Mariagerfjord Hospice

Palliative Architecture

2017

Project title : Mariagerfjord Hospice
Semester : MSc04
Field of study : Architecture & Design
Project period : 01.02.2017 - 18.05.2017

Project group : 1

Supervisor : Isak Worre Foged,
MSc.Eng.Arch., M.Arch.,
Architect MAA, PhD
Techinal supervisor : Claus Topp,
MSc, civil Engineering,
PhD Cevil Engineeting
Pages : 121
Apendix : 29

Marie Riisberg Mikkelsen

Morten Skjøttgaard Pedersen

READING GUIDE

This thesis is divided in a program, a representation of the project, a design process, and an appendix. The program will guide the reader through the main topics of the project, as well as site analysis and case studies. These will be the foundation of the project and lead to the design parameters, which have been used in the design development.

A representation of final design proposal is shown by a masterplan, plan solutions, sections, facades, and these are supported by detail drawings, simulations, and calculations as well as the choice of material. Visualizations is used to sustain the perception of the internal and external spaces, and the different atmospheres.

After the representation, a clarifying design process is presented in four phases, where an introduction of each phase informs the reader what the focus is in the current phase. Furthermore, a diagram of the parameters of an integrated design, illustrate which of parameters the phase concerns. This should ensure that each of the parameters have been activated in the design process. Each phase contains different iterations, which have influenced the project. Both the design process and the representation are sustained by the appendix.

As a final a conclusion and a reflection of the thesis are made.

The simulations and calculations of the indoor enviroment have been done at the patient room and the atrium. These are chosen because the atrium is one of the most critical rooms in the building, and the high focus on the room quality of the patient rooms.

The Harvard method has been used for references.

MOTIVATION

In Denmark, every third of the population are effected by cancer, and fortunately the medical science can cure above half of the cancer patients, but the other half will die approximately within the first five years of their illness. (Kræftens Bekæmpelse 2014) Most of these patients have been through long medical treatments, operations and consultations with different nurses and doctors, and this have been a painful and stressful journey. At the final stage of the cancer patient's life it is important that all this painfulness and stressfulness is replaced with a relief of pain, space for reflection and an embracing atmosphere. This is the experiences they can have at a hospice. A hospice should be welcoming and provide with a homely character which embrace the patients and their relatives. This should be emphasized through the architecture, by using the theories of healing architecture and set focus on the keywords aesthetics, nature, and a homely character (Hansen 2017).

Healing architecture has curt our interest because of the influence, the architecture can have on the human body and mind, as well as how the design principles of healing architecture is used to create architecture with a high focus on the quality of materiality, tactility, and detailing. The choice of using the theories of healing architecture within a hospice, is made upon that fact that both of us have had close relatives with cancer diagnoses. This have increased our interest to bring focus on the institutions in Denmark which are focused on terminally ill people, and how it is possible to create unique beautiful moments in the end of life. In the end, it is the smaller things in life that matters.

We have chosen to work with the project of Mariagerfjord Hospice, because it is located in a district which do not have a hospice at the moment. The site we have chosen, has through the last five years been a part of project Mariagerfjord Hospice. At the current moment, the project has been delayed because of the lack of funds. It is in our interest to provide with some input to the project to make it possible to realize Mariagerfjord Hospice in a nearly future.

ABSTRACT

This thesis is done by group 1 at MsC04 at Architecture and Design, Aalborg University, 2017. The thesis present a design proposal of Mariagerfjord Hospice, and the process that have led to the final design. The design is sustained by analysis of Hospice in Denmark, Palliative architecture, Nordic architecture, Indoor environment, User group and site analysis. Furthermore, case studies have been used as inspiration in the design process. Through the design process the important iterations is described to create an understanding of the final design.

TABLE OF CONTENT

INTRODUCTION

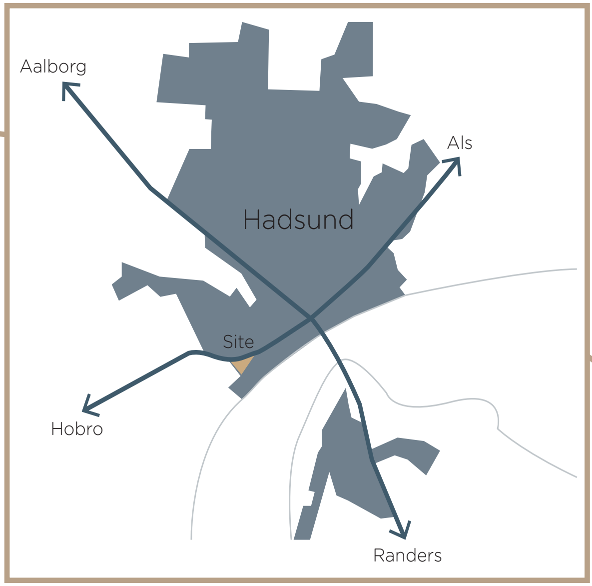
LOCATION

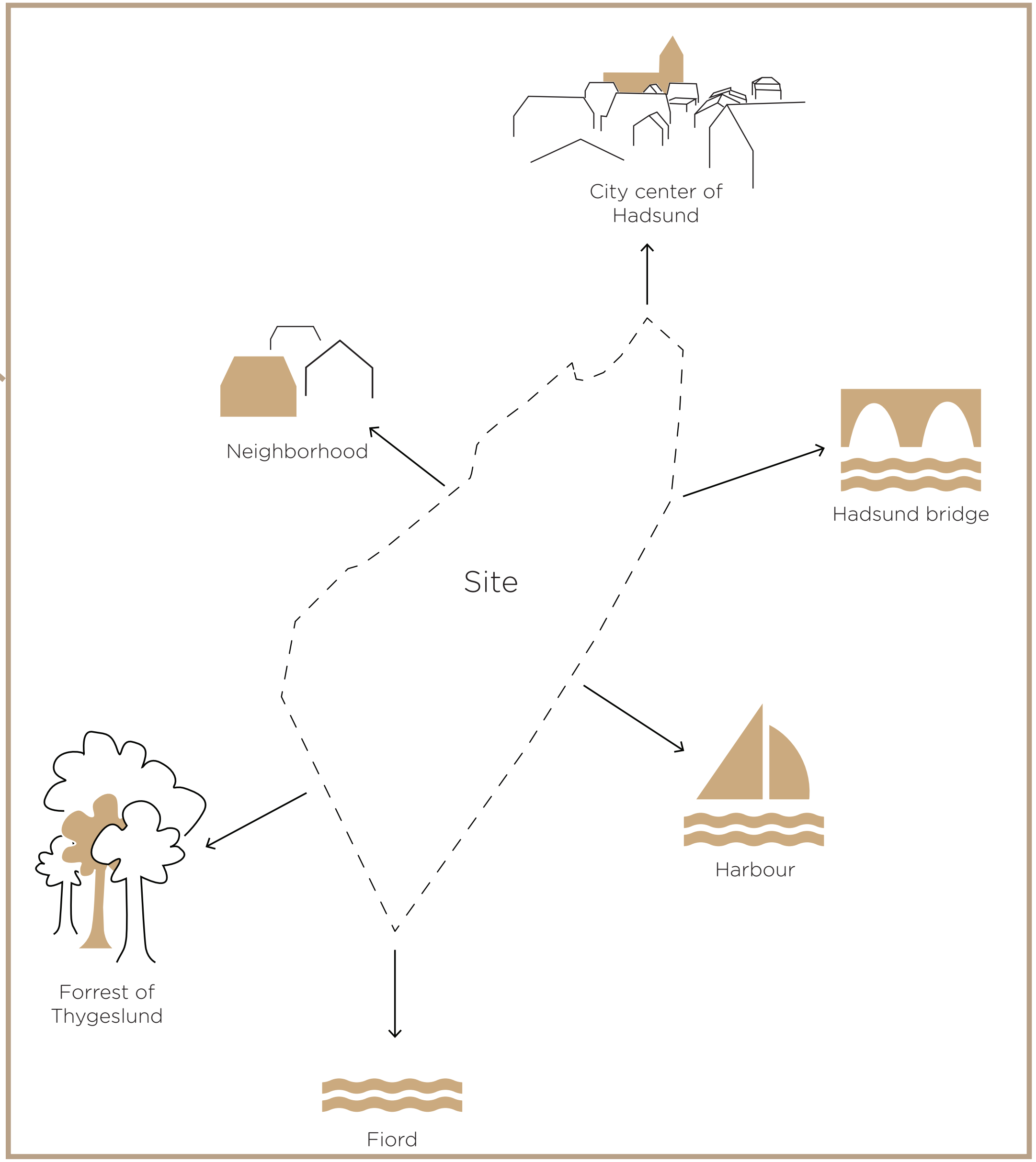
This thesis is aim to investigate the theories of Healing Architecture used in a building design of a hospice. Healing Architecture has become an important part of the care sector, and research have increased through the last decade. The influence, architecture has on the human body and mind, is inspiring and it has been scientifically proven that Healing Architecture has a positive effect on ill people.

In Denmark, hospices as an institution has existed for twenty years, and its importance in palliative care has grown throughout the years. A hospice provides care and secure the quality of life for the patient and their relatives alike. The philosophy of a hospice is based on quality of life, self-condence, and a dignified death. The task is to create a fully functional institution which is able to provide the patients and their relatives with a warm and embracing atmosphere. It is equally important, that the hospice creates a good work environment.

This project is located on a site in North Jutland in the outskirts of the small town Hadsund, next to the forest of Thygeslund. The site is located on top of a hill, with a 180 degrease view of Mariagerfjord facing south. On the north, a smaller neighborhood is located, which is connected to the city center east from the site. The church in the city center function as a landmark, which is visible from the site.

Ill 1 - Diagram of the palcement of the site in Denmark.


Aalborg
Als
Hadsund
Site
Hobro
Randers


City center of
Hadsund
Neighborhood
Hadsund bridge
Site
Harbour
Forrest of
Thygeslund
Fiord

METHODOLOGY

This project is based on an integrated design process (IDP), which follows an iterative process between architectural and engineering qualities. The purpose with the use of an integrated design process is to end up with a design solution, which is presented as one unity, where the engineering and the architectural qualities are merged. This project has a focus on healing architecture and an engineering focus on social sustainability and the indoor environment. Mary-Ann Knudstrup has made a proposal on a method of the integrated design process, where the process is divided in five phases, which should function as guideline though the project. The different phases are connected as a linear process between the phases, with the possibility to have an iterative process shuffling between the phases. (Knudstup 2010) But the design process is difficult to put in boxes and specific phases, because the design process never is chronical, and the process is always individual to each project and each team. It is an iterative process, which contains both simple and more complicated elements, and different problems appear through the process. (Dikson 2002)

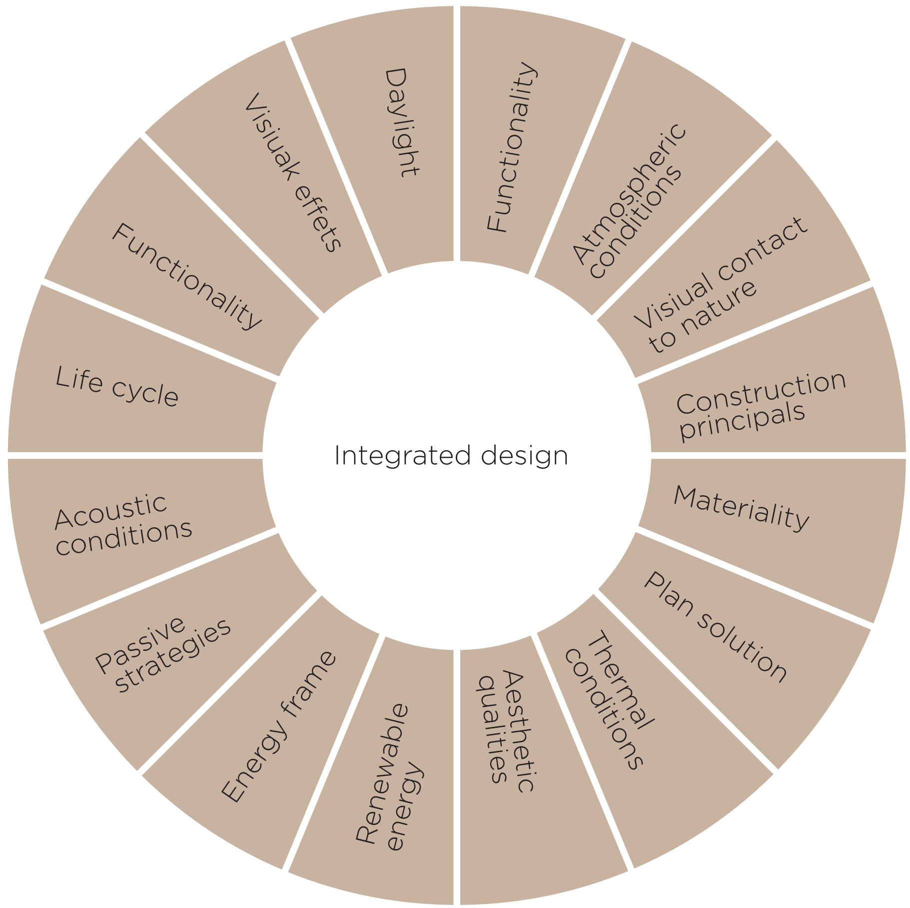
To create a foundation of the project a program is be formed, upon both qualitative, quantitative, and phenomenological methods, through the different analysis and investigations. The program will present the climate conditions at the site, mapping of the surroundings, materiality, topology, infrastructure etc., cases studies, analysis of healing architecture, indoor climate, and the Nordic traditions of architecture. All the studies are based on sustaining literature and interviews.
The microclimate is investigated by using the quantitative methodology, by making the investigations upon the data from the Danish Metrology Institute from 2016 at Aalborg Airport. (DMI, 2016)

To create an understanding of the site mapping is used. Mapping is a method James Corner has described as a design tool when creating urban spaces and architecture at a specific site. Mapping is a phenomenological method, because the maps always will be created upon a subjective opinion. By using this tool, the group maps what is important at the site, and each map give specific information of all the elements, which gives the design group an overview of what is preserved and what needs to be changed. (Cosgrove 1999) In this thesis mapping is used to create an understanding of the surroundings at the site, the placement of the site in Hadsund, and to get a survey of the infrastructure etc.
In addition to get an understanding of the site the method of photo registration is used to sense the place. (Ehlers 2001) Photo registration is a phenomenological method as well as mapping, and gives the design group the understanding of how one approach the site, what materials and elements that defines the site.

Case studies are made to sustain the design development, and give the design group inspiration. To make an adequate analyze the method of Vita Riis is used. When using this method one divide the analyze in different parts; Inside, Outside, Form, Construction/Technique, and Function. This division is efficient when one wants to remember all the smaller details, and when investigating specific parts of a building or space ex the plan solution, the light conditions etc. (Riis 2001) Through this thesis this method is used to investigate different cases which are relevant for the project, and by that create inspiration for the further design development. At each case, specific parameters are chosen to investigate, to ensure the relevance to this project.

The themes of this thesis have been analysied, and these are sustained by literature, and visits of hospices and interviews with people working in the field as well. It is chosen to use the method of the qualitative interview because this method gives the informant the possibility to provide with information, which the interviewer has not thought of. To prepare the interview it is important to clarify who the informant is, and what is relevant for the project. (Birkmann 2009) The program will in the end provide with knowledge and an understanding of the project, and specific design parameters

can be selected, and used as a direction tool though the further design development. The program end up with a vison for the project provide with a common understanding to the design group of what the goals are.
Through the process of making a program ideas and thoughts of how the project should be will appear, and that is the time early conceptual sketching will be drawn. The sketches are used as a communication tool between the group members as well communication between the group and the supervisors, and is used through the whole design process. Sketches and physically models are used as a method to create an overall concept. The physical models are both used to investigate the scale of the building in the context, and to make smaller muck ups of daylight conditions. This is done by a phenomenological approach, while the use of simulations of sound, light, the energy frame etc. are done with a quantitative approach, when the data of the simulations are measurable. The simulations provide with the knowledge of whether the demands and the desirable goals are reached. The simulations is used when the first overall concept have been made, to secure that the important elements are implemented correctly. The tool of 3D models will be activated early in the design process as well, when the 3D model can illustrate more details of the project, and can be used as a foundation to the simulations. When using both sketches, physical models, and 3D models the project can be observed through three different medias, which can provide the group with a profound understanding of the project, and along with the development of the project, more detailing will be added to the sketches, physical models, and 3D models. The design process ends up in a presentation of the project, and this is the part where the presentation material should be made.



Ill 2- Diagram of parameters influencing the integrated design process.

ANALYSIS

HOSPICE IN DENMARK - PALLIATIVE ARCHITECTURE - NORDIC ARCHITECTURE - INDOOR ENVIROMENT - USER GROUPS

HOSPICE IN DENMARK

Today's hospice philosophy is inspired by the British nurse, doctor, and social worker Cicely Saunders, who opened the first modern hospice in London in 1967. Her aim was to create an institution which can take care of patients who are dying of chronic diseases, and secure a dignified death of these patients. (Videbæk 2012)

Cicely Saunders used the expression "Total Pain" (1964) to explain what treatment and care the dying patients needs in the end of life. "Total pain" includes both the physical, the emotional, the social, and the spiritual pain dying patients can have, and Saunders believed that all these parameters should be considered in the palliative care, to ensure the possibility of a peaceful death. (Madsen,2017) Since 1964 the hospice philosophy has been used all over the world in the treatment and the care of terminally ill patients, and the expression "Total pain" have become the foundation of the modern hospice philosophy, (Hjort 2017). It is as well this theory which created the foundation of the palliative care and hospice in Denmark in 1992 when the first hospice Skt. Lukas Hospice in Hellerup was founded.

In Denmark hospices provides terminally ill patients with a place to die in peace, and with the possibility to live the last part of life whiteout unnecessary anxiety. (Realdania 2009) When the patients arrive to hospice, they should be able to feel safe, calme, and at home, these parameters should be provided by the surrounding building and the staff. A calm and homely atmosphere is a contrast to the hospitals where most patients arrives from longer treatment periods, and therefore the arrival to hospice is a relive to most patients and relatives. Most hospices in Denmark gives the possibility for the relatives to stay with the patients throughout the stay, which has a positive effect on most relatives experience of hospices and the death of a loved one. When the relatives are able to leave the everyday stress at home, it creates a unique possibility to be part of the patients, life before death, and this can be helpful in the grief after death. At a hospice taken care of the patients and the relatives are equally important. (Hansen 2017)

Since the first hospice was established in 1992, 19 hospices have been built in different regions of the country. Both the care sector and the public support of this institution has increased through the years, and the 19 hospices in Denmark do not cover the needed capacity any longer. The increased pressure on the hospice to accommodate more patients originates from an increase in the demographic of the patient group. Previously the focus was patients with cancer diagnoses (Realdania 2009), but recently a desire to offer patients with other chronic diseases space at the hospices has increaced. (Kristensen 2017) These changes create new demands of the hospice, and it is important to design the hospices in a way, that makes it easy to adjust, when this institution is in constantly development.

