Tungestølen - Program
Master Thesis in Architectural Design 2015
Jeanne Juel Lichon & Line Toft Jensen
Aalborg University

TUNGESTØLEN - PROGRAM

THEME
Sustainability

4st SEMESTER M.Sc. PROJECT
Aalborg University
Department of Architecture, Design & Media
Technology

PROJECT PERIOD
02.02.2015 - 27.05.2015

PAGES: 56
NUMBER OF COPIES: 6

MAIN SUPERVISOR
Lars Brorson Fich, Arcitect MAA

TECHNICAL SUPERVISOR
Peter V. Nielsen, Ph.D., M.Sc. from DTU

Line Toft Jensen

Jeanne Juel Lichon

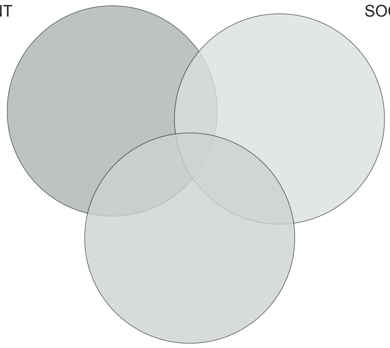
PREFACE

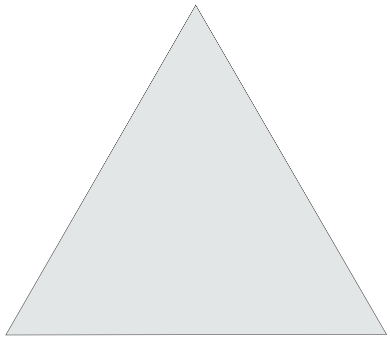
People from all around the world have travelled to experience nature in connection with the largest glacier in continental Europe, Jostedalsbreen. Traditionally it was mostly glacier hikers and climbers, who visited the area, and when nature was too hard or the night too dark, they found shelter in the cabin at Tungestølen. But in the last hundred years, all kind of people have used the tourist cabin, when they come to experience the dramatic nature (Fetveit, J., 2013).
The tourist cabin Tungestølen was placed in the village Vietastrond in Luster municipality, Norway. This village is one of the few around Jostedalsbreen that still can be experienced as untouched. The landscape surrounding the glacier is dramatic and characterized by its deep valleys, and the climate is often demanding with cold and stormy winters.

The west coast of Norway was the 25. of December 2011, afflicted by the hurricane Dagmar. Dagmar generated great devastation, and especially the infrastructure was harshly stricken. During the storm the former tourist cabin in Tungestølen was totally destroyed (Fetveit, J., 2013).

The cabin is going to be rebuilt as a part of the Norwegian tourist association DNT, to help them promote their ideals concerning a simple, active, versatile and sustainable outdoor life, while simultaneously preserving the natural and cultural values along the Norwegian tourist routs.

CONTENT





Ill. 1.01: Brundtlandsmodel for sustainable living and vitruvian triad

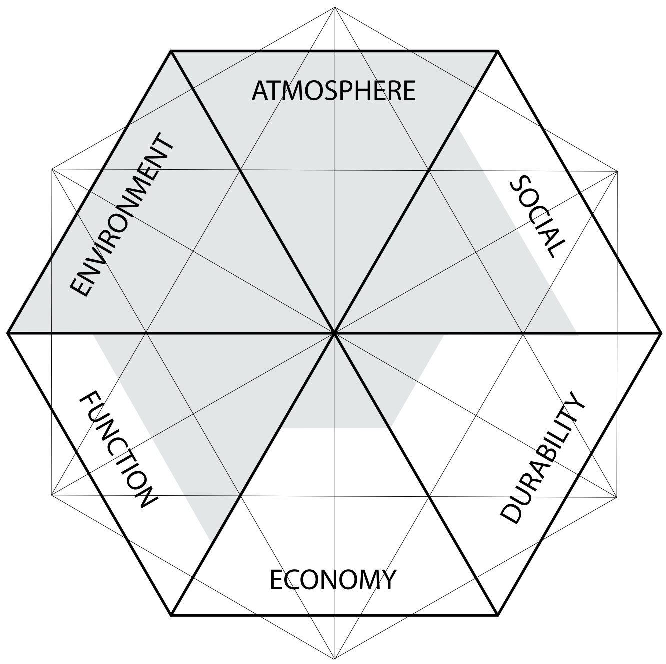
METHOD

Designing a building is a complex process, where many different parameters have to be taken into consideration. When choosing to make a building that is sustainable in relation to how it effects its surroundings, the complexity is further increased. The design will become more dependent on how it implements sustainable solutions, both in terms of the indoor climate and energy, which makes it essential for these parameters to be integrated early in the process.
To create a sustainable building, it requires a balance between both the functional, aesthetic and technical parameters, to meet the requirements for energy and climate, while not compromising the quality of the project.

The Integrated Design Process have been prescribed as the methodological approach. The design process is defined by Mary-Ann Knudstrup, and aspires to link knowledge of the architectural and the engineering field, within the design process. The method implements parameters, that serves as a catalyst of the design development, and therefore helps to detect aesthetic as well as technical issues early in the process. It focuses on the creative element in the process, and helps to find new opportunities and innovative solutions to different issues.

First a program is made, to register the different parameters and potentials of the project. The program contains different analysis made to generate an understanding of the site, and the subject of sustainability, concerning building a tourist cabin in a Nordic context. The analysis concerns our approach to implementing Nordic traditions, both in terms of architecture, but also how welfare is generally defined. How these qualities, interplay with the qualities the site offers, and how these can be integrated with the topic of tourism. The conclusions made, will during the design process function as parameters that will be examined concerning their ability to benefit from their energy and architectural possibilities. These point out the relevant potentials, and issues for further development of the design, which will be stated within an overall strategy.

The initial sketching is based on the parameters obtained from the analysis, and concerns the development of the design, where the concept evolves. To be able to create a sustainable solution, climatic and technical issues will already be included in the reflections towards each solution. The initial design process is categorized into different studies,



Ill. 1.02: Delimitation

that have been examined both in terms of atmosphere and environment. Mainly BSim will be used for initial calculations of simplified models. Bsim will work as a tool to investigate how the different design concepts and solutions, effects the indoor climate and energy use. The results will function as guide lines, when the design further develops. The calculations will be decisive for the decision-making, but we find it important to point out, that the best technical result, not necessary is the best solution to a given design task. The calculations will functio as a guidance for the decisions of the design.

Through several iterations, the design will further develop into a more realistic level, where the information from each study should help create a consistent whole. The projects final form and expression, will be stated through adjustments and calculations, in relation to optimizing the considered parameters and solutions existing in the analysis and sketching phases. Bsim will now be used to test and optimize the concept design, and finally to verify the goals concerning environment. The design will further be evaluated in relation to the parameters defined within the strategy.

The project will finally be conveyed and documented through explanations, presentation models and graphic material (M. Knudstrup, 2006).

The project aims to create architecture with a high level of quality, while simultaneously designing a sustainable building. To obtain both objectives, the Brundtlandsmodel for sustainable development (Keiner. M, 2005), and Vitruvius triad for architectural quality have been composed into a scheme (Statensnet, 2000). It is the intention to use this scheme as a navigation tool that can help navigating the project through the various stages, by ensuring the objectives for each parameter is meet.

NORDIC ARCHITECTURE

1

THE ENVIRONMENT OF THE NORDIC

If the word north refers to a geographical identity, you may assume that architecture in the north refers to architecture, where place operates as a starting point. This approach is coherent with the idea that architecture represents the environment to which it belongs. In the following different parameters will be illuminated to describe the environment of the north.

The climate and weather is first and foremost an important part of the environment. In Norway the word vær (weather) relates to å være (to be). Å være, relates to the mentality the Norwegians have when facing changing and unpredictable forces in climate and weather. It is the mentality, not to sit and wait for the sun, but to be,w however the weather is. The sun is something extraordinary. Only one thing is for sure in this climate - the change of seasons (Norberg-Schulz, C., 1996).

Louis Kahn descries light as something that *gives all things their presence* (Wurman, R. S., 1986). The light of the north is no exception. The sun frames objects, in a symphony of diffuse light and shadow. The light creates space of moods, with shifting nuances of colours, even when the light is filtered through an overcast sky. In Italian the north is mezzanotte - translated into midnight (Norberg-Schulz, C., 1996). That may describe the light in the north, both in the summertime where the midnight is light, and in the wintertime where the day may seem as dark as the night. While people from all around the world is enthused by the Northern light, and have a perception of a land full of magic, the self-perception among Northerners seems closer to a description of "nightlands" (Forster, K.W., 2012).

Ill. 1.03: Northern Lights in Tromsø, Norway

THE ENVIRONMENT OF NORWAY

The endless plain upon which I stood was bathed in half light and mysterious shadow. I saw deformed, twisted and overturned trees, mute indications of nature's inconceivable powerful forces, for the storm's might and fury. Now all lay calm and still: the stillness of death. I could hear my own rapid breathing. Before me in the distance rose a range of mountains, beautiful and majestic in the moonlight, like petrified giants. The scene was the most magnificent and filled with fantastic stillness that I have ever experienced. Over the white contours of a Nordic winter stretched the sky's endless vault, filled with myriad glimmering stars. It was like a holy service in a great cathedral. Haradl Sohlberg's winthernight in Rondane (Nasgaard, R., 1984 p.110)

In the nature of the Nordic, the nature of Norway appears strongest and most immediate. Norberg-schulz describes Norway as one enormous Rock, riven with valleys. Even though the land is large and vigorous it seems smaller because it is missing prospect. The prospect can be found in the panorama at the top of the mountains. The everyday life takes place in the valleys, and the dream is to reach the prospect over the top of the mountain.

To be (å være) in space is determined by a tension of above and below - something related to the ground, something related to the sky. In valleys, we are below; this is our place of dwelling, where we create the order supporting our existence. Here people are at home, and animals are safe.

On the top we are exposed. On the top the weather forces are unleashed. The panorama and prospect puts you in a fragile condition. Here things do not exist in a harmonic presence, but instead as Norberg-Schulz describes, it participate in the environmental interplay of forces (Norberg-Schulz, C.,1996).

Ill. 1.04: Fishing city in Norway


Ill. 1.05: Stegastein viewpoint

THE WELFARE OF THE NORDIC

Christian Norberg-Schultz's, Nightlands, Nordic Buildings (1996): describes Nordic architecture as "a manifestation of the environment in which it is placed". Every place is significant, and it is the architect's task to understand and respect this. Whether it has to do with embracing climate, light and life, you may argue that the understanding of environment is the first and foremost art of understanding and navigating in architecture – both if the environment is placed in the south, or in the north. It is a tool that is not connected to a specific environment and thereby it is not something you would categorize as particularly neither Nordic, nor Nordic architecture.

MacKeith characterizes Nordic architecture as public architecture - Architecture emerging from, and reflective of the society and community, in which it is situated. As Erik Gunnar Asplund mentioned at the Gothenburg exhibition in 1923 "forms that do not threaten, but invites" MacKeith argues that this could characterize the modern tradition of Nordic architecture (MacKeith, P., 2012). Architecture that provides society with forms that invites, forms that are turned towards the human, forms for everybody – forms for individual and national welfare.

Welfare in the northern society and community is characterized by the democratic space. The idea of a no mans land (Nielsen, T., 2012) - a free and natural space that is open for expression. A space that not only have the ability to frame each individual, despite a variety of different cultural and political positions in a global world, but also help people to understand that diversity. By building architecture as a democratic space, it creates a sense of belonging for the inhabitants. The extreme conditions in the north require that space in some way is delimited and protected – a place for man to dwell (A. de Saint 1948, Norberg-Schulz, C., 1996).

"In the Nordic life does not ensure on the piazza but in the home, and this entails that intimacy and warmth are more important than representative grandeur." (Norberg-Schulz, C., 1996, p. 22)

This statement emphasizes that ordinary homes, have become part of the discussion about Nordic architecture. That a home can be considered as architecture, is something Nordic. That chairs and furniture can be cultural statements is something Nordic (Lund 2008). It shows that the architects saw the importance in designing such ordinary things, and also shows that society considered these as cultural importance. That small everyday things are just as important, as big prestigious architecture is welfare.
MacKeith argues that the most powerful assessment, is to provide a full quality of life to everybody through what he characterizes as the social art – architecture.
Such have the importance of social responsibility in Nordic architecture sustained. Such should the importance of social responsibility in Nordic architecture continue to sustain – not only for our children, but also for our grandchildren.

THE FUTURE WELFARE OF THE NORDIC

The American historian John Lukas questions: Can the increased possession and consumption of material goods and the continuous desire for material growth and development be the basis of a community? (MacKeith, P., 2012 p. 134)

MacKeith argues if we want to maintain both welfare and cultural integrity, the economic pressures and ambitions must be reconsidered with a collective self-knowledge - the reality must be perceived through the nordic culture and traditions (MacKeith, P., 2012). Mankind must go back to basic and find his roots. Sverre Fehn brought up that idea in 1983 as a response to a problem he highlighted as: nature had been reduced to visual beauty (Fjeld, P. O., 1983). Nature is no longer something you sense and experience. Nature has been materialised and distanced.

Another answer to John Lukas question may be the World commission of environment and developments report *Our Common Future*. The report announced the term sustainable development, connecting social and economic sustainability to environmental problems to ensure welfare both now, and for the next generations. A sustainable development according to the Brundtland report is *..a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*
The report describes the principle to avoid ecological collapse, in order to prevent emission of Carbon Dioxide and the resulting greenhouse effect (Brundtland commission, 1987).

The energy savings, in the building industry plays a significant role in the reduction of CO_2 emissions, and the use of non- renewable fossil fuels. The awareness concerning energy consumptions related to architecture and building have raised remarkably the last years. The Danish building code have become stricter with new energy frames for 2015 and 2020. The development points towards further optimized energy reduction and energy neutral buildings.

The definition of Nordic architecture is ambiguous and constantly moving. Starting with defining the qualities of the environment, to defining social and cultural qualities, and ending with results that shows that the answer is holistic. If poetic acknowledges the qualitative identity of a place, you may argue Nordic architecture manifests living poetically, under Nordic conditions.

Ill. 1.06: Cabin in Sognefjord, Norway

USER GROUP

2

THE NORWEGIAN TOURIST ASSOCIATION

Den Norske Turistforening, DNT, is the largest organization for outdoor activities in Norway. The aim of the organisation is to promote a simple, active and environmentally friendly outdoor life and to preserve national, natural and cultural values. DNT promotes the outdoor life as being good for body and soul, thereby hoping to improve the public health.

DNT has over 245,000 members, and 500 cabins. The cabins are located in forests, mountains and along the coast. Some of the cabins are designed to hold up to 200 travellers and offers catering service, and some of them are smaller with only a few beds, and offers equipment and food supply for self-service.

In 1880s the members of DNT were mainly men who belonged to the upper layers of society in science, art and culture. These were men, who had time and could afford going to the mountains. But from 1920 people from the other classes of society also showed an interest. Today DNT works towards making the nature and outdoor life easily accessible for not just members, but also national tourists from different social backgrounds. It is every man's right to be in nature. In Norway a law called Allemannsretten, gives right to free movement in nature.

As a part of the programme, DNT arranges school camps and encourages more and better outdoor activity in kindergartens and SFO´s. Many children have parents who take them out in nature from an early age, but it is far from all. DNT reaches out to all children regardless of social background, finances, nationality and physical condition.

As the nation's largest outdoor organization, DNT find it important to be environmental and climate responsible. DNT believes it is possible to merge high activity with a lower use of resources. They work to develop the outdoor life, in a direction that reduces the consumption of energy and natural resources, by being dependent on renewable sources.

Nature in Norway is used for many purposes, agriculture, forestry, hunting and fishing, tourism and outdoor recreation. Local development based on local, natural and cultural resources have received increased attention in recent years. Sustainable and multiple uses of natural resources are prioritized in DNT.

The cabins use a small amount of energy themselves. An increased standard in the cabins will in many cases lead to an increased use of resources. DNT instead strives towards having a program of high quality; local food, knowledgeable hosts and a pleasant atmosphere. When building new cabin, it is essential to link design and energy saving initiatives (DNT, 2015).

Ill. 1.07: People hiking on Jostedalsbreen

USERS

The concept of luxury, is in many ways changing from what it once was perceived as. More people is now beginning to seek experiences, as a contrast to the previous perception of luxury, where focus was on materiel goods, abundance and a high demand of energy.
Luxury is by many perceived as the possibility, to travel to far of destinations, and experience their unique nature and culture. Experiences that somehow creates an awareness of how different people choose to live, and how they choose to interact with the nature that surrounds them.

The people that seek places such as Tungestølen, is often searching for the luxury they find in unspoiled and spectacular nature. The users therefore share a common appreciation and respect for the nature, and are willing to live on its premise during their stay, to best possible preserve it in the future. It is a place that offers the visitor a respite from the everyday life. It is a place where the visitor becomes aware of the luxury that we normally take for granted, such as hot water and electricity. And once it is not accessible, and you have to work for it, it suddenly becomes a luxury. It teaches the visitor to concentrate on one's own basic needs, and appreciate the luxury when fulfilling these, for example by turning on the stove, and feeling the heat from it (Danmarks Radio, 2014).

Visiting one of DNT's cabins, you will likely share the cabin with other people, you not necessarily have meet before. You can't be denied access to the cabin, even if it is completely occupied.
This is the backbone of DNT's main concept, that we share the nature, and that everyone have the right to experience it on equal terms. This will often initiate meetings between the visitors, providing them with a potentially great value, no matter if you travel alone, or accompanied by others.

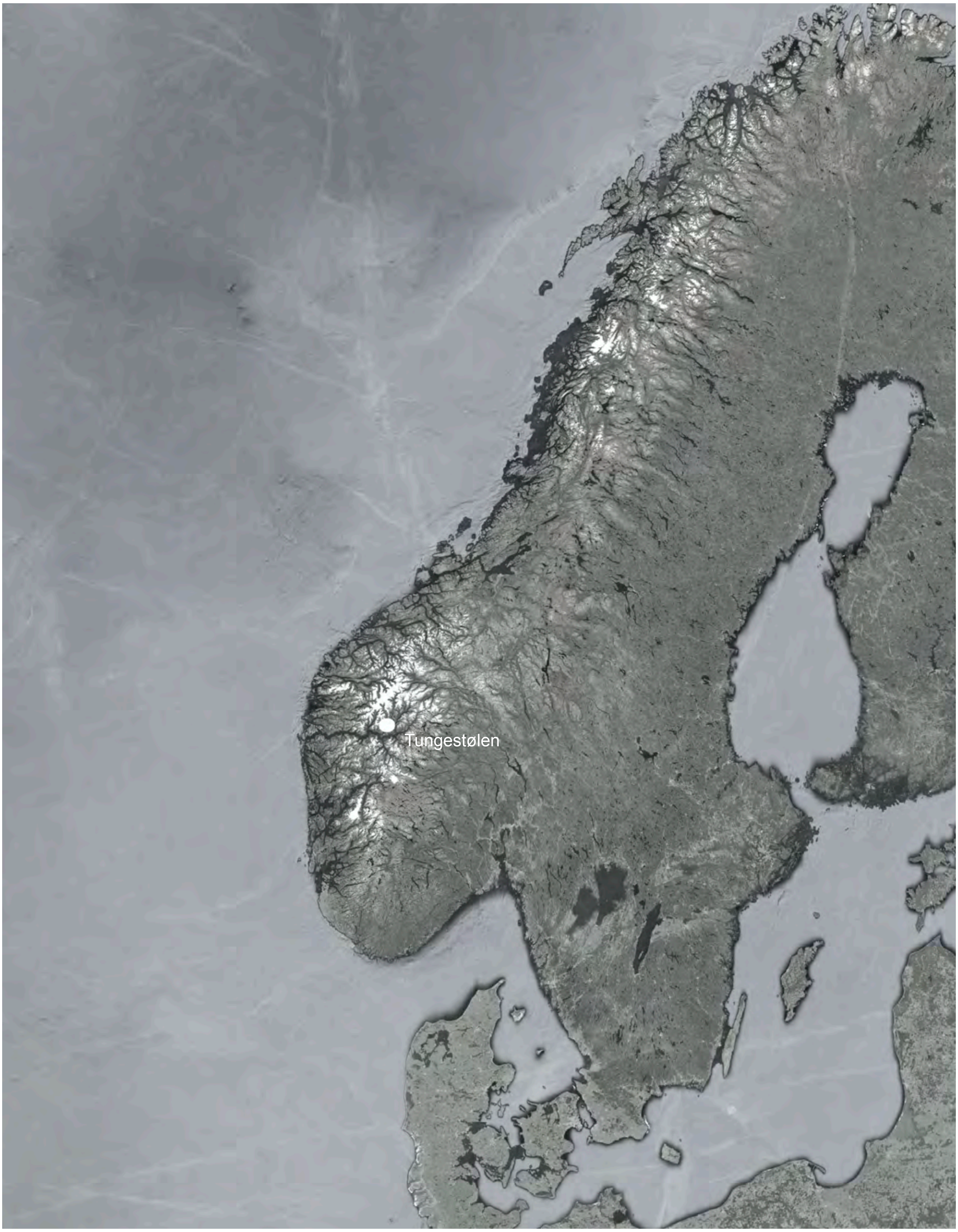
The visitors can roughly be categorized into three groups: the tourist, returning visitors, and the locals. The tourist are visitors who come to experience Tungestølen for the first time. Some are national and some international. Some are used to travelling through the Norwegian landscape, and some are unaccustomed by being away from normal civilisation. Common for them all, is that they mostly visit the site during the summer period. For many of them, this will be a stop, that will only be part of a longer journey. The primary goal of the visitors, is the journey and to experience the nature (DNT, 2014).

Returning visitors are visitors who have experienced Tungestølen before, and come to re-experience the nature and atmosphere. The returning visitors mostly visit during the summer period.

The local are inhabitants who live nearby, either in Veitastrond, Hafslo or other places in the municipality. They visit the place both during weekends and vacations all year round. They both use the tourist roads and the unmarked roads. The responsibility of maintaning the cabin, will be given to some of the locals (Tibballs, A.M., 2014).

SITE

3



Ill. 1.08: Placement

Ill. 1.09: Meeting between Austerdalen and Langedalen

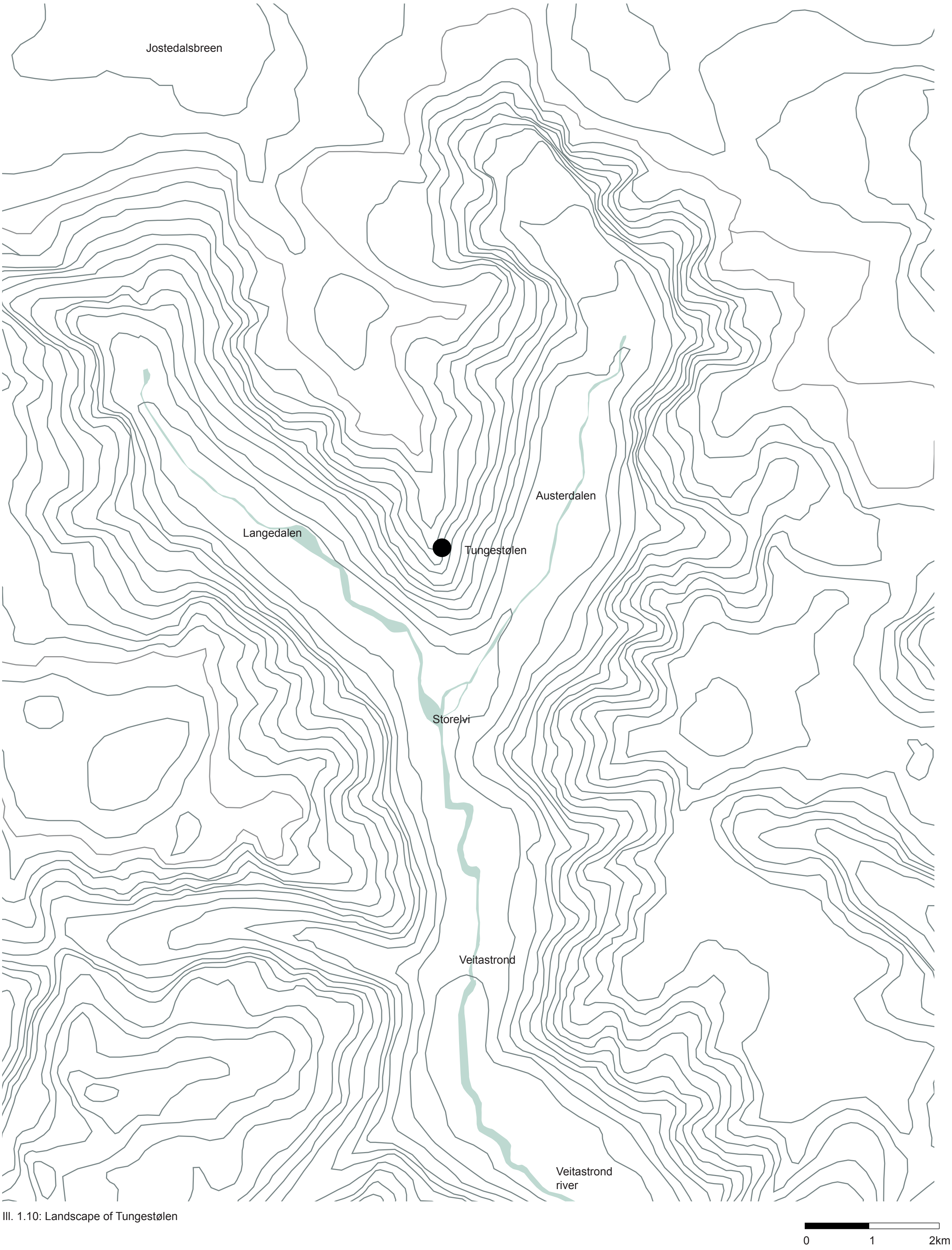
TYPOGRAPHY

THERE IS A PLACE

Once, everything was covered in ice, a thick blue ice, and a protective shell. It rocked back and forward, slow and steady forming the landscape, as a carpenter forms his wood. When it was finished, it quietly retired. As a mother who teaches her child to stand on his own, and afterwards carefully withdraw, to observe in the background.

The place was formed, this one specific place, it was released from the ice, to see the daylight for the first time. The little place between the mountains, and down the valley.

Every spring the sun came to create life, the grass and flowers started to blossom. And every fall the site was colored by every nuance of yellow, red and brown. But fall also meant wind, rain, and sometimes powerful storms, before the snow would start to fall, and cover the fields in a light layer of white powder. In this way the site of Tungestølen, was taught how life is between the mountains (Fetveit, J., 2013)



Ill. 1.10: Landscape of Tungestølen

LANDSCAPE

Tungestølen is marked by its location along the Norwegian west coast, where rivers gathers and creates larger fjords, that slowly dissolves the landscape into small islands, out against the west coast.

Tungestølen is placed down in one of the many valleys, created by the glacier Jostedalsbreen, where small streams runs down and form rivers. Specific for Tungestølen, the ice have mainly been moving down from Jostedalsbreen both from northeast Austerdalen and northwest Langedalen, colliding in the Storelvi stream, which runs down south into the river, by the city Veitastrond.

Ill. 1.11: The road leading to Veitastrond

VEITASTROND

Tungestølen is build 3km from to the village Veitastrond, a small village with 123 inhabitants placed in Luster municipality, and the Sogn and fjordane region. The city contains shops with the most essential facilities such as food and medicine.

It was first in the 1950, that the road that connects the city with the outside world was built. Before there was not even a path along the water, properly due to the issue of the steep hillsides, which would have made the path vulnerable concerning rockslides. The river was therefore used as the main thoroughfare during summer, and sledges were used during winter. The inhabitants made a living from farming, and selling cheese, butter, leather and meat, that all was produced in the valley. The production was often transported all the way to Bergen by boat.

The inhabitants of Veitastrond, have therefore through centuries been accustomed to live on the premise of the nature and landscape. They faced challenges caused by climate, but the environment did also serve as the inhabitant's main source of income, both in terms of agriculture and tourism. In 2000 the Norwegian government published a report, concerning tourism and agriculture, stating that the tourist industry can be a cornerstone for employment and development in smaller communities. The report highlights the value of untouched landscape, and emphasizes that the development of tourism should be conducted to protect natural and cultural environment from degradation, as well as to make it attractive for visitors (Fetveit, J., 2013).

Ill. 1.12: The former Tungestølen complex

TUNGESTØLEN

In the meeting of Austerdalen and Langedalen a small cabin called Tungestølen was build in 1910. The cabin have through generations been private owned, but the last couple of years it have been run by The Norwegian Tourist Association, DNT. Numerous of people have experienced the beautiful nature, during their stay. Traditionally professional glacier hikers and climbers mostly visited the site, but it now functions as desired destination for a broad variation of visitors. Since 2002 an annual festival have been arranged, providing outdoor activities for young adults (DNT, 2015).

Tungestølen was a complex consisting of four small cabins surrounding a courtyard. The complex contained a main building, and three cabins with a varying number of beds. The complex was self-served, where food was available for the visitors in a food deposit. The cabin complex was not connected to any municipal infrastructure, and had neither water, sewage electricity or coverage for mobile telephones. This meant that the visitors had to receive water from a well, and otherwise heat the building by burning wood. Gas was used when cooking. Oil lamps, candles and a few 12W lamps were used for lighting.

The hurricane Dagmar, came to Norway the 26. december 2011, and with a wind speed of 112km/h, blew the former buildings of its foundations (Fetveit, J., 2013).

Ill. 1.13: The Valley of Tungestølen

TUNGETØLENS LANDSCAPE

The mountains enclose the landscape of the site, and frame the view of the horizon. The only sign of civilizations are a few small and simple houses, otherwise there is only nature. The site is situated down a small valley which borders up against the glacier Jostedalsbreen, here the agricultural village benefits from the flat and fertile land, to cultivate the land and farm animals (Fetveit, J., 2013), (Nesoyane, 2010).

The bedrock at Tungestølen is mainly granite and schists, and down the valley there are plenty of low vegetation, due to the swamp valley ground (Ramberg et.al., 2007), (Fetveit, J., 2013). Several smaller sawmills are placed in the nearby area, where pine is most prevalent (Sonnesynsag, 2015). Smaller local industries can also be found in the municipality, concerning the production of stone for construction (InternettOpplysningen, 2015),(Onlineguiden, 2014).

Agriculture is still the most important industry in the municipality, and is well recognized for their meat and milk production, from both goats, sheep's and cows. Their production of berries is currently one of the biggest in the country. Tourism also still serves as one of the main industries of the area, which is evident in the high amount of hotels and cabins. These are made to accommodate the tourist who visit the area, and wish to experience the nature and landscape (Visitnorway, 2014).

Ill. 1.14: Entrance to the valley of Tungestølen


Ill. 1.15: Jostedalsbreen

MAPPING

INFRASTRUCTURE

The village of Veitastrond is placed at a dead end road, and to be able to get there, you must pass the city Hafslo and drive 20km along Veitastrond lake. Hafslo is populated by 457 inhabitants, and if you wish to visit a larger city Sogndal (7500 inhabitants) is situated 50km away, or a one hour drive (Wikipedia, 2014).
The road leading from Hafslo to Veitastrond is a narrow and intricately road, that often during the winters is blocked by snow, thereby leaving the inhabitants of Veitastrond stranded. Due to this issue, a new project concerning the construction of a 1565m long tunnel was begun in 2014. This, along with an avalanche securing of the road, should thereby help secure the infrastructure for the inhabitants in the future (Vegvesen, 2014).
To get to the site internationally, the nearest airports are placed in Ålesund and Bergen, which both are located approximately 300km away. However there is also an airport in Sogndal, but it only serves inland departures and arrivals.

ACTIVITIES

The main attraction at the site, is the spectacular nature and landscape, which offers both inhabitants and tourist with several activities. Jostedalsbreen, Tungestølens closest neighbor contains a national park that serves several arranged tours, where tourists can go hiking on the glacier. In 2009 a new adjoining national park Breheimen was opened, now serving the area with two parks. The great variety of nature, containing mountains, glaciers, lakes, forest, rivers and valleys offers the tourist with several outdoor and extreme sport activities, such as skiing, glacier hiking and climbing, rafting and kayaking (Breheimsenteret, 2015).
The Norwegian Tourist association, offers a broad variation of outdoor activities and arranged tours, within the area. Furthermore three routes of the National Tourist routes in Norway, is placed in driving distance from the site: Gaularfjellet, Sognefjellet and Aurlandsfjellet (Nasjonaleturistveger, 2015).

Due to the nature of Luster municipality, tourism, is considered an important industry, and therefore well developed hotels, camping facilities and cabins are important factors to maintain and develop the industry.

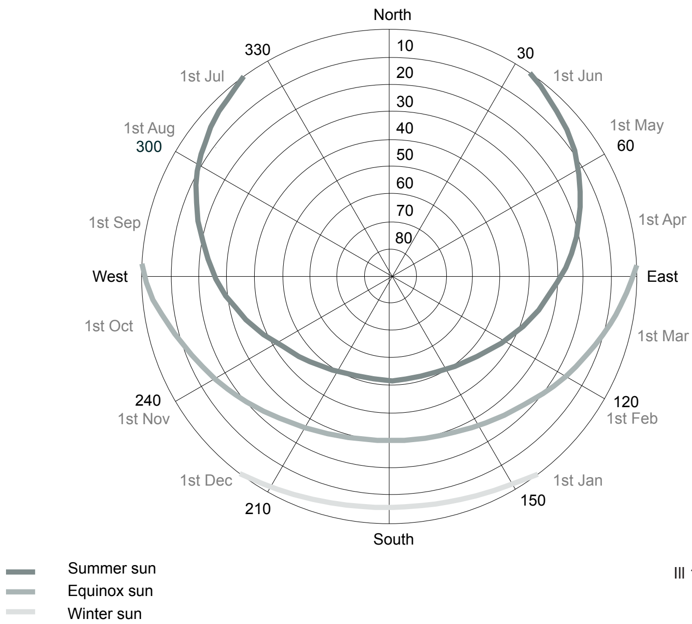
Ill. 1.16: Mapping

CLIMATE

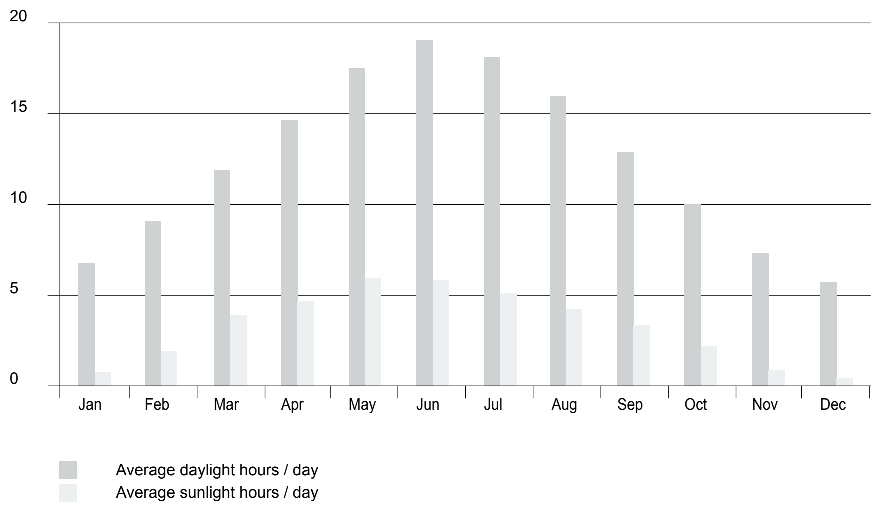
NATURAL LIGHT

The northern location of the site, is evident in the sun path diagram. During the winter the sun rises at 9am and sets at 3pm, only rising 10 degrees over the horizon. During the summer the sun rises at 4am and sets at 11pm. Characterizing the winters as dark and the summers as light, where the sun hardly sets during the day (Gaisma, 2015).

The number of sunlight hours, however shows that only about 1/3 of the daylight hours is direct sunlight (Climatemps, 2014).

