: Kakslauttanen, Finland
Year built: 1999
Type: Resort

At Kakslauttanen Arctic Resort in Finland, the home for the unique Glass Igloos and Kelo Glass Igloos are located. Both types are designed to explore the Northern light from the bed. The first prototype was built and designed by the owner of the resort, Jussi Eiramo. After some few trials of the prototype, Eiramo together with local's Finnish construction professionals built the Glass Igloos in 1999. Today there are altogether 65 glass Igloos, where 53 are small and designed to accommodate two people, and 12 larger ones recommended for four people.

The Glass Igloos are constructed in a dome frame system covered with thermal glass, which also keeps the environment inside warm and the glass free of snow [Kakslauttanen.fi, 2018]. Each Glass Igloo has a storm flap in front of the entrance to create a shelter from the wind and snow.

The small Glass Igloos are furnished with two single beds and the possibility for a third one and a toilet, but no shower. The showers facilities for the small Igloos are at the main house. The lager Glass Igloos are furnished with four beds and a toilet with their own shower [Archello, 2018].

The newest hot facilities at the resort are the Kelo Glass Igloos, which are designed with the same concept as the Glass Igloos. The difference is that the Kelo Glass Igloos are a log cabin with much more facilities in it. They are equipped with their own sauna, toilet, fireplace and with the Glass Igloo integrated on one side of the wood construction.

The main house contains the guest facilities as restaurant, bar, sauna, shower, reception, etc. This is also the only place with TV and Wi-Fi, so the guest can be able to have a digital detox, and instead experience the nature [Kakslauttanen.fi, 2018].

VILLA ASSERBO

By: Eentileen
Location: Asserbo, Denmark
Year built: 2011
Type: Privat Residential

Villa Asserbo is a cradle to cradle designed cottage located in Denmark. It is the first digital built construction, with a big focus on the material choice. The building is built out of 400 cassettes in individual modules made of Finnish pin. Each cassette is constructed and designed with a joint system solution, so they easily can be fixed or moved to another place. This system makes the building process possible to be built without any cranes or any other heavy machinery.

Every decision through the project is made upon, that it only should be biodegradable materials, so all the used wood for the project comes from sustainable forestry. All the wood cladding outside is treated with Eco impregnation, where the inside cladding is treated with linseed oil and beeswax.

The building is isolated with wood fiber, which is pumped into every single cassette. This makes the building's environment healthy with no harmful degassing. The building's foundation is neither constructed by the tradition concrete but instead made as a point foundation out of 28 wood pellets, which easily can be pulled up of the earth again.

With these decisions has the finished building and the building process asmall influence on the surrounding environment and energy consumption under the preparation [Guldager Jørgensen and Lyngsgaard, 2013]

◀ *Ill.66.1: The igloos, covered in snow, placed along the path*
◀ *Ill. 66.2: The entrance to the igloos*
▶ *Ill. 67.1: The wood exterior of Villa Asserbo*
▶ *Ill. 67.2: The view from an internal opening towards the living room*

VILLA GRENAA

By: Loop Architects
Location: Grenaa, Denmark
Year built: 2017
Type: Private Residential

This private residential is built upon the cradle to cradle concept, with sustainable thoughts, decisions, and material choice. Especially the materials play a big part in this project, where it is possible, the materials are cradle to cradle certified and additionally the building will be able to produce more than enough energy than needed on the site [Looparchitects.dk, 2018].
The house are in the walls insulated with eelgrass, which are a very new technology with a certification on gold level [Vugge til vugge ApS, 2018 ,1]. The eelgrass is designed with the same attentions as normal mineral wool, but in a sustainable solution and with the same properties. It is the first insulation product in the world with a gold certification. Under the steel roof the roof is insulated with seaweed tuft, which have the same properties as the eelgrass [Vugge til vugge ApS, 2018 ,2].
The buildings facades are cladded with shou sugi ban wood, which means it is burned and waterproof at the same time [Looparchitects.dk, 2018].

TANGHUS

By: Vandkunsten
Locatioin: Læsø, Denmark
Year built: 2012-2013
Type: Private Residential

The modern Tanghus is a sustainable house with a negative CO2 level. The house is built in a new modern way of the old building tradition on Læsø, where seaweed was used as one of the main materials and used on the roofs. It has been just outside the door for free, have a good insulation ability and a natural impregnated for pests [Nielsen, Klebak and Søndermark, 2013].
The modern Tanghus, has adapted these traditions for the present, and by using few types of materials in a sustainable way, they have converted the seaweed to be used as insolation, interior padded clothing, and as outer visible facade clothing, the rest of the house will be built out of wood. Normally the seaweed would extract CO2 when it rots, but by letting it dry and use it as a sustainable building material, the material instead decreases the CO2 level [Nielsen, Klebak and Søndermark, 2013].

The house is built out of prefabricated wood cassettes for the roof, floor, and walls, wherein the seaweed insulations are placed. To control the seaweed, it is put into thin wool fykes made of strong wool yarn. By this method, it also reduces the mounting time. The seaweed in the ceilings are upholstered with flax linen and works as an insulating material with an acoustic damping way [Realdania.dk, 2018].

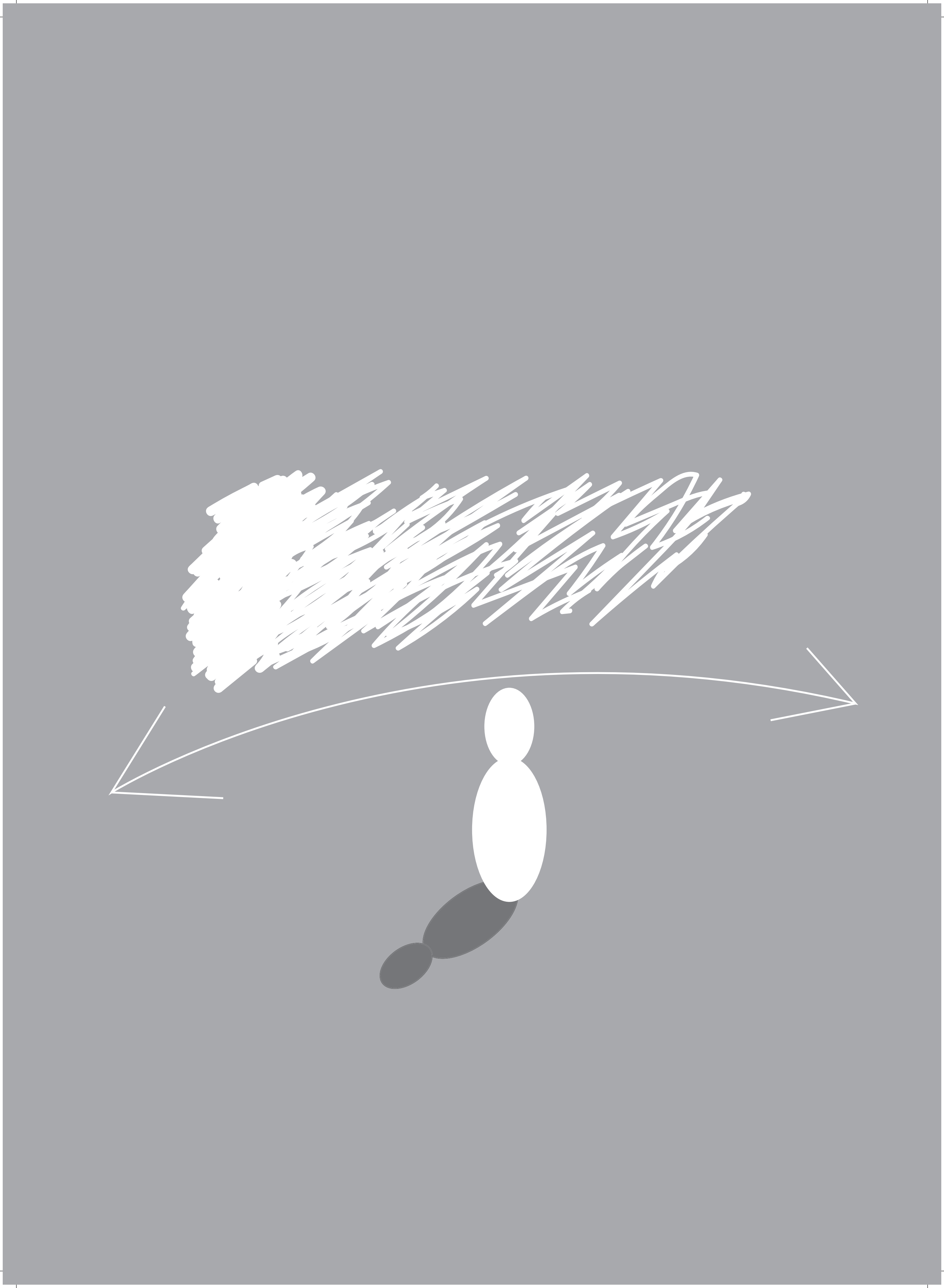
◀ *Ill.68.1: Exterior view of Villa Grenaa*
▲ *Ill. 69.1: Ceiling covered by seaweed and flax linen*
▲ *Ill. 69.2: Tanghuset with its seaweed roof*

CHAPTER CONCLUSION

In Therme Vals, by Peter Zumthor the guest is being guided through the building by the light. Lights are placed on the roof near the wall, so the guest will follow its direction, but also experience how the stone wall's texture seemed changed, due to its uneven surfaces is in focus by the enhanced shadows.
The Kakslauttanen Arctic Resort also focuses on the light – the northern lights. The entire roof is made of glass, for the user to be in their cabin and enjoy the northern lights from all directions.
The last three cases show how the Cradle to Cradle principles can be used. Villa Asserbo is insulated with wood fibre, Villa Grenaa is insulated with eelgrass while Tanghus is insulated with seaweed. These three methods are all Cradle to Cradle certificated.

chapter five
specifications

This chapter consists of three case studies, that relate to the themes of this project. The rest of the texts are explanations of what the project will result in – the different demands and flow of the rooms are shown in the functional diagram and room program. The analysis results in a problem statement and vision for the project. Design and energy criteria will guide the process and project.



USERS

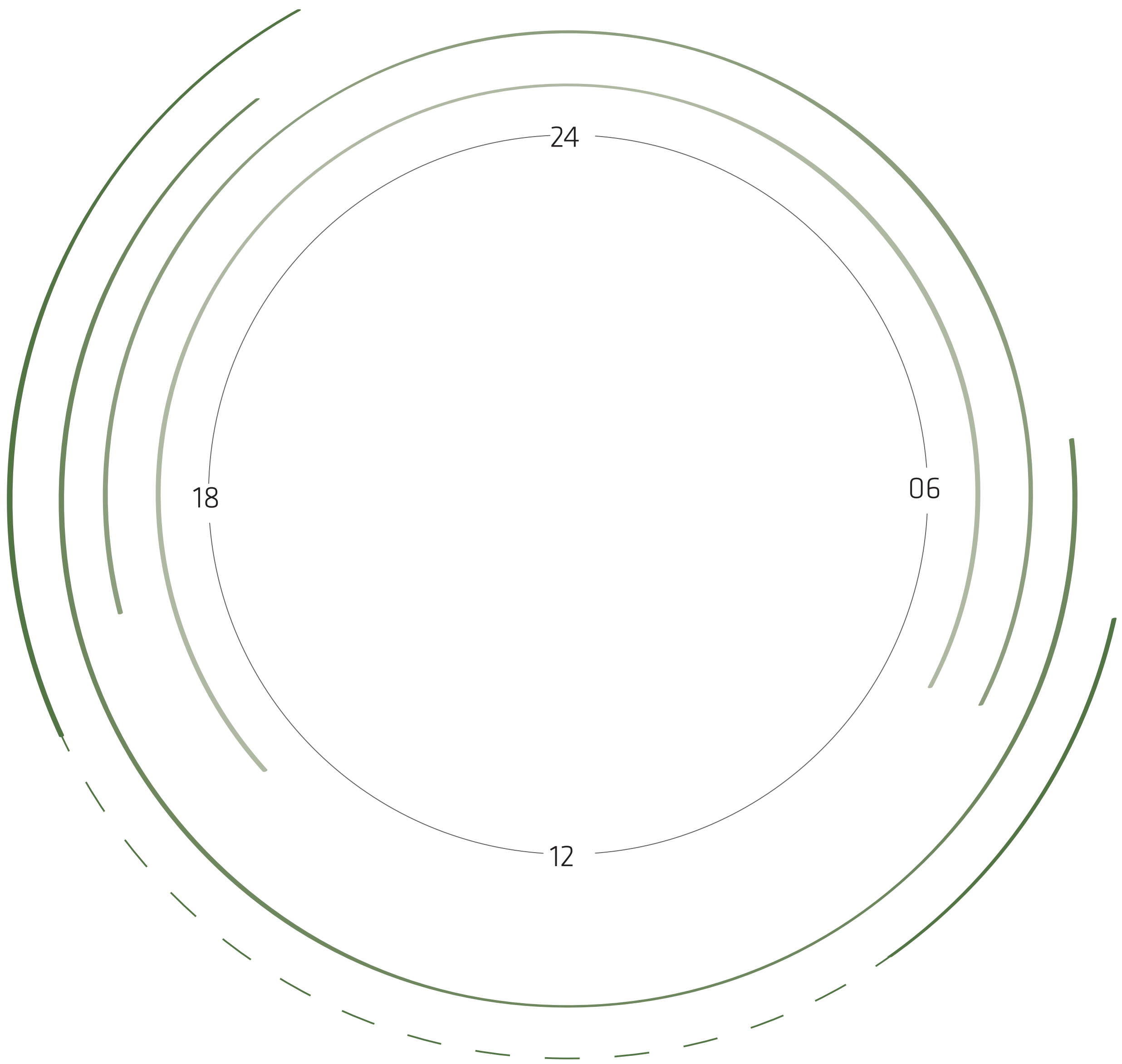
This guest resorts are going to host different types of users.
The first residential user is the host family. They are the owner of the hole place and are those who invite all the different types of guests into their home. The family is defined for the project as a family of four, consisting of two parent and two children. Regarding to a time schedule, it is assumed that the parents are working at the resort from 8-17 and the children are going to school from 8 – 15. This means that the family are gathered in the afternoons and evenings, and shall have common space in their home, where all members can be at once and spend time together, but also spaces where they have the opportunity for privacy. This also led up to, that the family needs in some way a privacy distance from the resort, so they can relax and feel safe. The rooms shall, therefore, be distributed after orientations, time use, view, and privacy.
By having the host family and the guest facilities at one place, the host family shall have an easy access to facilities, where the two functions in some way are melting together, but with a clear division.

The second user is the staff members. Besides the host family their works at the resort, there will be five staff members [Iceland Northern Lights Rooms, 2017]. These five members only work at the resort and live at another place.
From the time schedule, the staff members are at work from 6 – 22. Where they in the morning are making ready for breakfast for the guest and working too after dinner in the evening, where they in the meantime, are helping in the reception, cleaning and making the cabins ready for new guests.
Therefore there has to be incorporated some staff area and functions with an optimal flow, where the staff can relax, but also a place, where more functional things are coming through and gathered.

The last residential user, which is most important for the resorts, are the guests. These guests are staying at the resort, to explore the different types of light in the day and night time. And especially in the wintertime by the northern light from their beds and the other facilities. Besides the light, the resort is attracting guests to the resort, by the famous Icelandic horses and the northern Icelandic landscape. Based on statistics stating, the primally guests are tourists, were holiday was the main reason for foreigners to visit Iceland with over 90 percent. These statics also shows that the most primally type of tourist in Iceland is families or couples of different ages, and primarily are staying 2-4 night per place. [Ferdamalastofa.is 2018].
The guest houses shall, therefore, be designed to host different types and members, which led up to two-person cabins and the four-person cabins.
Both cabins will be designed after the light, so they are functional and cozy and at the same time and designed with a view of privacy and optimal exploring of the Northern Lights from the beds. The cabins shall be placed, so the guests are going up to the light to reach the main house, but with a distance of privacy from the other guests.

The guests time schedules are divided in two. One for the cabin use, and one for the main house.
It is assumed, that the guests are out exploring the tourist attraction nearby doing the day and are gathered at the main house for meals and social event the rest of the day before they are going to their cabins for relaxing and bed. That means that the cabins only are used from 16-8, where they in that period are using many of the hours at the main house.

▶ *Ill. 75.1: 24h diagram for when the different users are home*



Guests in Main Buuilding

Staff

Guests in Cabins

Familiy

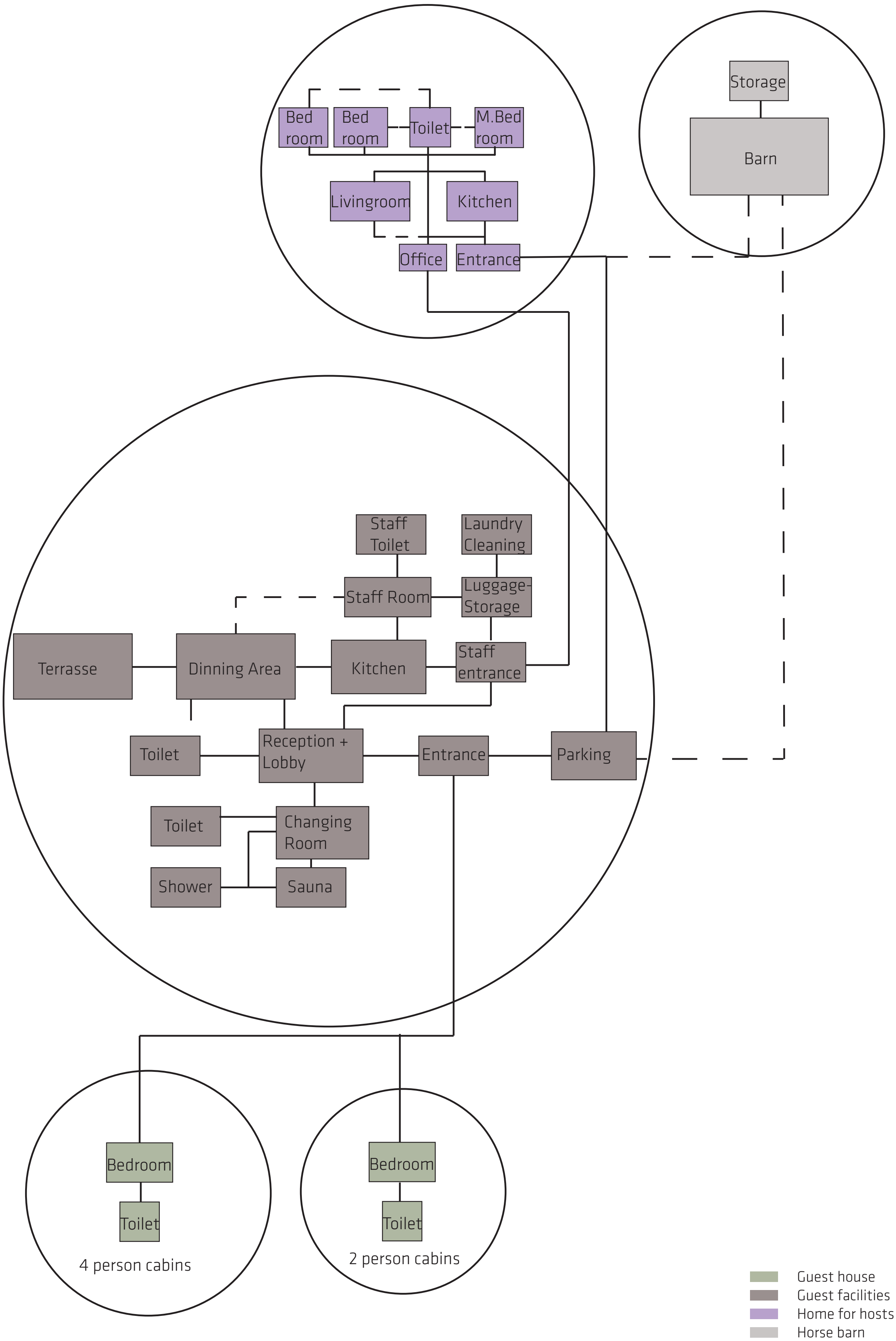
FUNCTION DIAGRAM

The guest houses' focus is to be an attraction of the experiencing the northern lights, and not just being an accommodation [Iceland Northern Lights Rooms, 2017]. Due to this being special guest houses, we assume that the primary user will be tourists based on statistics stating that holiday was the main reason for foreigners to visit Iceland with over 90 percentage [Ferdamalastofa.is, 2018]. The attractions nearby are Mývatn Nature Baths, Hverir, Dimmuborgir lava fields, Grjótagjá Cave, which mostly are being visited by tourist during the day, so the tourist will retreat to the guest houses during the evening from being outside all day. They will eat and relax and hopefully see the Northern lights during the late evening and night time.
Based on statistics, people travel to Iceland with their spouse, friends or as a family with kids [Ferdamalastofa.is, 2018]. The guest houses will, according to those facts and our assumptions, be designed for users from two to four people per guest house.

The competition program stats that there must be up to 20 guests, including different sizes of rooms. The layout for the bedrooms must be simple, so the focus stays on the Northern lights [Iceland Northern Lights Rooms, 2017]. Besides the requests from the competition are a small living room and entry area added to the room program to give each guest house a social area.

The guest houses will be designed in two different sizes; the smallest type, will be designed for two people, and the largest type, will be designed for four people. Both types will be equipped with their own toilet with a shower and a bedroom. All the guest houses shall have a nearby access to the reception in the main house with the guest facilities, such as a parking lot. In the main house, will as described, including all the guest facilities, such as the dining area, sauna, and lobby combined with the staff facilities. From the main house shall there either be close or a direct access to the hosts family's house. This house is designed by assuming the family will consist of two adults and two children. It should, therefore, contain three bedrooms, at least one toilet with a shower that is in connection with the rest of the home, including a Livingroom and kitchen.
The barn shall be a shelter for 10 horses and will be placed with a very close connection to the host family's home and has an easy connection from the main house.

▶ *Ill. 77.1: Function diagram*


Bed room
Bed room
Toilet
M.Bed room
Livingroom
Kitchen
Office
Entrance
Storage
Barn
Staff Toilet
Laundry Cleaning
Staff Room
Luggage-Storage
Terrasse
Dinning Area
Kitchen
Staff entrance
Toilet
Reception + Lobby
Entrance
Parking
Toilet
Changing Room
Shower
Sauna
Bedroom
Toilet
4 person cabins
Bedroom
Toilet
2 person cabins
Guest house
Guest facilities
Home for hosts
Horse barn

ROOM PROGRAM

The room program tells the total square meter size of the project, which is 977 m^2. It shows the amount and sizes of the rooms for this project. But also which technical criteria as which rooms shall have natural light or a sensuous experience. And at least which room the guest shall have access to according to the flow of the resort.

▶ *Ill. 79.1: Room program*

BUILDING	ROOM	AMOUNT	AREA	PEOPLE	TEMPERATURE	HUMIDITY	AIR INPUT	VENTILATION TYPE	DAYLIGHT FACTOR	FIRE CATEGORY	NATURAL LIGHT	SENOUS EXPERIENCE	VISITOR ACCESS
			m^2		°C	%	L/s	Natural, Mechanical	%				
2 PERSON GUEST CABIN													
4 units	Bedroom	1	16	2	22 +/- 2	50 +/- 20	0,3 /m^2	N + M	2	5			
	Bathroom	1	4	1	22 +/- 2	50 +/- 20	15	M	-	5			
4 PERSON GUEST CABIN													
3 units	Bedroom	1	28	2	22 +/- 2	50 +/- 20	0,3 /m^2	N + M	2	5			
	Bathroom	1	6	1	22 +/- 2	50 +/- 20	15	M	-	5			
GUEST FACILITIES													
	Reception	1	54	5	22 +/- 2	50 +/- 20	0,3 /m^2	N + M	2	5			
	Lounge	1	94	25	22 +/- 2	50 +/- 20	0,3 /m^2	N + M	2	5			
	Dining	1	51	25	22 +/- 2	50 +/- 20	0,3 /m^2	N + M	2	5			
	Sauna	1	28	10	-	-	-	-	-	5			
	Changing room (sauna)	1	42	8	22 +/- 2	50 +/- 20	15	M	-	5			
	Toilet	6	3,5	1	22 +/- 2	50 +/- 20	10	M	-	5			
	Kitchen	1	18	5	22 +/- 2	50 +/- 20	20	N + M	2	5			
	Staff room	1	22	5	22 +/- 2	50 +/- 20	0,3 /m^2	N + M	2	5			
	Luggage / storage	1	22	2	22 +/- 2	50 +/- 20	0,3 /m^2	N + M	-	5			
	Laundary and cleaning room	1	22	2	22 +/- 2	50 +/- 20	10	N + M	-	5			
	Roof Terrace	1	280	25	-	-	-	-	-	-			
	Technique room	1	12	1	-	-	-	-	-	4			
HOME FOR HOSTS													
	Entry	1	15	2	22 +/- 2	50 +/- 20	-	-	-	4			
	Living room / Kitchen	1	69	4	22 +/- 2	50 +/- 20	20	N + M	2	4			
	Master bedroom	1	22	2	22 +/- 2	50 +/- 20	0,3 /m^2	N + M	2	4			
	Childrens room	2	13	1	22 +/- 2	50 +/- 20	0,3 /m^2	N + M	2	4			
	Bathroom big	1	9	1	22 +/- 2	50 +/- 20	15	M	-	4			
	Bathroom small	1	5	1	22 +/- 2	50 +/- 20	15	M	-	4			
	Office	1	12	2	22 +/- 2	50 +/- 20	0,3 /m^2	N + M	2	4			
HORSE BARN													
	Stall	10	6	-			-	-	-	-			
	Tack room	1	10	1			-	-	-	-			
	Wash/groom room	1	6	1			-	-	-	-			
TOTAL		51	977										

ATMOSPHERE

The atmosphere for the rooms has been divided into four categories; calm, excitement, private and public. The calm rooms are calm and simple. Not full of colors or a lot of diversity in the material choice. They are meant for the guest to feel calm and safe. The sauna and the cabins should be calm.
Excitement is for the rooms where the guest should explorer and feels excited, such as the reception and the atrium.
The private atmosphere is for the rooms that are private and the guests using it should feel safe and private.
The public rooms are the rooms with several people in it, who are not necessarily the one you travel with, such as the atrium.
The following studies are made with these requirements in mind.

▶ *Ill. 81.1: Atmospheres per room*

	CALM	EXCITEMENT	PRIVATE	PUBLIC
Main house ground floor				
Reception		■		■
Kitchen and living room	■	■		■
Children's room	■	■	■	
Children's bathroom	■		■	
Master bedroom	■		■	
Main house first floor				
Atrium		■		■
Dining area	■			■
Lounge area		■		■
Sauna	■			■
Changing room	■	■	■	
Kitchen	■			■
Staff room	■			■
Two person cabin				
Bedroom	■		■	
Bathroom	■		■	
Four person cabin				
Bedroom	■		■	
Bathroom	■		■	

PROBLEM STATEMENT

How can a guest resort be holistic designed with the knowledge about light's variation and its effect on the human body and the architecture, with the use of a sustainable approach, the Cradle to Cradle principles, to use materials and the place to strengthen the senses and the calm/excited atmospheres at the resort, and make the experience of the northern light stronger?

▶ *Ill. 83.1: A stream from a waterfall at Þingvellir National Park*

VISION

To design a retreat with light experience by designing for the senses to emphasize the atmosphere for the visitors. Designing calm, simple and inviting houses for the guests to relax and enjoy the nature by day and the Northern lights by night. A private home for the host family with a clear connection to the social guest facilities and horse barn. By focusing on knowledge about lights, the aim is to design an atmosphere of safety and calmness with the beautiful features of Nordic architecture. Enhance the connection to nature by visibly making use of sustainable solutions and local materials.

DESIGN CRITERIA

Based on the analyses in this program have these design criteria been created:

- Light will be the key factor to enhance the atmosphere
- Light and shadows will be used to create a flow in the buildings
- In the bedroom and living rooms in the cabins must a multi-sensory experience of the atmosphere be created
- Explore the northern light from the bed
- Low maintenance
- Cost effective construction
- Local materials must be used
- Passive strategies must be integrated to lower the energy consumption
- The Cradle to Cradle principles must be used
- The comfort zone must be designed according to the energy requirements of BR2018
- Enhancement of the social interaction between the different guests, while still creating space for each guest couple or group to be private

ENERGY CRITERIA

For this project, the Danish Building Regulation 2020 be used as the energy and indoor climate regulations. Since the aim is to design a building with a very low energy consumption, the small amount of energy that the buildings' need, must be supplied from renewable sources.

Passive strategies will be used to lower the energy consumption for the building. Furthermore, must the site be supplied with heat, cold and hot water from renewable resources.

During this design process the buildings wil be designed using the sustainable approach, Cradle to Cradle, whereas its three principles will be in use; trash = feed, use renewable energy and celebrate diversity.

CHAPTER CONCLUSION

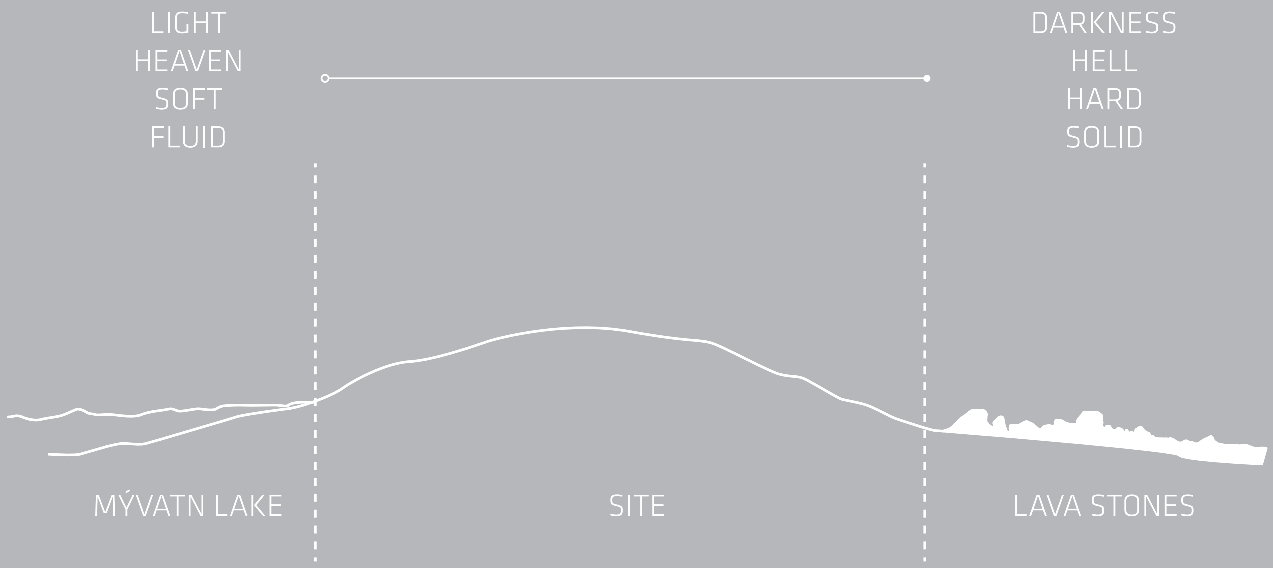
The specifications of this project started off with a description of the users. The users consist of the guest, the staff, and the families. The guests are usually at the resort during the evening, through the night to the next morning. The staff members are working from 6 – 22 while, the family are at home from 15-8.

The function diagram shows how the rooms should relate to each other, as well as how the buildings are connected. The cabins consist of a bedroom and bathroom, while the main building consists of several rooms, such as dining area, sauna, lounge, etc.

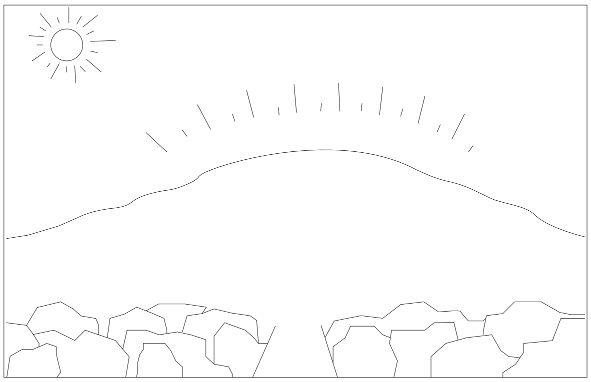
The room program shows the area and specifications of all the rooms, with a 977 m2 in total. The selected rooms are described further with their atmosphere requirement of calm, excitement, private and public.

Based on all the previous pages of analysis and theories have a problem statement and vision been made, as well as the design criteria and energy criteria.

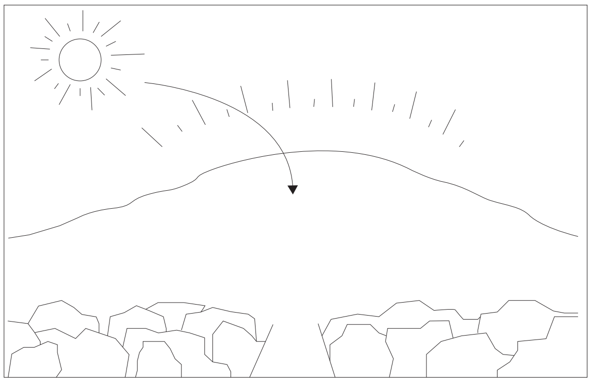
During this program, several analyses, theories, and case studies have been investigated to give a fulfilling understanding of the themes, the location and the conditions for the project. The following design process will be derived from this program and used throughout the different phases.


LIGHT
HEAVEN
SOFT
FLUID
DARKNESS
HELL
HARD
SOLID
MÝVATN LAKE
SITE
LAVA STONES

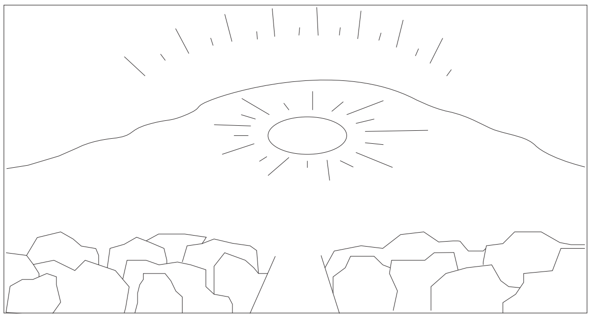
CONCEPT



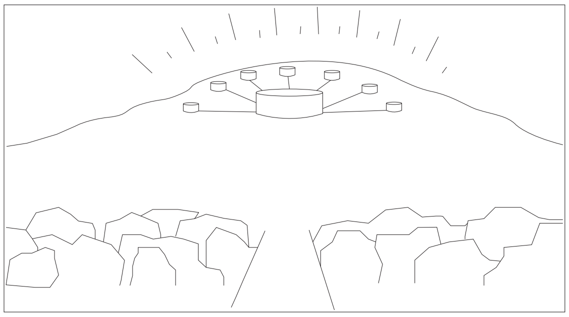
1. The site appears as an embrasure in between all the darkness from the lava stones



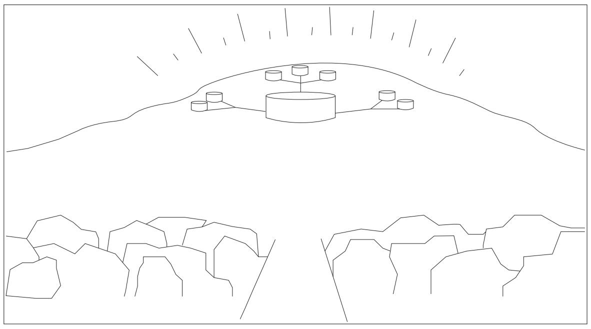
2. To emphasize the contrast to the darkness, the sun is being taken down to be placed on the site



3. The sun is being laid down and with its rays spread out on the site - like a glowing circle



4. Out from sun rays, the cabins are being placed

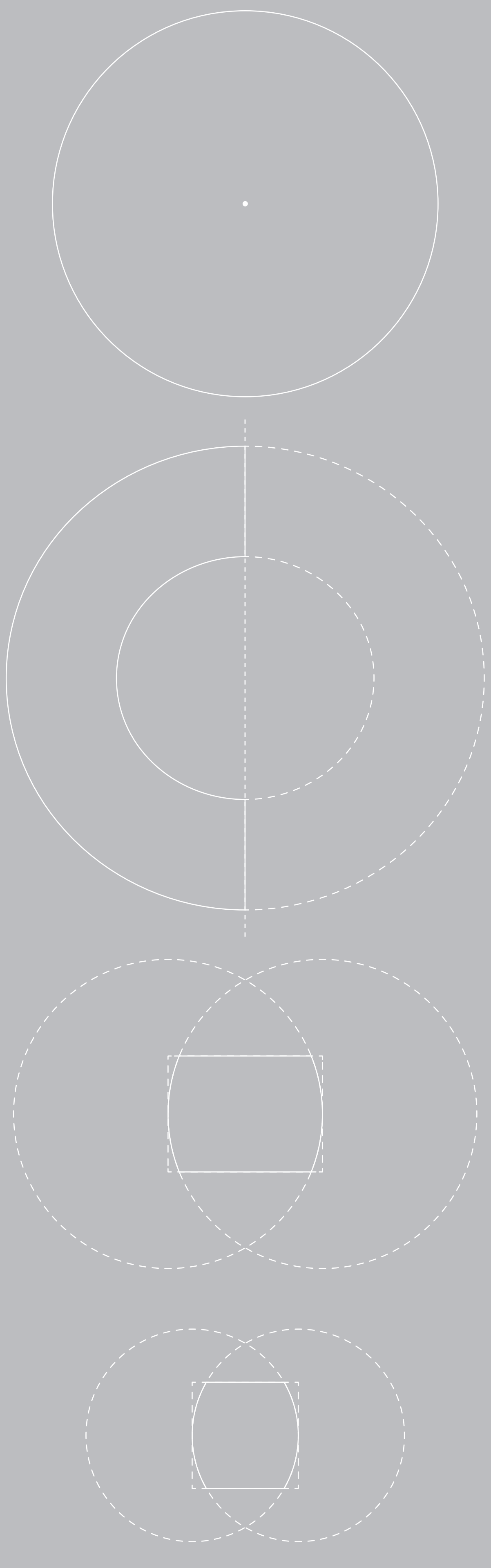


5. The cabins are being gathered in small groups to minimize the path and pipe length

◀ *Ill. 88.1: Overall concept*
▲ *Ill. 89.1: Concept*

chapter six
studies

The design process of the main building, the horse barn, the four person cabin and the two person cabin is the content of this chapter. The focus for this project has been light, so to decide on the most optimal window size for the shape of the buildings and rooms was studied using models and renders, and afterward, the ventilation and temperature was calculated. Daylight factor and lux studies were made to measure the amount of light entering the room while comparing the lights in the renders. The renders also showed how the material changes in the different daylight situations. Studies of the building's performance at 10 m/s was tested as well. Inside this chapter is four subchapters, one for each building.



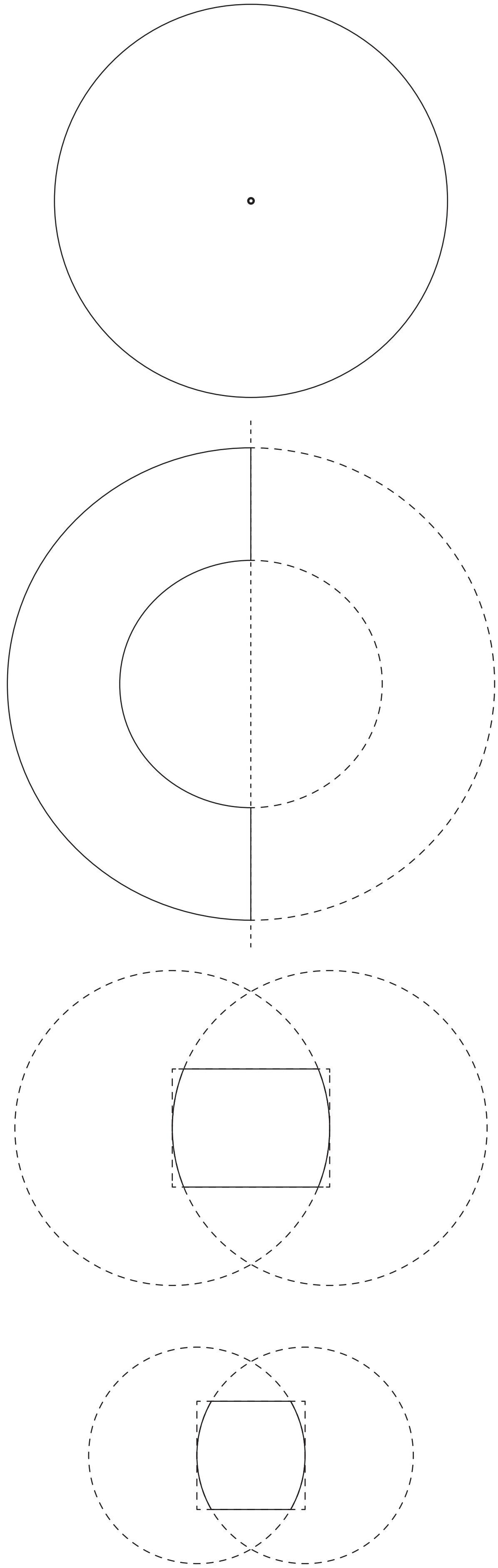
FORM CONCEPT

The form concept for the buildings is designed out from the concept of light and the symbolic meaning of a circle.

One of light most important factors is the sun. Through astrology, the symbolic symbol for the sun is the circle. [Holismen.dk, 2018]. A circle is also a symbol for the entirety, cosmos, harmony, magic [Denstoredanske.dk, 2018] and social gathering [Ordnet.dk, 2018]. These symbolic meanings connect to the projects fulcrum, which is light, social gathering, Northern Lights, and cosmos.

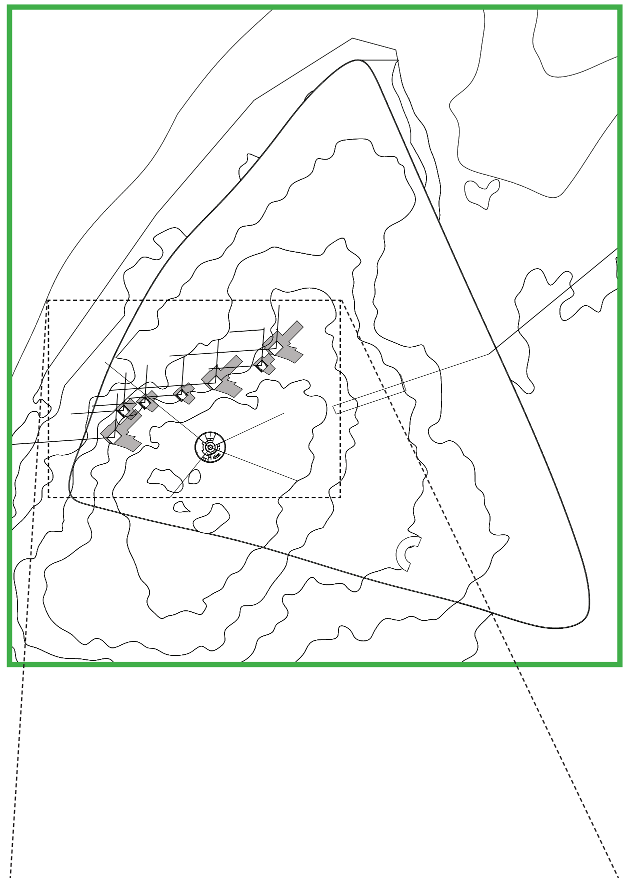
All the buildings are therefore shaped a designed out from the circular form, which also connects the different types of typologies.

The main building is formed after a closed circle because it will be the center, the social gathering point and creates the entirety of the resort. The cabins are based on circles, that intersect each other in the center. The external walls are shaped by these lines and create the shapes for the cabins. The two-person cabin and four-person cabin are designed from two different sizes of circles to fit exactly the functions need and minimize the space. And last, the horse barn is formed after a half circle to create more functional space and boxes for the horses.

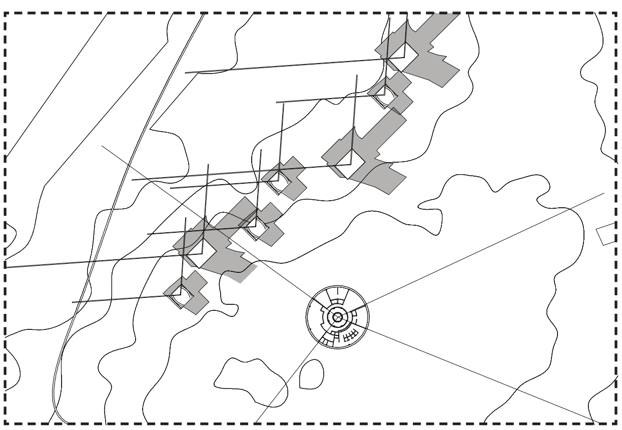


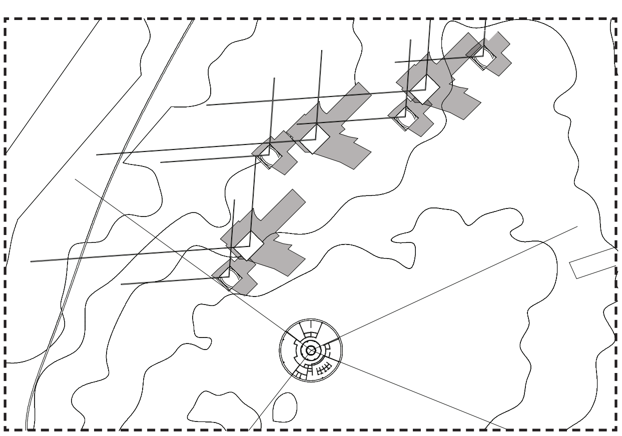
▶ *Ill. 92.1: Form concept*
▲ *Ill. 93.1-5: Placement studies*

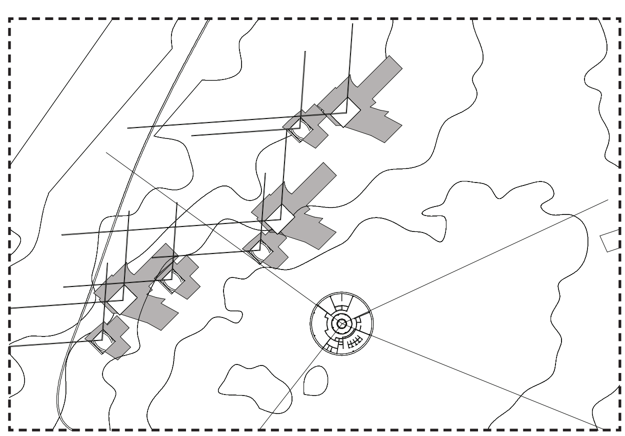
PLACEMENT



To find the right placement for the buildings, shadows-, wind-, and view studies are made, while the topography of the site has been used, as a benefit to the placement. Out from the concept, one of the main factors for the placement has been that the cabins were placed on a lower level, than the main building. So, the guest will walk up towards the light, to reach the main building, and go down to their cabin. To reach this in a more sustainable way, the typography is used, by placing the cabins on the west side of the site, and in that way also using the typography to hide the cabins from the artificial light from the cars there are coming through the driveway and creating privacy.
Another main factor from the concept has been to place the buildings, in small groups or close to each other, to create this conceptual sun, for minimize the pipe length, but without shadowing for any of the other buildings surfaces, there are used for creating light in the building. As shown in the diagrams below, the cabins are places after their shadows they are creating through a year, and with a certain distance, so their view is clear and private. The main building is placed on the highest point, with no elements to disturb the interesting view from the important functions. The highlighted placement was in the end, checked for the wind conditions, to make sure that the placement of the buildings wouldn't create any turbulence, as seen in appendix.







main building
studies

The main building is the social gathering space for the guest to enjoy each other's company, reading a book, the sauna, the northern lights on the roof top, etc, but also a home for the family running the resort. Studies have been made for the most important rooms, for parameters such as daylight, direct sunlight, diffuse light, materials, etc.