"It is not allowed to give up today, you have to fight for it! It is the doctors most important job to treat the patients as long as possible. This effects the last time of the patient's life, and most of them would have had a more peaceful end of life if they have ended treatment earlier!"
- Bodil Kristensen 2017

Another development the staff at the hospices experience, is the fact that the hospitalization of the patients decreases, which is the result of longer treatment than earlier. More of the patients comes in a more bad stage than earlier, and this requires adjustments within the medical capability, the equipment, and the surroundings. (Kristensen 2017) This development could be an occasion of implementing day-centers in the hospice. The day center can be part of the palliative strategy, and let the patients using the facilities of the hospice earlier in the process. The day-center should provide the patients with professional care through the day, while they still are able to be at their own home, and in the end, they can be hospitalized at the same hospice, were they know the staff already. Day-centers is not part of the hospice strategie in Denmark today, and it is our belief that implementation of day-centes in new hospices will increase the qualiaty palliative care. The day-centers will undermine the definition of hospice as plce to die.

“Buildings do not merely provide physical shelter. In addition to housing our fragile bodies, they also need to house our mind, memories, desires and dreams”

- Pallasmaa 1996

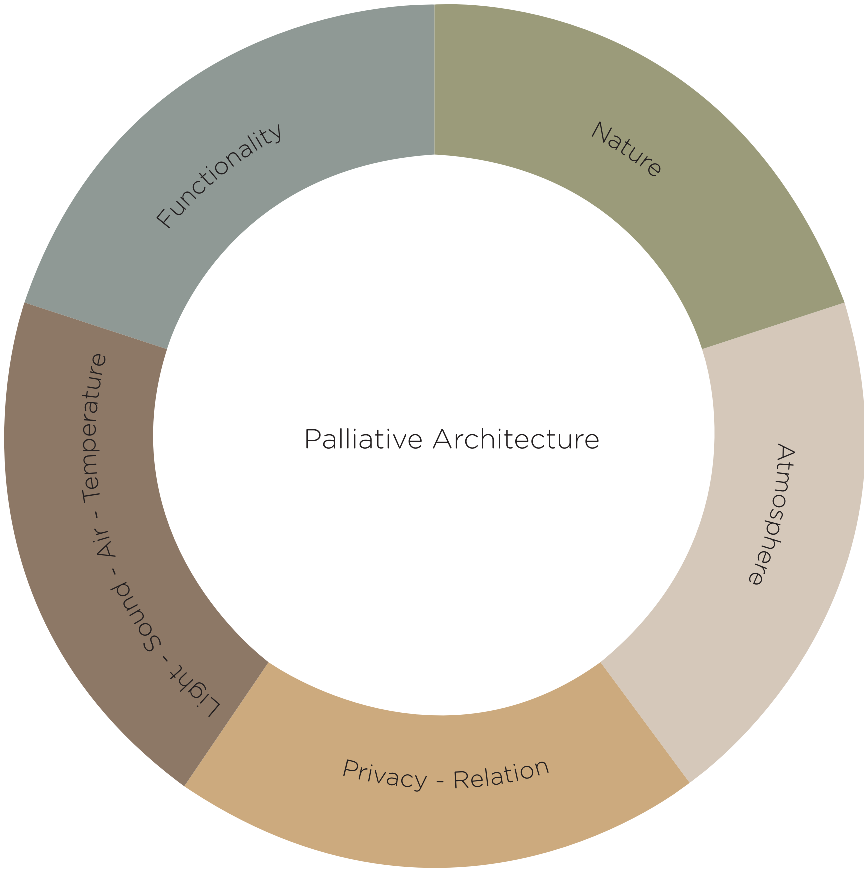
PALLIATIVE ARCHITECTURE

Through the last decade, the aspects of healing architecture have become a part of the design development of the new hospitals in Denmark, and the research within the area has been investigated more closely. The theories of healing architecture should increase the rehabilitation of the patients and by that reduce the hospitalization of the patients at the hospitals. Within a hospice, the theories of healing architecture can be used in the creation of palliative surroundings, and by that enhance the palliative care at the hospice. The architecture is used to provide terminally ill patients and their relatives with more positive surroundings, where a high focus on the physical senses, the human relations, and security creates the most efficient conditions for the patients to be able to live the life before death. (Frandsen 2009)

More aspects and elements are part of the definition of healing architecture, and to get an understanding of these, investigations, of how the different elements influence the physical and psychological perception of the surroundings, and the architecture, have been made. The investigations is used as part of creating design principles which can improve the experience of being hospitalized, and reduce the amount of days of hospitalization. The elements of light, colors, art, sound, movement, private-, common- and outdoor areas are some of those parameters, which have a huge impact on the perception of the architecture, because these have an influence on the human body and mind. It is these parameters the Danish research group were investigating more closely in the paper "Healing Architecture" in 2009. (Frandsen 2009) By the results of the report of healing architecture the knowledge Center of Rehabilitation and Palliation (REHBA) has established five design principals' in coherence with the study by Real Dania "Det Gode Hospice", and these design principals have been composite as a tool to the design development of a hospice. REHBA´s project is named "Palliative Architecture" and consists of the five principals; Privacy and relations, Nature, Light, sound, air and temperature, atmosphere, and functionality. The five principles are equally important in the process in the creation of a hospice. (REHBA, 2015) The palliative architecture creates the settings for a healing place and be a part of the palliative strategies along with the palliative care provided by the staff. (Frandsen 2009) To secure that the architecture become a part of the palliative care, the architects must actively implement the design strategies which supports the treatment of the patients, in the early stages of the design process. (Frandsen 2014)

Privacy and relations
A hospice is a place that provides terminally ill patients with a calm and peaceful place to spend their remaining time with their relatives. A hospice provide the patients and their relatives with different opportunities through the stay. Both private and common areas should be available. Privacy is important in the end of life, but also the possibility to be part of a solidarity is important. That is why a hospice offer private patient rooms, were the patient is able to be private and confidential with both relatives and staff members, and common rooms, which creates the possibility for the patients and the relatives to interact with each other. (REHBA 2015) The common room can function as areas for unofficial meetings, as well as they can function as a place for the relatives to get a break from the greave and intense atmosphere that appears in the situation of nearby death. It is also important to create zones of privacy in the common areas, to ensure that the patients and their relatives do not feel exposed, when useing the common facilities. (Kristensen 2017)

Nature
The physical senses at the hospice is an important factor in the creation of healing architecture. Nature can activate all the physical senses, and nature has a huge influence on both the human body and mind. It is proven that nature has an alleviating effect on stress, pain, and depression. (Frandsen 2009) To increase the quality and make sure that the patients are able to use the gardens and the outdoor areas, the outdoor areas have to be considered



Ill 3 - The five parameters which influence the palliative architecture.

early in the design process. Terminally ill patients often are confined to their bed which require a high focus on accessibility both in the gardens and inside the hospice. (REHBA 2015) To create the possibility for these patients to interact with nature, to feel a breeze of fresh air, smell the flowers in the garden and hear the birds singing, it is important that the gardens are established for their needs and restrains. The interaction with nature has a positive effect on the patient's life quality, and to extend the possibility to use the outdoor areas, winter gardens could be implemented in the design proposal of the hospice. (Hansen 2017)

Beside the possibility to use outdoor areas, the visability to nature influences the human body. By being able to see the nature from inside, it is possible to reduce the patients' use of pain-reviling medicine and their stress level. (Frandsen 2009)The possibility to use the outdoor areas have a positive effect on the staff and the relatives as well, and it have a positive effect on the everyday lafe at the hospice. (REHBA 2015) Also the view to nature provides with a positive atmosphere and has a calming effect on those who use the indoor spaces. It is important to consider the outdoor areas, and the placement of the windows according to the patient's rooms, as well as the views to nature should be incorporated in the design of the private and the common rooms. (Frandsen 2009)

Light

Through the investigation of healing architecture by Aalborg University, the most prominent element the patients and the staff mentioned was the effect of daylight and the possibility to see the landscape outside the building. It has been documented that the amount of daylight in the patient room, influence how fast the patients were discharged, as well as it has an influence on the stress- and pain level.(Frandsen 2009) A study showed that patients hospitalized in a patient room facing south, reduced the hospitalization with one day in preference to those who were hospitalized in a patient room facing north, while another study showed that the use of pain medicine was reduced by 22% when the patients were placed in a room facing west instead for east (Frandsen 2009). The light conditions do as well influence the circadian rhythm of all the users of the hospice (REHBA 2017), which has a huge impact on the wellbeing on the human. When we as humans are in balance we make less mistakes, and we become more positive, which is important at a hospice.

Beside the daylight, the artificial light is an important factor as well. The artificial light can create different atmospheres, by being able to regulate the intensity of the light, but also candles can be used to provide an atmosphere. In Denmark, the candles are associated with a friendly and homely atmosphere, which is a desired atmosphere within a hospice. Beside the friendly and homely atmosphere, the candles have a more international association with religion and hope. The light is able to lighten up in the dark times, and create a safe atmosphere. (Steenfeldt 2017)

A hospice is a work place as well, and both the daylight conditions and the artificial light should consider the staffs doings through the day. To avoid mistakes in the dosing of the medication, it is important to increase the amount of light in the staff areas and the medication room (Frandsen 2009).

Sound

Tranquility is some of the first thing one meet when entering a hospice, and it is an important factor of a hospice to ensure a space of calmness and confidentiality. (Hansen 2017) Noise has a negative influence on the human, and is important to consider in the design development of a hospice. Noise can increase the stress level and influence the quality of the sleep. WHO recommend that the noise level inside a patient room to be lower than 35dB through the day and 30dB at night. (Frandsen 2009) This should secure the quality of rest, sleep, a low stress level and lower pain level for the patients. The noise level influence the staffs stress level and wellbeing, as well.

Music and music therapy can be used to create a positive atmosphere, and is able to reduce stress and pain (Frandsen 2009). By implemnting music as part of the everyday at hospice, it can underline different moods and atmospheres, and this is able to calm the patients, as well as the sound of the nature can have a caleming effect. To avoide the feeling of lonliness, the sound of people in the surroundings have a huge impact. The possiblity to have total tranquility inside the patient room, and to be part of the life in the building when opening the door it will increase the quality of the patient room. (REHBA 2015)

Air and temperature

The side effects from the treatment of cancer patients often includes nausea, which makes them more sensitive to the smell, and for that reason it is important that a high air quality is ensured. By implementing flowers and vegetation in the furnishing of hospice, it is possible to bring up memories among the patients. (REHBA 2015) The temperature influences the air quality as well, and to increase the positive experience of the temperature, it should be possible to regulate the temperature in the patient rooms, and possible to open the doors and windows to the outside. (Frandsen 2009)

Atmosphere

It is desirable to create a homely atmosphere at a hospice, and most of the previous mentioned elements is part of the creation of atmospheres. An atmosphere depends on more parameters, and it concern the relation between the human body and an object, and how they interact with each other. (Hauge Kristensen 2017) The main atmosphere that is desired with in the hospice is a homely and embracing atmosphere, and this is reached by the combination of materiality, light, colors, the indoor climate conditions and the visibility and accessibility to nature. It is important to offer different atmospheres within the hospice, to ensure a possibility to use different areas of the hospice according to one's mood.

Functionality

Functionality is a fundamental part of the design of a hospice, and functionality appears in different levels in a building like a hospice. The plan solution should be simple and easy to understand as soon one enters the building. If the plan solution is to complex it can cause confusion and frustration among the users. Studies have shown that it is easier to understand a plan solution if the rooms have 90 degrees' corners (Frandsen 2009). To enhance the understanding of the organization in the building, landmarks within furniture, art and specific colors can be used as a tool, as well as by placing work stations in the areas where it is more difficult to understand the organization. (REHBA 2015)

The private patient rooms should be flexible, due to the fact, patients want the room to fit their needs. By rearranging the furniture and maybe adding some of their own, the patient can feel more at home and safe, which is an important parameter in a hospice. (REHBA 2009) And as well as the patient rooms should be flexible more of the common rooms should be multi-functional, to ensure the possibility to accommodate different events. (REHBA 2015)

In this thesis, the building design concerns the creation of a hospice which offer thermally ill patients with surrounding that have a positive effect in the pain and stress level. This is done by creating private and common areas, focusing on the placement of the rooms according to daylight, and implementation of nature, in the aim of creating atmospheres. Materiality, light, sound, and thermal conditions sustain the atmospheres, and these are the parameters which this thesis will involve in the design development.

NORDIC ARCHITECTURE

Sustainability, ecology, and a homely atmosphere is some of the parameters that characterize the Nordic identity today (Kjeldsen 2012). This is the result of the past fifty years with a welfare system as the fulcrum of the culture and architecture in the Nordic countries. Also a foundation of traditions through the past decade, created by some of grates architects in the northern countries has indluenced how the Nordic architecture is understood today. Through the years, the architecture has had the ability to challenge the interpretation on the welfare system, by always pushing the standards in public housing to a higher level (Andersen and Schelde 2012). The focus on creating architecture within the common housing, is as well a feature of the Nordic architecture, along with the tradition in creating funiture as a part of the architecture.

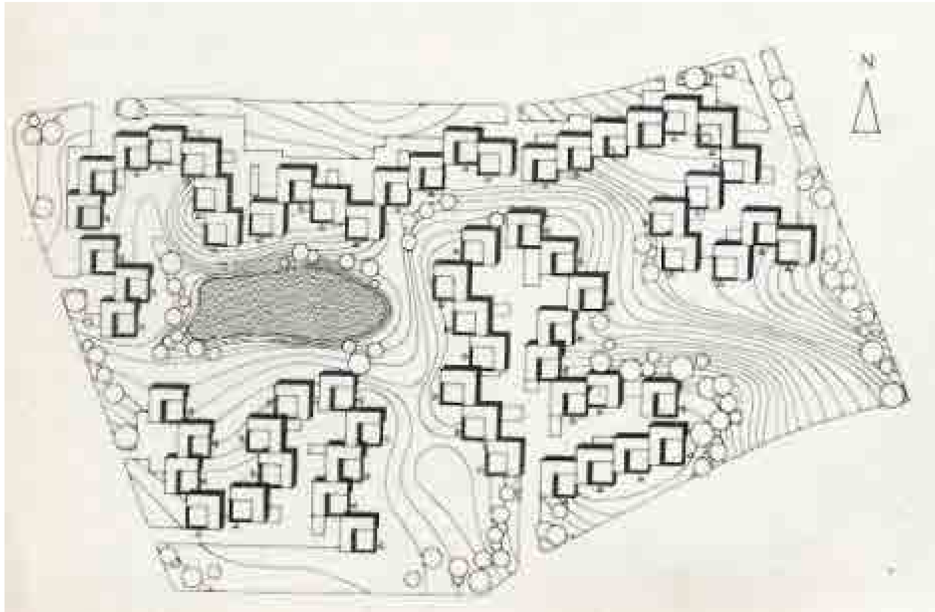
The tradition and the identity of Nordic architecture is based upon different international stylistic periods, which have been interpreted and refined by some of the pioneers of the Nordic architecture, Alvar Aalto, Gunnar Asplund and Jørn Utzon, are some of the architects who made a foundation for the what characterize the Nordic architecture. These architects have been part of the creation of the Nordic architecture, by experimenting with the international styles. They transformed the national style, by the use of materiality, the respect of the quality of the handicraft and by implementing the style in the local context. A common desire for the architects was to create honest and solid architecture. (Lund 2008)The stylistic period of functionalism became more popular in the north than the rest of Europe, when this ideology fited the welfare system, that characterize most of the Scandinavian countries. Furthermore the transformation of functionalism in the Scandinavian countries made the style appear more, light and refined compared to the heavy expression of the original German functionalism. (Lund 2008)

"The same sensation of a logical construction and proportioning are known in all primitive architecture, when that simplicity seam effortlessly and natural, when we have to strain us self to reach a clear and simple result."
- Jørn Utzon, 1953

In Denmark, the architecture has been transformed into a local style among Arne Jacobsen, Jørn Utzon, Kay Fisker etc. and common for them was the respect of materials, handicraft, and the desire of creating elegance. It is easy to see the development of the transformation of an international style to become part of a local style in Arne Jacobsen's work. He was inspired by the functionalism, which is reflected in his early pieces within the use of materiality and the expression of the buildings. In his later pieces he uses local materials such as bricks, which has been used as a main construction material in Denmark since xx. He also implemented inclined roofs in his work, which fits the climate conditions in Denmatk better than flat roofs. (Lund 2008) Another architect who has influenced the local understaning of Nordic architecture in Denmark is Jørn Utzon. He implemented a new strategy for single-family houses, with a simple open plan solution, which make the house appear lighter, and easy adjustable. He focused on flexibility and compact solutions be an additive systems which allow each user to adjust the house for different needs a long time. (Lund 2008) Flexibility and the open plan solution have since become part of the Danish tradition, and it is desirable to create buildings that are adjustable today.

For this thesis it have been chosen to work with nordic architecture acoording to the choise of materials, the compact plan solution and the aim to reach elegance by simple architecture.

Ill 4 - Image of the Kingo houses in Kalundborg, Denmark, by Jørn Utzon 1957 - 1960. In this desing Utzon has used the addiative system, and implemented local materials.



Ill 5 - Masterplan of the Kingo houses in Kalundborh, Denmark, by Jørn Utzon 1957 - 1960.

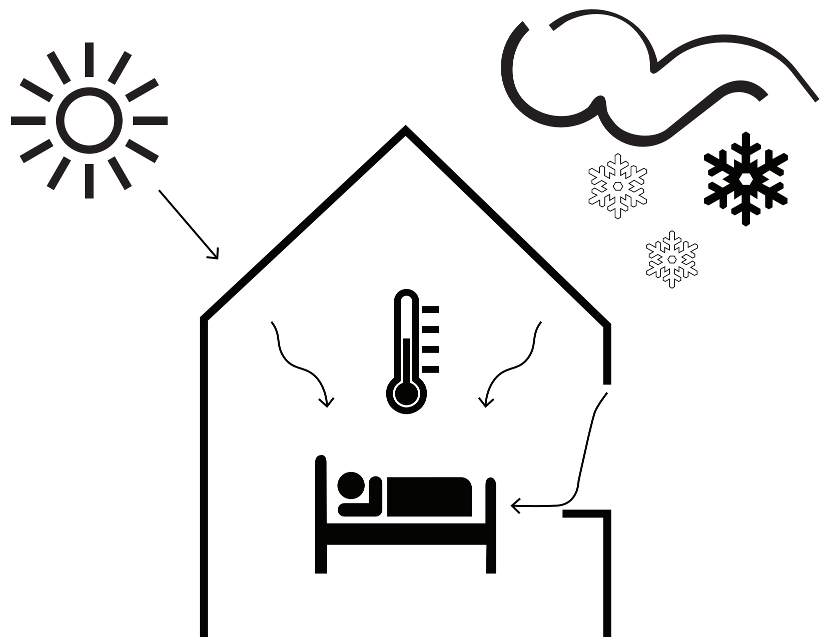
INDOOR ENVIROMENT

Sustainability
Sustainability is the future within architecture and building development . Sustainability consist of three aspects; environmental sustainability, social sustainability, and economical sustainability. These three aspects are considered as a unit, where each aspect is weighted for each building project. In this thesis, there will be a high focus on the social sustainability which concerns the health, security, and well-being of the users. (Energistyrelsen 2015)
Social sustainability complement the theories of healing architecture here the users wellbeing are highly prioritized as well as society.