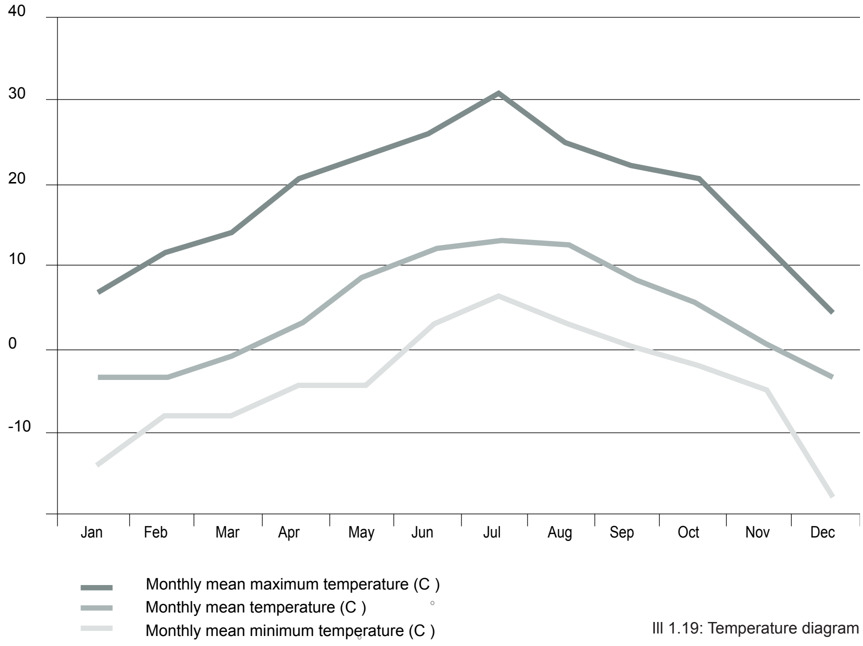


Ill 1.17: Sun diagram



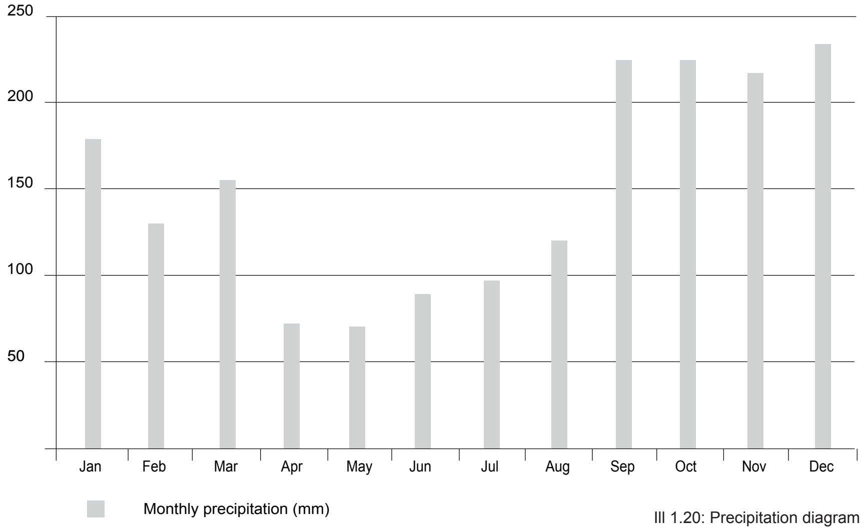
Ill 1.18: Diagram showing hours of sunlight and daylight

TEMPERATURE
The average air temperature in Tungestølen, only varies very little. The temperatures only drops a few degrees below zero during the winter, and during summer the temperatures hardly rises above 20degrees. The small variations in temperature, can help minimize both heatloss and overheating. However the effect of the wind should not be underestimated, as it can result in a cooling effect all year round (Meterologisk institut, 2015)

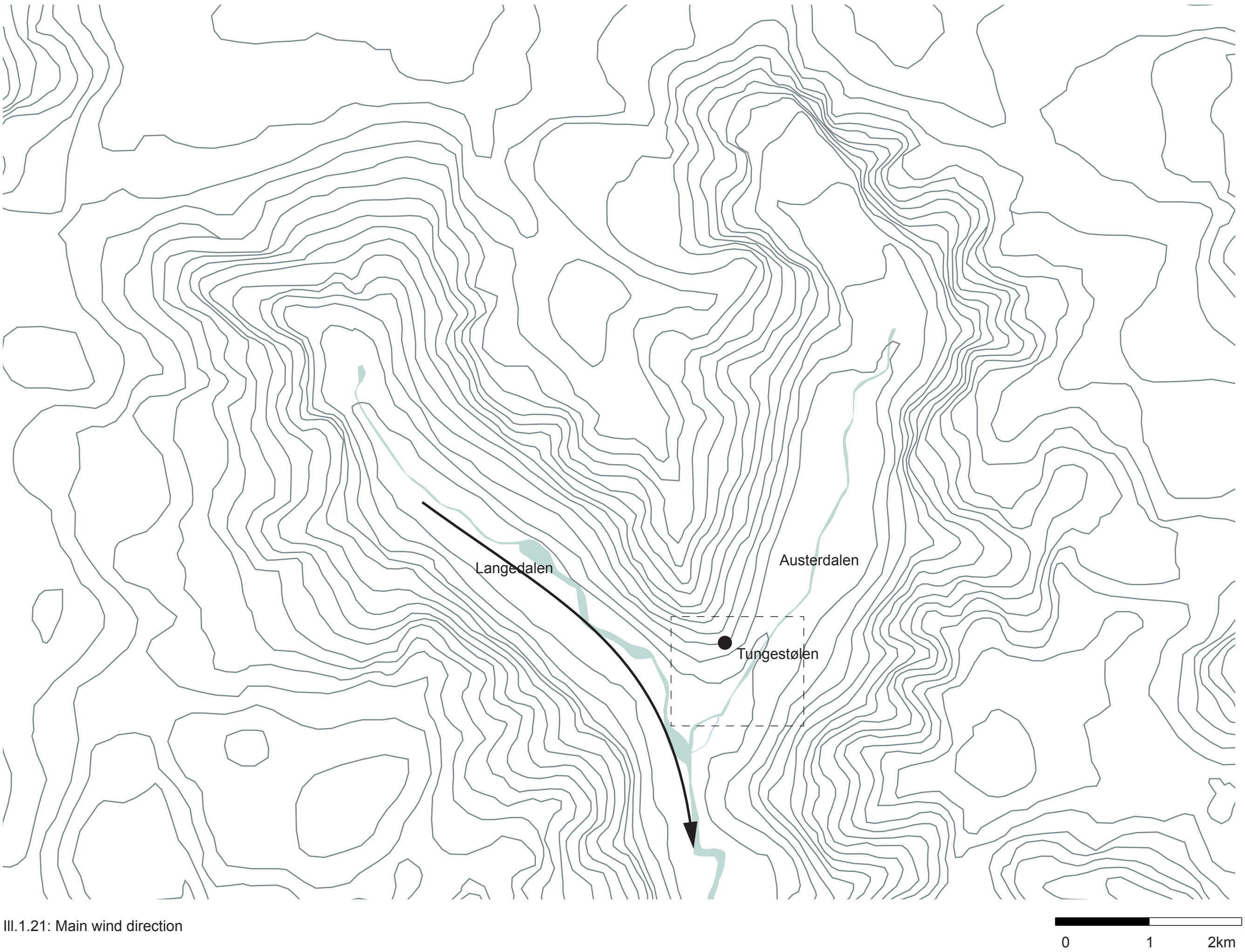


Ill 1.19: Temperature diagram

PRECIPITATION
With a precipitation average at 1700mm a year, and 250 days of rain and snow, it is clear that precipitation have a great effect on the perceived climate of the site. To compare the average precipitation in Aalborg is 700mm (Meterologisk institut, 2015).



Ill 1.20: Precipitation diagram

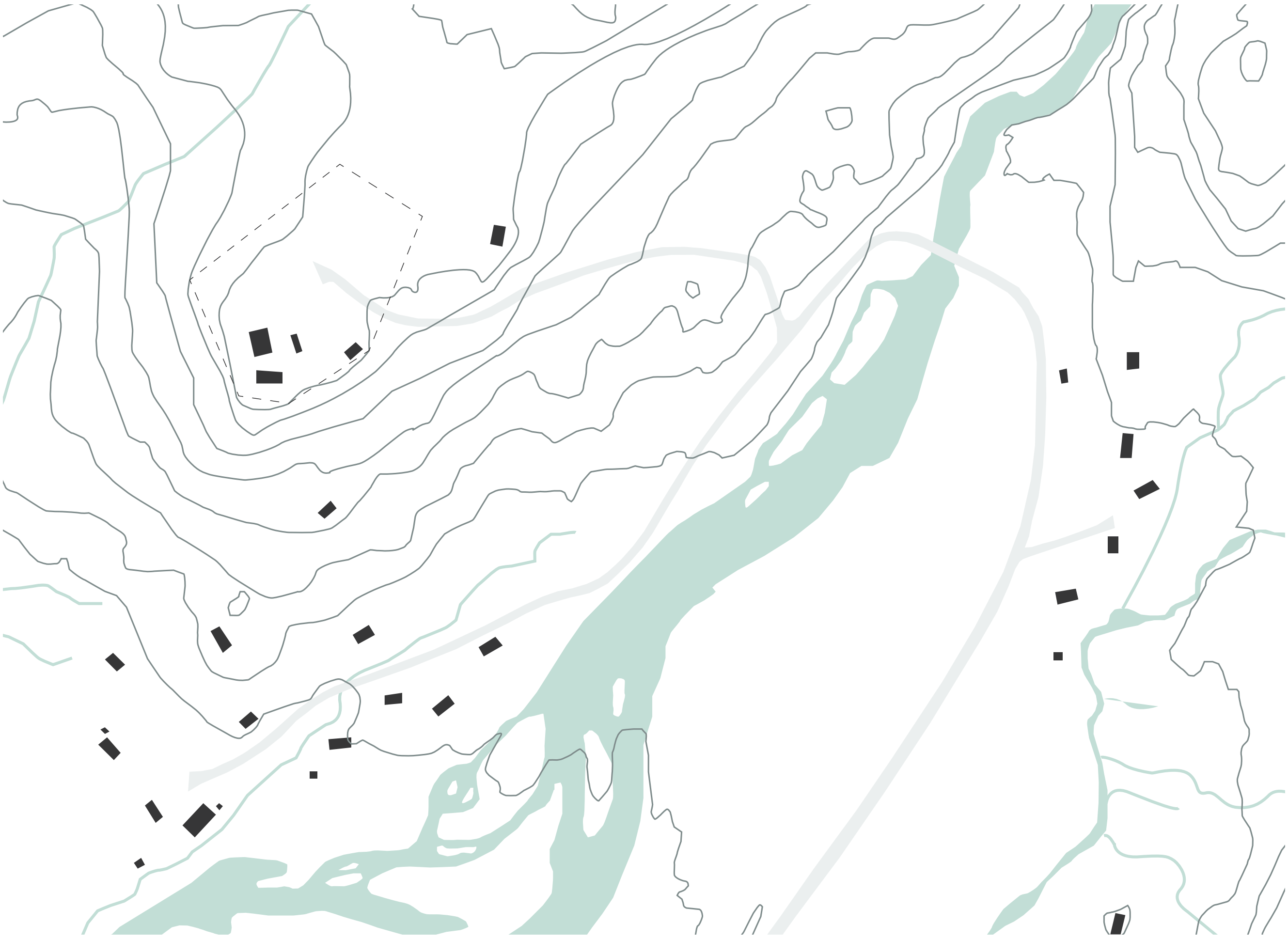


Ill.1.21: Main wind direction

WIND

The wind conditions in Norway are often very site specific, due to the many fjords, valleys and mountains. Data from the report Tungestølen DNT, Jostedalsbreen by Jenny Fetveit have been used, due to the fact, that there is no weather station that collects wind data from the area. Jenny Fetveit has in close connection with meteorologist Mariann Aabrekk identified the wind as primarily coming from North West, down Langedalen (Fetveit, J., 2013).

The wind at the site have an average speed of 1,4m/s, and to compare the average wind speed in Aalborg is 7m/s. The site is placed within a small valley surrounded by mountains, which serve as shelter for the site (Meterologisk institut, 2015). However, even though the average wind speed is slow, storms with the same strength as Dagmar (112km/h) are expected to occur again. The report hvor sterk var Dagmar, by Kjeller vindteknikk AS, states that storms with the same wind speed can occur as frequent as every 10 to 40year, and that the return time for a storm with the same specific strength and direction is expected to occur every 40 to 100year (Kjeller vindteknikk AS, 2012).



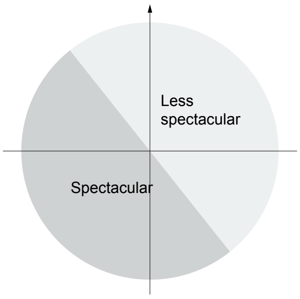
Ill. 1.22: Orientation - Contour lines at every 5m

50m

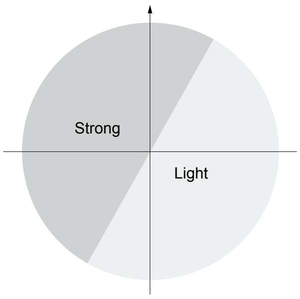
ORIENTATION

All the settlements in the valley are placed slightly up the hillside, turning the narrow side toward the wind, to help reduce heat loss. The former tourist cabin complex was placed slightly higher, on the top of a smaller plateau, making the site slightly more vulnerable and exposed to wind. However the quality of placement is the view, which would be difficult to obtain other places in the valley.

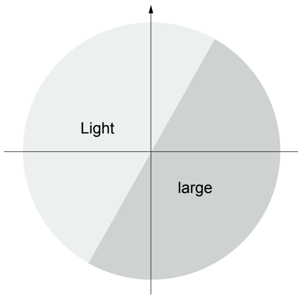
The placement up against the hillside, creates a natural direction according to the view. The most spectacular view is towards the meeting of the two valleys, and down the river towards Veitastrond, where the valley between the mountainsides is visible. The site also offers a great view down along the Langedal valley.



Ill. 1.23: Quality of view

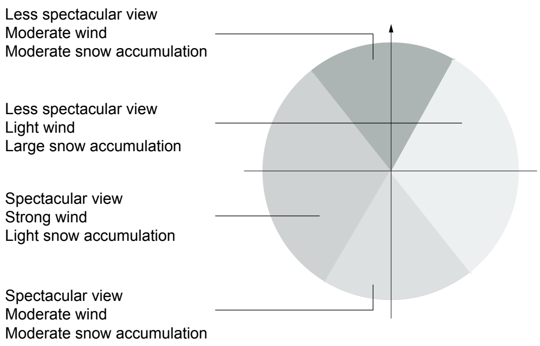


Ill. 1.24: Wind



Ill. 1.25: Snow accumulation

In order to gain a better understanding of the site, and to best possible to orientate the design, the following diagrams have been made. First illustrating the quality of the view, the second shows the direction of the wind, and the third diagram showing the snow accumulation.



Ill. 1.26: General orientation

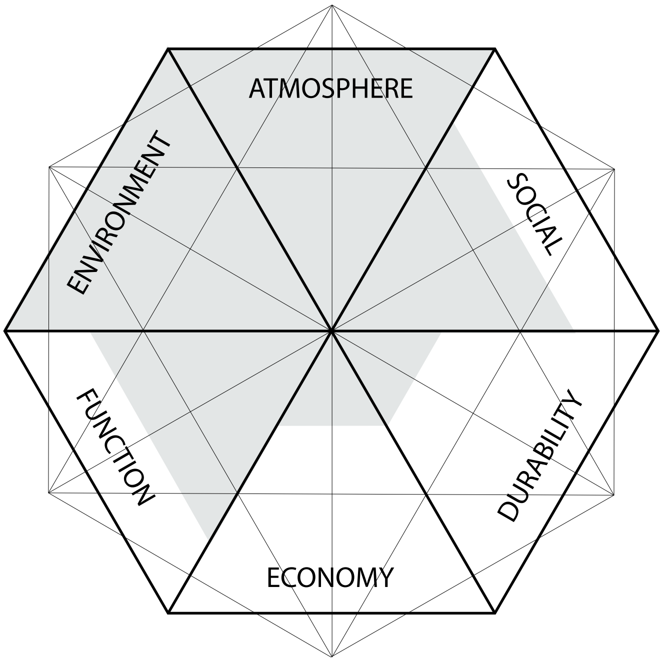
STRATEGY

4

VISION

We want to reinterpret Nordic Architecture for our welfare to sustain. The project will provide a place for man to dwell, and to be one with nature. A place in the tension between the earthbound and the heavenly, Tungestølen, Norway.

Ill. 1.27: Sogndal



STRATEGY

The model presented within the method (p.7), will be utilized to point out the focus points, gained from the analysis. These points will function as the point of departure within the design process, where proposals will be evaluated according to how they meet the following demands. However the different points will be prioritized different, with atmosphere and environment as the primary.

ATMOSPHERE

LANDSCAPE
The placement in the very powerful landscape will operate as a defined starting point. Here it is more important than ever that the architecture respects and represents the landscape to which it belongs. The architecture must simultaneously emphasize the nature and landscape, by integrating the building within the context.

A PLACE FOR MAN TO DWELL
The aim is to hold on to the traditional use of the tourist cabin, as a space where the travellers can seek shelter and protection from the weather. The cabin will function as an intimate and delimited space, where it will feel natural for the travellers to dwell. The people that seek places such as Tungestølen, is searching for nature experiences both to find peace, and, or a contemplative pause. The space must comprehend quietness and contemplation for visitors to disconnect, and focus on nature.

SENSING
The place should provide the visitor with a space where he can disconnect from the everyday life, and instead focus on one's own wellbeing, both physically and mentally.

ENVIRONMENT

OFF GRID

The cabin is placed rather isolated and have no connection to any municipal infrastructure. It has neither water, sewage, electricity, nor coverage for mobile telephones. The site is therefore completely off grid, and any solution, regarding the input and output of the building therefore have to be considered, in order for the building to be self-sufficient.

It is possible to implement different active strategies in order to produce electricity. Solar cells can be placed, on the footprint of the building, thereby minimizing the impact on the landscape. However the effect of the solar cells is minimal, due to a small amount of sunlight hours. Other strategies such as water turbines and earth warming will have to big an impact on the landscape, and also remove the awareness from the visitor, of how the energy is produced. Due to a user group, that wish to experience and sense nature to the fullest, and the wish to create a place that interacts with the nature. It is chosen to make a building with no use energy.

By not having energy sources, alternative solutions for the basic functions will have to be integrated. The users therefore have to sense themselves, to obtain a wished comfort. Creating a sustainable cabin complex that rely on local resources, and is self-sufficient, will reinforce the experience of the site, and make the visitors more aware of the quality of nature.

DEFINITION OF A CABIN, ACCORDING TO DANISH STANDARDS

The building will due to its function, be defined as a vacation house. Meaning a building, that isn't used for permanent inhabitation. According to the Danish building regulations there is no energy demands for vacation houses, however, they are required to fulfil the following u-values and line loss.

External walls	0,25 W/m2K
Partition walls	0,40 W/m2K
Ground slabs	0,15 W/m2K
Ceiling and roof	0,15 W/m2K
Windows, exterior doors	1,80 W/m2K

Foundations	0,15 W/mK
Windows and external doors	0,03 W/mK
Roof windows	0,10 W/mK

These values applies with a window area of 30% of the floor area (Bygningsreglementet, 2014).

THERMAL COMFORT

Due to the specific user group, and the function of the building, a Class 3 standard regarding thermal comfort is chosen to be satisfactory. The user group visits the site to experience the nature, and we can therefore assume that they are less critical regarding specific temperatures. Class 3 according to EN 15251:2007 standard (Dansk standard, 2007)

Predicted mean vote: -0,7 < PMV < +0,7
Predicted percentage dissatisfied PPD: < 15%

Winter:	22±3
Summer:	24,5±2,5

Hours > 27:	100
Hours > 28:	25

INDOOR AIR QUALITY

Class 3 according to EN 15251:2007 standard and CR1752 standard (Dansk standard, 2007), (Dansk standard, 2001)

Percieved air quality % dissatisfied, PD < 30%

dp:	< 2,5 decipol
CO_2:	> 1200ppm

DAYLIGHT

The light conditions are only determined for the kitchen workspace, to obtain desirable work conditions. For the other functions it is desired to have lower light demands, to obtain a more warm and embracing atmosphere.

Kitchen:	>200lux

FUNCTION

A PRACTICAL DOING
The project must have a logic functionality so practical everyday tasks are done, easily and effective.

FUNCTION PROGRAM
We all experience our surroundings through physical presence, while we place ourselves in time and space through actions and experiences. Architecture as a built form, manifest our reality, and through interactions makes it understandable for us. We wish to define architecture as a verb, and relate to the action, rather than the function. To cook, rather than defining the space of a kitchen. To sleep rather than the space of a bedroom

The main function for the cabin in Tungestølen is a place for man to dwell. To best obtain this goal, activities relating to the use and function of the cabin have been defined. Designing from these activities should help define the main function.

The cabin complex is intended for approximatly 30 travellers.

ACTIVITY	NARRATIVE	VIEW	NEEDS
To arrive and go	To arrive. Orientate the new surroundings, and feel satisfaction of having reached the end point of today's journey. To get inside and look out, recognizing the landscape outside	XX	Surfaces that withstand water. A place to drop of shoes, bags and ski
To cook and to eat	Motivated, preparing a good breakfast to gain energy for today's travel. Or slowly preparing todays dinner while reflecting on today's adventures, relaxing over dinner, feeling tiered and satisfied	XXX	Kitchen with water, wood stove for cooking, workspace and storage for kitchenware and food
To meet	Sitting by the fireplace, looking into the flames, and sharing experiences. Or staring a conversation over the dinner table with other travelers	XX	A fireplace
To sleep	Crawl into one owns cave, and slowly calm down. Waking up, feeling light and energetic for today's journey	XX	A fireplace
To shower	Enjoying washing of the dirt, after a long day outside	X	Water tank. Surfaces that withstand water.
To toilet		X	Toilet

Ill. 1.28: Function program

SOCIAL

WELFARE FOUND IN NATURE
Through the project, the aim is to question how we want to live our life, and raise nature and wilderness as a response to the stressful modern society in the city. Through the architecture mankind can reconnect with his roots, and again become accustomed to live on the premise of nature and landscape.

THE DEMOCRATIC SPACE
The purpose of rebuilding the tourist cabin is to hold the increasing number of tourists who wish, to experience the beautiful nature. As the nature of Norway is for everyone, the space shall be a democratic space, a space for different people to meet and learn from each other.

SUPPORTING THE LOCALS
Tourism is considered an important industry of Luster municipality, a redevelopment of the cabin of Tungestølen will help to maintain and develop the local tourist industry.
Furthermore, it is the intention to develop facilities that can accommodate school camps for local schools in Luster municipality.

ECONOMY

By using local found materials such as wood and stone, and purchasing these from local businesses, will secure a high quality, lower prices for transportation and maintenance.
It is the intension that the local must maintain the cabin and provide local agriculture to the cabin.

DURABILITY

MATERIAL PROPERTIES
The used materials should preferably be easy to maintain, and the patina must further contribute to its quality. When choosing construction materials and methods, the wet conditions of the site have to be considered.

A STRONG CABIN
As the previous tourist cabin was destroyed by a storm, it is crucial to secure the new building from another storm. You may argue it as being most sensible to rebuild the cabin in another location. At the same time it is considered important to maintain the current placement because of its view. As the current site is vulnerable and exposed, wind conditions and risk of storms therefore have to be taken into consideration, to ensure the building in the future.

EPILOGUE

5

REFERENCES

LITTERATURE

Brundtland Commission (1987) Our common future, Oxford, Oxford University Press

Dansk standard (2007) Input-parametre til indeklimaet ved design og bestemmelse af bygningers energimæssige ydeevne vedrørende indendørs luft-kvalitet, termisk miljø, belysning og akustik, Copenhagen, Dansk standard

Dansk standard (2001) Ventilation i bygninger – Projekteringskriterier for indeklimaet, Copenhagen, Dansk standard

Fetveit, J. (2013) Tungestølen DNT Jostedalsbreen - Appendix, Norway, Norwegian University of Science and Technology

Fetveit, J. (2013) Tungestølen DNT Jostedalsbreen- Essay, Norway, Norwegian University of Science and Technology

Fetveit, J. (2013) Tungestølen DNT Jostedalsbreen- Premiss, Norway, Norwegian University of Science and Technology

Fjeld, P. O. (1983) Sverre Fehn - The Thought of Construction, New York, Rizzoli, p. 26

Forster, K.W. (2012) "Lyset tøndes i natlandene" in New Nordic – Arkitektur og identitet, Kjeldsen, K., et al, Denmark, Louisiana Museum of Modern Art, p.18

Kjeller vindteknikk AS (2012) Vinden som blåste i fjor - hvor sterk var Dagmar, Norway, Norges vassdrags- og energidirektorat

Knudstrup, M. (2004) Integrated Design Process in Problem Based Learning, Aalborg, Aalborg University Press

Lund, N. (2008) Nordisk Arkitektur, Denmark, Arkitektens forlag

MacKeith, P. (2012) "Bygningskunsten den sociale kunst: Tanker om en nordisk offentlig arkitektur" in New Nordic – Arkitektur og identitet, Kjeldsen, K., et al, Denmark, Louisiana Museum of Modern Art, p. 134

Nasgaard, R. (1984) The mystic North, Toronto, University of Toronto Press

Nielsen, T. (2012) "Uformel sameksistens og herlighed for alle: demokratiske byrum i norden" in New Nordic – Arkitektur og identitet, Kjeldsen, K., et al, Denmark, Louisiana Museum of Modern Art, p. 166

Norberg-Schulz, C. (1996) Nightlands - Nordic Building, USA, Massachusetts Institute of Technology

Ramberg, I.B.1., Bryhni, I.1. & Nøttvedt, A. (2007) Landet blir til - Norges geologi, Trondheim, Norsk geologisk forening

Tibballs, A. M. (2014) En innfallsport til Jostedalsbreen nasjonalpark, Sogndal

Wurman, R. S. (1986) What Will Be Has Always Been: The Words of Louis I. Kahn, New York, Rizzoli

WEBPAGES

Breheimsenteret (2015) Available: http://www.jostedal.com/index.htm (Accessed: 10/2 2015)

Bygningsreglementet (2014) Available: http://bygningsreglementet.dk/br10_04_id119/0/42 (Accessed: 7/5 2015)

Climatemps (2015) Available: http://www.bergen.climatemps.com/sunlight.php (Bergen) (Accessed: 8/2 2015)

Danmarks Radio (14/12 -2014) Vilde Hoteller - episode 6, Available: http://www2.statsbiblioteket.dk/mediestream/tv/record/doms_radioTVCollection%3Auuid%3Ab14d283a-c703-4ffe-82fe-f13d303a299b (Accessed: 8/4 2015)

DNT (2015) Available: http://www.dnt.no/visjon/ (Accessed: 25/2 2015)

Gaisma (2014) Available: http://www.gaisma.com/en/location/bergen.html (Bergen) (Accessed: 8/2 2015)

InternettOpplysningen (2015) Available: http://io.no/info/luster-trelastlager-as-1454767 (Accessed: 10/2 2015)

Keiner, M. (2005) Available: http://e-collection.library.ethz.ch/eserv/eth:27943/eth-27943-01.pdf (Accessed: 9/2 2015)

Meterologisk institut (2015) Available: http://stage.yr.no/place/Norway/Sogn_og_Fjordane/Luster/Tungest%C3%B8len/statistics.html (Accessed: 8/2 2015)

Nasjonaleturistveger, (2015) Available: http://www.nasjonaleturistveger.no/en/routes (Accessed: 10/2 2015)

Nesoyane (2010) Available: http://www.nesoyane.com/index.php?option=com_content&view=article&id=5&Itemid=8&lang=nn (Accessed: 9/2 2015)

OnlineGuiden (2014) Available: http://www.onlineguiden.no/firma/sogn-stein-oeyvind-heggestad-625911 (Accessed:10/2 2015)

Sonnesynsag (2015) Available: http://sonnesynsag.no/ (Accessed: 5/5 2015)

Stantensnet (2000) Available: http://www.statensnet.dk/pligtarkiv/fremvis.pl?vaerkid=12582&reprid=0&filid=20&iarkiv=1 (Accessed: 9/2 2015)

Vegvesen - Første spadestikk i Veitastrond (2014) Available: http://www.vegvesen.no/Fylkesveg/fv337veitastrondsvegen/Nyhetsarkiv/f%C3%B8rste-spadestikk-i-veitastrond (Accessed: 9/2 2015)

VisitNorway (2014) Available: http://www.visitnorway.com/dk/produkt/?pid=91537 (Accessed: 10/2 2015)

Wikipedia- Veitastrond (2014) Available: http://no.wikipedia.org/wiki/Veitastrond (Accessed: 9/2 2015)

ILLUSTRATIONS

Ill. 1.03: https://www.flickr.com/photos/rafawin/12872497213/in/photolist-kBuUX8-dyWith-6rikT3-85zPBx-c1Zvaf-7s4HfP-TfxYe-r7YydL-a3G12T-6E1v9e-aAvJVR-9qrLMH-rmtzac-9ij4uS-oRrVhC-G9dA1-7tnR
JZ-dWovJ-FYNbr-8ApBi6-q6Gi7m-atFyh2-76N6n8-77D254-8G1TcW-8VCsWe-dm2KFy-rchVtE-cWqKt5-6LsAzh-cvCv29-r57NSN-6icYLU-ftXtLy-rJDY8L-oyVF7z-7QsAGU-6zsnvP-p1YLGB-
8nKuaJ-cvCuX9-wJ8qz-ojwjuf-doQBVo-a5MazV-aLxgw2-7rSYNh-dvJpy-ftJF4g-adpkT1

Ill. 1.04: https://www.flickr.com/photos/rawmeyn/6218661152/in/photolist-4d8chG-iDjqK-oKJyFP-att5og-nwh8qx-fj3k25-aEEwNf-atwgiJ-89juwe-oq425C-2NMnMK-6TDhoL-qHPXKU-agEVni-odDvuh-b4fYrF-
mzE8b3-wJ8qz-72xmfC-cYNcus-oyXcyT-ovGjW5-o7Dqf7-758w1d-oKGq7D-6C4Uih-r1k2Co-o5B4ru-8cdn4o-nHm7wv-992ogg-6JmYP4-27qTan-cJyaHh-9AbftM-fHBShR-5xi6Xq-6V9sEY-oDC

t9j-oY47hU-kBt3V6-ovGFkx-a6uRpP-9Yq8g6-fzbgin-aD5Dk4-8xfGY6-cHfSmj-cS8irW-8CUuVi

Ill. 1.05: https://www.flickr.com/photos/brostad/4644465287/in/photolist-85q6HH-7fZU7K-85q6HB-qR5EQb-qbQWdV-q4jCCN-aiKjzW-6rBGkS-85q6HP-86F9xn-6rxzvn-aiGwMg-6rxy1K-aiJc1h-aiKiLL-6rxzaF-
85q6Hr-85q6Hk-85q6Hg-qHU7pt-r1aUNi-q4x7rP-qR4cH5-dNumSD-dNumNc-q4x7BZ-qR4cLS-qbCBaE-dNun2K

Ill. 1.06: https://www.flickr.com/photos/redjunasun/5937648493/in/photolist-a3G12T-oi7Nqh-6E1v9e-dPmYSu-3wetD9-7NzVkB-9qrLMH-8tP6et-7f3CnP-79Z53C-7mRzyb-9ij4uS-tucBX-oRrVhC-8gRosY-8kstf6-
aevqhJ-G9dA1-gHSgu6-cVX3vy-ozTPX1-dWovJ-FYNbr-c1MaYC-8ApBi6-q6Gi7m-atFyh2-76N6n8-dFTAsf-ku2c3-77D254-8G1TcW-dm2KFy-iFwqi-dGqhE4-rchVtE-6LsAzh-cvCv29-6icYLU-
ftXtLy-rJDY8L-oyVF7z-7QsAGU-6zsnvP-4HpJxn-p1YLGB-8ocZci-8nKuaJ-cvCuX9-8oAMpU

Ill. 1.07: https://www.flickr.com/photos/vironevaeh/6008904688/in/photolist-a9Zd1Y-d3FFWd-a9Zjtd-a9WvFe-9tMyF5-d3FbxC-a9ZgKQ-a9Wu9r-a9WrJ8-cxSNJA-94zat3-a9Wpm2-a9ZhfG-8ug8A9-8ug681-9sT
opt-a969Kc-a98Xgm-a96aRB-a9WtuP-a98X99-a7Bizh-a9ZffN-4w5w6-a9Wta4-ardoQZ-a9Zdr3-5AAYAM-a96aFT-a969zZ-a98XT5-a98XnY-a9WpZV-5VBDW1-8ug8eW-gHRPdi-anVvGx-a98WW1-
94zaio-9NkcT1-a98WKo-hLz86-osyM5r-9DyJpK-8snQHi-9yAqsh-8ud29K-8ucP7a-8ug9MC-8ufV15

Ill. 1.09: Fetveit, J. 2013; Tungestølen DNT Jostedalsbreen- Forarbeid, Norway, Norwegian University of Science and Technology (p.21)

Ill. 1.11: Tibballs, A. M. (2014) En innfallsport til Jostedalsbreen nasjonalpark, Sogndal, (p.6)

Ill. 1.12: Foto recived from Per Rygh, taken by Stine Wike

Ill. 1.13: Foto recived from Per Rygh, taken by Stine Wike

Ill. 1.14: Tibballs, A. M. (2014) En innfallsport til Jostedalsbreen nasjonalpark, Sogndal, (p.5)

Ill. 1.15: https://www.flickr.com/photos/redjunasun/5938205424/in/photolist-a3JRA9-anG8ku-a9ZdEs-a9WsnX-a9ZiGE-a9Zezf-8omFBb-a9WrcR-5VBDLE-5VBDxG-a96aRB-a9ZffN-5VBEJo-a9Zkxh-a96aFT-nX
R5C-a9WpZV-a98XT5-a98XnY-a969Kc-a969zZ-a98Xgm-a9Wv2i-a9Ze2E-a98WW1-a9Wwfi-a9ZjPY-a9Zenb-a9Zd1Y-a9Wp1i-a9WvFe-a9ZgKQ-aqSkE6-a98WKo-a9WrJ8-a9ZhfG-a9Wpm2-a9WrxR-
nXyzoR-nHm7wv-6oPrGf-nXvipg-o43LzU-8T1yyo-8Pjpym-8SXpBg-nTFumJ-8PgLaR-8PjBEG-nVCzp1

Ill. 1.27: https://www.flickr.com/photos/martindelusenet/13365075923/in/photolist-mn2vrv-8mcNnP-oj4QKw-cfRrpw-dWDfL4-nhY6J-5iTsd1-d1YtDL-oKMuqq-dWJts1-8wKgSv-79CMmq-5hUS7v-coNbu7-
r1FnBP-8F7f2Z-4nvuYm-ebENas-b86uVD-bsFBt6-doBGbD-jK1m7-e69utm-g41keE-fedR9N-nn41w-e5t3V2-nVXjU5-cHW5Vd-xX78C-h4seoD-pxVkmJ-cfRtLA-pfmCNH-9Jpnrt-9tHWxy-qWwNC6-rSP
MYi-brxrne-6Yo6qF-kk5Zr-9FFBBB-9i1oPZ-oLtKG-rnR16S-8R3cMN-odDvuh-73UoCB-9drgnj-7yiVxu

Tungestølen - Process

Master Thesis in Architectural Design 2015
Jeanne Juel Lichon & Line Toft Jensen
Aalborg University

TUNGESTØLEN - PROCESS

THEME
Sustainability

4st SEMESTER M.Sc. PROJECT
Aalborg University
Department of Architecture, Design & Media Technology

PROJECT PERIOD
02.02.2015 - 27.05.2015

PAGES: 57
NUMBER OF COPIES: 6

MAIN SUPERVISOR
Lars Brorson Fich, Arcitect MAA

TECHNICAL SUPERVISOR
Peter V. Nielsen, Ph.D., M.Sc. from DTU

Line Toft Jensen

Jeanne Juel Lichon

INTRODUCTION

When initiating the process of designing a tourist cabin in Tungestølen Norway, the strategies contracted from the program, will serve as the main catalyst. The design process contains studies carried out from the first sketches, until the development of the final concept. The design process have been carried out in stages, where different studies have been made, according to the current state of the project. The studies will mainly be presented, first with focus upon the atmospheric qualities, and afterwards which possibilities these solutions allows in terms of indoor environment and energy.

The studies, concerning atmosphere, will be presented through sketches, model pictures, diagrams and 3d visualisations. Bsim will be used to examine the technical requirements. Sustainable buildings are often demanding, a Bsim simulation can therefore be essential to secure good thermal and atmospherically conditions.

CONTENT

INITIAL STUDIES

1

THE CAVE

Tourists have for decades been visiting the dramatic landscape of Tungestølen, Norway. They come to experience the unique nature, with valleys, rivers, mountains and Jostedalsbreen as its closest neighbor. The former tourist cabin had a desirable placement in close connection with several nature attractions and activities. Ever since the cabin was destroyed by a storm back in 2011, it have been desired to rebuild a new one, to accommodate the many tourists.

Meteorologists have predicted that recurring storms will occur again, so to secure the cabin from future storms, an idea came up, concerning building the cabin complex into the mountain hillside.
What it means to build inside a mountain, what advantages and disadvantages it creates, both in terms of atmosphere, energy and indoor environmental solutions, will in the following be elaborated and examined.

The function of the cabin is to create a place where man can dwell, after a long and physically challenging day outside. A place where you have to sense yourself, become comfortable, and able, just to be.

DEFINING TO BE

"At a time when architecture tends to drift away from its mythical and existential task, the ontological echo of its origins, it is important to survey the mythical origins of architecture and its human essence. The primary task of architecture is to create the experience of placeness." (Pallasmaa, J., 2013 p. 179)

Man is the center of architecture, meaning that everything around us, we relate to ourselves. According to Pallasmaa, the definition of placeness, contains a perception of a place, as a distinct whole, that can be identified with a specific meaning and by a name. To create placeness is to define mans location in relation to the placeless and infinite natural space. By creating structures, it enables man to inhabit the landscape, by defining spaces, it structures the experience of the world, along with our understanding of ourselves.

The cave can be considered as a paradox. An empty space, that is enclosed by the entire globe, a infinite and natural mass. Contradictory to a normal structure, the cave is not an architectonic object, but only a defined space, that can contain fragments of a dwelling, in terms of walls, floors and ceiling.
Build structures relates to their specific nature and context, which helps them to define a spaces identity. The interpretation of light, materiality, and the interaction between landscape and architecture, helps to define placeness, and how we dwell (Pallasmaa Juhani, P., 179).