MAIN BUILDING

WIND STUDIES OF SHAPES

When deciding on the shape of the main house, three shapes were tested for their performance in 10 m/s wind. Since the site is located on the top of a hill with no shielding from the wind, the shape of the main house is very important. For this study, three shapes were examined using Flow Design to stimulate how the wind behaves when moving around the shape.

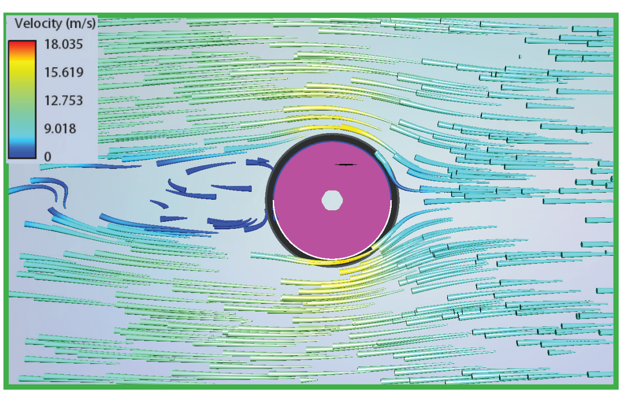
The three shapes are a circle, a hexagon, and an oval shaped building. The preferred shape was the circle due to the concept, while the hexagon was a shape that could be used to creating straight internal walls and the oval to create longer rooms.

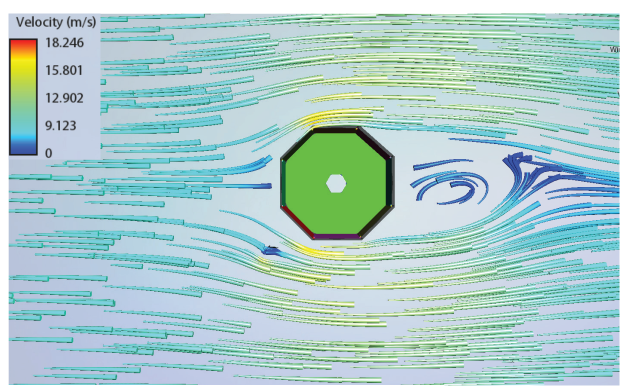
The circular building creates 15 m/s winds on the side of the building, before quickly decreasing to the 10 m/s the wind originally was.
On the part of the façade where the wind hits directly, the wind is being sucked to the side of the building, creating an area of low-velocity wind with a bit of turbulence, but due to the velocity being near 0 m/s, it is not an issue to enter the building or walk near it here.

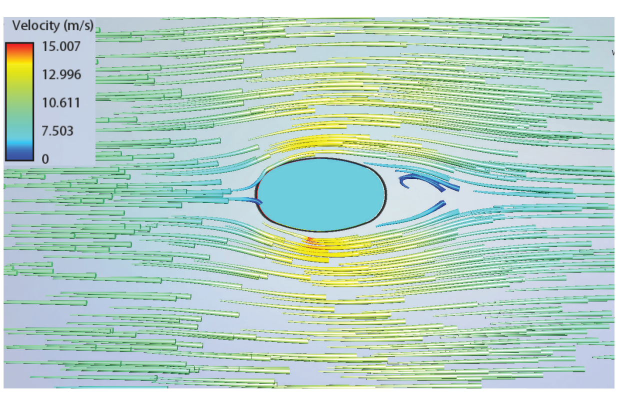
The hexagon creates 15 m/s winds on its sides as well but compared to the circular shape it creates a low turbulence area in opposite part of the building of where the wind comes from. The wind hits the building from its direction with a velocity of 5 to 10 m/s.

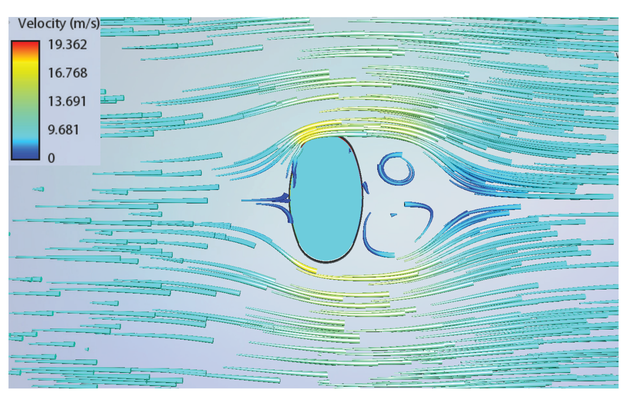
The last shape is the oval, where two simulations were made to ensure how it will perform from both sides of the building since the wind rose of the site shows that the wind comes from all directions [meteoblue, 2018]. The first simulation is where the wind follows the shape and hits the building on its narrowest part.
This creates winds of 13 to 15 m/s on the sides and creates a bit of low-velocity turbulence at the back of the building. The other simulation shows the wind hitting the building on its widest part, where the wind on its side becomes 17 to 19 m/s, which is almost a doubling of the original wind velocity of 10 m/s. On the back of the building, turbulence occurs with a velocity of 5 to 9 m/s.

Of these three shapes, the one that was chosen as the building shape is the circle due to its performance in the wind simulation but also because of its natural fit to the concept of having a glowing sun on the top of the site.









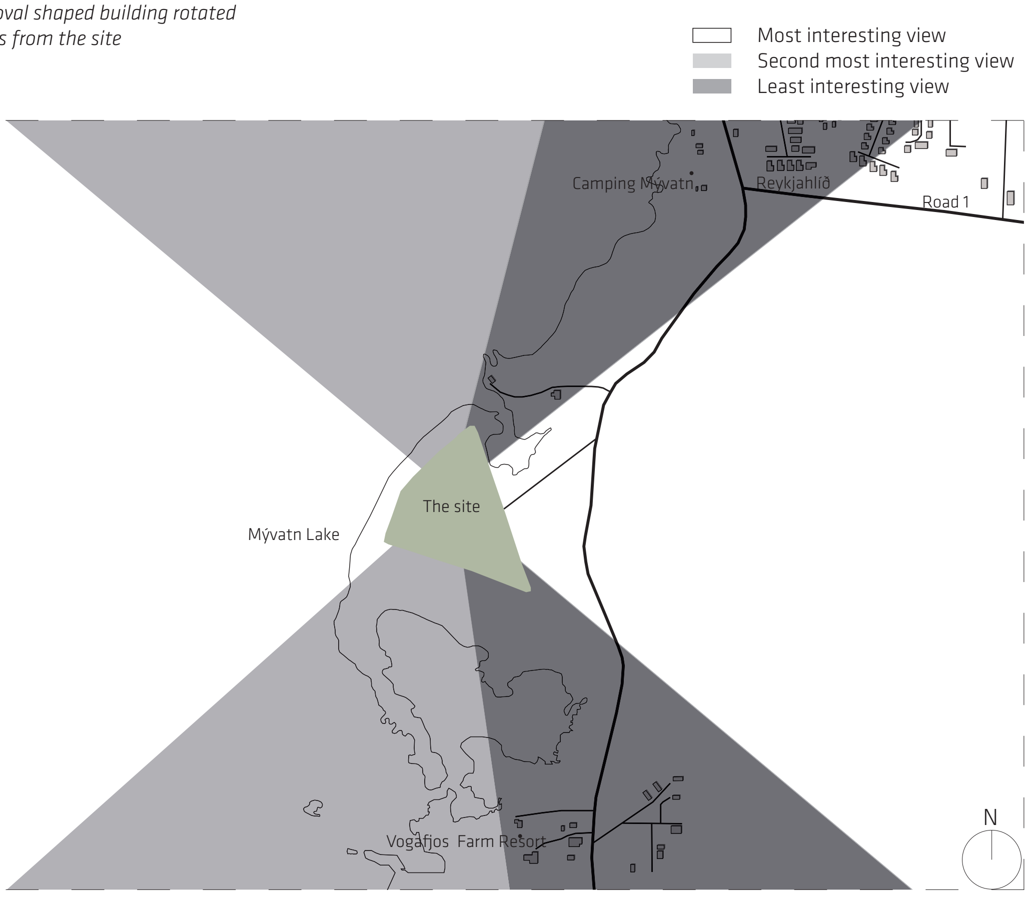
MAIN BUILDING

ORIENTATION

Based on our experience of being on the site we fast determined that some views are better than others. Close to the site is the neighbor house located on its own hill. From the site, you can see their living room and for the users staying at this resort during their vacation, the neighbor's living room is not the best view. Instead, the view toward the east with the lava stone driveway and the two volcanos, and the western view with Mývatn Lake is much better. These views both have a lot of nature to look at, and from the top of the site, it is possible to see far away into the horizon of mountains. The second most interesting view is the northwest and the southwest part. Here the coastline of Mývatn Lake is visible and further away the lake's other resorts can be seen. The least interesting view, together with the view of the neighbor house, south of the site is the closest resort with its random placed cabins.

When placing the rooms within the building the orientation is also very important the room temperature. Rooms that need to be colder will be placed in the northern part of the building – bedrooms will need to be colder to avoid the family to sleep in a hot room. For the social rooms such as kitchen and living room, can be placed in the southern part of the building where, since it is acceptable for these rooms to be hotter than the bedrooms.

◀ *Ill. 96.1: Wind study of circular building*
◀ *Ill. 96.2: Wind study of hexagon shaped building*
◀ *Ill. 96.3: Wind study of oval shaped building*
◀ *Ill. 96.4: Wind study of oval shaped building rotated*
▼ *Ill. 97.1: Interesting views from the site*



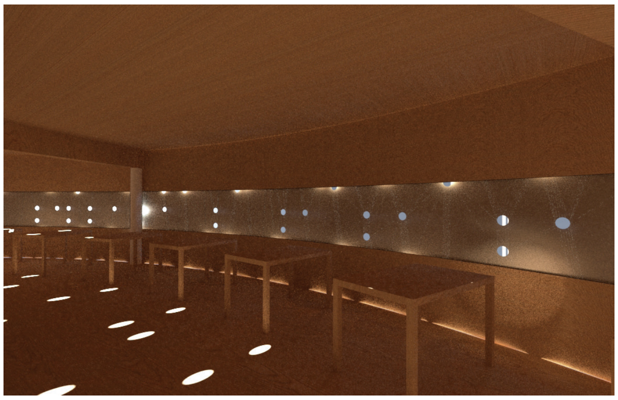
MAIN BUILDING

WINDOWS AND FACADE

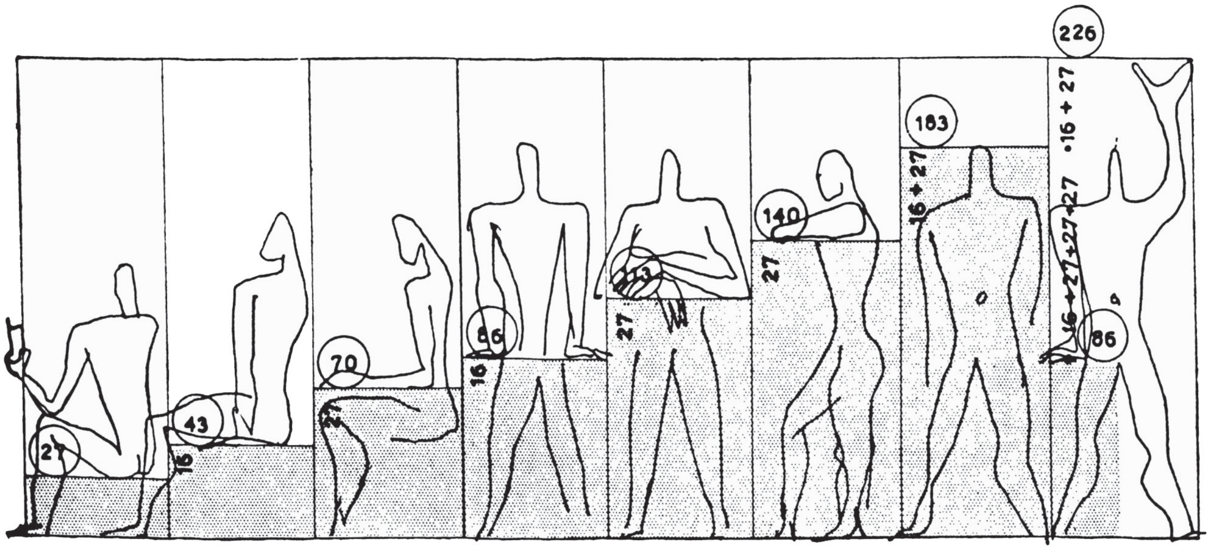
Since light is our focus the what the way light enters the rooms is very important. By starting out with looking at the dining area, which should be calm so that the users can enjoy the view and their dinner in a calm environment, the principle of how the windows should be designed overall is made.

At first, the window size was calculated to control the heat not becoming too high and to make sure that there is enough daylight in the room (these numbers for the dining area is stated later in this report). After the area for the windows was calculated they were divided out to each table, to ensure them in having its own space of light, as described by Marilyne Andersen. It became too strict and equal placed, where the idea was to make every table special with its own space.

The other idea we tried was to use a perforated aluminum plate, to play more with the light. In this case, it was quickly decided that it was what was best for this room. It became dark and the view disappeared.



At last Le Corbusier's modular man was used to design the windows, that is placed on the façade material renders on the next page. The modular man was used to decide the heights of the windows. Since in several rooms and in the cabins it would nice for the guest to sit in the window and enjoy the view, the lowest starting height of the window is 430 mm. The next is 860 mm, so it fits a dining table. And the last two chosen heights are 1400 mm and 1830 mm to create a window that is placed tall enough to be private. The varies of windows can be found in the appendix.



MATERIALITY

For the facade, two materials were in the consideration – aluminum and concrete. Wood was not a consideration due to the low amount of wood accessible in Iceland [Vidste du at, 2018] and the amount of wood used for the façade would be high. Another issue with using wood for the façade is that it requires a lot of maintenance every year with an oil treatment and stated in the competition brief low maintenance is a requirement [Iceland Northern Lights Rooms, 2017]. The weather on Iceland is very hard with its low temperature and hard winds, which will harm the wood.

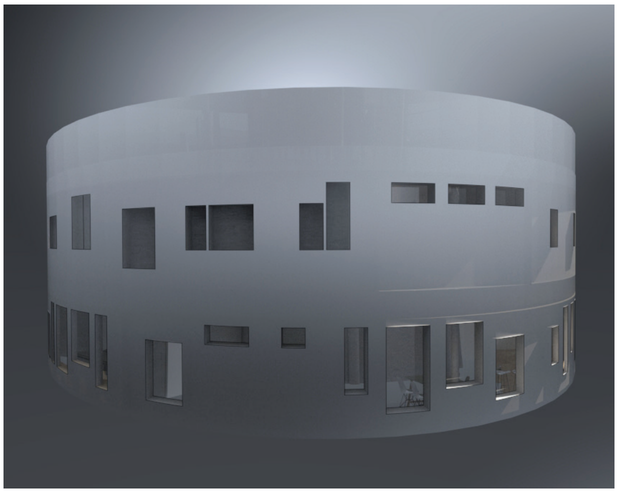
So, to decide between aluminum and concrete renders was made of three different solutions. The first one is an aluminum façade made of plates. It creates a façade that reflects its surroundings, wherein the situation of the render where the background is dark grey, a dark grey color begins in the bottom and graduates to a light grey at the top of the building. The smooth aluminum plates give the façade a doll tactile experience and the light is not reflected in the building as well as the other two are.

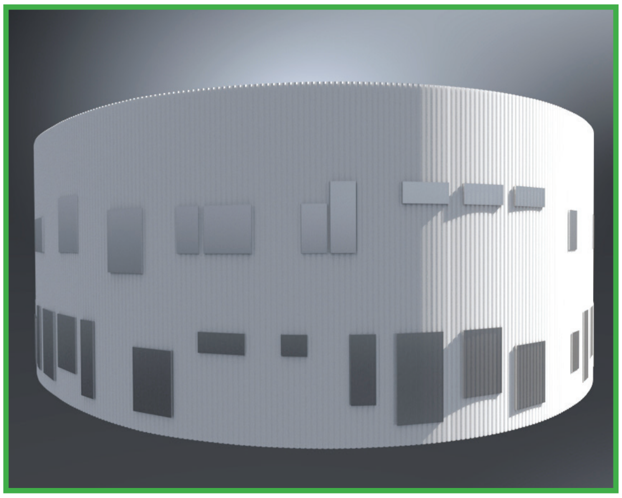
In the most cities, we visited on our study trip to Iceland one material was corrugated aluminum in a variety of colors. At first look, it seemed like painted wood panels. The corrugated aluminum makes the main house seem taller and slimmer as it reaches for the sky. And when the sun shines on the façade it reflects the light in several directions due to the shape of the corrugated aluminum.

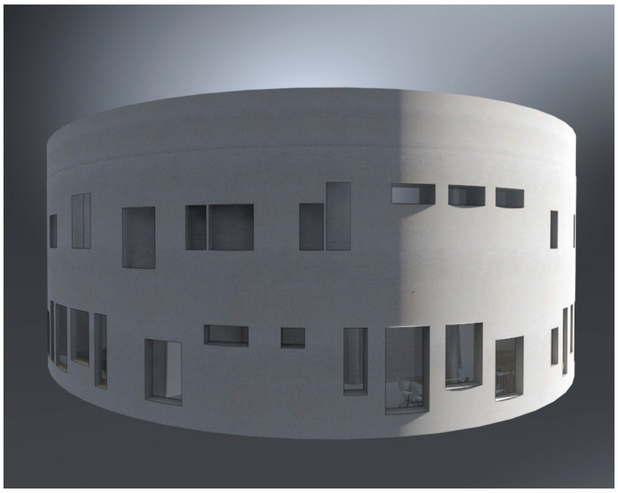
The concrete façade seems soft when the sun hits the façade, but hard on the shadowed side. With the dark color of the concrete, the façade gets a darker visual expression than the two other solutions, and it gets too dark to be able to achieve the glowing effect from the concept.

Hence, the chosen façade used for this project is the corrugated aluminum, that reflects the sunlight.

◀ *Ill. 98.1: Windows infront of every dining table*
◀ *Ill. 98.2: Perforated aluminum facade's effet on dining area*
◀ *Ill. 98.3: Le Corbusier's modular man [Le Corbusier]*
▼ *Ill. 99.1: The aluminum facade study*
▼ *Ill. 99.2: The corrugated aluminum facade study*
▼ *Ill. 99.3: The concrete facade study*







MAIN BUILDING

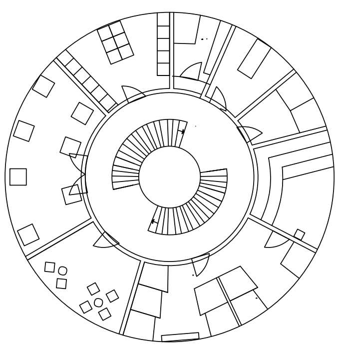
PLAN DRAWINGS

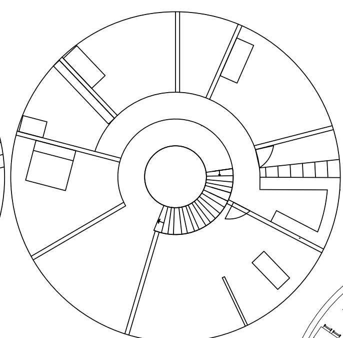
Based on the concept of the main building is a glowing sun coming up from the ground, the ideal shape, to begin with, was a circular building. From the first plan drawing to the last a bunch of plans was created. From the first drawings seen below on this page, the atrium was in mind. The light atmosphere walking towards the light and then around it was an idea that was part of all the plans. The placement of the rooms was made according to the preferred views and to shield from the South sun.

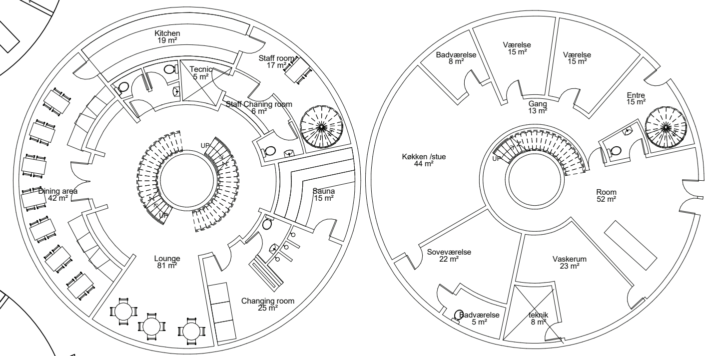
An iteration moving the technical room into the center and then pushing the atrium towards South was and solution to keep the pipes for water as short as possible. By having short pipes compares to long ones are that the floor slabs would become thinner due to the pipes need to be inclined to move the water within. This solution made gave a lot of the room's problems with their sharp corners.

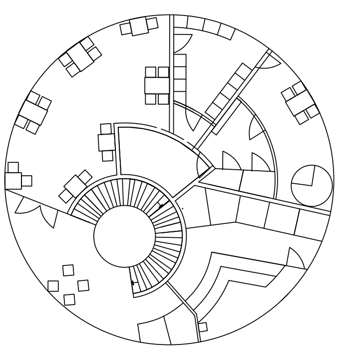
After that, the atrium was kept in the center of the building, and the atrium was worked on to make it a social heart of the building. Furniture was integrated into the atrium with benches and bookcases – but with a radius of 8000 mm the atrium was too small to achieve the wanted effect and the rest of the rooms was as well being squeezed.

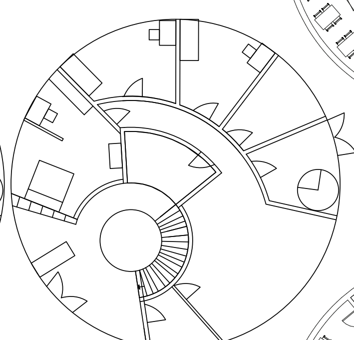
Hence, the radius of the circular building was increased to 10.000 mm. This gave the building much more area and a lounge area was added in the Southern part of the building. To avoid have specially made furniture the walls became straight by diving the building up into several pieces. At the top plan on the next page, the plan shows this idea, and here is it visible that the walls seem unintentionally shaped compared to the circular external walls and atrium glass. Instead was the building divided into fewer pieces to make it clear what the idea of the straight wall was – but here the rooms' size did not fit their function.

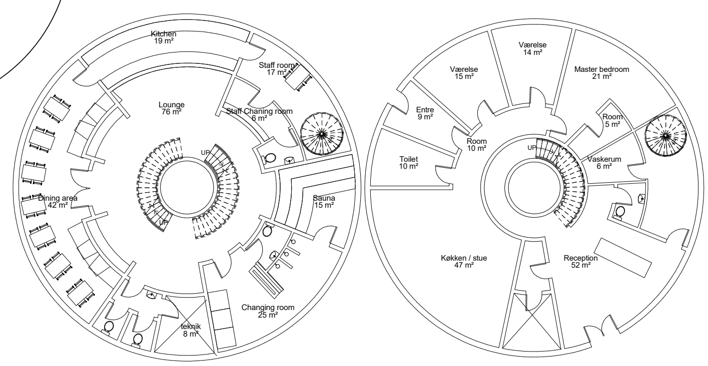






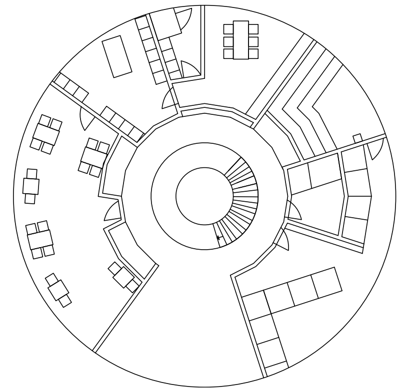


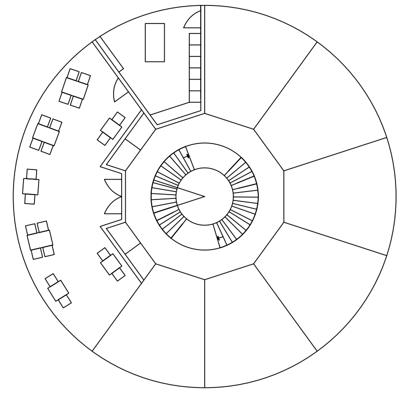




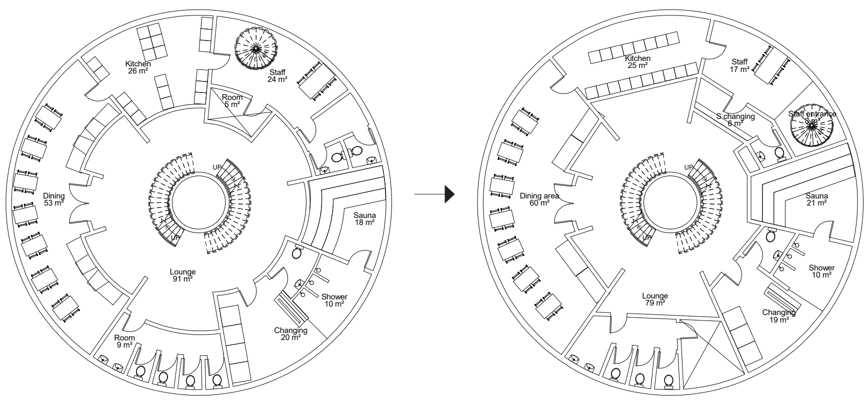
The idea of the straight walls was dismissed for a while, and a new plan was made without having a lounge at the external wall, but instead moved it to the atrium – like the previous idea. The rooms surrounding the atrium was pushed back and forth to create niches for the benches. The idea of the straight walls was used on this plan, and it made the niches more closed, which was not intentional. The walking area around the atrium was also very wide, which could be used somewhere else – hence, the lounge was in again.

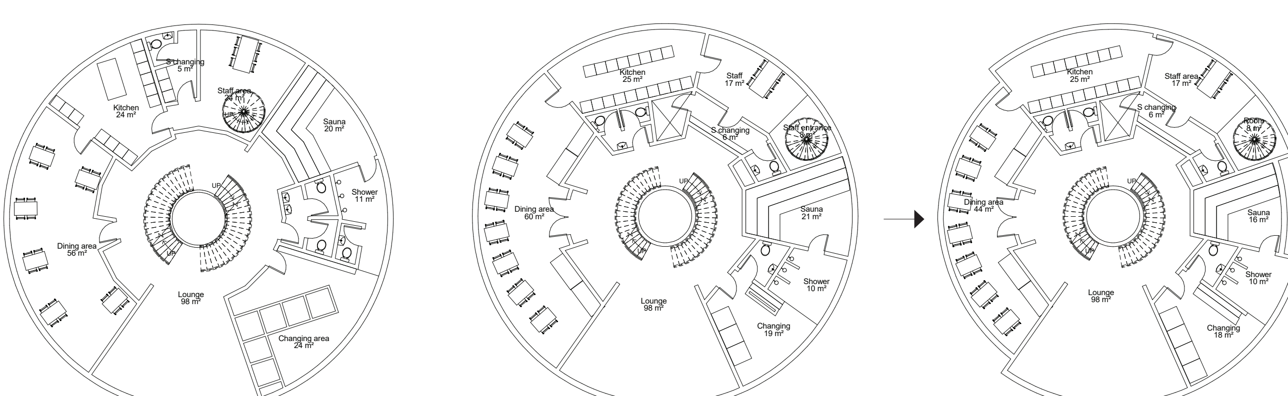
In the bottom of this page to the left, the lounge was implemented, and the straight walls used again. The rooms' placement was played with and the sauna ended up being to the east. The last iteration before looking further into the atrium and the construction that determines the final plan, is created from the idea of pushing back and forth – where it is used on the façade, but due to the concept of the glowing sun on the ground it was deselected since the shape's corners ruined the circular shape.





◀ *Ill. 100.1: Plan drawings with a radius of 8000 mm*
▶ *Ill. 101.1: Plan drawings with a radius of 10000 mm*





MAIN BUILDING

DAYLIGHT OF ATRIUM

For the plan drawings study the atrium was designed with a radius of 1,5 m, and to ensure that would be sufficient for achieving a 2 % daylight factor, a study was made of it. In this study, five different sizes were examined with its daylight factor and lux.

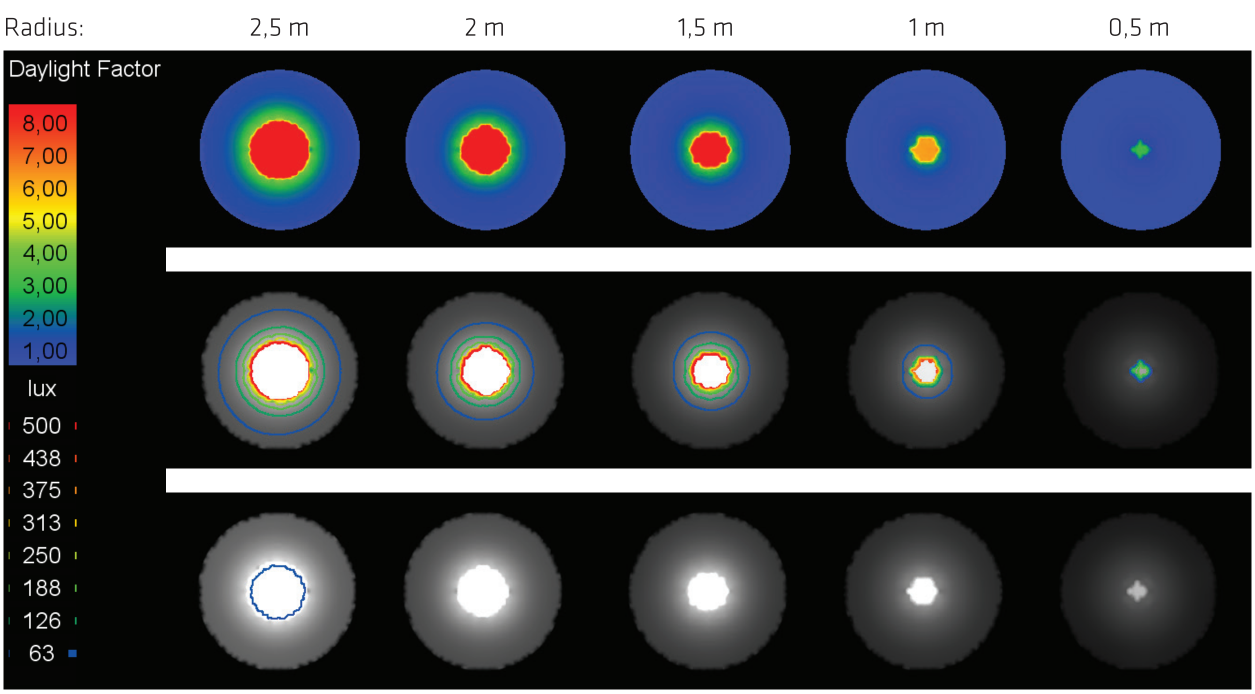
The daylight factor is the average daylight factor during an entire year. This shows how the ration of light level in the center of the building, where the atrium is placed. Both in the 0,5 m and the 1 m atrium do not let enough light due to it being too small. The wanted daylight factor at 2 % should cover most of the space around the atrium and not only in the atrium itself.

The 1,5 m atrium achieves this goal and is a good size of atrium since it doesn't fill up the entire space. When looking at the 2 m and the 2,5 m, they take up more space than the rest and the amount of daylight are increased more than needed.

When looking at the lux coming from the atrium, the amount 0,5 m and 1 m is very low and do not create enough lux for the room. First from the 1,5 m atrium and up after, the amount of lux is sufficient for the space around the atrium.

The size wanted for the atrium is one of 1,5 m due to its performance in daylight factor and lux, but also because of it not being too large and taking up too much space.

▼ *Ill. 102.1: Daylight factor and lux simulations of the atrium*



MAIN BUILDING

MATERIAL CHOICE

"Light is like a fabric to architecture, just like materials, shapes, and rooms are...The experience of the material for the shape and the room It not only expired by the material, the shape, and the room but together with the light" [Voltelen, 1976, p1].
As light is the main factor and the only way to see and explore materials, it is important that the rooms not are being too bright or too dark. Otherwise, the materials and the constructions details will fade together. The light shall therefore together with the material create the right atmosphere and ember. The light does not only shine on the materials but also for them, which make the materials appear through the light [Bille and Flohr Sørensen, 2012].

Out from the following light and materials studies, on how the materials interact with the light and based on the knowledge from the materials life cycles according to Cradle to Cradle. Only a few different types of materials have been chosen for all the buildings, according to the sustainable view, but manly that factor that it should be the light which creates a diversity in the room and not many different types of materials. Therefore, these following materials have been chosen.

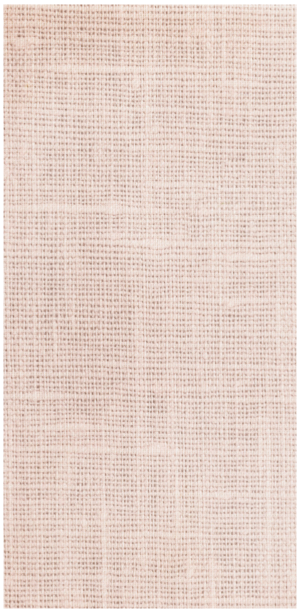
Concrete is the primary material in a light color, which will be used in the structural system, on the wall, the floors, roof and somewhere as the ceiling.
This will in the daytime do the light will be able to reflect itself into the room with a material there not are too absorbent or to reflective and course discomfort. The concrete will create a colder light, which will together with the light color activate people and their movements. The color prevents the discomfort of blindness, when looking out of the window because the concretes color and the light ambient factor will not have a to big difference. And with the concretes smooth surface, it will be able to create soft as hard shadows and generate the lights contrast.

Wood will only use on those surfaces, which should have a warmer expression and light. Like the walls in the niches, or on all the integrated furniture's.

All the ceilings will be lined with flax linen to cover the seaweed. The flax will create a soft contrast to the hard concrete and give a calmer feeling. Be choosing a bright flax the light won't be absorbed into the fabric, but instead create a soft smooth light in the rooms.

On the main building's facade, corrugated aluminum is chosen to reinforce the feeling of the brightness from the outside through day as night. Studies show that people connect light with asociality, life and a gathering point [Bille and Flohr Sørensen, 2012]. With the corrugated aluminum, the façade will be able to reflect the light with appropriate sheen, so the façade not will aperture. This will make the main building even stronger on the social aspect of the concept.

▼ *Ill. 103.1: Flax fabric*
▼ *Ill. 103.2: Light grey concrete*
▼ *Ill. 103.3: Pine wood*
▼ *Ill. 103.4: Brushed aluminum*




MAIN BUILDING

STRUCTURE AND CONSTRUCTION

Based on the theory of Eduard Sekler of the importance of the structure and the construction [Sekler, E. F. 1965, 2018]

this study has been made to determine the structural system, the buildings and the rooms spacious feeling and atmospheric approach have been considered. Hence, a column and beam structure system have been chosen to keep the spaces open while maintaining a vertical direction in the atrium towards the light.

For the construction aspect of his theories, has the entire building to avoid having ventilation pipes visible in the ceiling due to the wanted simple atmosphere would be achieved. The column would continue through a sewn ole in the flax linen ceiling and support the beam lying on top of it.

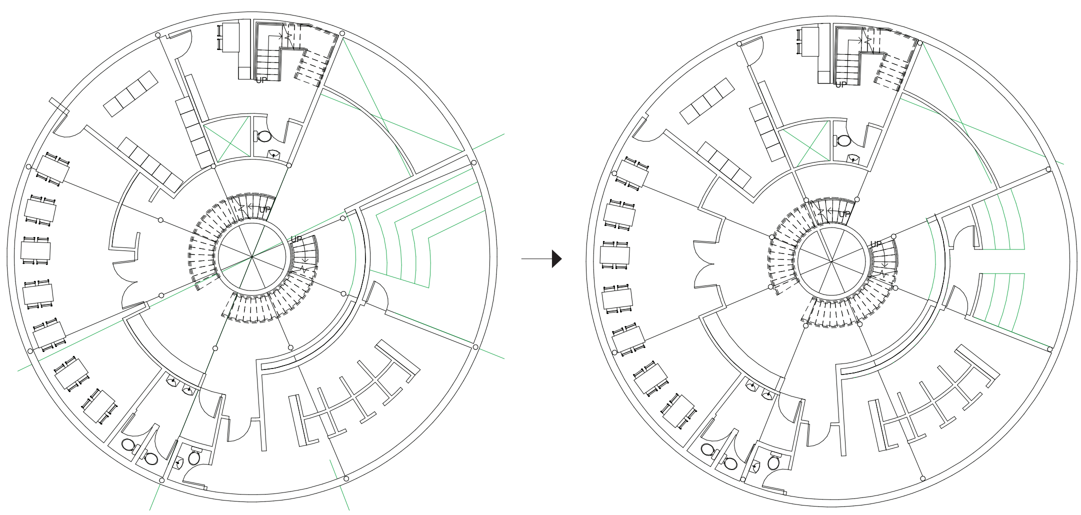
This system makes it possible to have a more open and free façade and the atrium in the middle, but also to have some bigger spans in some of the rooms, without having any walls to divide the room for carrying some of the load.

By defining, how big the span of the floor slab should be, which would be around 10 meters. [Betonelement.dk, 2018]. Several column and beams structure systems studies were made. As the diagrams show, the structure systems, where divided from six to nine pieces according to the span of the floor span.

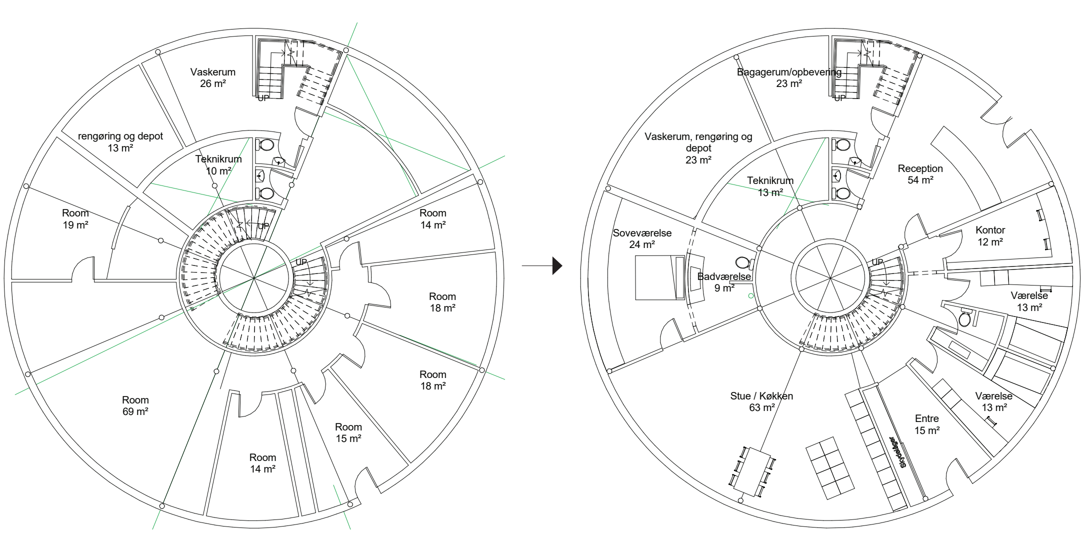
These systems were placed in the plan layout, to see which would match the layout best, so the column will have a constructional joint with the inner walls. The eight divided system was chosen as the final chosen system. And as the plan layout diagrams show, only some few small adjustments were made for some of the rooms inner walls, to make the structural system by integrated into the main building.

The final system showed in the 3D diagram, here the columns are enough to carry all the loads from the building

First floor

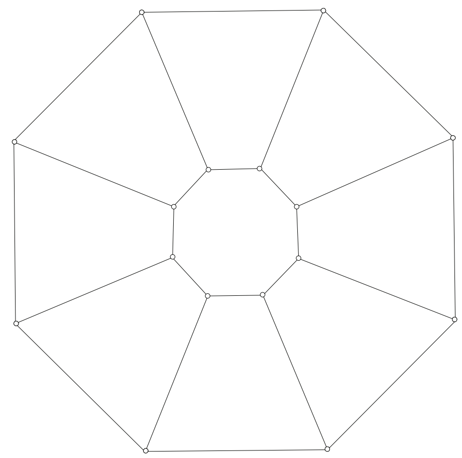


Ground floor

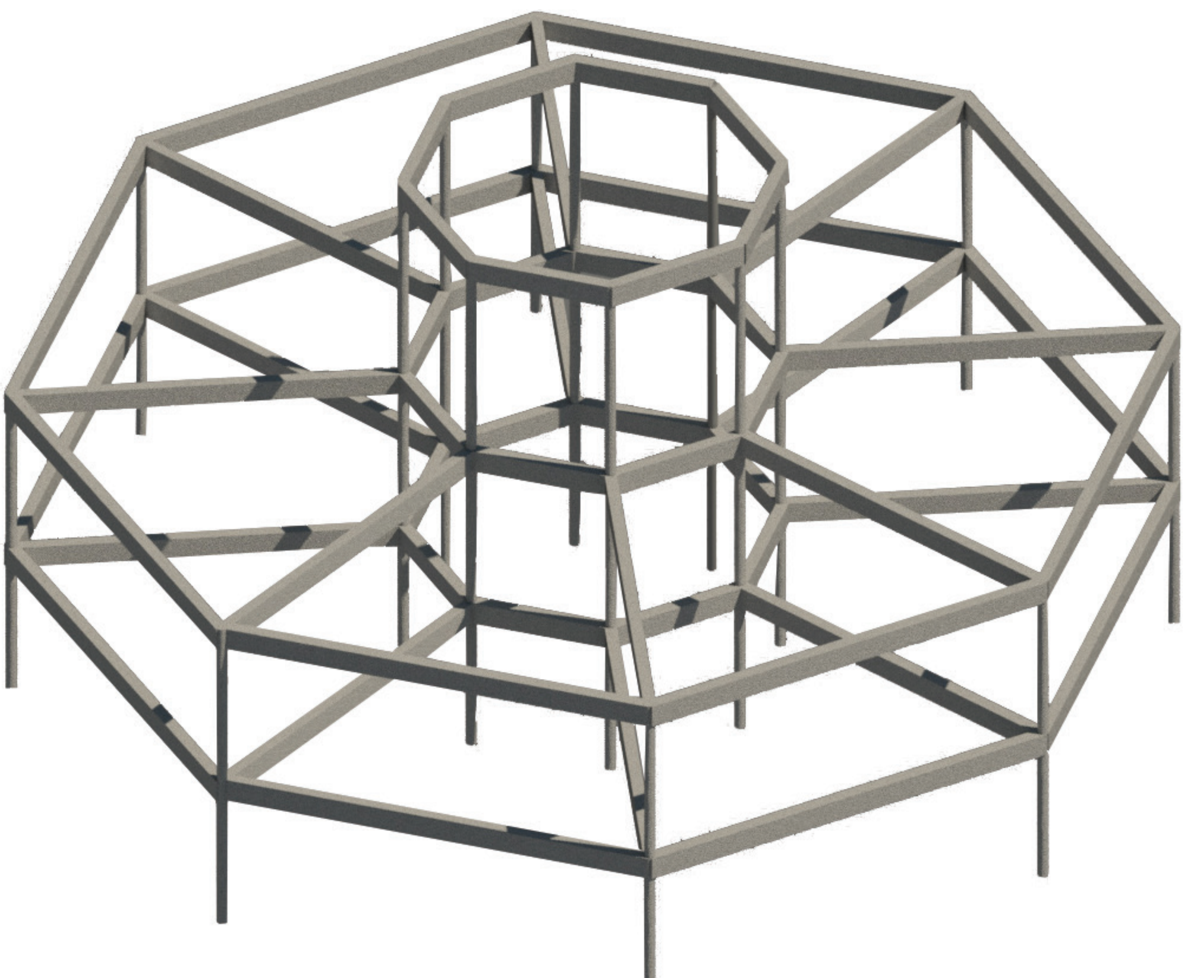


and are only being supported by the beams to make the system stable. The columns are placed just inside to the outer wall for minimizing cold bridges, but also to make the structural system visible and making the visible constructions details between the elements in the rooms. The structural system is made of concrete and gives the elements these following dimensions.

The columns are of 180mm, and even though that the beams only shall carry their own weight and stabilize the system, their dimensions are 200*400 mm [Ahler, 2010].