Social sustainability
Social sustainability considers both measurable elements such as the indoor climate (noise, daylight conditions, and the thermal conditions) and non-measurable elements such good architecture and spatial quality. Both kinds are important parameters to ensure the social qualities of a building. Social sustainability can be divided in three aspects; the social quality inside the building, the surroundings of the building and the proportion to the society. The social qualities inside the building concerns the daily use of the building such as the indoor climate, the functionality, accessibility and the architectural qualities. The needs of all the users of the building should be considered in the design development: what is their job in the building?, how active are they? and how is their movement in the building? By asking those questions you ensure the quality of the building for all users. While the inside qualities concern the users of the building mostly, the qualities of the surroundings of the building both consider the users of the building and people who are passing by the building. Usable outdoor areas increase the well-being of the users, and by letting people passing by use some of these outdoor spaces, it creates life around the building. This can be a joy for the patients. The architecture of the new building must therefore consider the surroundings, the placement according to the city, and the history of the site, to ensure that the building will not appear as one insulated instance. (Energistyrelsen 2015)

Thermal indoor climate
In order to achieve thermal comfort, there are several parameters there must be fulfilled. These parameters is temperature, draft, and heat radiation. Temperaturewise there is a close relation between human physical activity, heat production and clothing. As many patients are confined to their bed, the activity level is low and can be set at 0.8 met. Besides the low activity, a light garment similar to a summer clothing results in a low thermal resistance of 1 clo. This lead to an optimal operating temperature around 24° C in the patient room as the thermal comfort can be maintained. (Chapter. 2.3, Table 1 DS474) (DS474 1993l)
With the relatively high operating temperature, the temperature moves close to the temperature tolerance of the maximum temperature for a given time interval. Tolerance for housing should not exceed 27 ° C more than 100 hours per years and 28 ° C more than 25 hours per year. (BR15 2015)
To regulate the temperature one must consider solar heat, solar shading, ventilation, and the surrounding surfaces heat accumulating abilities. The materials in the room can have various surface temperatures and this can be the course of an asymmetry of heat radiation. An asymmetry of the heat radiation often occurs next to the window and this can create drafts of cold air. When designing for patients, it is important to consider the fact that this user group is more susceptible to heat and cold exposure. Therefore, it is important to avoid any thermal radiation asymmetry in the occupied zone. This can be done by paying attention to the design of the window board to make sure, that cold air down-draught are headed down toward the floor rather than in the direct direction of the patient. (See diagram 6) Drafts can cause discomfort. This may occur in connection with the

use of natural ventilation, where an opening of a window can cause a sudden drop in temperature. By a decrease in temperature this will cause a greater heat loss from the patient's body. Professor P. O. Fanger describes it as; the heat produced in body = heat lost from the body. (Fanger 1970) Thereby the patient's heat production increases and unnecessary resources are spent to maintain the body temperature. Therefore, mechanical ventilation is preferable, since this ventilation form is more reliable. The choice of the ventilation method could affect the building's energy effciency in a negative direction. But the experience of fresh air, must be considered in the design as well, and it is necessary to let the users have the possibility to open the windows. This provides the users with the possibility to gain user control of the building, which is experienced as a positive quality .



Ill 6 - The micro climate, the activity level and clothing influences the thermal indoor environment.

Atmospheric indoor climate

The atmospheric comfort depends on the perceived air quality. The required air quality is maintained through ventilation. For this to happen, ventilation must be stationary balanced in re- lation to the added pollution and contamination removed by ventilation. To maintain a satisfying air quality under category B (DS447 2013), the ventilation requirements must be regulated by the concentration of the pollution, that comes from CO2, olf and moisture. These factors are influenced by the people-load, and therefore the people-load is the essential factor in determining ventilation requirements. For a given person-load the air change rate, will be less, the larger the room volume is per. person. The room volume is constant, while the person-load varying in the range of 1 to 5 people in the patient rooms. Therefore, the ventilation requirements can change and this will have an effect on the air exchange rate. The concentration of CO2 will be influenced by the people-load as well. Sources of moisture in a typical housing could be people cooking, personal hygiene, drying laundry, and cleaning. Since cooking and laundry don't conducts in the patient room, these moisture sources can be disregarded. Moisture for people is 42% , personal hygiene is 15% and cleaning is 2%. These percentage are based on a typical home. (Koch 1987)
The warmer the air is, the more moisture it can hold. Therefore, it is also expected that the moisture content in the patient room will be higher than an average home, when the operative temperature in patient homes are higher than average.

The experienced air quality often depends on the odor, which is measured and calculated in olf. A sedentary person makes one olf. Once again it will be the people-load that dilate a major role due to ventilation and air exchange. In relation to the working environment for employees, smoking may not occur in the patient room and therefore air pollution by smoking is disregarded. The odor can be neutralized by the the smell of nature, and this can be utilized by the ability to open the windows.

Acoustic indoor climate

A good acoustic quality is defined by a combination of both objective and subjective measures that are related to the distribution, dissemination in space and size of the space related to the noise level in a room. The modern acoustics has its origins in the 1890s when the American physicist Wallace Clement Sabine (1868-1919) established a simple relation between a room's reverberation, volume of the room and sound absorption in the room. The acoustics must comply with requirements in the text BR15 chapter 6.4.2, corresponding to the functional requirement for housing designed as class C in DS 490 (DS490, 2007), (Sound classification of dwellings). According to the hospice there is an aim for higher sound class because a quiet and peacefully atmosphere is desired by the patient and its relatives (Hansen 2017) and it is recommended that the level of noise, should be lower than 35dB by day and lower than 30dB by night. (Frandsen, 2009) Class A is selected as the desired acoustics of the patient room. Class A is described as particularly good sound where the inhabitant only occasionally is disturbed by sound or noise. (DS490, 2007). This is chosen upon the fact that noise is a stress factor to the human body and mind. In terms of the acoustics there are two different conditions, building acoustics and room acoustics. Building acoustics (sound insulation) refers to the measures designed to reduce sound transmission from one room to another. Room Acoustics (Sound Control) describes the measures to be done to regulate the sound in the same room as the buzzer. Typically, sound regulation relates to a room's acoustic quality in such as concert halls, classrooms, meeting rooms etc.

Visual indoor climate

The general goal for this thesis is to supply the users with a high quality of light, this is done by minimizing; direct glare, reflections, and excessive brightness ratios. The quality of light depends on the amount of illuminance in the room, as well as the color of the light, and whether if it is direct or indirect light. The intensity of illuminating should be 200lux in the patient's room. (DS 700, 2005) To achieved an adequate

Ill 7 - The atmospheric environment is influenced, both by the outdoor pollution and the people load within each thermal zone.

Ill 8- Noise from the surroundings influence the indoor acoustics, as well as user behavior and the organization of the room program influence the acoustics.

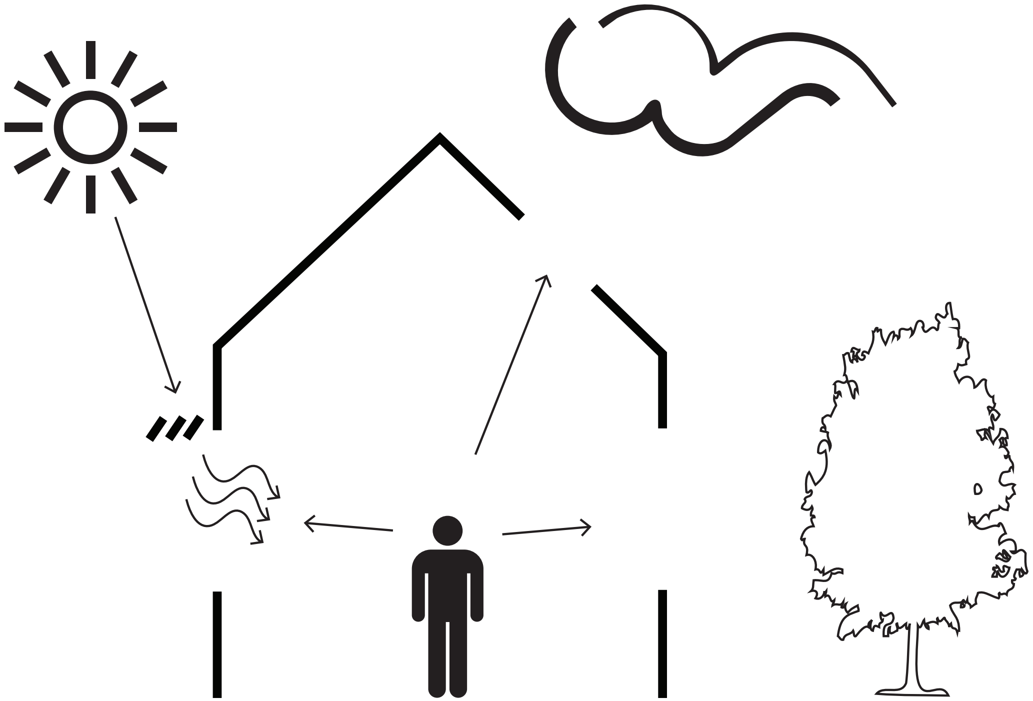
daylight access the window area must be minimum 15 pct. of the floor area in case of sidelight. The window area must be minimum 10 pct. of the floor area in terms of skylight. (BR20) (2015 krav 10% og 7%)

When designing the patient rooms, it is important to get the light deep into the room, and use the full aesthetic potential of the daylight. This is especially important within a hospice, because the daylight reduce the stress and pain level as described in analysis of palliative architecture. These parameters must be combined with the desire of the thermal comfort and thereby reducing or preventing direct glare of unprotected windows and skylights. This can be achieved by minimizing veiling re ections, especially from skylights and clerestory windows, by creating integrated solar shading such as blinds, overhang, and shutters. The solar shading options can be of a permanent or a exible character, creating reflections which can create interesting light experiences. Furthermore, it have the advantages of the user, being able to adjust the solar shading them self.

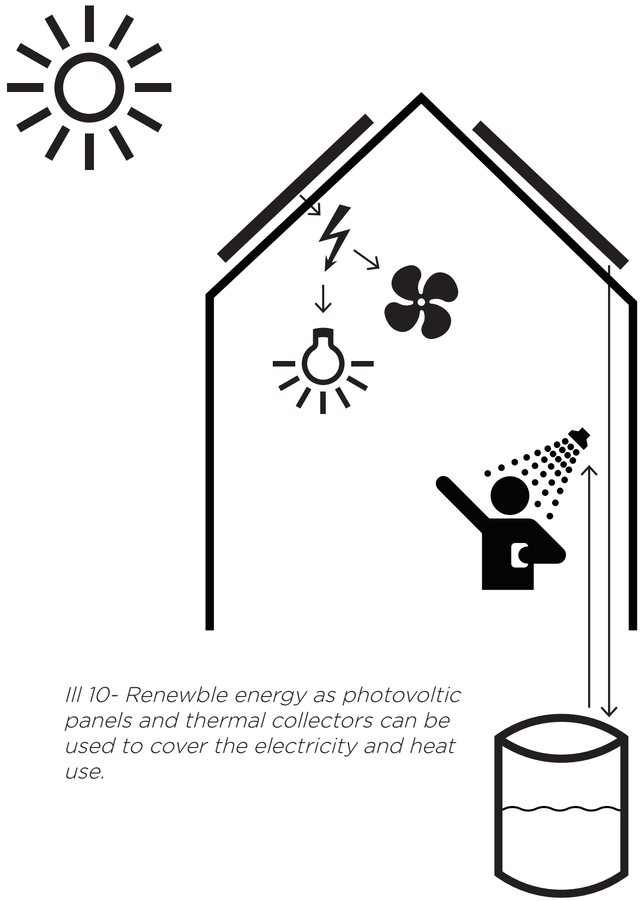
Renewable technologies

Our goal is to reach energy class 2020 (BR15 2015) energy class 2020 contains an energy frame of the total need for energy supply for heating, ventilation, cooling and hot water per. m^2 heated floor area does not exceed 20 kWh / m^2 per. Year. To meet the energy frame the building will be designed on behalf of passive strategies and renewable technologies will be integrated to fulfill the energy frame. As a large part of the site is facing south utilization of the sun can be an efficient way to active energy. Do to the relative high operating temperature, solar thermal collectors can be an options as a supplement to the space heating and domestic hot water. Solar thermal collectors converts the energy of the sun into heat, that can be used for meeting the demands for domestic hotwater and space heating. There are different types of solar collectors and system combinations to run a solar thermal collector installation. In case of the need of both a supplement of domestic hot water and space heating a system to obtain both functions are prefured. The collectors type there is optimal for suiting the needs of both domestic hot water and space heating could be a high efficient evacuated tube collector, due to a lower heat losses through the top cover, that is protecting the absorber plate and thereby preventing loss of heat. By this system combination an orientation towards south and a declination of 60 degrees +- 15 degrees is optimum. When using this type of renewable technologi a water tank is required and need to be taken into constitutions in the design of the hospice.

Besides heat supply a need of electricity supply can occur because of the choice of having mechanical ventilation. Thereby I relation to the orientation of the site and the putative high electricity consumption, photovoltaic panels can be a way of meeting the energy frame of 2020. An advantage of appalling this type of renewable technology is that the electricity is produced in the daytime, when the demand is highest. This solution is expected to be a supplement to the total consumption of energy because a relativiely high area demand of PV panels versus the amount kWh produced and it is thereby not expected that the PV-panels can cover the total electricity consumption. The most efficient solutions of Pv-panels are the monocrystalline and together with a high efficient inverter this system is the most profitably. It is important to pick a high efficient system as a starting point due to the knowledge of the PV – panels being less efficient by being integrated I the design rather than a free standing solution. As mentioned in the context analysis a high amount of large threes are to be found around the site and the shading of theses threes will have an effect on the efficiency of the PV- panels. These factors have to be included in the calculation of energy produced by the PV-panels.



Ill 9 - The experience of the daylight can be adapted by different window openings in the building envelope. The experience of daylight through a sky-light is influenced by the weather situation while daylight through openings in the façade is influenced by shading methods.   .



Ill 10- Renewble energy as photovoltic panels and thermal collectors can be used to cover the electricity and heat use.

USER GROUPE

NEEDS AND USE OF THE BUILDING FACITIES

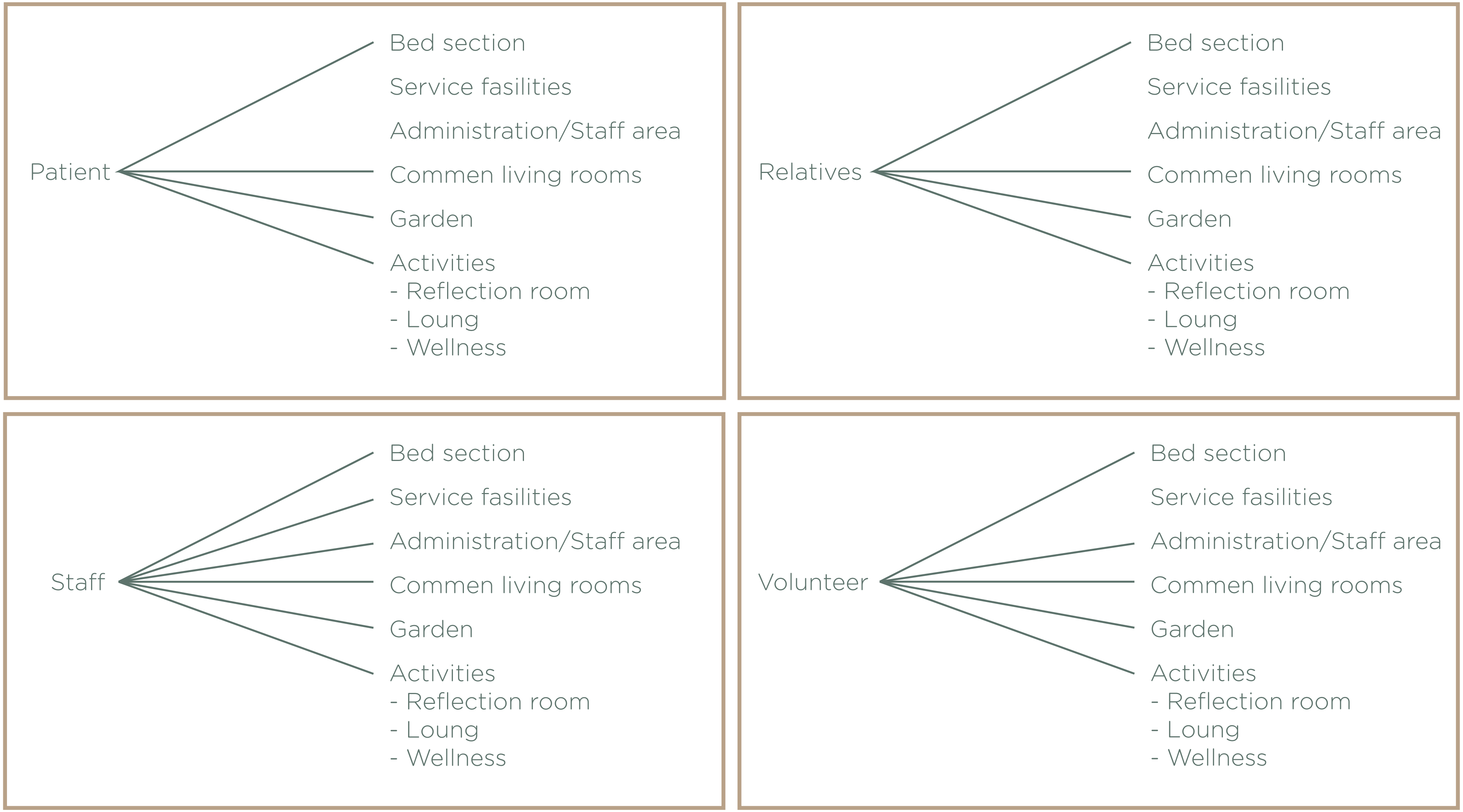
Hospices contain four different user groups, with different interests and use of the buildings faciities. A hospice has to be a home for the patient and their relatives. Create space for life, happiness, grief and social interaction among the inhabitants as well, as being a place for work. Based on a number of visits at different hospices in Denmark as well as the research material as “Det Gode Hospice” by Realdania, a fundamental knowledge about the users has been established.