The cave differs from a build structure, by being naturally defined within a infinite mass. Our culture begins in the caves, and it was the first space, where humans began to create images of ourselves, and the surrounding world. The caves, functioned as shelter, and was inhabited by the measurement of the body. The enclosed cave, afterwards became the starting point for the build structures, that helped man define placeness.

To define placeness within a cave, that functions as a tourist cabin, the different functions will be defined by a specific atmosphere. The two philosophers Plato and Martin Heidegger, have each defined a atmospheric experience in relation to the cave and the dwelling.

PLATO

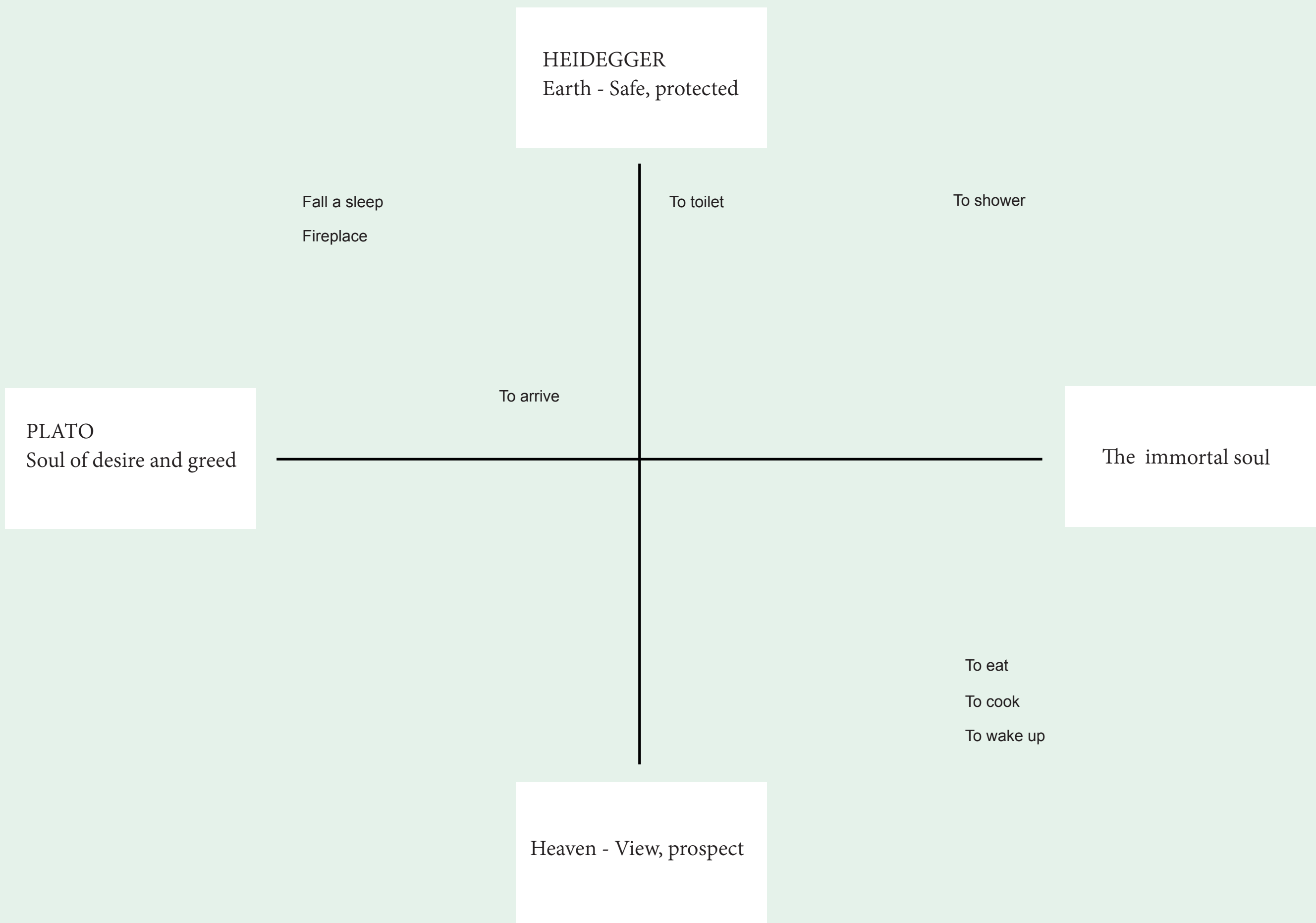
Plato describes the human soul as a tripartite, containing one immortal and two mortals, corresponding with the three sections of the cave. The first immortal, reasonable soul is placed in the head, outside and below the sun. The second immortal soul contains willpower which is placed in the chest, in the middle of the cave. The mortal soul of desire and greed, is placed in the solar plexus, in the darkest, lowest section of the cave (Plato, 1957)

HEIDEGGER

Martin Heidegger describes the central aspect of dwelling, in connection to his concept of the "fourfold". The four elements consists of the earth and sky, divinities and mortals. The fourfold creates a fullness, which is all part of a dwelling, the parts cannot be divided and only works as a unity. Heidegger therefore argues that man is not only a being on earth, but a part of the fourfold.
The earth is the supporting ground, which supports us, and makes us feel safe and protected. The sky, which relates to the heavenly, as a spiritual component relating to eternity. We are always here, but we are also beyond, searching for a new prospect. The mortals are human beings, relating to our finiteness and instability, and according to Heidegger the divinities, describes god as a poetic fiction (culturalstudiesnow, 2011).

ATMOSPHERE DIAGRAM

These two definitions corresponds with Norberg-Schulzs description of Norway (Program p.12), where he states that the prospect can be found on the top of the mountains, referring to the heaven, somewhere beneath the sun. Whereas the valleys provide security, and is related to earth. By that, to be is determined by a tension of above and below - something related to the ground, something related to the sky.
The definition of Plato and Heidegger, have been simplified, and combined into one diagram, which will help define the different atmospheres of the different functions. Plato's theory will focus upon the two extremes, the soul of desire and the immortal soul. Heideggers theory will mainly focus upon the earth and the heaven, in relation to creating an atmosphere, for the mortals can dwell within, and strive for divinity. All the functions combined and how they interact, will help to create a place where the visitors will be able to connect with themselves and the nature, and feel free just to be within the present.



Ill. 2.01: Atmosphere diagram

ATMOSPHERES

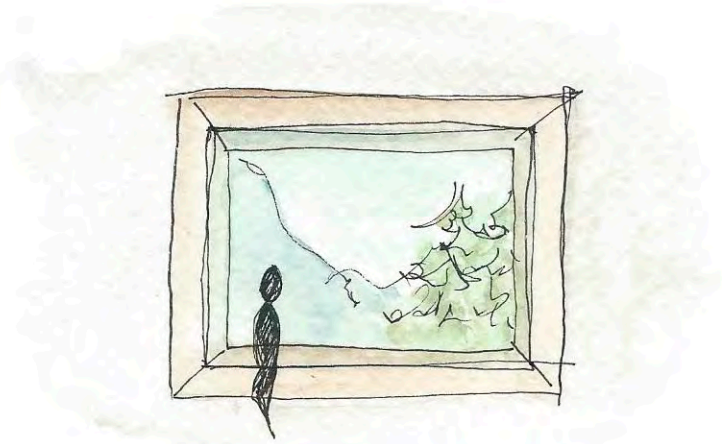
The different functions, presented in the previous diagram, will in the following be presented and elaborated, where focus will be on how the function is experienced, and which atmosphere is desired. This will provide the basic for the further development of the design.

Ill. 2.02: To arrive

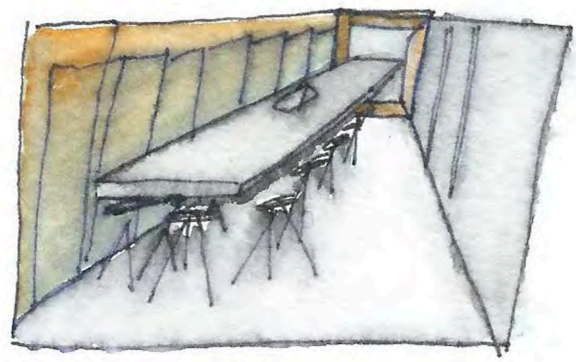
TO ARRIVE

When arriving to the cabin, you arrive through the landscape. Arriving through the main road from Veitastrond, the cabin must become visible in its placement on the mountain hillside, to build up the travelers expectations. By Exposing the building, the traveler becomes aware of their specific goal - to reach the cabin. By exposing it from a distance, the traveler can build up expectations, and by reaching the cabin, you will feel a greater sense of accomplishment.

The entrance, will be through the mountain, making it as a fluent transition, from the natural outside, into the build inside.



Ill. 2.03: Difuse seperation between in- and outside

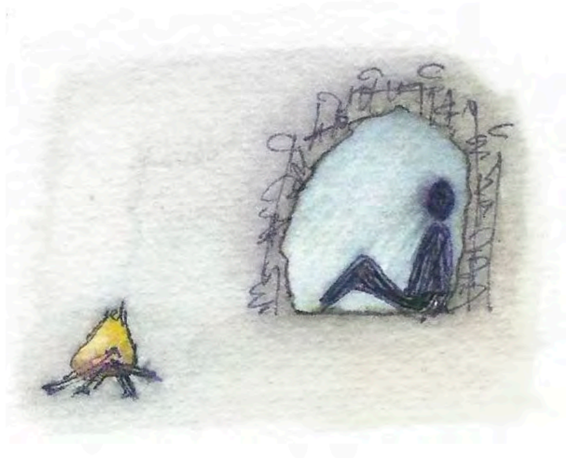


Ill. 2.04: Direction towards the view

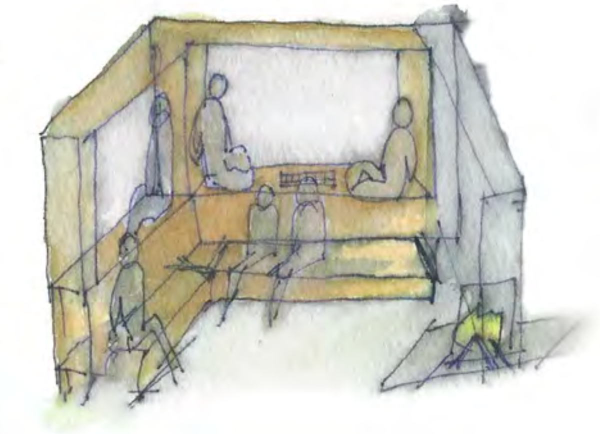
TO EAT AND TO COOK

When the travelers eat and cook, it is either just before they are leaving before today's adventure, or after they have returned. Either way the function works as a transition, from outside and inside. The space shall therefore reflect this transition, and the separation off in and outside must be more fluent.

The functions must meet both the expectations for the day, and accomplishment when the travelers return. By exposing the view, and by orientating the direction within the space towards the view, it will become the focus, and thereby function as a prospect for the traveler.



Ill. 2.05: Safe place by the fire

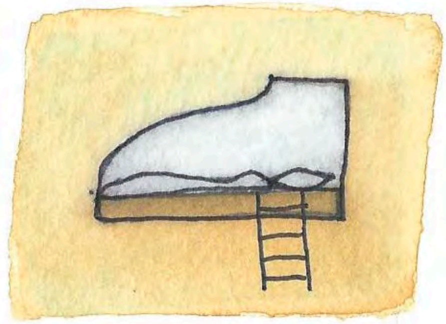


Ill. 2.06: Meeting space by the fire

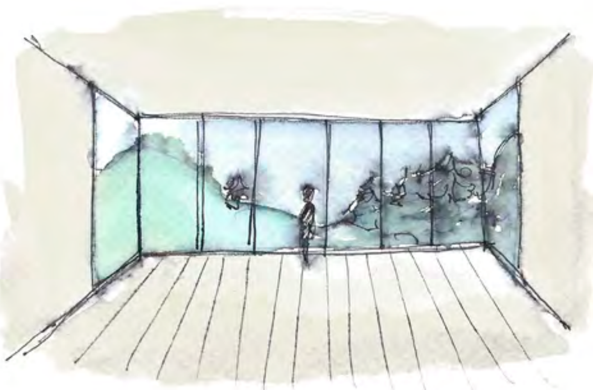
FIREPLACE

The cabin is being heated by wood stoves, thereby making these important design parameters. The fireplace will provide the travelers with heat, but some will also function as gathering elements. When the travelers return after a long day outside, after they have eaten, and before they go to bed, they gather in a protected space, around the fireplace.

By the fire they feel safe within a delimited space enclosed by the mountain. Within the warm and dark space, the travelers can feel free to as they desire, and be able to relax. Whether it is by discussing today's adventures with other travelers, to curl up with a good book, enjoying the view or a glass of whisky. The fireplaces will for the traveler be associated with safety and warmth, making them feel able to sense and to contemplate.



Ill. 2.07: Sleeping niche

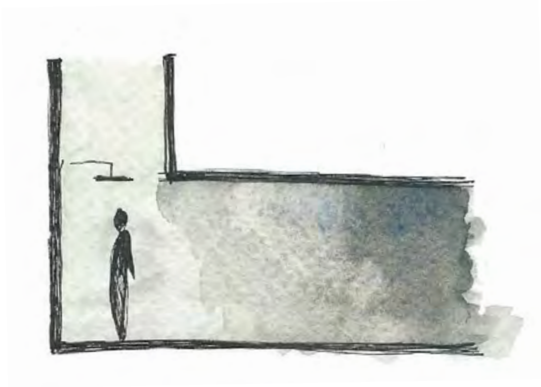


Ill. 2.08: Panorama view

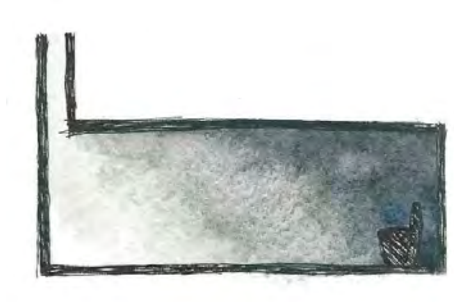
TO FALL ASLEEP AND AWAKEN

After the days adventures, the functions will slowly become more enclosed and private, and at the end of the day, the visitor will have the ability to retreat into one's own space. A dark and enclosed space to be alone, and to fall asleep. A protected space, where focus is on the individuals needs, a place for man to dwell.

When the traveler wakes up, he will be awakened by the light. By a new day, and a new adventure. The place is lit with light, creating a positive atmosphere, that initiates the travelers expectations for the day, a view of the landscape that creates a prospect, and delight.



Ill. 2.09: Showering, bathed in light



Ill. 2.10: Toilet, placet within the dark

TO SHOWER AND TOILET

TO SHOWER AND TOILET
Common for both the shower and the toilet, is that they are functions that are related to the earth. Volumes that are enclosed by the mountain, that thereby create a safe and protected atmosphere, where the travelers can be vulnerable and naked.

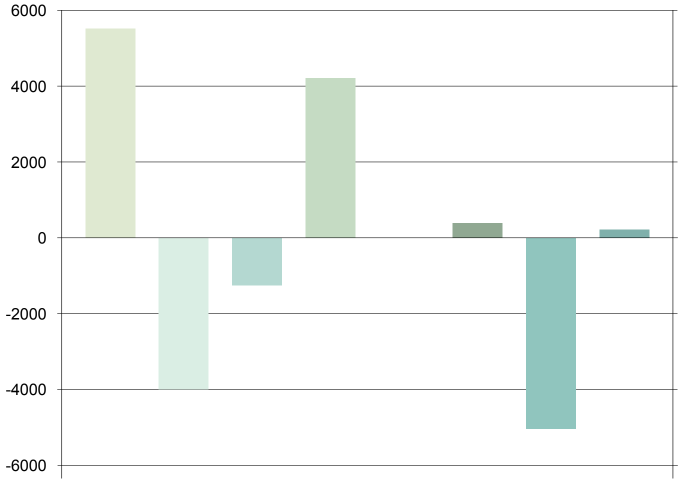
However the shower will be connected to the light source within the room, and the toilet placed in the dark, where focus will be towards the light. This creates two different atmospheres, one where you are protected by the earth, and exposed towards the heaven, creating a light and positive atmosphere. And one where you are placed within a completely enclosed and dark space, looking towards the light.

TECHNICAL ADVANTAGES

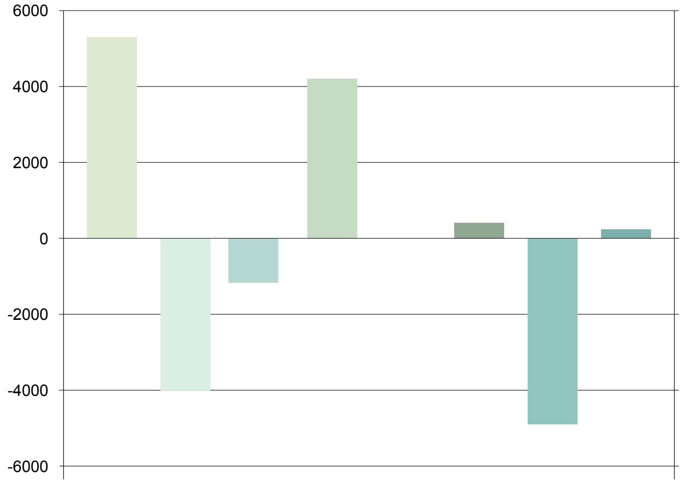
Designing inside a mountain creates some technical advantages. Inside the mountain you find an environment that offers a constant temperature of 7 degrees all year – also in the wintertime. In addition the environment it is protected from wind and precipitation.

Building inside the mountain, makes it possible to not only secure the cabin from a new storm, but also lower the energy use and improve the indoor environment. The stabile and protected environment lowers the transmission loss, as well as the heating demand with up to 5 % for a high-insulated building. A simulation have been made in BSim to verify the efficiency of the design solution.

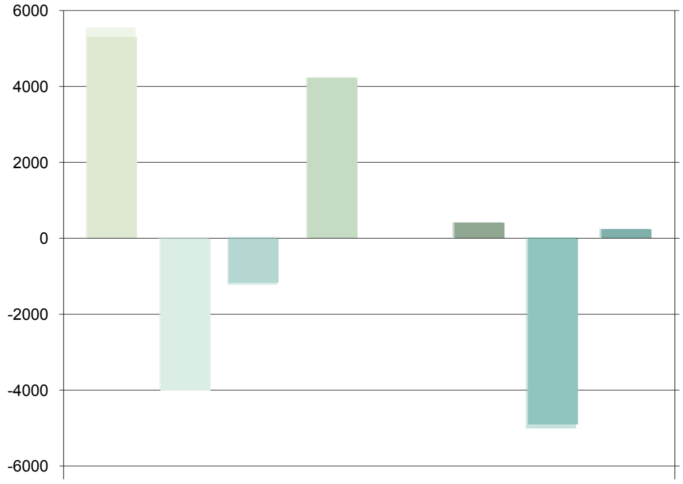
The simulation has been performed on a "basic room" created with dimensions of 6x10x3m. Constructions and windows with high resistances equal to a basic ZEB building have been used. Heating-, infiltration-, lightening-, people load-, ventilation- and venting systems equal to a basic ZEB building has been set up. This building will additionally be used for the following initial simulations.

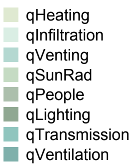


Ill. 2.11: Energy use (kWh/year) in a building placed on ground, surfaces facing outdoor



Ill. 2.12: Energy use (kWh/year) in a building placed in the mountain, facing ground





Ill. 2.13: Energy (kWh/year) comparison between the two different placements of the same building

BUILDING IN A MOUNTAIN

2

DESIGNING OFF GRID INSIDE A MOUNTAIN

Designing an OFF grid building asks for new ways of designing. When no energy will be produced for the building, the complexity increases even further.

By not having energy sources, alternative solutions for the basic functions will be integrated. Taking point of departure in defining the basis needs, it is possible to ”track” the cycle of energy from cradle to grave/cradle for each basic need.

The very first basic need will be to eat. Being able to eat demands food, that has to be stored and cooked. A fridge will be advantageous for storing, but with no electricity it is not possible. By building the fridge outside the thermal envelope into the mountain, the design can achieve a natural fridge with 7 degrees. For cooking a wood stove is used.

For getting water into the building complex, a pump would usually be integrated. Without any use of energy a solution of collecting rainwater in a tank placed further up the mountain can secure water supply without any use of pumps, only by using the inclination of the mountain and gravity. The tap in the kitchen contains a filter that will cleanse the water for drinking. A local delivery will deliver food and whiskey from local suppliers.

After eating, there is garbage left. There will therefore be an integrated system for sorting garbage, in the kitchen. The garbage will be reused for compost. The supplier will deliver the garbage to the tree farm that can use the garbage for compost nourishing the trees the building will use for heating. The same implies for the outcome from the toilet.

For the shower, a design will be made, to dose the water into a tank, that will be heated by a wood stove. In the shower it will be possible to use only natural soap, so the grey water can have a natural outlet. The soap will be made of the ashes from the wood stoves, and will be available in the entire building.

To make it easy for the traveller to travel light, sheets will be available in the building. These will be delivered from a local laundry.

In the entire building, the heating demand will be meet by burning wood in stoves. The supplier will deliver the wood from a tree farm. It will be possible for the traveller to go to the farm to plant a tree.

Burning wood is very sustainable way of heating a building, as the total CO_2 balance reaches zero. The tree will during its life convert CO_2 to O_2. That means, when turning the tree into wood, heating the building by burning wood, the CO_2 outlet that appears, will already have been removed from the balance. For every tree that has been used for heating the building, a new one will be planted. The circle is closed.

As the building uses renewable energy for heating, and there will be produced no electricity, a ventilation system with heat recovery will not been integrated. A natural ventilation strategy will secure a comfortable indoor air quality all year.

The light in the building will be natural, and during night candles and oil lamps will be used.

To reduce the transport of gods to the building, all gods will be collected and delivered a few times a year. The supplier will on his/her way back bring garbage, compost, used sheets, and ashes for the suppliers to reuse.

SUPPLIER	INPUT - SUPPLIANCE	BASIC NEED	OUTPUT	”CARE TAKER”
Local suppliers 7 degree mountain Wood stove Collected rainwater	Food Fridge Stoves for cooking Water	TO EAT	Garbage - - Gray water	Sort the garbage, reuse, compost to own tree farm, pick up by supplier Natural outlet
Collected rainwater Agder Brennri and Arcus AS (Norwegian)	Water Whiskey	TO DRINK	-	-
-	-	TO TOILET	OFF GRID compost toilet	Compost used in own tree farm
Collected rainwater Own tree farm supply	Water Wood for heating	TO SHOWER	Warm grey water	Natural outlet
Local wash and laundry	Sheets	TO SLEEP	Used sheets	Pick up by supplier
Own tree farm Natural drive forces Candles and oillamps by supplier	HEATING Wood COOLING Natural ventilation LIGHTENING Candels and oillamps	COMFORT	Ashes - -	Used to enrich the compost and produce soap for taking a shower - -

Ill. 2.14: Life cycle analysis

PLAN ORGANISTAIONS

Organizing the functions within the mountain causes some issues, regarding orientation and light. You only have one facade where it is possible to create a view, and receive light from. Otherwise the functions will be lit by skylights. This causes a clear direction within the volumes, from the darkest end to the lightest, out towards the view.

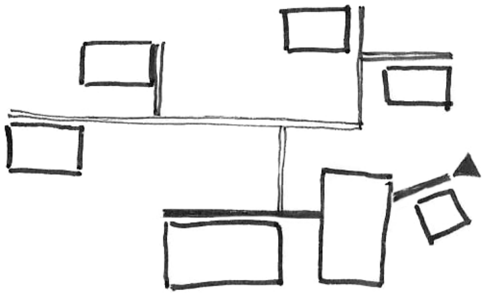
When it is desired to place all main functions towards the same direction, you easily create a long and narrow complex, where corridors will have to connect these. A corridor system therefore became the main concept for connecting the volumes. This creates the possibility for the different volumes to be placed independently from each other.

The corridor, and how it connects the volumes, will therefore function as a main part of the overall organisation of the complex. The bedrooms should be able to accommodate approximately 30 travellers, and to create a more intimate atmosphere within each of these, the rooms have been divided into four smaller cabins. The common functions, kitchen, dining and living room is desired to be placed together, so they will function as a common area where the visitors all can gather. The common functions will be connected by a heated corridor. The corridor that connects the common functions and the rooms will be unheated, and placed within the mountain.

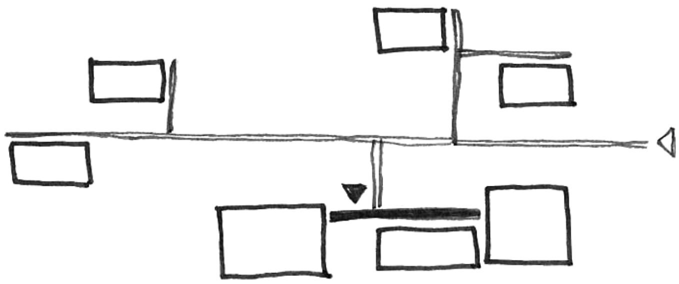
The first proposal, suggest, that you enter directly into the common functions, and you have to walk through these to enter the unheated corridor, that connects to the rooms. This organisation will first reveals the inheated corridor after the visitor have moved through the common functions. The common functions will therefore become partly a hallway, and focus will therefore be removed from their function. The second proposal, have the entrance placed directly into the unheated corridor, and will function as a connecting element for all the volumes. The common functions are divided into three volumes, but will within the facade be perceived as one dominating building, and will therefore differentiate from the volumes containing the rooms. Within the third proposal, the common volumes are connected by a heated corridor, which will make them seem as two separate volumes in the facade.

The entrance, will be through the unheated corridor, making it as a fluent transition, from the natural outside, into the build inside. The unheated corridor will be perceived as a mystical unknown element, that will have to be explored, to make sense, and will seem as a contrast to the defined spaces of the volumes. The corridor will be a dark element only lit with light from skylights, emphasizing the mysterious flow.

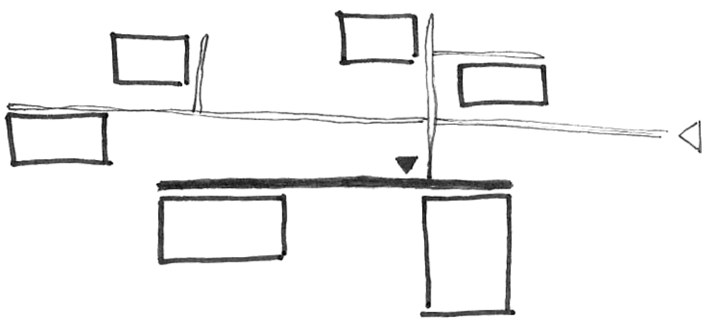
Within this proposal, the kitchen volume will be the dominant, and its proportions will be opposite the other volumes. It will thereby function as a focus point within the façade, and within the volume the direction, will create a more fluent transition between, in and outside. The volumes direction means that the kitchen will be more exposed in terms of how much of the volume will be covered by mountain.



Ill. 2.15: First proposal



Ill. 2.16: Second proposal



Entrance to heated corridor

Entrance to unheated corridor

Heated corridor

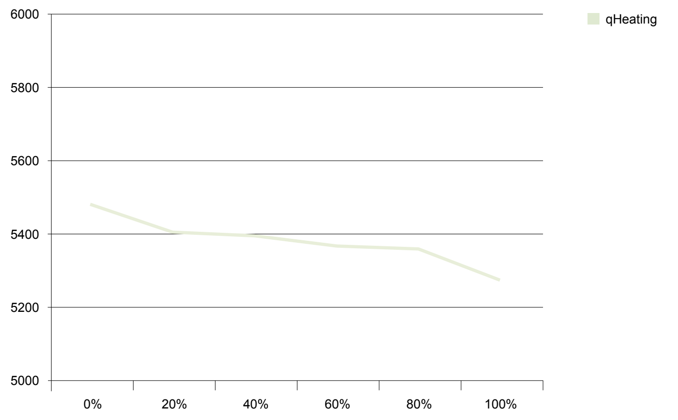
Unheated corridor

Ill. 2.17: Third proposal

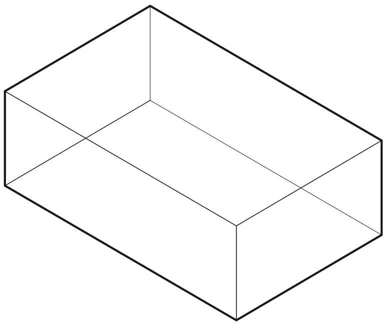
RATIO REVEALED BUILDING

Simulations have been performed to examine the influence of revealing the building through the mountain. By that, different ratios of revealed building, have been examined. See ill. 2.18 and 2.19.

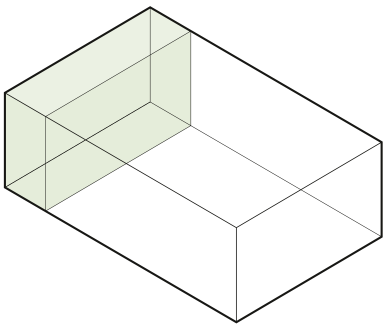
The biggest difference is found in exposing the gables, from 0%-20% and from 80%-100%. Revealing a bigger or smaller area in-between these, only has a small impact. Simulation results is found in appendix, p.48.



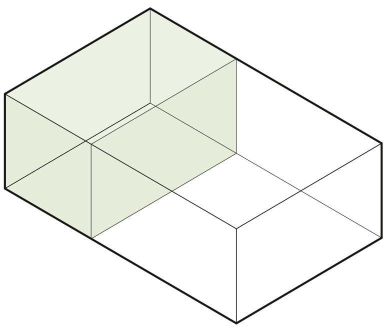
Ill. 2.18: How the different rations of mountain influsences the energy demand (kWh/year)



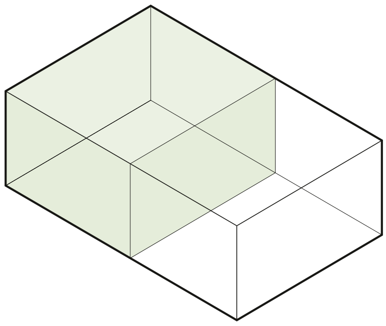
Mountain ratio of 0 %
Heat demand 5487 kWh/year



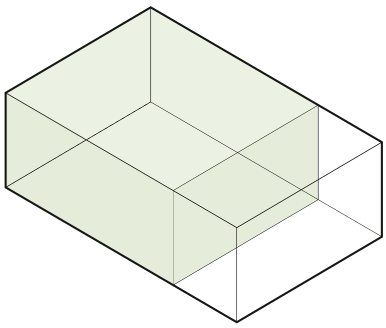
Mountain ratio of 20 %
Heat demand 5411 kWh/year



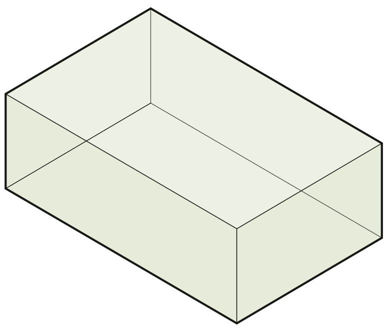
Mountain ratio of 40 %
Heat demand 5401 kWh/year



Mountain ratio of 60 %
Heat demand 5373 kWh/year



Mountain ratio of 80 %
Heat demand 5365 kWh/year



Mountain ratio of 100 %
Heat demand 5279 kWh/year

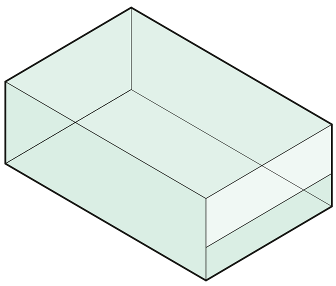
Ill. 2.19: Mountain ratios effect on heat demand

RATIO GLASS AREA

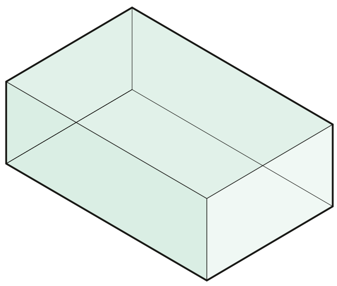
A lot of different parameters have to be considered when dimensioning, the volumes. One of the main parameters is daylight. It is the aim to reach a daylight factor of 200 lux in the kitchen, because it conains the only working station. Following it is examined how the dimensioning of space and placement of windows affect the daylight.

When the window is placed in top of the façade, an acceptable daylight factor of 200 lux is potential in a 6 meters deep room.

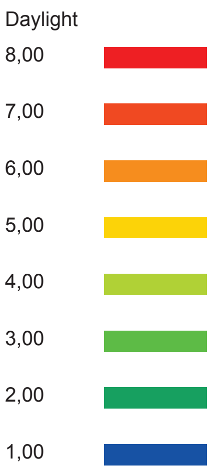
By extending the window from floor to ceiling it is possible to extrude the depth of the room from 6 to 8 meters, maintaining the 200 lux. By supplementing the glass façade with a window in the back of the room, it will be possible to increase the room depth even further. This will make it possible to create a deeper room for the kitchen.