◀ *Ill. 104.1-4: Plans regulated by structure*
▲ *Ill. 105.1: Structure principle*
▼ *Ill. 105.2: Render of structure*



MAIN BUILDING

VENTILATION

To achieve a good indoor climate, a mechanical ventilation system combined with natural ventilation principles are implemented.
By having two very different types of typologies in the same building, the main building is supplied by a VAV system, so each room can be changed or adjusted the climate after its use. This means if one room needs to be cooled down, it won't affect the other rooms like using a CAV system.
The size of the aggregate for the VAV system is defined out from the air change hand calculations, as seen in appendix. In these calculations, the air changes are calculated for the worst-case scenario for each room. The chosen aggregate system for the main building is a VEX160H-V from Echausto, which have the dimension 940x1800 mm [Echausto.dk, 2018]
A strategy and a requirement are to have exhausting in all the wet room and kitchen and have an inlet in all living spaces [Historisk.bygningsreglementet.dk, 2018]. It is important to create air balance, so there won't occur under pressure or overpressure. This is achieved by having the same amount of insufflation as exhausting, where afterward the ventilation tubes can be defined [Echausto.dk, 2018]. In the wintertime, the VAV system has a heat recovery to decrease some of the heat loss, where it in the summertime the systems can be swift out with natural ventilation. The VAV system is placed on the first floor in the technique room, where it delivers air to each floor.
On the plan layouts underneath, the distribution of the tubes is shown on each floor. Here the tubes will be hidden with a suspended ceiling and placed beside the beams. Only in the bathrooms with shower and the changing room, the ventilation system will be visible, because of the seaweed ceilings.

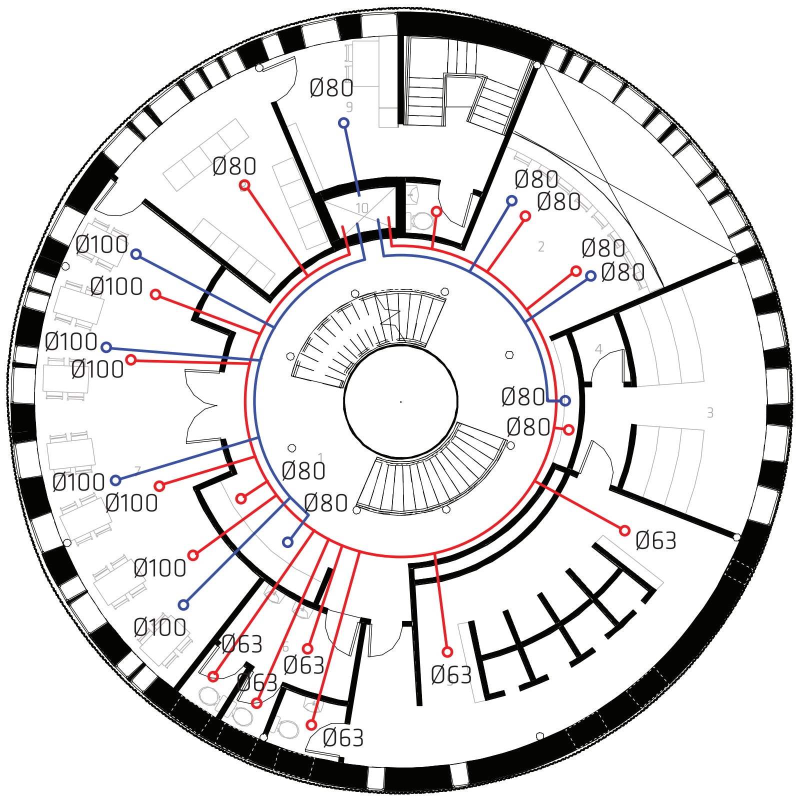
NATURAL VENTILATION

All the rooms are designed after the natural ventilation principles.

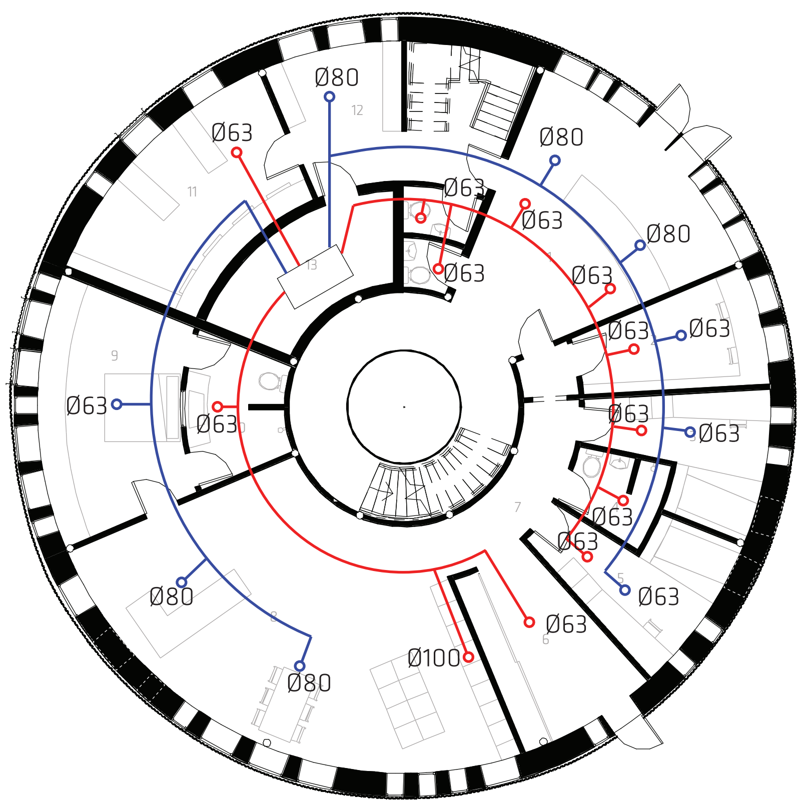
The thumb rule for single-sided ventilation:
Width <2 x The room's height.

▶ *Ill. 107.1: Ventilation pipes in the main building*

FIRST FLOOR



GROUND FLOOR



Exhaust pipes
Intake

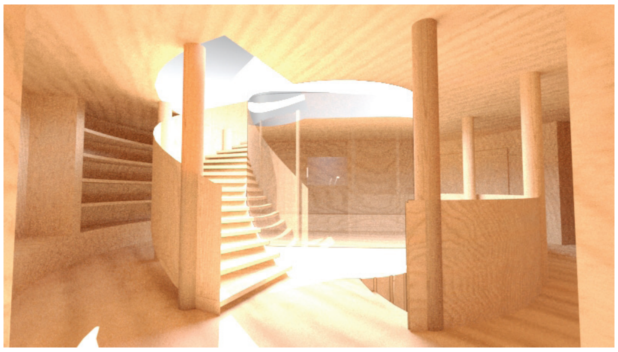
MAIN BUILDING

ATRIUM

As mentioned earlier, the idea of creating a glowing atrium come at the beginning of the design process. It ended up being the heart of the building, as the atrium what you see when entering the building from the reception and walks up the stairs to the social part of the atrium.

After the first couple of plan, drawings were made the, a render was made to show what the room would look like with the glass atrium and its surrounding integrated furnishing. It showed the hoped effect of the atrium lights up space with light from every direction. For the stairs, small wood columns were used to hold up the steps and still be open enough to spread the light in the room. Having a solid handrail around the stairs limits the light, hence the material for it should be transparent. Please note that these studies at first are made with a wood material texture, due to its ability to reflect light and still has visible shadows.

The wanted atmosphere for this space is to create the light effect of journey, where the columns would cast shadows to create this effect.



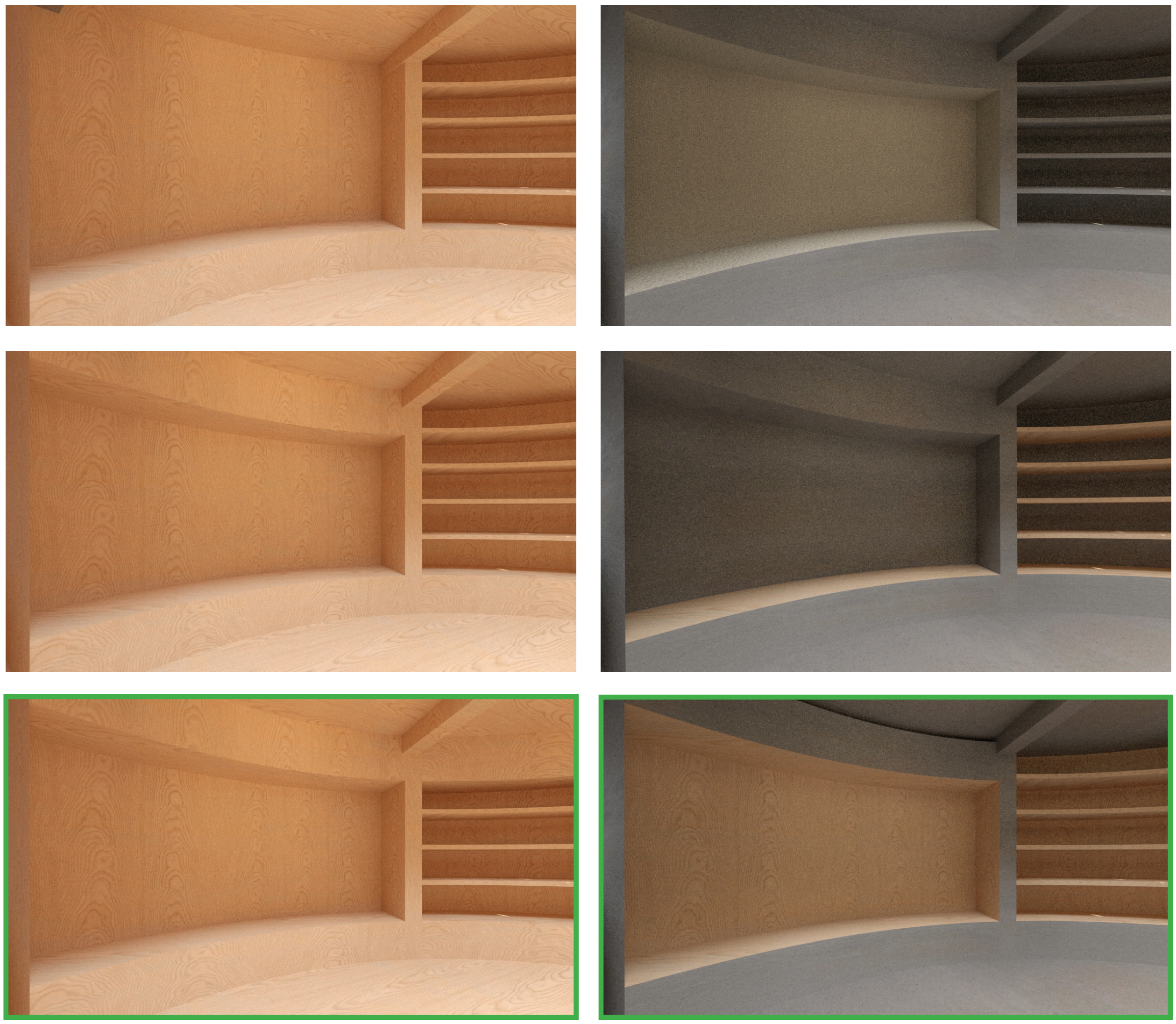
NICHES

For the social heart of the building, the atrium's niches were created for the guests to use a calm space to read in the travels books from the bookshelf, charge and/or check their phone, relax, etc. The first study of these niches is made in wood as well, where the study was to examine how the top part of it should be. The first one is designed to sit in the niche with a full height to the ceiling at 2500 mm. The next study is where the top part of the niches is moved a bit down to create a cave-like and safe feeling for the guests. The last one where the top part of the niche also affects the top part of the bookshelf to create an aligned look.

To create a calm and safe area and more simplified visual expression with the bookshelf has the last design been chosen. And to test how the feeling would be with that solution, its materiality is very important, so three renders have been made to show three scenarios of combinations of wood, flax fabric and concrete. The first solution is where everything is made of concrete except for the niche, that is made of a beige flax fabric. The second solution is where everything except the shelves and the seat of the niche is made of concrete. The seat and the shelves are made of pine wood. The last solution is where the inside of the niche is made of pine wood, and the entire bookshelf is made of pine wood as well.

Surrounded by the concrete these niches need to be calm and a place for the guest to relax, so the choice for the materials is the last option, with pine wood in the entire niche and bookshelf. The concrete creates a darker frame around the niches and bookshelf, that lights up with a warm pine wood color.

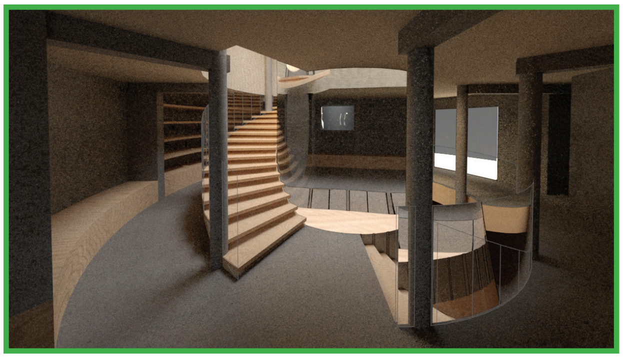
▲ *Ill. 108.1: The first render of the atrium*
▲ *Ill. 108.2: The stairs being supported by slim columns*
▲ *Ill. 108.3: Solid handrail on the stairs*
▶ *Ill. 109.1: The ceiling heigh niche*
▶ *Ill. 109.2: The lowered ceiling*
▶ *Ill. 109.3: The bookshelf's ceiling aligned with niche*
▶ *Ill. 109.4: Flax fabric in niche*
▶ *Ill. 109.5: Pine wood seating in the niche*
▶ *Ill. 109.6: Pine wood niche and bookshelf*

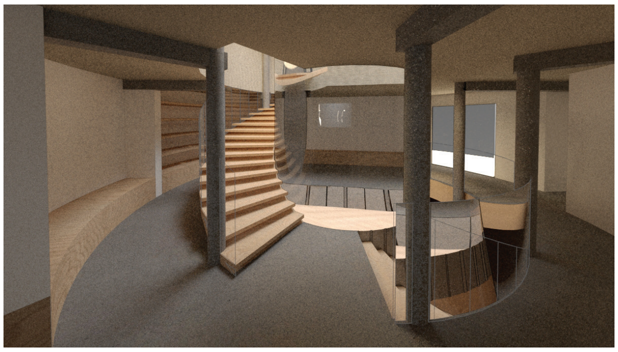


MAIN BUILDING

ATRIUM

The decision of the materials for the niches was made simultaneously with the material study for the rest of the atrium. For this study, the room started out being in all wooden material, which was to give an understanding of the room and its objects.





The two renders of the atrium with concrete material on it were made to examine the material of the walls. It was already decided that the ceiling should be made of flax linen with seaweed to ensure the acoustic performance of the room begins well. For these two renders, a dark grey concrete material was added to the wall, which made the room's shadows darker than if the material was made of white plaster walls. The white plaster walls made the entire room feel larger and more open than if a dark concrete was used. The room suddenly has a lot of different materials, which made it a bit messy and not simple and focused on the light as the wish was.

So, by choosing the concrete on the walls, there would be fewer variations of materials, but as these studies showed, the dark grey concrete was too dark for the room. Instead, a concrete texture of a brighter grey color was chosen, and the result of that choice can be seen on the next page.

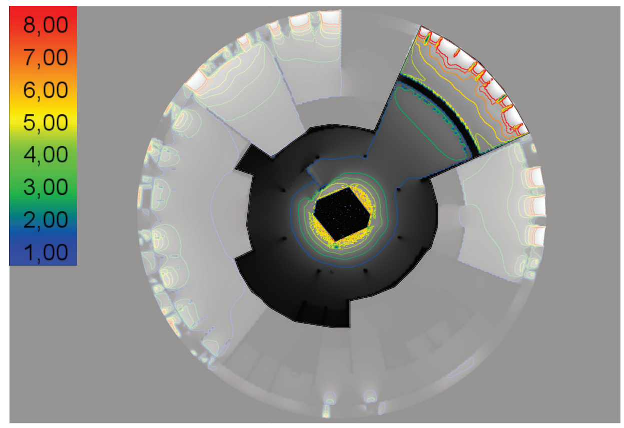
To ensure that the room would not be overheated from the atrium glass and the glass wall in the reception, which is a double height room, calculations were made. At first calculations for the need airflow and air change was made for the room with 25 people in it, as a worst-case scenario. The amount of needed ventilation for the room with that amount of people in it was inserted into the calculation for the size of the windows.
The aim for the maximum temperature was to be below 30 °C since this calculation is for Denmark and not the colder Iceland. Three different situations were looked at, where the first was for the room without having a suspended ceiling, with a room height of 3 m, for this solution the windows could be 34 m^2 in total to avoid the room being overheated.
With a suspended ceiling the room height is 2,5 m and the window can be 37 m2 with a thick curtain in front of it and 13 m^2 without any solar shading. The 2,5 m height room with 13 m^2 windows was the best fit for this room since the atrium should feel intimate. The curtains should not be used, since then would the guests not be able to enjoy the view from the lounge area.

▲ *Ill. 110.1-3: Material study of atrium*
▶ *Ill. 111.1: Ventilation calculation results*
▶ *Ill. 111.2: Temperature calculation results*
▶ *Ill. 111.3: Daylight factor*
▶ *Ill. 111.4: Direct sunlight*
▶ *Ill. 111.5: Diffused daylight*

An analysis of the daylight factor shows how the light from the atrium makes the atrium glow in the middle and creating darker and more intimate niches for the guests to feel safe and calm. From the windows on the façade, the lounge area is enlightened with daylight, which fits perfectly to the lounge area being a social and gathering space for the guest to play games and talk together.

Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
149	372,5	25	285	0,3	2,7

Atrium, recep,lounge	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	54	34	63,0	2,75	25,5	29,6
Thick curtain	54	37	68,5	2,75	26,2	29,8
2,5 m room height	54	13	24,1	6	23,6	26,9



DIRECT SUNLIGHT
21 June at 12.00 o'clock

DIFFUSED DAYLIGHT
21 June at 15.00 o'clock

MAIN BUILDING

DINING ROOM

The dining area is for the guest to eat their breakfast and dinner. It is assumed that the guest is out exploring Iceland during the day, hence eating lunch by themselves outside the resort. In the morning and the evening, the staff members cook food and arrange it as a buffet in the dining area, where the guests can eat and drink what they like.

Since the very first plan drawings of the main building have the dining room as a long room near the façade, for each guest to enjoy the view. This idea went through all the iterations of the dining area, which resulted in being on the west part of the building.

The placement of the dining area to the west is designed to give the guests the best view. The atmosphere for the room is to be calm so that they can enjoy their breakfast and dinner calmly while looking at the amazing nature outside their windows. In the west, the Mývatn Lake is located, which is full of a rich bird life during the warmer parts of the year, while in the winter the lake is covered with ice and snow.

The render to the right shows is the first visualization of the room with the tables along the windows to enjoy the view. In this render, the temperature was not calculated on but used to show the idea of having the tables near the view.

After calculating the needed ventilation for the room, the window sized was calculated for a room height of 3 m

and 2,5 m with and without a thick curtain and for a pull-down curtain. This calculation showed that to keep the temperature below 30 °C, as mentioned earlier, the size could be 10 m^2 without using any form of solar shading.

Using solar shading the view would disappear and the wanted atmosphere would not be achieved. The 10 m^2 was divided into the seven tables, whereas the dimensions of the windows varied.

By making use of one to two windows per table, the private atmosphere was achieved using room-in-room principle, where the light divides the room into smaller parts. As seen in the daylight factor plan, the lights from the windows show where the seven tables are going to be.

The walls are made of concrete with openings for the windows to let the light in. The ceiling is of flax linen with seaweed inside to achieve a good acoustic atmosphere.

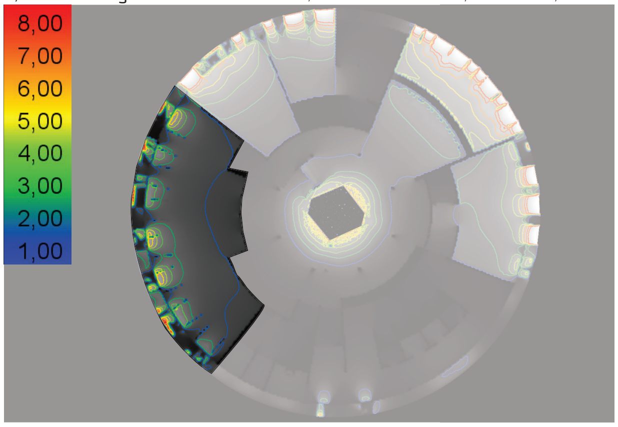
DIFFUSED DAYLIGHT
21 March at 8.00 o'clock

The flooring is made of pine wood, that gives the room a warm feeling and works well with the wooden tables. For the final design of the dining area is have the tables been integrated into the window frame, which makes the tables seem like they are extruded from the light. A render of this iteration and final design can be found in the second to last chapter, called presentations.

◀ *Ill. 112.1: First render of dining room*
◀ *Ill. 112.2: Diffused daylight*
▶ *Ill. 113.1: Ventilation calculation results*
▶ *Ill. 113.2: Temperature calculation results*
▶ *Ill. 113.3: Daylight factor*
▼ *Ill. 113.4: Direct sunlight*

Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
51	127,5	10	107,8	0,1	3

Dining room	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	51	13	25,5	6	25,2	29,4
Thick curtain	51	13	25,5	6	25,4	29,3
Pull-down curtain	51	24	47,1	6	25,3	29,1
2,5 m room height	51	10	19,6	6	25,6	29,5



DIRECT SUNLIGHT
21 June at 19.00 o'clock

MAIN BUILDING

RECEPTION AND LOUNGE

At the reception on the first floor, the guest will be met by the staff behind the reception desk. The desk is shaped from the circle and fits the lounge on the first floor.
Behind the reception desk, the guests will be led by the light where a curved hallway follows the perimeter of the atrium and ends at the bottom of a staircase to the first floor.

To iterations was made of the reception area to decide whether the room should be double height or not. The first render shows the room the guest would enter without the double height room. Here the room feels squished since it becomes narrower towards the hallway around the atrium.

The second render shows the first floor moved away from the façade, which makes the room feel larger and more welcoming. Just when entering the room, the guest can see the first floor and see a sneak peak of the lounge area. The area behind the reception desk becomes darker, so the guests must move into a passage of darkness and then into the atrium's beginning where the curiosity fills up the room as the guest walks up the stairs, and arriving at the lounge area, which they had a sneak peek of earlier.

The same procedure as for the previous rooms has the ventilation for the room been calculated to get the correct window sizes. Most of the façade is covered in windows, and as the calculations show, it would not be too hot in the room.
The reception desk has been pushed further into the room to minimize the amount of direct sunlight on the staff member standing behind the desk.

In the lounge area on the first floor, the handrail at the end is made of pine wood, so the area would not be covered in light from the large windows.
In the atrium space, a large amount of light from the

2,5 m room height

Double height room

façade would also ruin the wanted glowing effect of the daylight coming from the atrium. Inside the glass of the atrium stones from the lava formations near the drive way will be placed to get a relation to the dark context of dimmuborgir, but also as a contrast to the atrium of light.

The pinewood handrail creates an integrated furniture where a table extrudes from the handrail. This is a place meant for the guest to use their computers for checking emails, updates on weather and check up on where the next exploration is going to be.
Lounge chairs are placed for the guests to relax in while chatting with the other guests.

◀ *Ill. 114.1: 2,5 m room height*
◀ *Ill. 114.2: Double height room*
▶ *Ill. 115.1: Ventilation calculation results*
▶ *Ill. 115.2: Temperature calculation results*
▶ *Ill. 115.3: Daylight factor*
▼ *Ill. 115.4: Direct sunlight*
▼ *Ill. 115.5: Diffused sunlight*

Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
149	372,5	25	285	0,3	2,7

Atrium, recep,lounge	Area	Window	Window	Airchange	Daily mean	Max temp
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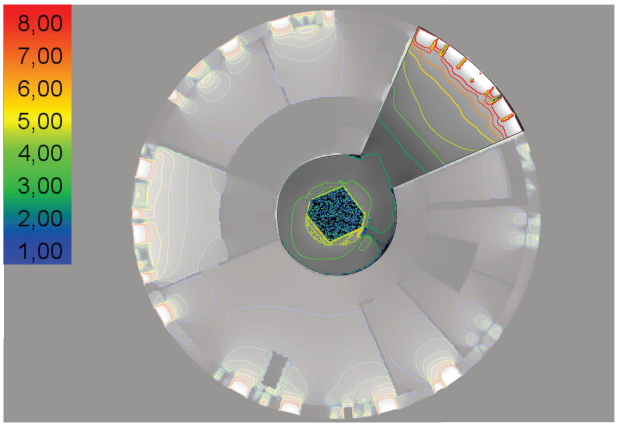
Thick curtain	54	37	68,5	2,75	26,2	29,8
2,5 m room height	54	13	24,1	6	23,6	26,9



DIRECT SUNLIGHT
21 June at 6.00 o'clock

DIFFUSED DAYLIGHT
21 June at 12.00 o'clock

DIRECT SUNLIGHT
21 June at 8.00 o'clock

DIFFUSED DAYLIGHT
21 June at 19.00 o'clock

MAIN BUILDING

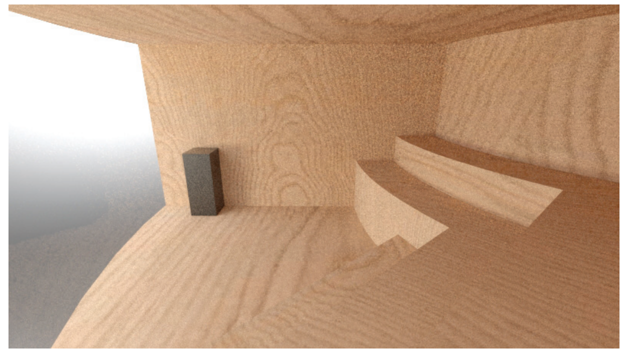
SAUNA

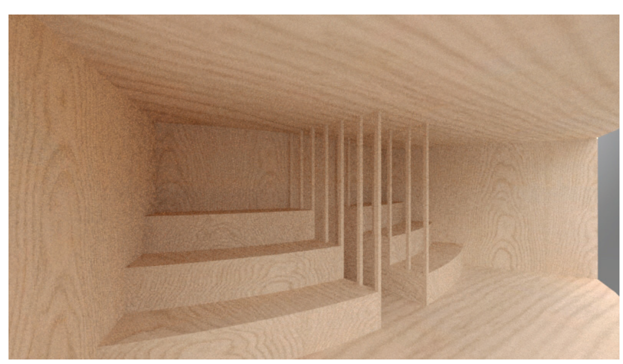
The sauna is a requirement from the competition [Iceland Northern Lights Rooms, 2017], but also a room that has been through a lot of studies to ensure that the room achieves an atmosphere of calm and silent – a place for the guest to experience the nature of volcanoes and mountains, while enjoying the experience of the sauna itself. The view from the sauna is the east of the site, where the master plan is designed for the guests on its benches to have a minimal view of the resort's parking lot.

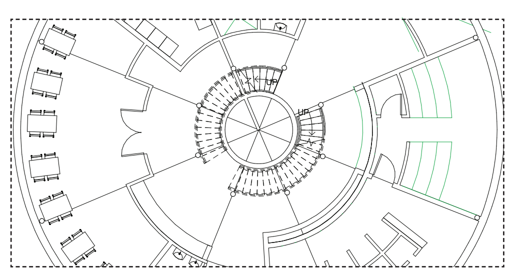
Iterations of the sauna's interior have been made since the plan drawings began. The original idea was to use the circle to shape the benches in the sauna, as seen on the top render. In many plan iterations, the sauna was designed with an entrance from its side, and the guest comes into to the benches straight away. Later iterations of the sauna were with an entrance from the middle of the benches.

In this iteration, the benches are placed along the wall, so that all the guests are turning towards the windows and not each other. This creates a more intimate and private atmosphere.

The entrance being in the middle creates an atmosphere of surprise and wonder when walking into the sauna from a dark hallway, turning to the right and then into an entrance of columns along the benches, as seen in the bottom plan drawing (the green lines are the benches). Other than the guest not be able the see the sauna when they enter the door into it, the guest can use its other sense to explorer the entrance. The exciting element of listing to the voices and breaths of the people sitting in the sauna, make them becoming more drawn to the benches around the corner.

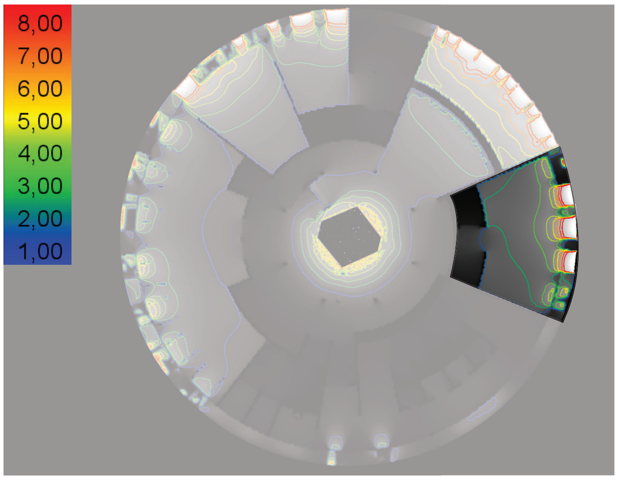






▲ *Ill. 116.1-4: Interior studies*
▶ *Ill. 116.5: Plan of sauna*
▶ *Ill. 117.1: Daylight factor*
▶ *Ill. 117.2-3: Material study*
▼ *Ill. 117.4: Direct sunlight*
▼ *Ill. 117.5: Diffused sunlight*

To make sure that the people on the top bench get enough daylight factor, a study of it showed that the light reaches the benches.
The windows are placed with the biggest and tallest one at the center of the entrance, so the person walking into the sauna is walking towards the light. In front of the benches, wide windows are placed for the people to enjoy the view.



A study of the materiality showed how the combination of concrete and pinewood could be. The first one was of a concrete floor, ceiling, and walls. This creates a hard room with soft furnishing, which not was the intention. T
he second iteration was basically the same as the previous one, except that the walls are made of wood to ensure that it would pleasant for the guest to lean against the wall.
The third and final iteration is where the furnishing, internal walls and the floor is of pine wood, and the ceiling and external wall is of concrete. This makes sure that the guest can walk on the wood floor and feel comfortable with the heat.

Concrete walls, roof and floor
Wooden furnishing and columns

Concrete roof and floor
Wooden furnishing, columns and walls

DIRECT SUNLIGHT
21 June at 10.00 o'clock

DIFFUSED DAYLIGHT
21 June at 18.00 o'clock

MAIN BUILDING

SAUNA

This is a study of how many columns should be placed and the arrangement thereof. The columns are used to create privacy for the guest sitting on the bench while a new one enters the sauna – the sauna will be used as a visual shield, but also a guidance into the sauna.

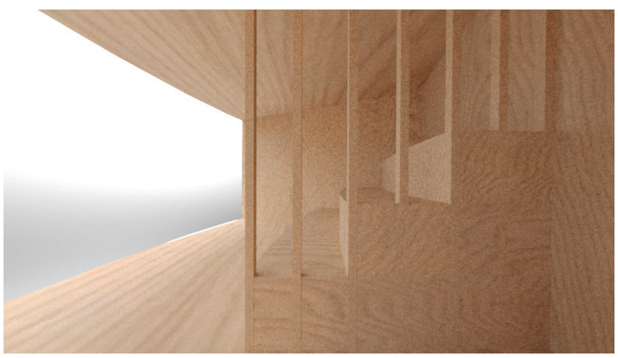
At the first iteration, the columns are of an equal number of on each bench and this does not shield enough for the guest. By placing them with a gradient, with the most columns near the top bench, the guests entering the sauna will be met by a darker hallway that ends in light.

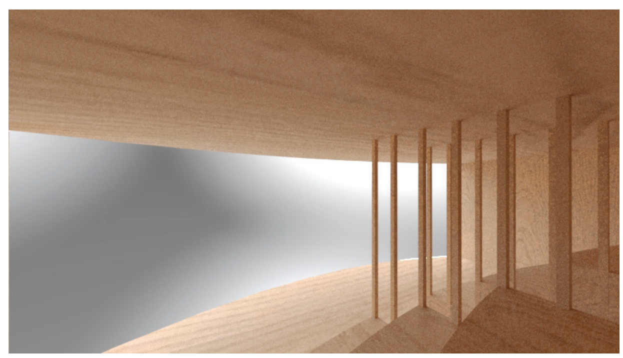
It also shields for the people sitting the top bench for the people to look at them, which is very important here due to the eye height that bench begins in.

Two iterations of this gradient were made. The first one is two columns on the lowest bench, then three and four columns. The second iteration is of three columns on the lowest bench, then four and five.
Based on these iterations the chosen type is the last one, due to it being the most private one but also creates a good experience walking into the sauna.

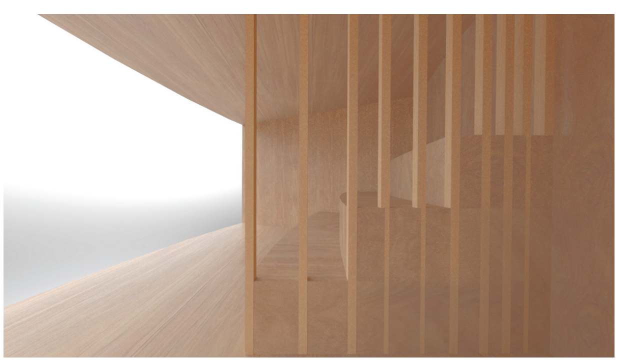
▼ *Ill. 118.1-6: Interior studies*
▶ *Ill. 119.1-6: Interior studies*

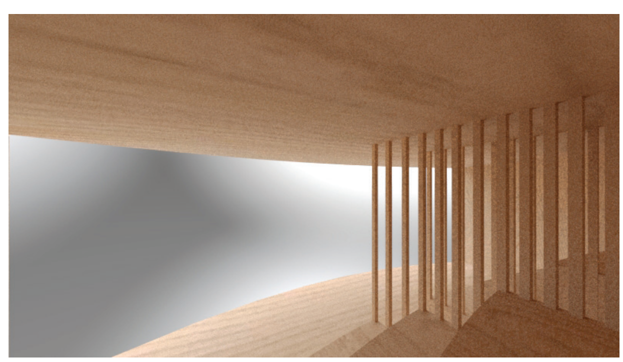
Two columns pr bench



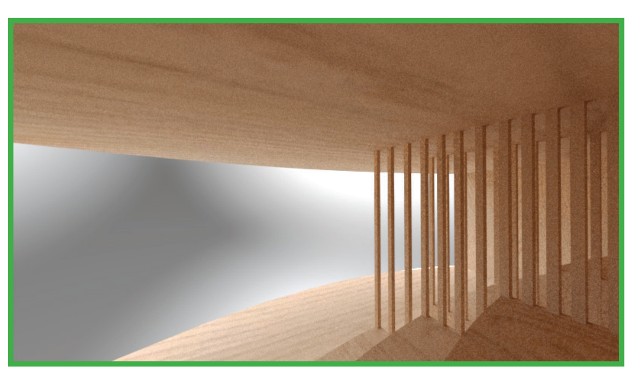


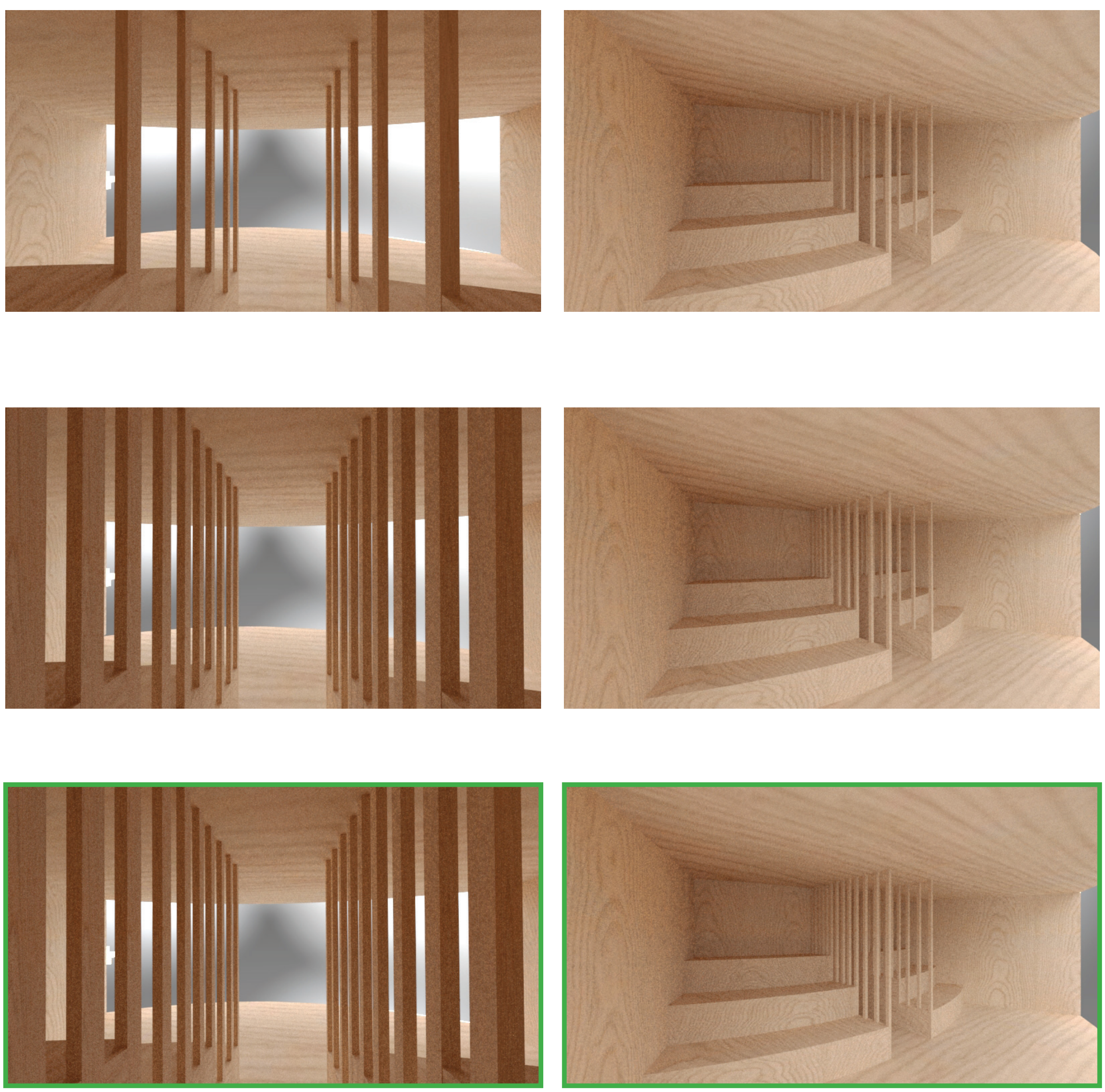
Gradient of columns - two, three, four





Gradient of columns - three, four, five





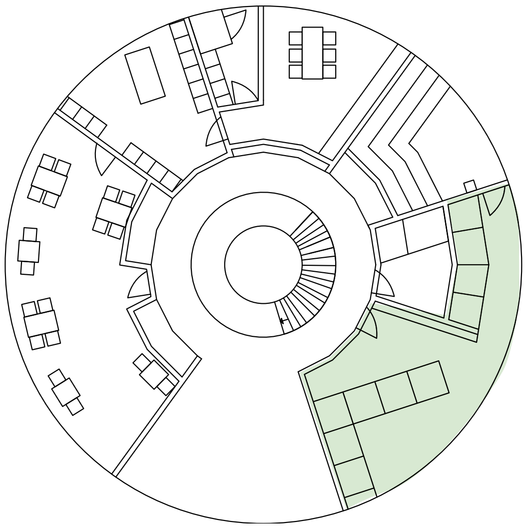
MAIN BUILDING

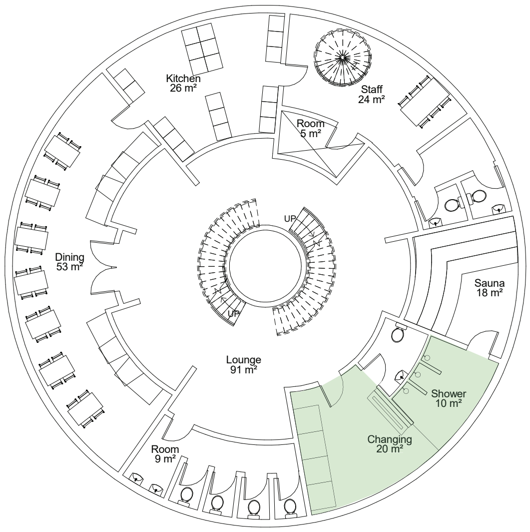
CHANGING ROOM

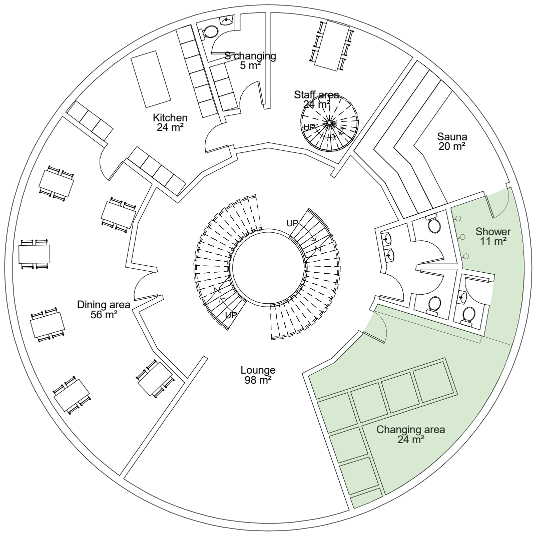
The changing room for the sauna has been through a lot of iterations, due to making the furnishing fit its function. This changing room is a unisex room, so it was important not only to have showers with locked doors but also minor changing rooms within the changing room.

Other than the shower should a toilet be placed in the changing room to avoid people walking out of the sauna and changing room and into the atrium to get to the nearest toilet. To ensure that the pipelines would be short the showers and the toilet would be placed near the other toilets and fit well with the bathroom or kitchen on the ground floor.

The changing room should be light experience as well, which is the reason why on these iterations that all have a short hallway before entering the sauna. At this hallway would the showers and toilet be placed, to be near the sauna and to avoid wet floor in the changing part of the room.







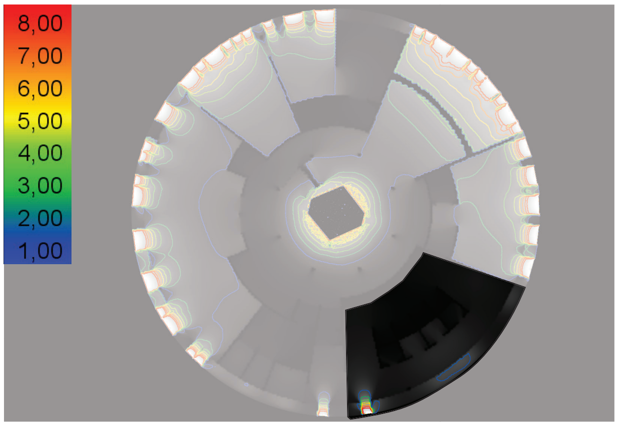
▲ *Ill. 120.1-3: Interior studies*
▶ *Ill. 121.1: Ventilation calculation results*
▶ *Ill. 121.2: Temperature calculation results*
▶ *Ill. 121.3: Daylight factor*
▶ *Ill. 121.4: Direct sunlight*
▶ *Ill. 121.5: Diffused sunlight*

From the calculated ventilation for this room has the window size been calculated to 1,4 m2. The windows are divided into two smaller windows near the changing rooms. To send the light to the shower area on the other side of the wall has the height of the wall been lowered to 2100 mm.

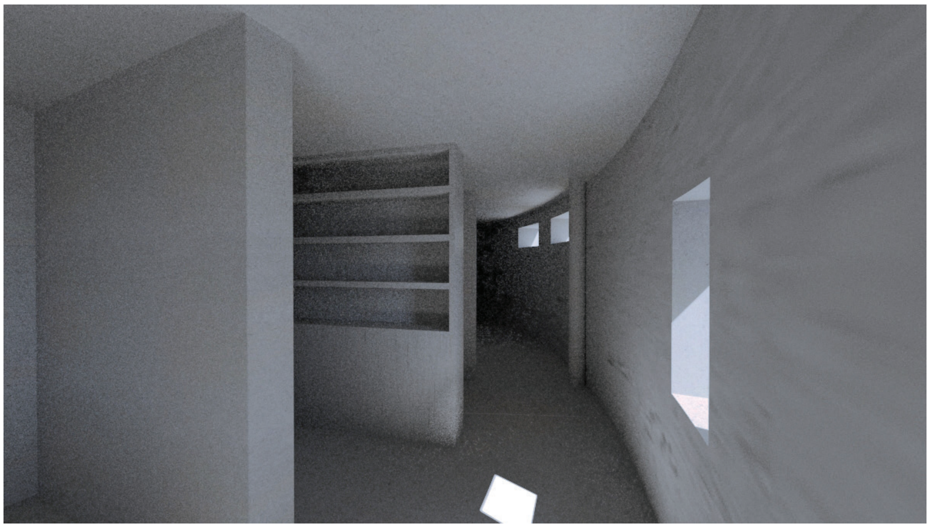
At each end of the showers is a storage unit for the guest to put their towels and lock away their belongings. Here and at the entrance is a medium sized window placed for more daylight in the less private zone of this room.

Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
43	107,5	-	15	0,015	0,5

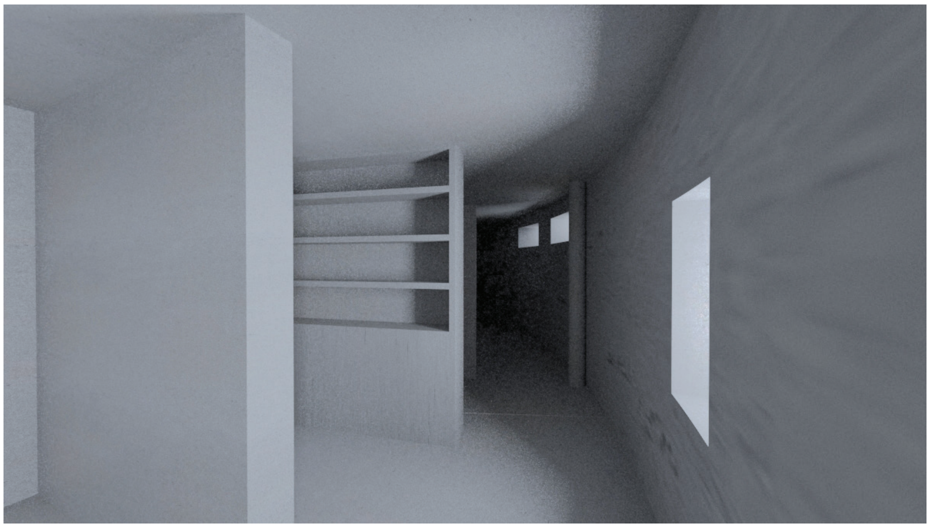
Changeing room	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	43	2	4,7	0,5	28,6	29,7
Thick curtain	43	2	4,7	0,5	28,9	29,8
2,5 m room height	43	1,4	3,3	0,5	28,9	29,8



DIRECT SUNLIGHT
21 June at 12.00 o'clock



DIFFUSED DAYLIGHT
21 June at 15.00 o'clock



MAIN BUILDING

KITCHEN

In the kitchen, the staff members will make breakfast and dinner for the guest during the day. Due to it being a functional work environment the light in this room is very important to go deep into the room. Daylight studies are made based on the amount of ventilation need for this room with five staff members working in it. From the need airflow, the size of the windows was calculated. Due to the room needs to be functional the room need to have no solar shading, and with a room height of 2,5 m, the window area becomes 8m2. The light from these windows reaches far into the kitchen.

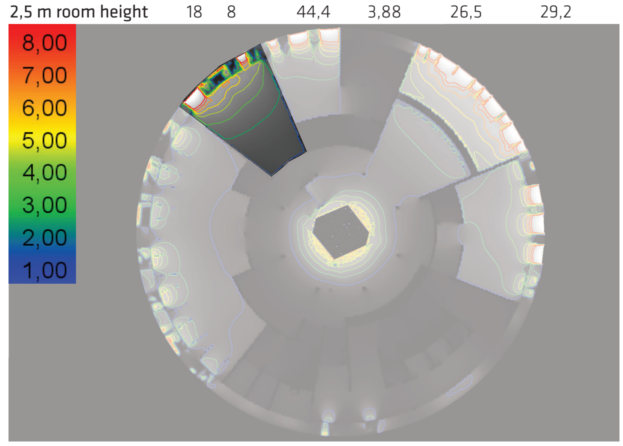
Iterations of the furnishing was a lot, due to the circular shape makes a room that requires handcrafted kitchen elements. The final solution was to take advantage of the depth of the room, where the kitchen elements would be placed along the straight wall. At the end is a working station for the waiters to get the ready food.

The furniture will be made of pine wood, while the floor and walls will be made of concrete. As for the rest of the building, the ceiling is made of seaweed and flax linen.

▶ *Ill. 122.1: Ventilation calculation results*
▶ *Ill. 122.2: Temperature calculation results*
▶ *Ill. 122.3: Interior study*
▶ *Ill. 122.4: Daylight factor*
▼ *Ill. 122.5: Direct sunlight*
▼ *Ill. 122.6: Diffused sunlight*

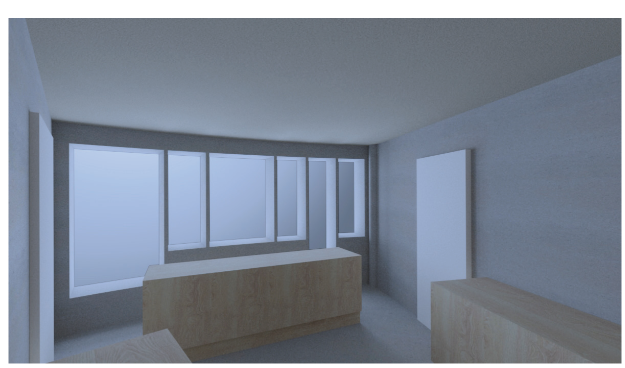
Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
18	45	5	48,6	0,04	3,8

Kitchen	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	18	11	61,1	3,88	26,3	29,4
Thick curtain	18	12,5	69,4	3,88	26,8	29,6
2,5 m room height	18	8	44,4	3,88	26,5	29,2



DIRECT SUNLIGHT
21 June at 20.00 o'clock

DIFFUSED DAYLIGHT
21 June at 10.00 o'clock



MAIN BUILDING

STAFF

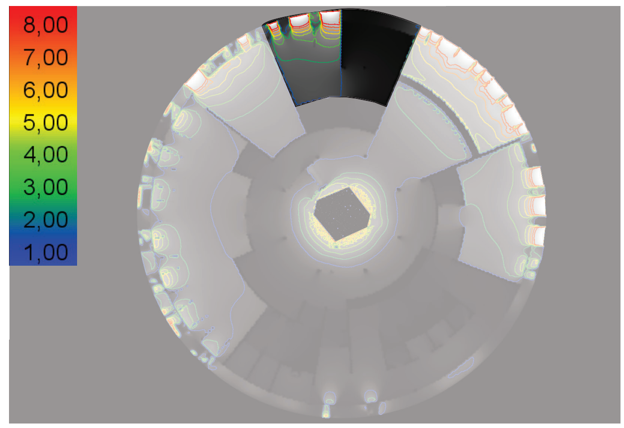
The staff room is made for the staff members to have a place to take a break and relax. They enter it from their own staircase that is placed within the room, or through the kitchen and then to the atrium.

This room is made with a focus on the staff members to have a quiet and calm place to be, which is why the amount of furniture has been kept to a minimum to keep a simple design.
A bench is made from the window, which makes it possible for the staff member to sit in the window and enjoy the view when the person is on its break. A large dining table is placed together with the bench a two seating.

▶ *Ill. 123.1: Ventilation calculation results*
▶ *Ill. 123.2: Temperature calculation results*
▶ *Ill. 123.3: Interior study*
▶ *Ill. 123.4: Daylight factor*
▼ *Ill. 123.5: Direct sunlight*
▼ *Ill. 123.6: Diffused sunlight*

Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
23	57,5	5	52,1	0,05	3,26

Staff room	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	23	13	56,5	3,26	26,7	29,7
Thick curtain	23	15	65,2	3,26	26,5	29,3
2,5 m room height	23	11	47,8	3,26	26,8	29,6



DIRECT SUNLIGHT
21 June at 22.00 o'clock

DIFFUSED DAYLIGHT
21 June at 16.00 o'clock

MAIN BUILDING

LIVING ROOM AND KITCHEN

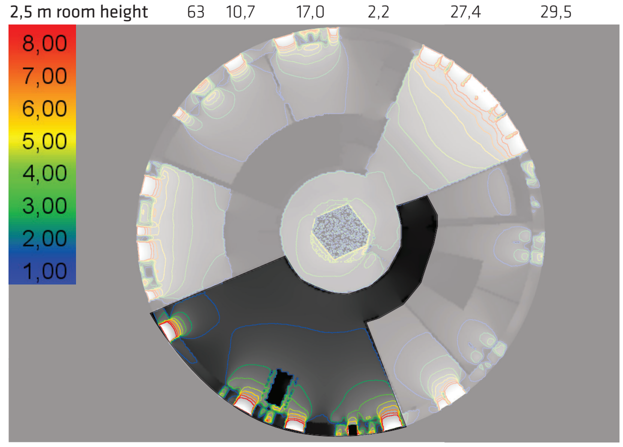
In the family's part of the main building is the living room and kitchen merged into one room, as the social gathering part of their home. In this room, they will cook, eat and relax together as a family.
The kitchen is the first area when you enter this room. A kitchen island is placed for the family to cook together and for the parents to watch over their small children playing in the room. Here the windows are large to get enough functional light into the working zone.

The windows are placed in an exciting way, which also includes the windows near the dining area. For the living room area by the sofa, the windows are smaller, creating a darker more intimate and calm area for the family to relax in.

▶ *Ill. 124.1: Ventilation calculation results*
▶ *Ill. 124.2: Temperature calculation results*
▶ *Ill. 124.3: Daylight factor*
▼ *Ill. 124.4: Direct sunlight*
▼ *Ill. 124.5: Diffused sunlight*

Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
63	157,5	4	73,6	0,07	1,7

Kitchen, livingroom	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	63	14	22,2	2,2	27,1	29,5
Thick curtain	63	15	23,8	2,2	27,3	29,4
2,5 m room height	63	10,7	17,0	2,2	27,4	29,5



DIRECT SUNLIGHT
21 June at 15.00 o'clock

DIFFUSED DAYLIGHT
21 June at 22.00 o'clock

MAIN BUILDING

MASTER BEDROOM

For the parents of the family, the master bedroom will be their calm, private space. Behind the room is their master bathroom, which will have two doors on each side of the bed. The bed is located in the middle of the curved wall into the bathroom. From their bed, they will have a panoramic view to the Mÿvatn Lake.

The windows for the rooms have been calculated on based on the needed air change for the room. In front of the windows is a large bench for them to enjoy the view from the windows. The bench has another function, which is to store their clothes and items.

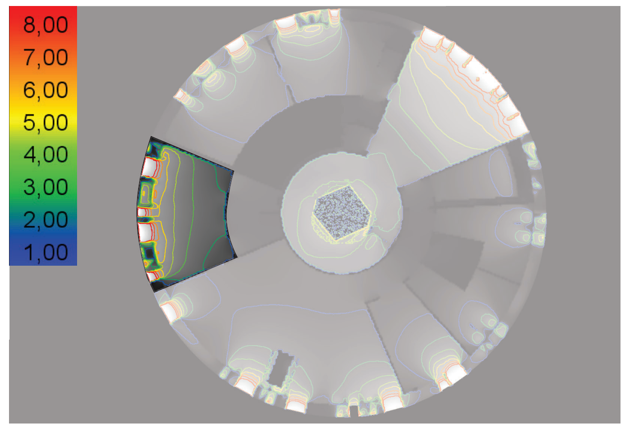
The amount of windows creates a daylight-filled room and during the night possibilities to watch the northern lights from their bed or from the bench by the window.

The furniture along the winds and the floor is made of wood to mae the parents feel at home in a warm environment.

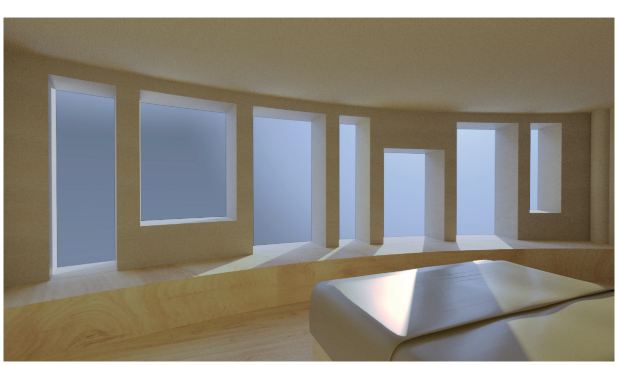
▶ *Ill. 125.1: Ventilation calculation results*
▶ *Ill. 125.2: Temperature calculation results*
▶ *Ill. 125.3: Interior study*
▶ *Ill. 125.4: Daylight factor*
▼ *Ill. 125.5: Direct sunlight*
▼ *Ill. 125.6: Diffused sunlight*

Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
24	60	2	31,4	0,03	1,8

Master bedroom	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	24	12	50,0	1,88	28,1	29,5
Thick curtain	24	13	54,2	1,88	28,2	29,5
2,5 m room height	24	9	37,5	1,88	28,4	29,6



DIRECT SUNLIGHT
21 June at 22.00 o'clock



DIFFUSED DAYLIGHT
21 June at 11.00 o'clock

MAIN BUILDING

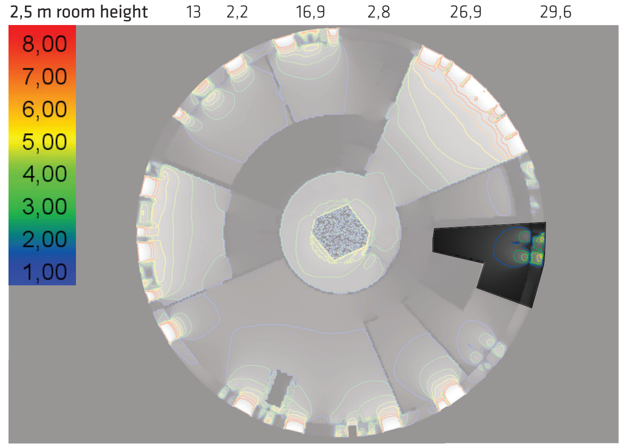
CHILDREN'S ROOM

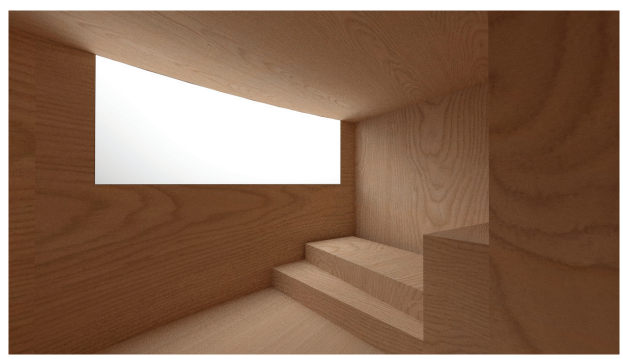
The two children's rooms are placed next to each other with a shared bathroom between them. The bathroom's placements create a niche, where an integrated bed is made. The bed has a step up and then a normal sized 900x2000 mm madras can be placed as a bed.
At the top part of the bed, near where the head is, a closet is placed, for the children to use for clothes or toys. On the opposite of the bed, there is enough space for the child to furnish as wished with a desk or play area, etc. As the previous rooms, first, the ventilation for the room calculated and then the temperature to get a window size. In this room are three windows placed; a small one over the bed, where it is possible to hang a TV under, a large one next to the bed and a medium sized. The medium sized is chosen due to the possibilities for the children to furnish this corner as wanted, where with a tall placed window it would be easier to place a desk or large doll house, etc. The floor is made of pine wood to make the room feel warm next to the concrete walls, and for the children to play on.

▶ *Ill. 126.1: Ventilation calculation results*
▶ *Ill. 126.2: Temperature calculation results*
▶ *Ill. 126.3: Interior study*
▶ *Ill. 126.4: Daylight factor*
▼ *Ill. 126.5: Direct sunlight*
▼ *Ill. 126.6: Diffused sunlight*

Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
13	32,5	1	16,4	0,01	1,8

Children's room	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	13	2,8	21,5	2,8	26,5	29,4
Thick curtain	13	3	23,1	2,8	26,8	29,4
2,5 m room height	13	2,2	16,9	2,8	26,9	29,6





DIRECT SUNLIGHT
21 June at 20.00 o'clock

DIFFUSED DAYLIGHT
21 June at 16.00 o'clock

MAIN BUILDING

CHILDREN'S BATHROOM

As mentioned between the two children's room is their bathroom located. The walls and floor are made of concrete due to it being a wet room, that can be filled with damp.

The cabinet with the sink in is made of wood and is a shield from the water by the wall between it and the shower.

On the wall near the shower are two windows placed near the ceiling. Each of them is placed into the wall of the children's room, so get light in from their windows. The glass will be made of frosted glass, so it would not be possible to see into the bathroom from windows.

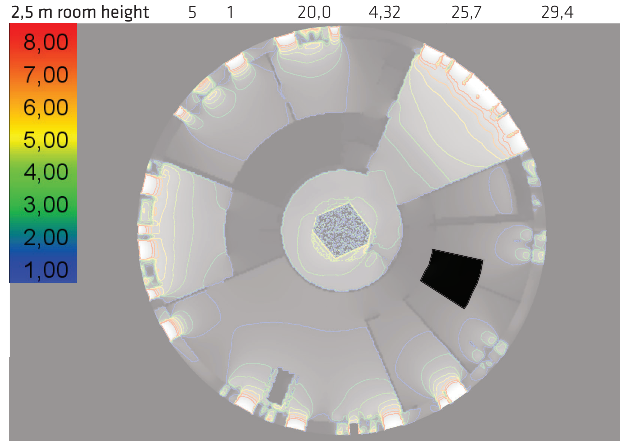
The windows are only used for daylight and not for ventilation since the moist air should not enter the children's rooms.

Mechanical ventilation is added and calculated for.

▶ *Ill. 127.1: Ventilation calculation results*
▶ *Ill. 127.2: Temperature calculation results*
▶ *Ill. 127.3: Daylight factor*
▼ *Ill. 127.4: Diffused sunlight*

Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
5	12,5	-	15	0,015	4,3

Children's bath	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	5	1,3	26,0	4,32	25,4	29,4
Thick curtain	5	1,5	30,0	4,32	25,9	29,7
2,5 m room height	5	1	20,0	4,32	25,7	29,4



DIFFUSED DAYLIGHT
21 June at 12.00 o'clock

two person cabin
studies

To find the best form for this cabin type several studies were made of five different forms. The five forms went through studies of their performance in a wind simulator at 10 m/s, the view from their beds, daylight factor, lux, ventilation, and temperature. Afterward the chosen shape's roof was studied to find the optimal type according to the view perspective from the bed. Details in the final shape were made by making studies of the interior and material. Finally, using daylight factors, ventilation, and temperature the window placement was found for the bedroom and the bathroom.

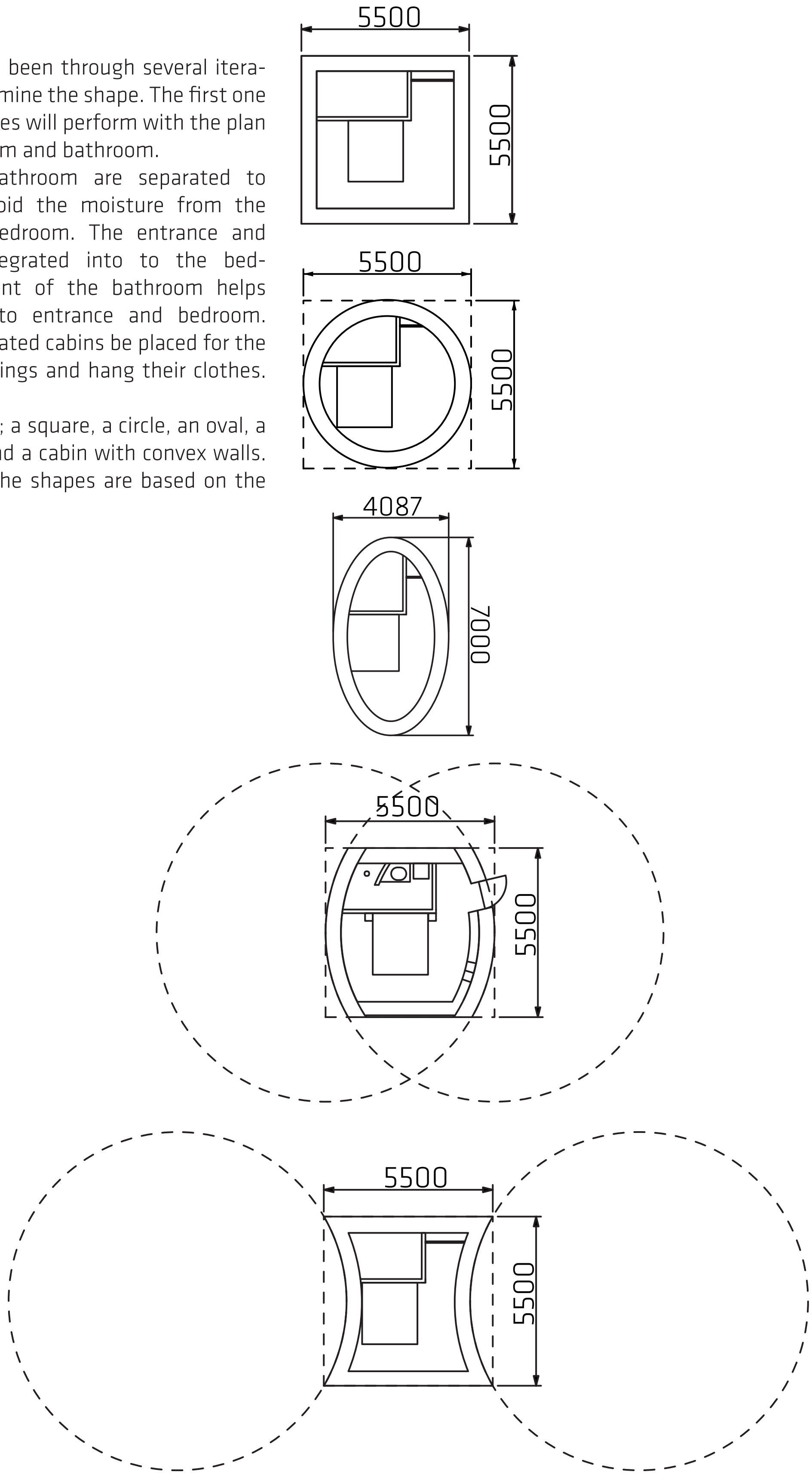
TWO PERSON CABIN

FORM STUDIES

The shape of the cabin has been through several iterations of the factors to determine the shape. The first one is of how the different shapes will perform with the plan layout of the cabin's bedroom and bathroom.
The bedroom and the bathroom are separated to ensure privacy and to avoid the moisture from the bathroom to enter the bedroom. The entrance and storage area will be integrated into to the bedroom, where the placement of the bathroom helps dividing the space up into entrance and bedroom. Along the wall would integrated cabins be placed for the guest to store their belongings and hang their clothes.

Five shapes were examined; a square, a circle, an oval, a cabin with concave walls and a cabin with convex walls. Except for the square, all the shapes are based on the circle concept.

▶ *Ill. 130.1: Form study*
▶ *Ill. 131.2: Wind study*

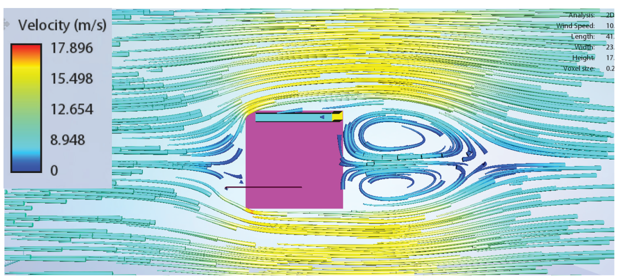


TWO PERSON CABIN

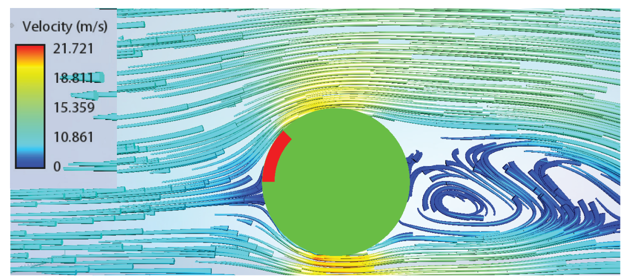
WIND STUDIES

Wind studies of each shape were made to examine how the different shapes perform. The aim is for the shape to create a calm, low-velocity area around the shape, and not increasing the velocity. This study is made with 10 m/s velocity wind coming from the left of the picture. The square increases the velocity on each of its sides.
Behind the shape, turbulence is created due to the high-velocity winds on each side affecting this area. The second one is the circle that also creates high-velocity winds on its sides, close to the façade. The oval creates as well high velocity on each side no matter which was winds comes from. Behind it, a lot of turbulence is created. The concave creates the lowest velocity on its side, but also creates turbulence behind the building. The convex is the worst in this study since it creates the highest velocity close to the building – no matter which way the winds comes from. The best performer in this wind study is the concaved shape. More wind studies can be found in appendix.

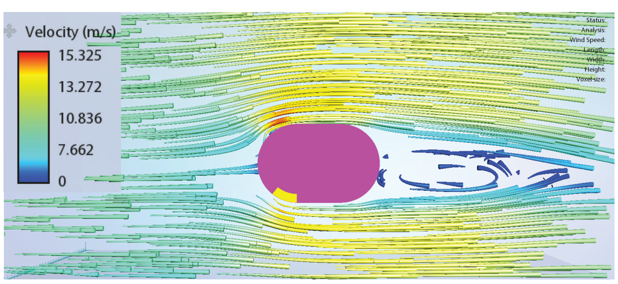
THE SQUARE

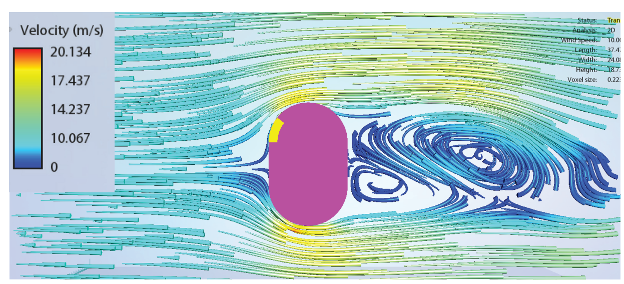


THE CIRCLE

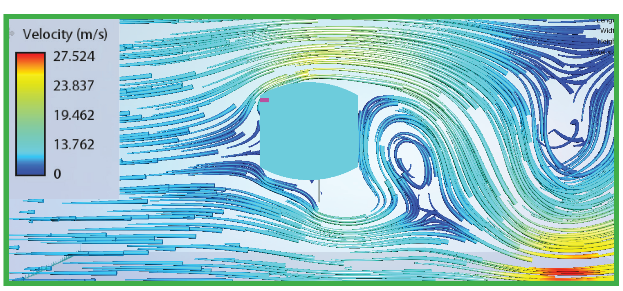


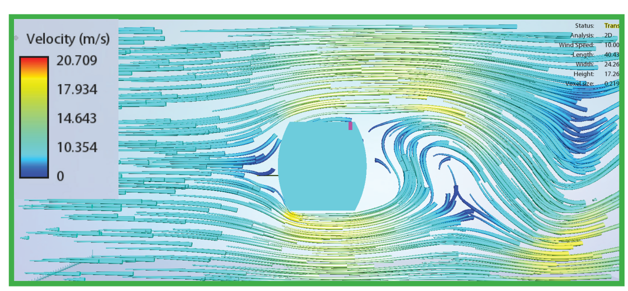
THE OVAL



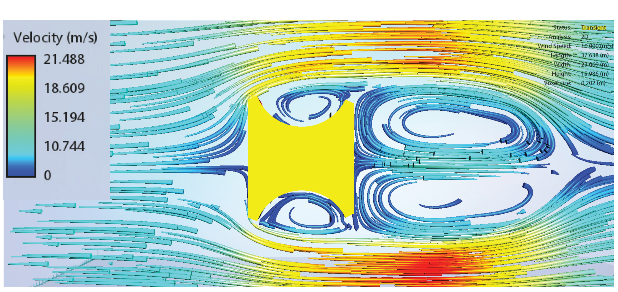


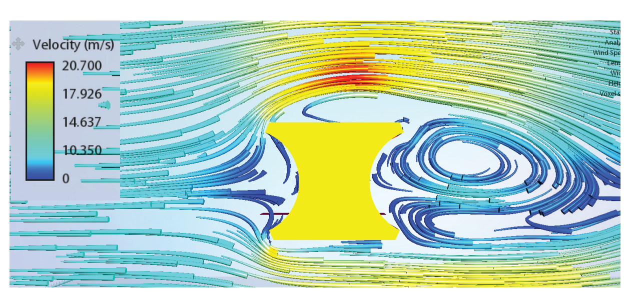
THE CONCAVE





THE CONVEX



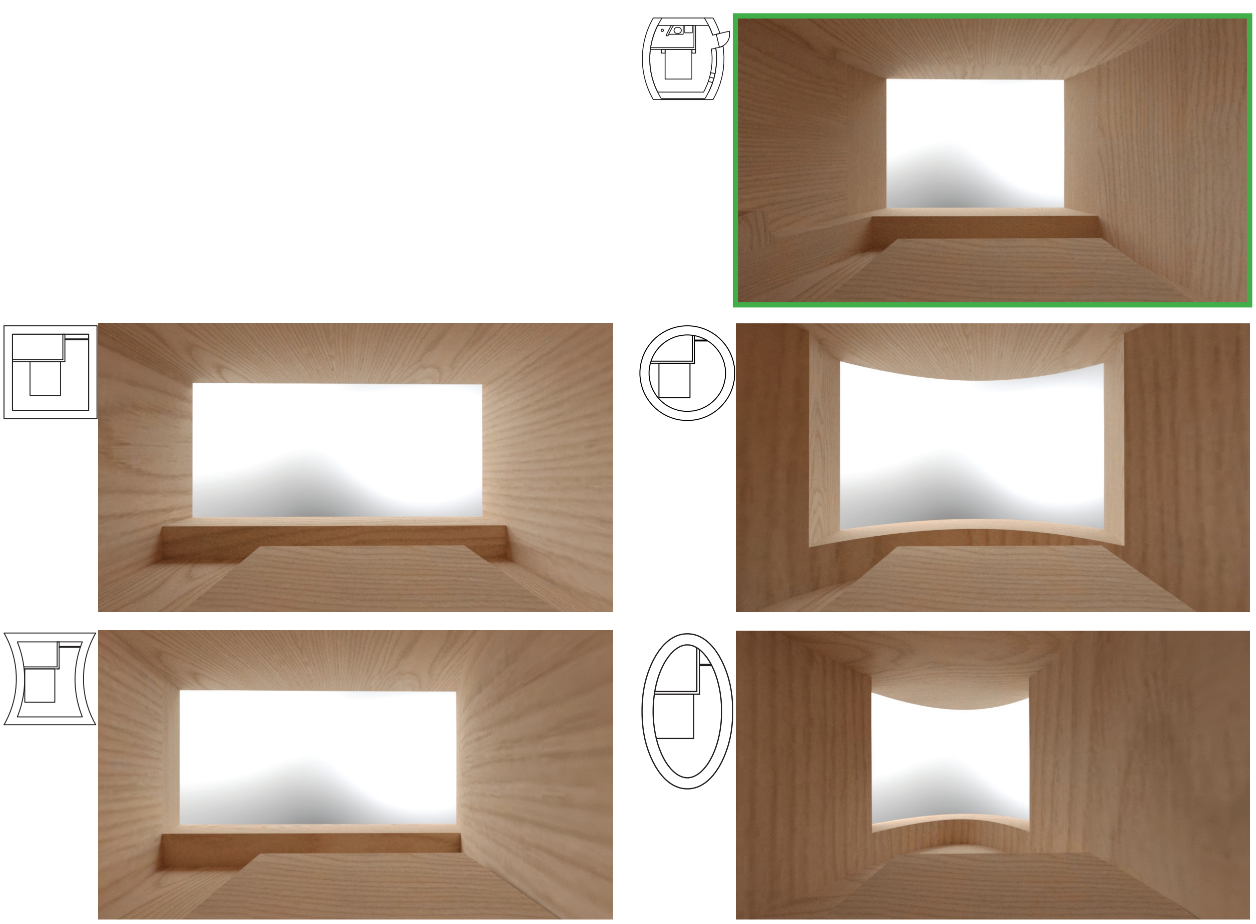


TWO PERSON CABIN

FORM STUDIES

From the bed should the guest be able to enjoy the northern lights but also the view during the day. Hence, a study of the view from their beds has been made to see how the light would be reflected into the room and to create an atmosphere of walking towards the light. All the shapes have been furnished the same way, where and the renders are made from their bed towards the windows. In this render all the windows are large to show what the shape can offer in size of the windows. A bench has been placed under each window to create a seating area near the window. By doing this the cabin can be smaller since no space has to be made for lounge chairs.
The square creates a room full of corners and a very large window. The light comes straight into the room but is the feeling of walking towards the light is not achieved due to the window being so large and close to the bed.
The convex shape makes the room feel squeezed near the bed, and the window becomes very large at the end. Looking at the plan drawing it is visible that this shape creates sharp corners and a narrow hallway. The bed can only be access from one side, due to the wall being next to it.
The concave shape makes enough space for the guest to walk on each side of the bed. From the bed, the wall helps the eye being guided to the window at the end. The window is a good size for this room and fits well with the placement of the bed.
The square creates more space in the hallway but still not enough next to the bed. The window becomes a curved shape and the guest seating in the window would be very exposed from its sides since the window moves around the seated person.
The last one is the oval, where the room becomes very long and create a lot of wasted space at the end near the window. The window moves around the guest seating in it, even more, compared to the circular shape.

▼ *Ill. 132.1: Form study*
▶ *Ill. 133.2: Evaluation schedule*
▶ *Ill. 133.2: Daylight factor and lux for June and Decemeber*



TWO PERSON CABIN

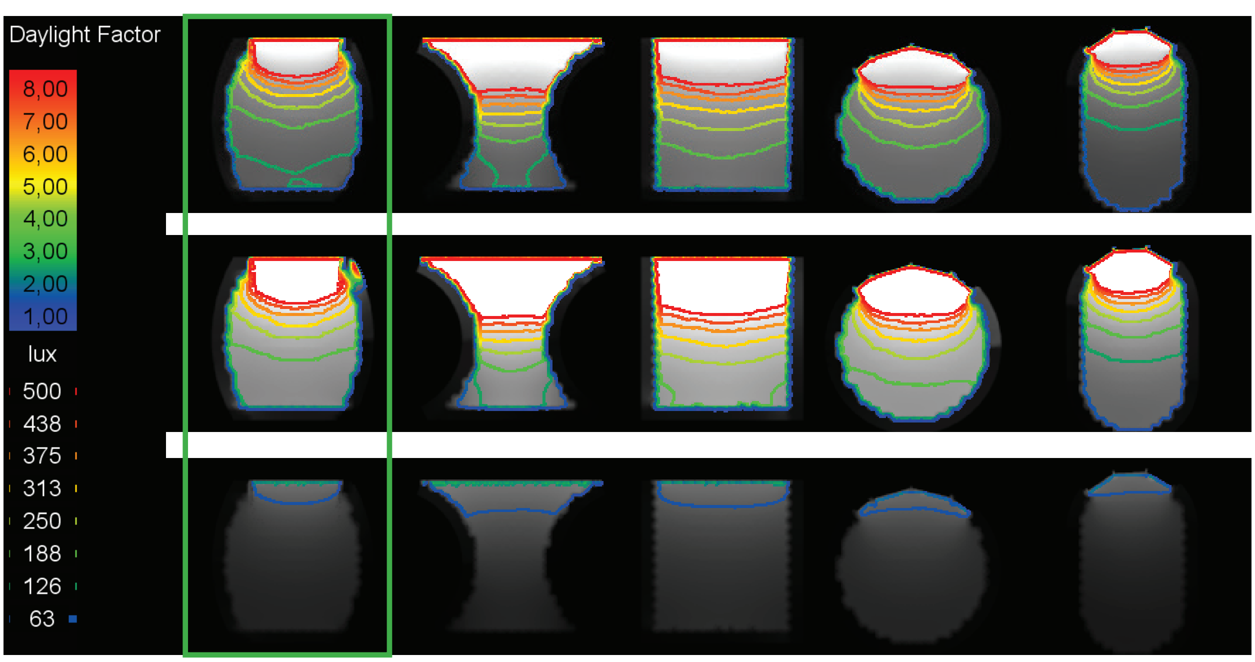
WINDOW STUDIES

Each shape was tested for its daylight performance to see how the shape would reflect or minimize the amount of sunlight in the room. Daylight should be able to reach into the middle of the room, since that is where the internal wall is, hence where the guest's head would be in the bed.
The concave center most of its daylight near the windows but still reaches into the middle of the room.
The convex shape creates too much daylight in the room. At atmosphere should be calm for the guest to relax in their cabins. The same happens with the square shape, which actually gets filled with light the most.
The circle creates sunlight where near the windows and the light comes further into the room then the concave shape, which is not necessary.
The oval is the one that creates the least amount of daylight since it is a long and narrow shape.
This study was also made for these shapes with 22 % of window area, which can be found in the appendix.

Based on these three studies of the shapes the best shape for this cabin is the concave shape. To make that decidtion each of the shapes was evaluated in a schedule as seen below. Each shape was evaluated in the different parameters on a scale from 1-5, where 5 is the best. The total score shows that the concave shape is by far the most suitable shaped.

WINDOWS	Concave	Convex	Square	Circle	Oval
22% window area	5	1	1	1	2
Daily mean temperature	5	3	2	1	4
The view in relation to the walls	5	3	3	2	3
Spatial experience	4	2	3	3	3
Waste area	5	2	3	4	1
Furnishing - standard vs. handcrafted	1	1	5	4	1
Daylight factor	5	2	1	4	3
TOTAL	**30**	**14**	**18**	**19**	**17**

THE CONCAVE THE CONVEX THE SQUARE THE CIRCLE



TWO PERSON CABIN

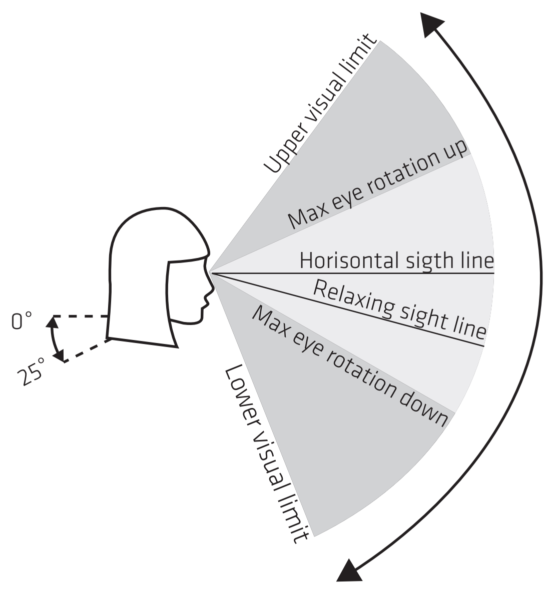
ROOF STUDIES

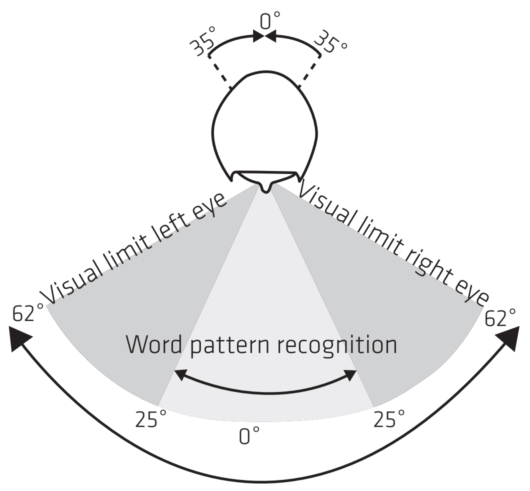
After deciding on the concave shape different nine types was examined by using renders and calculating the temperature. The nine roof types are the following: diffused (only diffuse lights come into the room), flat roof, double-peaked roof, curved gable roof, gable roof, shed at 10 degrees, shed at 15 degrees, shed at 25 degrees and a curved shed.

The ventilation was calculated and then the temperature for the different types was calculated. An evaluation overview can be found on the next page. All the windows are the same size to illustrate how wall the room height is.

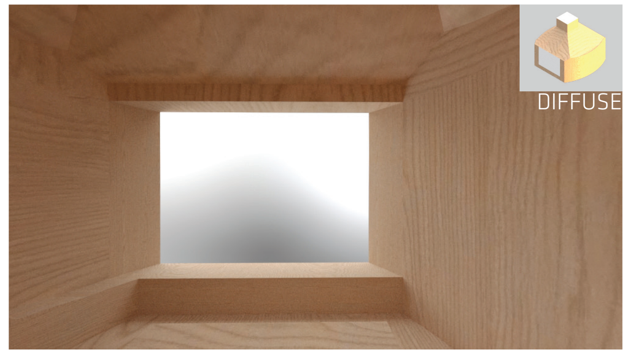
To make sure that the person lying on the bed can enjoy the view, the diagram below showing the angles the eye can perceive – by evaluation it in 3D, this has been part of the evaluation [Zanden, 2014].

▼ *Ill. 134.1: Viewing angle*
▼ *Ill. 134.2: Temperature calculation results*
▶ *Ill. 135.1: Roof study*



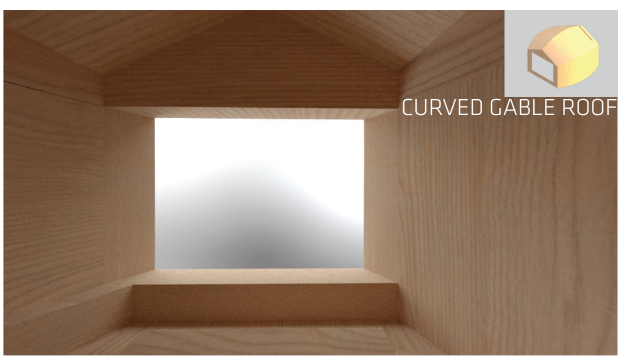


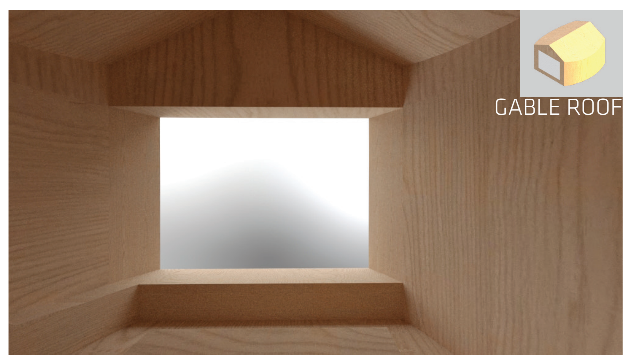
TEMPERATURE	Area	Volume	Window	Window %	Airchang	Airflow	Daily mean	Max temp
	m^2	m^3	m^2	%	h^{-1}	m^3/s	°C	°C
Diffused	27,6	77,5	6	21,7	0,3	0,006	44,1	47
Flat roof	27,6	69	6	21,7	0,3	0,006	46	48,9
Double peaks roof	27,6	75	6	21,7	0,3	0,006	44,1	47
Curved gable roof	27,6	89	6	21,7	0,3	0,007	42	45,7
Gable roof	27,6	86	6	21,7	0,3	0,007	42,9	45,8
Shed 10 degrees	27,6	82,4	6	21,7	0,3	0,007	43,4	46,3
Shed 15 degrees	27,6	89	6	21,7	0,3	0,007	42,2	45,1
Shed 25 degreed	27,6	104	6	21,7	0,3	0,009	39,9	42,8
Curved shed	27,6	75,9	6	21,7	0,3	0,006	43,9	46,8


DIFFUSE


FLAT ROOF


DOUBLE PEAK


CURVED GABLE ROOF


GABLE ROOF


SHED 10°


SHED 15°


SHED 25°


CURVED SHED

TWO PERSON CABIN

EVALUATION

To evaluate these past studies different parameter was evaluated on and compared to a schedule. The room in room parameter is based on knowledge of creating different areas in one room with the use of light. The spiritual atmosphere is to how the room feels spiritual with its light and the view.
The calm/excitement is based on how calm the building can be vs. excitement.
The view angle is based on the range a human can look while being comfortable.
The relation to the walls is how well the roof type works with the concave walls.
Precipitation is for how easy the precipitation can fall off the roof and not store the water in a puddle.
The wind is for how the roof makes the wind act during 10 m/s winds. This study can be found in the appendix.
The last one is how the roof can be used as a peak towards the sky.

The total score shows that the double-peaked roof performed best of all these roof types, hence this is the type that was chosen.

▼ *Ill. 136.1: Evaluation schedule*
▶ *Ill. 137.1: Plan study*

ROOF STUDY	Room in room	Spiritual atmosphere	Calm/ excitement	View angle	Relation to walls	Precipitation	Wind	Peak towards the sky	TOTAL
Diffused	1	4	1	4	2	5		5	**22**
Flat roof	5	1	1	1	5	1		1	**15**
Double peaks roof	5	5	5	3	5	2		5	**30**
Curved gable roof	5	2	2	4	2	5		2	**22**
Gable roof	5	3	2	4	3	5		2	**24**
Shed 10 degrees	5	2	4	3	5	3		4	**26**
Shed 15 degrees	5	3	3	4	4	4		4	**27**
Shed 25 degreed	5	4	1	5	1	5		5	**26**
Curved shed	5	4	4	4	5	3		4	**29**

TWO PERSON CABIN

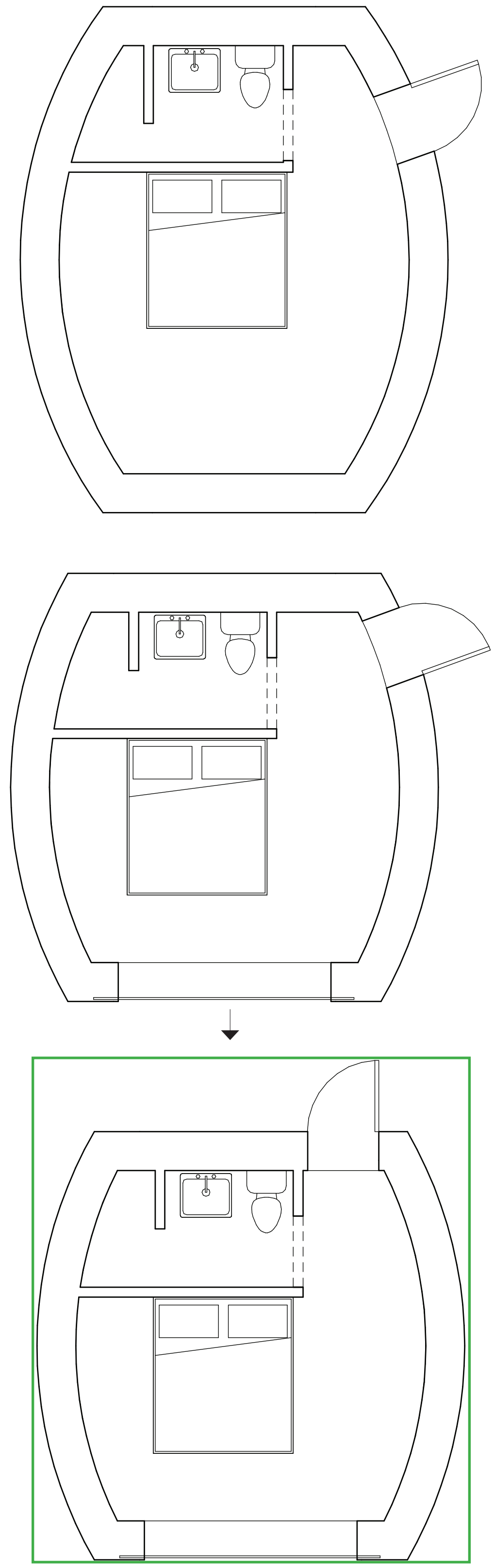
PLAN STUDIES

Three iterations were made of the plan for the two person cabin to optimize the plan layout.