Patients
The spontaneous social encounters that can occur in a hospice, is important for the overall expe- rience of the hospice. It is therefore important in the physical configuration of the hospice, to support these meetings through common areas, such as lounges, dining areas and small niches in the corridors and gardens. (Herdis Hansen 2017) The patient room is the most important room to the patients, and this is where they spend most of their time. The patient room should be able to create security, privacy and tranquility for the patient. (Hansen 2017) In addition, analysis shows that the degree of privacy in the form of visibility to the context, and any interference with passing people, have a major impact on the comfort of the patient as well as the experience in terms of size, light, sound, and the thermal conditions help to create a comfortable stay. (Realdania 2009)

Relatives
As with the patient, it is important to create the framework for the community of the hospice. Areas where the relatives can come together as a family to grieve or to get a break. These areas may be kitchenettes, laundry rooms or something similar, where the relatives can perform a specific action, and relax by doing everyday things. In addition, gathering areas like small niches and lounges help to provide a more comfortable stay. As relatives, the opportunity to stay overnight are given in bedrooms, designed to operate as a small hotel room. This option can provide the relatives with the possibility to stay without the everyday stress, and to avoid a long drive between the hospice and their home. The aim of this is to make it easier for relatives to spend as much time with the patient as possible.

Staff
A greater part of the staff works among the patients, and therefore it is natural to establish flexible workstations in the office areas, which can be used by more than one employer, rather than each staff member has his own workstation. By gathering the staff, it is possible to ensure greater sharing of knowledge across disciplines. By not offering every employer their own office, it is important to create meeting rooms, which can accommodate meetings of all staff members at the same time. In addition, plenty of storage facilities in patient rooms helps to ease the workflow of the staff, as they do not have to travel great distances to get an object.

Volunteers
The volunteers in a hospice is a larger independent unit of about fifty people . (Realdania 2009) These peoples aim is to create life and a homely atmosphere to the patients and the relatives, as well as taking care of daily chores like window washing and gardening. Additionally the volunteers operate as hosts and hostesses at lunch and dinner. All these activities are planned and organized by one of the employees. (Hansen 2017)


Patient
Bed section
Service fasilities
Administration/Staff area
Commen living rooms
Garden
Activities
- Reflection room
- Loung
- Wellness
Relatives
Bed section
Service fasilities
Administration/Staff area
Commen living rooms
Garden
Activities
- Reflection room
- Loung
- Wellness
Staff
Bed section
Service fasilities
Administration/Staff area
Commen living rooms
Garden
Activities
- Reflection room
- Loung
- Wellness
Volunteer
Bed section
Service fasilities
Administration/Staff area
Commen living rooms
Garden
Activities
- Reflection room
- Loung
- Wellness

Ill 11 - 14

SITE ANALYSIS

MAPPING - SENSE OF PLACE

MAPPING

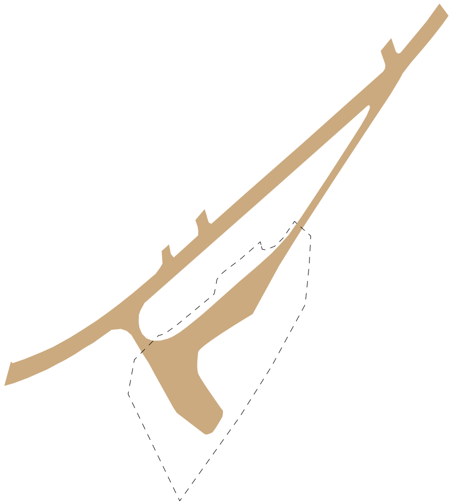
Infarstrucure
The site is placed next to one of the main roads in Hadsund, Hobrovej, which involute all the in- and outgoing traffic from the westside of town. The fact that it is a main road, makes it easy to access the site. The road is lowered from the site, which mute the noise form the traffic. The placement of the site is efficient when considering public traffic, the regional bus stops 200 m. from the site. The connections to the larger cities Aalborg, Hobro and Randers are easy accessible through the main roads in Hadsund, because Hobrovej is connected to the north- and south going main road Himmerlandsgade.

Contour
The site is placed on top of a hill and the surrounding contour is undulating . This position provides the site with a panorama view of the fjord and an overview of the town only disturbed by the tall trees surrounding the site. The high placement isolate the site form the surroundings, and it is possible to use this in the building design to exclude external people to have glimpse of the patient rooms and the private areas of the hospice.

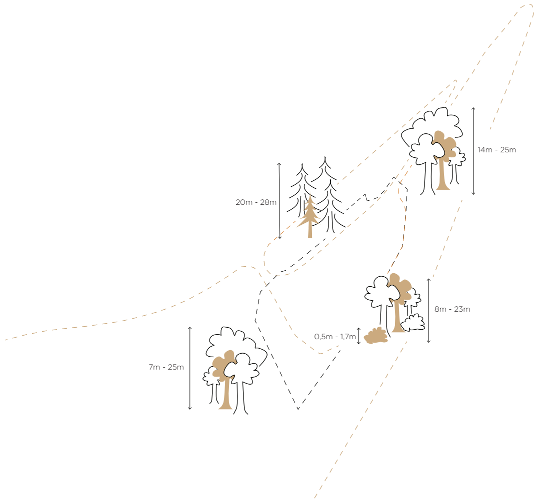
Hights
Old trees surround the site, and they are the main element characterizing the site. There are two different kind of trees at the site; pine and beech, where beech is the most dominant kind. The height of the trees varies from 0,5 m to 28 m, and the heights should be considered according to shading, and the effect of this when designing the outdoor spaces and when considering the indoor environment. There are no other buildings, which are affecting the site, because the site is placed isolated from the rest of the town, and next to the forest as the only neighbor. The trees facing Hobrovej shades from the traffic noise and creates a wall from the town and Hobrovej, which makes the site more private. These qualities should be considered in the building design and the development of the outdoor areas.

Wind analysis
Through the last decades, the wind speed has increased in Denmark, and larger storms occur more frequently than earlier. (DMI 2014) This creates different issues, and it is important to take these more extreme weather conditions in consideration in the new building design. The site is manly exposed to the wind from west and north-west, and this should be considered in the design development according to the indoor environment and the possibility of natural ventilation in the building. The high placement of the site can influence the experience of the wind as well and should be considered in the design development of the outdoor spaces, the directions of the patient rooms and their individual terraces.

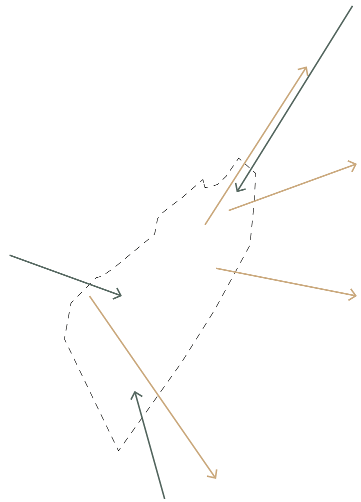
Optical axis
More optical axes appear from the site to the surroundings, with individual character which can all be used in the building design. Three of the optical axes are experienced from the southern part of the site, and they provide views to Mariagerfjord, which is placed behind tall beech trees, and in summertime it is possible to have a glimpse of the fjord while at wintertime the view is more exposed to the fjord. On the eastern part of the site two optical axes appear towards the town of Hadsund. At the same time, it is possible to see the site from the surrounding context. From the main road Hobrovej one can have a glimpse at the buildings on the site, and the same is possible from Skovvej, which is placed below the site. This should be considered in the orientation of the different functions and the building design.



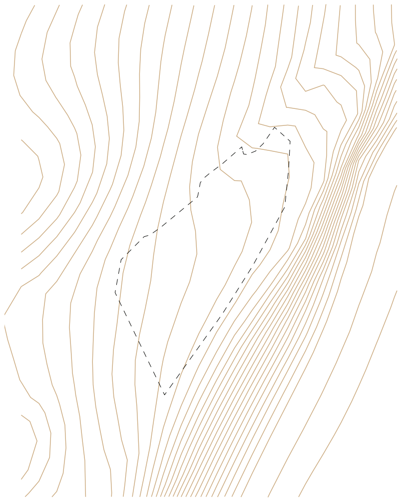
Ill 15 - Infarstrucure



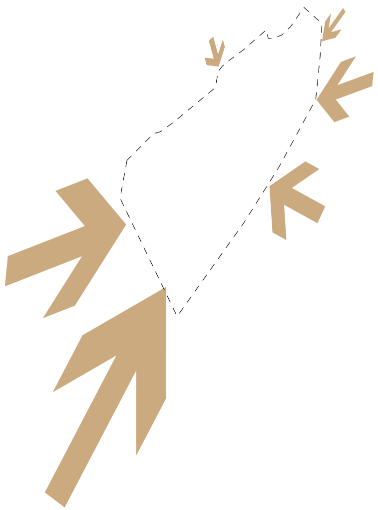
Ill 16 - Hights



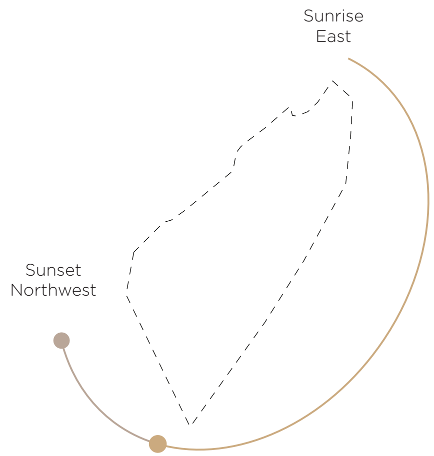
Ill 17 - Optical axis



Ill 18 - Contour of the site



Ill 19 - Wind



Ill 20 - The sun path

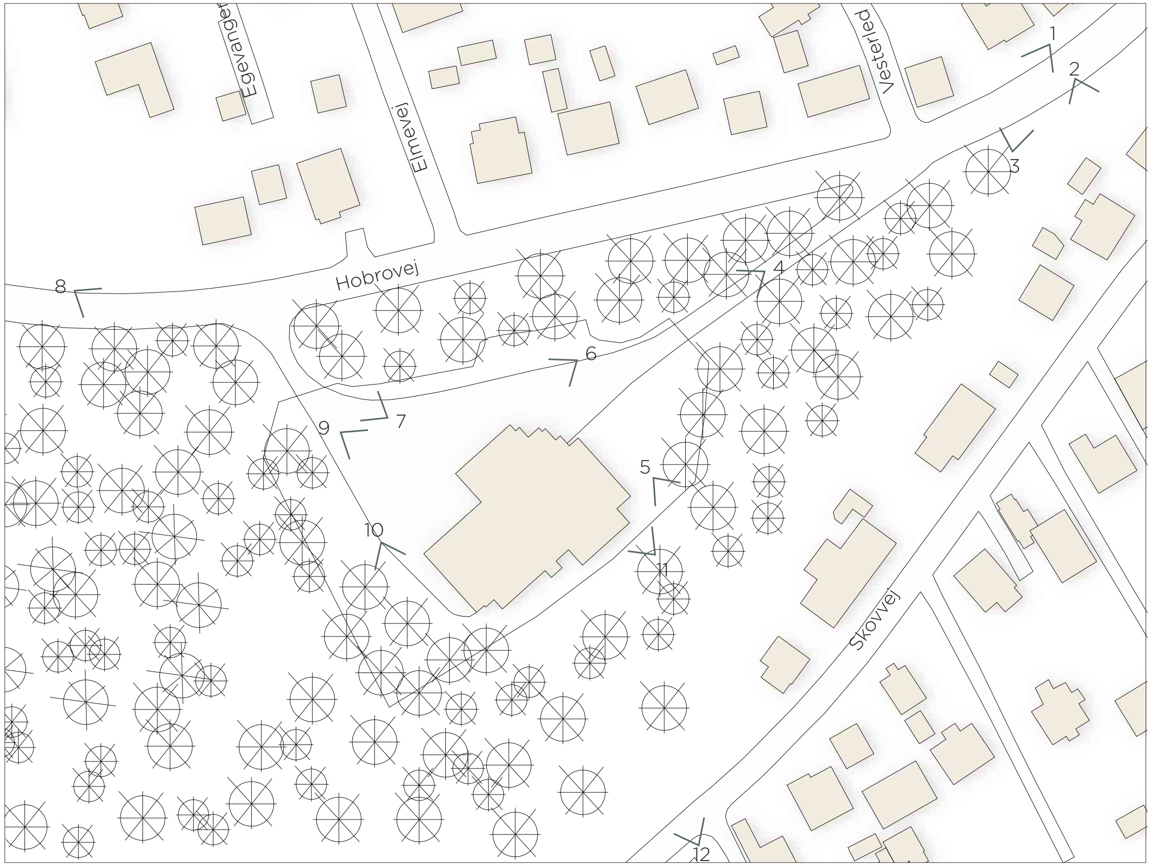
SENSE OF PLACE

PHENOMENOLOGICAL REGISTRATION

The analysis of the sense of place is made to create an understanding of the sites placement, materials and surroundings. It is important how one approaches the site, and what experience one will get on the site. These investigations are used in the development of the hospice. Both the trees on the site and the neighbouring brick houses is used as a referance to the materiality of the hospice.

The site is placed on the west orientated outskirts of the town Hadsund, and on the edge to the forest of Thygeslund. Trees are surrounding the site, which hides the buildings from the surroundings. Furthermore, the site is placed on a hill, which emphasize the enclosed experience around the site. These elements are considered as qualities for the site, and have been considered in the design development to create a fusion between the buildning and the landscape.

The town is close by, and to create a link between the new hospice and thown, a path through the site is created. This ensure the posibility a collaboration between the citizen and the hospice .



Ill. 21

Ill. 22 -33

CASE STUDIES

ANKERFJORD HOSPICE - RAINDEER PAVILION

ANKER FJORD

FOCUS ON ORGANIZATION AND PLAN SOLUTION

Anker Fjord is a hospice placed in the south-western part of Jutland in the small town Hvide Sande. Anker Fjord was built in 2005 – 2006, and the design of the hospice was based on the program "Det Gode Hospice I Danmark".

The design accession was rather prismatic when the building of "Anker Fjord Hospice" found its shape . The hospice is shaped as the name refers as an anchor in relation to Ringkøbing fjord. (Krabbe hospice 2011) the shape of the anchor was chosen as a metaphor for the place where the patient set their anchor and the journey of life ends. (Hansen 2017)

The shape of the anchor expands from one floor at the top of the anchor to two floors at the arch of the anchor. As one approach the building, one will meet the narrow one floor core of the building, which provides with an intimate human scale related to a single-family house. This is achieved by a fragmented composition of volumes in the angel of the view, when one approach the building. When moving around the building one will experience a different scale on the outer circle of the arch rises in two floors, making a composition and an impression for a larger institution which blur the essentials of a homely atmosphere.

Within the shape there are three different zones containing patient rooms, common facilities in- cluding the entrance and the staff section. The plan layout of the building expresses a clear establishment of the three zones, and each zone contains a theme, which support the functionality and purpose of the specific area. The core of the building contains common functions and staff area, while the arch of the anchor contains the patient rooms, smaller kitchens, and spa facilities. The arch feature two floors with the same plan layout, locating patient rooms at the outer circle providing these rooms with the fully experience and visual connection to the landscape. To reinforce the experience of the landscape, large balconies are created on the entire eastern façade.

"Nature it's the best way to bring people together" - Flemming Bay-Jørgensen

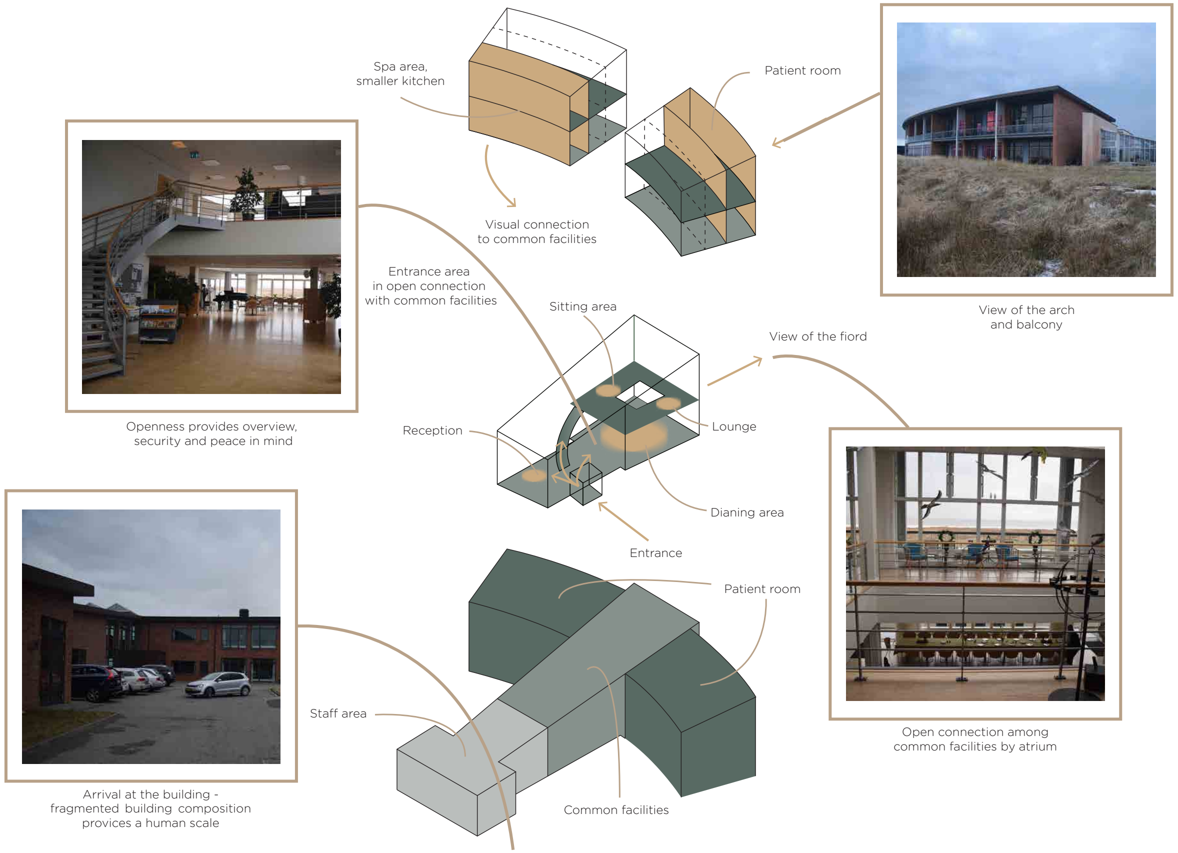
At the inner circle of the arch, kitchenettes, spa facilities and playrooms are located, and by the shape of the arch these functions face the rest of the common functions at the core of the building.

The entrance and common facilities are the heart of the building. The aim of the area is to create a warm space, which opens and embrace the patients and their relatives, the moment they step inside. Openness provides security and peace in mind (Flemming Bay-Jørgensen 2017) this statement is visible in the entrance and reception area, which appear as a hall, because of the open connection with the rest of the common facilities. These facilities are distributed on two plans, which are connected by a sweeping stair. When moving up the stairs, the full experience of the landscape and Ringkøbing fjord appears. On the second floor lounges and intimate smaller sitting groups are located. These spaces invite to reflection and absorption of grief, and the possibility to have some privacy and still be a part of the community. This appears through a special connection between stories do to the atrium.