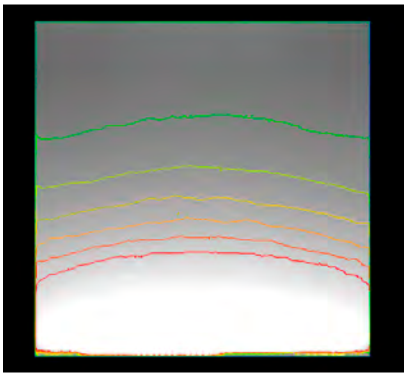


Ill. 2.20: Small window

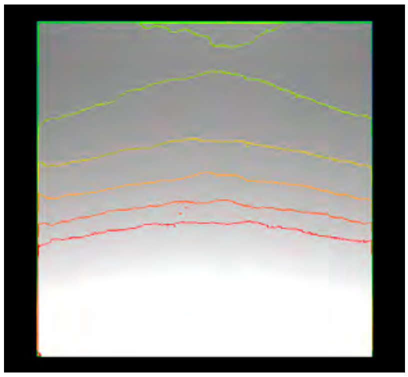


Ill. 2.21: Full window

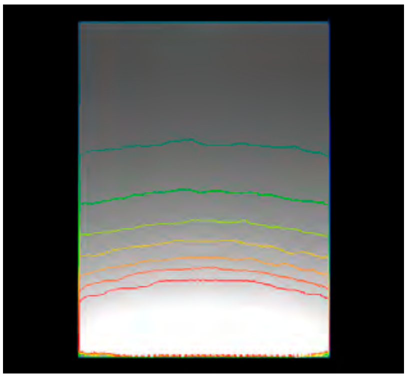




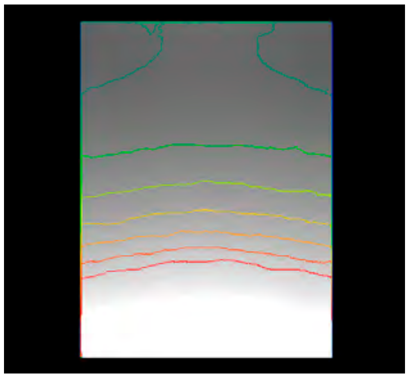
Small window, room proportion 6x6m



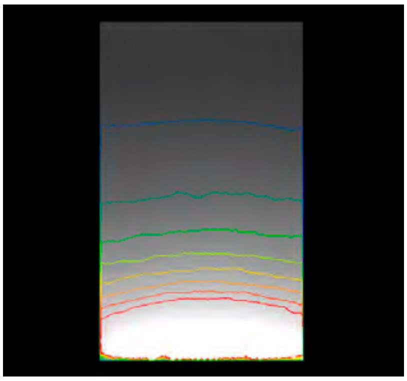
Full window, room proportion 6x6m



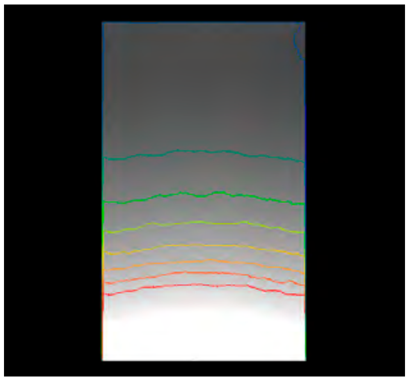
Small window, room proportion 6x8m



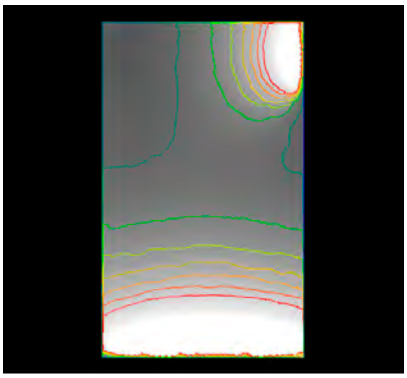
Full window, room proportion 6x8m



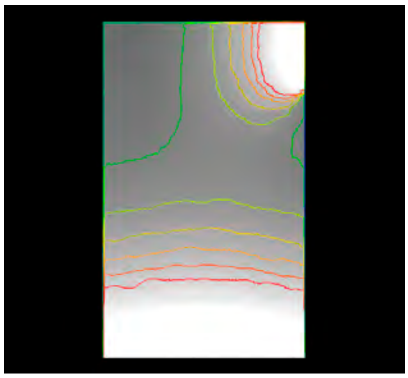
Small window, room proportion 6x10m



Full window, room proportion 6x10m



Small window, room proportion 6x10m, extra window



Full window, room proportion 6x10m, extra window

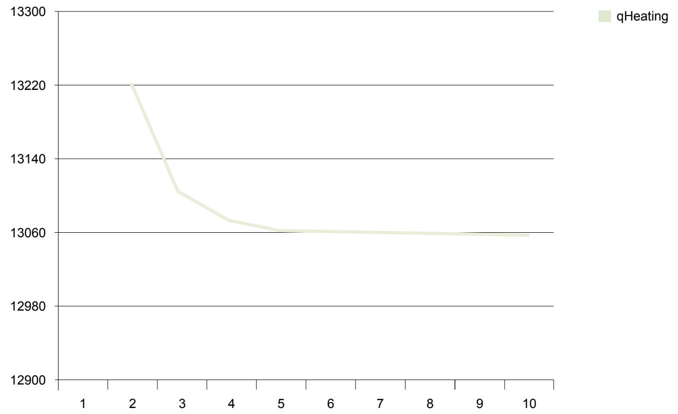
Ill. 2.22: Daylight factor study or two different window designs, made in Velux

MATERIAL STUDIES

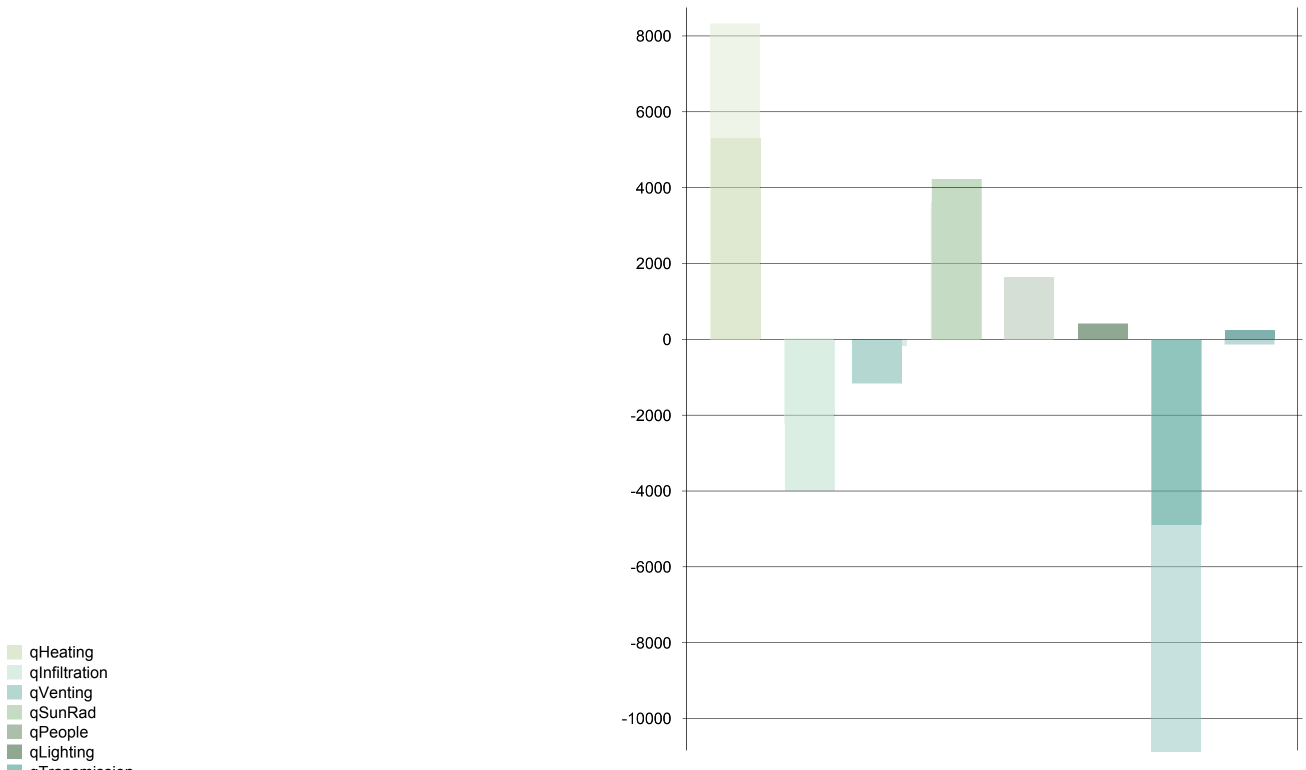
MOUNTAIN AS CONSTRUCTION
When building into the mountain a question very naturally comes op.

Is it possible to use the mountain as construction, and expose the mountain from the inside, like being inside a cave?
Is it possible to use the endless thermal mass of a mountain, as something advantageous in an energy strategy? If the construction is endless thick, and 7 degrees, the question is, whether it is possible to heat the mountain to a certain point, where it will maintain a temperature that can be comfortable? A simulation has been performed in BSim to examine this question.
The simulation shows the point where the heating demands maintain the same level over several years. It will be possible to reach this point of only 5 years. See ill. 2.23. When the balance is meet, the energy use is not as efficient as when insulated from the mountain. See ill. 2.24.

If we want the building to have a comfortable indoor environment, and an energy use that is as low as possible, it is most advantageously to insulate from the mountain. A high-insulated construction is used both inside the mountain and on the revealed constructions. Appendix, p.50.



Ill. 2.23: Energy demand (kWh/year) for the building with mountain as construction. Finding the point in time (years) where the mountain will obtain a constant heat from the building.



Ill. 2.24: Energy balance (kWh/year) comparison between a construction insulated from the mountain and mountain as constrution after 10 years

Ill. 2.25: Two Caves by Manuel Fonseca Gallego

EXPERIENCING THE MOUNTAIN

How do you achieve an atmosphere of being inside a cave, when you cannot see and sense the mountain from the inside of the building? Would it be possible to reveal the inside of the mountain in a design solution?

Would it be possible to expose the mountain in unheated spaces? An unheated shower with warm water, an unheated corridor and an unheated fireplace, both have the possibility of revealing the inside of the mountain, without any obstacles. To make the experience in these spaces, as strong as possible, the design will be organic and natural. To make the experience even greater, the heated spaces will be a contrast to the unheated spaces. The design aims for a clear separation between the heated/unheated, warm/cold, nature/culture.

Sou Fujimotos ”Primitive Future” examine the cave and the nest, as being the very first primal states of architecture. Fujimoto describes the cave, as not being prepared and designed for human. It existed before people. It was naturally created by landscape. The nest as the opposite is designed to fit human perfectly.

Being designed to fit human, makes the nest functional and arranged. The space indicates a certain way of interacting in space - a certain way of living. The space in the cave is unpredictable being characterized by contours and hollows, expansions and contractions – almost being alive. This space is a space to explore. This space is rather heuristic than functional (Fujimoto, S., 2008).

The project aims for a clear separation between heated/unheated, warm/cold, nature/culture – a clear separation between the cave and the nest.

Ill. 2.26: Vacation Home by Peter Zumthor

HEATED AND UNHEATED

This separation between the heated and unheated spaces will be visible in plan and design. The unheated spaces will be designed organic, being almost unplanned and natural, being carved out of the mountain. The heated space will be designed and planned as being functionally relating to human. The heated space will be designed simple and straight, as being something cultural in nature.

The exposed mountain in the unheated spaces will have its own special identity. The temperature will be cold all year around. The material will look rough, something you would not want to touch, but heavy as something that protects you. And the space will have its very own hollow sound.

Different materials have been examined to find the most advantageous for the interior of the heated space. See appendix, p.52.

Pine wood will be used as interior material in the heated space to emphasize the space as being warm. The colour of wood has the quality of reflecting light in warm nuances. Wood as a soft material has the quality of being nice to smell and touch. Wood as a soft material, also has the quality of lowering the reverberation time to promote a good acoustic indoor environment. To make the atmosphere even stronger, wood will be the only material used in all heated spaces. This is possible because most of the wet functions, are placed in the unheated space.

VIEW

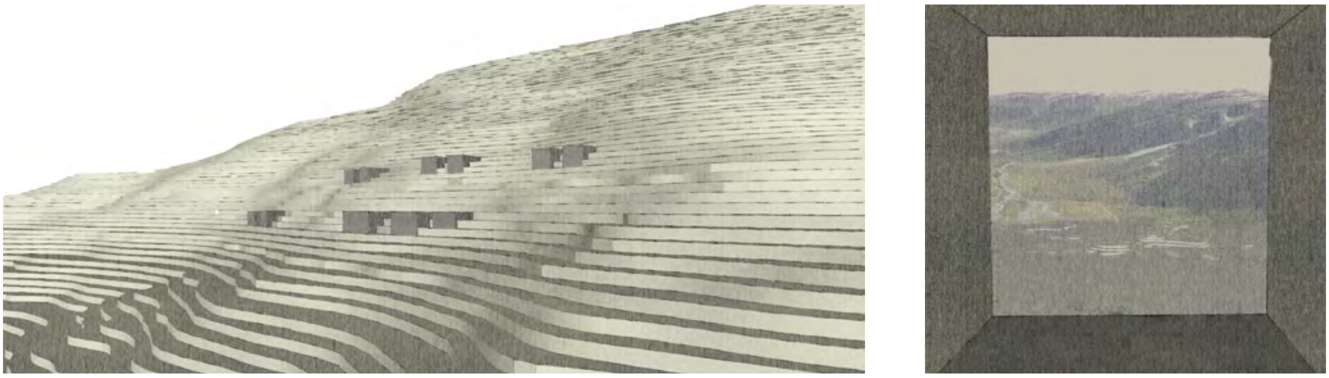
The volumes that will form the cabin complex, will individually be formed as regular spatiality's, that more or less will have their south facade exposed outside of the mountain. Making it the only facade that can contain a view. It is therefore essential how we experience this view, because it will be a dominating element within the spaces. Different suggestions to how the view could be preformed, was therefore made to gain a better understanding of how we experience the view from the inside, and how it integrates within the landscape.

It is desired to have large glass facades, to create a panorama view out towards the valley. The empty spaces within the mountain is enclosed by the entire globe, a infinite and natural mass, that will be experience, as spaceless. The viewpoints will therefore not only provide the travelers with a nice view, and light, but also help them identify their placement, and inhabit the landscape. It helps man to structure his experience of the world, along with his understanding of himself.

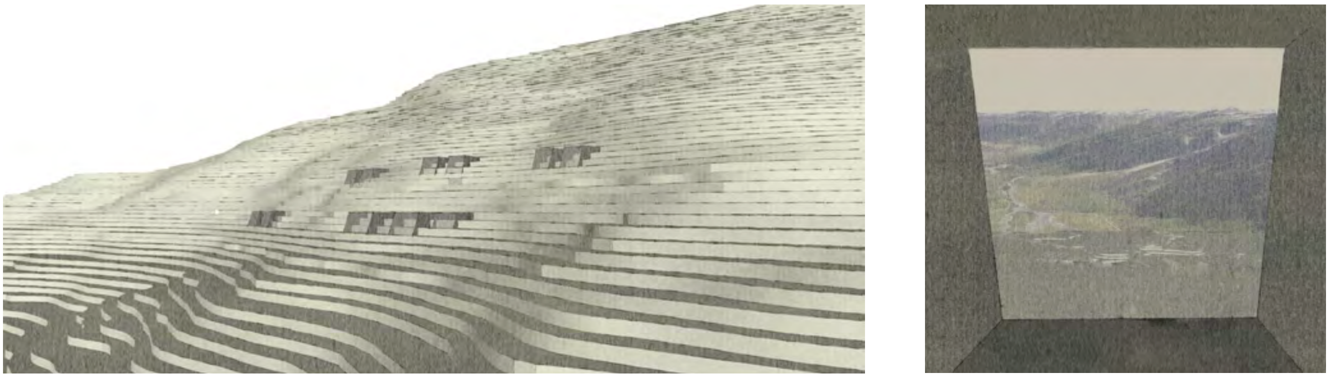
When the traveler walks through the undefined and mysterious corridors within the mountain, he will partly lose his direction and understanding of his oven placement. The view in the volumes will therefore contrast the mountain corridor, by being well defined, and clear about its relation to the landscape.

The pictures shown to the right, illustrates different ways of dimensioning a view, and how the solution will look within the landscape. The solution with the angled window, creates a view, that focuses more upon heaven. Seen in the landscape, the windows will follow the slope of it.
The solution where the glass arches around the facade, creates a more three dimensional experience of the view, where as the rectangular and circled solution, frames the view in two dimensions.

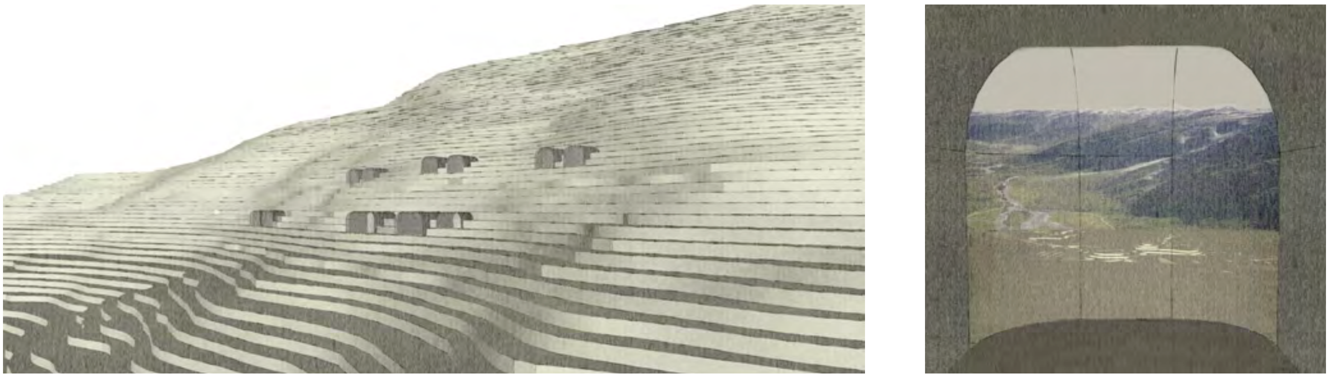
The rectangular window, is preferred, due to its simplicity, where focus is only on the view. This solution can also be modified, and extend around the corners, to achieve a more three dimensional experience, as in illustration 2.29.



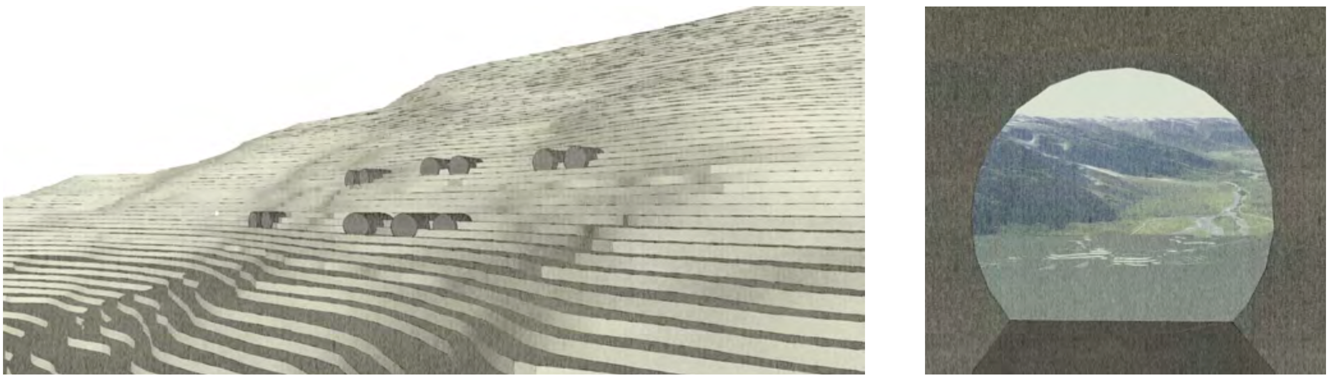
Ill. 2.27: Rectangular view



Ill. 2.28: Angled view



Ill. 2.29: Three dimensional view



Ill. 2.30: Circular view

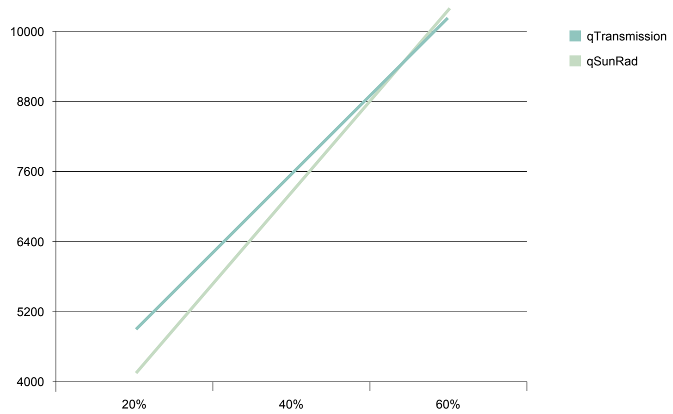
WINDOW RATIO

The window size has to be carefully dimensioned to increase solar gain and decrease heat loss and overheating.

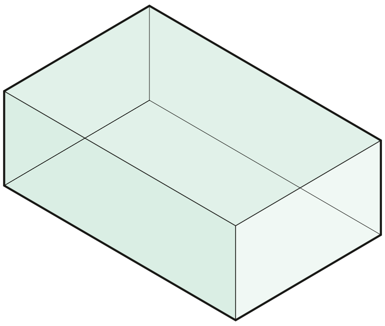
Simulations have been performed to examine the relation between glass area, solar gain and transmission loss. By that different ratios of glass area have been examined. See ill. 2.31.

The bigger the window, the greater solar gain, resulting in a smaller heating demand when the sun is out. But the bigger window area also increase the heating demands, by increasing the transmissin loss.

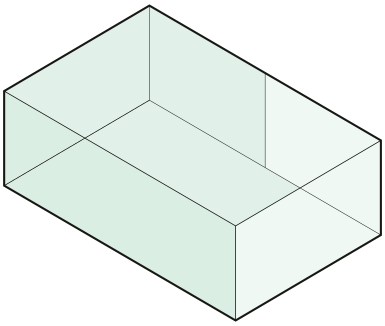
It is aimed to design the glass ratio between 20-40% to increase solar heat gain and decrease the trasmission loss. Simulation results is to be found in appendix, p.54.



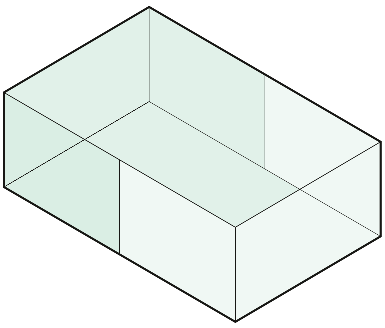
Ill. 2.31: Connection between window ratio and solar gain in the room (kWh/year)



Window ratio of 20 %
Heating demand 5279 kWh/year



Window ratio of 40 %
Heating demand 5525 kWh/year



Window ratio of 60 %
Heating demand 7791 kWh/year

Ill. 2.32: Window ratio effect on heat demand

DECREASING OVERHEATING BY COOLING

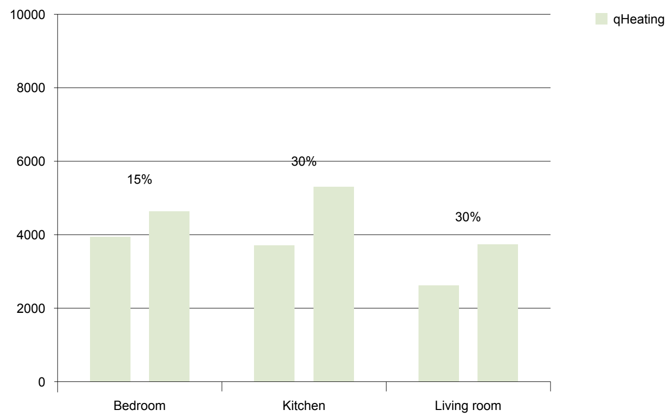
To avoid overheating in periods with a big sun radiation, shading system is often used as a solution. The downside of a shading system, in any kind is that it will interfere with the view. As it is the intention to design big glass areas, to be part of nature, a shading device would be a highly interfering element. In this project it is the aim to avoid being dependent on a shading system. It should still be possible to use a manual interior shading system to secure comfort if problems with glare.

The aim is to design a natural cooling system that can allow an uninterrupted view of nature all time. If the mountain has a constant temperature of 7 degrees, it is assumed that air moving through the corridors inside the mountain, will have a temperature of 7 degrees. Air with a temperature of 7 degrees have the possibility to cool the indoor space when overheated. Air with a temperature of 7 degrees has the possibility to work as a preheated air when the outdoor temperature is cooler.

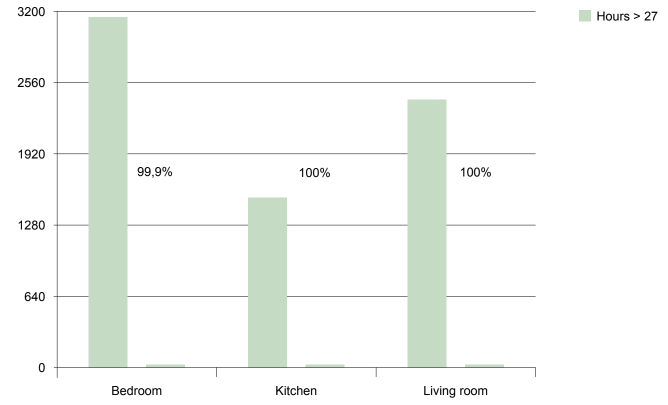
Simulations have been performed to examine the influence of using the 7 degrees air from the mountain as inlet. A ventilation system with an inlet of 7 degrees air has been set in BSim.

The output shows that the solution uses up to 30 % more heating. The solution saves heating in wintertime, but it uses a bit more heating in times, where the outdoor temperature is above 7 degrees. This problem can be avoided by integrating an additional venting strategy, for times when the outdoor temperature is above 7 degrees.

The solution decreases overheating with 100%. Appendix, p.56.



Ill. 2.33: The cooling systems effect on heating demand (kWh/year) before and after applying cooling system



Ill. 2.34: The cooling systems effect on overheating, hours > 27 degrees before and after applying cooling system

LIGHT

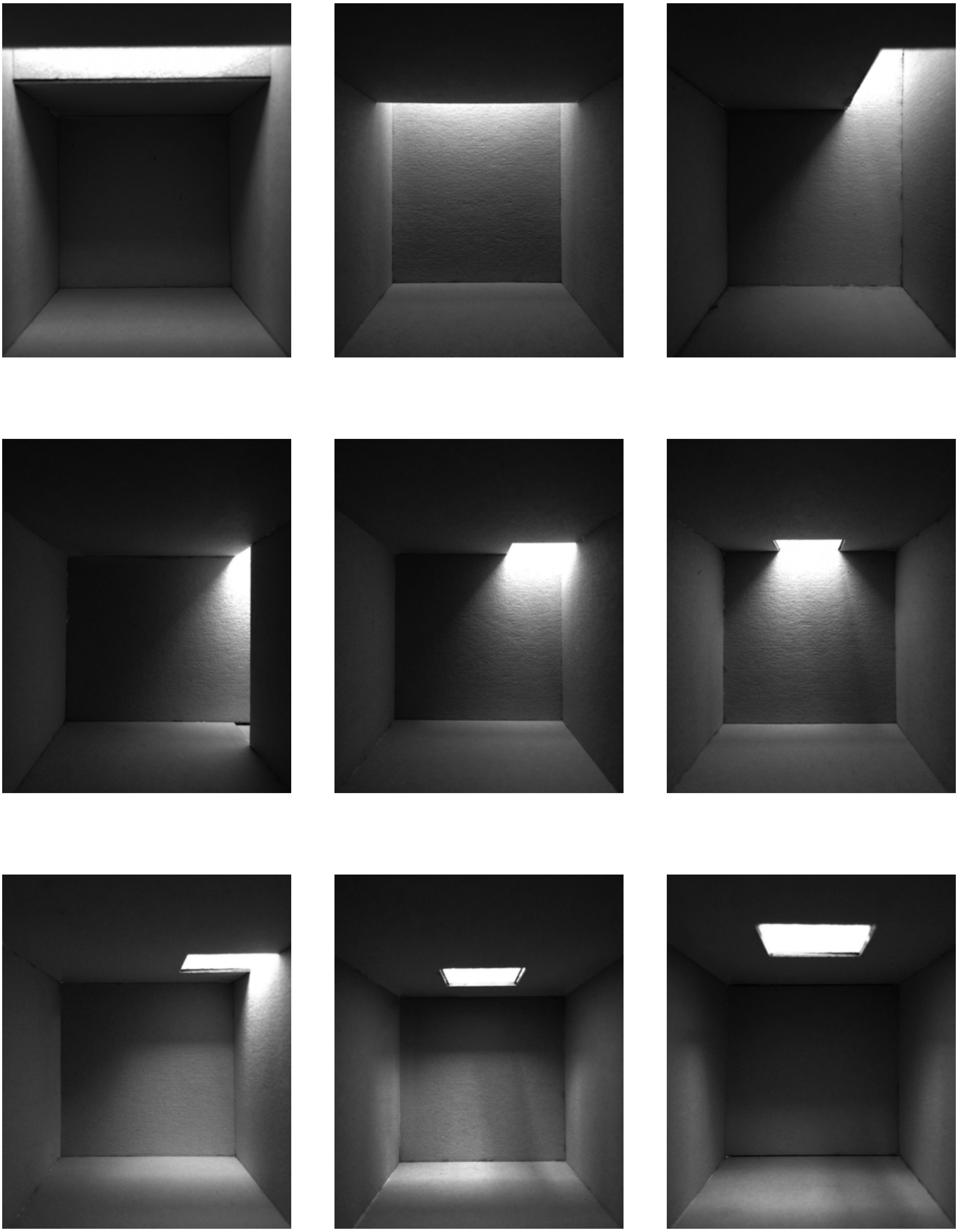
By building into the mountain, it is only possible to receive daylight, from the only facade towards south. This creates some challenges, concerning the depth of the rooms, and rooms that don't need a view. These rooms, will therefore be provided with skylights, in order to obtain the desired daylight amount within each room.

Several models was therefore made, in order to evaluate the effect of different kinds of skylights. Seen from the pictures, the skylights that are in direct contact with a wall element, creates a different light, where focus in upon lighting the surface, instead of lighting the room.

The skylights that are in connection with a surface, also creates a more defined light, with a more defined shadow/light markings. This creates a more dramatic light, whereas the skylight placed in the middle of the ceiling spreads a more defuse light.

Depending on the function of the room, each solution can be chosen. The first one conveys a more light atmosphere, and can maybe be used, if the atmosphere of the function matches. The second is more dramatic, and focuses, not only on light but also the darkness, which can create a more safe and protected atmosphere.

The skylights will further be used within the mountain corridor, to provide the otherwise totally enclosed space with light. The mountain corridor is intended as a outdoor natural path system, where the traveler can sense being outside. The openings must therefore be without glass, to allow fresh air to flow through the space. To prevent rocks that can fall down along the mountain, to end up within the corridor, concrete elements will rise up from the corridor and up above the landscape, providing the corridor with light, and also preventing rocks, within the corridor.



Ill. 2.35: Different configurations of skylights

ROOM	MAX AIRCHANGE PR HOUR	OPENING SIZE
Kitchen	4	0,15 m2
Livingroom	4,2	0,2 m2
Bedroom	4,5	0,2 m2

Dimensioning openings for venting

VENTILATION

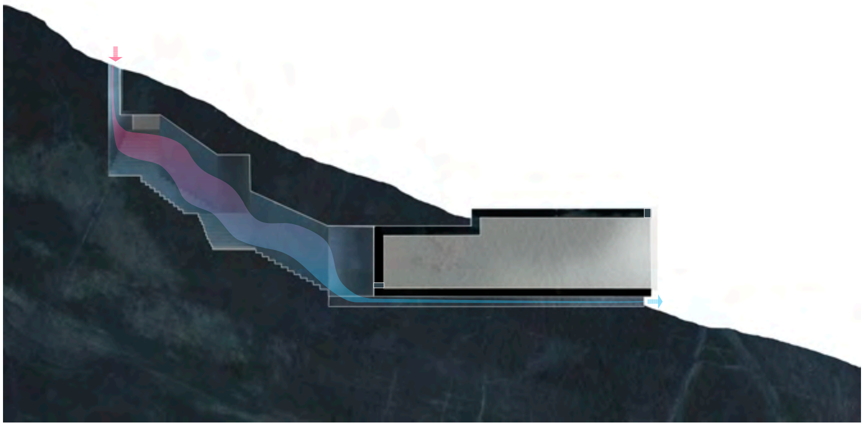
Building the entire complex into the mountain, raises some questions whether the specific conditions can be utilized for a ventilation strategy.

The arrangement offers a great height difference for the corridor to ventilate naturally by thermal buoyancy. In the lower part of the corridor an opening to the outside will be made in the bottom. In the higher part of the corridor the opening in the top will be used in the ventilation strategy. The internal temperature of 7 degrees will secure an airflow created by thermal buoyancy all year around. In winter time the airflow will be upward in summer time the airflow will be downward. See ill 2.36-2.38.

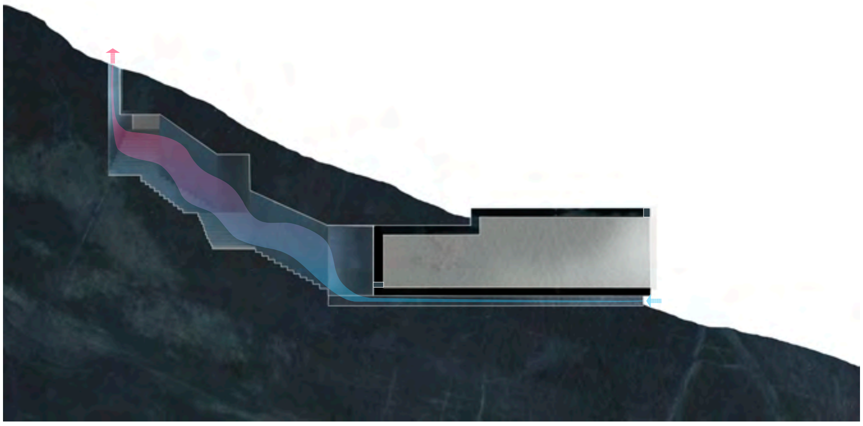
When a constant airchange is secured in the corridor, the air inside the corridor is considered as non-polluted air. From here it is possible to have inlet to the heated building. With an indoor temperature higher than both the outdoor temperature and the temperature in the corridor, it is possible, to create thermal buoyancy. In the bottom of the room, an opening facing the unheated corridor will work as inlet. In the front of the room an opening placed in the ceiling will work as outlet. See illustrations. The venting is secured in both winter and summer.

In BSim the venting has been set as a ventilation system. By that it is possible to control the inlet temperature. After running the simulation it is possible to read the maximum air change rate that is needed to secure both thermal and atmospherically comfort.

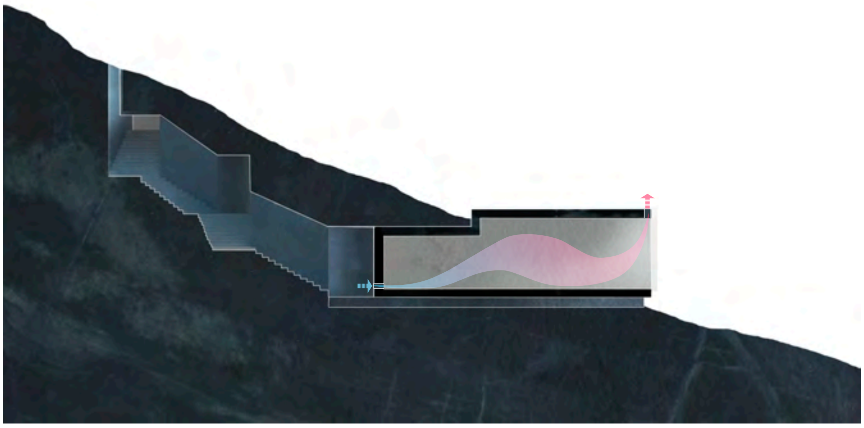
The excel-sheet for natural ventilation is used to dimension the openings in the different volumes according to the maximum air change rate. If dimensioned according to this, it is possible to decrease the openings to decrease the air change for example in wintertime. The excel-sheets are to be found at the CD.