The first plan shows cabin made a bit longer, which affects the bathroom to become very narrow in the shower. The area in front of the bed becomes too large, hence the window is too far from the bed to achieve the wanted atmosphere and view.

The next iteration of the plan made shorter, which create a larger shower area. The entrance area also becomes wider compared to the previous iteration. The area in front of the bed has a suitable size for the view and maneuvering around the bed. The only thing wrong with this plan is that the guest will have to walk straight into the bathroom door.

Instead, the third and final iteration shows that the door was moved the end of the cabin, where the guest will see the light from the large window when entering the cabin.



TWO PERSON CABIN

INTERIOR STUDIES

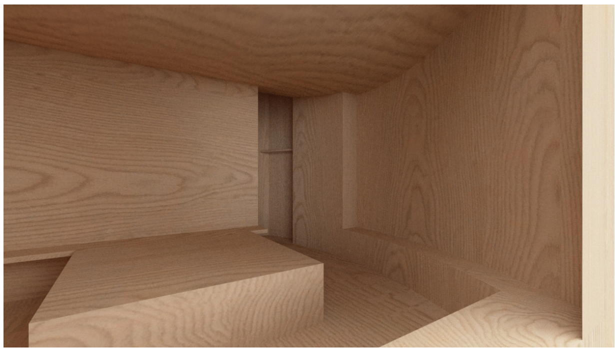
Along the curved wall, an integrated furniture is designed for the guest to hang and store their clothes, hide their luggage and sit and enjoy the view. Enough space to hide the luggage was very important as well as a designated area for wet boots and jacket, which is something that we were very aware of on our study trip to Iceland. The design of the integrated furniture went through three iterations.

The first one is based on curvy lava stone area at the driveway, where the lava stones from the dimmuborgir are placed. The furniture is full of curves and ends in a horizontal line that becomes the seating area along the wall and window.

The second iteration is of four different height of closets and ends in the bench following the wall and window. This is the option with the most storage.

The third and last iteration is of a ceiling high closet near the entrance and then begins the bench. This makes the bench very long. Common for these three iterations is the clothes rack near the door, for the guest to hang their jacket and put their shoes underneath.

The chosen option for the integrated furniture is the second one, due to its amount of storage units and the different heights create a gradient towards the entrance.



▶ *Ill. 138.1: Interior study*
▶ *Ill. 139.1: Material study*

TWO PERSON CABIN

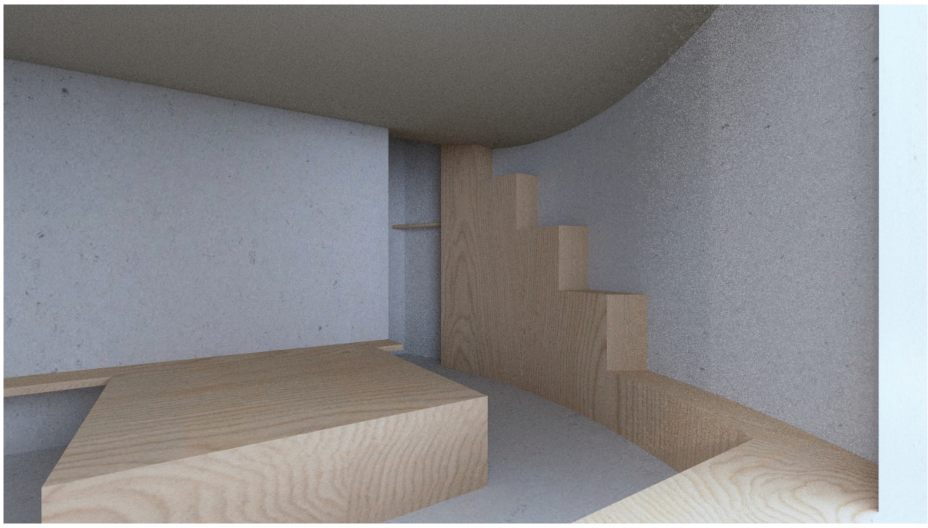
MATERIAL STUDIES

A material study was made for the cabin to examine how two types of concrete, a light and a dark, will affect the light and the atmosphere. The cabin should have a calm atmosphere and behave a space for the guest to relax and enjoy the light and the northern lights.

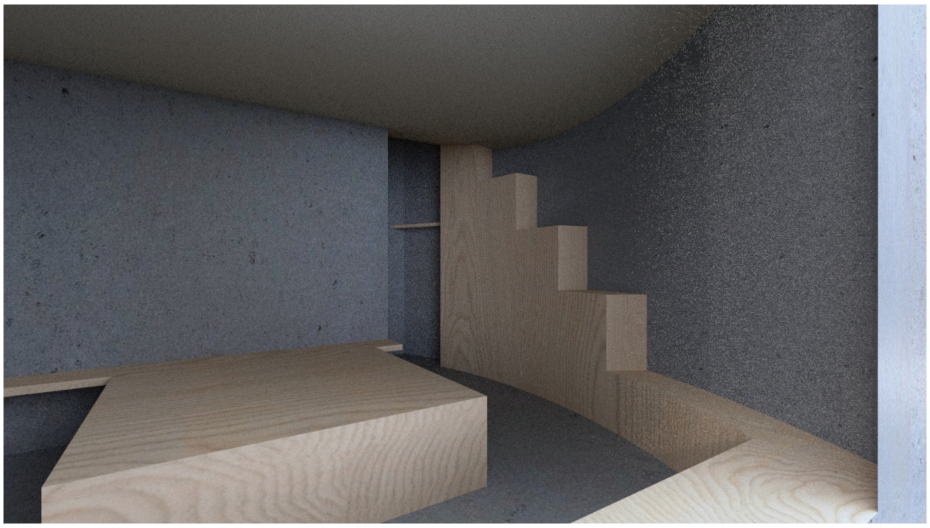
Originally the dark colored concrete was favored, but by comparing these two renders with each other, the dark colored concrete became too dark, and it absorbs a lot of the daylight. At the end, where the entrance is, the dark colored concrete becomes heavy and hard, compared to the light colored concrete. Here the light enlightens the space – also at the entrance area. But the room seems too bright, so for the final choice of wall material is a mixture of these two colors concrete.

The ceiling is made of flax linen. The floor and furniture are made of pine wood, to give the room a warm atmosphere.

Light colored concrete walls



Dark colored concrete walls



TWO PERSON CABIN

VENTILATION

The ventilation for the two person cabin will be mechanical by the use of Inventilate's MicroVent 6. MicroVent 6 is a decentralized aggregate, that will be installed in the external wall.
For the cabins is it important to keep the space as simple as possible to make the room feel calm – this aggregate is very suitable since it is small (112 mm x 850 mm) on the wall, vs having a larger aggregate in a closet or on the roof.
It changes the air in the room by having two ventilation units; a supply and an exhaust ventilator and coordinates the room's air balance. It has a very low SEL-value at only 278 J/m3, meaning that it needs a low amount of electricity to run.
The uses a heat recovery system when at its highest is 96 % and minimum 78 % [inventilate.dk (2018)]. By calculating on the needed ventilation for the bedroom, the needed air flow would be 25,7 L/s, and the MicroVent 6 can ventilate from 19,2 L/s to 53,4 L/s, so this ventilation would be sufficient for the room.

The windows in the bedroom can be opened and be used as an escape route in the case of fire. The wall window in the bathroom will be used to ventilate the room as well. By using one of the windows the room would be ventilated using single sided ventilation, but the guest can also ventilate the room using both windows, hence cross ventilation will be possible, as seen on the illustrations on the next page.

Two thumb rules for ventilations that has been used is for single sided ventilation should the width be lower then two times the height. For cross ventilation should the width be lower than five times the height to work.

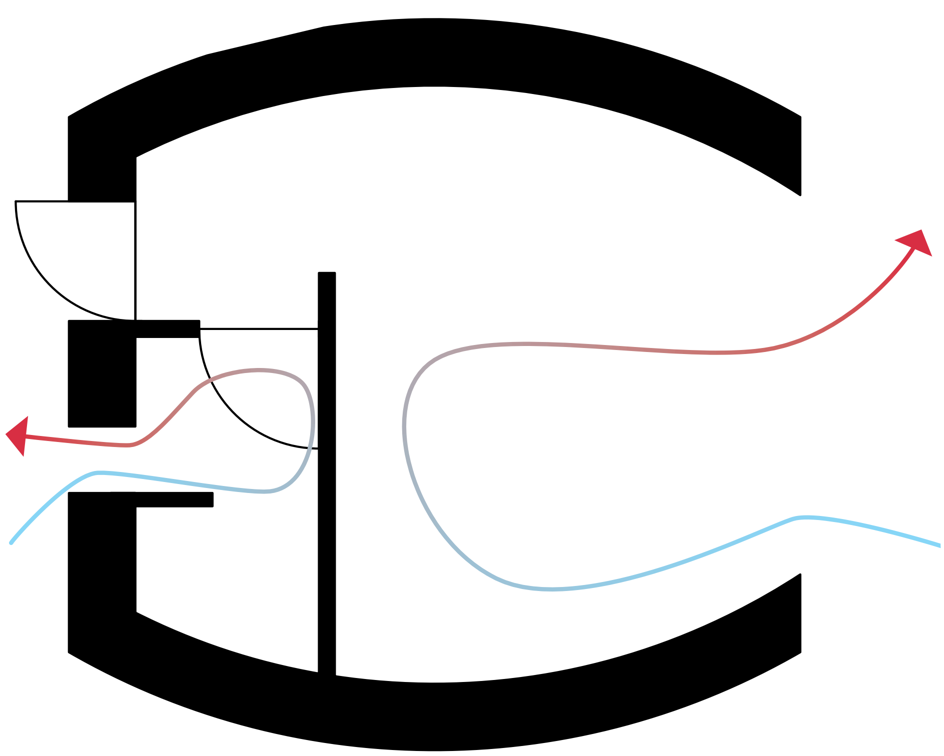
▼ *Ill. 140.1-2: Ventilation calculation results*
▼ *Ill. 140.3: Natural ventilation on plan*
▶ *Ill. 141.1: Natural ventilation on section*
▶ *Ill. 141.2: Natural ventilation on plan*

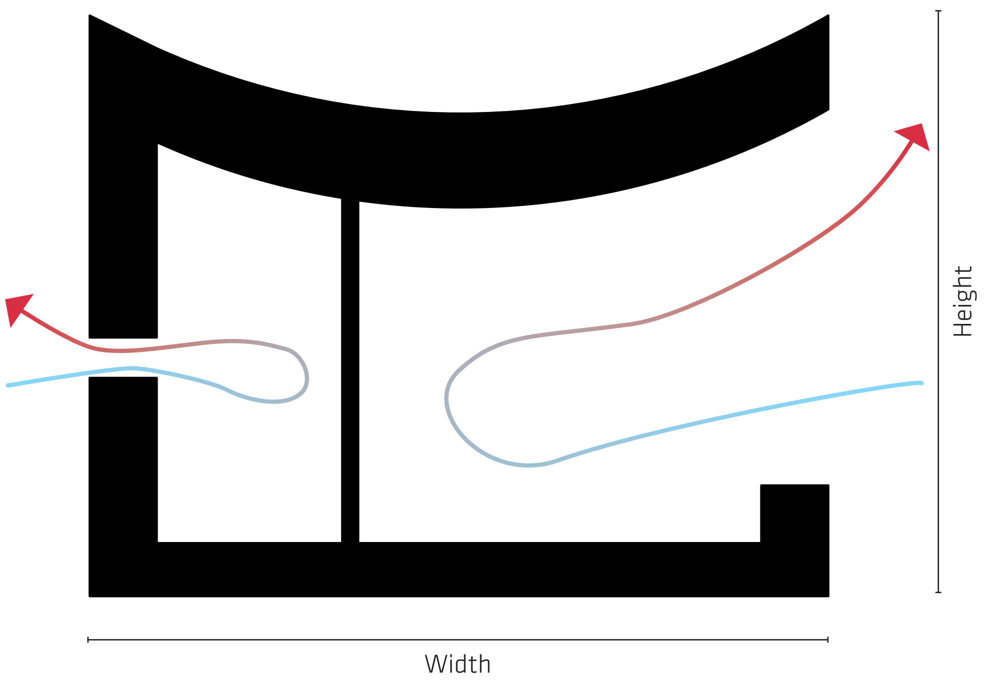
Ventilation for the bedroom:

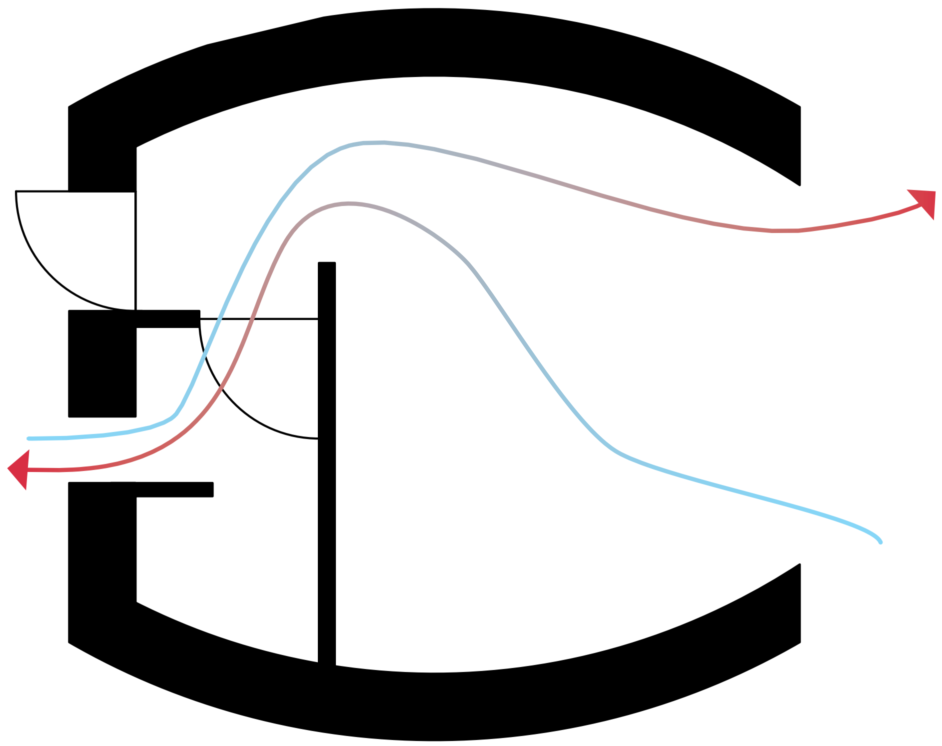
Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
16	40	2	25,7	0,02	2,3

Ventilation for the bathroom:

Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
4	10	-	15	0,015	5,4




Height
Width



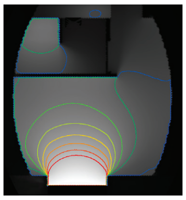
TWO PERSON CABIN

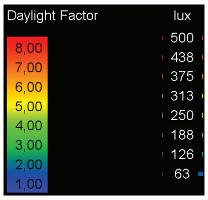
DAYLIGHT STUDIES

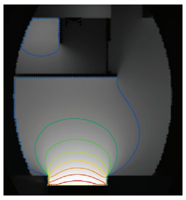
The temperature has been calculated for the bedroom with a 3 m room height, a 2,5 m room height and a for the room with a thick curtain.
For this cabin the window of 5 m2 was chosen, due to the height of the cabins should be higher than it already is.
Afterward, daylight studies were made for the daylight factor for the average of an entire year and show how the light is centered in front of the bed and the spiritual atmosphere of bathing in the light in the shower.
During March the lux shows that the light reaches into the room, while during June the entire room is covered by light.
During December the lux level is very low and artificial lighting needs to be used. The renders at the bottom of the page show how the room lights up in two very different ways.
The first two is of the room is bathed in sunlight 21 o'clock, which creates a warm and yellow colored room. All of the materials feel warmer. During diffuse daylight at 8 o'clock the room looks colder than the sunlight renders, but by looking only at the diffused daylight render, the room still has a warmth to it. The beige pine wood flooring that reaches up to the closets to the beige ceiling create a warm room as well.

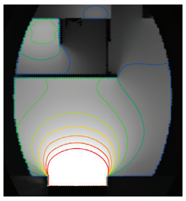
▶ *Ill. 142.1: Ventilation calculation results*
▶ *Ill. 142.2: Daylight and lux in June and Decemeber*
▼ *Ill. 142.3: Direct sunlight*
▼ *Ill. 142.4: Diffused daylight*

2-per. cabin bed	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	16	7	43,8	2,3	27,4	29,7
Thick curtain	16	7	43,8	2,3	27,4	29,5
2,5 m room height	16	5	31,3	2,3	27,6	29,7



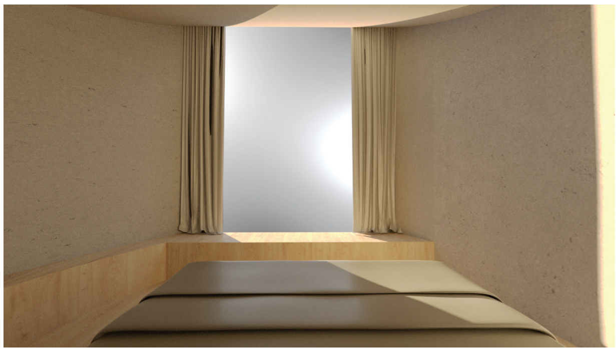


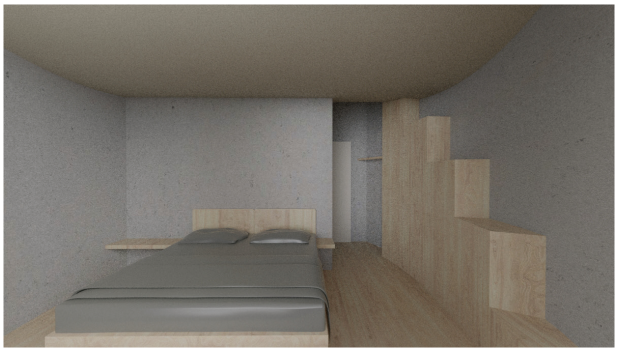




DIRECT SUNLIGHT
21 June at 21.00 o'clock

DIFFUSED DAYLIGHT
21 June at 8.00 o'clock





TWO PERSON CABIN

BATHROOM

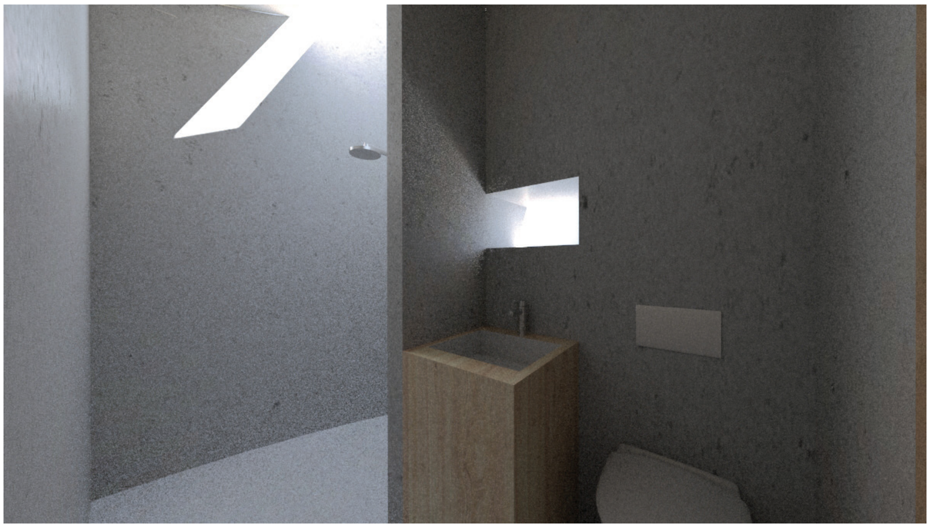
From the very beginning of working on this project, the idea of being bathed in the light was stuck in our minds. Standing under a shower with running water, and the skylight coming through the window above you. In the cabin, this idea succeeded, as shown in the daylight studies, where the bathroom lights up in the shower area.

The size of the windows came from a calculation showing that they should be 0,8m2. Other than the window over the shower, a window is added near the sink to ensure that this part of the bathroom also would get a bit of daylight.

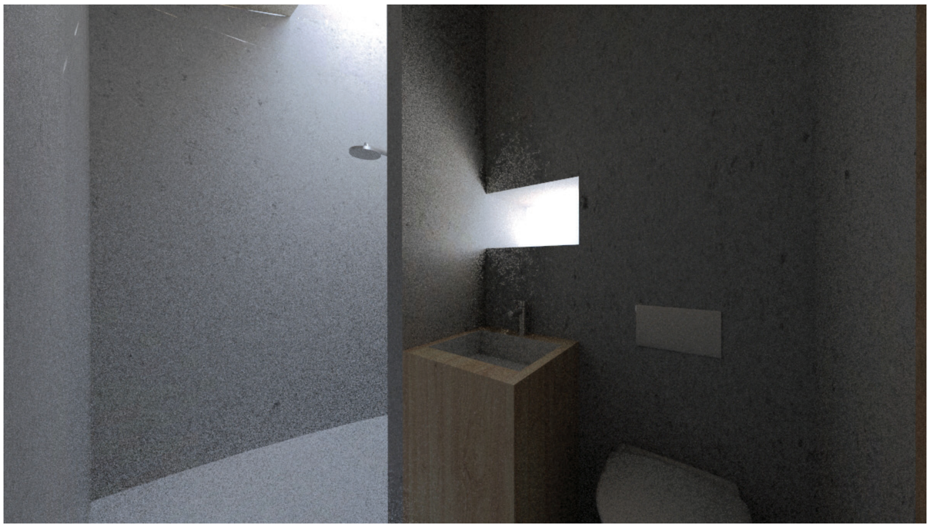
▶ *Ill. 143.1: Ventilation calculation resultsr*
▼ *Ill. 143.2: Direct sunlight*
▼ *Ill. 143.3: Diffused daylight*

2-per. cabin bath	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	4	0,85	21,3	5,4	25,5	29,6
Thick curtain	4	0,85	21,3	5,4	25,7	29,5
2,5 m room height	4	0,8	20,0	5,4	25,7	29,5

DIRECT SUNLIGHT
21 June at 15.00 o'clock



DIFFUSED DAYLIGHT
21 June at 10.00 o'clock



four person cabin
studies

The four person cabins have the same type of concave shape, and since this, a cabin for four people, the cabin's plan layout was studied to fit them all. Two iterations were made of the roof type together. Same procedure as the other rooms, the four person cabin had its ventilation need and temperature calculated and daylight simulations and renders done as well. The bathroom was studied to achieve the wanted atmosphere.

FOUR PERSON CABIN

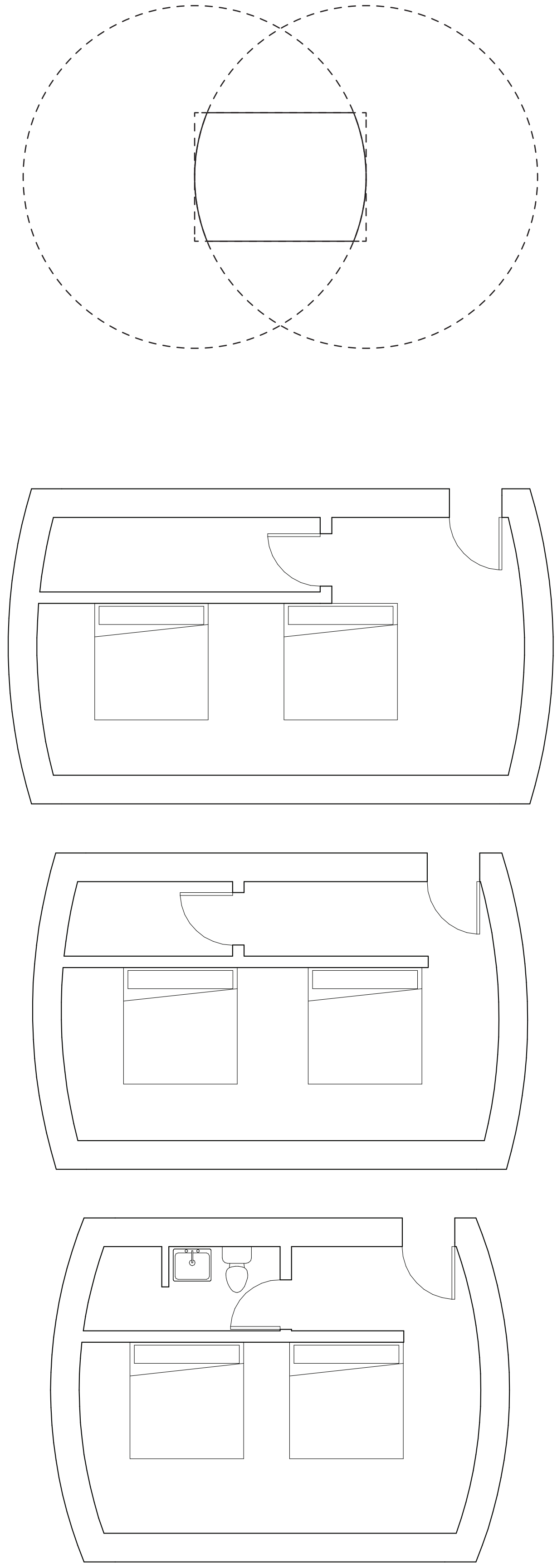
FORM STUDY

The two type of cabins has the concave shape, but for the four person cabin, the shape needed to be bigger to fit two beds. It was discussed whether the cabin should have two separate bedrooms or one together. By creating a two bedroom cabin, the social aspect of the concept as well as the daylight would not fit. It is assumed that when four people, whether is a family, friends, or two couples, that they can sleep in the same room together. As mentioned earlier, the cabins will be used during the evening to the morning, since they are out exploring during the day and eating dinner in the main building.

Another idea was to separate the two beds with a wall in a bed distance, but it would affect the wanted light and shield from part of the window so that the user would not get the full view to watch the northern lights. So, the decision landed in one bedroom with two beds.

The size of the concave form changed a bit. To make enough room for the beds the cabin became too wide, which created a very long bathroom. The cabin had a lot of wasted areas. The next iteration was narrower, and the bathroom was made shorter by creating a hallway.
To make the wasted area as small as possible, so the form became smaller and the hallway was more fitting size, where the guests can hang their jackets and place their shoes. The beds get closer together, and they share the experience of seeing the northern lights together from each their beds.

▶ *Ill. 146.1: Form study*
▶ *Ill. 147.1: Roof study*



FOUR PERSON CABIN

ROOF AND WINDOW STUDY

The roof of the four person cabin was based on the previous studies for the two person cabin, where the visual and the technical, such as wind studies, part of the roof was studied. The double-peaked roof was implemented from the two person cabin, where the same curve was used, which is the two person cabin's wall's curve. For the other iteration the curve from the walls of the four person cabin was used, and it showed that its own curve created a taller window.
The chosen roof type is one of the same curves as the four person cabin's wall to fit the principle of the roof type, and it can create a tall enough window.

Same roof curve as the wall

Two person's roof

FOUR PERSON CABIN

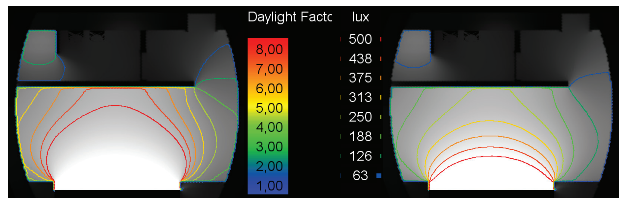
FORM STUDY

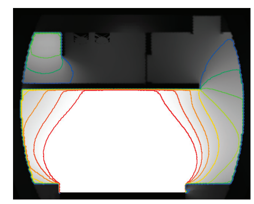
By using the same method as the previous rooms, the ventilation and temperature were used to find the maximum size of the window is. The daylight factor and lux studies show that the two beds will be in the same light area and be together in the light. This will unite the experience of the daylight and the northern lights from the beds. In the bathroom, the daylight creates a spiritual glowing light from the top of the shower.

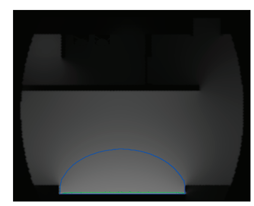
As the renders show, the sunlight will reach far into the building at 21 o'clock during the summer solstice. The room becomes warm with the same material chosen as in the two person cabins. During diffused daylight, the room is still light and bright.

Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
27	67,5	4	47,8	0,04	2,5

4-per. cabin bed	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	27	15	55,6	2,55	27,1	29,6
Thick curtain	27	16	59,3	2,55	27,2	29,4
2,5 m room height	27	11	40,7	2,55	27,2	29,4







- ▶ Ill. 148.1: *Ventilation calculation results*
- ▶ Ill. 148.2: *Temperature calculation results*
- ▶ Ill. 148.3: *Daylight factor and lux in June and December*
- ▼ Ill. 148.4: *Direct sunlight*
- ▼ Ill. 148.5: *Diffused sunlight*
- ▶ Ill. 149.1: *Ventilation calculation results*
- ▶ Ill. 149.2: *Temperature calculation results*
- ▶ Ill. 149.3: *Direct sunlight*
- ▶ Ill. 149.4: *Diffused sunlight*

DIRECT SUNLIGHT
21 June at 21.00 o'clock

DIFFUSED DAYLIGHT
21 June at 9.30 o'clock

As mentioned the ventilation and temperature was calculated to find the maximum window size and placed in the bathroom. A window is placed on the top of the shower, where the light will be reflected down to where the guest is showering. Another window is placed near the two sinks, where the guests can enjoy the view while getting ready for their day.

Area	Volume	People	Airflow	Airflow	Air change
m^2	m^3	Number	L/s	m^3/s	h^{-1}
5	12,5	-	15	0,015	4,3

4-per. cabin bath	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	5	1,4	28,0	4,32	25,6	29,5
Thick curtain	5	1,7	34,0	4,32	25,8	29,4
2,5 m room height	5	1,2	24,0	4,32	25,8	29,4

DIRECT SUNLIGHT
21 June at 15.00 o'clock

DIFFUSED DAYLIGHT
21 June at 10.00 o'clock

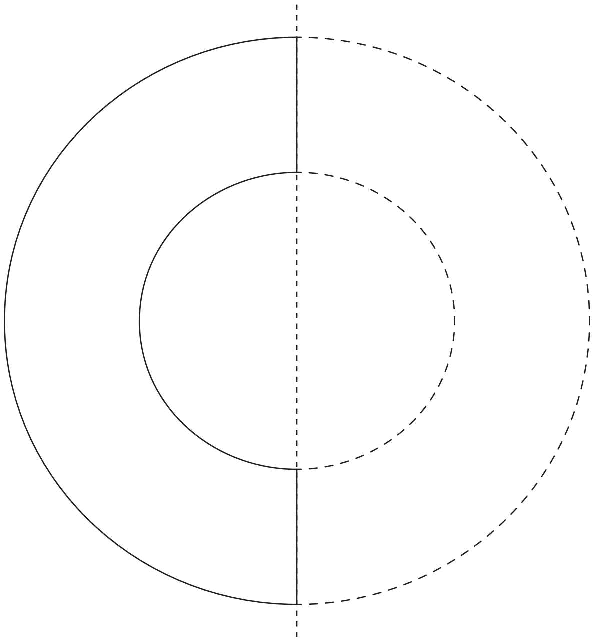
horse barn
studies

The horse barn is for the horses to seek shelter and for the staff members and the family to store their riding equipment. Based on the circle the horse stable has been created. Studies on how the paddock should be to fit the concept have been made as well. Final renders of the horse stable are made to illustrate what it would look like

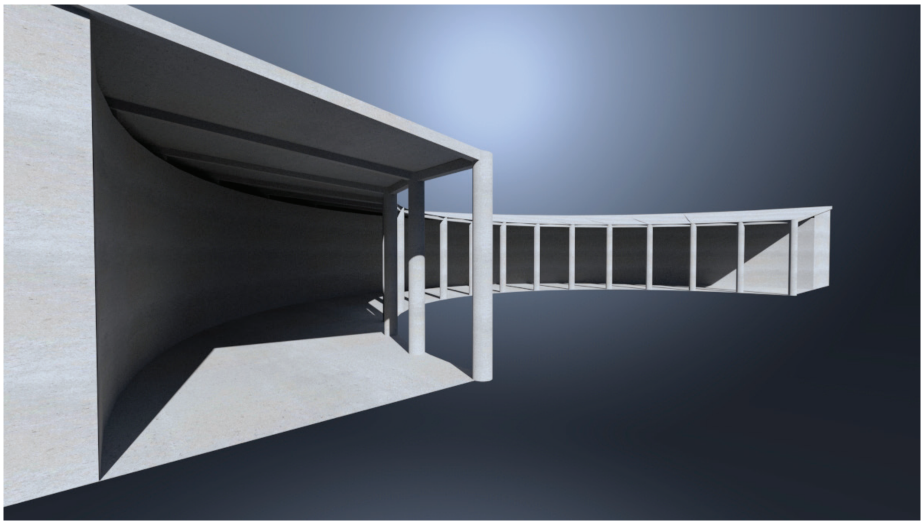
HORSE STABLE

FORM STUDY

The horse stable is created for the horses to be in shelter from the harsh winter months. Its shape origins in the circle, where half of it is cut away.
The boxes for the horses are in both ends of the horse stable with space for hay and tack room in the middle. The staff members and family can take care of the horses under the ceiling, to avoid standing in rain or snowy weather. To stabilize and carry the roof columns are placed along the hallway, as a reference to the columns in the atrium. Each room will have it own opening as a door. The wall turning into the center of the building should be lowered a bit, to make a slice of opening to make use of natural ventilation and for the horses to stand in daylight.
The horse stable will be dogged into the terrain and fits in the terrain curve, so it will seem like it comes naturally out of the ground – openings up towards its paddock. The horse stable is oriented so it would be integrated into the ground and not that visible from the main house, but visible for the guests arriving at the site



The entrace



The hallway

HORSTE STABLE

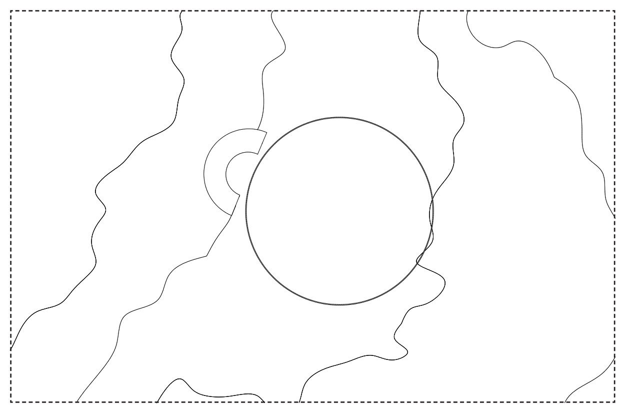
HORSE PADDOCK STUDY

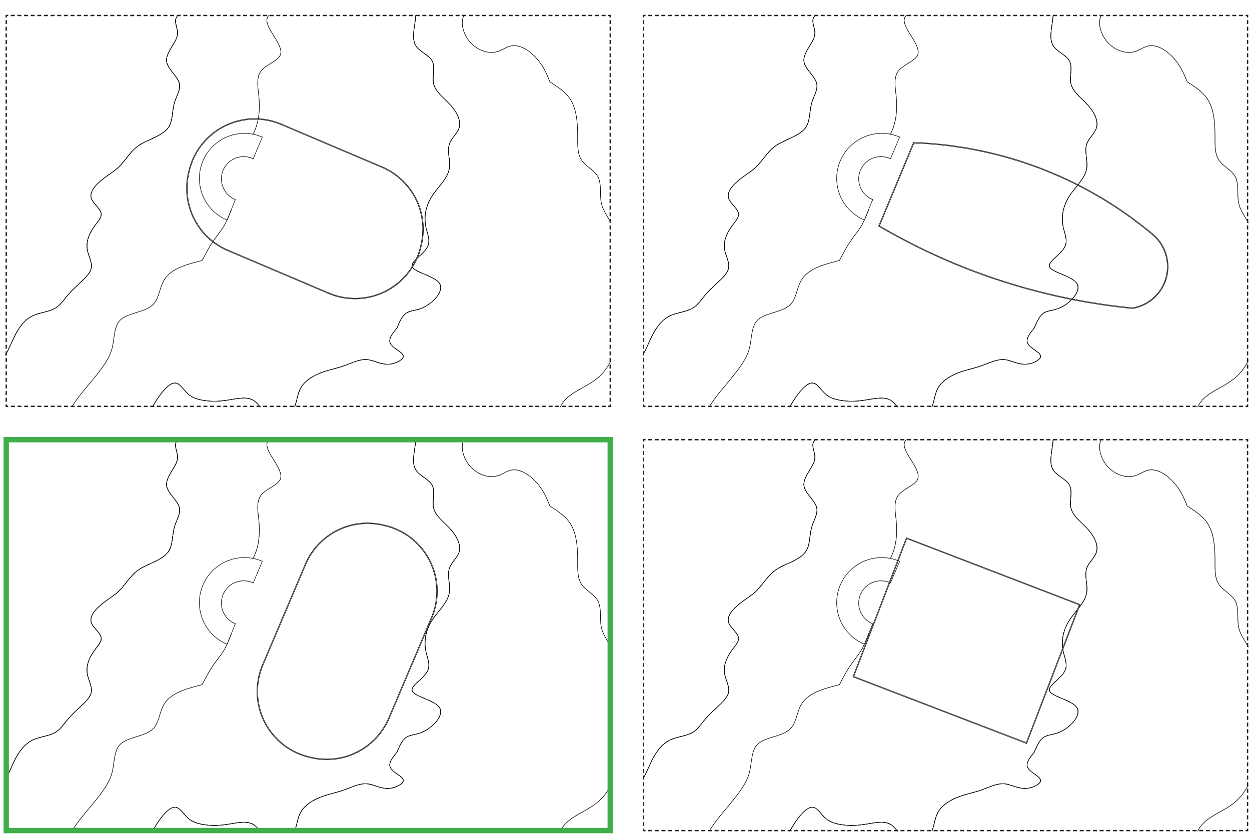
The horse paddock is placed close to the horse stable for the staff members and the family to gain easily access to the horses outside to take them into the horse stable. When the horses are being rented out to the guests for riding tours in the landscape, the horses must get ready with their saddles and equipment.

The shape of the horse paddock was made to find the right relation to the horse stable. Five iterations were made, where as the square option quickly was dismissed due to not fitting the concept of the glowing circle. The circular paddock did not fit the shape of the horse stable since the two curves would meet in a strange way.

The option that was chosen was the ellipse, placed along the curves of the site. Here the horses would on a large, almost-even grass filled paddock.

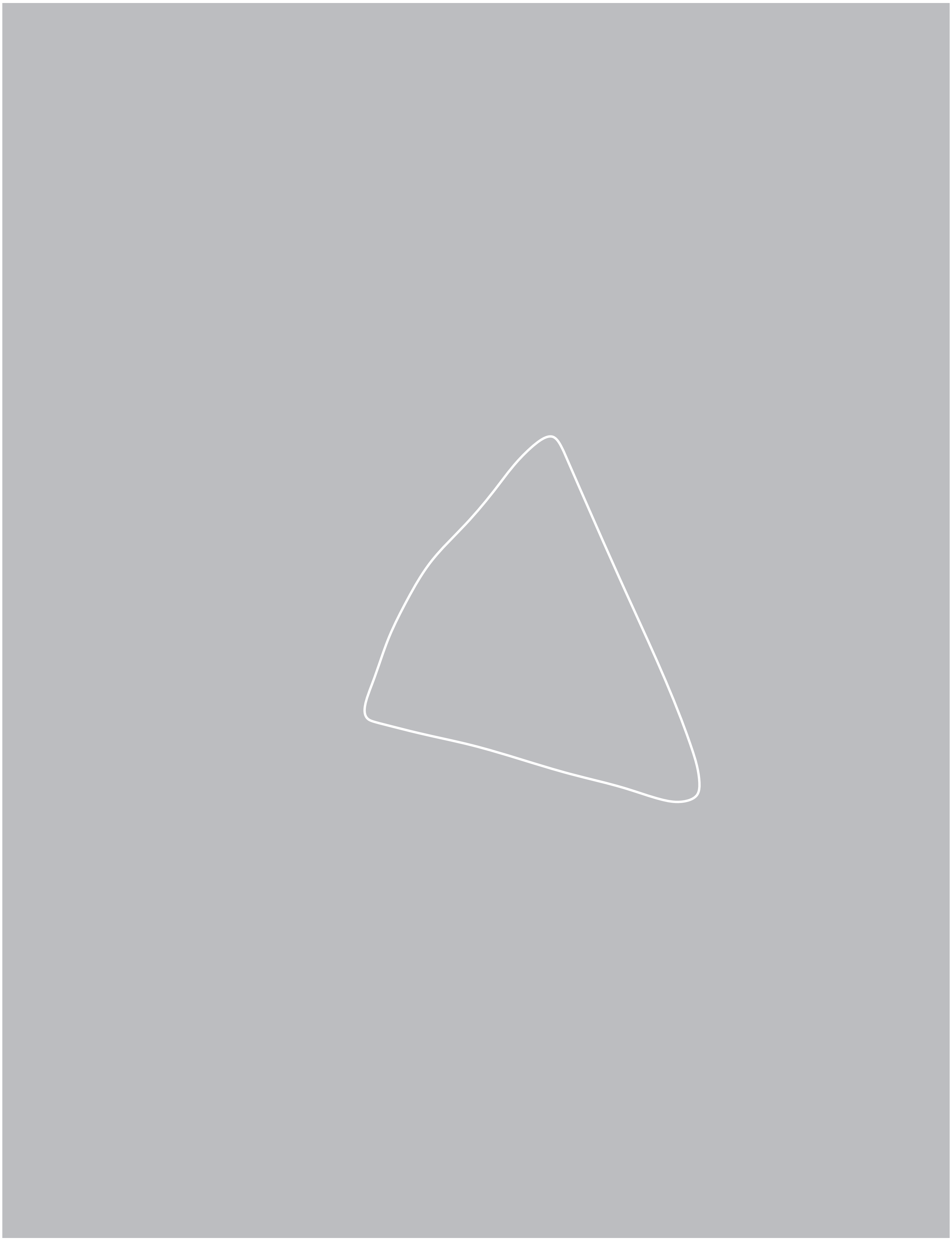
◀ *Ill. 152.1: Shape from circle*
◀ *Ill. 152.2: The entrance of horse barn*
◀ *Ill. 152.3: The hallway of horse barn*
▶ *Ill. 153.1-5: Paddock form study*





master plan
studies

The studies for the master plan was made how the buildings will touch the ground; whether it is by being on columns, placed on the ground or dug into the ground. The parking's placement and shape were studied together with the final placement and widths of the all of the paths and roads on the site.



MASTER PLAN

PARKING AND PATHS

The placement of the buildings on the ground was based on three principles; the building being lifted by columns; a foundation and the building is dug into the ground.

By lifting the building up from the ground, the building seems lighter and the guest gets closer to the light and the northern lights. Out of these three principles, this one creates the smallest footprint on the ground since the entire area of the building does not touch the ground. But by being placed on the columns the building can seem fragile. The building will need to be supplied by more heat due to during the winter the temperature is below zero, and the cold air is below the floor deck. Compared to the others, where they get more heat from the ground that is warmer than the air. Due to the building being lifted the pipe length would be longer.

The foundation principle is where the building is placed on the ground so that the guest can enter the building in the same level as the ground, but in the other end of the building, it seems like it is hovering over the ground. The foundation would be dug into the ground, while the building's floor will maintain being over the ground.

By the building be dug into the ground, the guest will have to walk down a path that has been cut out of the terrain. Inside the building, the guest will enter at in the buried part of the building and walk towards the open part of the building that is at the same level as its ground. This will get more surfaces covered by soil, hence use less heating. It will get a more down-to-earth feeling.

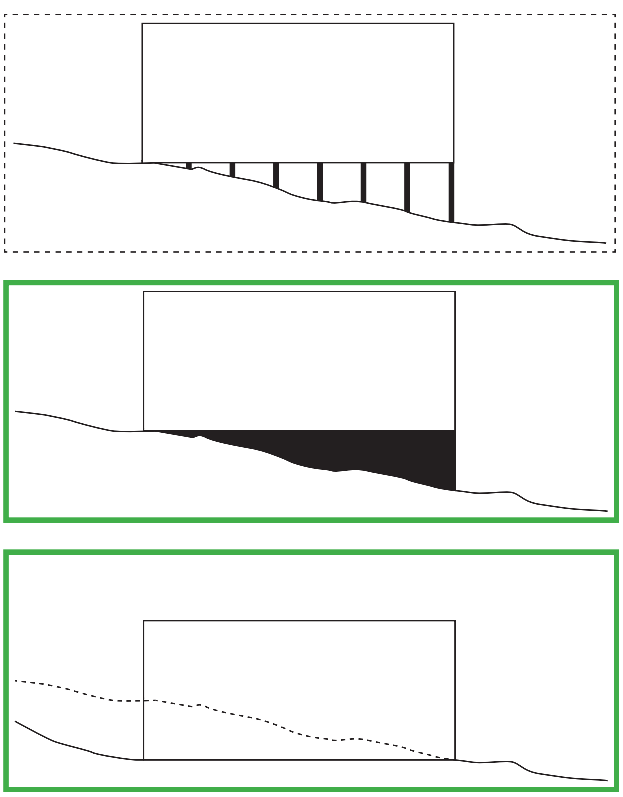
Based on these three principles the cabins and the horse barn will be dug into the ground to get the atmosphere of walking down to the cabins in the darker and more intimate space, where the typography can be used rather than adding to the site.

The main house will be placed on the ground using a foundation to be placed tall on the hill, but still down to earth.

PARKING

The parking area will be will 17 parking spots, 10 to the cabins, two to the family and five to the staff members. The parking area will be located along the driveway to the site. To avoid the light from the cars hitting the cabins, the parking area is placed with the hill between them. At first, the parking area started our with parking spots turning towards north and south, but due to the risk of car lights hitting the buildings, the parking area was made to only park the cars on the south part of the road.