The patient room contains some of the essential features of the conceptual framework of Anker Fjord Hospice, as the surroundings and view of the nature creates what really matters, a place of reflection (Bay-Jørgensen 2011), Anker fjord hospice is the only hospice in Denmark, which has a room for relatives inside the patient room. This provides with peace in mind by being able to be close with your love ones in a difficult time. The possibility to let the relatives stay overnight strengthen the spirit of the hospice, and provides the patients and their relatives with the possibility to live in the present and enjoy their last time together, without the everyday stress.
The staff area is the machine of the building, and most of the staff functions are located in the op- posite end of the common functions, beside the reception and the nurse office, which are located next to the

common functions. create a close relation

In the design development of Mariagerfjord hospice an inspiration of the flow from Anker fjord is used to ensure the functionality. Furthermore, a gathering point within the building is desired to accommodate the atmosphere in the hospice.



Ill. 34

REINDEER PAVILION

FOCUS ON MATERIALITY, TACTILITY, FRAMING

The Norwegian Wild Reindeer Centre Pavilion is located at Hjerkinn on the outskirts of Dovrefjell National Park, overlooking the mountain Snøhetta. With the view and the austere nature, the context is the essential element in the experience of the site and The Reindeer Pavilion reflects the Nordic architectural tradition. A powerful imprint of the contexts form and materiality have been processed and challenged in the pavilion. Contrasts and links to the context are the key words for this architectural work, and it is in this tension between contrast and similarity the pavilion develop fully. It is creating a unique space in the open landscape which relate to the human scale . The architecture has, as mentioned earlier, a clear reference to the contexts form, materiality and color schemes and can be described as;

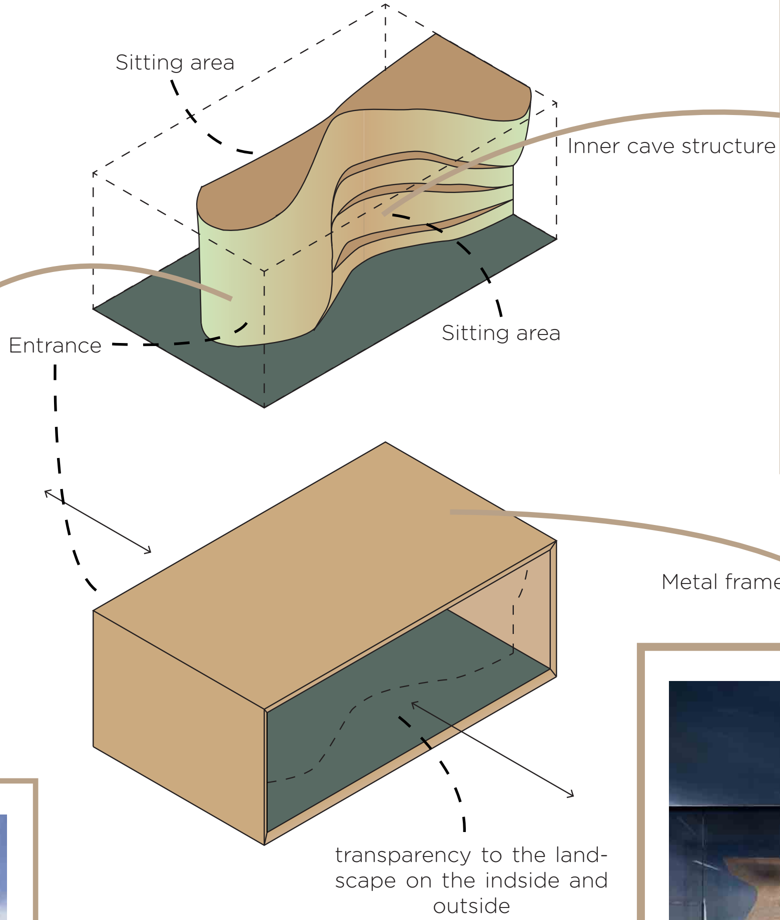
“The architecture works with form and mass like the art of the sculpture; with colors like the art of painting but it has to itself that it is an applied art. It solves practical purposes” - Steen Eiler Rasmussen.

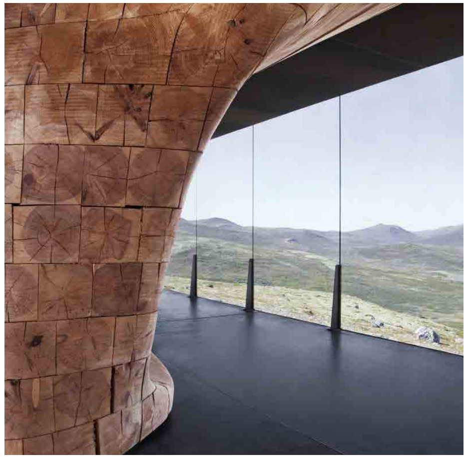
The practical task in this case is to create a space for the observation of the nature as well as to create a connection with nature. The architecture must create a framework of nature . If the pavil- ion is split into two general concepts, there are an outer and an inner concept.

The exterior creates the framework for the architectural experience, and the rectangular shape underline the individual figure of the pavilion, which is clad with an oxidized metal plate. There is a harmonious proportion, which creates an over- all elegant impression. The elegance is enhanced by lines and the assembly details, which appear clean. This supports the shape and simplicity in the composition between the metal and glass facades. The glass facades clearly define which of the facades are open and which are closed, and this emphasize the understanding of the framework of the architecture. The paradox of the pavilion is the way the metal frame both frames the nature seen from the inside and out, but also framing a piece of nature seen from the outside and in, because of the pavilion interior is congured as a rock or a piece of ice, as an imitation of a shape which has been formed by natural forces such as wind and water.

The pavilion’s interior clearly communicates the function as an observation pavilion, as the pavilion’s interior consists of a large piece of furniture made of pine wood. The piece of furniture is made of pine tree strains, stacked on top of each other, which creates the impression that the metal frame has been filled with pine tree trunks and then been adapt to create a warm and welcoming cave environment, where the visitors can create shelter and still have visual contact with the context. Through the glass facade a soft natural white light is glowing, only broken by the warm color scheme from the pine tree. The floor of metal plates reflect the light and the clouds as they drift across the sky and the surface casts diffuse light into the cave and sitting area.

The design of the pavilion is able to isolate the essence of the context and transform the landscape to the central part of the building creating a sculptural core. The interior of the pavillion merges with the context in the idiom and creates a relationship between the inside and outside. The shape of the pavilion adds a new form element to the context, and the choice of the oxidized metal plates links these together. The shape and the choice of materials creates a connection and a contrast to the context. The external dimension’s shape creates a contrast, while the choice of materials, the consistency of the metal plates rustic texture and shades of color compliments the context. At the internal dimensions is just the opposite. Here its shape creates a relation to the shape of the landscape, while the choice of material inside the pavilion creates a contrast to the hard, cold materials in context. This play with the shape and the selection of material according to the context is a strong perceptible element, which is used to create a sense of place in the hospice.


Sitting area
Inner cave structure
Entrance
Sitting area
Metal frame
transparency to the land-
scape on the indside and
outside



Ill. 35

SUMMARY

SUB CONCLUSION - DESIGN PARAMETERS - VISION - ROOM PROGRAM - ROOM DIAGRAM

SUBCONCLUSION

PROGRAM SUMMERY/CLOSING

Through the analysis of The Hospice in Denmark, Healing Architecture, Sustainability, Indoor Climate and Nordic architecture, we have developed an understanding of the theme of the thesis. The requirements for hospices develop all the time, and for that reason we have chosen to implement a day-center in Mariagerfjord Hospice, as a new initiative of the palliative care in Denmark. The flexibility and the flow of the hospice is important to consider in the design of the plan solution. The entrance must appear as a distribution point, creating a clear division of the functions. The flow of patients occurs within approximately 16 days, and this should be considered in the flexibility in the patient rooms, which should be changeable for each patient. Furthermore, it is important to create a homely atmosphere at the hospice, not only in the occupation areas, but also in the bathrooms and the spa room, which today is bear the impression of institution. To achieve a design solution, which makes the optimal settings for a hospice, the five design principals from REHBA is used as foundation of the design development. It is important to emphasize the effects of the visibility of nature, the light, the acoustic conditions, the materiality, and the tactility, and how influence the atmosphere. The experience of the materiality and tactility are influenced by the light and the acoustic as well as the colors influence the experience.

To emphasize the atmosphere inside the hospice, the social sustainability and the indoor environment are important factors as well, and they will be equally considered in the design development. We have decided that the building must reach the energy frame of 2020, and this is done by using both passive strategies and renewable energy. The indoor environment will reflect, that it is ill people who are the main users of the building. This have an influence on the indoor environment according to the operative temperature, which must be higher than usual and natural ventilation should not be part of the ventilation strategy, because many patients are more sensitive to draft. As earlier mentioned the light has a huge impact on the perception of a room, and that is why this should be high prioritized. The light must reach the demands of 2020, and be used in the creation of interesting light conditions.

The site is situated in a scenic part of Hadsund, with 180 degrees view of Mariagerfjord. This is emphasized in the design of the hospice as well as the optical axis to the city center. It is important to create a back to the main road Hobrovej and the northern neighborhood, to shield the site from noise and glare. The new building considers the placement of the common area and the patient rooms according to the surroundings and the sun path.
The case studies are used as a tool to obtain inspiration from existing buildings. The case study of Anker Fjord provides with an understanding of how to create a functional plan solution. The case also shows how the relation between the different functions are and how to create the most efficient solutions inside a hospice. The Reindeer Pavilion have been used to create an understanding of how the use of materials, the shape, the contrasts, and the connection to the nature has been used as elements of the Nordic tradition of architecture.

DESIGN PARAMETERS

PROGRAM SUMMERY/CLOSING

- Close of against Hobrovej
- Utilize the natural surroundings of nature
- Consider the weather conditions and orientation of the outdoor areas.
- Avoid an institutionalized atmosphere
- Create outdoor areas for each patient room.
- Enhance the acoustic performance of the building
- Light conditions and window openings should be investigated in relation to atmosphere and nature.
- Clearly marked entrance
- Renewable and passive strategies should be investigated
- Create spaces for reflection
- Limit travel distances for the staff
- Provide a close relation between patient rooms and common facilities

VISION

PROGRAM SUMMERY/CLOSING

Our vison for this thesis is to create a hospice in the municipality of Mariagerfjord, which should be able to handle the new challenges within the palliative care sector. It is important that the new hospice has a high architectural quality, which provide the patients and their relatives with a homely atmosphere. We want to use the architecture to create experiences of the spatial perception, the light, the acoustic, and the materiality, which support the atmosphere. By using engineering proficiency to strengthen the architectural qualities. To create a close relation between the staff and the patients and create a homely and embracing atmosphere, the hospice should be in a smaller scale, and that is why it is chosen to create a hospice with 12 patient rooms.

ROOM PROGRAM

SUPPORT

Room	Area
Support facilities	204 m²
Enterance area	
Kitchen	120 m²
Janitor office	10 m²
Changing room- women	30- 40 m²
Changing room- men	20 m²
Toilets	7 m²
Laundry room	8 m²
Distant storage	70 m²

STAFF

Room	Area
Staff area	272 m²
Office space (16 staff members)	17 m² per work station.
Meeting room	10 - 15 m²
Wait area	5 - 10 m²

BED SECTION

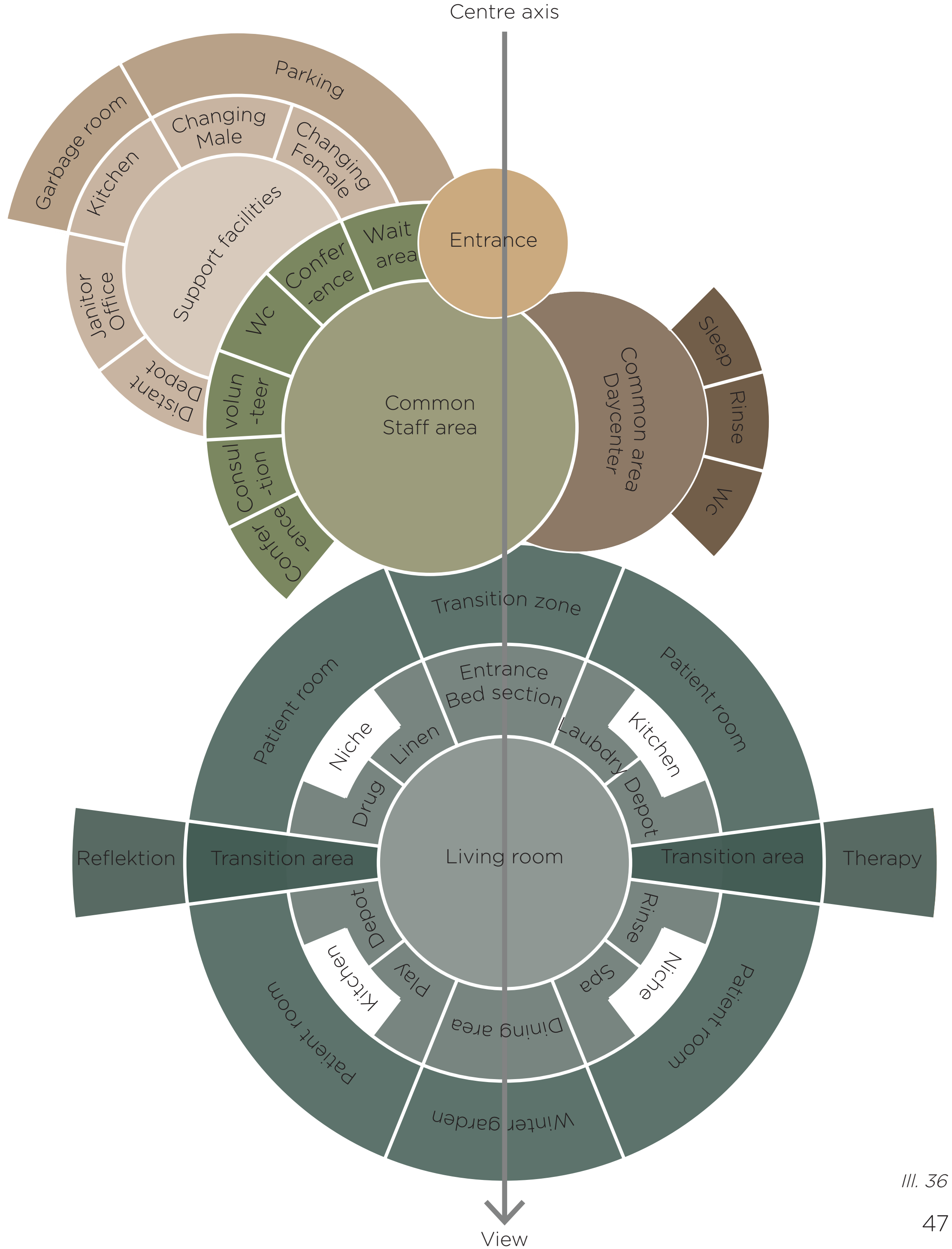
Room	Area
Bed section	550 - 750 m²
Living room	min. 40 m²
Kitchenette	20 m²
Patient room	25 - 35 m²
Relative room	15 - 20 m²
Niches	10 - 15 m²
Meeting room	10 - 15 m²
Medicine room	15 m²
Spa room	20 m²
Rise room	10 - 15 m²
Storage	15 m²

DAY-CENTER

Room	Area
Day-Center	144 m²
Common area	120 m²
Rinse room	12 m²
Relaxation room	10- 12 m²
Reflection room	min. 30 m²
Therapy room	15 m²
Toilets	

FUNCTION DIAGRAM

RELATION AND FUNCTIONAL CONNECTION BETWEEN ROOMS



Ill. 36

REPRESENTATION

PLANS - SECTIONS - ELEVATIONS - VISUALIZATIONS - SIMULATIONS - DETAILS

MARIAGERFJORD HOSPICE

Mariagerfjord Hospice is placed in the outskirts of the forest of Thygeslund, and is surrounded by tall older beeches. This location makes the new hospice appear as a house in the forest, and this is emphasized in the placement of the building, the new infrastructure of paths, and plantation of new beech at the site. The building is placed upon an oval shape (see desing process ill. 94), where the center point becomes the gathering point of the paths leading to the circular shaped building which embrace the users and people passing by when standing in the center point. A path has replaced the entrance road from the east, for use of pedestrian and bikes, this goes across the site, and by that create a link between the town and the new hospice. To enter the site by car, the north-western entrance road is used, and this is now connected to a new road leading to a parking lot at west see caculation for parking appendix 11. The road is divide in the middle of the parking lot, were a road leads to the center point and down to the entrance of the hospice, this is meant to be used by patient transportation, and as a path from the parking lot to the hospice.