Ill. 2.36: Corridor venting strategy winter



Ill. 2.37: Corridor venting strategy summer



Ill. 2.38: Building venting strategy summer and winter

EPILOUQUE

3

REFERENCES

LITTERATURE

Carter, A. Botin,L. Tyrrell, R. (2013) Dwelling, Landscape, Aalborg University Press, p. 179

Fujimoto, S. (2008) Primitive future, Inax, Japan

Pallasmaa, J. (2013) Dwelling, Landscape, Place and Making Adrian Carter, Lars Botin and Roger, Tyrrell. Aalborg University Press, p. 179

Plato (1957): "The state" book 7 - the Cave parable, Museum Tusculanums Press, Translation: Louise Olesen Kragh, p. 279 – 280

WEBPAGES

Cultural Studies now - Heidegger's concept of "fourfold" in "Building Dwelling Thinking" (2011) Available: http://culturalstudiesnow.blogspot.dk/2011/05/heideggers-concept-of-fourfold-in.html (Accessed: 2/5 2015)

ILLUSTRATIONS

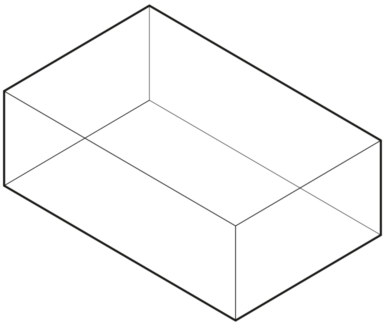
Ill. 2.25: http://www.landezine.com/index.php/2011/10/cave-landscape-architecture/

Ill. 2.26: http://zumthorferienhaeuser.ch/wp-content/uploads/2012/09/leis-_021-1600x1066.jpg

APPENDIX

4

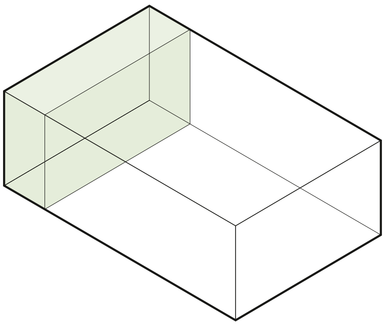
PLAN ORGANIZATIONS



2015 | Month | Hours | ThermalZone306

ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	5487.03	757.63	662.47	583.00	372.44	286.85	190.16	165.86	198.45	320.04	451.59	675.94	816.02
qCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qInfiltration	-4011.23	-446.03	-419.35	-436.62	-385.01	-286.45	-223.10	-188.06	-193.21	-249.03	-341.20	-397.10	-427.06
qVenting	-1254.35	0.00	0.00	0.00	0.00	-306.61	-286.25	-269.57	-246.37	-143.54	0.00	0.00	0.00
qSunRad	4130.98	85.89	192.44	330.39	491.92	642.12	593.52	557.71	509.18	362.36	299.36	100.45	34.02
qPeople	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qEquipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qLighting	387.50	64.90	39.40	23.50	15.40	16.50	15.00	15.50	15.90	19.80	35.50	57.30	69.90
qTransmissi	-5017.16	-519.77	-526.01	-550.60	-479.54	-351.51	-278.35	-258.39	-262.57	-321.03	-434.20	-486.97	-548.30
qMixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qVentilation	209.31	79.69	51.06	36.44	-15.22	12.69	-0.97	-11.85	-16.29	10.01	-11.45	40.57	54.67
Sum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
tOutdoor me	6.7	1.8	0.9	2.9	4.9	8.6	11.7	13.3	13.5	10.7	7.2	3.9	2.5
tOp mean(°C	22.6	22.1	22.4	22.7	23.5	22.8	22.8	22.9	23.1	22.3	22.9	22.1	22.0
AirChange/	1.8	1.5	1.5	1.5	1.5	2.2	2.4	2.4	2.4	1.9	1.5	1.5	1.5
Rel. Moistur	30.1	24.5	21.8	19.9	22.9	29.6	36.4	42.7	40.7	41.2	30.9	26.8	24.3
Co2(ppm)	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0
PAQ(-)	0.5	0.6	0.6	0.6	0.6	0.5	0.4	0.3	0.3	0.4	0.5	0.6	0.6
Hours > 21	8760	744	672	744	720	744	720	744	744	720	744	720	744
Hours > 27	341	4	27	40	85	10	27	34	56	0	59	3	0
Hours > 28	260	0	15	32	60	1	27	25	49	0	47	2	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	913.54	77.59	70.08	77.59	75.09	77.59	75.09	77.59	77.59	75.09	77.59	75.09	77.59
HRec	4995.15	568.51	535.40	554.70	482.10	365.03	266.59	233.05	229.62	304.46	423.20	488.60	540.00
CRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HCoil	3429.35	429.08	389.50	293.61	295.10	242.97	171.46	140.56	140.53	190.12	250.90	254.59	404.44
CCoil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Humidif	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorHeat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorCool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

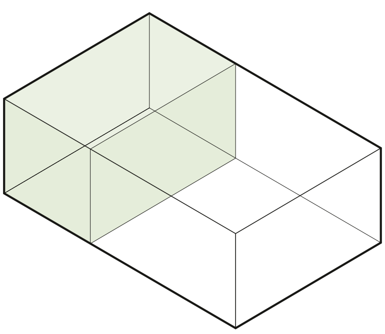
Ill. 2.39: Mountain ratio of 0 %



2015 | Month | Hours | ThermalZone306

ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	5411.20	735.16	636.54	567.89	305.90	295.02	201.21	180.96	211.73	326.56	446.03	686.42	707.72
qCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qInfiltration	-4017.35	-447.97	-419.40	-437.34	-386.04	-297.71	-224.14	-198.98	-198.97	-249.44	-341.77	-397.09	-426.61
qVenting	-1229.18	0.00	0.00	0.00	0.00	-305.97	-279.40	-262.06	-239.39	-142.37	0.00	0.00	0.00
qSunRad	4196.98	85.85	192.44	338.39	491.92	642.12	593.52	557.71	509.18	363.36	298.36	100.45	34.82
qPeople	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qEquipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qLighting	387.50	64.80	39.40	23.50	15.40	16.50	15.00	15.50	15.90	19.80	35.50	57.30	68.90
qTransmissi	-4946.94	-497.42	-499.82	-527.65	-469.80	-358.96	-293.20	-278.37	-280.06	-326.18	-426.41	-467.72	-521.36
qMixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qVentilation	195.81	59.74	50.85	36.22	-17.47	10.00	-2.99	-13.77	-17.50	8.27	-12.71	40.66	55.62
Sum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
tOutdoor me	6.7	1.8	0.9	2.3	4.9	8.6	11.7	13.3	13.5	10.2	7.2	3.9	2.5
tOp mean(°C	22.6	22.1	22.4	22.7	23.6	22.6	22.7	22.9	23.1	22.3	23.0	22.1	22.0
AirChange/	1.8	1.5	1.5	1.5	1.5	2.2	2.4	2.4	2.3	1.8	1.5	1.5	1.5
Rel. Moistur	30.1	24.3	22.0	19.9	22.8	29.5	36.3	42.6	40.5	41.1	30.9	26.6	24.3
Co2(ppm)	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0
PAQ(-)	0.5	0.6	0.6	0.6	0.6	0.5	0.4	0.3	0.3	0.4	0.5	0.6	0.6
Hours > 21	8760	744	672	744	720	744	720	744	744	720	744	720	744
Hours > 27	340	4	25	41	85	8	27	31	56	0	60	3	0
Hours > 28	280	2	16	34	69	1	20	24	44	0	47	3	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	913.54	77.59	70.08	77.59	75.09	77.59	75.09	77.59	77.59	75.09	77.59	75.09	77.59
HRec	5003.77	569.53	535.67	555.54	484.44	367.50	267.92	234.13	230.51	305.54	423.90	488.59	540.36
CRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HCoil	3420.77	429.07	388.30	292.79	293.83	241.36	170.12	139.42	139.05	198.04	250.25	255.01	404.96
CCoil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Humidif	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorHeat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorCool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

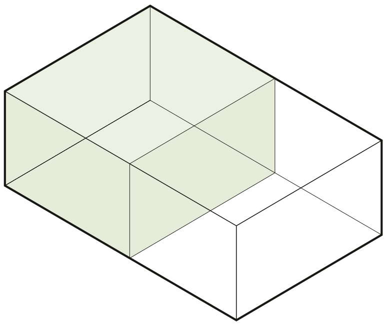
Ill. 2.40: Mountain ratio of 20 %



2015 | Month | Hours | ThermalZone306

ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	5407.46	727.86	630.69	563.32	365.37	299.14	205.34	185.96	215.83	329.07	446.32	682.28	781.29
qCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qInfiltration	-4017.56	-447.33	-413.43	-437.43	-386.17	-257.80	-224.13	-193.93	-193.80	-249.50	-341.86	-397.08	-426.54
qVenting	-1222.24	0.00	0.00	0.00	0.00	-305.16	-277.67	-259.50	-237.37	-142.19	0.00	0.00	0.00
qSunRad	4190.36	85.89	192.44	330.39	491.92	642.12	593.52	557.71	509.10	363.36	299.36	100.45	34.82
qPeople	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qEquipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qLighting	387.50	64.80	39.40	23.50	15.40	15.50	15.00	15.50	15.30	19.80	38.50	57.30	59.90
qTransmissi	-4943.15	-490.27	-493.80	-522.82	-408.78	-363.59	-289.12	-285.50	-286.38	-328.67	-425.40	-463.60	-515.14
qMixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qVentilation	195.14	53.83	50.79	35.03	-17.74	9.92	-2.59	-13.79	-17.36	0.14	-12.91	40.67	55.67
Sum	-0.00	0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00
tOutdoor me	6.7	1.8	0.9	2.3	4.9	8.6	11.7	13.3	13.5	10.2	7.2	3.9	2.5
tOp mean(°C	22.6	22.1	22.4	22.7	23.6	22.6	22.7	22.9	23.1	22.3	23.0	22.1	22.0
AirChange/	1.8	1.5	1.5	1.5	1.5	2.2	2.4	2.4	2.3	1.9	1.5	1.5	1.5
Rel. Moistur	30.1	24.4	22.0	19.9	22.8	29.5	36.3	42.5	40.5	41.1	30.8	26.6	24.3
Co2(ppm)	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0
PAQ(-)	0.5	0.6	0.6	0.6	0.6	0.5	0.4	0.3	0.3	0.4	0.5	0.6	0.6
Hours > 21	8760	744	672	744	720	744	720	744	744	720	744	720	744
Hours > 27	342	6	25	41	85	8	27	31	56	0	59	3	0
Hours > 28	261	2	16	34	68	1	20	24	44	0	48	3	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	913.54	77.59	70.08	77.59	75.09	77.59	75.09	77.59	77.59	75.09	77.59	75.09	77.59
HRec	5004.29	569.47	535.72	556.68	484.56	367.64	267.97	234.23	230.53	305.62	434.06	488.58	540.28
CRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HCoil	3420.36	429.13	388.29	292.86	293.72	241.16	170.08	138.38	138.62	197.56	258.22	356.01	408.08
CCoil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Humidif	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorHeat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorCool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

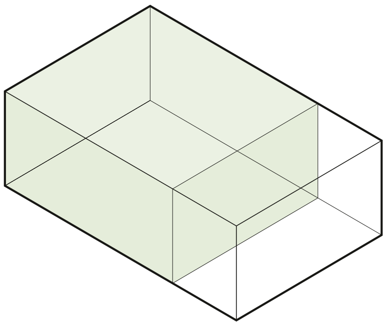
Ill. 2.41: Mountain ratio of 40 %



2015 | Month | Hours | ThermalZone336

ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	5373,61	706,05	613,17	549,93	363,74	311,34	217,92	201,39	228,33	306,60	443,38	629,80	761,96
qCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qInfiltration	-4019,26	-447,65	-419,58	-437,79	-366,65	-298,09	-224,19	-200,07	-199,63	-249,71	-347,25	-387,11	-426,35
qVenting	-1202,32	0,00	0,00	0,00	0,00	-302,90	-272,33	-253,71	-231,59	-141,77	0,00	0,00	0,00
qSunRad	4158,96	65,89	192,44	338,39	491,92	642,12	583,52	557,71	509,18	363,36	295,36	100,45	34,82
qPeople	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qEquipment	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qLighting	387,50	64,60	39,40	23,50	15,40	15,50	15,00	15,50	15,90	19,90	35,50	57,30	69,90
qTransmissi	-4930,23	-463,69	-475,88	-508,29	-465,67	-377,16	-316,80	-306,85	-305,15	-336,00	-422,28	-451,07	-496,35
qMixing	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qVentilation	191,74	59,39	50,46	34,25	-10,75	9,19	-2,11	-12,96	-17,03	7,72	-13,71	40,63	56,06
Sum	-0,00	-0,00	0,00	-0,00	-0,00	-0,00	-0,00	-0,00	0,00	-0,00	0,00	0,00	-0,00
tOutdoor me	6,7	1,8	0,9	2,5	4,8	8,6	11,7	13,3	13,5	10,2	7,2	3,6	2,5
tOp mean(°C	22,6	22,1	22,4	22,7	23,6	22,6	22,7	22,8	23,0	22,3	23,0	22,1	22,0
AirChange/	1,9	1,5	1,5	1,7	1,5	2,2	2,4	2,4	2,3	1,8	1,5	1,5	1,5
Rel. Moistur	30,0	24,5	22,0	19,9	22,8	29,4	36,2	42,5	40,5	41,0	30,8	26,6	24,4
Co2(ppm)	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0
PAQ(-)	0,5	0,6	0,6	0,6	0,6	0,5	0,4	0,3	0,3	0,4	0,5	0,6	0,6
Hours > 21	8760	744	672	744	720	744	720	744	744	720	744	720	744
Hours > 27	342	6	25	42	85	10	26	30	55	0	60	3	0
Hours > 28	257	3	18	34	69	0	20	23	42	0	49	3	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	913,54	77,59	70,08	77,59	75,09	77,59	75,09	77,59	77,59	75,09	77,59	75,09	77,59
HtRec	5006,51	569,38	535,35	556,14	484,59	360,00	268,14	234,43	230,63	305,88	424,34	488,61	540,01
ClRec	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HtCoil	3418,04	429,22	288,03	282,17	258,89	240,88	163,20	139,10	139,52	197,70	257,30	354,35	405,31
ClCoil	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Humidif	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorHeat	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorCool	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

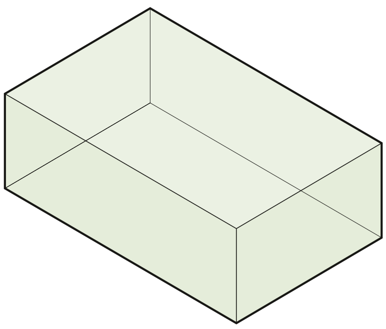
Ill. 2.42: Mountain ratio of 60 %



2015 | Month | Hours | ThermalZone336

ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	5365,39	698,02	607,47	545,59	363,29	315,49	222,20	206,01	232,67	339,16	442,32	635,71	755,46
qCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qInfiltration	-4012,80	-447,02	-413,60	-437,34	-306,93	-290,21	-224,22	-200,09	-199,60	-249,70	-342,43	-387,12	-426,26
qVenting	-1195,01	0,00	0,00	0,00	0,00	-302,13	-270,59	-251,79	-223,75	-141,64	0,00	0,00	0,00
qSunRad	4192,96	65,60	192,44	338,39	491,92	642,12	583,52	557,71	509,10	363,36	298,36	100,45	34,02
qPeople	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qEquipment	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qLighting	387,50	64,60	39,40	23,50	15,40	15,50	15,00	16,50	15,90	19,00	35,50	57,30	69,90
qTransmissi	-4926,15	-461,54	-468,95	-503,48	-464,63	-381,70	-322,70	-313,93	-311,41	-338,46	-421,26	-446,92	-490,17
qMixing	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qVentilation	190,20	60,04	50,30	33,93	-19,15	8,94	-3,19	-14,01	-16,97	7,56	-14,09	40,59	56,25
Sum	0,00	0,00	0,00	0,00	0,00	0,00	-0,00	0,00	0,00	0,00	0,00	0,00	0,00
tOutdoor me	6,7	1,8	0,9	2,3	4,9	8,6	11,7	13,3	13,5	10,2	7,2	3,9	2,5
tOp mean(°C	22,8	22,1	22,4	22,7	23,6	22,6	22,7	22,8	23,0	22,3	23,0	22,1	22,0
AirChange/	1,8	1,5	1,5	1,5	1,5	2,2	2,4	2,4	2,3	1,8	1,5	1,5	1,5
Rel. Moistur	30,0	24,6	22,0	19,8	22,7	29,4	36,2	42,5	40,5	41,0	30,8	26,6	24,4
Co2(ppm)	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0
PAQ(-)	0,5	0,6	0,6	0,6	0,6	0,5	0,4	0,3	0,3	0,4	0,5	0,6	0,6
Hours > 21	8760	744	672	744	720	744	720	744	744	720	744	720	744
Hours > 27	344	6	25	43	86	10	26	30	54	0	60	4	0
Hours > 28	254	3	19	34	71	0	20	23	42	0	49	3	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	913,54	77,59	70,08	77,59	75,09	77,59	75,09	77,59	77,59	75,09	77,59	75,09	77,59
HtRec	5007,46	569,35	536,08	556,35	485,14	360,16	268,21	234,49	230,69	305,50	424,45	490,64	520,09
ClRec	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HtCoil	3417,09	429,25	387,91	391,96	293,13	240,64	169,03	139,13	139,47	197,60	257,70	354,95	405,43
ClCoil	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Humidif	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorHeat	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorCool	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Ill. 2.43: Mountain ratio of 80 %



2015 | Month | Hours | ThermalZone336

ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	5279,69	654,70	500,20	523,33	356,12	327,73	236,09	225,32	248,55	346,89	435,71	616,55	727,62
qCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qInfiltration	-4000,48	-446,22	-418,63	-437,07	-386,06	-297,06	-223,18	-199,20	-198,66	-249,30	-341,80	-386,24	-425,18
qVenting	-1175,02	0,00	0,00	0,00	0,00	-300,25	-285,45	-245,19	-223,59	-141,35	0,00	0,00	0,00
qSunRad	4158,56	85,28	192,44	330,39	491,92	642,12	580,52	557,71	509,10	362,36	299,36	100,45	34,02
qPeople	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qEquipment	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qLighting	387,44	64,60	39,40	23,46	15,40	15,50	16,00	15,50	15,90	19,80	35,48	57,20	69,90
qTransmissi	-4897,04	-472,54	-446,03	-484,03	-459,96	-399,43	-345,77	-341,75	-336,35	-348,03	-416,68	-430,62	-465,85
qMixing	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qVentilation	215,25	67,50	52,61	35,89	-17,43	11,40	-1,00	-12,37	-15,03	8,63	-12,27	42,58	58,69
Sum	0,00	-0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,00	0,00	0,00	-0,00
tOutdoor me	6,7	1,8	0,9	2,3	4,9	8,6	11,7	13,3	13,5	10,2	7,2	3,9	2,5
tOp mean(°C	22,6	22,1	22,5	22,8	23,6	22,6	22,7	22,8	23,0	22,3	23,0	22,1	22,0
AirChange/	1,8	1,5	1,5	1,5	1,5	2,2	2,3	2,4	2,3	1,9	1,5	1,5	1,5
Rel. Moistur	30,2	25,3	22,1	19,6	22,8	29,4	36,2	42,5	40,5	41,0	30,9	26,7	24,5
Co2(ppm)	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0
PAQ(-)	0,5	0,6	0,6	0,6	0,6	0,5	0,4	0,3	0,3	0,4	0,5	0,6	0,6
Hours > 21	8760	744	672	744	720	744	720	744	744	720	744	720	744
Hours > 27	337	5	25	44	87	8	24	28	53	0	60	3	0
Hours > 28	262	2	16	37	70	0	19	23	41	0	51	3	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	913,54	77,59	70,08	77,59	75,09	77,59	75,09	77,59	77,59	75,09	77,59	75,09	77,59
HtRec	4993,74	567,11	534,53	555,09	494,39	396,89	287,22	230,90	230,15	305,31	423,68	497,34	538,31
ClRec	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HtCoil	3430,01	431,49	379,45	383,22	253,09	242,11	170,02	139,72	140,00	196,27	250,50	356,25	407,01
ClCoil	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Humidif	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorHeat	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorCool	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Ill. 2.44: Mountain ratio of 100 %

MOUNTAIN AS CONSTRUCTION

2015 | Month | Hours | ThermalZone336

ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	12931.42	1555.61	1241.60	1249.60	1005.57	815.05	683.24	634.37	705.56	950.41	1164.50	1300.07	1532.51
qCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qInfiltration	-4092.58	-464.06	-426.40	-440.19	-372.30	-307.32	-230.04	-203.61	-198.85	-263.25	-340.54	-402.12	-443.90
qVenting	-5.72	0.00	0.00	0.00	0.00	-1.59	-1.02	-2.06	-1.04	0.00	0.00	0.00	0.00
qSunRad	4198.56	85.69	192.44	338.29	491.92	642.12	593.52	557.71	509.18	363.36	259.36	100.45	34.02
qPeople	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qEquipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qLighting	388.30	64.80	39.50	23.70	15.40	15.50	15.00	15.50	15.90	19.60	36.00	57.30	69.90
qTransmissi	-13514.47	-1267.30	-1093.19	-1201.02	-1151.83	-1153.48	-1025.06	-1040.23	-1018.66	-1049.79	-1148.99	-1151.16	-1211.74
qMixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qVentilation	34.09	25.26	25.85	29.25	11.24	-10.32	-15.63	-21.88	-16.09	-20.52	-10.33	8.66	18.41
Sum	0.00	0.00	-0.00	-0.00	0.00	-0.00	-0.00	0.00	-0.00	0.00	0.00	-0.00	0.00
tOutdoor me	6.7	1.8	0.9	2.3	4.8	8.6	11.7	13.3	13.5	10.2	7.2	3.9	2.5
tOp mean(°C	22.0	22.0	22.0	22.0	22.0	22.1	22.1	22.1	22.1	22.0	22.0	22.0	22.0
AirChange/	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Rel. Moistur	29.4	21.5	21.0	19.2	23.3	29.6	36.2	43.3	41.4	39.7	30.3	25.0	23.1
Co2(ppm)	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0
PAQ(-)	0.5	0.6	0.6	0.6	0.6	0.5	0.4	0.3	0.3	0.3	0.5	0.6	0.6
Hours > 21	8760	744	672	744	720	744	720	744	744	720	744	720	744
Hours > 27	0	0	0	0	0	0	0	0	0	0	0	0	0
Hours > 28	0	0	0	0	0	0	0	0	0	0	0	0	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	913.54	77.59	70.08	77.59	75.09	77.59	75.09	77.59	77.59	75.09	77.59	75.09	77.59
HRec	5134.21	591.66	549.17	559.06	468.33	380.60	281.02	245.42	241.69	323.53	424.64	508.96	564.13
CRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HtCoil	3230.34	406.94	388.81	309.25	309.96	228.70	157.92	128.20	120.46	100.05	257.63	334.63	381.19
CCoil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Humidif	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorHeat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorCool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Ill. 2.45: Mountain as construction after 1 year

2016 | Month | Hours | ThermalZone336

ThermalZon	Sum/Mean	1 (31 days)	2 (29 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	13234.03	1541.84	1370.75	1330.24	1052.45	840.88	604.59	696.46	704.60	941.58	1153.45	1377.50	1521.21
qCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qInfiltration	-4112.52	-464.03	-442.66	-441.35	-373.41	-308.04	-230.33	-203.96	-198.94	-262.10	-340.37	-401.50	-443.71
qVenting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qSunRad	4209.14	85.69	202.70	326.00	488.10	530.58	502.35	559.40	511.49	365.84	301.17	101.59	35.20
qPeople	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qEquipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qLighting	389.10	64.80	40.60	23.70	15.40	15.60	15.00	15.50	15.90	19.00	35.90	57.10	69.90
qTransmissi	-13742.59	-1253.47	-1211.41	-1273.32	-1182.48	-1175.08	-1045.79	-1045.32	-1015.76	-1044.07	-1140.19	-1143.40	-1201.31
qMixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qVentilation	22.94	25.23	32.39	25.46	8.88	-11.94	-16.36	-22.18	-16.28	-20.37	-9.97	9.06	19.83
Sum	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00
tOutdoor me	6.7	1.8	1.0	2.3	4.9	8.6	11.7	13.3	13.5	10.2	7.2	3.9	2.5
tOp mean(°C	22.0	22.0	22.0	22.0	22.0	22.1	22.1	22.1	22.1	22.0	22.0	22.0	22.0
AirChange/	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Rel. Moistur	29.4	21.5	20.9	19.1	23.2	29.3	36.2	43.3	41.4	39.7	30.3	25.0	23.1
Co2(ppm)	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0
PAQ(-)	0.5	0.6	0.6	0.6	0.6	0.5	0.4	0.3	0.3	0.3	0.5	0.6	0.6
Hours > 21	8784	744	696	744	720	744	720	744	744	720	744	720	744
Hours > 27	0	0	0	0	0	0	0	0	0	0	0	0	0
Hours > 28	0	0	0	0	0	0	0	0	0	0	0	0	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	916.09	77.59	72.58	77.59	75.09	77.59	75.09	77.59	77.59	75.09	77.59	75.09	77.59
HRec	5150.71	591.66	566.05	561.40	469.82	381.57	281.43	245.57	241.70	323.44	424.42	508.70	563.07
CRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HtCoil	3295.47	406.94	399.56	306.04	300.46	227.23	156.63	120.04	120.45	100.14	257.85	334.88	381.45
CCoil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Humidif	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorHeat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorCool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Ill. 2.46: Mountain as construction after 2 year

2017 | Month | Hours | ThermalZone336

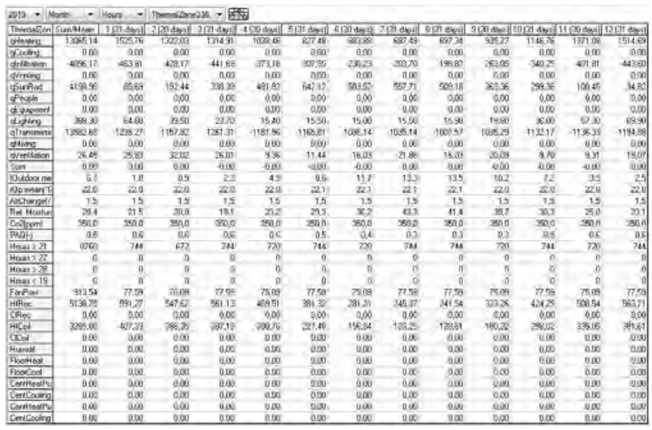
ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	13107.06	1521.25	1326.60	1319.57	1042.44	831.11	697.13	680.58	700.21	938.13	1149.44	1373.54	1517.00
qCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qInfiltration	-4096.87	-463.91	-435.25	-441.78	-373.25	-307.91	-230.28	-203.75	-196.86	-253.10	-340.29	-401.85	-443.64
qVenting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qSunRad	4198.56	85.69	192.44	338.29	491.92	642.12	593.52	567.71	509.18	363.36	259.36	100.45	34.02
qPeople	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qEquipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qLighting	388.30	64.80	39.50	23.70	15.40	15.50	15.00	15.50	15.90	19.60	36.00	57.30	69.90
qTransmissi	-13622.35	-1243.56	-1162.14	-1265.60	-1165.71	-1168.24	-1039.23	-1038.03	-1010.32	-1037.93	-1184.70	-1138.65	-1137.07
qMixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qVentilation	24.35	25.62	31.85	25.93	3.21	-11.57	-16.14	-21.36	-16.11	-20.20	-3.00	8.32	18.86
Sum	-0.00	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	-0.00
tOutdoor me	6.7	1.8	0.9	2.3	4.9	8.6	11.7	13.3	13.5	10.2	7.2	3.9	2.5
tOp mean(°C	22.0	22.0	22.0	22.0	22.0	22.1	22.1	22.1	22.1	22.0	22.0	22.0	22.0
AirChange/	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Rel. Moistur	29.4	21.5	20.8	19.1	23.2	29.3	36.2	43.3	41.4	39.7	30.3	25.0	23.1
Co2(ppm)	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0
PAQ(-)	0.5	0.6	0.6	0.6	0.6	0.5	0.4	0.3	0.3	0.3	0.5	0.6	0.6
Hours > 21	8760	744	672	744	720	744	720	744	744	720	744	720	744
Hours > 27	0	0	0	0	0	0	0	0	0	0	0	0	0
Hours > 28	0	0	0	0	0	0	0	0	0	0	0	0	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	913.54	77.59	70.08	77.59	75.09	77.59	75.09	77.59	77.59	75.09	77.59	75.09	77.59
HRec	5135.71	591.41	547.73	561.24	469.67	381.40	281.28	245.44	241.63	323.33	424.31	508.60	563.75
CRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HtCoil	3284.58	407.15	386.24	307.07	300.67	227.40	156.77	128.10	120.59	100.25	257.36	334.85	381.55
CCoil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Humidif	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorHeat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorCool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Ill. 2.47: Mountain as construction after 3 year

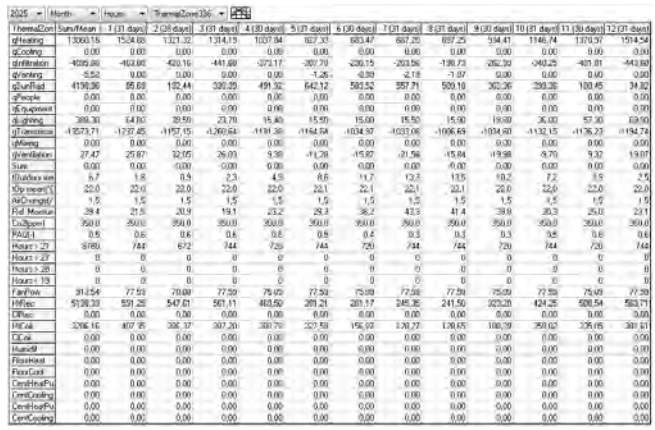
2018 | Month | Hours | ThermalZone336

ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	13076.62	1527.28	1323.27	1316.16	1039.59	828.47	694.77	680.34	698.11	936.06	1147.50	1371.76	1515.33
qCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qInfiltration	-4096.76	-463.84	-429.19	-441.72	-373.20	-307.97	-230.24	-203.71	-196.82	-263.06	-340.26	-401.82	-443.61
qVenting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qSunRad	4198.56	85.69	192.44	338.29	491.92	642.12	593.52	557.71	509.18	363.36	259.36	100.45	34.02
qPeople	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qEquipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qLighting	388.30	64.80	39.50	23.70	15.40	15.50	15.00	15.50	15.90	19.60	36.00	57.30	69.90
qTransmissi	-13593.35	-1239.71	-1158.99	-1262.50	-1162.98	-1166.74	-1036.38	-1035.36	-1008.32	-1036.03	-1132.87	-1136.98	-1195.49
qMixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qVentilation	26.04	25.70	31.98	25.96	9.32	-11.48	-16.06	-21.89	-16.05	-20.12	-8.73	9.29	19.05
Sum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
tOutdoor me	6.7	1.8	0.9	2.3	4.9	8.6	11.7	13.3	13.5	10.2	7.2	3.9	2.5
tOp mean(°C	22.0	22.0	22.0	22.0	22.0	22.1	22.1	22.1	22.1	22.0	22.0	22.0	22.0
AirChange/	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Rel. Moistur	29.4	21.5	20.9	19.1	23.2	29.3	36.2	43.3	41.4	39.7	30.3	25.0	23.1
Co2(ppm)	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0	350.0
PAQ(-)	0.5	0.6	0.6	0.6	0.6	0.5	0.4	0.3	0.3	0.3	0.5	0.6	0.6
Hours > 21	8760	744	672	744	720	744	720	744	744	720	744	720	744
Hours > 27	0	0	0	0	0	0	0	0	0	0	0	0	0
Hours > 28	0	0	0	0	0	0	0	0	0	0	0	0	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	913.54	77.59	70.08	77.59	75.09	77.59	75.09	77.59	77.59	75.09	77.59	75.09	77.59
HRec	5139.01	591.31	547.85	561.10	469.54	381.34	281.23	245.39	241.55	323.28	424.27	508.56	562.72
CRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HtCoil	3265.54	407.29	386.32	307.15	300.74	227.46	156.82	128.21	120.60	100.38	258.00	335.04	381.59
CCoil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Humidif	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorHeat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorCool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

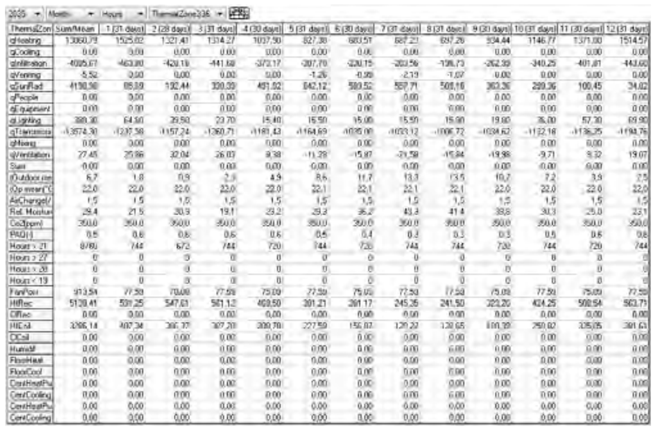
Ill. 2.48: Mountain as construction after 4 year



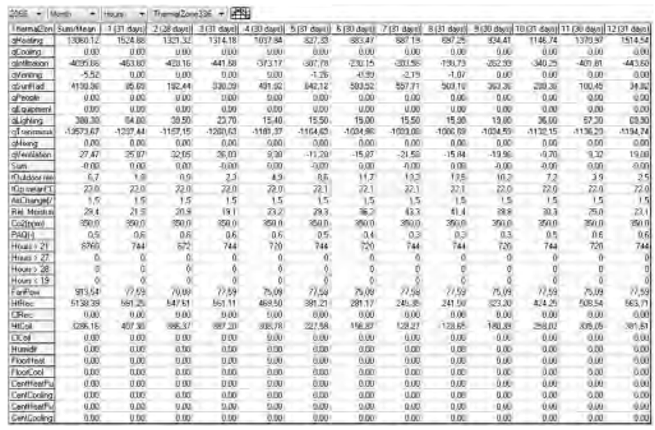
Ill. 2.49: Mountain as construction after 5 year



Ill. 2.50: Mountain as construction after 10 year



Ill. 2.51: Mountain as construction after 20 year



Ill. 2.52: Mountain as construction after 50 year

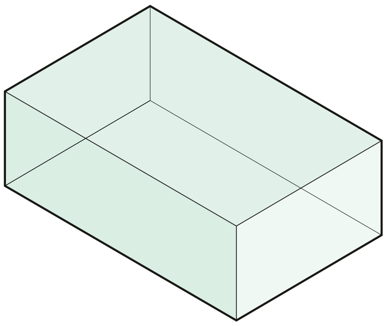
MATERIAL STUDIES

Initially in the process, different material studies was made. The results of the research resulted in the following diagram, which shows the different qualities of the materials, that where considered. The diagram evaluates the materials, from the atmosphere that they convey, how they can work as construction, and how they age, to convey an overall impression of how the material could perform with in the project.

	PINEWOOD	CONCRETE	CORTEN STEEL	ZINK	SLATE
CONSTRUCTIVE PRE-FORMANCE	Light construction Cladding Floors	Heavy construction Thermal mass	Cladding	Cladding	Cladding Floors Thermal mass
LIGHT, COLOUR AND TACTILITY	Warm Weak color reproduction	Clear colours Tactility created by light Focus on light	Varm Weak color reproduction	Clear colours Focus on light	Focus on light Focus on materials
ATMOSPHERE	Warm Inviting Comfortable	Protecting Cold	Honest		Protecting Cold
SENSES	Nice to touch Nice to smell	Cold to touch Smooth to touch	Cold to touch	Cold to touch	Nice to touch Cold
LOCAL	Yes	No	No	No	Yes
MAINTAINANCE	Does not work in wet conditions Indoor material	Work under wet conditions Can be used indoor and outdoor	Nice patina	Nice patina	Work under wet conditions
INTERPLAY WITH MOUNTAIN	Natur/ cultur Cold and heany / varm and soft	Culture/ nature Cold and heavy			Similar
INTERPLAY WITH LANDSCAPE		Same colour Culture/ nature	Contrast in colour Cold/warm		Similar

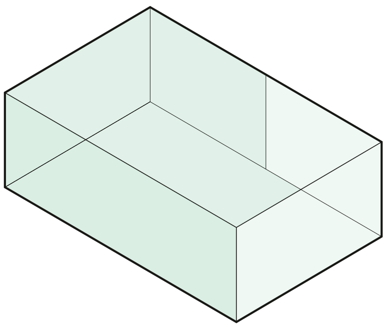
Ill. 2.53: Material investigations

WINDOW RATIO



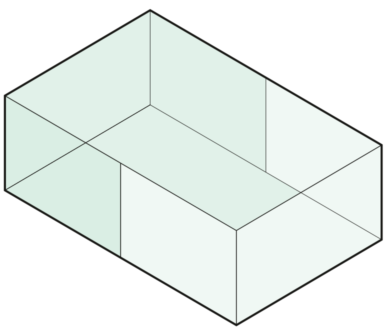
ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	5279,69	654,78	580,20	523,33	256,12	327,73	236,89	225,32	248,55	346,89	435,71	416,55	727,62
qCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qInfiltration	-4008,48	-446,23	-418,63	-437,07	-386,06	-297,06	-223,18	-199,29	-138,66	-249,30	-341,60	-386,24	-425,19
qVenting	-1175,82	0,00	0,00	0,00	0,00	-300,25	-285,45	-245,18	-223,58	-141,35	0,00	0,00	0,00
qSunRad	4198,96	35,69	192,44	338,39	491,92	642,12	593,52	567,71	509,18	363,36	298,36	100,45	34,82
qPeople	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qEquipment	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qLighting	387,44	64,80	39,40	23,48	15,40	15,50	15,00	15,50	15,90	19,60	35,48	57,28	69,90
qTransmissio	-4897,04	-422,54	-446,03	-484,03	-459,96	-399,43	-345,77	-341,75	-336,35	-348,00	-415,68	-430,62	-465,05
qMixing	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qVentilation	215,25	63,50	52,81	35,03	-17,42	11,40	-1,00	-12,32	-15,03	6,63	-12,27	42,58	58,09
Sum	0,00	-0,00	0,00	-0,00	-0,00	0,00	0,00	-0,00	0,00	-0,00	0,00	0,00	-0,00
tOutdoor me	6,7	1,8	0,9	2,3	4,9	8,6	11,7	13,3	13,5	10,2	7,2	3,9	2,5
tOp mean(T	22,6	22,1	22,5	22,9	23,6	22,6	22,7	22,0	23,0	22,7	23,0	22,1	22,0
AirChange(/	1,9	1,5	1,5	1,5	1,5	2,2	2,3	2,4	2,3	1,9	1,5	1,5	1,5
Rel. Moistur	30,7	25,3	22,1	19,9	22,8	29,4	36,2	42,5	40,5	41,0	30,9	26,7	24,5
Co2(ppm)	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0
PAQ(-)	0,5	0,6	0,6	0,6	0,6	0,5	0,4	0,3	0,3	0,4	0,5	0,6	0,6
Hours > 21	8760	744	672	744	720	744	720	744	744	720	744	720	744
Hours > 27	337	5	25	44	87	6	24	28	53	0	60	3	0
Hours > 28	262	2	16	37	70	0	19	23	41	0	51	3	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	913,54	77,59	70,08	77,59	75,09	77,59	75,09	77,59	77,59	75,09	77,59	75,09	77,59
HtRec	4993,74	567,11	534,53	555,09	404,39	366,69	267,22	233,90	230,15	305,31	423,63	487,34	538,31
ClRec	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HtCoil	3430,01	421,40	399,45	293,22	250,00	242,11	170,92	138,72	140,09	190,27	298,50	256,25	407,01
ClCoil	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Humidif	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorHeat	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorCool	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Ill. 2.54: Window ratio of 20 %



ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	5525,08	911,48	743,24	568,27	245,96	183,52	102,65	78,15	133,16	291,77	683,29	910,38	973,21
qCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qInfiltration	-3988,03	-443,75	-413,58	-431,53	-386,32	-296,87	-225,42	-202,27	-201,51	-246,29	-333,18	-383,56	-423,75
qVenting	-2144,60	0,00	0,00	0,00	0,00	-550,42	-540,91	-467,27	-395,13	-190,87	0,00	0,00	0,00
qSunRad	7286,90	113,93	271,81	541,47	838,55	1211,47	1132,15	1043,80	912,97	602,07	421,88	138,80	59,95
qPeople	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qEquipment	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qLighting	337,50	55,00	32,00	18,30	15,00	15,50	15,00	15,50	15,50	15,80	28,50	49,20	63,20
qTransmissio	-7277,28	-705,55	-697,00	-744,32	-696,24	-575,14	-478,15	-465,62	-444,37	-487,41	-636,96	-663,14	-725,40
qMixing	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qVentilation	280,43	68,90	63,54	47,82	17,96	11,84	5,35	18,28	20,62	14,92	5,45	48,32	61,75
Sum	0,00	0,00	0,00	0,00	0,00	0,00	-0,00	-0,00	0,00	-0,00	-0,00	0,00	0,00
tOutdoor me	6,7	1,8	0,9	2,3	4,9	8,6	11,7	13,3	13,5	10,2	7,2	3,9	2,5
tOp mean(T	22,7	22,1	22,3	22,6	23,0	23,0	23,3	23,4	22,5	22,3	22,7	22,1	22,0
AirChange(/	2,0	1,5	1,5	1,5	1,5	2,6	3,0	2,9	2,8	2,0	1,5	1,5	1,5
Rel. Moistur	30,4	24,9	22,5	20,3	23,0	29,0	36,3	42,0	40,0	41,5	31,5	26,9	24,6
Co2(ppm)	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0
PAQ(-)	0,5	0,6	0,6	0,6	0,6	0,5	0,4	0,3	0,3	0,4	0,5	0,6	0,6
Hours > 21	8760	744	672	744	720	744	720	744	744	720	744	720	744
Hours > 27	380	0	10	34	101	24	45	51	75	0	39	1	0
Hours > 28	265	0	7	25	71	5	34	35	63	0	25	0	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	913,54	77,59	70,08	77,59	75,09	77,59	75,09	77,59	77,59	75,09	77,59	75,09	77,59
HtRec	4954,93	563,69	527,49	547,47	485,89	366,16	265,90	234,05	229,00	301,33	413,86	483,71	536,38
ClRec	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HtCoil	3439,62	434,92	406,49	400,84	292,39	242,64	172,14	139,57	141,15	202,36	368,41	308,88	408,94
ClCoil	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Humidif	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorHeat	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorCool	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