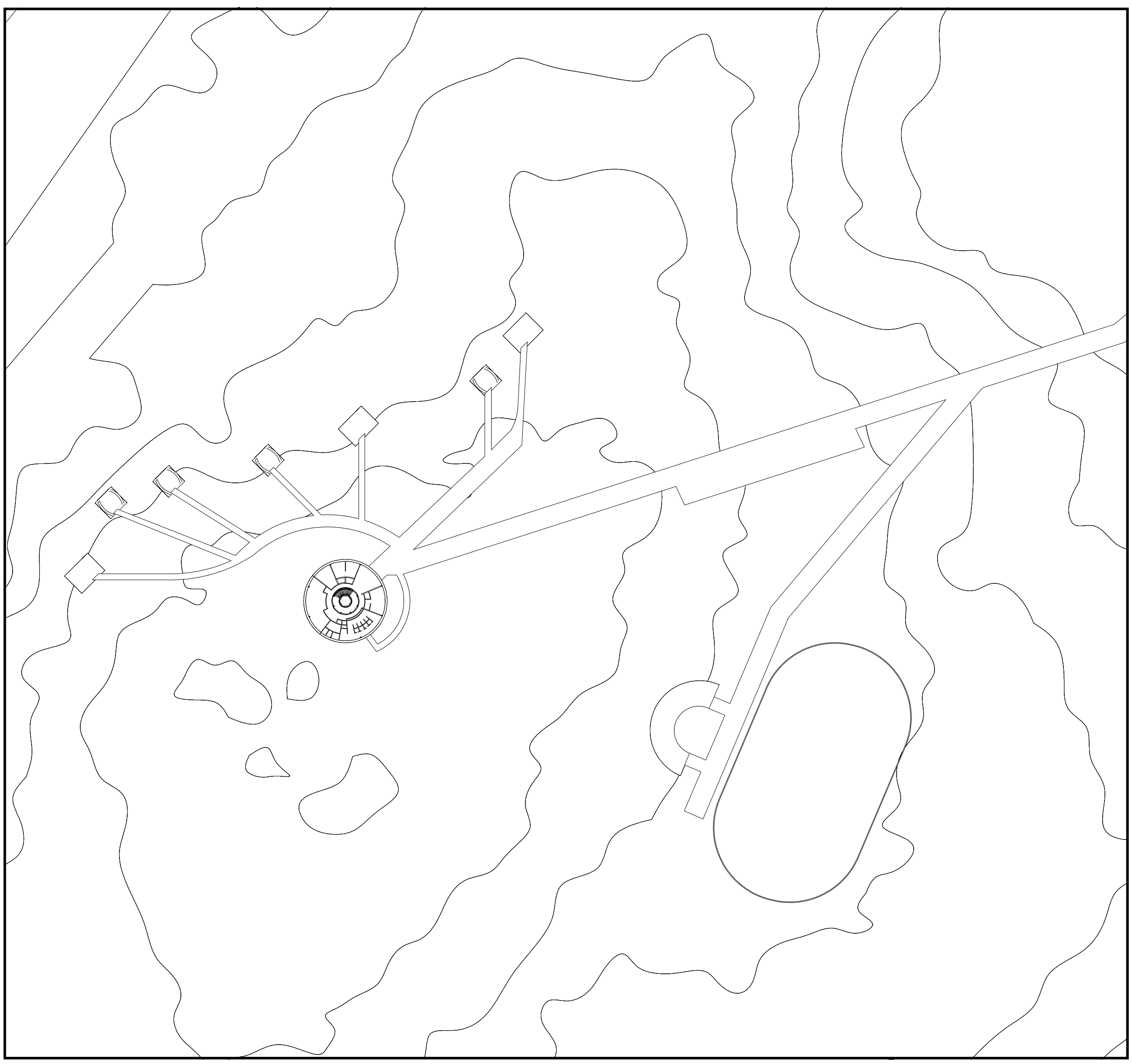
▼ *Ill. 156.1-3: Placement study*
▼ *Ill. 156.4-5: Parking study*
▶ *Ill. 157.1: Paths*



PATH

The paths on the site have been designed from the original driveway in East. From here the guests will park their cars before walking up to the main house's reception. There are two types of the path – one that is wide enough for the cars and meets the fire requirements and is placed on the ground.

The smaller paths are dug into the ground forget the feeling of walking into a safe and calm cave. To make the guests park their cars at the parking lot a different material will be used for the rest of the road from the parking lot. So, the parking lot and road to the horse barn and main road will be made of asphalt while the rest of the path to the main building and the cabins will be made of smaller, non-moveable, stone pieces. This makes the guests slow down.



CHAPTER CONCLUSION

Studies, such as wind simulations, orientation, etc. were made to find the shape of the main building, which ended up being a cylinder. Façade material, plan drawings, construction, etc. of the main building was made to detail it further and then studies of the most important rooms of the building was made to ensure that the atmosphere and quality of the room were high enough.
Renders of the rooms with integrated furniture was used to visualize and examine it. Calculations of ventilation and temperature were made to find the maximum window sizes without any need for solar shading. The windows were designed to achieve the wanted atmosphere of calm, excitement, private and public along studies of daylight factor and lux.
Studies of the material showed that the walls should be made of light colored concrete and as floor material in the rooms that need to be functional. The rooms that could be warmer and calmer had pine wood flooring. The ceiling was made of seaweed and covered by flax lined as a soft surface.
The entire construction would be made of concrete.

The cabin was designed almost the same way. It started out with finding the right form, the concave, based on studies of several forms in relation to daylight, light quality, wind performance, etc. The same procedure for the roof type. Studies of the interior such as the integrated furniture and materiality were made. And the cabin resulted in the same materials used as the main building.

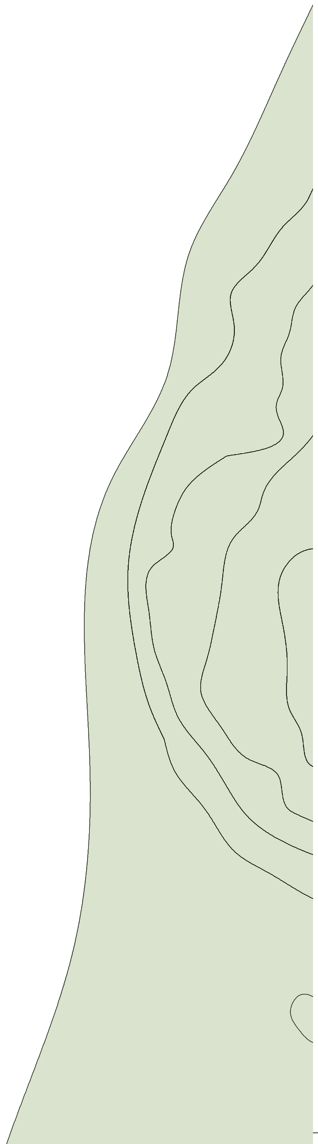
The horse barn was studied by making visualizations of the barn shape as a half circle and its paddock.

The master plan studies of how the buildings should meet the ground, whereas the cabins and the horse barn will be dug into the ground, the main building will be on top of the ground, made with a foundation. The parking shape and the location of the path were made as well.

chapter seven
presentation

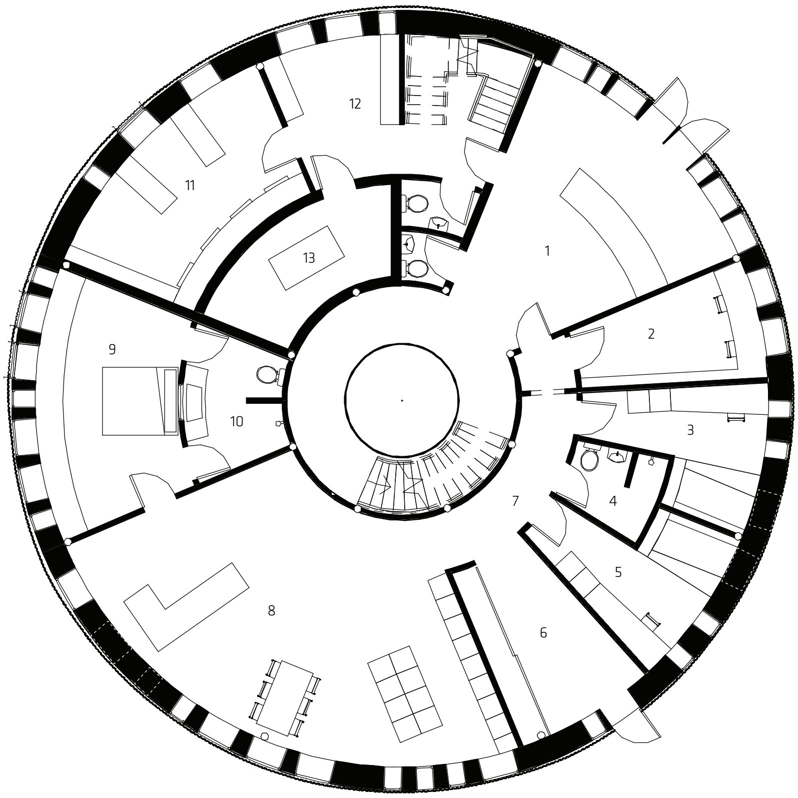
The following chapter consists of a presentation of the final buildings. Each building has a plan drawing, section, and elevation. Renders are made the most important rooms together with the entrance to the cabin and the main building. Solar cells are used to reach the BR2020 requirements and illustrated. The results for the indoor climate and energy consumption are showed. A conclusion sums up the entire project and report, and a reflection is made for further thoughts.

MASTERPLAN 1:2000



▲ *Ill. 163.1: Master plan*

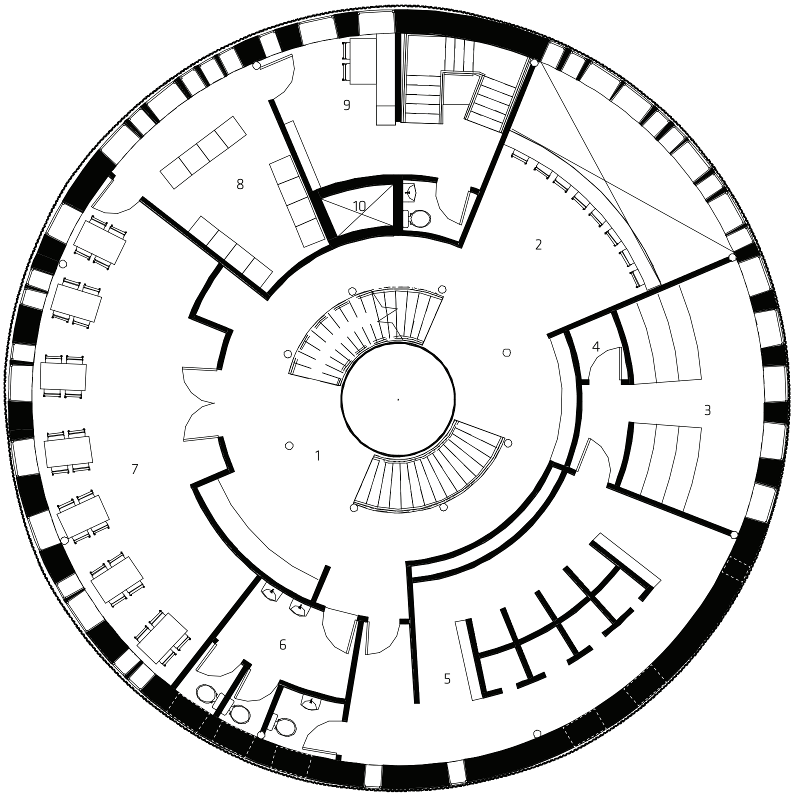
MAIN HOUSE PLAN - GROUND FLOOR, 1:200



1 : Reception
2 : Office
3 : Children room
4: Small bathroom
5 : Children bathroom
6 : Entrance
7 : Hall
8 : Kitchen / Livingroom
9 : Masterbedroom
10 : Big bathroom
11 : Laundry / cleaning room
12 : Luggage room / storage
13 : Technique room

▲ *Ill. 164.1: Main house ground floor*

MAIN HOUSE PLAN - 1. FLOOR, 1:200



1 : Atrium
2 : Lounge
3 : Sauna
4 : Storage
5 : Changing room
6 : Toilets
7 : Dining area
8: Kitchen
9 : Staff area
10 : Technique room

▲ *Ill. 165.1: Main house first floor*

MAIN HOUSE PLAN - SECOND FLOOR, 1:200

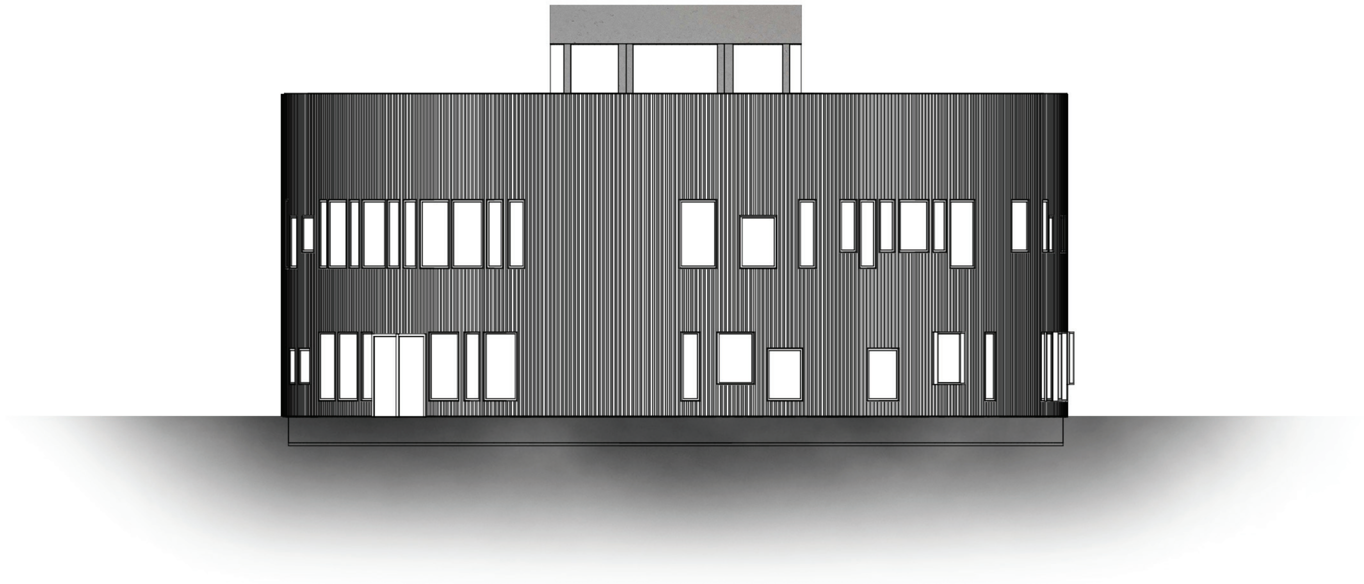
▲ *Ill. 166.1: Main house second floor*

MAIN HOUSE PLAN - ROOF PLAN, 1:200

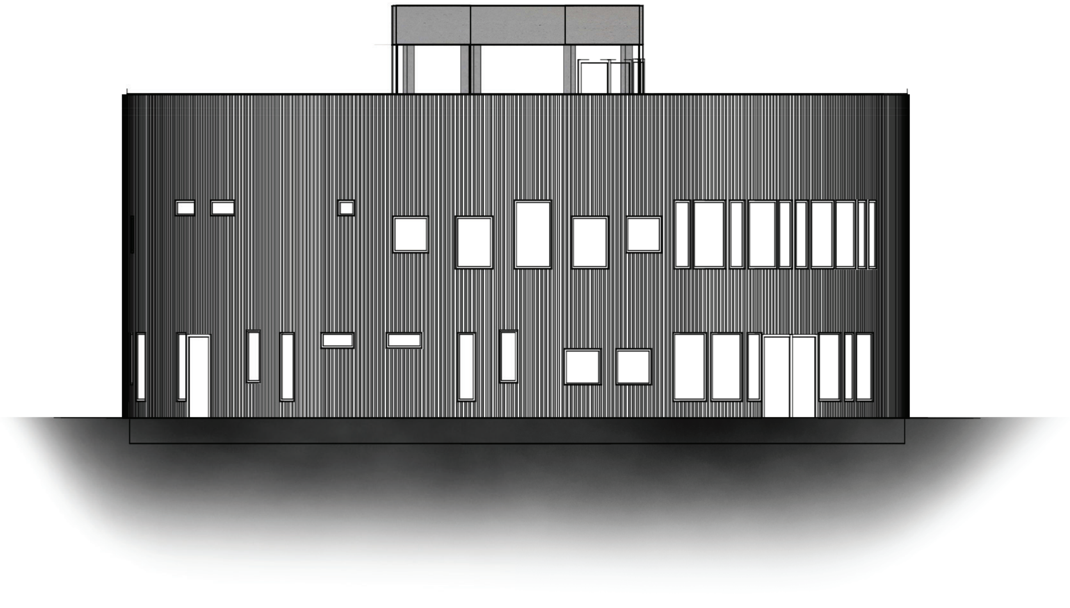
▲ *Ill. 167.1: Main house roof*

MAIN HOUSE ELEVATIONS 1:200

NORTH



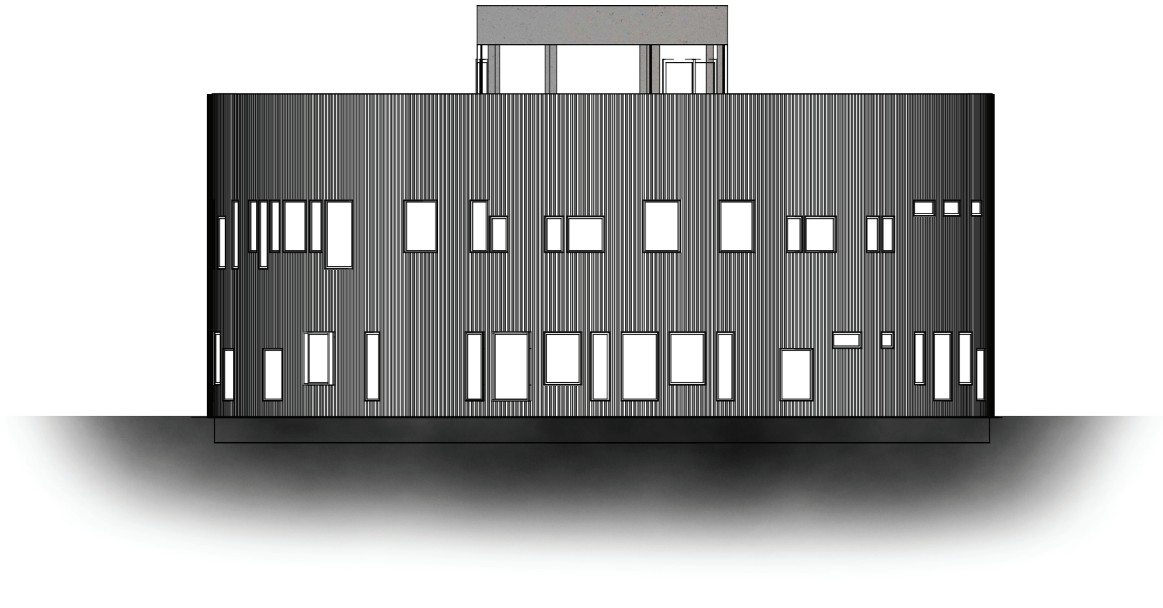
EAST



▲ *Ill. 168.1: Main house north elevation*
▲ *Ill. 168.2: Main house east elevation*

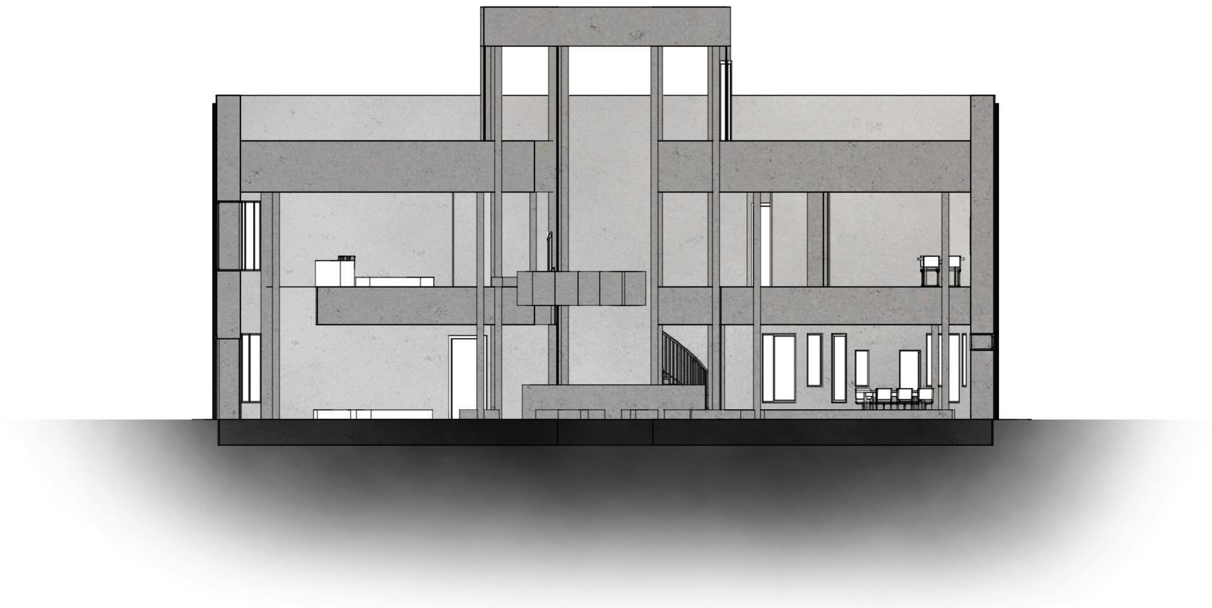
SOUTH

WEST



▲ *Ill. 169.1: Main house south elevation*
▲ *Ill. 169.2: Main house west elevation*

MAIN HOUSE SECTION 1:200



▲ *Ill. 170.1: Main house section*

VIEW FROM DRIVEWAY

▲ *Ill. 172.1: View from driveway render*

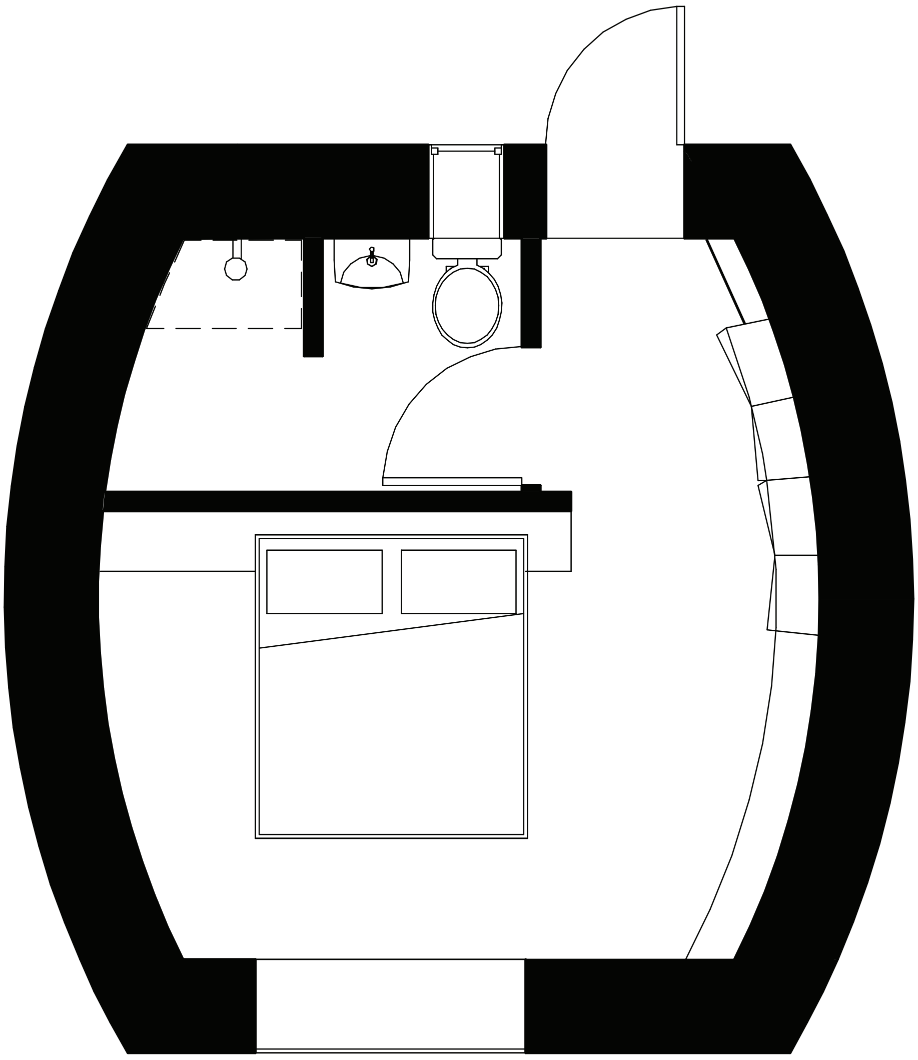
ATRIUM

▲ *Ill. 174.1: Atrium render*

DINING AREA

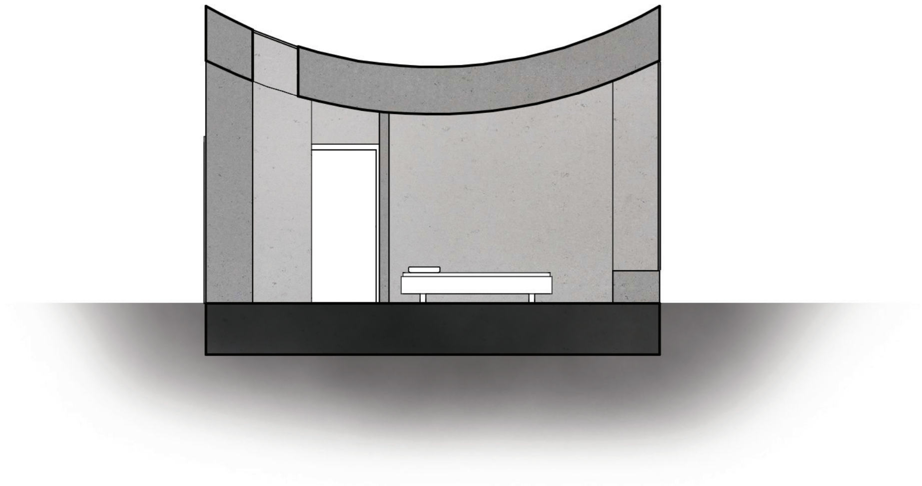
▲ *Ill. 175.1: Dining area render*

TWO PERSON CABIN PLAN, 1:50



▲ *Ill. 176.1: Two person cabin plan*

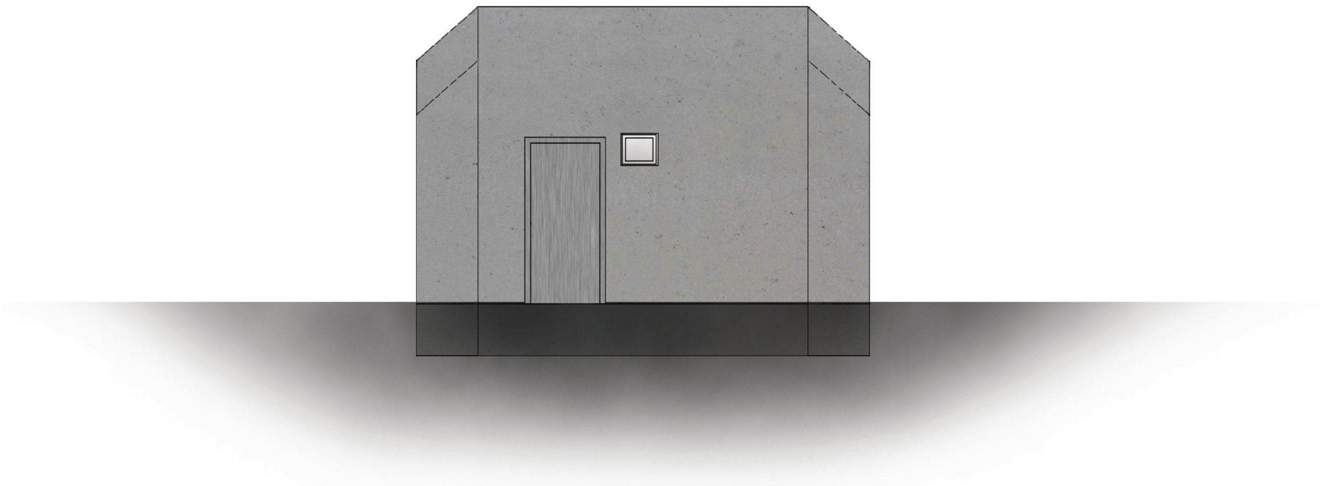
TWO PERSON CABIN SECTION, 1:100



▲ *Ill. 177.1: Two person cabin section*

TWO PERSON CABIN ELEVATIONS, 1:100

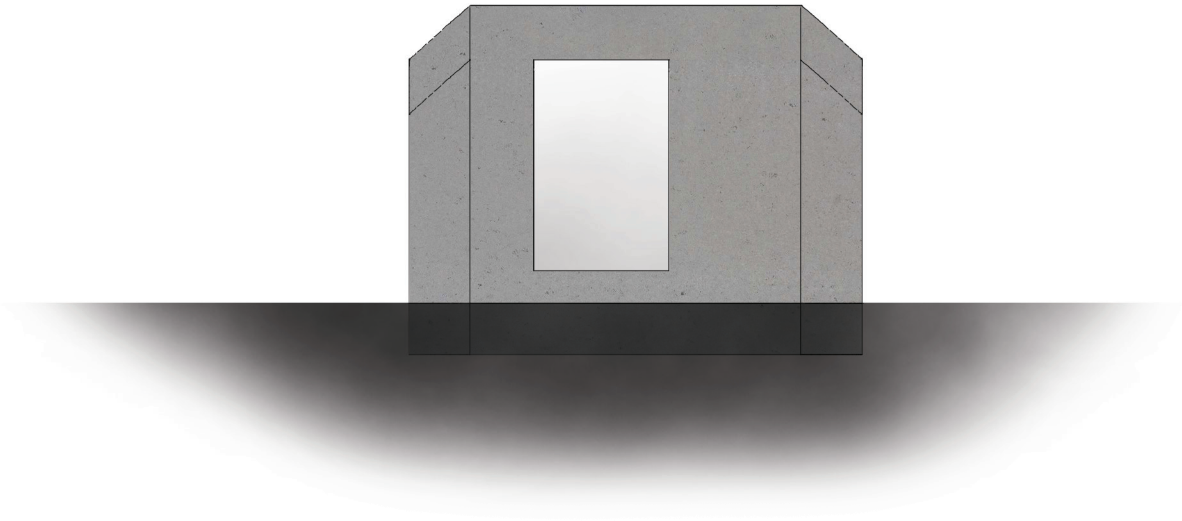
NORTH WEST



NORTH EAST

▲ *Ill. 178.1: Two person cabin northwest elevation*
▲ *Ill. 178.2: Two person cabin northeast elevation*

SOUTH EAST



SOUTH WEST

▲ *Ill. 179.1: Two person cabin southeast elevation*
▲ *Ill. 179.2: Two person cabin southwest elevation*

TWO PERSON CABIN BEDROOM

▲ *Ill. 180.1: Two person cabin bedroom*

TWO PERSON CABIN BEDROOM

▲ *Ill. 181.1: Two person cabin bedroom and hallway*

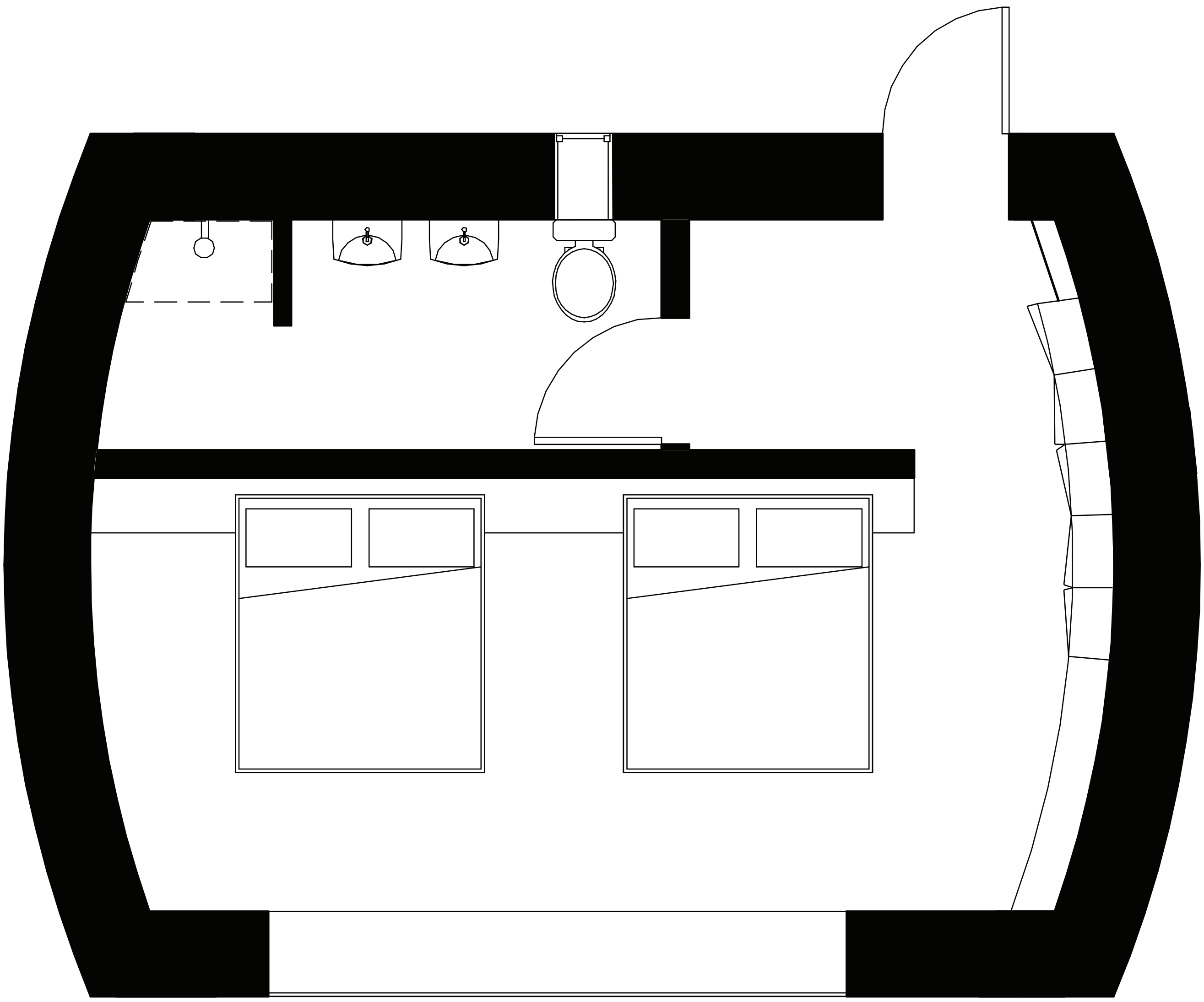
TWO PERSON CABIN BATHROOM

▲ *Ill. 182.1: Two person cabin bathroom*

TWO PERSON CABIN ENTRANCE

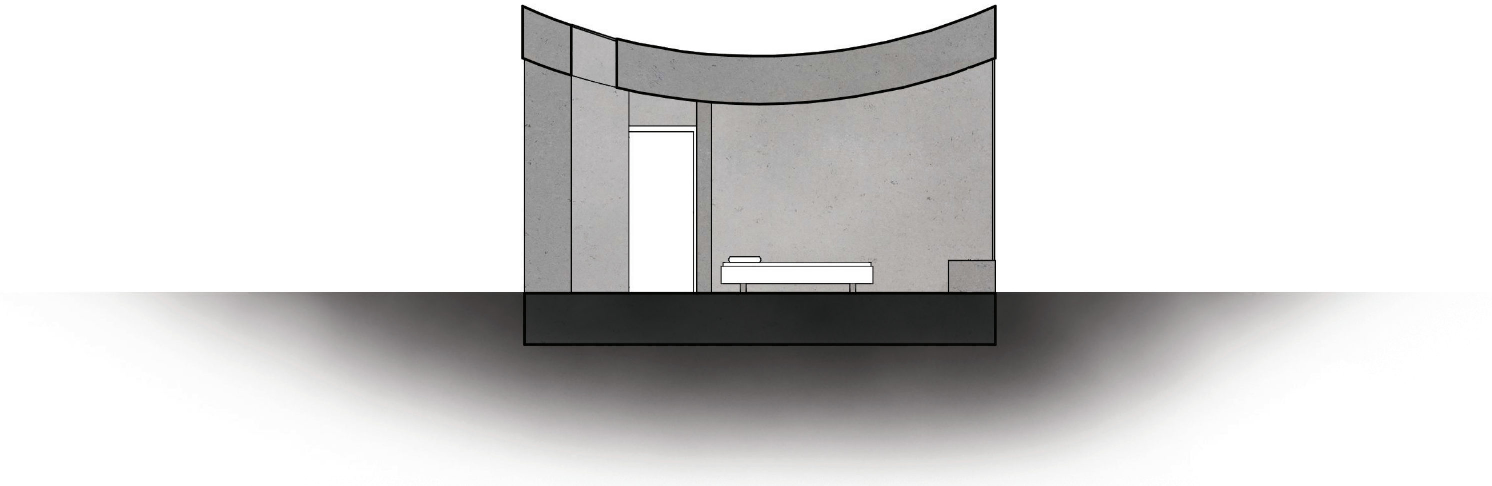
▲ *Ill. 183.1: Two person cabin entrance*

FOUR PERSON CABIN PLAN, 1:50



▲ *Ill. 184.1: Four person cabin plan*

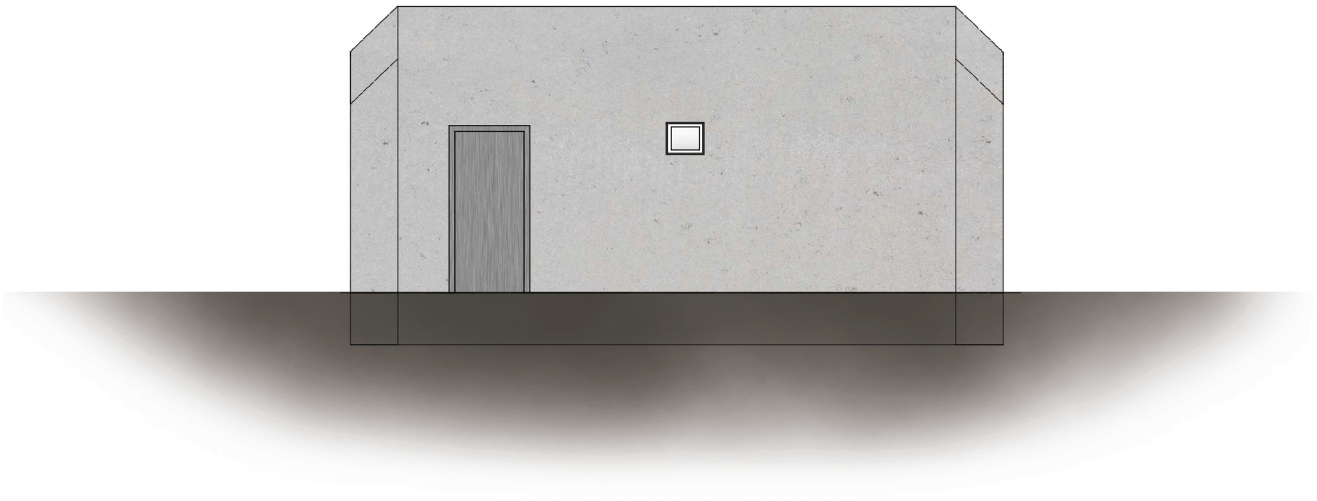
FOUR PERSON CABIN SECTION, 1:100



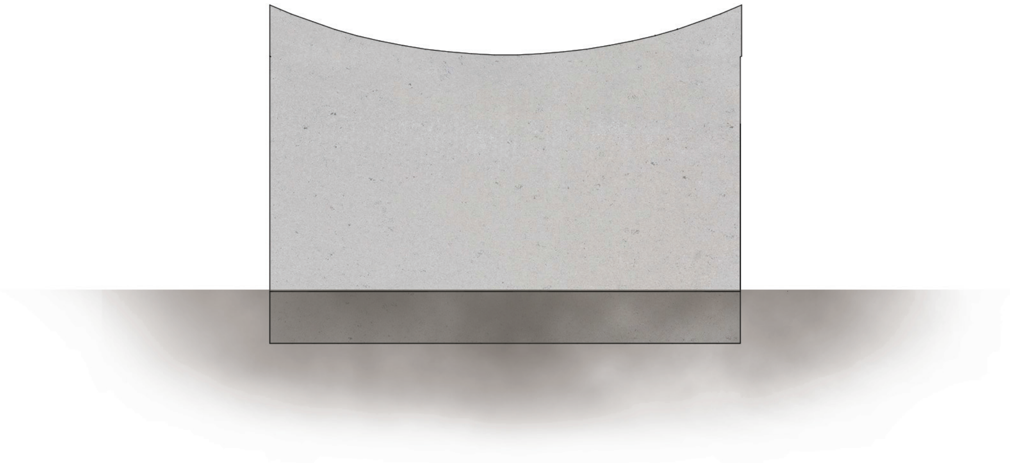
▲ *Ill. 185.1: Four person cabin section*

FOUR PERSON CABIN ELEVATIONS, 1:100

NORTH WEST



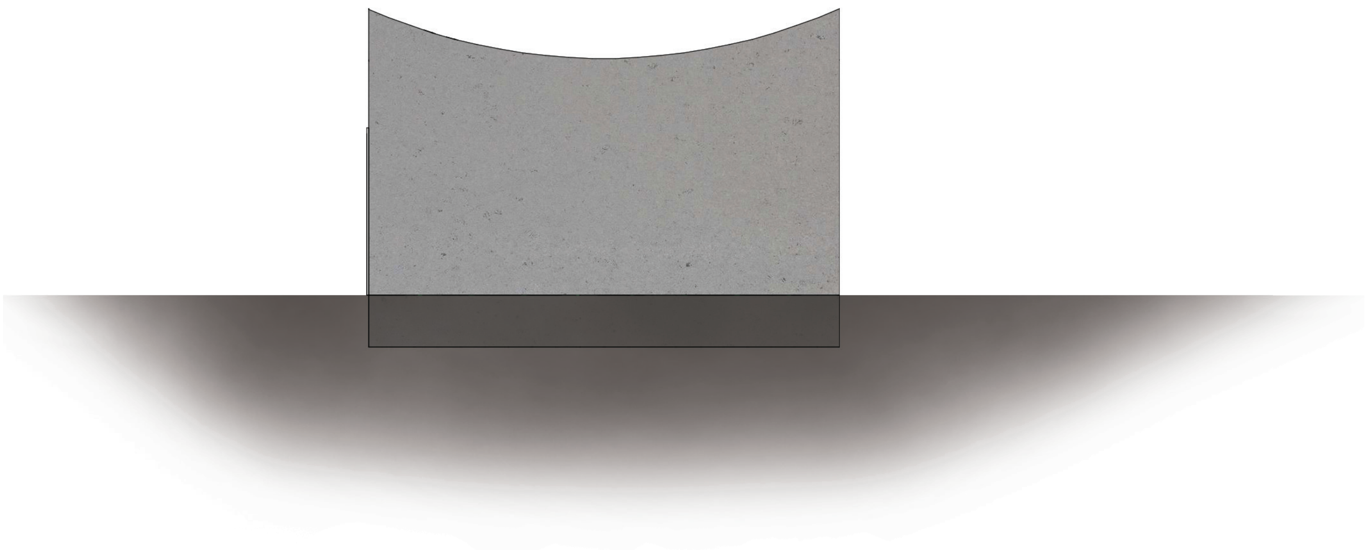
NORTH EAST



▲ *Ill. 186.1: Four person cabin northwest elevation*
▲ *Ill. 186.2: Four person cabin northeast elevation*

SOUTH EAST

SOUTH WEST

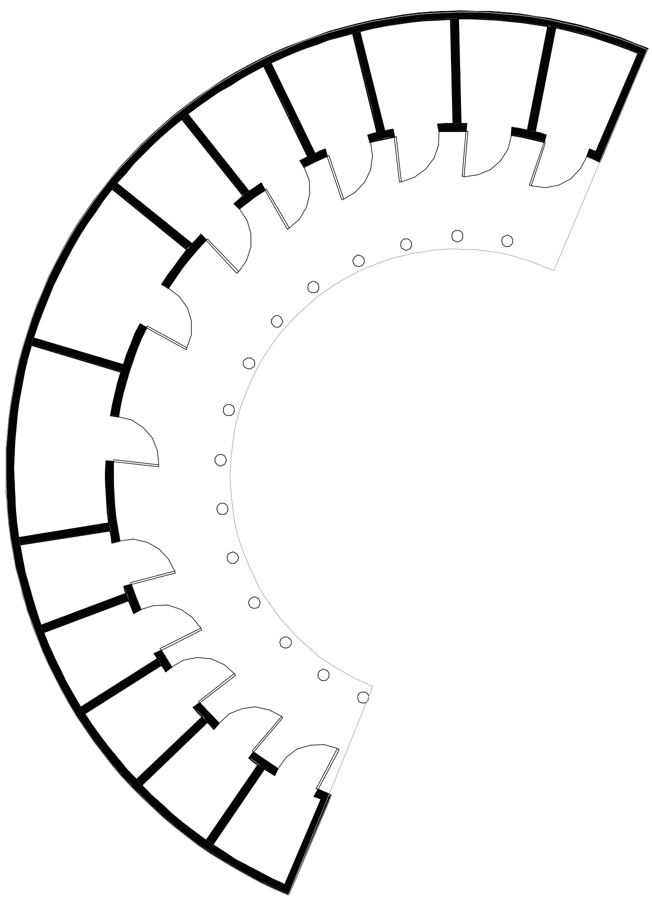


▲ *Ill. 187.1: Four person cabin southeast elevation*
▲ *Ill. 187.2: Four person cabin southwest elevation*

FOUR PERSON CABIN BEDROOM

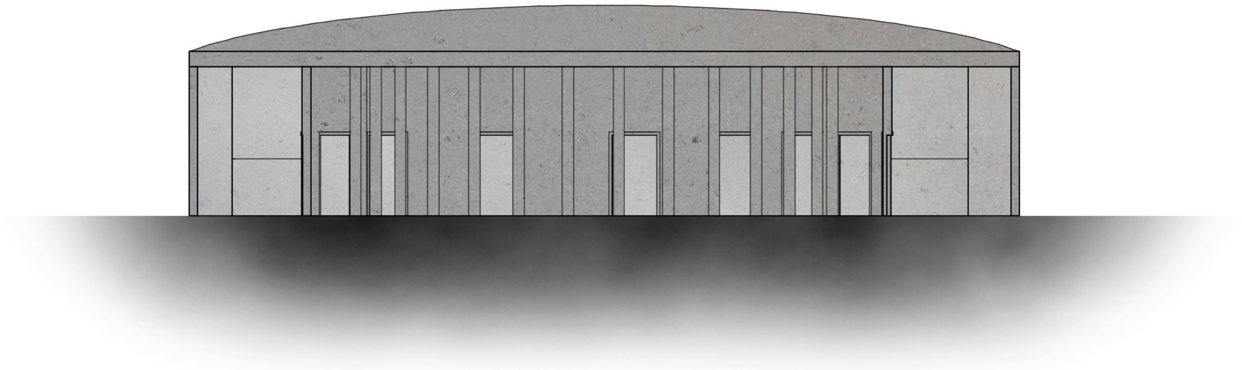
▲ *Ill. 188.1: Four person cabin bedroom*

HORSE STABLE PLAN, 1:200



▲ *Ill. 190.1: Horse stable plan*

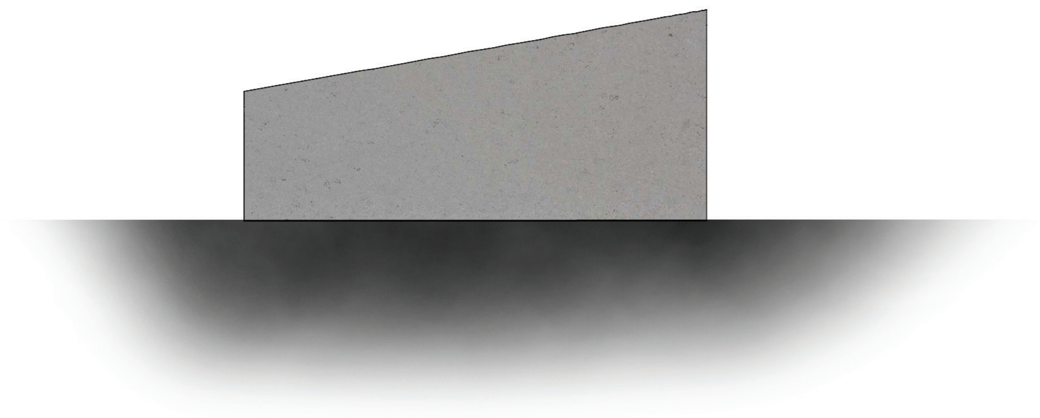
HORSE STABLE SECTION, 1:200



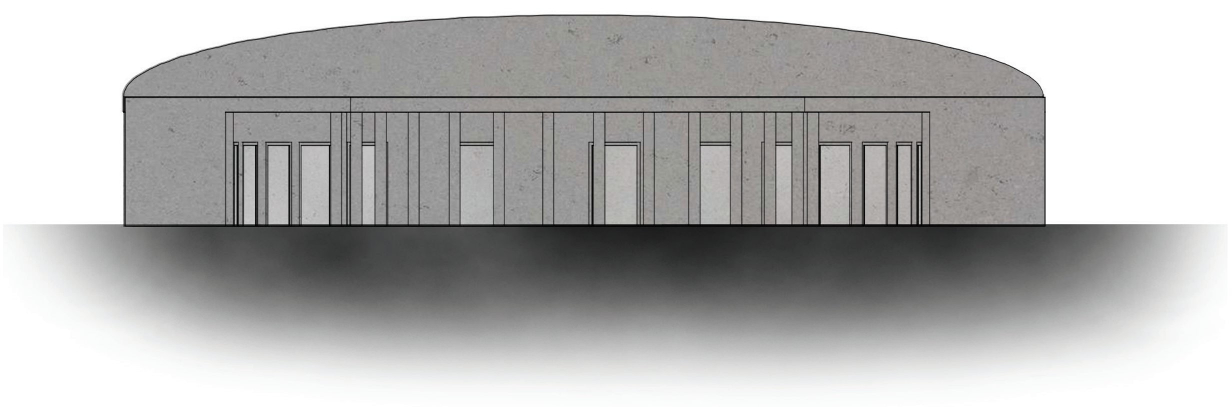
▲ *Ill. 191.1: Horse stable section*

HORSE STABLE ELEVATIONS, 1:200

NORTH WEST

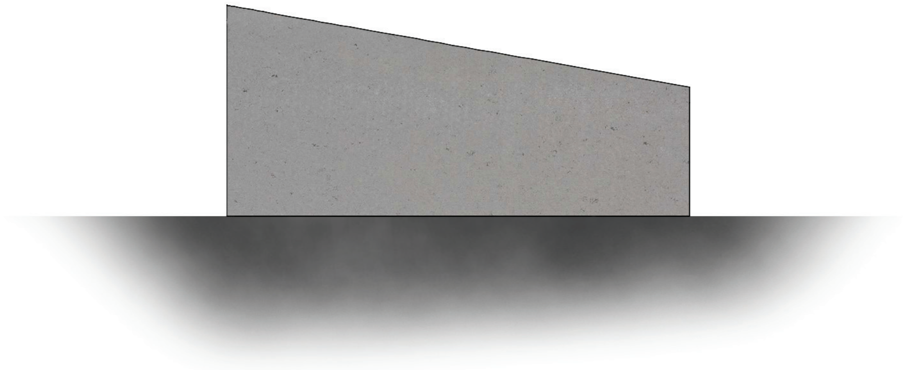


NORTH EAST



▲ *Ill. 192.1: Horse stable northwest elevation*
▲ *Ill. 192.2: Horse stable cabin northeast elevation*

SOUTH EAST



SOUTH WEST

▲ *Ill. 193.1: Horse stable southeast elevation*
▲ *Ill. 193.2: Horse stable southwest elevation*

SOLAR CELLS

To reach the 2020 energy demands, the project need a renewable energy source. Solar cells are therefore being calculated on in the following text, to find the right peak performance of the energy consumptions that the solar cells need to cover the last energy consumption of kWh/m^2 pr. year.