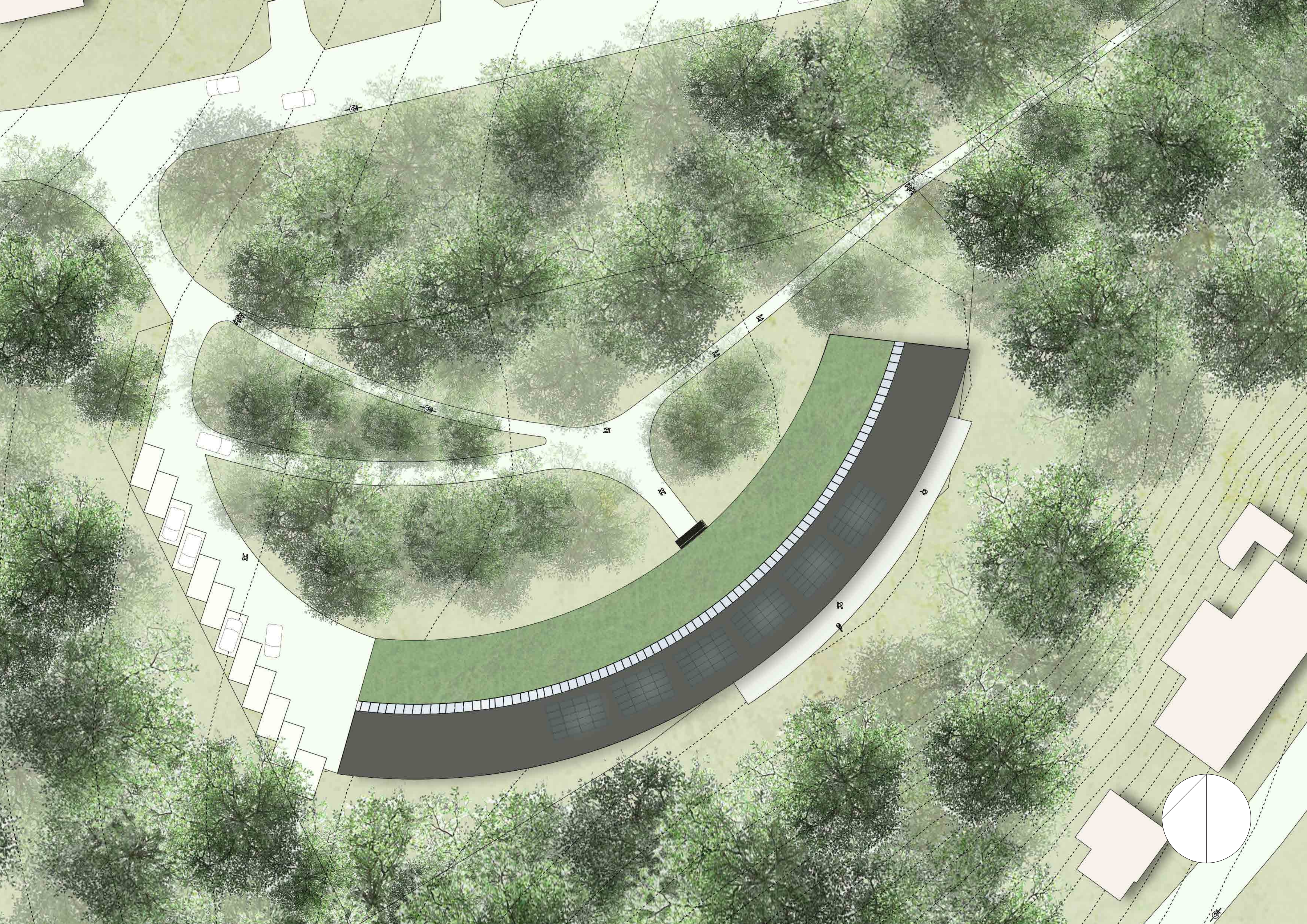
The light gray brick façade with wooden window frames and the green roof makes the hospice appear as a lighting in the forest, where the perception of tranquility occurs see ill. 37. The tactility of the materials is used in the making of different atmospheres within the hospice. The solid brick façade is easy readable, while the window frames in wood appears as a direct reference to the beech forest, that the hospice is placed in. These window frames are drawn all the way inside the opening, which makes it visible when moving along the building, and at the same time it creates a warm and inviting atmosphere inside the hospice, where the wood will appear as a contrast to the white walls.

When entering the hospice, a bright atrium welcome both patients, relatives, and visitors. The atrium function as a gathering point between the different departments of the hospice, the day-center is placed to the left, whilet the support- and staff facility are placed to the right. The bed section is placed on the first floor, to ensure tranquility for the hospitalized patients. Mariagerfjord Hospice offer a day-center, which should provide terminally ill patients, who are able to live at home, with a place to spent the day among other patients, and staff who are specialized within palliative care. The day-center creates more life in the daytime at the hospice, and provide with a high possibility for social interaction between patients, relatives, and the staff. This is also occur in the dining area in the atrium, where all meals are served. Smaller music appearances is in the dining area should function as a connection between the bed section and the ground floor. The music function as a central element of the palliative care as well.

The bed section on the first floor consists of 12 private patient rooms, 6 rooms for relatives, two smaller kitchenettes and a living room in the atrium. The patient rooms are facing south to both ensure a high amount of light in the rooms and to enhance the view of the fiord.These are parameters which are elementary in palliative architecture. The patient rooms have tall window areas shaded by the overhang above the balconies, which ensure the view of nature all day.

The following pages is a representation of Mariagerfjord Hospice, consisting of plans, sections, elevtions, visualizations, simulations and details.

ill 36 - Masterplan See drawing folder drawing 1 for scale 1:500 >
ill. 37 - Visualization of the outdoor space on the next page



ill 38 - The northern facade. See drawing folder drawing 9 for scale 1:100.

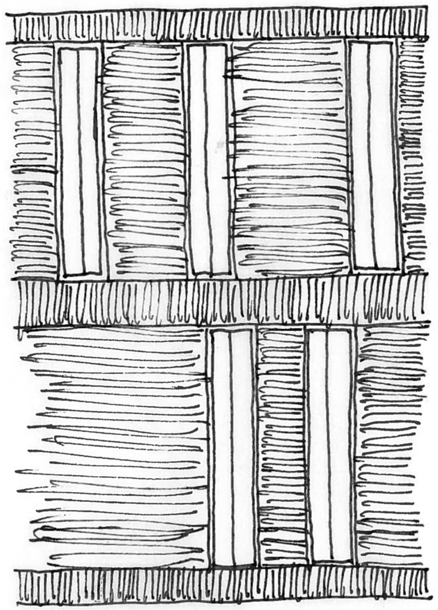
DETAILS

OF THE NORTHERN FACADE

The shape of the building creates a horizontal direction, which is emphasized by an elongated brick. To underline the construction and the window openings, a vertical orientation are used, and this creates a contrast to the horizontal building volume. The vertical direction creates reference to the forest surrounding of the building as well.

To emphasize the construction elements of the roof an overhang both at south and at north has been implemented. The roof at north is covered by sedum grass, which complement the forest surrounding the site, and emphasize the arrival to the site. The detail sketch of the northern roof shows how the roof rafter is shown above the façade, and how a vertical band of bricks meets this, this shows the transition which is happening between the roof and the wall see ill.39. This vertical band of brick is shown at the story partition and at the joint between the foundation and the wall see ill 40.

ill 39 - Detail of the joint between the roof and the wall at noth.



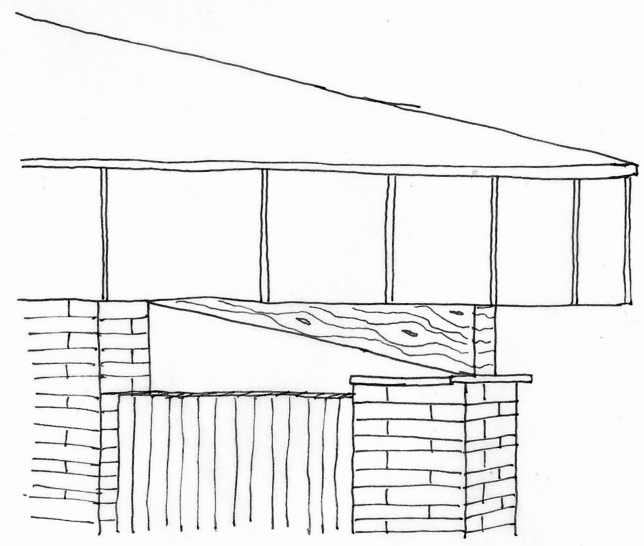
ill 40 - Detail of the facade design.

ill 41 - The southern facade. See drawing folder drawing 10 for scale 1:100.

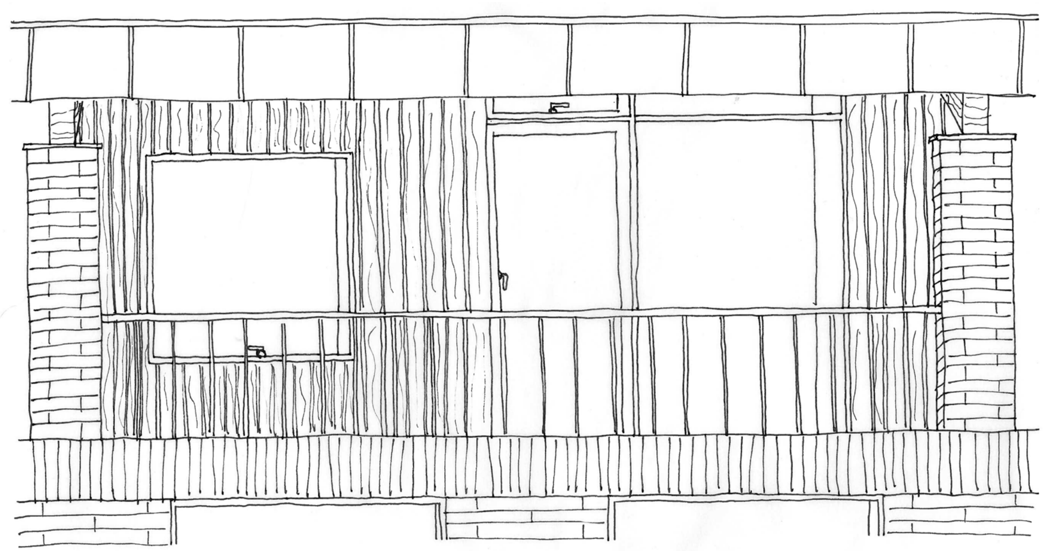
DETAILS

OF THE SOUTHERN FACADE

At south the roof rafter is supported by brick columns, because the façade at first floor is drawn back to create a lager overhang as a part of the passive strategy to prevent overheating in the patien room. This is investegated in the passive strategies in the design process, phase 1. The detail sketch ill 42, shows how the roof meet the brick column and how the roof is sheltered from the micro climate by cobber cladding, and the cobber cladding is used above the brick column as well. The sketch ill. 43, shows how the southern façade at the balconies are clad with vertical wood slates, to emphasize the fact that this do not have a structural purpose, but it is the brick columns which carry the loads from the roof construction. Besided to emphasize the structure of the wall the wood is used at the balconies to create a warmer atmosphere, and underline the balconies as a cutout of building volume. Wood appears more soft and warm than the bricks, and this will make it more attractive to use balconies for stay through a longer period of the year, compared to a brick wall. A brick wall has some thermal qualities when it has a higher heat accumulation ability than wood do, but this will mainly have a perceptible effect in the summer period.



ill 42 - Detail of the joint of the roof on the southern facade.



ill 43 - The balconies at south.

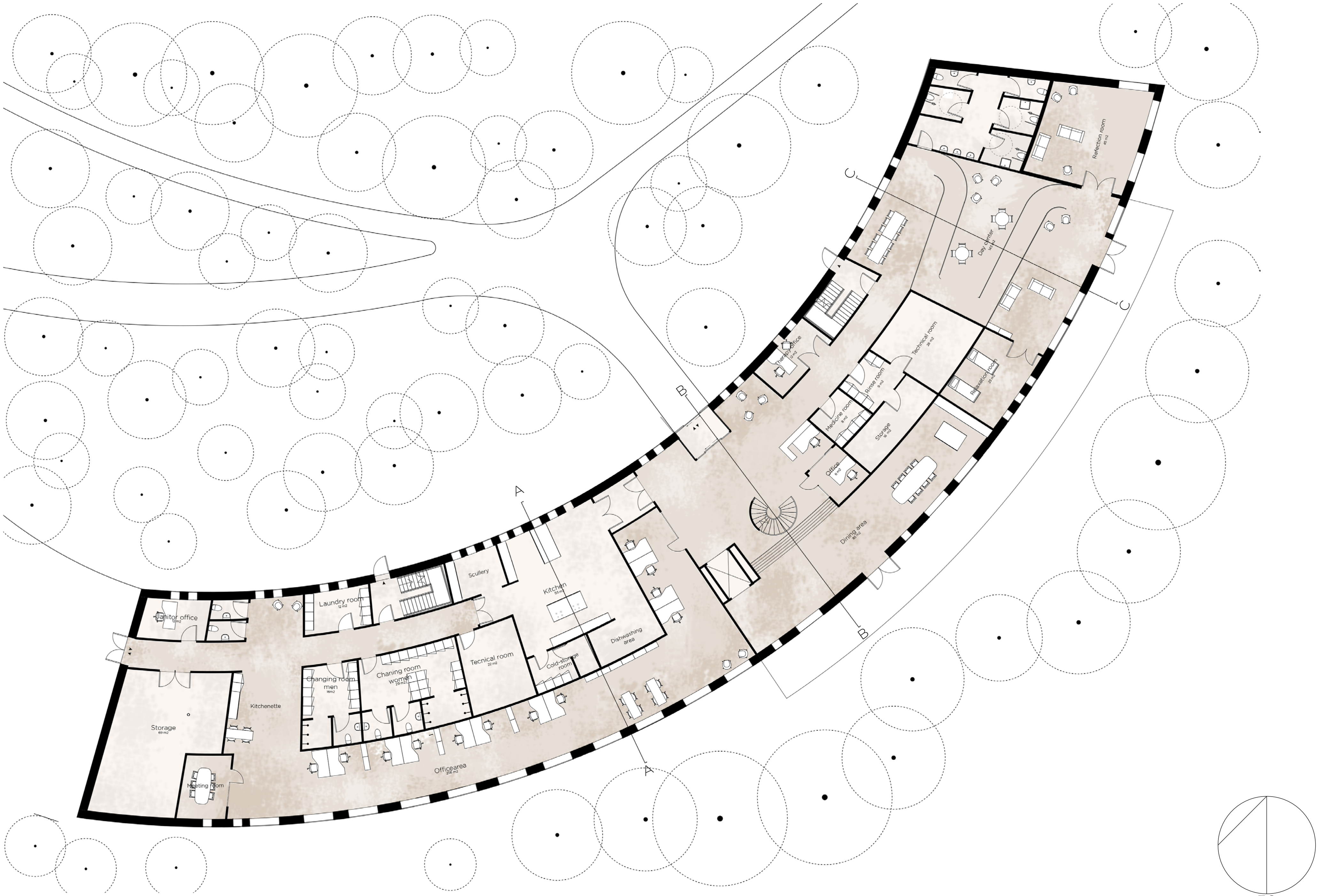
GROUND FLOOR

When entering the hospice one will enter through the atrium, where a receptionist will be welcoming. The Atrium is the gathering point of the building, and all functions are divided from here. The day-center is placed to the left, which is characterized by the slope, dividing the room in smaller zones. At south of the atrium a stair leads one down to the dining area, which is the gathering point for all meals, and this is where smaller music events take place as well. By playing music in the dining area the music audible on the first floor as well. All the users of the hospice can make of use the day-center, which offer different activities though the day. The day-center is used for conversation, smaller handicraft workshops, play area for children etc. A reflection room is placed along the day-center, and this should invite for tranquility and contemplation, but also for smaller events.The therapy office is as well placed along the day-center, and to ensure the possibility for all users to talk with a therapist, a vicar or similar, both if you are hospitalized, a relative or a patient using the hospice in the day time.

On the opposite site of the atrium the staff and support facilities are placed. The staff both need stationer and flexible workstations, and the office area consists of both. A meeting room for confidential conversations, and a staff kitchen is placed in the office area as well. The changing rooms for the staff is placed in the core of the staff and support area, with easy access from the staff entrance and the office space. Furthermore, the kitchen is placed between the staff area and the atrium, and this makes the transportation between the kitchen and the dining area in the atrium easy. To avoid smells from the kitchen an ante room is implemented between the kitchen and the atrium.
Fire ecape see appendix 9.

A

ill 44 - Plan solution of the ground floor. see drawingflolder drawing 2 in scale 1:200 >



Refection room
Day center
C
C
Technical room
Therapy office
Rinse room
Relaxation room
Medicine room
Storage
Office
B
B
Dining area
A
A
Kitchen
Scullery
Dishwashing area
Cold-storage room
Laundry room
Janitor office
Tecnical room
Changing room men
Chaning room women
Kitchenette
Storage
Meeting room
Officearea

ill 45 - Section BB through the atrium. See dawing folder drawing 5 for scale 1:100.