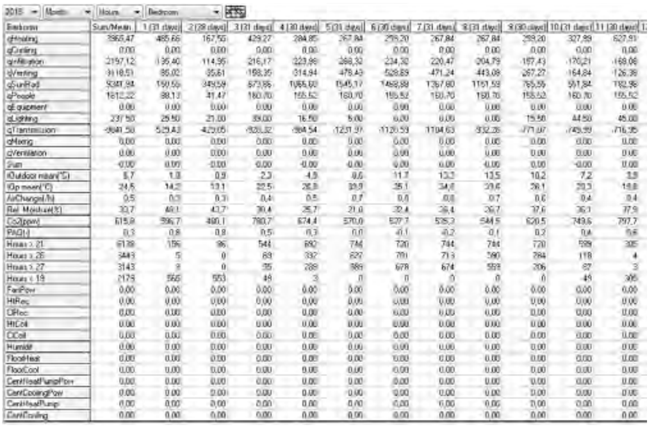
Ill. 2.55: Window ratio of 40 %



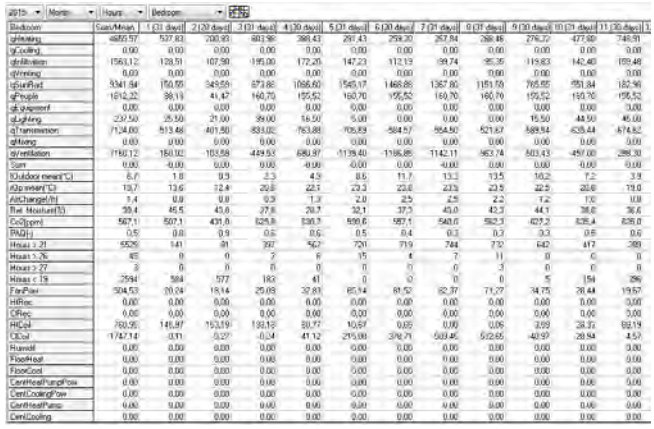
ThermalZon	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	7781,28	1172,40	967,27	766,29	424,82	354,55	239,44	320,93	288,17	462,50	658,93	1019,63	1227,80
qCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qInfiltration	-4181,71	-444,52	-416,53	-449,90	-435,68	-321,12	-251,00	-229,89	-223,07	-250,06	-350,42	-384,36	-425,15
qVenting	-3996,62	0,00	0,00	0,00	0,00	-988,01	-1000,23	-677,15	-699,93	-431,25	0,00	0,00	0,00
qSunRad	10477,27	141,10	385,24	729,23	1192,83	1789,02	1725,45	1579,53	1301,98	939,25	549,74	177,78	67,11
qPeople	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qEquipment	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qLighting	309,90	46,50	27,90	16,40	15,00	15,50	15,00	15,50	15,50	15,40	24,80	42,80	57,60
qTransmissio	-10224,08	-984,78	-977,84	-1070,30	-1065,96	-811,73	-603,85	-634,46	-613,21	-642,56	-851,42	-902,44	-992,42
qMixing	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qVentilation	-141,15	67,26	52,86	0,33	-122,82	-30,21	-57,67	-74,44	-64,28	7,16	-30,61	46,61	63,06
Sum	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,00
tOutdoor me	6,7	1,8	0,9	2,3	4,9	8,6	11,7	13,3	13,5	10,2	7,2	3,9	2,5
tOp mean(T	23,7	22,1	22,6	22,7	26,0	24,5	25,0	25,1	24,0	22,7	22,6	22,2	22,0
AirChange(/	2,3	1,5	1,5	1,5	1,5	3,1	3,5	3,4	3,1	2,4	1,5	1,5	1,5
Rel. Moistur	29,0	24,0	22,1	19,3	20,4	27,0	33,5	39,6	39,1	40,5	30,1	26,7	24,6
Co2(ppm)	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0	350,0
PAQ(-)	0,5	0,6	0,6	0,6	0,5	0,5	0,4	0,3	0,3	0,4	0,5	0,6	0,6
Hours > 21	8760	744	672	744	720	744	720	744	744	720	744	720	744
Hours > 27	1165	7	33	88	234	158	167	173	150	25	93	5	0
Hours > 28	1002	4	24	74	214	141	151	169	135	13	77	5	0
Hours < 19	0	0	0	0	0	0	0	0	0	0	0	0	0
FanPow	913,54	77,59	70,08	77,59	75,09	77,59	75,09	77,59	77,59	75,09	77,59	75,09	77,59
HtRec	5110,48	564,64	534,21	571,64	527,06	369,43	284,93	246,39	237,91	305,29	429,41	484,74	535,45
ClRec	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HtCoil	3334,14	432,86	399,67	376,68	251,21	219,37	153,12	127,22	133,04	198,29	252,06	358,06	409,87
ClCoil	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Humidif	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorHeat	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorCool	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Ill. 2.56: Window ratio of 60 %

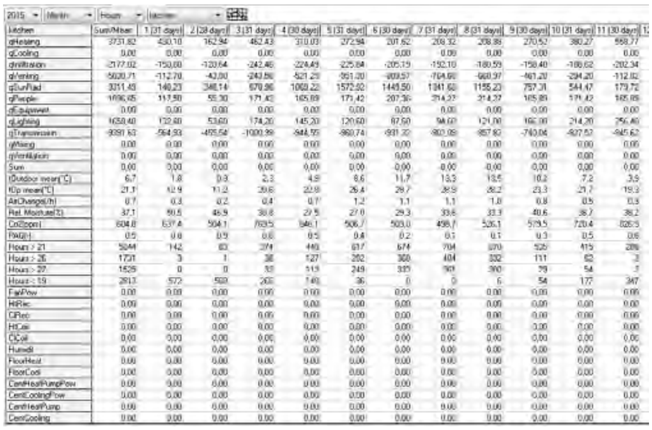
DECREASE OVERHEATING BY COOLING



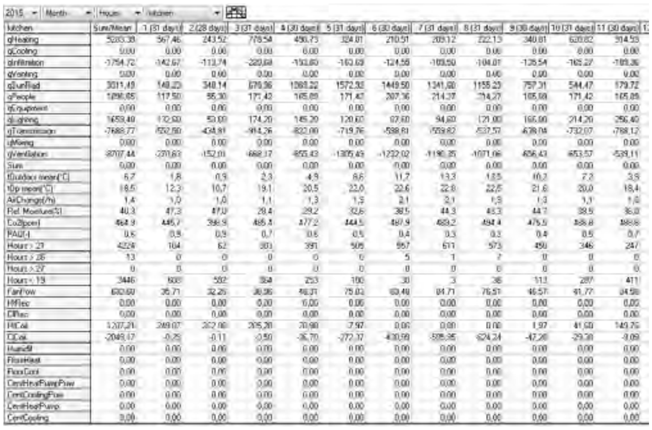
Ill. 2.57: Before cooling bedroom



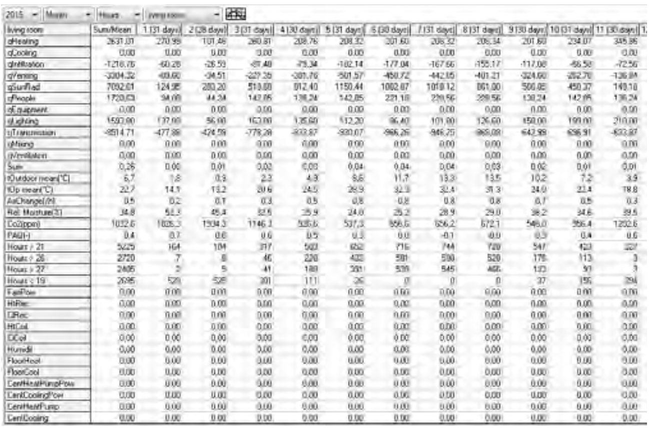
Ill. 2.58: After cooling bedroom



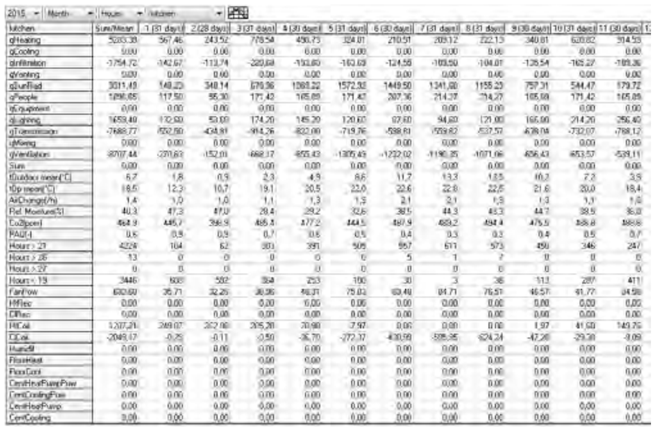
Ill. 2.59: Before cooling kitchen



Ill. 2.60: After cooling kitchen



Ill. 2.61:Before cooling living room



Ill. 2.62: After cooling living room

Tungestølen - Presentation

Master Thesis in Architectural Design 2015
Jeanne Juel Lichon & Line Toft Jensen
Aalborg University

MOTIVATION

As a response to a life determined and valued by status and materials, Christopher McCandless sets out on a physical and mental challenging trip to experience the beauty of nature and the pleasure of living off the land - experiencing the life in the wilderness in Alaska. He rejected his conventional life by destroying all of his credit cards and identification documents and donated all of his savings. Nature and wilderness were the only ingredients to reach the purpose of life.

The movie *Into the Wild* is based on the travels of Christopher McCandless (imdb, 2015). The story questions how we want to live our lives, and what we value and appreciate in it. It raises nature and wilderness, as a response to the life in the city.

It is a tendency that more people seek, a break from the life lived in the city, a life that is always on the run, and constantly striving for more (Smisethjell, L., 2015). Nature may, as the movie Into the Wild suggests, be the answer to that search. That makes Norway an attractive destination for travelers from the entire world. An increasing number of tourists wish, to experience the beautiful nature of mountains and fjords through activities in the nature (Smisethjell, L., 2015).

ABSTRACT

This report presents a proposal for a new cabin complex in Tungestølen Norway. The project takes its point of departure, in an investigation of how sustainability is interpreted in a Nordic context, but also points out some contemporary issues, relating to the subject. The design proposes a different solution to the issue of sustainability. It is not a proposal that is made to serve as a general example, when building sustainable, but a proposal that is meant to make people more aware on their impact on nature.

The site is situated down a valley created by Jostedalsbreen, the largest glacier in continental Europe. The landscape is characterized by its rough nature, placed with in a deep cut valley, enclosed by mountainsides, where small steams run down to create larger fjords. The wind is rough, and the winter's cold. Building here have therefore always been on the premise of nature.

The user group are usually hikers, however an increasing number of tourists is coming to experience the dramatic landscape of Tungestølen. They are a user group that spend all day in nature, wishing to sense, and to interact with it. When they return, they wish to return to a safe and protected space where they can retreat and recharge for a new and challenging outside. The report suggest a design that is built within the mountain, and thereby protecting the users from the wind and weather.

The design proposal, suggest a solution, where several volumes, built into the mountain, will be connected by a mountain corridor. The volumes will be characterized, as being well defined, volumes protected by the strength of the mountain, and accommodated by the wooden interior. These will be contrasted by a rough and cold corridor, that will provide an undefined and mysterious space, only lit by skylights. This space will emphasize the atmosphere within the volumes.

To emphasize the experience the visitors seek, when visiting Tungestølen, the complex will be functioning without any form of connection to a grid. The heating demand will be meet by burning wood, and domestic water for both showering and cooking, will be collected in a water tank. Light and ventilation will be natural. This causes the users to sense themselves, and take action, to obtain comfort, reinforcing the experience of the site.

By living on the premise of nature, and by taking away basic functions, the traveler in his everyday life takes for granted, he will become more aware upon his basic needs. The complex teaches the users to appreciate and respect the nature, to best possible preserve it in the future.

TUNGESTØLEN - PRESENTATION

THEME
Sustainability

4st SEMESTER M.Sc. PROJECT
Aalborg University
Department of Architecture, Design & Media
Technology

PROJECT PERIOD
02.02.2015 - 27.05.2015

PAGES: 64
NUMBER OF COPIES: 6

MAIN SUPERVISOR
Lars Brorson Fich, Arcitect MAA

TECHNICAL SUPERVIOR
Peter V. Nielsen, Ph.D., M.Sc. from DTU

Line Toft Jensen

Jeanne Juel Lichon

CONTENT

CONCEPT

1

CONCEPT

People have through centuries, been visiting the area of Tungestølen, wanting to experience its specific and dramatic landscape. The visitors come to experience, the nature, and a space where they can disconnect from the everyday life. They come to live on the premise of nature, and focus on being.

The practical aim of the cabin is to create a space, where travelers can seek shelter and protection from the weather, and provide them with at space where they can recharge before a new demanding day in the nature.
When the travelers return to the cabin from their adventures in the nature, they will be feeling tiered, exhausted, and hungry. Looking forward to rest by the fireplace, meeting other travelers, sharing experiences, or enjoying a warm cup of tea, and digest the experience, before going to bed. In one's own little cave.

In search for a cabin complex that emphasizes the experience of the nature, and adapts to the premise of the site, the complex will be built into the mountain side. It is desired to place all the functions towards south, to utilize the light, and provide the volumes with the most spectacular view. The volumes will therefore be placed as separate volumes, that will be connected inside the mountain by a corridor. This creates the possibility to orientate the specific volumes independently from each other, and design them each as well defined rectangular volumes.

The mountain corridor will therefore serve as the connecting link between the volumes, where the entrance will be placed through a mountain corridor, making it a fluent transition, from the natural outside, into the build inside. The cave corridor will be perceived as a mystical unknown element, that will have to be explored, to make sense, and will seem as a contrast to the defined spaces of the volume.

The volumes will be protected by the strength of the mountain, providing the travelers with a safe and covered back, so they safely can appreciate the view, provided by the open south façade. The volumes will accommodate the travelers with completely wooden interior, providing the spaces with a warm and soft atmosphere.

The complex will be functioning without any form of a connection to a grid. Heating demand will be meet by burning wood, do-

Ill. 3.01: Concept

mestic water will be collected in a water tank, placed higher up the mountain. Light will be natural, and supplemented by candles and oil lamps. Ventilation will be driven by the temperature differences, created by the mountain corridor. This causes the travelers to sense themselves, to obtain comfort. They have to take action if they wish to change the temperature, the air change, or the temperature of the shower water. Making the travelers interact with the nature, making them aware of the luxury of having these functions available.

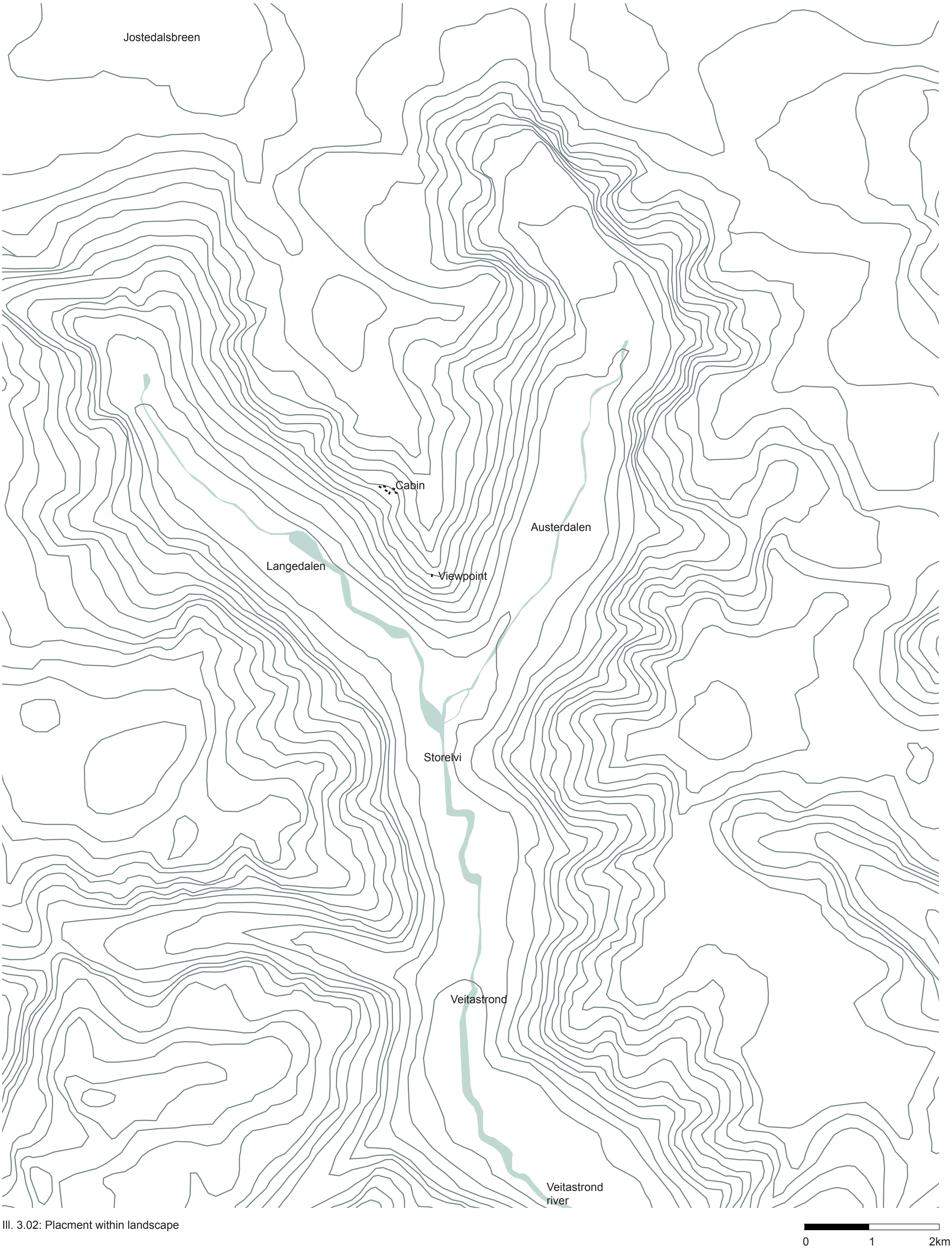
ATMOSPHERE

2

LANDSCAPE

The cabin complex is placed within the meeting between Austerdalen and Langedalen, forming the valley that leads down to the city of Veitastrond. A small city with only 123 inhabitants, and a few small shops. The road from Veitastrond, is the only way to arrive to the cabin, by car.
Then arriving to the site, you arrive through the Veitastrond valley, driving along the Veitastromd river, created by the Storelvi river and several smaller streams, running down the mountain sides.

The former placement, was directly in the meeting of the two valleys on a small plateau, thereby exposing it to wind from each side. The new placement of the cabin, is situated higher up the mountain, within a small erosion. This provides a desirable slope for the buildings to be placed within, and further protects the cabin from the wind. Placing the building up higher, also provides a greater view down the meeting of the valleys.



Ill. 3.02: Placment within landscape

Ill. 3.03: Section through landscape

A viewpoint have been placed, at the placement of the old cabin. Here the road stops, and the visitors therefore have to reach the last distance by foot. By the viewpoint a small volume is placed, which regularly will be filled with both food and firewood. It is thereby the visitors responsibility to make sure that cabin contains the sufficient necessities.

Ill. 3.04: Plan of landscape

Ill. 3.05: Approaching the cabin complex

BUILDING IN THE LANDSCAPE

When watching the volumes in the facade, they will seem as separate buildings, that each are orientated according their view, and according to each other. The inside mountain corridor will be connecting the volumes, and thereby providing the cabin complex , with a unknown element, that will have to be explored to make sense.
To understand the complex as a whole, the traveller will have to walk through the complex, and investigate the corridors, to be able to understand how the volumes are connected within the facade.

Within the facade, the contrast between the interior and exterior material is evident. The exterior is covered with concrete, which possesses the same qualities as the stone of the mountain, by being a cold and strong material. Concrete will however also serve as the cultural contrast, to the natural material of the mountain, and thereby highlight the volumes as build elements within nature.

The wooden interior, provides the traveler with a safe and comforting atmosphere, protected both by the strength of the concrete and the mountain.

Ill. 3.06: South facade

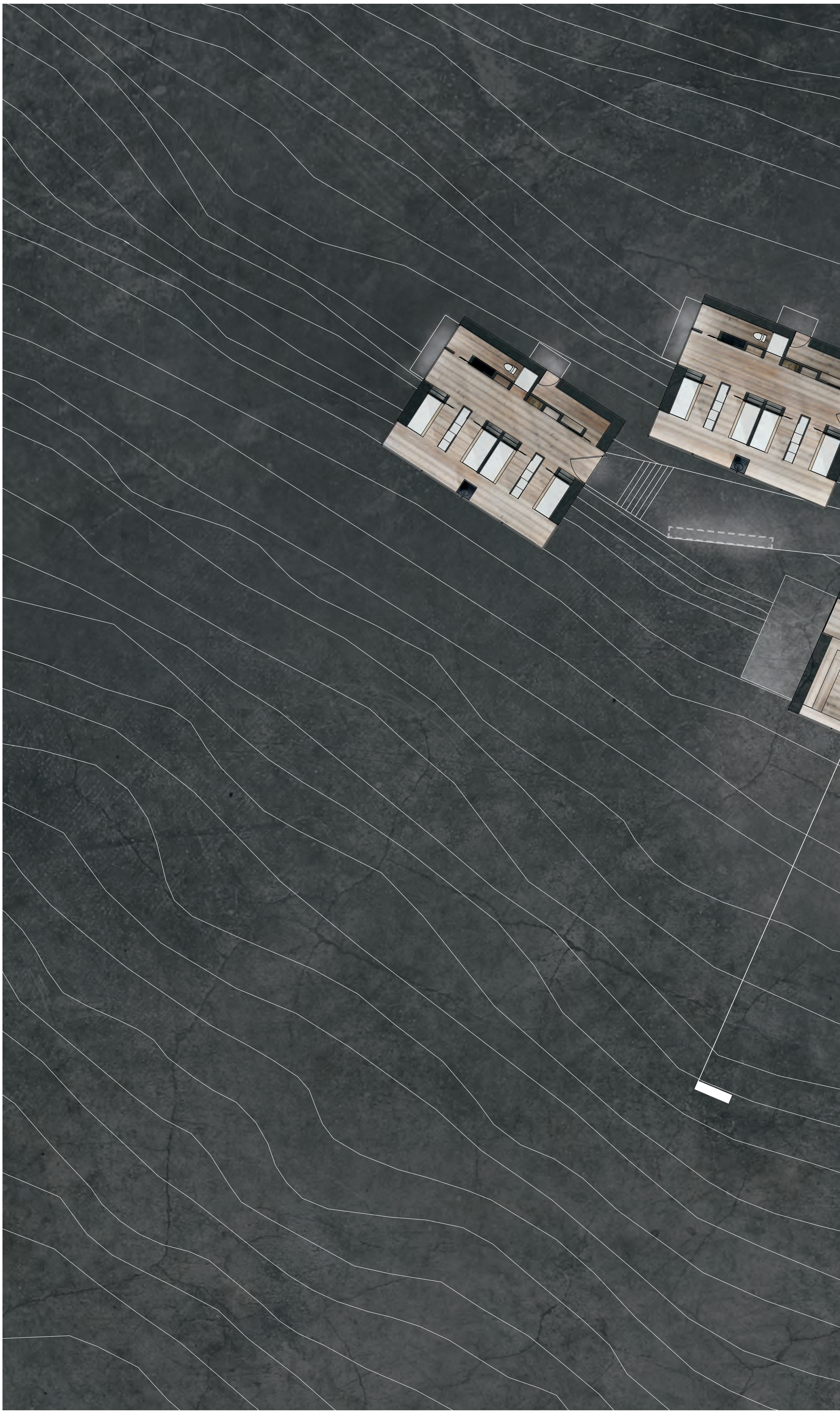
The functions will be placed facing south, and thereby gaining daylight, from the large glass facades. However some functions, such as the mountain corridor, toilet and shower, that are placed facing within the mountain, will need light from above. Several skylights have therefore been placed, according to the need of light within the complex. The skylights are made in concrete, to emphasize them as a build element within the nature. Further they also prevents rocks from falling down the mountain, and inside complex.

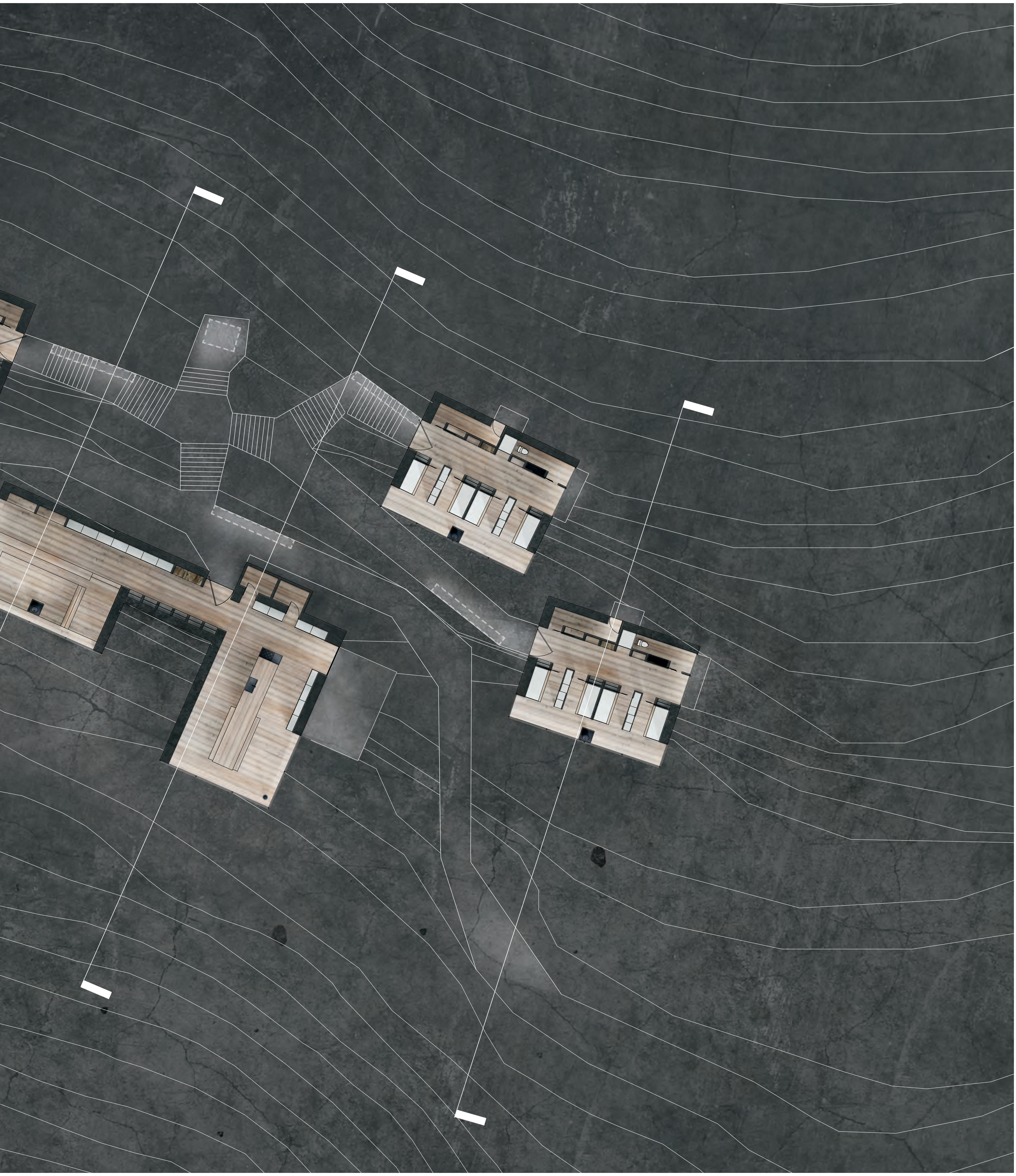
Ill. 3.07: Roof plan

PLAN

The plan shows the entire complex as a whole, and how the volumes are combined by the mountain corridor.
The volumes are placed within a small cluster, creating a greater community feeling between the volumes. Also providing the top volumes with a view, where the lowest volumes are visible, making the visitor feel he is part of a bigger complex.

When entering the common rooms, you enter through a hallway, that contains a wardrobe, where the travelers can hang their outerwear. Each end of the hallway, ends out in a glass door, that exits to a common terrace, thereby providing it with a natural light source in each end.





Ill. 3.08: Complex plan

Ill. 3.09: Kitchen volume

Ill. 3.10: Section through kitchen

KITCHEN

The kitchen volume is the only volume that is orientated outwards, emphasizing its function as a transition room. When the travelers use the kitchen, it is either before they are leaving for today's adventures, or returning after a long day outside. The kitchen is therefore the only volume that is orientated outwards, to emphasize the direction towards nature.

Due to the slope of the landscape, and the proportions of the kitchen volume, it shoots out of the landscape. This creates the sensation, when standing inside the kitchen, of being placed above the landscape, making the separation of in and outside more fluent, by not having a distinctive division. The kitchen volume is the most visible in the landscape, thereby making it function as a landmark for the travelers when they return after a long day outside.

The orientation within the kitchen, is supported by the placement of the kitchen element, and the orientation of the wooden planks on the wall. The kitchen element is centered in the room, and contains both kitchen and dining table, thereby simplifying the interior elements, and keeping focus upon the direction towards the view. It further helps to gather different groups of visitors around a common element, no matter if they are cooking or eating.

Benches are chosen as seating for the dining table, to avoid having several empty chairs, in periods with few visitors. A wood stove is placed at the end of the kitchen element, providing it with a total overview of the kitchen and view. Food and cleaning storage is placed in the back of the volume, where they both will be placed outside the thermal envelope. The food storage will therefore utilize the 7 degree temperature of the mountain to keep the food cold. Water will be collected in a tank placed higher up the mountain, and will in the kitchen be available through a foot pump.

The entire south facade is covered in glass, and also the corner towards the east. This provides the possibility for visitors to see, when others approach the cabin, and enjoy the morning sun. Due to the depth of the volume, a glass door have been placed back in the volume, this both functions as a second light source, but also as the exit to a east facing terrace, where the visitors can enjoy their breakfast, and the morning sun.

Ill. 3.11: Kitchen plan

Ill. 3.12: Section through living room

LIVING ROOM

The living room is proportioned to be as covered as possible, thereby creating an atmosphere of safety, by being protected by the strength of the mountain. The cabin is being heated by wood stoves, providing the travellers with heat, and also serving as a gathering element in the living room. The volume is designed with different levels of seating providing a more unformal seating arrangement surrounding the fireplace. The seating is designed as one element, where pillows, cushions and blankets can be moved around to accommodate the travellers best possible.

The change in level, causes the volume to be build down inside the ground, creating a more earthbound and safe atmosphere. As a contrast to the kitchen volume, the glass facade, does not cover the entire south facade, thereby providing the room with a distinctive division between in and outside. This division helps to emphasise the function of the room, a safe room, protected from the nature, a room where the travellers can feel free to do as they desire.

When the travellers return after a long day outside, after they have eaten, and before they go to bed, they will gather within the protected space of the living room, around the fire. Within this warm and dark space, the travellers can slowly calm down and relax, before going to bed.

The space provides them with several possibilities of interacting. The seating arrangement that encircles the fireplace, encourages social interaction, where the travellers can discuss the days adventures. In the back of the room two small niches are designed within the wall, this provides the traveller with a semi private space, within the common room. Here the traveller can enjoy a hot cup of tea, read a book, or just contemplate quietly.

As the kitchen, a glass door have been placed in the back of the room, providing it with a second light source, and an exit to a west facing terrace, where the visitors can enjoy the evening sun.
When the sun have set and the cabin is dark, the travelers will light the space with oil lamps and candels.

Ill. 3.13: Livingroom plan

Ill. 3.14: Section through bedroom

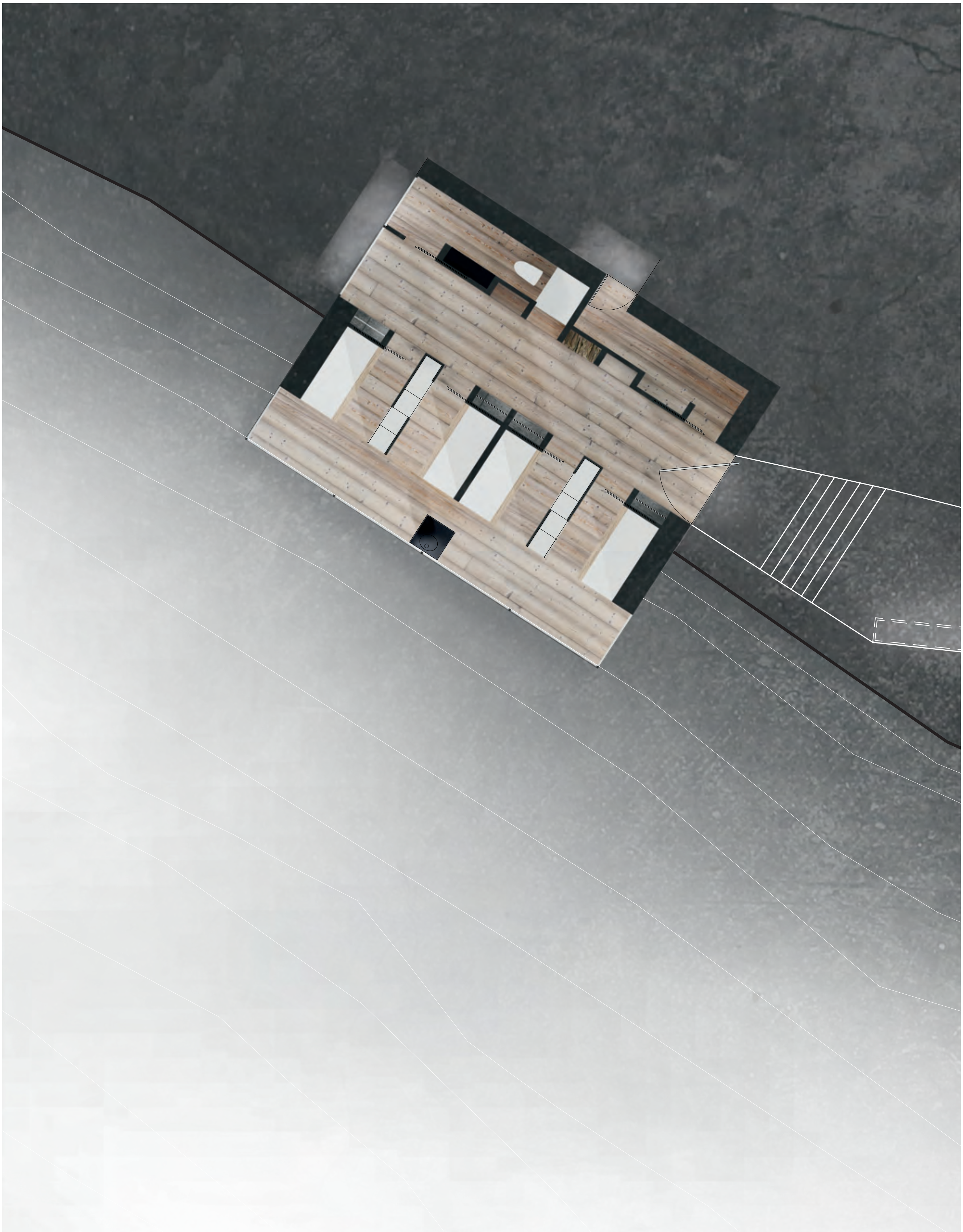
BEDROOM

You enter the bedrooms through the unheated mountain corridor, into a functional hallway. At the end of the hallway, a window is placed looking directly out into the mountain side, functioning as a lightwell for the hallway. It is further furnished wardrobes, wood storage and a seating possibility.

The bedroom is designed with four smaller niches, with a bunk bed within each, separated by a storage possibility, one closet per bed. Each niches shares a common room with the others, where the view is in focus. The entire south facade, and both the east and west corner are covered in glass, providing the space with a three dimensional view out towards nature. By sharing the common space, the traveller will experience the view as more fluent, when laying in their bed.

The functions within the complex gradually becomes more enclosed and private. At the end of the day, the visitor will have the ability to retreat into one's own cave. A private and enclosed space to fall asleep.
In the morning, the traveller will be woken by the light, by a new day, and a new adventure. The landscape will be lit up, and initiate the expectations for the day, creating a prospect for the traveller.