First the total energy consumption must be converted to the primary energy
35,4 kWh/m^2 pr. year *1,8 + 30,8kWh/m^2 pr. year = 94,52 kWh/m^2 pr. year
The total energy consumption factor from BE18 = 35,4 kWh/m^2
By using the solar cells, the electricity consumption for primary energy, has the factor 1,8.
The total energy requirements factor before solar cells in 2020 = 30,8 kWh/m^2

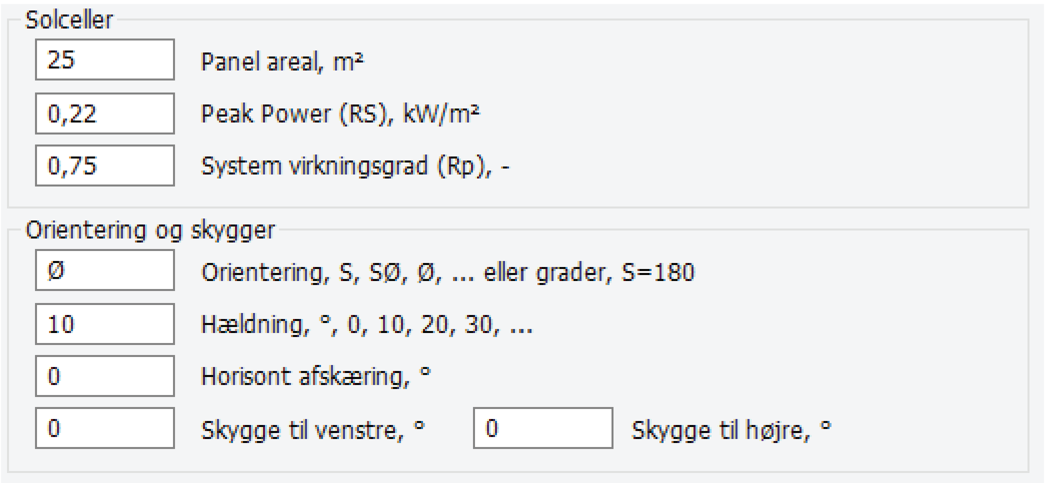
In the next step, the buildings energy consumption pr. year, which the solar cells must cover, are being calculated.
94,52 kWh/m^2 pr. year/1,8 =52,511 kWh/m^2 pr. year.
The buildings square meter = 673 m2
52,511 kWh/m^2 pr. year * 673 m^2 = 35340 kWh/year.

In the last step the peak performance is being calculated
35340 kWh/year = x * 0,8 * 1147 kWh/m^2 = 38,51 kW peak
System factor = 0,8
The solar radiation (For Denmark) = 1147 kWh/m^2

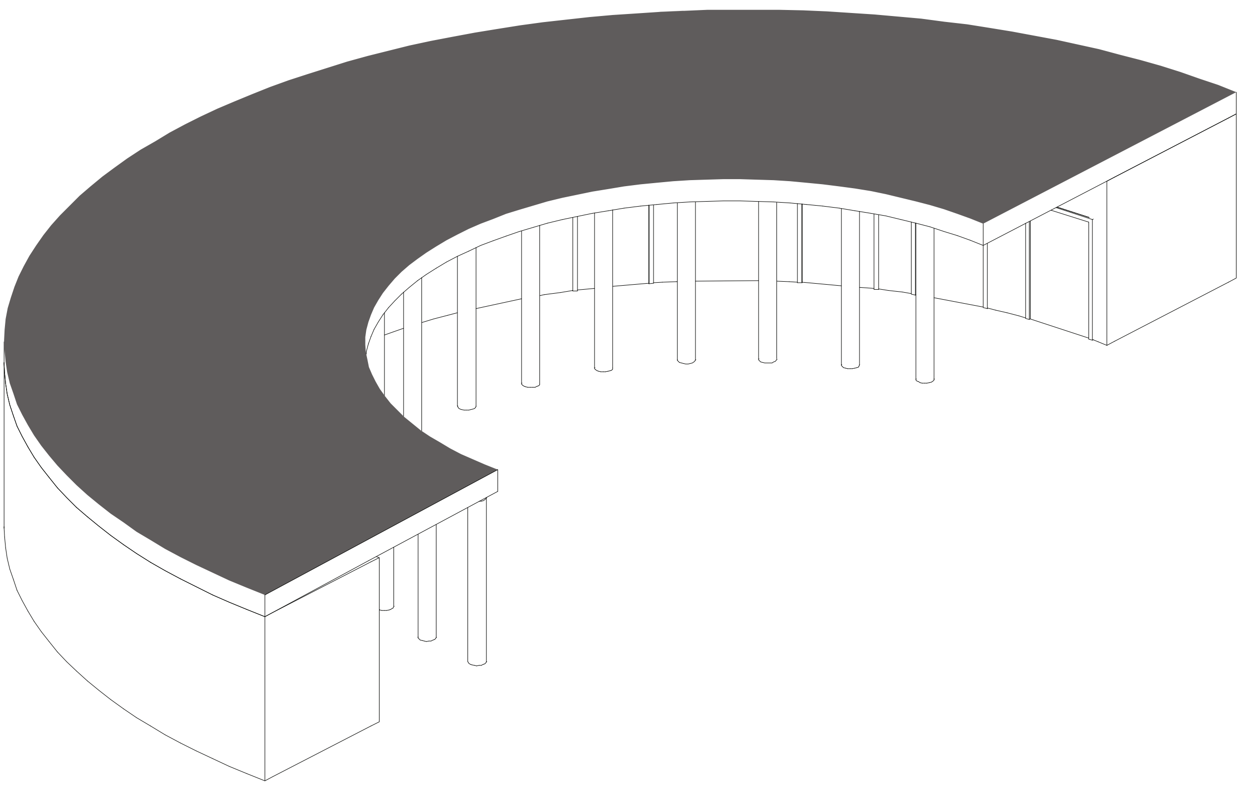
X = the installed effect/power the building needs to be covered to reach the requirements
The total area of modules. Which is on the of the hors barns roof area = 173 m^2

38,51 kW peak / 173 m^2 =0,22 kW/m^2

0,22 kW/m^2 Is the peak performance the solar cells need to cover det consumption on the given space.



▲ *Ill. 194.1: Solar cells in Be18*
▶ *Ill. 195.1: Horse stable with solar cells*



BUILDING PERFORMANCE

The guest resort has been simulated regarding the buildings' energy consumption and to be sure it reaches the requirements for 2020 with a good indoor environment according to the human comfort zone. This is made through the simulations programs as Be18, where the main building has been simulated. And in BSim where the dining area has been simulated, as it is one of the most exposed rooms according to its functions and capacity.

By looking at the energy consumption in Be18, the energy consumption has to be lower than 20 kWh/m2 per year. To reach this, the main buildings u-values have been implemented which have been hand calculated for the different surface according to the materials, as seen in appendi, and the same as for the line loss and the hand calculated air change for the ventilation. Studies of the windows have been made in both programs, Be18 as BSim. There have been made studies upon, which type of glass the window should have. Should it be a two layer or three layers of energy glass, which will affect the G-value as the LT value, according to how much heat gain as solar gain the window will allow to pass through the glass, and at last wherein the envelop the window should be placed.

According to the placement, it had already been decided through the multifunctional use of the windowsill, that the glass shall be placed along the envelops outside, so the windowsill also can be used as a place to sit. Go give the guest and the user an ultimate and the wanted daylight experience, a large area of windows had to be needed, which concluded to use the window type with three layer glass, which has a lower G-value and LT value than the two layer glass, otherwise the temperature of the room would be too high and would need more mechanical ventilation. This also matches the demands for the 2020, that the window area should be at least 15 % of the floor area if the LT value is 0,75 or bigger.

Through the studies of the wanted experience, it has been concluded to use a lower LT value, which matches the demand on the lower LT value, the area of the windows should be bigger [Historisk.bygningsreglementet.dk, 2018]. Even though with all the good numbers to prevent the heat loss through the elements, it was not enough to reach the 2020 requirements alone, renewable energy sources had to be integrated, where as solar cells were selected.
One of the issues that Be18 are not able to simulate on, which influenced the project, is the geothermal energy. As mentioned the resort is getting all the heat and electricity from the renewable geothermal power station nearby, so it would properly not be necessary to have the solar cells in real life.

By looking at BSim for reaching a good indoor environment, the temperature, the CO2 level, and air change has been looked at through the process of the simulation. As the temperature, ventilation, good insulations, passive strategies, and light have been integrated and calculated along the design process, the number of iterations through BSim have been minimal - the same goes for Be18.

The results for the dining areas indoor environment can be concluded on. A steady operative mean temperature from 20 to 23,6 °C which match to the human comfort zone and with a maximum indoor temperature at 26,40 °C which only will happen around 43 hours a year. Otherwise, the temperature will be between 20,3 to 24 °C.

The CO2 level is also very steady through the year around 450 ppm and will maximum reach the level of 803 ppm. And at last, the air change which matches very well with the hand calculations. It will normally lay around 3,6-4 but will be reaching a level of 6,9 through the year.

▶ *Ill. 197.1: Be18 result*

Nøgletal, kWh/m² år

Renoveringsklasse 2

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
114,8	0,0	114,8
Samlet energibehov		29,6

Renoveringsklasse 1

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
55,0	0,0	55,0
Samlet energibehov		29,6

Energiramme BR 2015 / 2018

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
31,5	0,0	31,5
Samlet energibehov		25,6

Energiramme Byggeri 2020

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
20,0	0,0	20,0
Samlet energibehov		19,5

Bidrag til energibehovet

Varme	20,2
El til bygningsdrift	2,9
Overtemp. i rum	2,2

Netto behov

Rumopvarmning	7,0
Varmt brugsvand	9,1
Køling	0,0

Udvalgte elbehov

Belysning	50,2
Opvarmning af rum	0,0
Opvarmning af vbv	0,0
Varmepumpe	0,0
Ventilatorer	9,1
Pumper	0,0
Køling	0,0
Totalt elforbrug	35,4

Varmetab fra installationer

Rumopvarmning	3,8
Varmt brugsvand	2,8

Ydelse fra særlige kilder

Solvarme	0,0
Varmepumpe	0,0
Solceller	6,3
Vindmøller	0,0

CONCLUSION

The project took its final shape based on the concept of the glowing cylinder, which resulted in the concave cabins, the half circle of the horse barn and the cylinder of the main house. The entire design process centers around the knowledge about light were implemented in the project along sustainability, Cradle to Cradle and tectonics. The light studies were made for the rooms and the cabins to ensure that the wanted atmosphere was achieved as well as the theories of sensuous architecture based on Zumthor and Pallasmaa.

The result of this project is a design there is made for the user to experience the light of Iceland, the nature of the site and its surroundings of lava formations and the Mývatn Lake. Studies have been made of the light to the selected rooms which include temperature and ventilation calculations, daylight simulations and renders of the architectural expression. This process has resulted in the rooms achieving their wanted atmosphere of either being calm, excited or a little of both.

The main building works as the lighting gathering and social part of the site, where the guests will eat breakfast and dinner together in the dining area. For the guest to interact with each other in the lounge, there is furnished different types and sizes of sitting areas as there the possibility to play one of the board games from the bookshelf. The niches around the atrium actives the room's hallway, where the guest can sit together or alone reading in the travel books placed on the nearby bookshelf in the light of the atrium.
In the sauna the guests can get a light experience from entering the sauna in a darker hallway, hearing the voices in the sauna, walking towards the light, and the site and enjoy the heat and the view in the sauna.
On the roof the guest can enjoy a 360 degrees view and experience the northern lights during the day.

From the main building the guest can walk to their cabins on a path that is dug into the ground, for the guest to get the feeling of walking down to their cabin, as well as walking up to the glowing main building. In the cabin, the user can enjoy the view over Lake Mývatn from a seating in the window or from their bed. The concave wall emphasizes the light and guide is further into the building. In their bathroom they guest will be showered in the light from the skylight, that spreads from the roof to the bathroom.

The horse barn is dug into the ground where the horses can seek shelter and the family and staff can store their riding equipment. The design of the building reaches to the sky and brings light into the horse boxes.

By having made these studies for the buildings, the light and theories have been integrated into the sustainable project.

REFLECTION

The atrium is made of a glass cylinder that makes the light distribute on the first floor. When the guest enters are they taking the stairs to the first floor, and will be walking around the glass of the atrium to get up. But the wall between this hallway on the ground floor at the stairs could be detailed further. It was discussed for a time that it could be made of a type of frosted and not-see-through glass, for the family home to get some of the light. The family home has a hallway connecting the children's bedroom to the kitchen and living room. To avoid wasting too much energy on the needed artificial lighting at this hallway a study of different ways to use the light from the atrium without compromising with the privacy of the family home.

The implementation of skylights has been discussed several times, whereas studies of how they can be used without people watching Northern lights can look down. Along the walls of the atrium and in the showers of the changing room was this considered, and due to other priorities, it was not used for this project.

The windows in the changing could be larger to ensure that more daylight would enter the room. By having larger windows area in this room, the ventilation airflow would need to be higher. To make the windows larger studies of how much larger should be made and its new ventilation demands.

The paths from the main building to the cabins is dug into the ground for the people to walk down to their cabins. The main building is the social gathering space, while the cabins are private, so they are darker and more intimate, while the main building is glowing and social. The paths should have artificial lights during the night time and should be integrated into the path to minimize the number of lights towards the main building, due to is distracting for the people watching the northern lights. The path should also be studied of how it meets the cabin, and how its snow and rainwater removed. It could be by using the closed system of pipes with a fluid in it that gets heated up by the hot wastewater, as mentioned in the supplied text and the interview with Janus Bjarnason.

The use of seaweed as an acoustic element in the ceiling should be calculated on of effective it would compare the thickness of the seaweed layer, as for this project its thickness is only assumed. Also, should it be examined whether it odor gets enhances by being placed in the ceiling of a wet room since it is not wanted to have the bathroom smelling like seaweed?

The concrete used for this project is a light type without any lava dust in it, even though it can be more sustainable. The research on this matter was not sufficient to evaluate if it could be used for this project. It could have been studied more with different variations of concrete colors based on the use of lava dust in it. The strength of the concrete should be documented and calculated for this project.

The details of how the columns pass the ceiling of flax linen should be studied more, to examine how the different types of details affect the design. But also, how the box that holds the flax linen and the seaweed up is connected by the ceiling.
The columns are placed in the internal walls several places and studies and detail drawings should be made to ensure that what it looks like aesthetically but also how the sound transmission is between the two rooms.

The structural system for the project is as mentioned divided into several slices, where the system makes some complications for the project, which only occur because of the atrium. One of them is that the slabs and roof elements need to be thicker, so the ventilation pipes can get underneath the beams. And another is the beam by using concrete for the structural system. The beams are only being used to stabilize the system, but because of their own dead load they are much bigger than expected in their dimensions and thereby need more material.

The ventilation pipes are placed on the ceiling and will have to move under the concrete beams to pass them. This affects the room height overall, but studies could be made of the rooms places between the beams, where the room height could be higher. This could also become a gradient of room height since the pipes become smaller in diameter at the end of it.

The solar cells were used to achieve the BR2020 requirements even though it was not planned that the building should cover its own electricity consumption. As mentioned earlier, Iceland is self-sufficient with their geothermal and hydropower. Near the site is a geothermal power station located, where the site can get renewable energy and heat from. In the program of Be18, this cannot be shown, that all the energy and heat already come from a sustainable source. For the family to pay for the solar cells does not fit with the economic aspect of sustainability, since they could save that money.

The guest can walk to the roof where they should be able to sit and watch the view during the day and the northern lights during the night. The furniture they will use to sit on should be designed through studies as well as the entrance on the roof.

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4MEfZb-96oW8E-8BZD6K-HA4ky-c39C55-8BZDdB-4MA54T-8LeroJ-7kZNJG-ngNG5c-4MA56M-3eLevH-7XC4WK-2Sb9f3-7AGMV2-DfNqNe-8Lerq1-657Zu6-8MAUtr-nfCE81 [Accessed 24 Feb. 2018].]
Ill. 65.1: The narrow sky lights guide the visitor [Drager, I. (2012). https://www.flickr.com/photos/irdrager/6786255964/in/photolist-fKqGkU-f99kkA-dQbjHP-fKoySr-fK76Xg-fKFVpd-qvbaXK-fntiJ7-fKoAgu-go9AkP-fntktb-fKp5y1-fK6WFk-5fQnNR-fK7oMa-fKqDk9-byAdg4-bkFktb-dQbsPt-fne95x-dVwp5g-dVC7es-dQbjqR-dVCbvu-fK7G7p-qvbmZV-dVCgvS-fnebve-4sXVys-fK9vFP-qvbjeK-qv1qKX-fnti5h-dQbkNk-7AGAJk-fKose3-qdLd8x-dQgZZf-dQgXZs-qdJtyD-qv1sRR-pybN1L-qdJsXD-qv1h5v-qdBCkE-qv1ocv-pZyUVZ-aH1Fqa-qv7z8C-qdCnmb/. [image].]
Ill. 65.2: The large windows give a nice view but also a lot of light on the hall ways, where entry to the various baths are possible [Parnow, U. (2013). Vals Therme. [image] Available at: https://www.flickr.com/photos/47637345@N03/9502688403/in/photolist-ftHLce-6e4UXz-8BZDc4-ajbBuc-8C3JHW-9185NA-99sUUY-ftYhBy-pinEt-rhbtx-fKou67-68hjrq-5pSGGa-pyP4Ak-3eLeJn-8tn6cK-HAaoX-3nbc3j-akPTce-RYbmuF-7iXUB9-6gHmK-pUk1D-8C3JEC-8tjWMz-ekzBHA-ftYkPY-69czTz-HT7N-ftX-RnN-9cgYiC-5E5MiN-8HybWX-8P1cea-ftYftS-8LbmWc-aeZQBq-2isUxs-8nh7uR-ftYaem-9kDjK2-Bimvm-8C3Jy3-ftGUjt-ftHSQ4-6gHgi-8C3Jzo-8wv6SG-9cgZhw-7Am2ZC [Accessed 24 Feb. 2018].]
Ill. 65.3: The building is half buried into the hill side [Fujimoto, K. (2013). Therme Vals. [image] Available at: https://www.flickr.com/photos/jutok/9680422482/in/photolist-fKqGkU-f99kkA-dQbjHP-fKoySr-fK76Xg-fKFVpd-qvbaXK-fntiJ7-fKoAgu-go9AkP-fntktb-fKp5y1-fK6WFk-5fQnNR-fK7oMa-fKqDk9-byAdg4-bkFktb-dQbsPt-fne95x-dVwp5g-dVC7es-dQbjqR-dVCbvu-fK7G7p-qvbmZV-dVCgvS-fnebve-4sXVys-fK9vFP-qvbjeK-qv1qKX-fnti5h-dQbkNk-7AGAJk-fKose3-qdLd8x-dQgZZf-dQgXZs-qdJtyD-qv1sRR-pybN1L-qdJsXD-qv1h5v-qdBCkE-qv1ocv-pZyUVZ-aH1Fqa-qv7z8C-qdCnmb [Accessed 24 Feb. 2018].]
Ill. 65.4: The green roof with its skylights that mimic the plan layout [Fujimoto, K. (2013). Therme Vals. [image] Available at: https://www.flickr.com/photos/jutok/9677264841/in/photolist-fKqGkU-f99kkA-dQbjHP-fKoySr-fK76Xg-fKFVpd-qvbaXK-fntiJ7-fKoAgu-go9AkP-fntktb-fKp5y1-fK6WFk-5fQnNR-fK7oMa-fKqDk9-byAdg4-bkFktb-dQbsPt-fne95x-dVwp5g-dVC7es-dQbjqR-dVCbvu-fK7G7p-qvbmZV-dVCgvS-fnebve-4sXVys-fK9vFP-qvbjeK-qv1qKX-fnti5h-dQbkNk-7AGAJk-fKose3-qdLd8x-dQgZZf-dQgXZs-qdJtyD-qv1sRR-pybN1L-qdJsXD-qv1h5v-qdBCkE-qv1ocv-pZyUVZ-aH1Fqa-qv7z8C-qdCnmb/ [Accessed 24 Feb. 2018].]
Ill. 65.5: An illustration of the amount of daylight in the building building [wikiarquitectura.com (n.d.). Thermas Vals. [image] Available at: https://en.wikiarquitectura.com/building/thermas-vals/#lg=1&slide=2 [Accessed 24 Feb. 2018].]
Ill.66.1: The igloos, covered in snow, placed along the path [Xaf (2011). Kakslauttanen. [image] Available at: https://www.flickr.com/photos/xaf/5553530991/in/photolist-7q31RX-7q3bk2-pgXL5G-mKBD2G-UfLu3m-71fnt3-oZuRF9-9sKihk-kYCYcn-7q37ev-7q6W2Q-SvBenP-7q6Yjb-9sNdV9-W691Gf-7q6WEL-8CSQ2G-mLcMrQ-7q32sK-9sNjGE-WbyYb6-7q3bxn-dZGSSH-24bYEnn-zgdpd-7q3bVK-dZzPzg-gyHoe1-bmgRKz-71ffiu-byeqZ3-byemNu-SDiwph-fFfmjc-QJRESt-71fh25-UD39rJ-UsoaXw-U7zAcE-jHJZ3N-aFNa5X-ffrwKs-4ChpAT-4CmGoC-e5KCsF-8CSX5h-8CPQM6-8CSVGs-8CSWh9-UD3bAJ/ [Accessed 24 Feb. 2018]]
Ill. 66.2: The entrance to the igloos [Cooper, J. (2013). Kakslauttanen Finland. [image] Available at: https://www.flickr.com/photos/95808980@N04/9633137999/in/photolist-7q31RX-7q3bk2-pgXL5G-mKBD2G-UfLu3m-71fnt3-oZuRF9-9sKihk-kYCYcn-7q37ev-7q6W2Q-SvBenP-7q6Yjb-9sNdV9-W691Gf-7q6WEL-8CSQ2G-mLcMrQ-7q32sK-9sNjGE-WbyYb6-7q3bxn-dZGSSH-24bYEnn-zgdpd-7q3bVK-dZzPzg-gyHoe1-bmgRKz-71ffiu-byeqZ3-byemNu-SDiwph-fFfmjc-QJRESt-71fh25-UD39rJ-UsoaXw-U7zAcE-jHJZ3N-aFNa5X-ffrwKs-4ChpAT-4CmGoC-e5KCsF-8CSX5h-8CPQM6-8CSVGs-8CSWh9-UD3bAJ// [Accessed 24 Feb. 2018]]
Ill. 67.1: The wood exterior of Villa Asserbo [Een til Een (2011). Villa Asserbo. [image] Available at: http://eentileen.dk/projekt/villa-asserbo/9 [Accessed 24 Feb. 2018]]
Ill. 67.2: The view from an internal opening towards the living room [Een til Een (2011). Villa Asserbo. [image] Available at: http://eentileen.dk/projekt/villa-asserbo/1 [Accessed 24 Feb. 2018]]
Ill.68.1: Exterior view of Villa Grenaa [Villa Grenaa (n.d.). Villa Grenaa. [image] Available at: http://villagrenaa.dk/ [Accessed 24 Feb. 2018]]
Ill. 69.1: Ceiling covered by seaweed and flax linen Vinther, L. and Gadeberg, L. (2018). Det Moderne Tanghus på Læsø. [online] Bolius.dk. Available at: https://www.bolius.dk/det-moderne-tanghus-paa-laesoe-34443/ [Accessed 13 May 2018].
Ill. 69.2: Tanghuset with its seaweed roof [Saaby, T. (2014) https://www.flickr.com/photos/tsaaby/14631153143/in/photolist-hQFd5v-nYECg4-oe76oq-5kGVwM-nYDpfs-oe781J-7f4kFa-nYDrTf-oe6RRf-og8Nqk-og6kus-nYDetf-og6cYq-nYDqiS-nYELBx-nYDSu8-ofXj5G-eH98rj-fBeSYF-6ZSDxK-9MXg6K-7f8eLG-bq57zm-boGi7d-4Gw8yK-oe6WVd-ofRdkz-nYDue5-ofXuAw-nYDQ3V-eFgtxj-aUwiYT-ohUu66-nYDxe5-KcMK4j-nYEJZz-xSpd2n-NkC3aF-og65pN-amDpyJ-xX98AQ-KcNNC1-yoZrZu-nX7WAW-nX7N57/ [image]
Ill. 75.1 - 98.2: [own illustration]
Ill. 98.3: Le Corbusier's modular man [Le Corbusier] Le

Corbusier's modular man [image]. Available at: http://donnallyarchitects.com/proportion-and-scale/attachment/031/ [accessed 11 May 2018]
Ill. 99.1 - 102.1: [own illustration]
Ill. 103.1: Flax fabric [tigercop2k3 2010] https://www.flickr.com/photos/tigerphotostock/16226825041/in/photolist-95B7fu-73Hpom-dmNhU9-YaCWYE-ekkS2y-GfxyV-S9bDun-71hZJ8-qHUHKx-S9bFze-r1yEHh-57z5kG-atgJ6K-ocMFcZ-fnoiTL-e2Mdre-8P3Lhw-7WW8R2-4Pwiw5-p7owgH-6gMayU-8bYnLd-gYmspk-orCS3J-dkeMxu-5vtdmM-4THfyw-nQap2g-6aEKEQ-VJwKys-rb2737-fZsqMf-bVSLFg-XaGYWA-bgyzb8-Jq7C8m-eCPyG3-7h81wm-6NjAiy-pvdpXS-7kQFf4-fh116t-cdg-pZq-4UdEXs-nCmZg8-qLwor8-reSeE1-5CL175-cGXqYY-nURwGZ [image] [Accessed 12 May 2018]
Ill. 103.2: Light grey concrete [from Vray3's material library, [Accessed 1 April 2018]
Ill. 103.3: Pine wood [from Vray3's material library, [Accessed 1 April 2018]
Ill. 103.4: Brushed aluminum [from Vray3's material library, [Accessed 1 April 2018]
Ill. 104.1 - 134.1: [own illustration]
Ill. 134.1: Viewing angle based on Zanden, P. (2014). Horizontal viewing angle. [online] Pietvanderzanden.weblog.tudelft.nl. Available at: https://pietvanderzanden.weblog.tudelft.nl/tag/horizontal-viewing-angle/ [Accessed 7 Apr. 2018].
Ill. 134.2 - 197.1: [own illustration]

chapter eight
appendix

INTERVIEW WITH JANUS BJARNASON

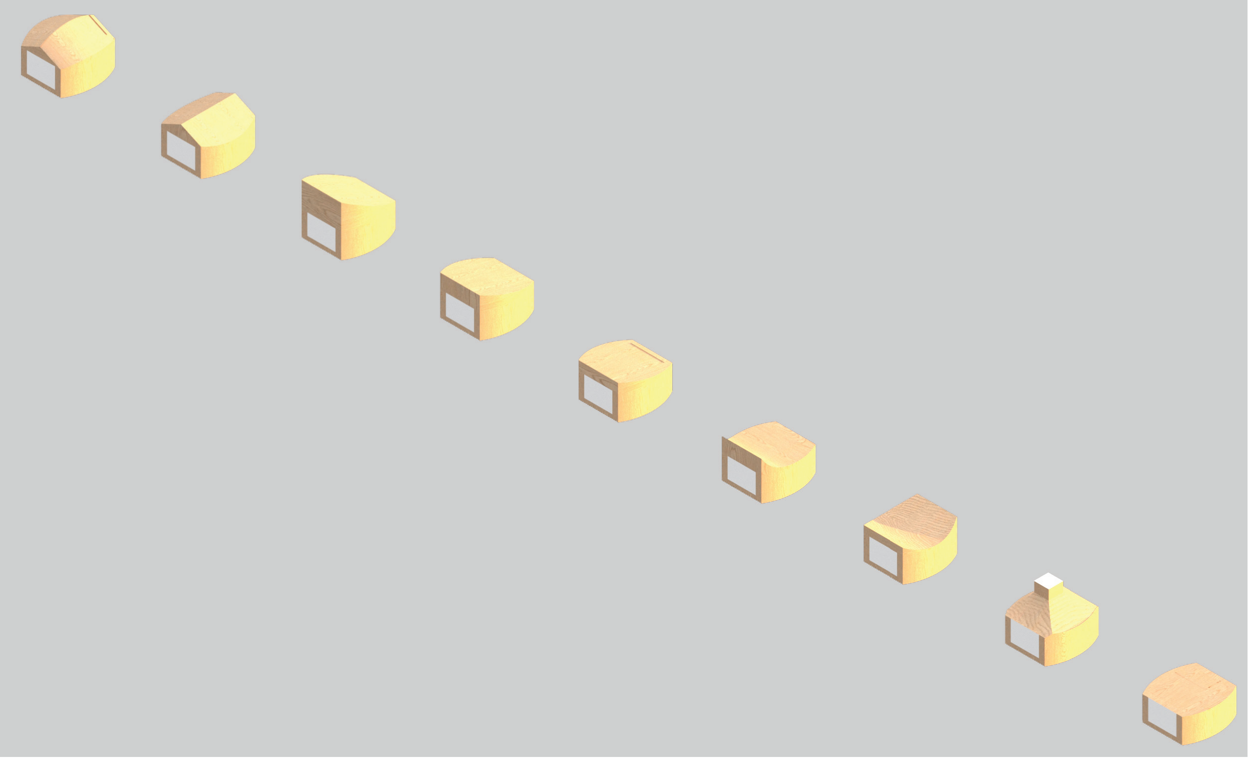
To get an understanding of how the builders in Iceland connects and uses the hot water from a geothermal supplier, we interviewed plumber, Janus Bjarnason from Lagnaþjónustan ehF, a plumber business from Reykjavik. From this interview these following notes was made:

The hot water is being pumped directly up from the ground at the geothermal power plant, used through the turbine to create electricity, transported in insulated pipes under the ground to the consumer, used for the heating via radiators and then used for hot water in the water taps and showers. After the water has been used in the house, it will run to the wastewater treatment plant.

In the old days would the hot waste water of 30-40 °C run through pipes in the driveway, to melt the snow and ice, before running to the wastewater treatment plant. Today a lot of the driveways will be heated up by pipes that runs in a closed system. The pipes will be heated up by the heat exchangers from the wastewater from the house. The pipes consist of its own non-freeze able fluids.

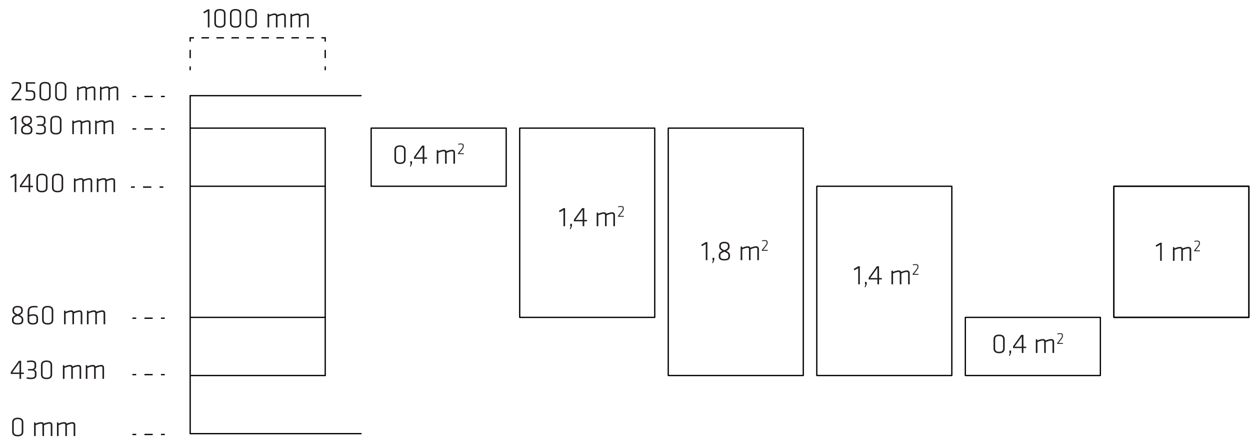
The cold, drinking water in their water taps is old ice and glacier water that has been filtered through the different layers of soil, and then being pumped up as clean drinking water. The water is being pumped up and then out to the consumer, without any need for water towers or treatment plants to clean the water.

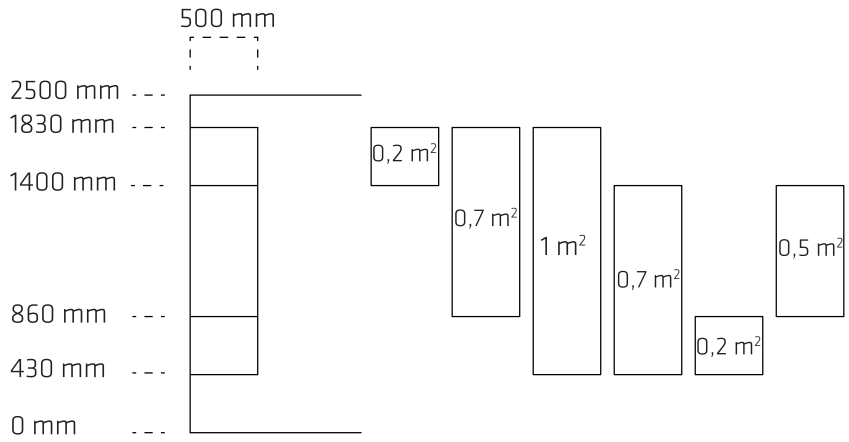
OVERVIEW OF CABIN ROOF TYPES



WINDOW SIZE

The window sizes are based on Le Corbusier's modular man, where the sizes are chosen after the user can be able to sit in the window, fit a table, and be high enough to make the windows private from people looking in.