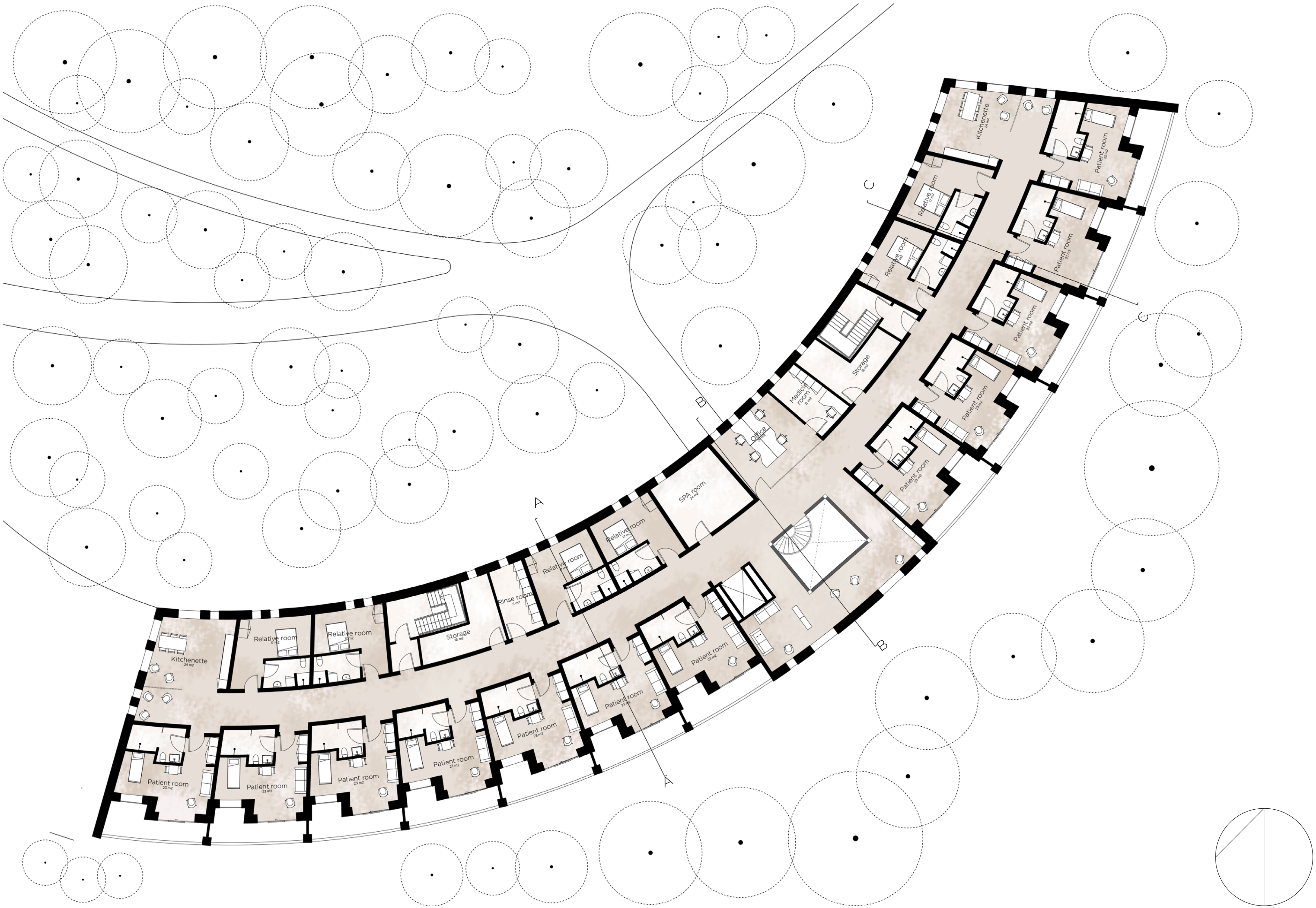
ill 46 - Visualization of the atrium >

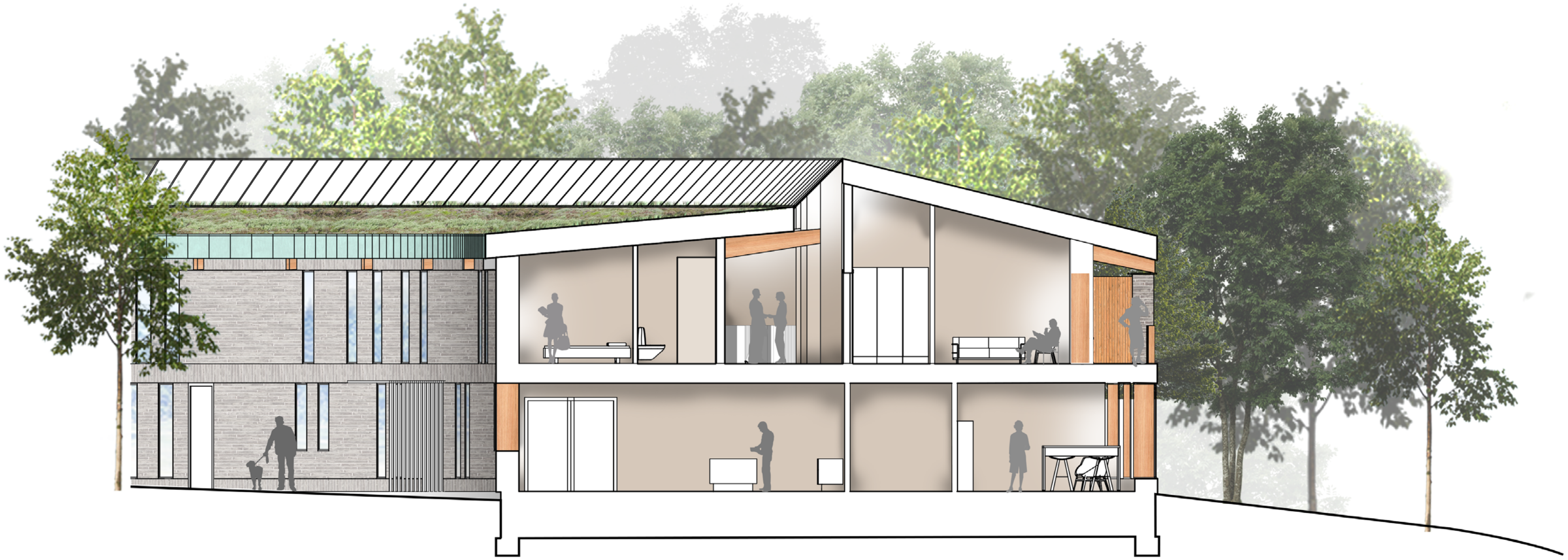
FIRST FLOOR

The first floor contains the bed section, which mainly consist of the twelve patient rooms. These are all facing south, to ensure a view of Mariagerfjord, which is situated below the site. The patient rooms are organized with smaller niches, to create spaces within the room, thereby allow the users to furnish the room as they desire see plan cutouts ill. 50 and 51. The patient rooms have each a balcony, which makes it possible to get outdoor and interact with nature. The possibility to use outdoor areas increase the life quality in the end of life. Beside the patient room the hospice offer the relative with a room for staying over night , to ease the relatives. The smaller kitchenettes and the living room area in the atrium is for use of the relatives and the hospitalized patients, and function as a spiracle with tranquility as the main element in the atmosphere. A spa room is as well placed in the first floor, and is orientated to the north, and is lit by the diffuse nothern light. The spa should provide the patients with a space for well-being, and a place to relax.

A smaller office is placed in front of the stair of the atrium, to secure the safety of the patients, by making it possibility get in contact with the staff, without leaving the bed section. In connection to the office a medicine room is located. The staff have smaller storages and rinsing rooms on the first floor, to avoid unnecessary transportation of equipment etc.
Fire escape see appendix 9.

ill 47 - Plan solution of the 1'st floor, see drawingflolder drawing 3 in scale 1:200 >


Kitchenette
Patient room
Relative room
Storage
Medicin room
Office
SPA room
Rinse room
A
B
C

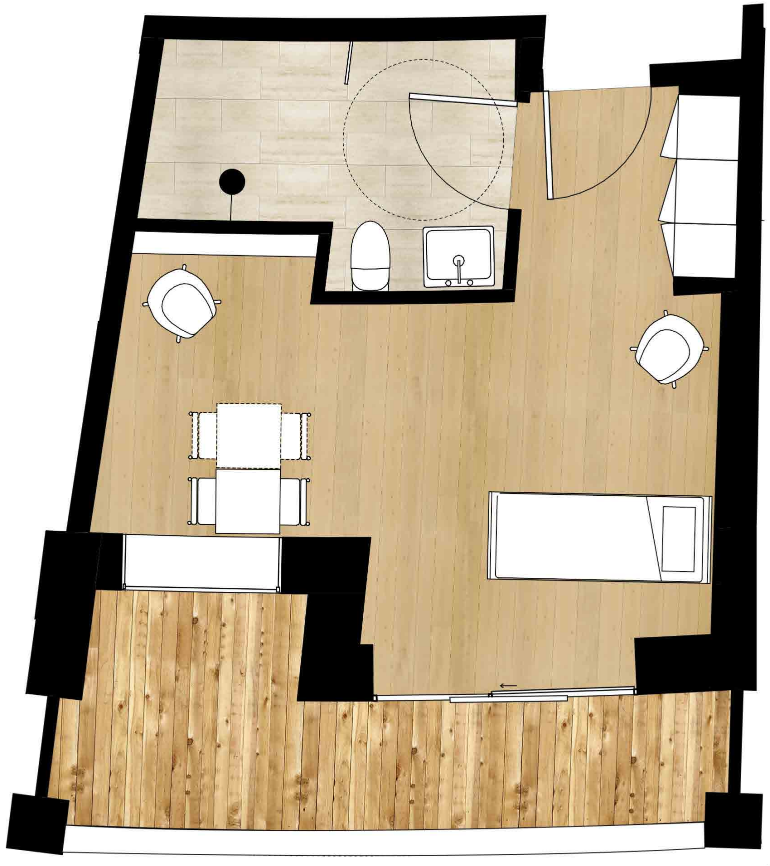


ill 48 - Section AA thrugh the office area. See drawing folder drawing 4 for scale 1:100.

ill 49 - Visualization of one of the kitcenetts. >

PLAN CUTOUT

ill 50 - Plan cutout of the patient room. A suggestion of funishment. See drawing folder drawing 7 for scale 1:50



ill 51 - Plan cutout of the patient room. A suggestion of funishment. See drawing folder drawing 8 for 1:50.

ill 52 - Visualization of the patient room. >

ill. 53 - Section CC shows the day-center, and how this is divided in smaller zones by the ramp system. The day-center face both the northern and the southern outdoor areas, and this will accentuate the placement of the building in the forest.
See drawing folder drawing 6 for scale 1:100.

MATERIALITY

As earlier mentioned the materiality of the facade is mainly consisting of elongated bricks which emphasize the shape of the building, while vertical bricks are used to emphasize the construction. The vertical lines have as well been used in the window openings as a contrast to the horizontal circular arc. Beech wood is used in the window frames and as cladding at the southern façade to accentuate the tactility in the façades. The wooden cladding at the balconies is used to create a warm atmosphere, but it also emphasizes that the wall is a light construction.

The window frames become both a material outside and inside the hospice. To generate a homely atmosphere the deep wooden frames should soften the withe walls in the internal spaces along with the beech wood flooring. The choice of using white walls is made upon, that a white colored wall become more neutral, and in the combination with wood it refines the perception of a room. Textiles and artwork will be the elements that apply more color to the hospice, and by applying color though these element, it makes it more flexible, and easy to adjust the color scheme in each patient room. Furthermore, it is chosen to use sandstone tile in the bathroom, when this has different earthen colored scales in it, which match the color schemes of the of the hospice. It is important that the bathrooms appear luxurious and far from an institutionalized bathroom, with white tiles on both the floor and the walls.

ill 54 - Petersen brick K91 with light mortar joint, and beech wood.

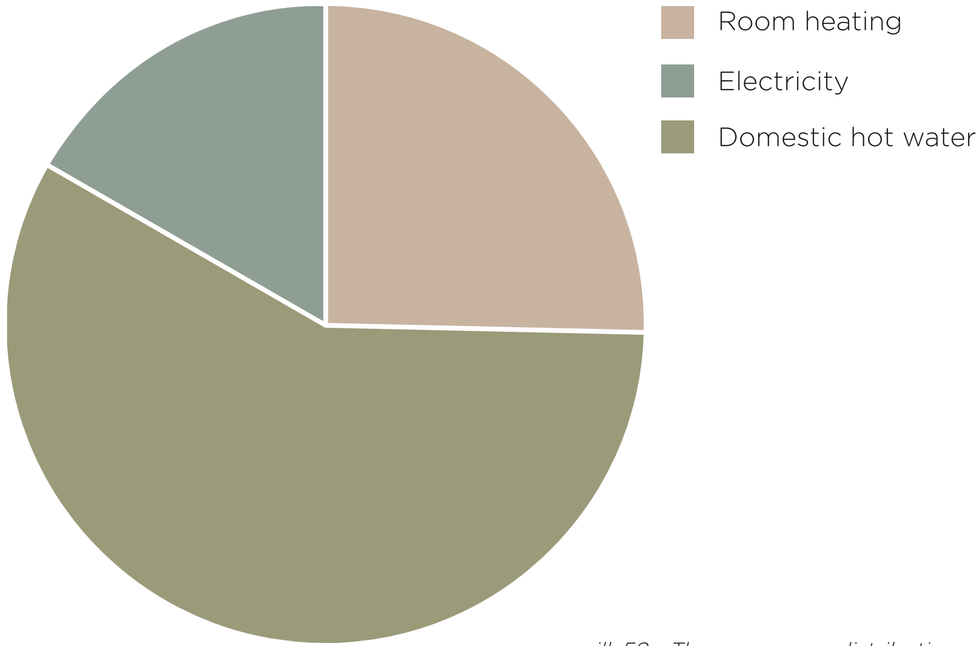
ill 55 - Beech wood for cladding on the southern facade

ill 56 - Light beech wood flooring.

ill 57 - Sandstone tiles in the bathroom.

ENERGY CONSUMPTION

The energy consumption of the building reach the energy frame of 2020, and the energy use is shown by the diagram ill. 58, which is based upon the key numbers from Be15 see ill. 59 and 60. To reach the energy frame, passive strategies have been used, which is described in the design process, phase 1. Mechanical ventilation is main air supply, and to avoid draft in the patients room a seepage celling is used to distribute the air supply equally in the rooms see ill. 66.
The Danish building regulation require that the transmissionsloss though the building envelope excl. the windows and doors should maximum 4,7 W/m2 for a two-storage building, and the result of our Be15 calculation shows that the transmission loss though our building is 2,5 W/m2 which is quiet low compared to the maximum of 4,7W/m2. To fully utilize the allowed transmission loss limit, the wall thickness could be investigated according to the amount of insulation. The curve ill 61 shows how the amount of insulation influence the U-value, and it is shown that the insulation less influences the U-value when applying more than 300 mm, and this should be considered both according to an economic aspect and an aesthetic aspect. Slimmer walls will affect the experience and the daylight conditions of the room. This parameter could be investigated closer.
When looking at the results of Be15 it has been chosen to apply photovoltaics to cover the electricity use for the building and the daily electricity use for lighting, computers, TV etc. When Be15 do not calculate the daily electricity use as a part of the energy consumption for dwellings, the electricity use of the building has been multiplied with 2, and the needed area of photovoltaic to cover this have been calculated (see appendix 1). The calculation shows that 177 m2 photovoltaics are required to cover the total electricity use, but the calculation do not consider the shadows from the trees, this have been applied in Be15, to get a realistic result. (See the key numbers from Be15)
See appedix 12 for futher decription of Be15 .



ill. 58 - The energy use distribution on room heating, domestic hot water and electricity with out lighting ect.

Key numbers, kWh/m² year

Renovation class 2

Without supplement	Supplement for special conditions	Total energy frame
111,6	0,0	111,6
Total energy requirement		30,0

Renovation class 1

Without supplement	Supplement for special conditions	Total energy frame
53,3	0,0	53,3
Total energy requirement		30,0

Energy frame BR 2015

Without supplement	Supplement for special conditions	Total energy frame
30,5	0,0	30,5
Total energy requirement		26,0

Energy frame Buildings 2020

Without supplement	Supplement for special conditions	Total energy frame
20,0	0,0	20,0
Total energy requirement		19,2

Contribution to energy requirement	
Heat	19,9
El. for operation of bulding	4,0
Excessive in rooms	0,0

Net requirement	
Room heating	6,0
Domestic hot water	13,8
Cooling	0,0

Selected electricity requirements	
Lighting	0,0
Heating of rooms	0,0
Heating of DHW	0,0
Heat pump	0,0
Ventilators	4,0
Pumps	0,0
Cooling	0,0
Total el. consumption	34,7

Heat loss from installations	
Room heating	0,0
Domestic hot water	0,6

Output from special sources	
Solar heat	0,0
Heat pump	0,0
Solar cells	0,0
Wind mills	0,0

ill. 59- Key numbers of Be15 calculation without photovoltic panels included in the calculation.

Key numbers, kWh/m² year

Renovation class 2

Without supplement	Supplement for special conditions	Total energy frame
111,6	0,0	111,6
Total energy requirement		9,8

Renovation class 1

Without supplement	Supplement for special conditions	Total energy frame
53,3	0,0	53,3
Total energy requirement		9,8

Energy frame BR 2015

Without supplement	Supplement for special conditions	Total energy frame
30,5	0,0	30,5
Total energy requirement		5,8

Energy frame Buildings 2020

Without supplement	Supplement for special conditions	Total energy frame
20,0	0,0	20,0
Total energy requirement		4,7

Contribution to energy requirement	
Heat	19,9
El. for operation of bulding	-4,0
Excessive in rooms	0,0

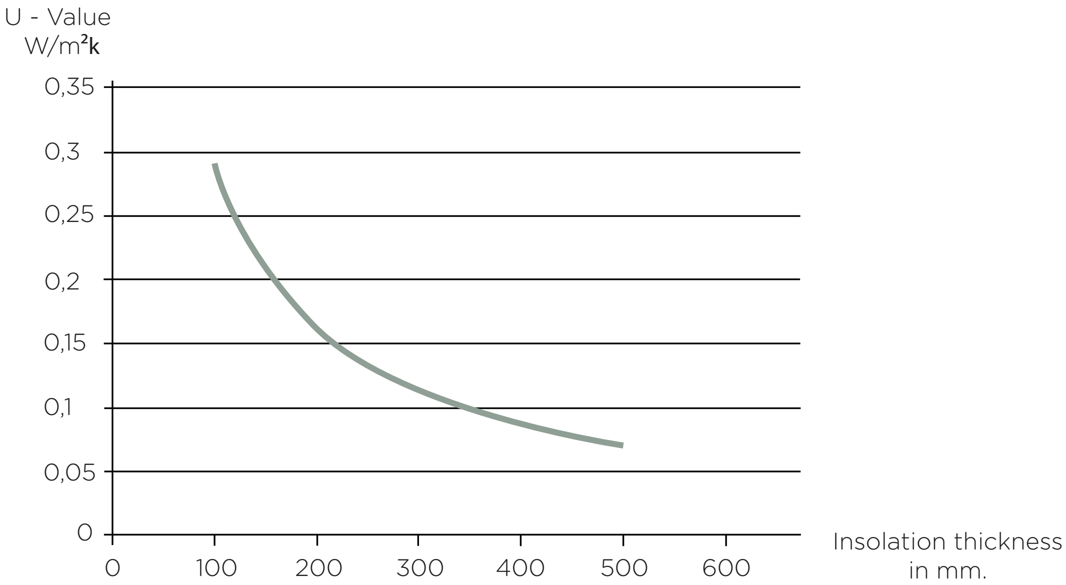
Net requirement	
Room heating	6,0
Domestic hot water	13,8
Cooling	0,0

Selected electricity requirements	
Lighting	0,0
Heating of rooms	0,0
Heating of DHW	0,0
Heat pump	0,0
Ventilators	4,0
Pumps	0,0
Cooling	0,0
Total el. consumption	34,7

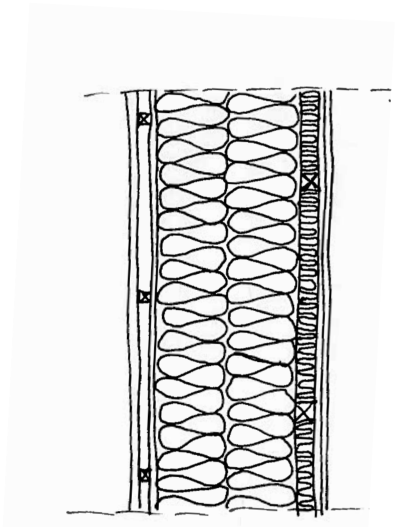
Heat loss from installations	
Room heating	0,0
Domestic hot water	0,6

Output from special sources	
Solar heat	0,0
Heat pump	0,0
Solar cells	8,1
Wind mills	0,0

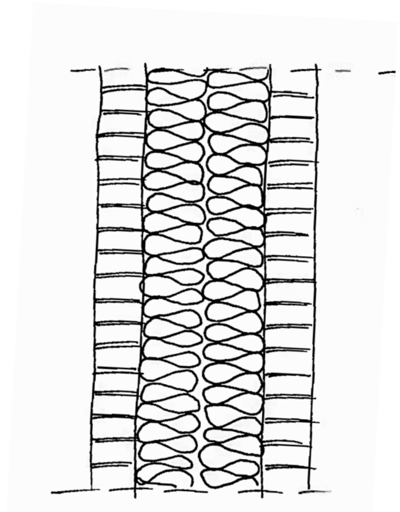
ill. 60 - Key numbers of Be15 calculation with photovoltic panels included in the calculation.