Both the shower and toilet, will be placed in the back of the volume, relating them to the earth. They will each be enclosed by the mountain, providing the traveller with a safe and protected atmosphere, there the they can be vulnerable and naked.
The toilet will be placed within a completely enclosed and dark space, looking out towards the mountain side, lit by a lightwell.
When entering the shower, you enter in the dark, and se the end wall being lit by light through a glass door. As you undress and walk towards the light, you will enter the outside placed shower, totally enclosed by mountain, but bathed in light from above.
The shower water will be collected within the water tank, where the traveller manually can heat it by burning wood.



Ill. 3.15: Bedroom pln

ENVIRONMENT

3

DAYLIGHT

Light studies have been performed in Velux Daylight Visualizer. The differentiation of atmospheres in the spaces is reflected in the plan of daylight.

There is a clear separation between the functions related to the ground and the functions related to the heavenly. In the back of the space the functions related to the ground are illustrated mysteriously, by being the darker heavy base, from which the lighter and heavenly grows.

By designing skylights through the mountain, the light that enters the spaces related to the ground will be more diffuse and cooler nuances.

By designing big window areas in the functions related to the heavenly, the experience of view and light will support the idea of reaching prospect. By using a wooden interior the nuances of light from the south will be warm and welcoming. By designing windows from floor to ceiling in the kitchen, the light will travel deep into the room and secure a daylight level of 200 lux in the kitchen.

Daylight

8,00

7,00

6,00

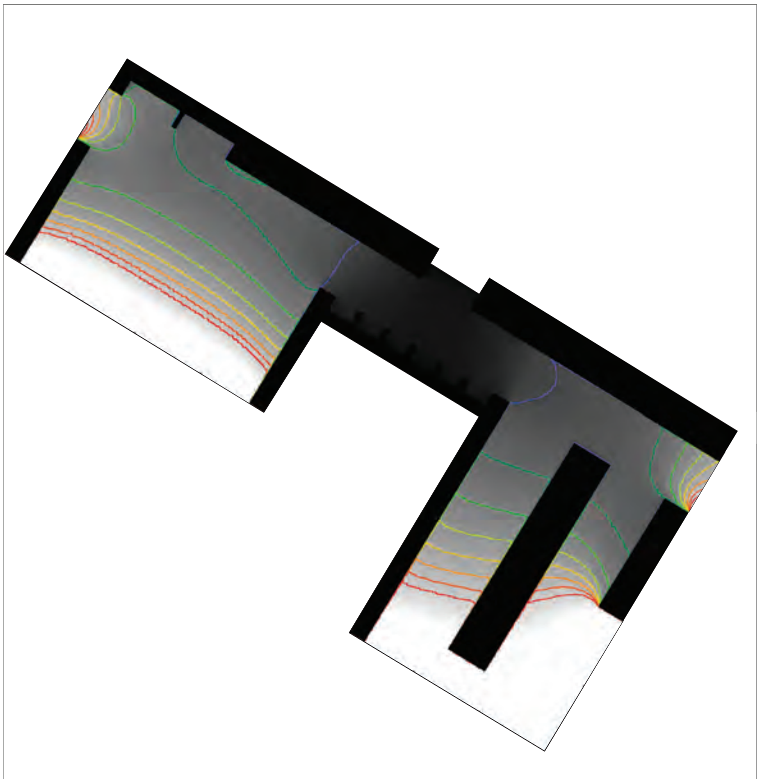
5,00

4,00

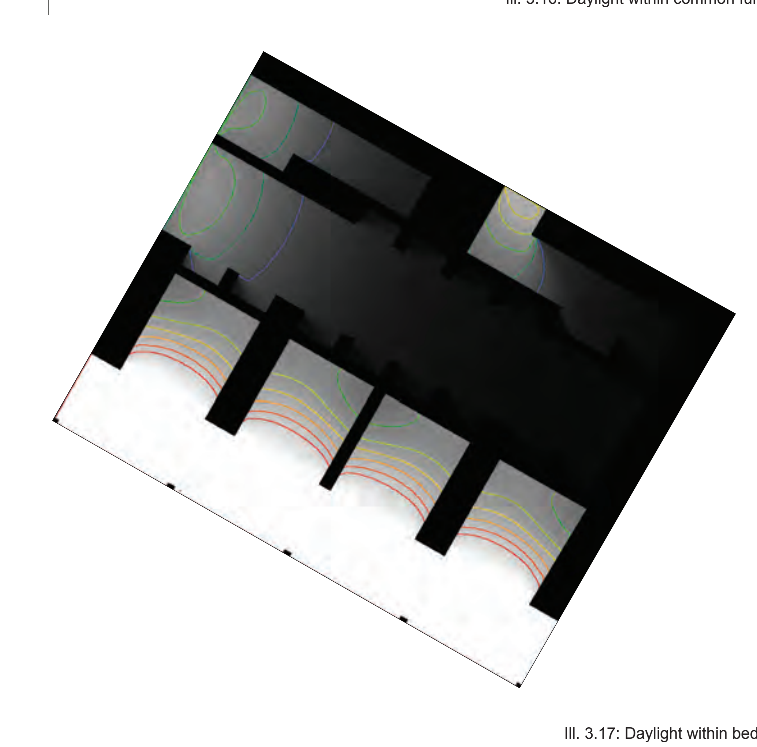
3,00

2,00

1,00



Ill. 3.16: Daylight within common functions



Ill. 3.17: Daylight within bedrooms

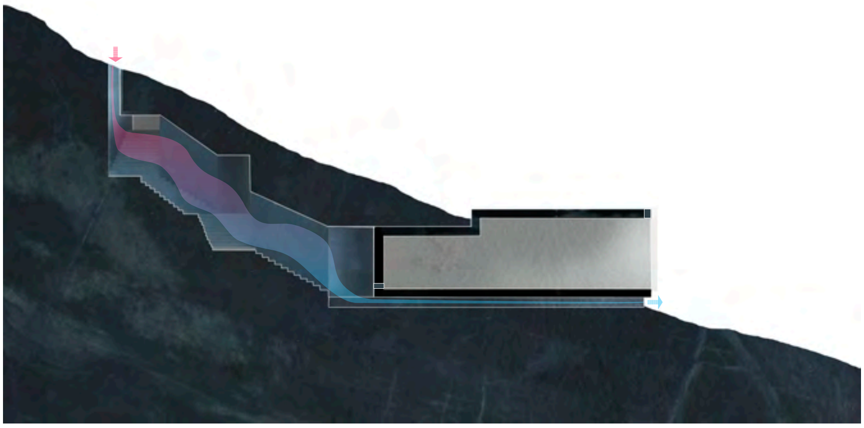
VENTILATION

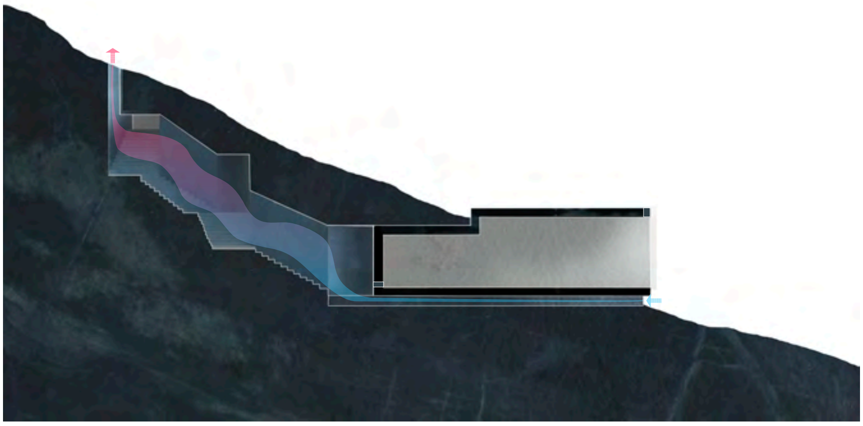
To secure a good atmospherically and thermal indoor environment a natural venting strategy has been designed. As the design will not use any sort of technical ventilation, a strategy for natural ventilation for both summer and winter has been designed.

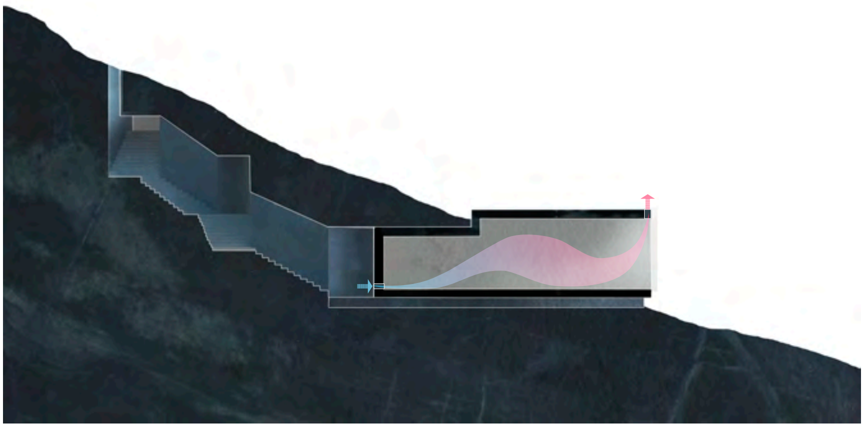
The natural ventilation system is designed to carry out the max air change. The max air change is dimensioned to decrease overheating in summer time. The basic air change is dimensioned to secure the atmospherically indoor environment all year.

The temperature of the mountain is adventurous to use for venting. Air with a temperature of 7 degrees has the possibility to cool the indoor space when overheated and at the same time, work as a preheated air when the outdoor temperature is cooler.

For detailed description of venting strategy see design process p. 40.


Ill. 3.18: Corridor venting strategy winter


Ill. 3.19: Corridor venting strategy summer


Ill. 3.20: Building venting strategy summer and winter

INDOOR ENVIRONMENT WINTER

Wintertime evokes the biggest temperature differences between inside and outside. By that winter is the season when the biggest temperature difference is found in the building, when the space transform from being uninhabited to be inhabited.

In the morning a 14 degrees kitchen meets you. One hour after lightening the wood stove the temperature will increase to 19 degrees. The same applies in the early afternoon when you get home after a day on the mountain.

In the afternoon the temperature will be 12 in the living room. One hour after lightening the wood stove the temperature will increase to 18 degrees.
The temperature when you go to bed will be only 14 degrees, but one hour after lightening the wood stove the temperature will increase to 19 degrees. If you make sure to keep the wood stove active during night the temperature will be 22 degrees when wakening in the morning.

The temperature will rise until it reaches a comfort level of 22 degrees. The indoor air quality is kept at a comfortable level by a limited use of natural ventilation.

For all spaces, the comfort level will increase with a bit of planning. Lightening the woodstove an hour before using the spaces is very advantageously. That will be possible to do in the morning in the kitchen and at night in the bedrooms. Only when returning from the day out on the mountain the room temperature will be 14 degrees. But that will be a warm temperature you meet, when you come from the outdoor temperature. It will be an comfortable experience sitting in the living room feeling the temperature raise parallel to the body temperature.

The ambitions for thermal indoor climate and the air quality are met in the winter period.

INDOOR ENVIRONMENT SUMMER

Summertime evokes the biggest challenges to the thermal indoor environment because of overheating caused by solar radiation. By that the summer season is the season that set strict demands to the venting system.

In BSim the air change rate has been dimensioned to secure the thermal indoor environment.

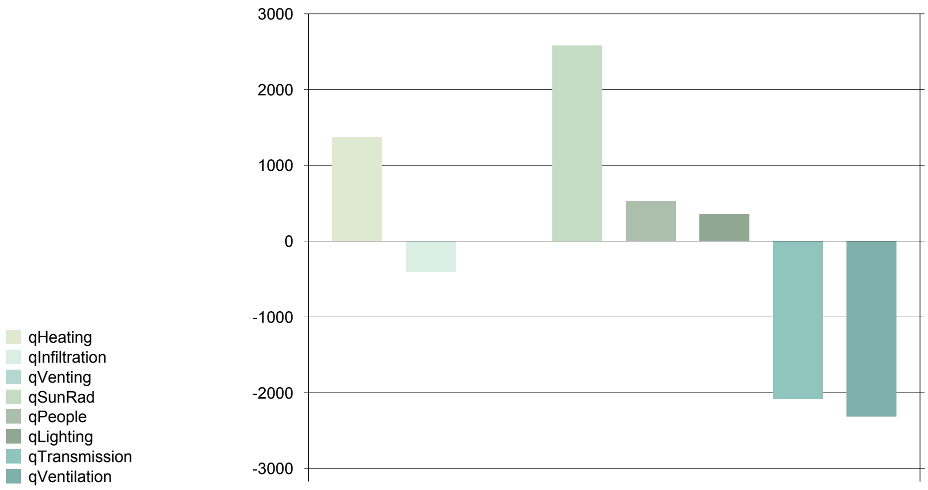
In the kitchen, living room and bedroom the air change rate has the possibility to increase to a max air change of 4-2,5 h-1.

That results in temperatures that do not exceed the acceptable temperature of 27, and only a limited amount of hours of 13 are above the 26 degrees.

The temperatures in the bedroom will exceed the given limits during day, when the bedroom is uninhabited. By that it has been aestimated that the overheating hours will not be a problem.

When the temperature reaches the comfort temperature of 24 degrees the users will activate the openings towards the corridor and in top of the room, to activate the venting. All openings for venting are dimensioned to carry out the dimensioned air change.

The ambitions for thermal indoor climate and the air quality are met in the summer period.



Ill. 3.21: Energy balance

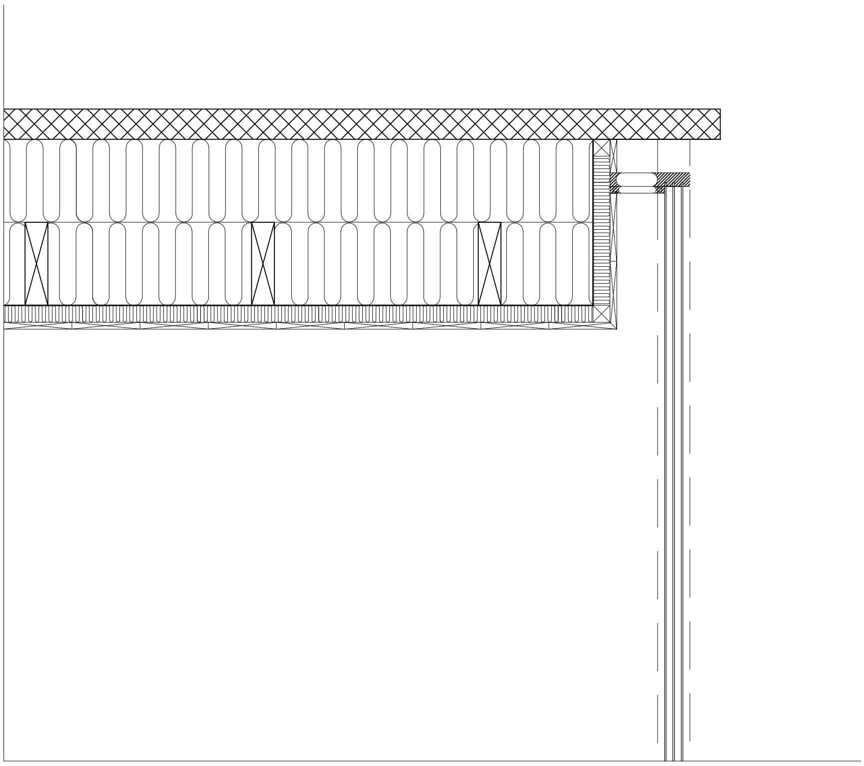
ENERGY BALANCE

Even though the energy balance will not be used to reach a specific category regarding the Danish building regulations, it was the aim to lower the energy balance, to decrease the use of wood for fire stoves.

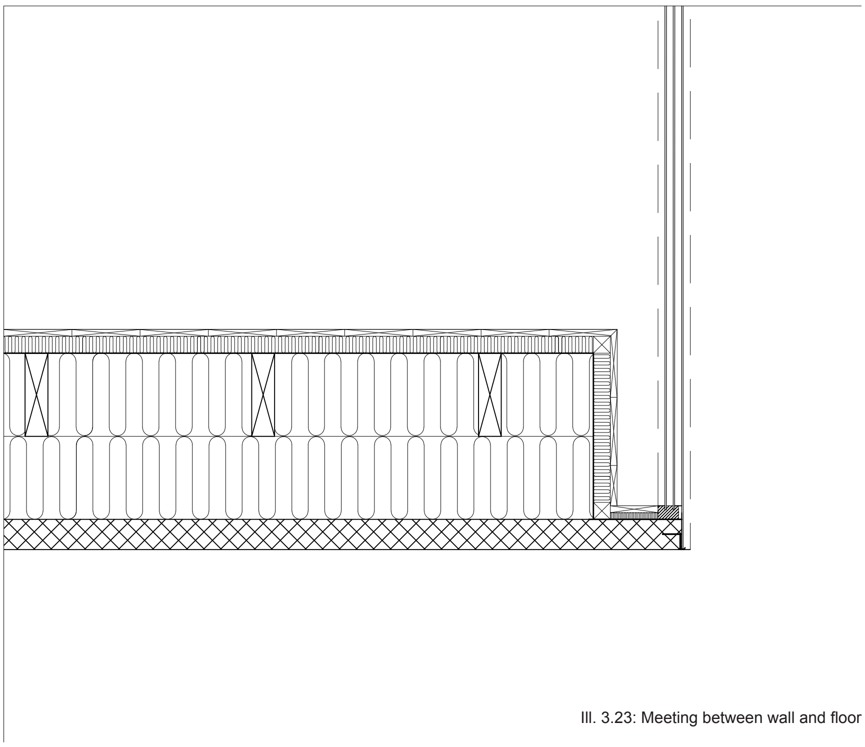
By building into the mountain, a low energy use is achieved by lowering the transmission loss and heatloss through ventilation. The transmission loss have been decreased by using a high-insulated constructions, highly resistant windows and dimensioning the windows to save transmission loss. The heat loss through the ventilation have been decreased by using the temperature inside the mountain as inlet in wintertime.

By using the outdoor air as inlet in periods where the outdoor temperature is warmer than the air from the corridor the heating demand will further decrease 30%. See p. 36 in the design process.

In this aspect it is interesting to dimension the quantity of wood for the fire stoves. The heating demand for the entire complex is 20.354 kWh, equal to a wood supply of 12 m3. By venting with the outdoor air in times when the outdoor temperature is higher than the mountain the heating demand will further decrease, and the wood supply will decrease as well.



Ill. 3.22: Meeting between wall and roof



Ill. 3.23: Meeting between wall and floor

DETAIL

To create the sensation, when standing inside one of the volumes, of having a fluent transition from in to outside, a detail is made, where the window bars are hidden within the construction. By hiding the window bars, the volumes will not have a clear indication of a division, between in and outside, and thereby leaving no disturbing elements, when the traveler admires the view.

FIRE EXIT PLAN

A building should be designed to accommodate evacuation easily and safely, either through escape routes or directly to the outside. Evacuation must be made to the outside, or to a safe place in the building.
The cabin complex consist of several volumes, separated by an outside mountain corridor. The material of the corridor is not combustible, and the open skylights, provide the space with constant air circulation. In terms of fire exit, the corridor will therefore be considered as a safe place, where it is possible for the visitor to evacuate.

Each of the volumes will function as a fire cell, meaning that the fire won't be able to spread to the other volumes. The mountain will prevent the fire from spreading, and thereby also making it easier to control. The rooms will be provided with one escape route, through the mountain corridor, and the common functions will be provided with three, one at the entrance, and one out to each of the terraces. Thereby maintaining a minimum distance to an escape route under 25m.

The building will be categorized as Application Category 5, a building that accommodate sleeping guests. They will not necessarily be familiar with the fire exit plan, but they will be able to bring themselves to safety.
Each room will further be equipped with a hose reel, and a battery-powered smoke detector (Bygningsreglement, 2014).

Ill. 3.24: Fire exit plan

Fire exit to a safe space

Fire cell

Mountain corridor

EPILOUQUE

4

REFLECTION

Through the project we have searched for the beauty, in connecting technical and aesthetic parameters in architecture. We have found that task deeply challenging, requiring not only the ability to understand the technical and aesthetic parameters, but also the ability to connect the parameters in new ways to solve complex problems.

We have throughout the project aimed to find new solutions, which can meet both the quantitative and qualitative requirements. Taking point of departure in securing the cabin for a new storm and reduce the area of the façade, facing the wind to decrease transmission loss, generated an idea about building the cabin into the mountain. An idea that could both improve the quantitative parameters, and at the same time define a strong architectural statement. Building the cabin into the mountain both answered different problems but also gave birth to new challenges, it became the turning point for the project.

The technical aspects have successfully been involved early in the process, achieving an early understanding of relations between e.g. volumes, mountain ratio and glass ratio. We found there is a very delicate balance, in how you prioritise the qualitative and quantitative parameters when they are conflicting instead of supporting each other. How do you compare the soft architectural qualities, with the hard technical facts? As an example, it has not been an aim to reach a light level of minimum 200 lux in all functions. Seen from a quantitative point of view, it is most functional to achieve a proper level of light in all functions. Seen from a qualitative point of view, a difference in light level through the building complex, will strengthen the experiences of being supported by the ground inside the mountain and being exposed in the prospect of the great view.

Throughout the project we have experienced how the technical parameters, instead of countering architectural quality, can be a useful tool to help navigating a project in the embellished field of architecture.

CONCLUSION

The project reinterprets Nordic architecture by going back to basics. The architecture and the nature makes it possible for mankind to reconnect with his roots and become accustomed to live on the premise of nature and landscape. The project questions how we want to live our lives and raises nature and wilderness as a response to the stressful modern society in the city

The cabin is placed rather isolated and off grid in a place of unspoiled and spectacular nature. Any solution regarding in- and output of the building complex have been considered in order for the building to be self-sufficient and simultaneously respect the nature and landscape.

By going back to basics, the design takes point of departure in defining the very basic needs for man, placing them in the very first primitive architecture, the cave, centralised around a fire. The fulfilments of the basic needs are met by manual solutions and wood as the only energy source all year around. The users will sense and take action themselves to obtain comfort, reinforcing the experience of the site and nature. Furthermore it will make people aware of their relation to and impact on nature. By that the design proposes a different solution to frame sustainability.

Summarizing the basic needs into a place for man to dwell, the dwelling can be characterized as a place for man to seek shelters and protection from the weather, a place where man can fulfil one's own very basic needs, a place for man to connect with himself, a place for man to be (å være). In the mountain to be is determined by a tension of above and below – something related to the heavenly, something related to the earthbound.

If to be (å være) relates to the mentality the Norwegians have when facing changing and unpredictable forces in climate and we¬ather. To be (å være) and Nordic architecture together relates to living poetically under the Nordic conditions.

REFERENCES

WEBPAGES

Bygningsreglement (2014) Available: http://bygningsreglementet.dk/br10_04_id76/0/42 (Accessed:05/05 2015)

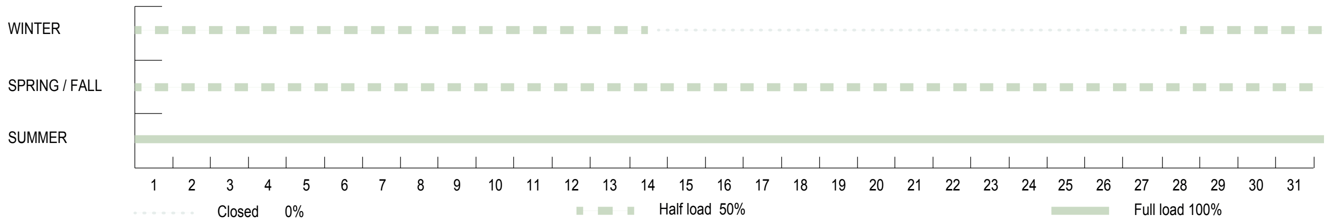
Imdb.com - Into the wild (2015). Available: http://www.imdb.com/title/tt0758758/?ref_=nv_sr_3 (Accessed: 09/02 2015)

Smisethjell, L. - Vil oppleve naturen, aktive turister vil oppleve natur og kultur (2015) Available: http://www.andalsnes-avis.no/nyheter/article10587861.ece (Accessed: 20/02 2015)