AIR FLOW FOR THE ROOMS

Atrium, reception and lounge	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	149	372,5	25	285	0,3	2,7

Dining area	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	51	127,5	10	107,8	0,1	3

Staff room	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	23	57,5	5	52,1	0,05	3,26

Changeing room	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	43	107,5	-	15	0,015	0,5

Kitchen	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	18	45	5	48,6	0,04	3,8

Kitchen/living rooom	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	63	157,5	4	73,6	0,07	1,7

Children room	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	13	32,5	1	16,4	0,01	1,8

Master bedroom	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	24	60	2	31,4	0,03	1,8

Office	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	12	30	2	22,8	0,02	2,7

Small bathroom	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	5	12,5	-	15	0,015	4,3

Large bathroom	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	9	22,5	-	15	0,015	2,4

Two person bedroom	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	16	40	2	25,7	0,02	2,3

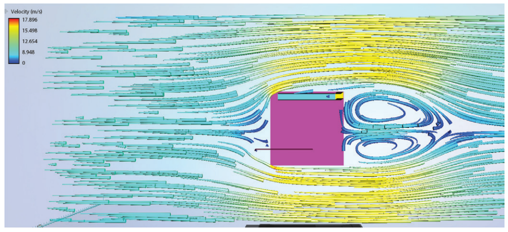
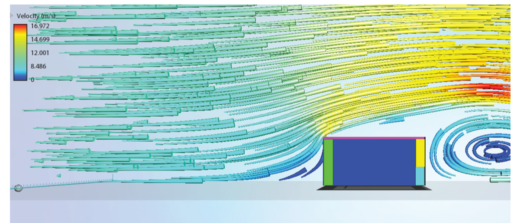
Two person bathroom	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	4	10	-	15	0,015	5,4

Four person bedroom	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	27	67,5	4	47,8	0,04	2,5

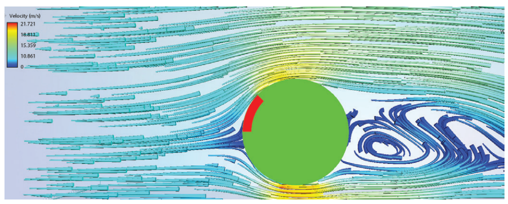
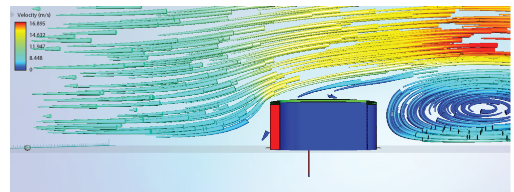
Four person bathroom	Area	Volume	People	Airflow	Airflow	Air change
	m^2	m^3	Number	L/s	m^3/s	h^{-1}
	5	12,5	-	15	0,015	4,3

WIND STUDIES OF CABINS

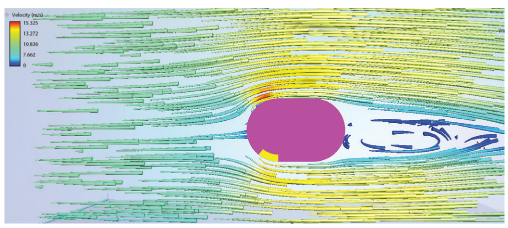
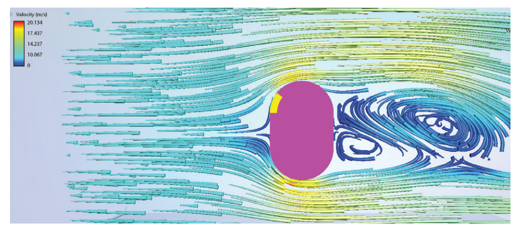
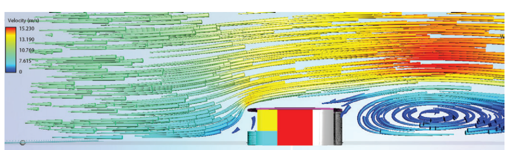
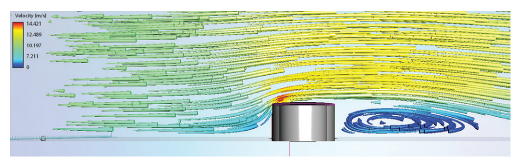
SQUARE

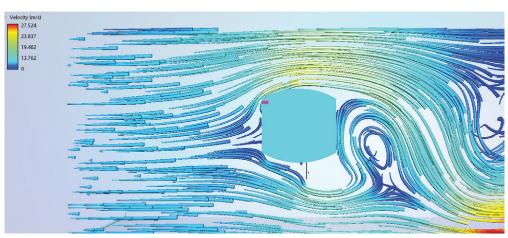
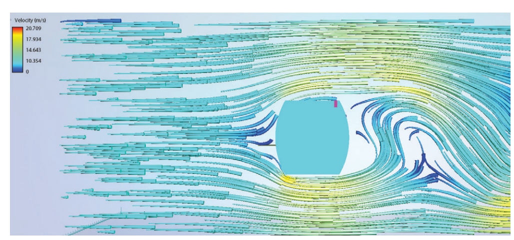
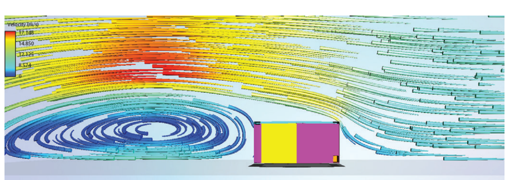
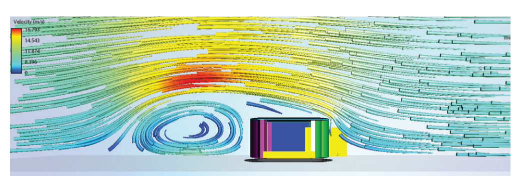
CIRCLE

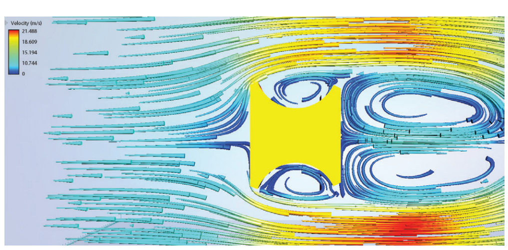
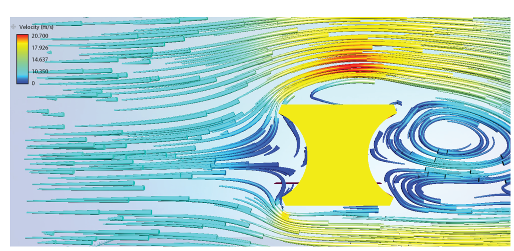
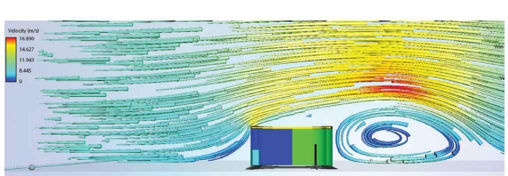
OVAL

CONCAVE

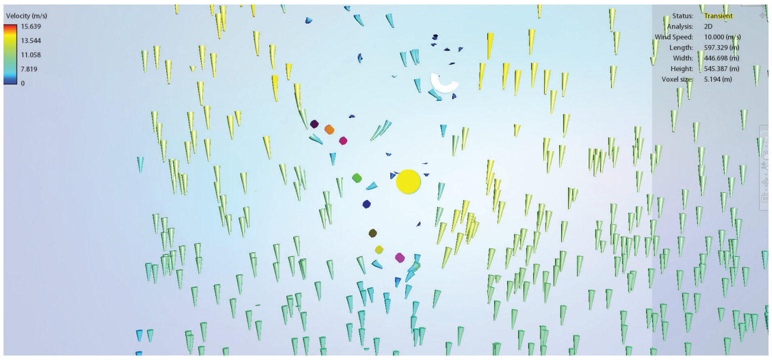





CONVEX

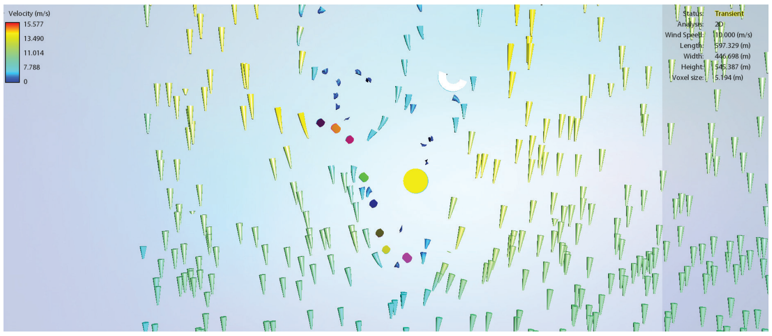





WIND STUDIES OF THE MASTER PLAN

WINDS FROM SOUTH

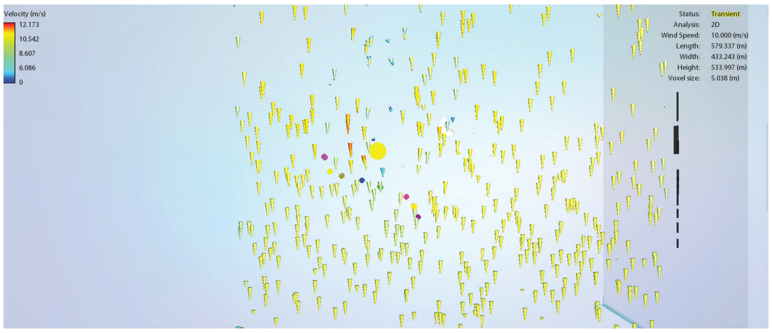


WINDS FROM SOUTH



WINDS FROM NORTH

WINDS FROM WEST

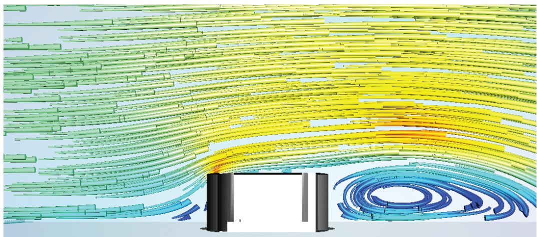


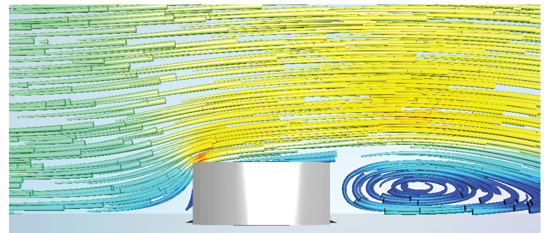
WINDS FROM EAST

WIND STUDIES OF CABINS

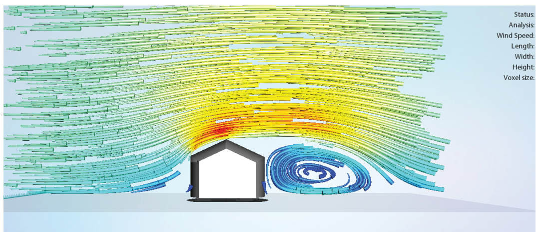
ROOF TYPES:

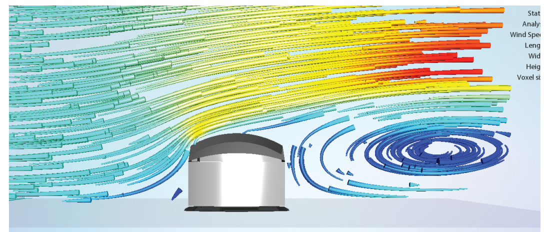
Flat

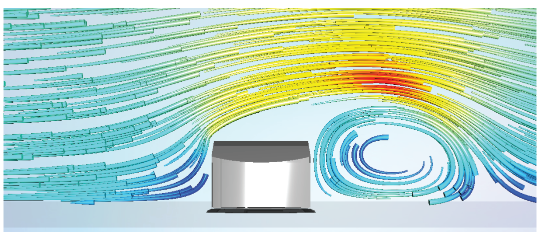


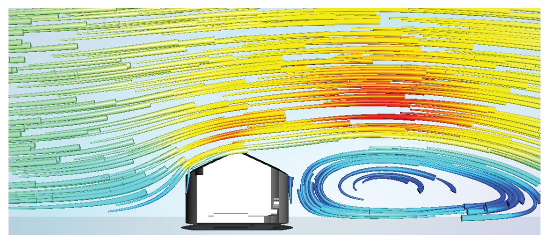


Gable

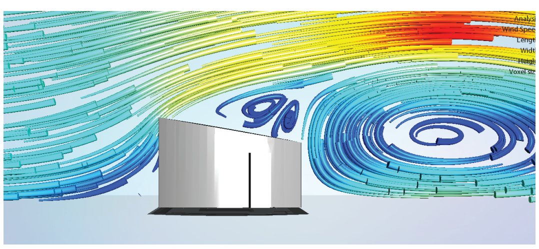


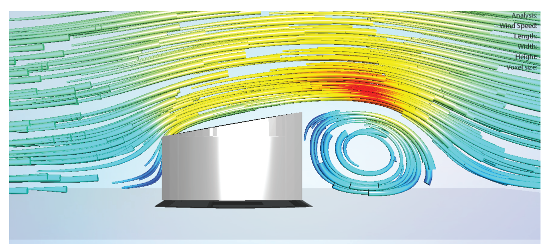


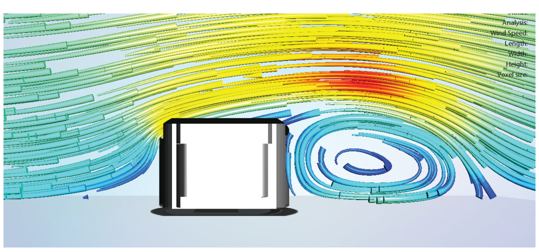




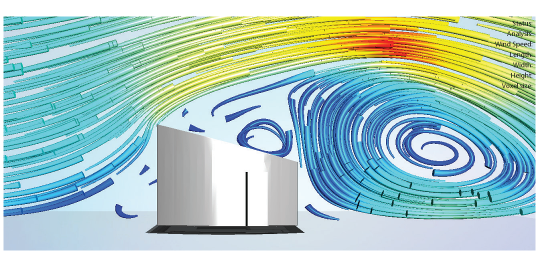
Shed 10°

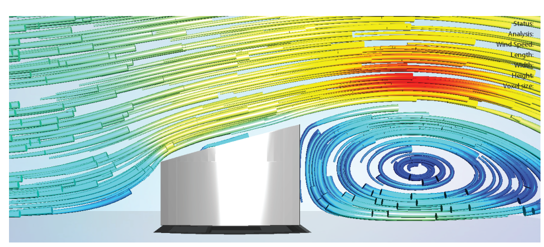


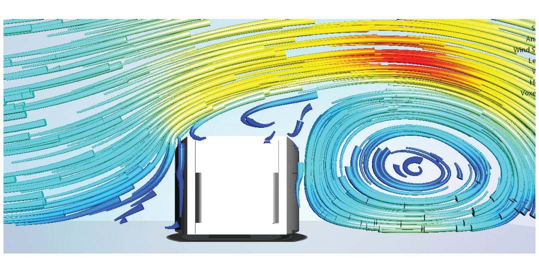




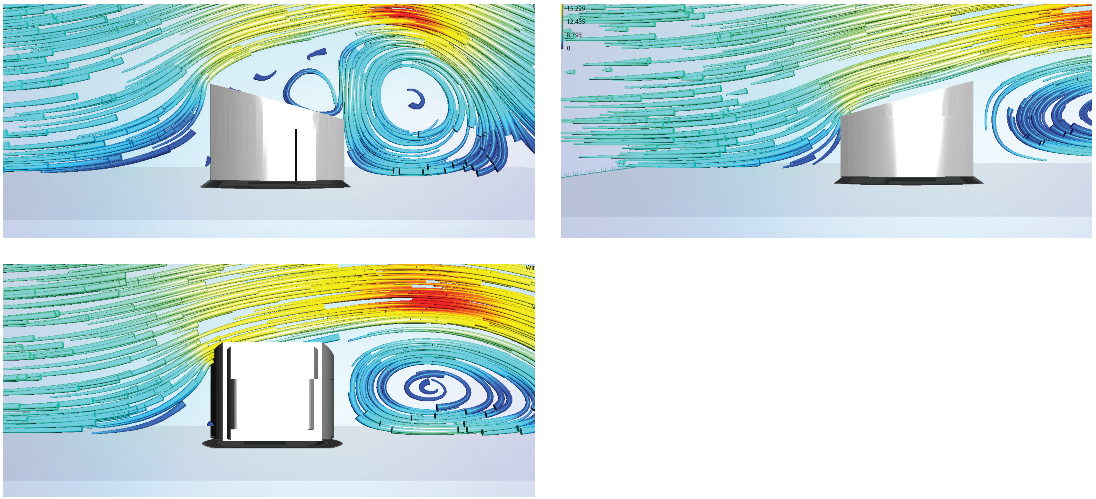
Shed 15°



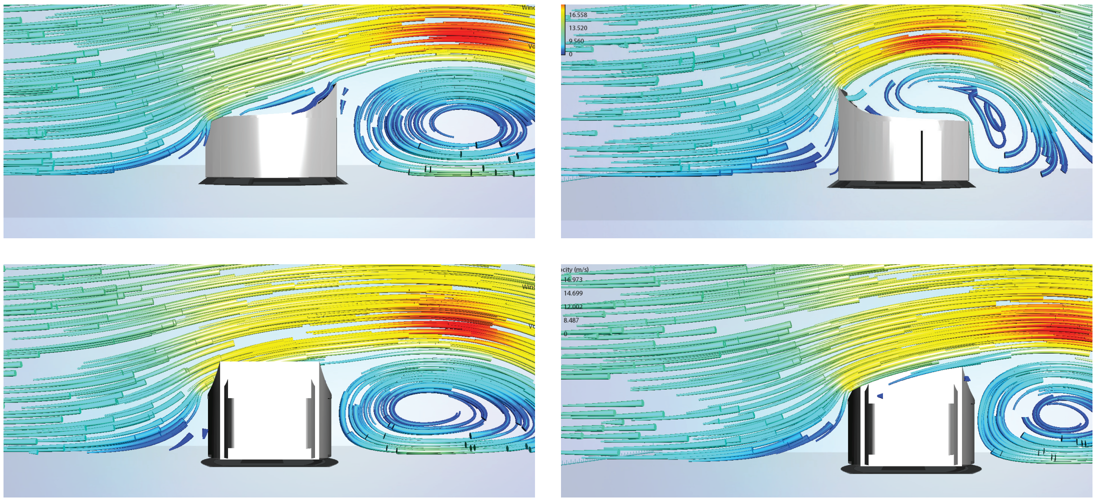




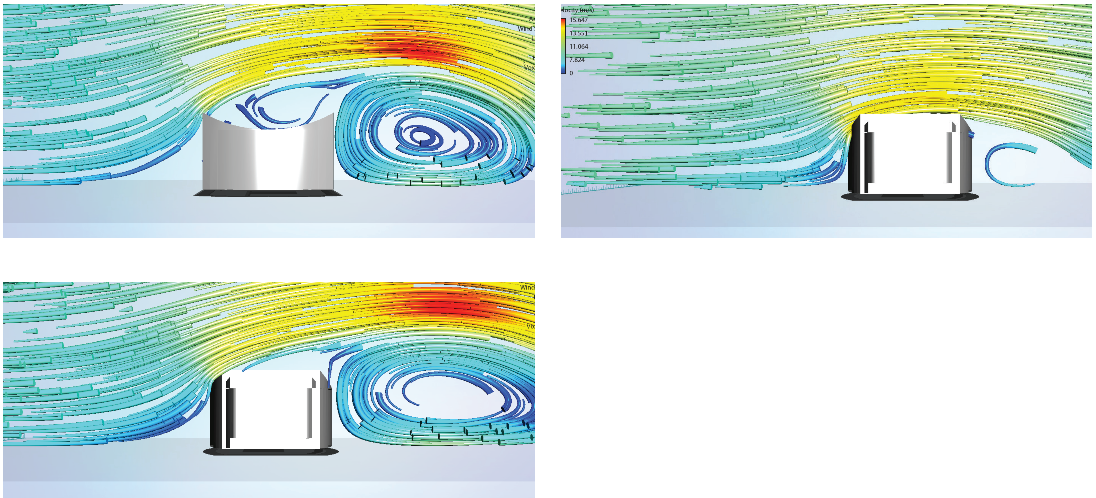
Shed 25°



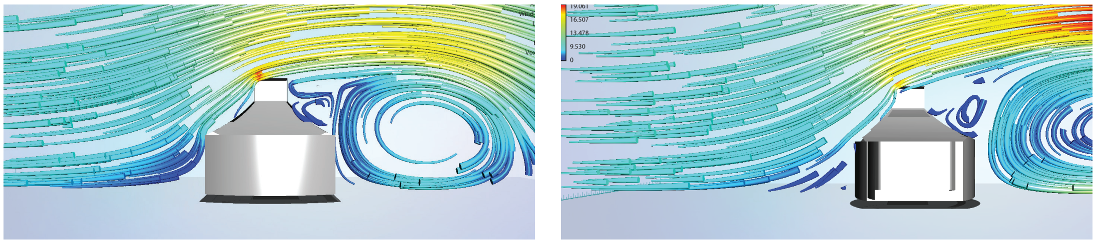
Curved shed



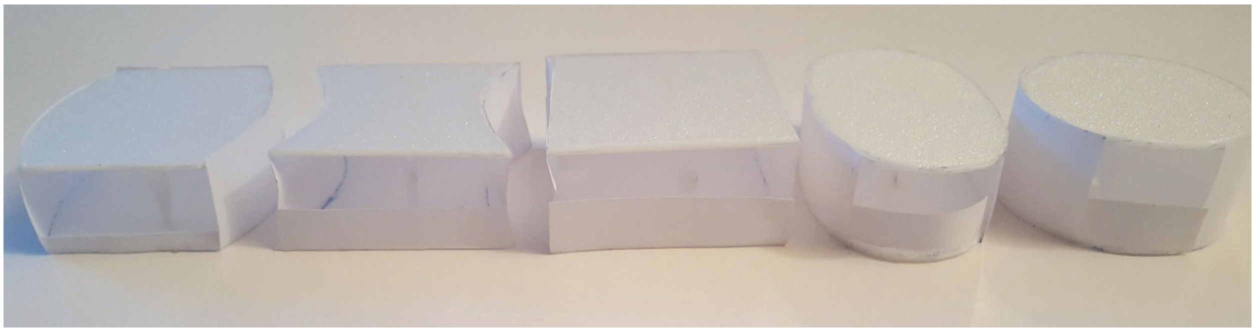
Double peaks

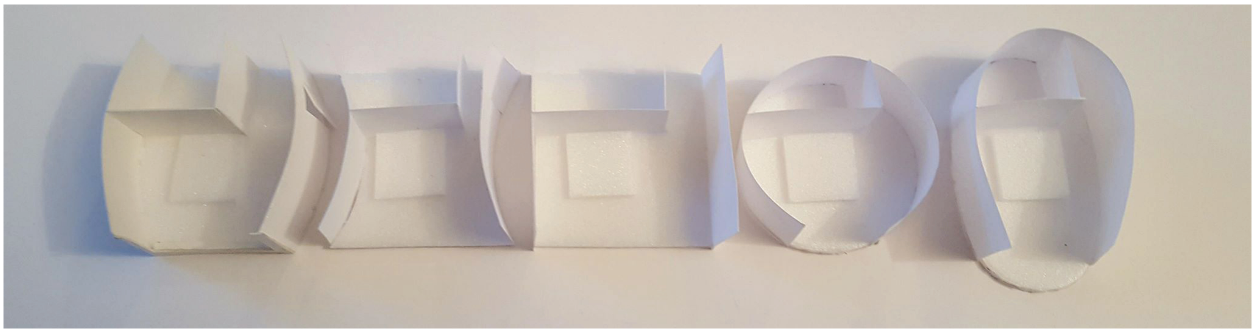


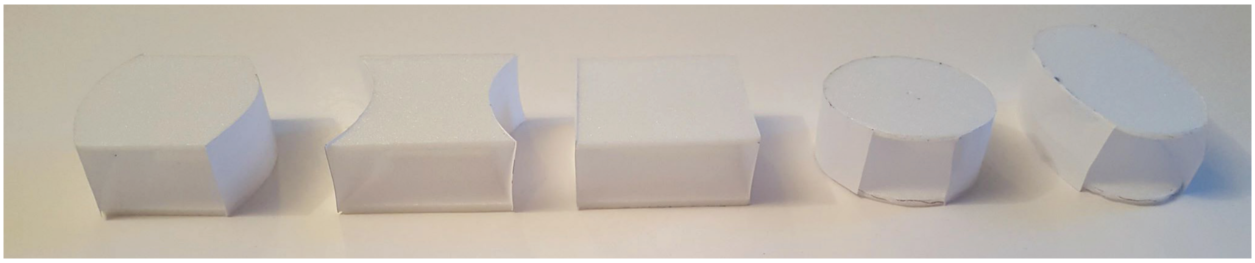
Diffused

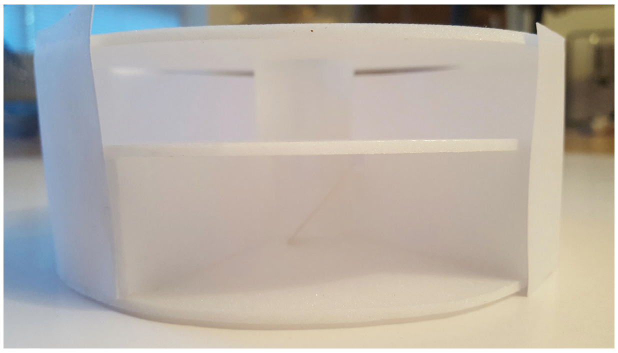


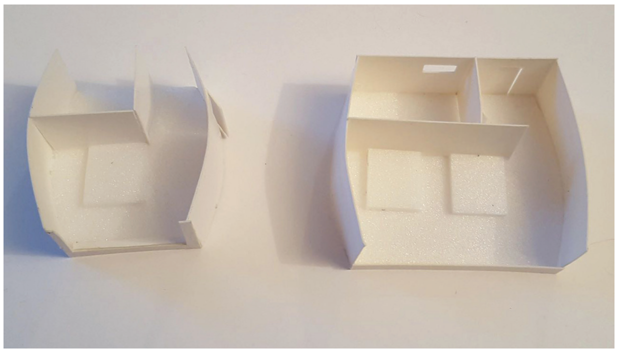
MODELS OF CABINS











BE18 BEFORE AND AFTER SOLAR CELLS

Nøgletal, kWh/m² år

Renoveringsklasse 2

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
114,8	0,0	114,8
Samlet energibehov		45,3

Renoveringsklasse 1

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
55,0	0,0	55,0
Samlet energibehov		45,3

Energiramme BR 2015 / 2018

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
31,5	0,0	31,5
Samlet energibehov		41,3

Energiramme Byggeri 2020

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
20,0	0,0	20,0
Samlet energibehov		30,8

Bidrag til energibehovet

Varme	20,2
El til bygningsdrift	9,2
Overtemp. i rum	2,2

Netto behov

Rumopvarmning	7,0
Varmt brugsvand	9,1
Køling	0,0

Udvalgte elbehov

Belysning	50,2
Opvarmning af rum	0,0
Opvarmning af vbv	0,0
Varmepumpe	0,0
Ventilatorer	9,1
Pumper	0,0
Køling	0,0
Totalt elforbrug	35,4

Varmetab fra installationer

Rumopvarmning	3,8
Varmt brugsvand	2,8

Ydelse fra særlige kilder

Solvarme	0,0
Varmepumpe	0,0
Solceller	0,0
Vindmøller	0,0

Nøgletal, kWh/m² år

Renoveringsklasse 2

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
114,8	0,0	114,8
Samlet energibehov		29,6

Renoveringsklasse 1

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
55,0	0,0	55,0
Samlet energibehov		29,6

Energiramme BR 2015 / 2018

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
31,5	0,0	31,5
Samlet energibehov		25,6

Energiramme Byggeri 2020

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
20,0	0,0	20,0
Samlet energibehov		19,5

Bidrag til energibehovet

Varme	20,2
El til bygningsdrift	2,9
Overtemp. i rum	2,2

Netto behov

Rumopvarmning	7,0
Varmt brugsvand	9,1
Køling	0,0

Udvalgte elbehov

Belysning	50,2
Opvarmning af rum	0,0
Opvarmning af vbv	0,0
Varmepumpe	0,0
Ventilatorer	9,1
Pumper	0,0
Køling	0,0
Totalt elforbrug	35,4

Varmetab fra installationer

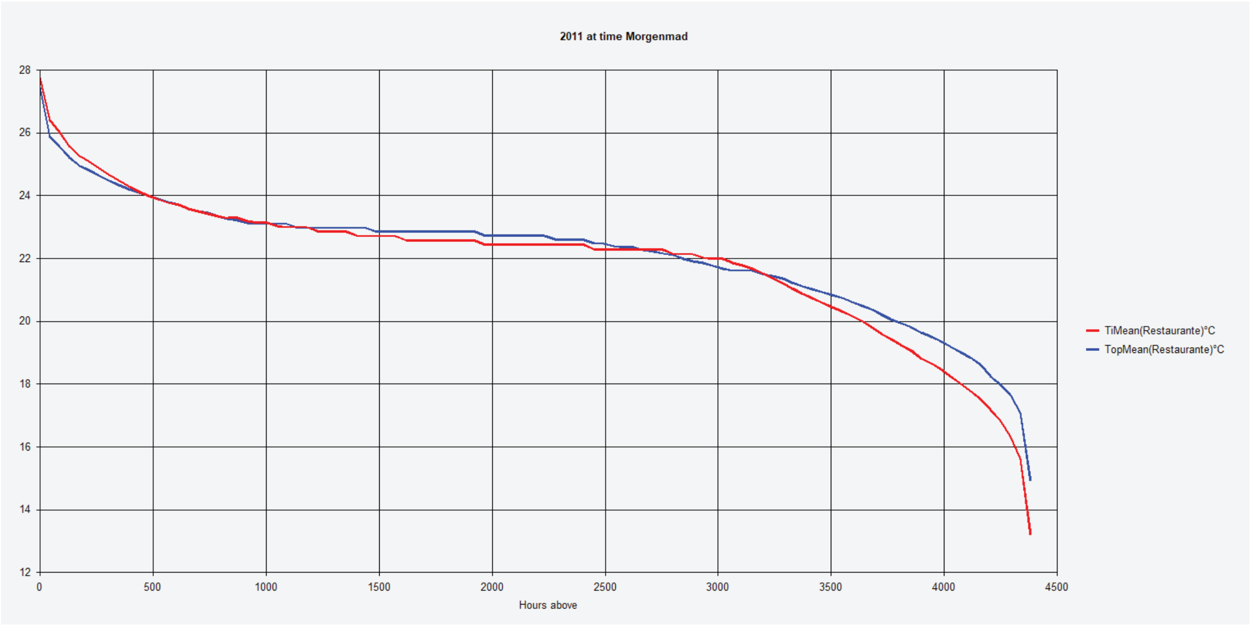
Rumopvarmning	3,8
Varmt brugsvand	2,8

Ydelse fra særlige kilder

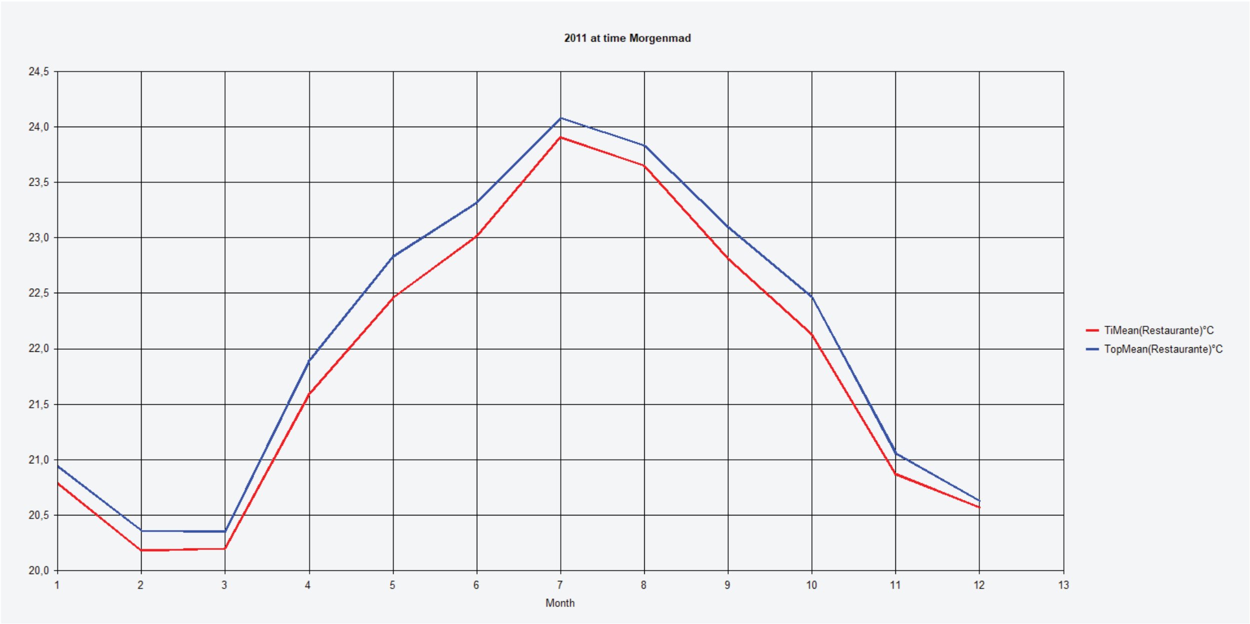
Solvarme	0,0
Varmepumpe	0,0
Solceller	6,3
Vindmøller	0,0

BSIM RESULTS - TEMPERATURE

Temperature hours above

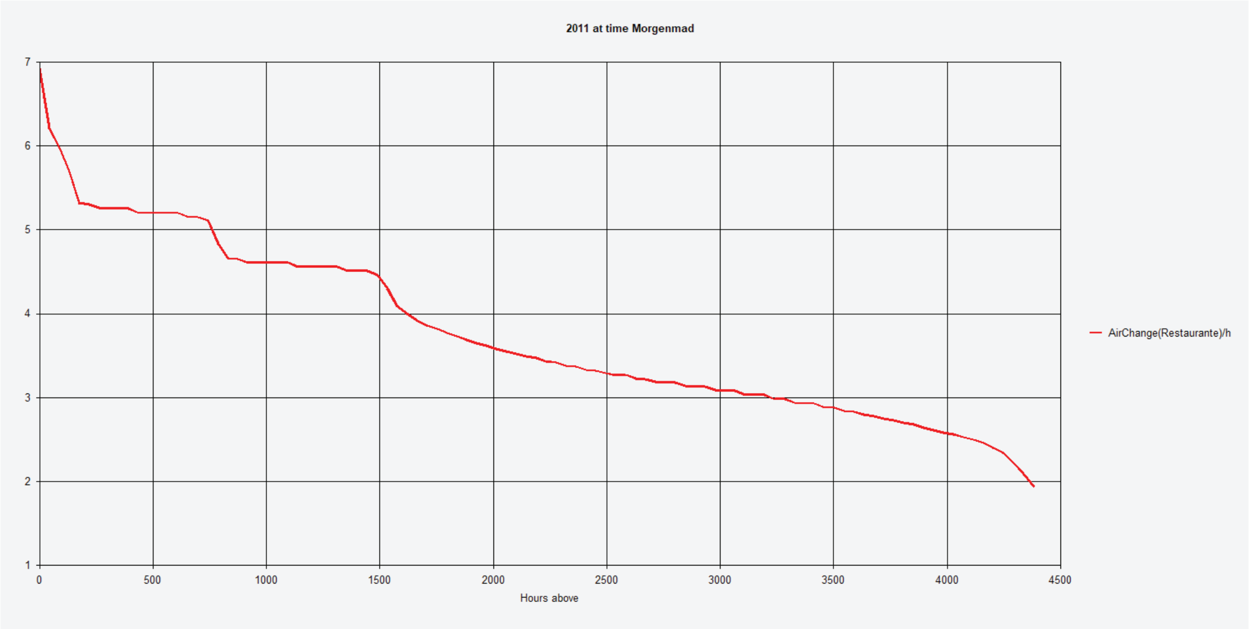


Temperature per month

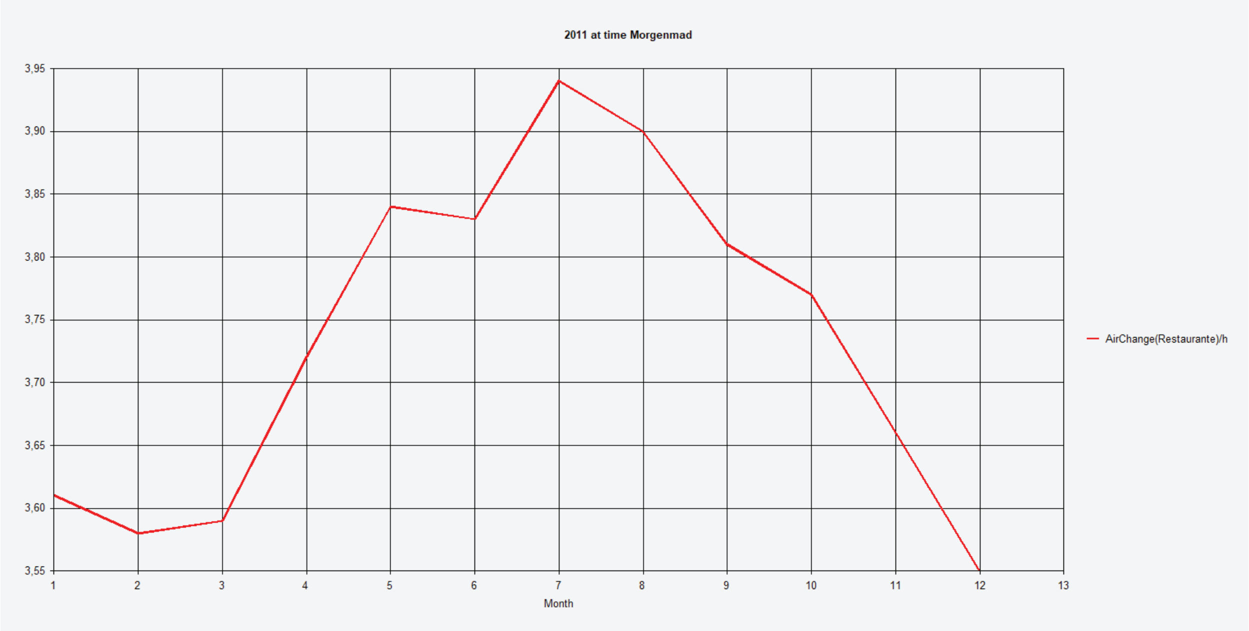


BSIM RESULTS - AIR CHANGE

Air change hours above

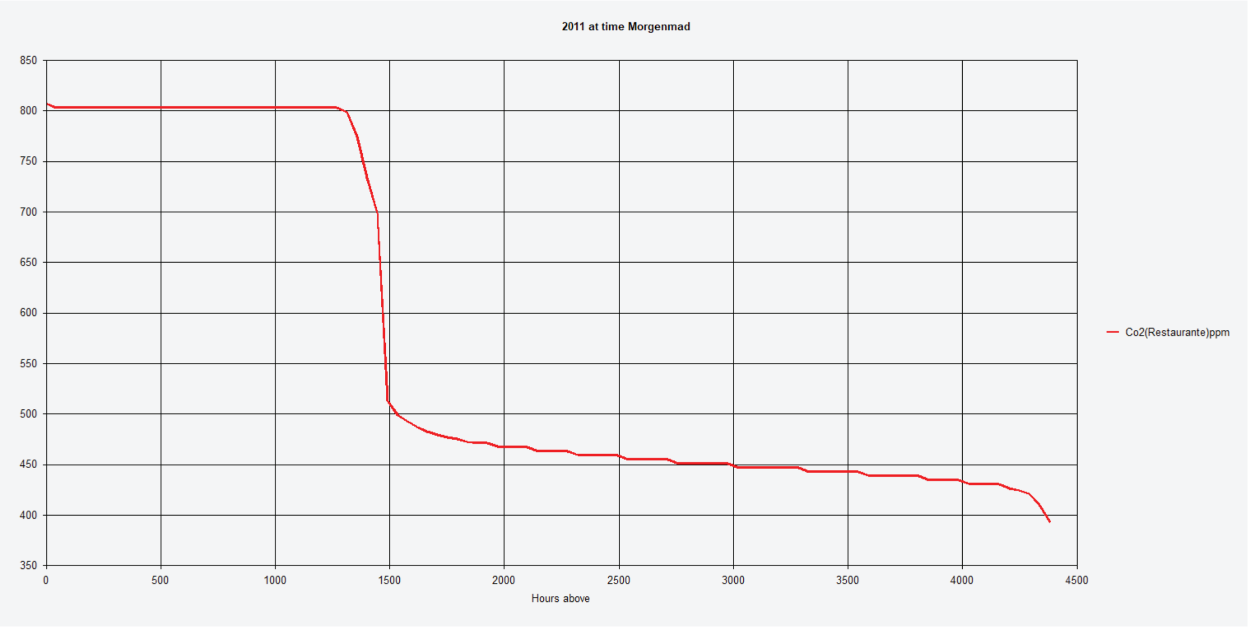


Air change per month

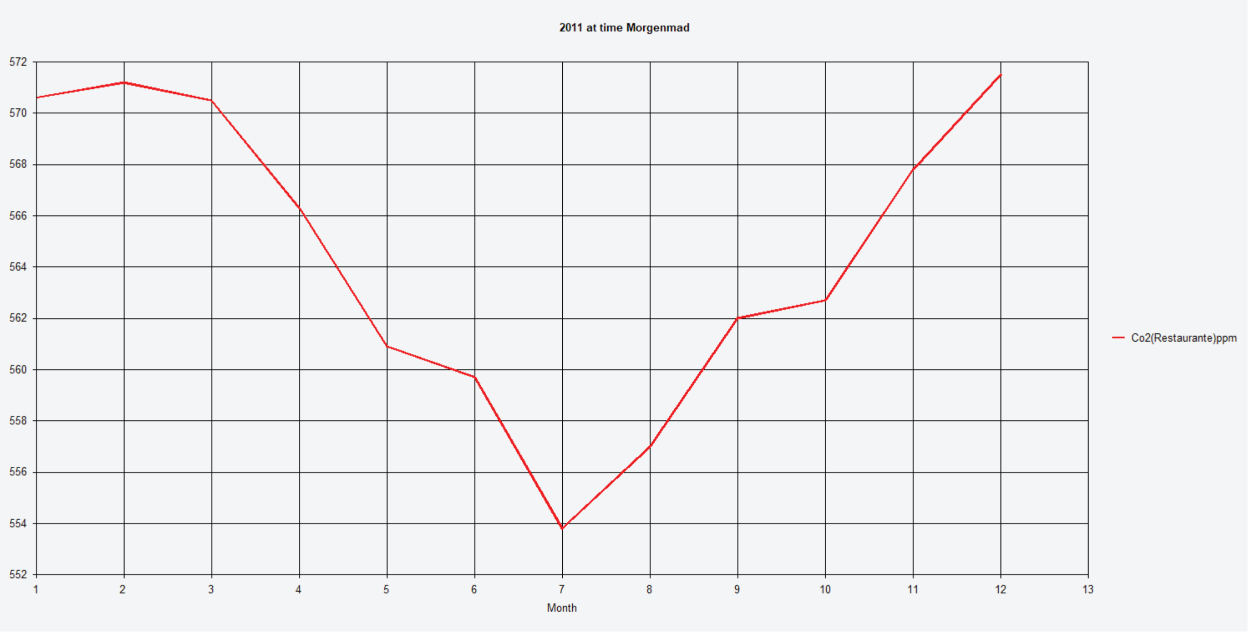


BSIM RESULTS - CO2

Air change hours above



Air change per month



TEMPERATURE STUDY

Atrium, recep,lounge	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	54	34	63,0	2,75	25,5	29,6
Thick curtain	54	37	68,5	2,75	26,2	29,8
2,5 m room height	54	13	24,1	6	23,6	26,9

Dining room	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	51	13	25,5	6	25,2	29,4
Thick curtain	51	13	25,5	6	25,4	29,3
Pull-down curtain	51	24	47,1	6	25,3	29,1
2,5 m room height	51	10	19,6	6	25,6	29,5

Staff room	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	23	13	56,5	3,26	26,7	29,7
Thick curtain	23	15	65,2	3,26	26,5	29,3
2,5 m room height	23	11	47,8	3,26	26,8	29,6

Changeing room	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	43	2	4,7	0,5	28,6	29,7
Thick curtain	43	2	4,7	0,5	28,9	29,8
2,5 m room height	43	1,4	3,3	0,5	28,9	29,8

Kitchen	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	18	11	61,1	3,88	26,3	29,4
Thick curtain	18	12,5	69,4	3,88	26,8	29,6
2,5 m room height	18	8	44,4	3,88	26,5	29,2

Kitchen, livingroom	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	63	14	22,2	2,2	27,1	29,5
Thick curtain	63	15	23,8	2,2	27,3	29,4
2,5 m room height	63	10,7	17,0	2,2	27,4	29,5

Children's room	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	13	2,8	21,5	2,8	26,5	29,4
Thick curtain	13	3	23,1	2,8	26,8	29,4
2,5 m room height	13	2,2	16,9	2,8	26,9	29,6

Master bedroom	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	24	12	50,0	1,88	28,1	29,5
Thick curtain	24	13	54,2	1,88	28,2	29,5
2,5 m room height	24	9	37,5	1,88	28,4	29,6

Children's bath	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	5	1,3	26,0	4,32	25,4	29,4
Thick curtain	5	1,5	30,0	4,32	25,9	29,7
2,5 m room height	5	1	20,0	4,32	25,7	29,4

2-per. cabin bed	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	16	7	43,8	2,3	27,4	29,7
Thick curtain	16	7	43,8	2,3	27,4	29,5
2,5 m room height	16	5	31,3	2,3	27,6	29,7

2-per. cabin bath	Area	Window	Window	Airchange	Daily mean	Max temp
	m^2	m^2	%	h^{-1}	°C	°C
3 m room height	4	0,85	21,3	5,4	25,5	29,6
Thick curtain	4	0,85	21,3	5,4	25,7	29,5

U-VALUES

The calculations were made by using the values from these sources; (C2c-centre.com, 2018), (Geyer, Svendsen and Virén, 2018), (Isover.dk, 2018)

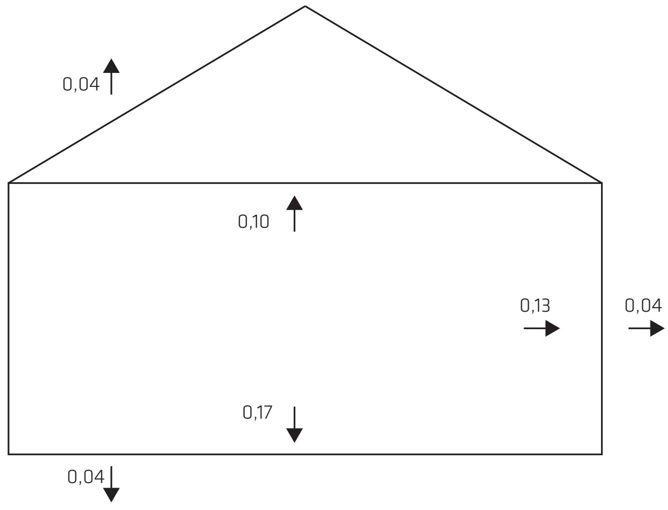
Element	U-Value (W (m^2/k)
Roof without suspended ceiling	0,089
Roof with suspended ceiling	0,03
Floor slabs without suspended ceiling – concrete floor	0,61
Floor slabs without suspended ceiling – wood floor	0,54
Floor slabs with suspended ceiling – concrete floor	0,03
Floor slabs with suspended ceiling – wood floor	0,03
External wall with Corrugated aluminum	0,086
External wall without Corrugated aluminum	0,089
Internal walls	2,9
Sound absorbing inner walls	0,56
Foundation – concrete floor	0,07
Foundation – wood floor	0,07

An example for the calculation on the outer wall for the main house:

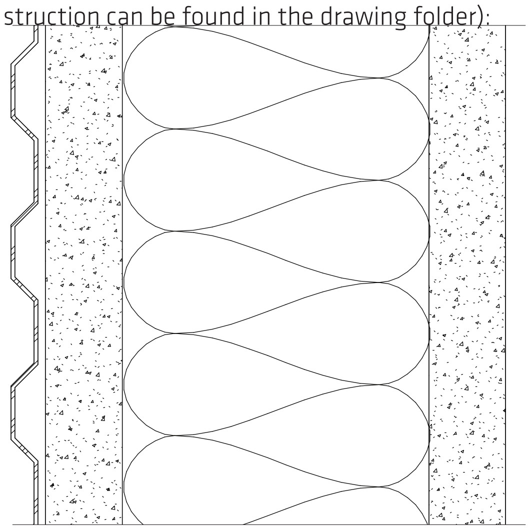
$$U = \frac{1}{0{,}13 + \frac{0{,}005}{205} + \frac{0{,}01}{0{,}024} + \frac{0{,}1}{1{,}2} + \frac{0{,}4}{0{,}037} + \frac{0{,}1}{1{,}2} + 0{,}04} = 0{,}086\ W(m^2/K)$$

Material	Thickness	Lambda
Concrete	100 mm	1,2
Seaweed Insulation	400 mm	0,037
Concrete	100 mm	1,2
Air gab	10 mm	0,024
Corrugated aluminum	5 mm	205

Thermal resistance:



Construction build up (a detail drawing of the construction can be found in the drawing folder):



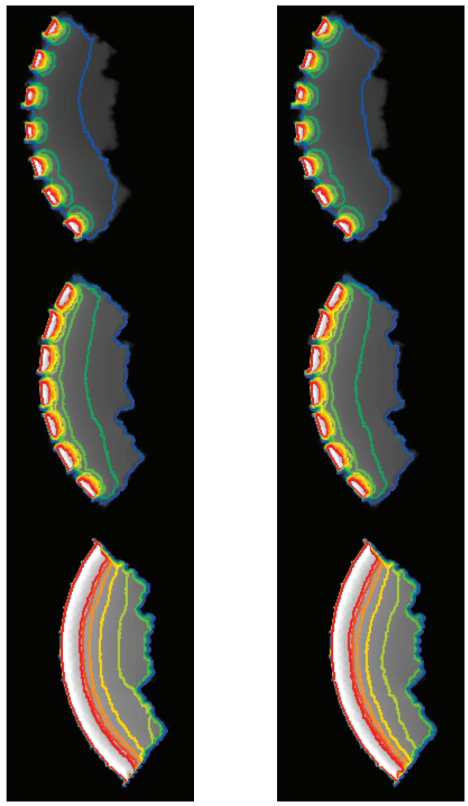
WINDOW STUDY OF CABIN

78 % Lystransmitant

Smaller windows

Larger windows

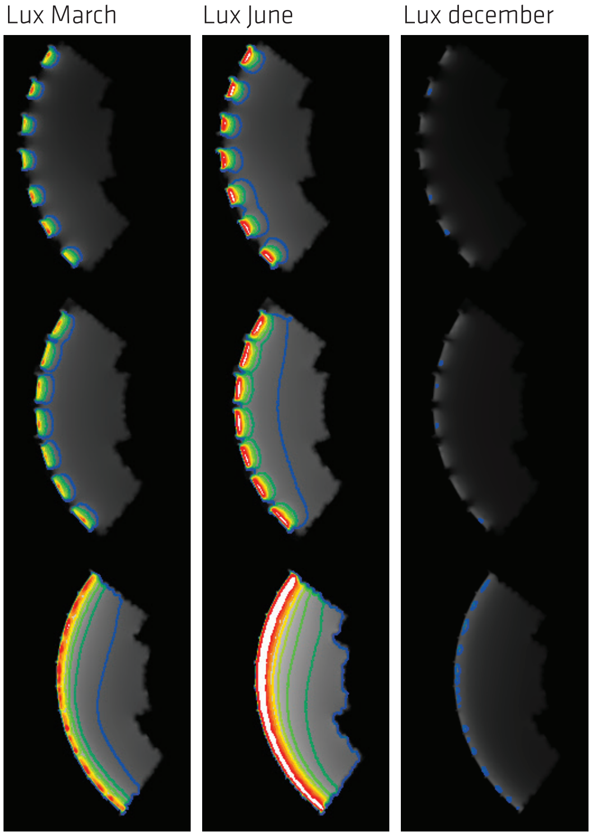
Windows the facade



Lux March

Lux June

Lux december



22% WINDOW SIZE OF CABIN

Diagram show:
1) daylight factor
2) lux for June
3)lux for December