APPENDIX

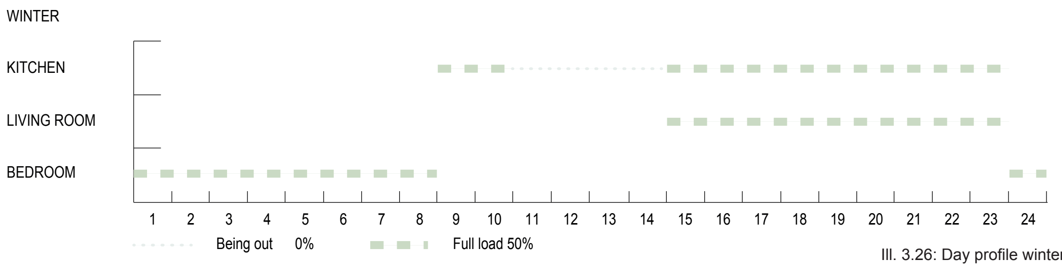
5

YEAR PROFILE

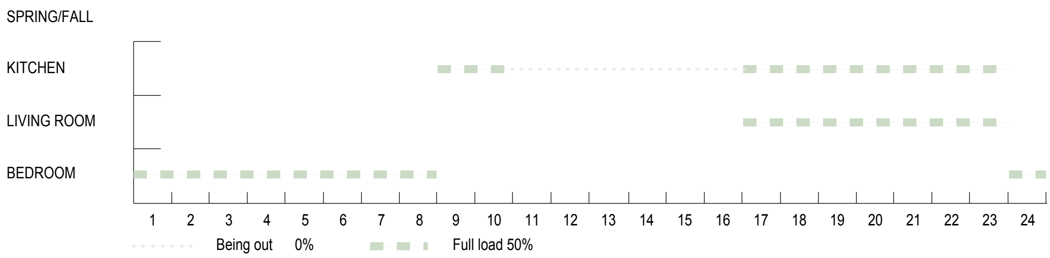


Ill. 3.25: Year profile

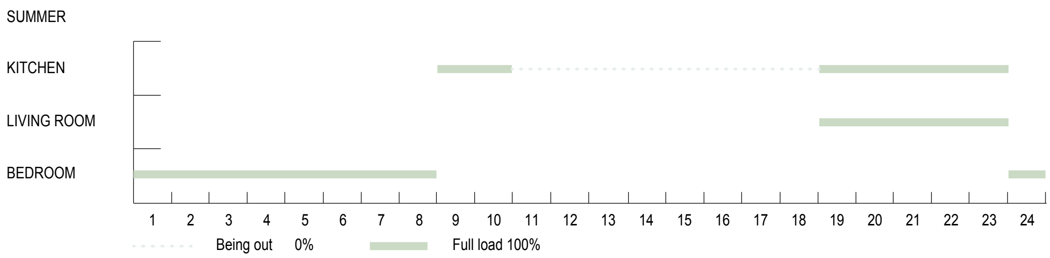
DAY PROFILE



Ill. 3.26: Day profile winter



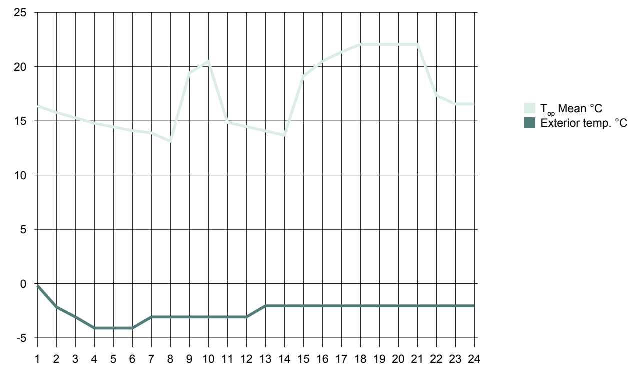
Ill. 3.27: Day profile Spring/fall

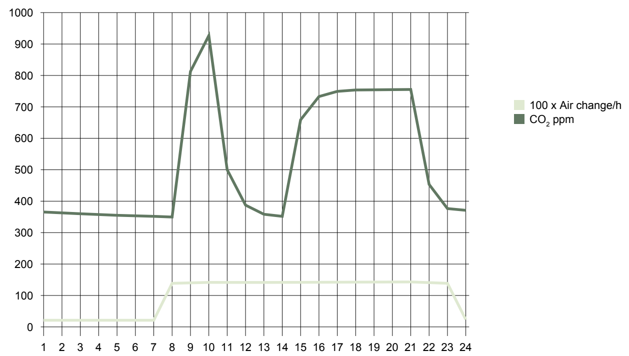


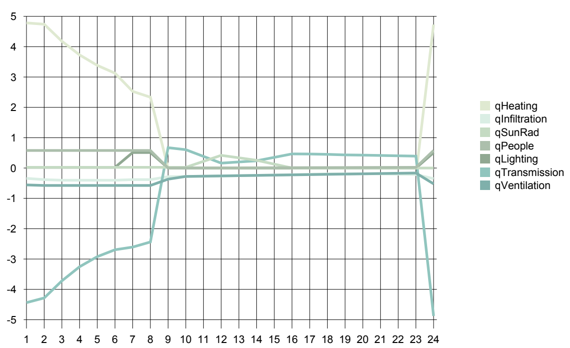
Ill. 3.28: Day profile Summer

DAY PROFILE - KITCHEN

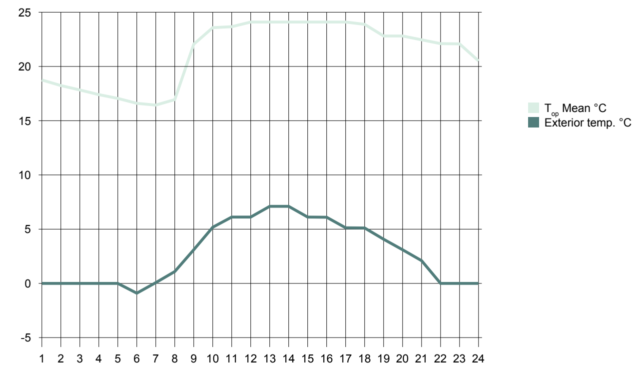
Ill. 3.29: 01.01.2015

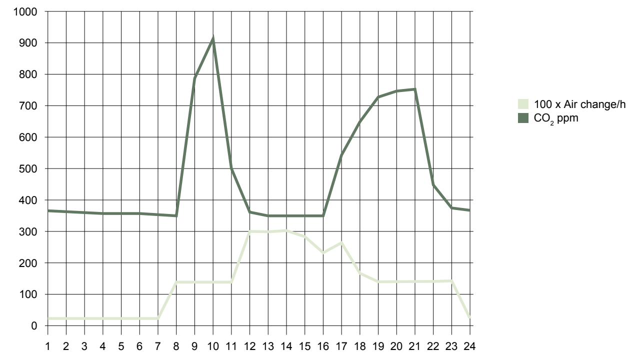


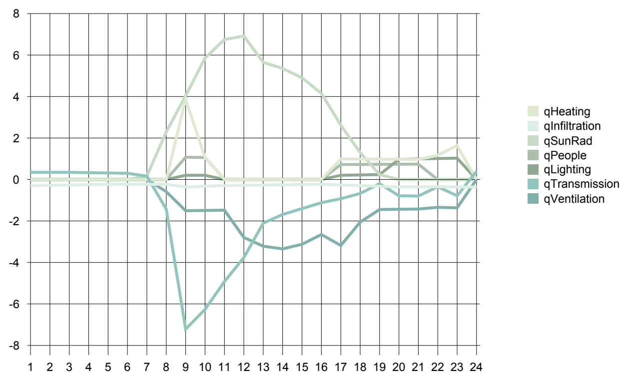




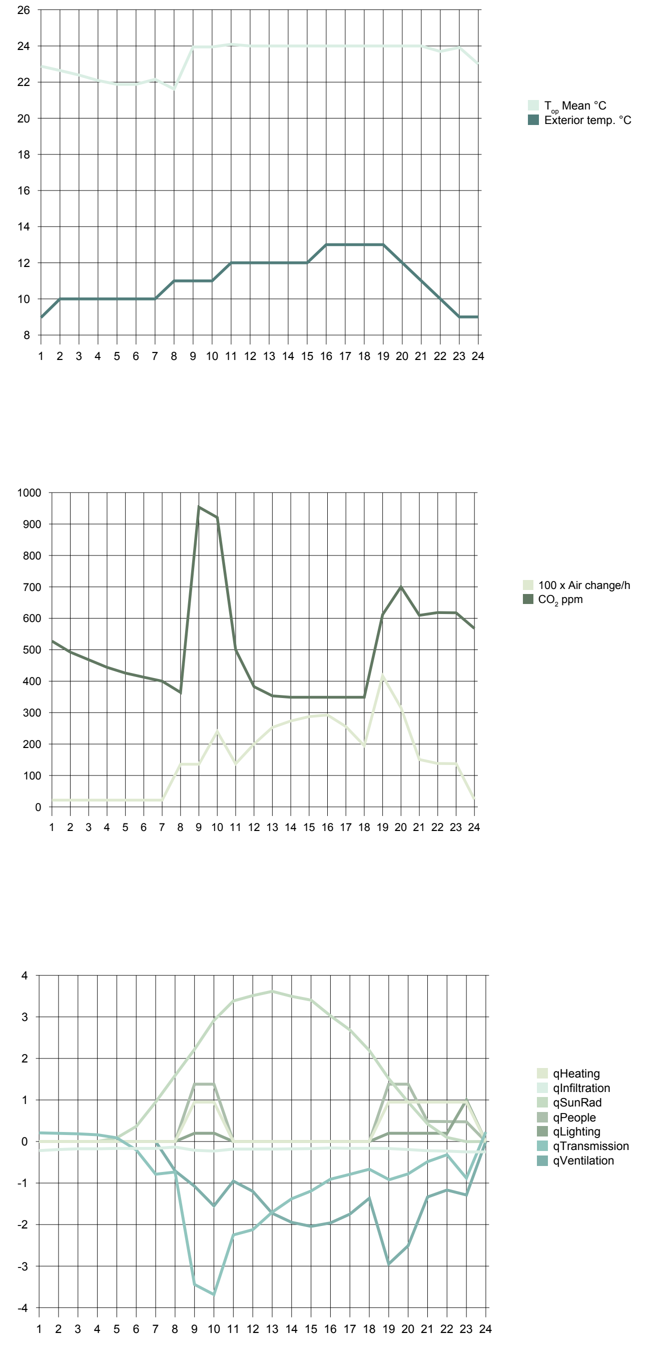
Ill. 3.30: 01.04.2015



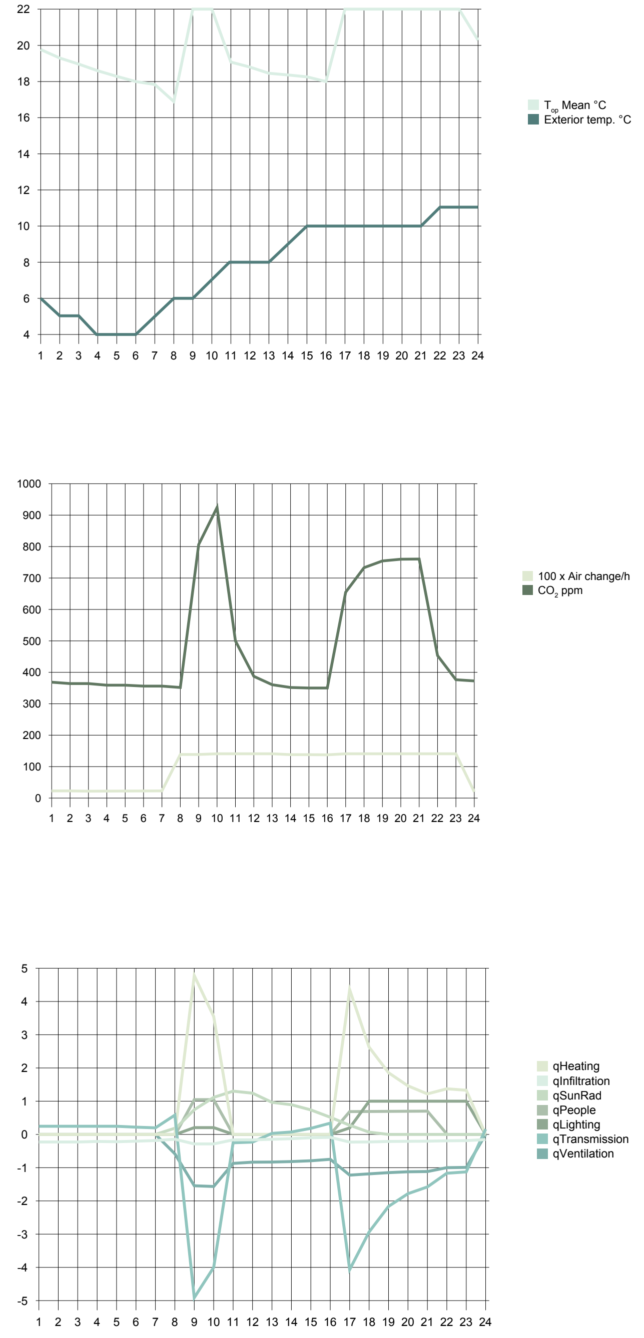




Ill. 3.31: 01.07.2015

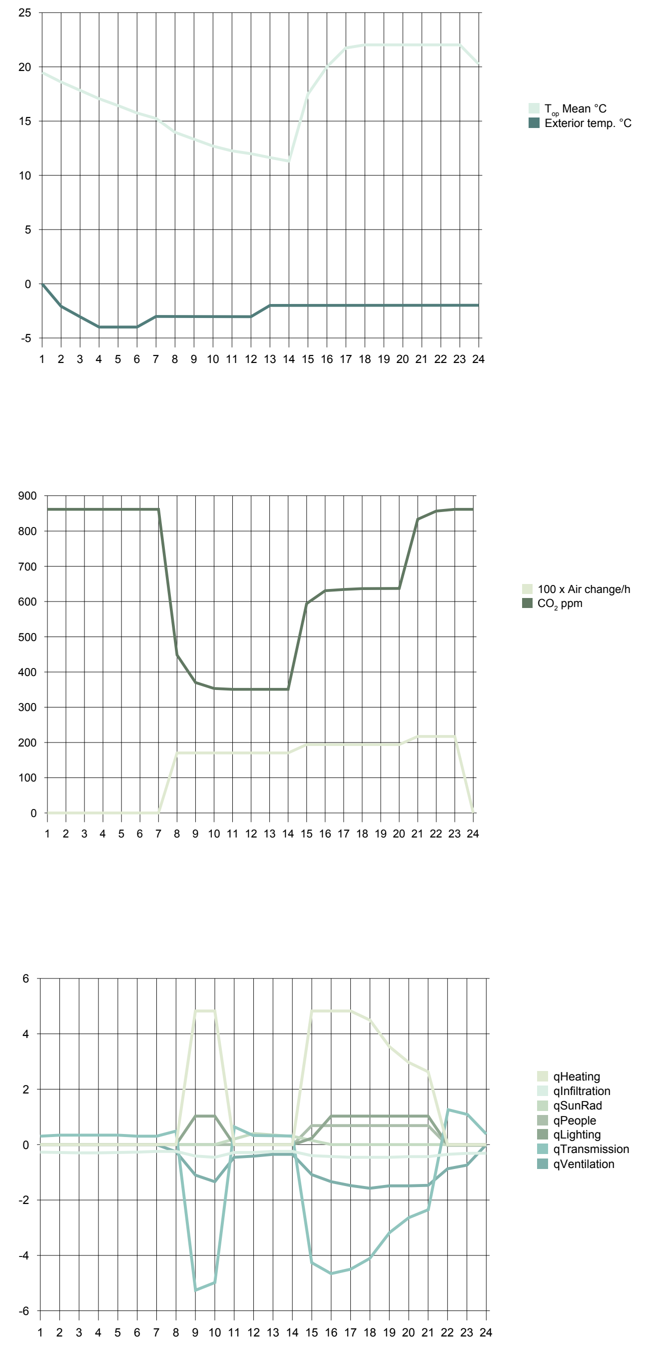


Ill. 3.32: 01.10.2015

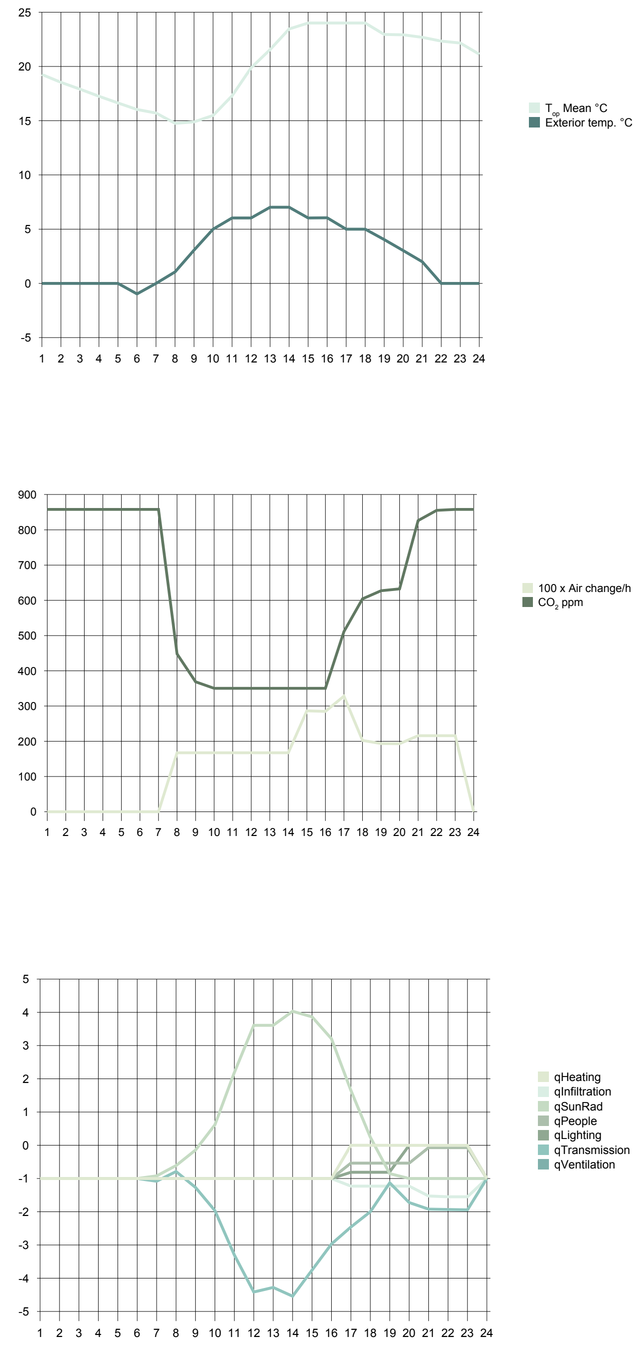


DAY PROFILE - LIVING ROOM

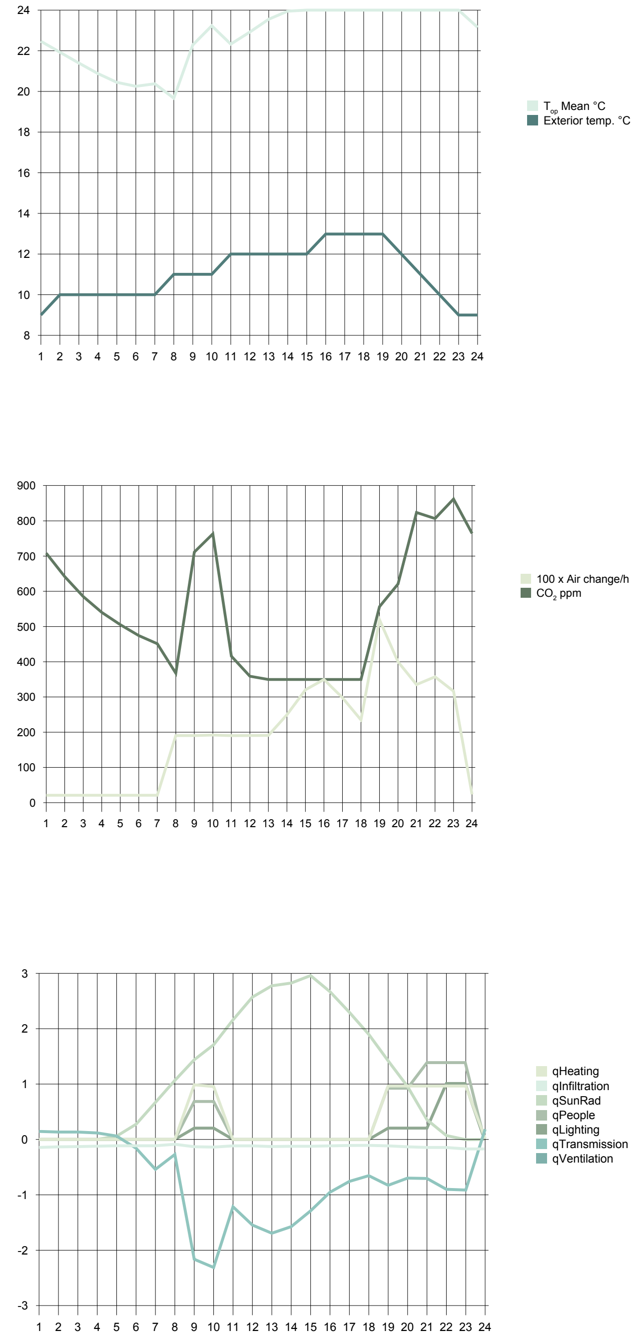
Ill. 3.33: 01.01.2015



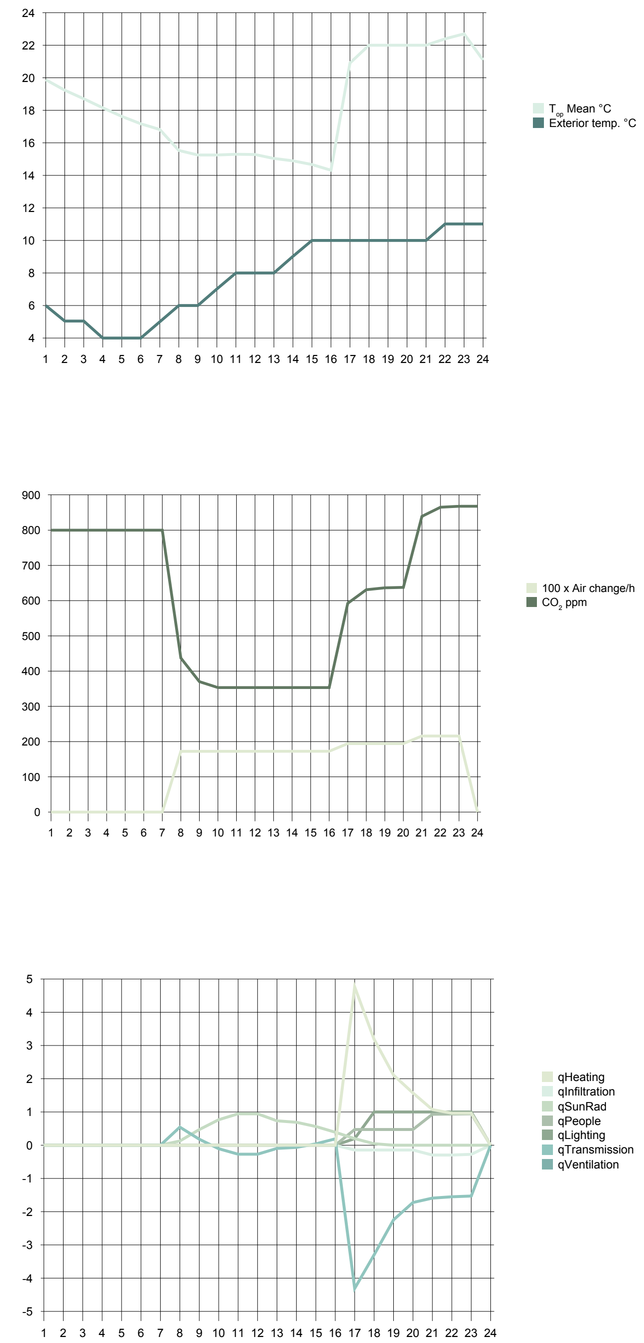
Ill. 3.34: 01.04.2015



Ill. 3.35: 01.07.2015

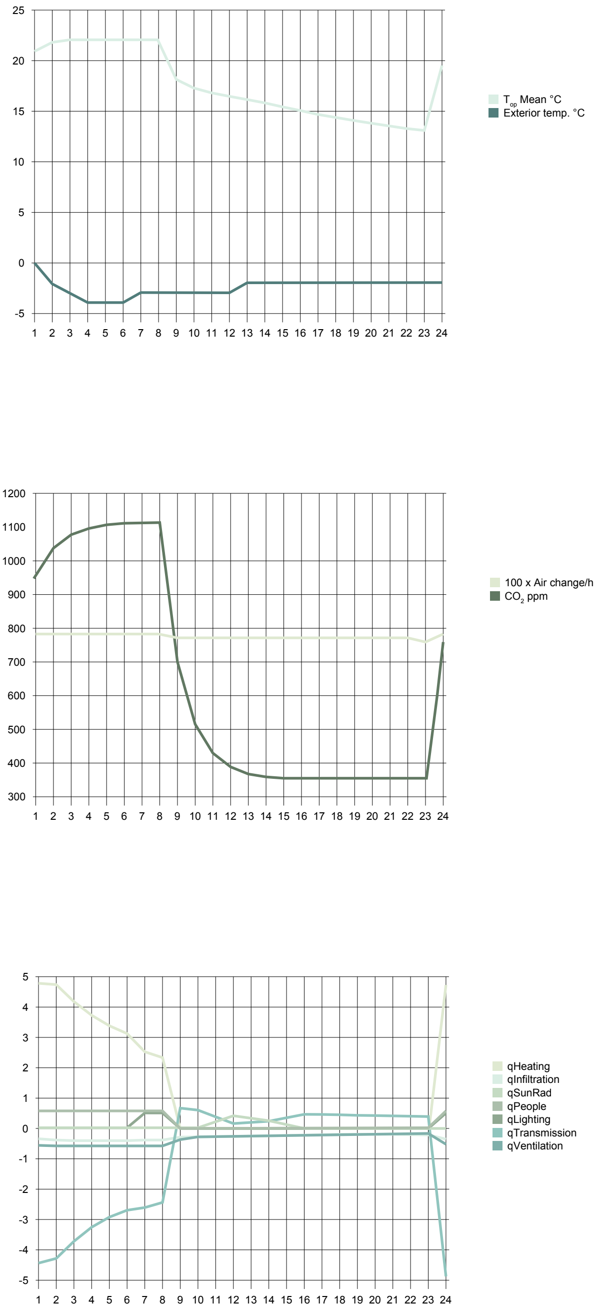


Ill. 3.36: 01.10.2015

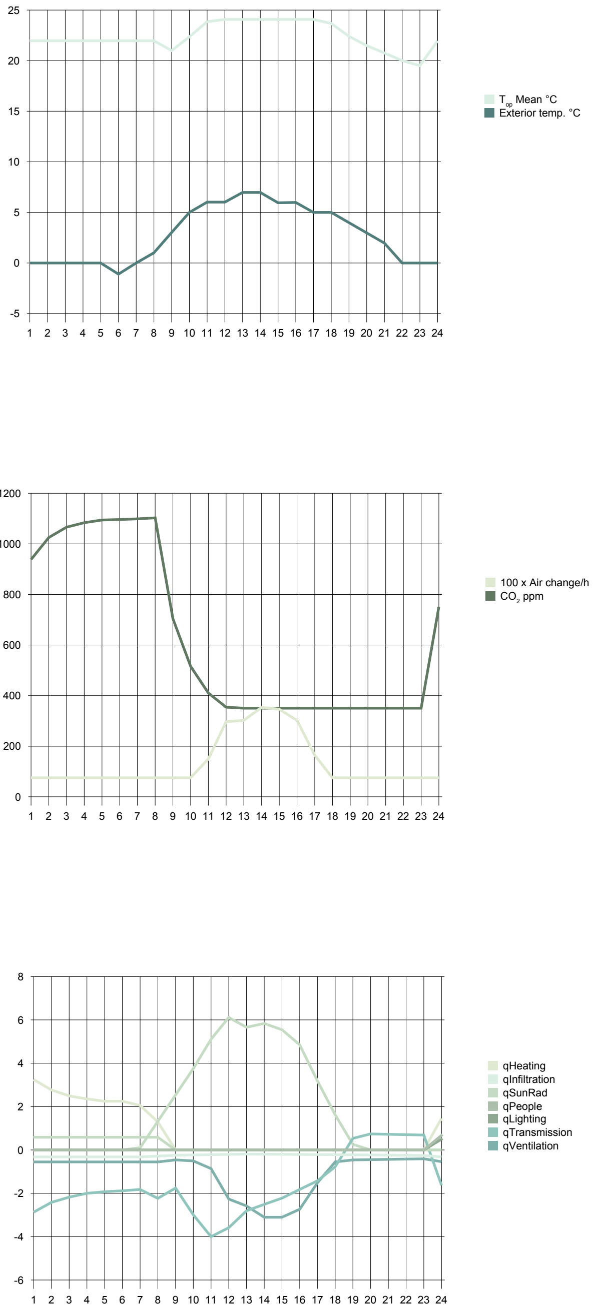


DAY PROFILE - BEDROOM

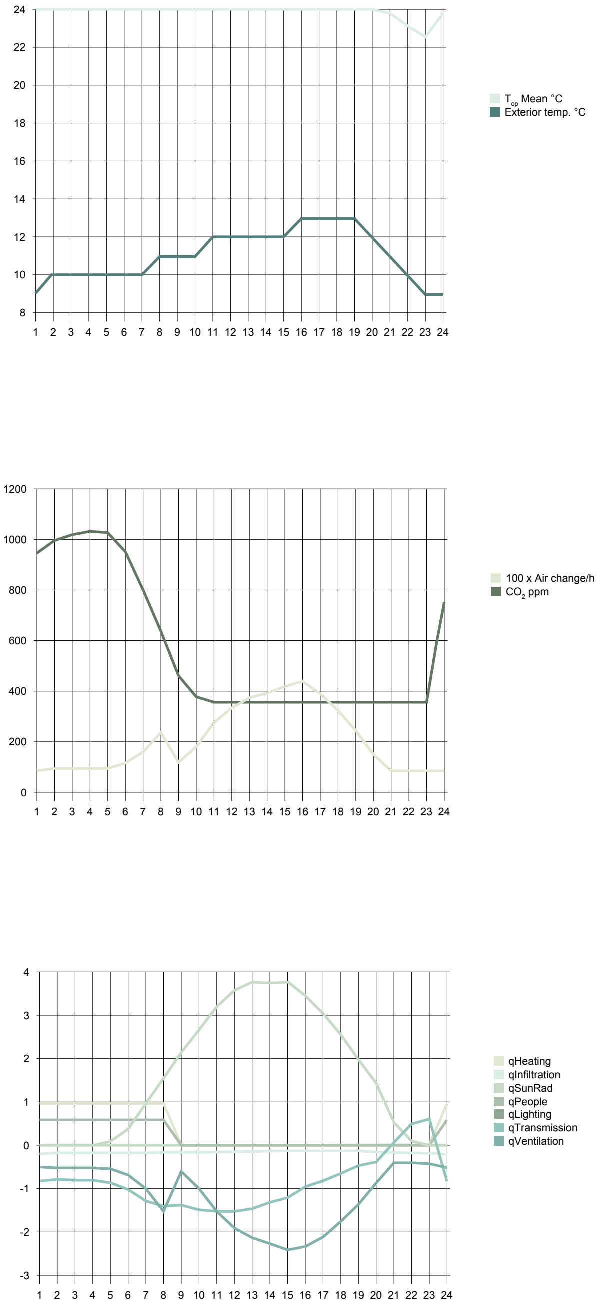
Ill. 3.37: 01.01.2015



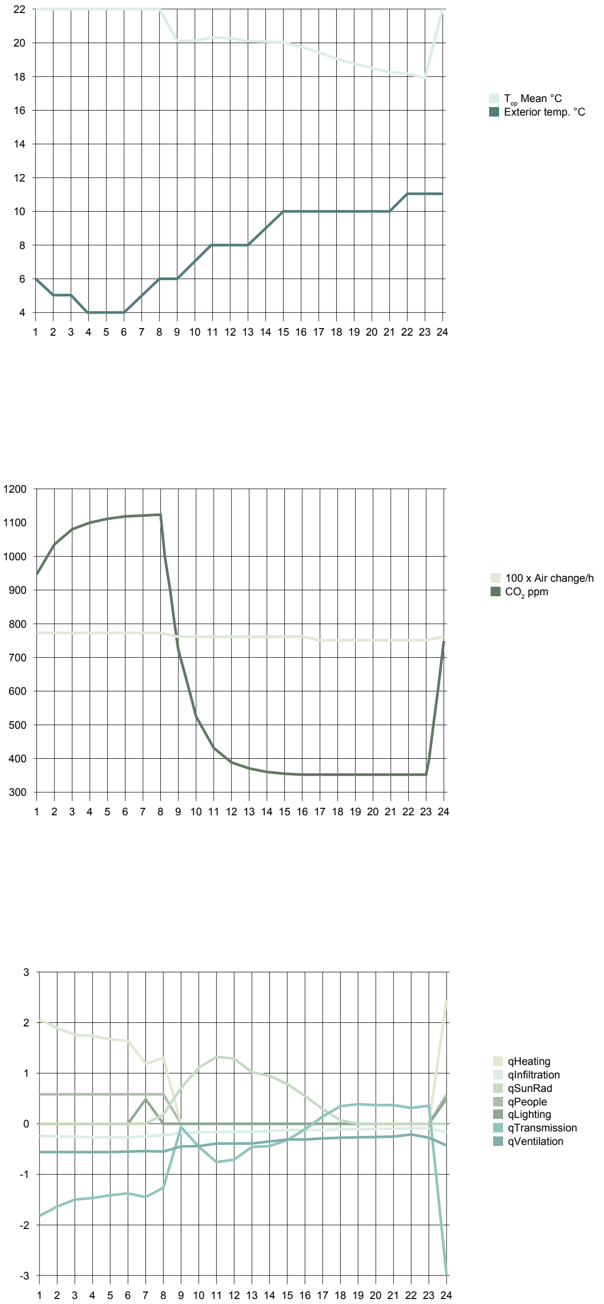
Ill. 3.38: 01.04.2015

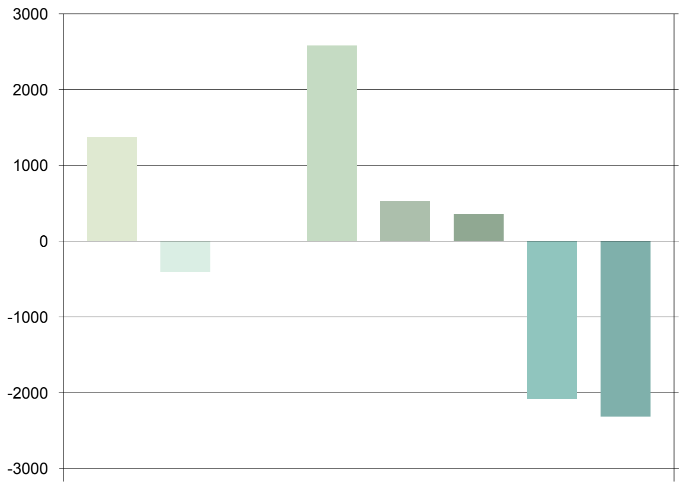


Ill. 3.39: 01.07.2015



Ill. 3.40: 01.10.2015



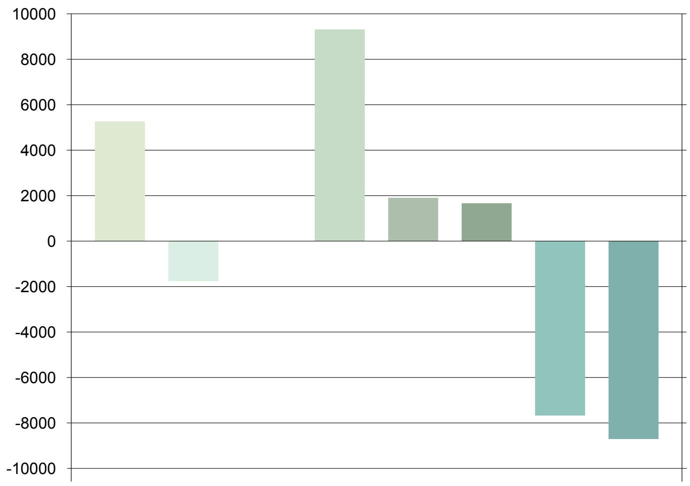


YEAR PROFILE - COMPLEX

2016 | Month | Hours | (Tungestølen)

(Tungestølen)	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)
qHeating	13700,56	1534,38	627,57	1863,29	1188,75	835,05	637,80	687,08	715,40	853,15	1478,85	2256,31
qCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qInfiltration	-4130,15	-320,24	-246,73	-492,83	-430,09	-419,23	-323,34	-284,59	-271,25	-341,26	-386,45	-413,98
qVenting	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qSunRad	25746,04	423,73	880,92	1872,51	2940,22	4268,53	4001,26	3727,60	3167,02	2108,71	1546,67	511,08
qPeople	5229,50	239,64	141,00	474,97	459,65	474,97	584,06	603,53	603,53	459,65	474,97	459,65
qEquipment	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qLighting	3400,70	226,00	131,40	277,00	287,50	237,00	184,00	196,40	247,60	333,50	457,70	511,40
qTransmission	-20850,06	-1519,84	-1198,11	-2423,76	-2209,20	-1989,12	-1686,38	-1585,41	-1515,87	-1707,34	-1815,55	-2032,84
qMixing	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qVentilation	-23186,33	-706,47	-436,05	-1671,16	-2253,90	-3408,97	-3441,17	-3340,57	-2947,20	-1712,02	-1675,90	-1286,41
Sum	0,27	0,00	0,01	0,02	0,03	0,08	0,04	0,04	0,03	0,02	0,01	0,01
tOutdoor mean(°C)	6,7	1,0	0,9	2,3	4,9	0,6	11,7	13,3	13,5	10,2	7,2	3,9
tOp mean(°C)	17,0	11,3	8,9	16,7	18,6	20,4	21,5	21,8	21,5	19,3	18,0	16,1
AirChange(/h)	1,1	0,7	0,7	0,8	1,1	1,5	1,9	1,8	1,7	1,0	0,9	0,6
Rel. Moisture(%)	44,9	51,2	50,1	34,5	34,4	36,8	41,7	47,5	46,6	50,7	44,8	43,2
Co2(ppm)	482,1	455,5	485,5	522,1	520,6	476,4	484,4	473,1	484,9	493,7	525,8	526,7
PAQ(-)	0,5	0,9	0,9	0,8	0,7	0,6	0,4	0,3	0,4	0,4	0,6	0,7
Hours > 21												
Hours > 26												
Hours > 27												
Hours < 19												
FanPow	1730,97	91,67	82,87	101,79	130,19	200,23	240,87	247,36	220,97	124,39	110,29	88,83
HtRec	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
ClRec	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HtCoil	3203,74	846,22	880,85	483,75	208,57	28,90	0,82	0,00	0,06	3,15	115,37	394,93
ClCoil	5261,84	0,61	-0,52	-0,99	108,86	863,87	1089,57	1496,61	1611,15	149,61	107,01	-27,15
Humidif	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorHeat	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorCool	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPumpPow	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCoolingPow	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPump	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Ill. 3.41: The cabin complex

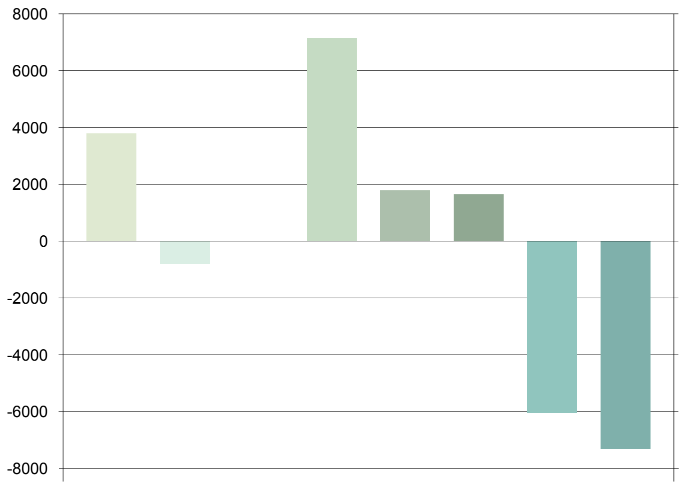


YEAR PROFILE - KITCHEN

2015 | Month | Hours | kitchen

kitchen	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)
qHeating	5203.38	567.46	243.52	778.54	490.73	324.01	210.51	209.12	222.13	340.81	620.82	914.53
qCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qInfiltration	-1754.72	-142.67	-113.74	-220.68	-153.65	-163.69	-124.55	-103.50	-104.01	-126.54	-165.27	-189.36
qVenting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qSunRad	9311.49	148.23	348.14	670.36	1068.22	1572.32	1449.50	1341.60	1155.23	757.31	544.47	179.72
qPeople	1896.05	117.50	95.30	171.42	165.89	171.42	207.36	214.27	214.27	165.89	171.42	165.89
qEquipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qLighting	1659.40	172.50	53.00	174.20	145.20	120.60	97.60	94.60	121.00	166.90	214.20	256.40
qTransmission	-7688.77	-552.80	-434.81	-914.26	-832.00	-719.76	-598.81	-559.82	-537.57	-678.04	-732.07	-768.12
qMixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qVentilation	-8707.44	-270.63	-152.01	-668.17	-855.43	-1305.49	-1232.02	-1190.35	-1071.06	-656.43	-653.57	-539.11
Sum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
tOutdoor mean(°C)	6.7	1.8	0.9	2.3	4.9	8.6	11.7	13.3	13.5	10.2	7.2	3.9
tOp mean(°C)	18.5	12.3	10.7	19.1	20.5	22.0	22.6	22.8	22.5	21.6	20.0	18.4
AirChange(/h)	1.4	1.0	1.0	1.1	1.3	1.5	2.1	2.1	1.9	1.3	1.1	1.0
Rel Moisture(%)	40.3	47.3	47.0	28.4	29.2	32.6	38.5	44.3	43.3	44.7	38.5	36.0
Co2(ppm)	464.9	445.7	398.9	485.4	477.2	444.5	487.9	489.2	494.4	475.5	486.8	488.6
PAQ(-)	0.6	0.9	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.4	0.5	0.7
Hours > 27	4224	104	62	303	391	505	557	611	573	450	346	247
Hours > 26	13	0	0	0	0	0	5	1	7	0	0	0
Hours > 27	0	0	0	0	0	0	0	0	0	0	0	0
Hours < 19	3446	608	582	384	253	100	30	3	36	113	287	411
FanPow	690.60	35.71	32.25	38.36	46.31	75.03	69.40	84.71	76.51	46.57	41.77	34.58
HtRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ClRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HtCoil	1207.21	249.07	202.00	205.20	20.90	7.97	0.06	0.00	0.00	1.97	41.50	149.75
ClCoil	-2049.17	-0.25	-0.11	-0.50	-35.70	-272.37	-430.59	-508.35	-624.24	-47.20	-29.30	-9.09
HumSt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorHeat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorCool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPumpPow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCoolingPow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPump	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Ill. 3.42: The kitchen

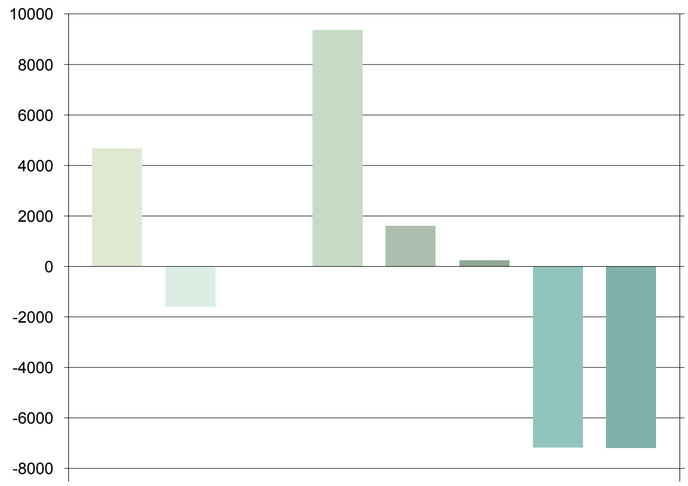


YEAR PROFILE - LIVING ROOM

2015 | Month | Hours | kitchen

kitchen	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)
qHeating	5203,38	567,46	243,52	778,54	456,73	324,01	210,51	209,12	222,13	340,81	620,82	314,53
qCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qInfiltration	-1754,72	-142,67	-113,74	-220,68	-153,60	-163,69	-124,55	-109,50	-104,01	-126,54	-165,27	-189,36
qVenting	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qSunRad	3011,49	148,23	348,14	676,36	1068,22	1572,32	1449,50	1341,60	1155,23	757,31	544,47	179,72
qPeople	1896,05	117,50	95,30	171,42	165,89	171,47	207,36	214,27	214,27	165,89	171,42	165,89
qEquipment	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qLighting	1659,40	172,60	53,00	174,20	145,20	120,60	97,60	94,60	121,00	166,00	214,20	256,40
qTransmission	-7688,77	-752,80	-434,81	-914,26	-822,00	-719,76	-598,81	-559,82	-537,57	-678,04	-732,07	-768,12
qMixing	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qVentilation	-8707,44	-270,63	-152,01	-668,17	-855,43	-1305,49	-1232,02	-1190,35	-1071,06	-656,43	-653,57	-539,11
Sum	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
tOutdoor mean(°C)	6,7	1,8	0,9	2,3	4,9	8,6	11,7	13,3	13,5	10,2	7,2	3,9
tOp mean(°C)	18,5	12,3	10,7	19,1	20,5	22,0	22,6	22,8	22,5	21,6	20,0	18,4
AirChange(/h)	1,4	1,0	1,0	1,1	1,3	1,9	2,1	2,1	1,9	1,3	1,1	1,0
Rel. Moisture(%)	40,3	47,3	47,0	28,4	29,2	32,6	38,5	44,3	43,3	44,7	38,5	36,0
Co2(ppm)	464,9	445,7	398,9	485,4	477,2	444,5	487,9	489,2	494,4	475,5	486,8	488,8
PAQ(-)	0,6	0,9	0,9	0,7	0,6	0,5	0,4	0,3	0,3	0,4	0,5	0,7
Hours > 21	4224	104	62	303	391	505	557	611	573	450	346	247
Hours > 26	13	0	0	0	0	0	5	1	7	0	0	0
Hours > 27	0	0	0	0	0	0	0	0	0	0	0	0
Hours < 19	3446	600	592	364	253	100	30	3	38	113	287	411
FanPow	690,60	35,71	32,25	38,36	46,31	75,03	83,49	84,71	76,51	46,57	41,77	34,58
HRec	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CRec	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HCoil	1207,21	289,07	262,00	205,28	70,90	7,97	0,06	0,00	0,00	1,97	41,60	149,76
CCoil	-2049,17	-0,25	-0,11	-0,50	-36,70	-272,37	-430,59	-505,35	-624,24	-47,28	-29,30	-9,09
HumSf	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorHeat	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorCool	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPumpPow	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCoolingPow	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPump	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Ill. 3.43: Living room



YEAR PROFILE - BEDROOM

2015 | Month | Hours | Bedroom

Bedroom	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)
qHeating	4656.57	537.83	200.93	603.98	388.43	281.43	259.20	357.84	268.46	276.22	477.80	748.91
qCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qInfiltration	-1563.12	-120.51	-107.90	-195.08	-172.20	-147.23	-112.19	-99.74	-95.35	-119.63	-142.40	-159.48
qVenting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00
qSunRad	9341.94	150.55	349.59	673.86	1086.60	1545.17	1460.06	1367.00	1151.59	765.55	551.04	182.98
qPeople	1612.22	80.13	41.47	160.70	155.52	160.70	155.52	160.70	160.70	155.52	160.70	155.52
qEquipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qLighting	237.50	25.50	21.00	39.00	16.50	5.00	0.00	0.00	0.00	15.50	44.50	45.00
qTransmission	-7124.00	-513.40	-401.50	-800.00	-763.06	-705.69	-584.57	-584.50	-521.67	-589.54	-625.44	-674.62
qMixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qVentilation	-7160.12	-160.02	-103.59	-449.53	-890.97	-1139.40	-1186.85	-1142.11	-963.74	-503.43	-457.00	-298.30
Sum	0.00	-0.00	0.00	0.00	-0.00	-0.00	0.00	-0.00	0.00	0.00	-0.00	-0.00
tOutdoor mean(°C)	6.7	1.8	0.9	2.3	4.9	8.6	11.7	13.3	13.5	10.2	7.2	3.9
tOp mean(°C)	19.7	13.6	12.4	20.6	22.1	23.3	23.6	27.9	23.5	22.5	20.8	19.0
AirChange(/h)	1.4	0.8	0.8	0.9	1.3	2.0	2.6	2.5	2.2	1.7	1.0	0.8
Rel. Moisture(%)	39.4	45.5	43.8	27.8	28.7	32.1	37.3	43.0	42.3	44.1	38.6	36.6
Co2(ppm)	567.1	907.1	431.0	629.8	630.7	598.6	597.1	540.0	582.3	627.2	636.4	635.0
PAQ(-)	0.5	0.8	0.9	0.6	0.6	0.5	0.4	0.3	0.3	0.3	0.5	0.6
Hours > 21	5529	141	81	397	562	720	719	744	732	642	417	388
Hours > 26	45	0	0	2	6	15	4	7	11	0	0	0
Hours > 27	3	0	0	0	0	0	0	0	3	0	0	0
Hours < 19	2594	584	577	183	41	0	0	0	0	5	154	386
FanPow	504.53	20.24	18.14	25.09	37.03	65.14	81.52	82.37	71.27	34.75	20.44	19.67
HtRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ClRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HtCoil	780.85	146.97	153.19	130.18	50.77	10.67	0.63	0.00	0.06	3.59	29.33	89.19
ClCoil	-1747.14	-0.11	-3.27	-8.24	-41.12	-215.20	-376.71	-500.45	-522.65	-40.97	-38.94	-4.57
Humidif	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorHeat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorCool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00
CentHeatPumpPow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCoolingPow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPump	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00

Ill. 3.44: Bed room