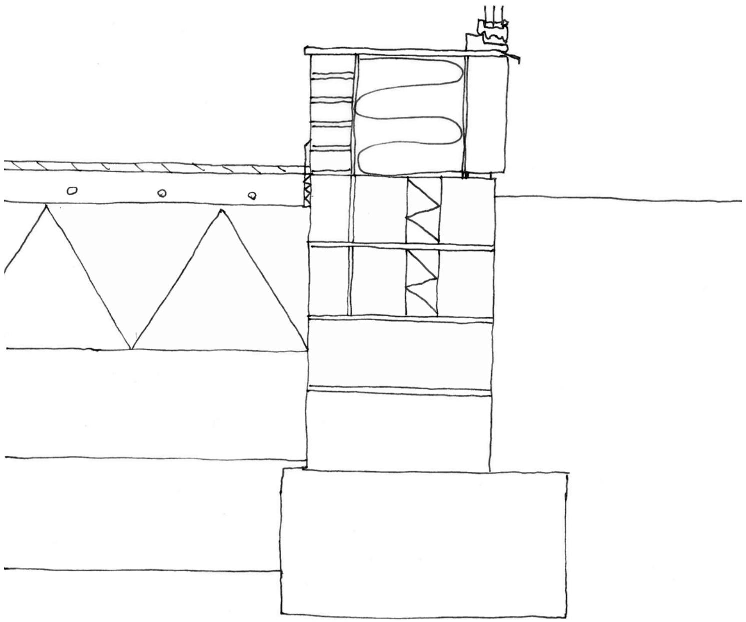
ill 61



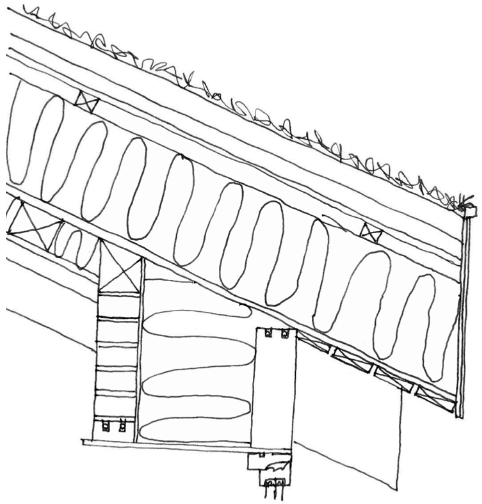
ill 62 - Construction detail of the wooden facade in the patient rooms



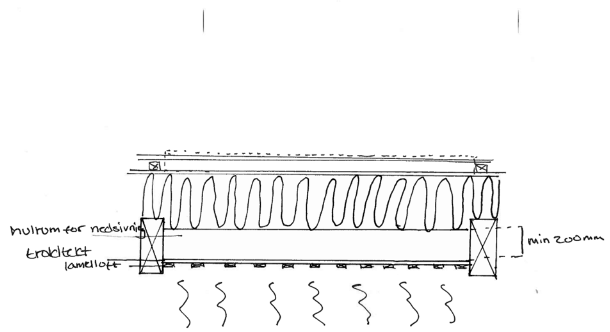
ill 63 - Construction detail of the brick facade in the patient rooms



ill 64 - Detail of the foundation see appendix 10 for scale 1:20



ill 65 - Roof detail see appendix 10 for scale 1:20

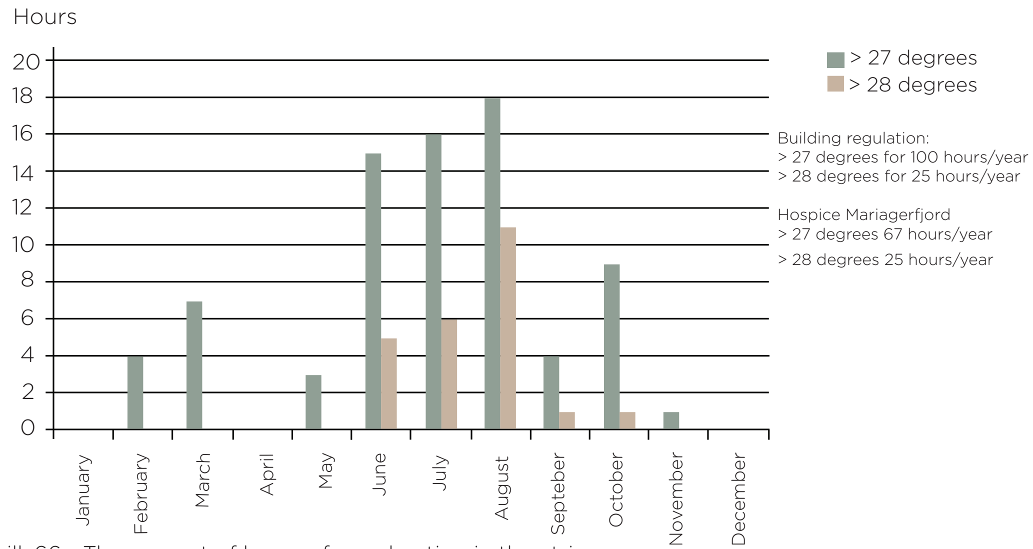


ill 66 - Ceciling detail.

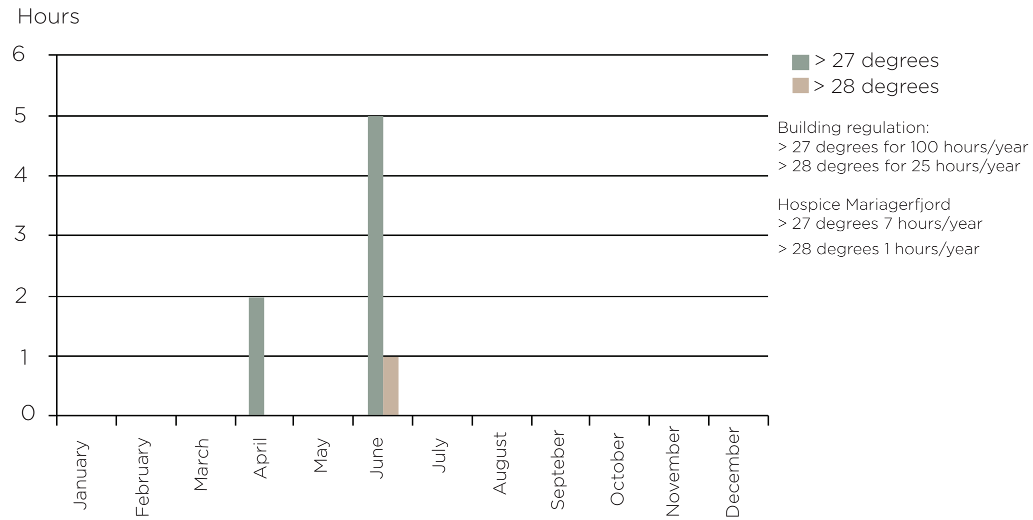
THERMAL INDOOR ENVIROMENT

The thermal indoor environment has been considered through the design process by simulations in Bsim, and different parameters have influenced these simulations. Passive strategies such as the placement of the windows in the external wall, passive solar shading by an overhang (see ill. 71 to 72.) and by utilization of the trees at south of the site. See the sections ill. 68 and ill. 69 which demonstrate how the trees is used as passive strategies through the year. The graph ill 67 shows that the passive strategies have had the desired effect in the patient room, when the amount of overheating is below the allowed number of hours above both 27 degrees and 28 degrees. The other graph ill. 66 demonstrate that the atrium is just below the allowed number of hours, and other parameters have been used to reduce the overheating. External solar shading was the first thing which were applied, but this did not reduce the overheating enough, and for that reason venting was applied. The possible air change rate was calculated by a simple calculation to verify the opening size of the windows see appendix 2. The result of the calculation showed that minimum 60% of the window should be able to open, and this effected the design of the windows see ill. 73.

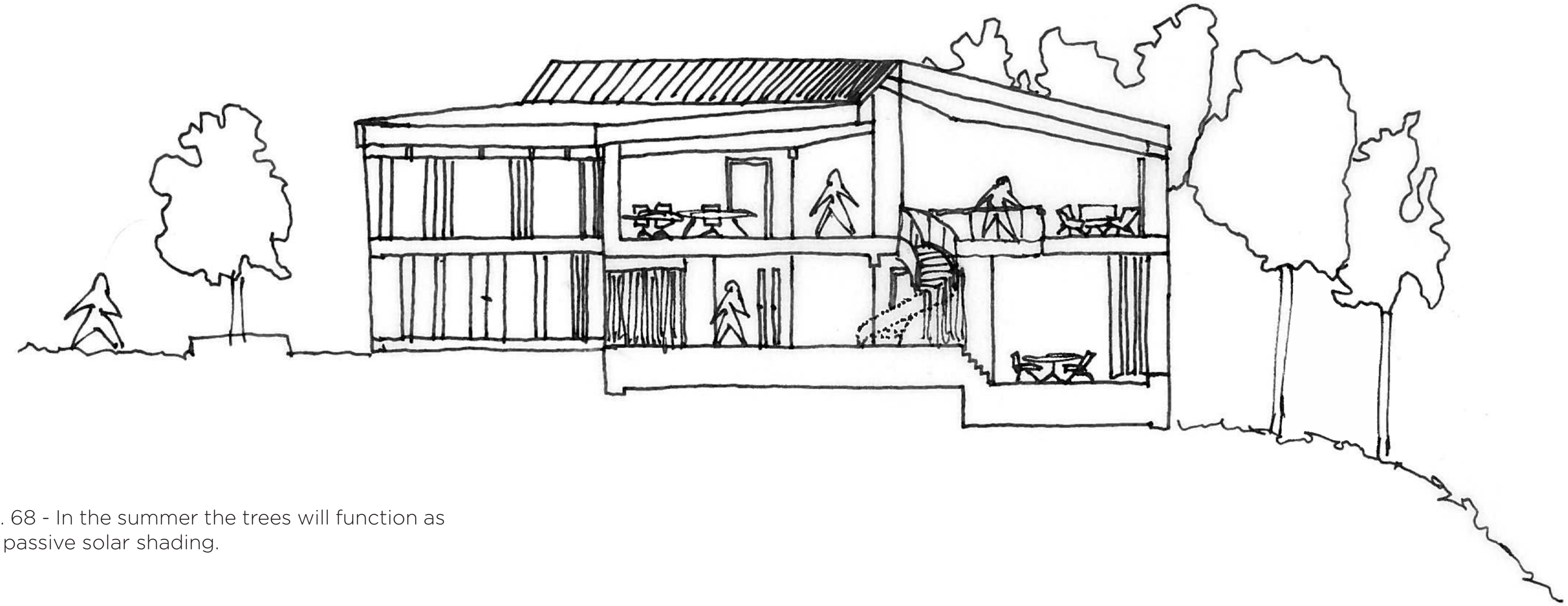
The atmospheric enviroment has been stablile through the the investegtions in Bsim, the CO^2 level for the patient room and the atrium is shown in appendix 6.



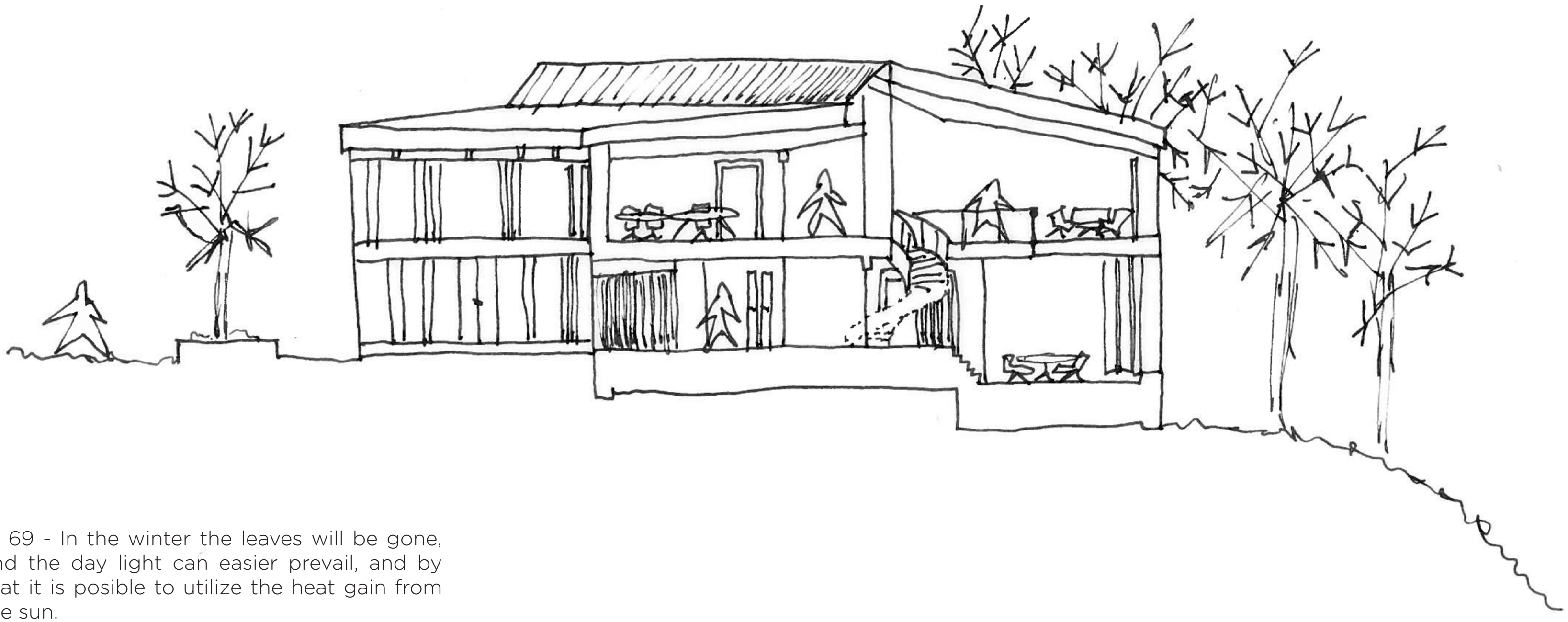
ill. 66 - The amount of hours of over heating in the atrium.



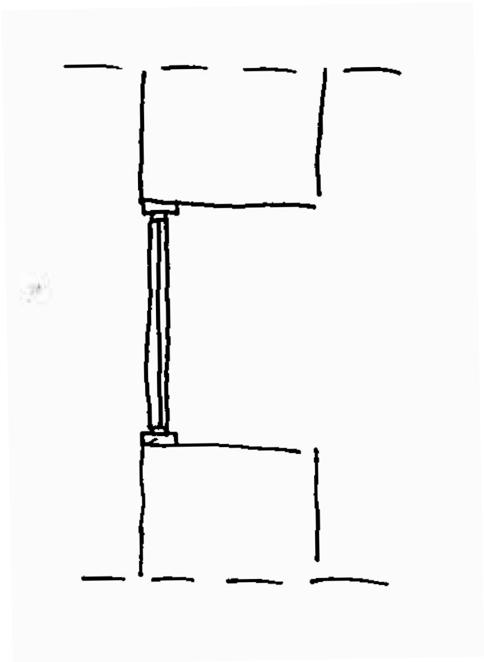
ill. 67 - The amount of hours of over heating in the patient room.



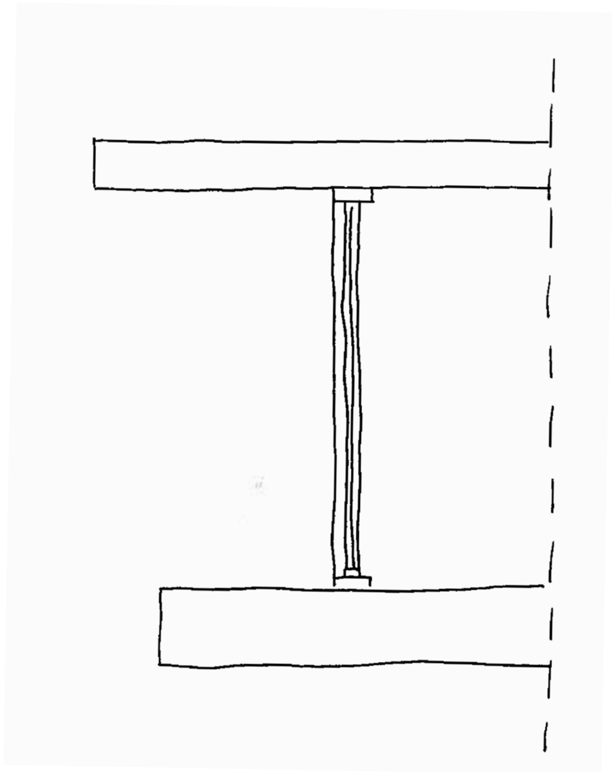
ill. 68 - In the summer the trees will function as a passive solar shading.



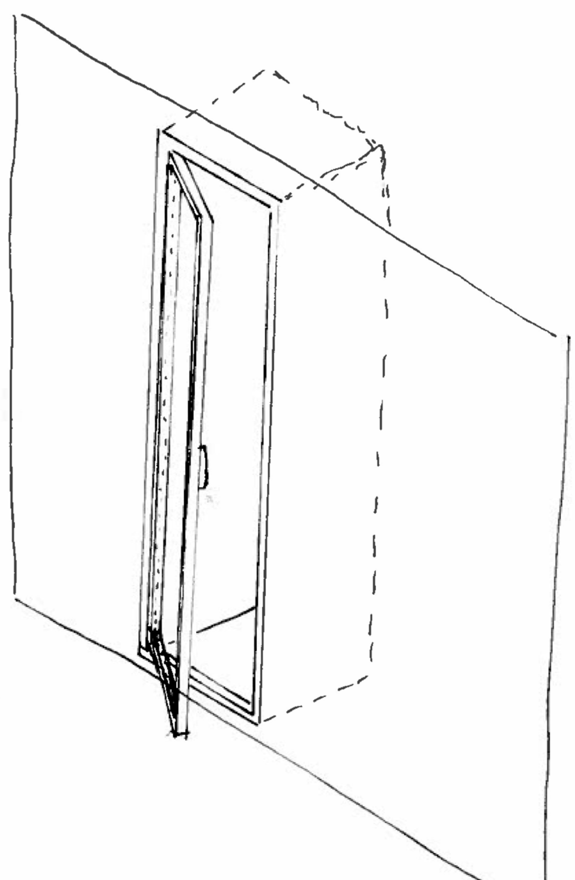
ill. 69 - In the winter the leaves will be gone, and the day light can easier prevail, and by that it is posible to utilize the heat gain from the sun.



ill. 71 - The placement of the window in the building envepole have been chosen to reduce the line loss.



ill. 72 - An overhang above the baconies in the patient rooms fuction as passive solar shading.



ill. 73 - The windows have to be able to open at least 60% of the window area, and that is why this soulution have been chosen.

VENTILATION STRATEGY

The ventilation strategies consist of natural ventilation and mechanical ventilation in the common areas. The mechanical ventilation is operated by two central aggregates located in the two central positions technique rooms in the ground floor. Each central aggregate supply half of the building, where the devision is placed in the middle of the atrium. Even though they are divided more or less in the middle the two central aggregates are not the same size because the capacity of the air supply is different. The calculations of the air change rate see appendix 3. This calculation determines the air supply and together with a calculation of the pressure loss through the pipes. See appendix 8. the calculation of pressure loss in the pipes is taken into account in the length of the pipes, the resistances of the shape of the pipe as well as the diameter, bendings of the pips, silent shutters, air speed and outlets. The sizing of the aggregates are made upon the two calculations, and estimated by the use of the program system airCad see appendix 8. This estimation of the two central aggregates ends up with a SEL value of the energy use to run the system and a percentage of the heat recovery. These numbers are used in the Be15 calculation of the energy consumption of the building.

The patient rooms are not operated by the central aggregates but a decentralized mechanical ventilation system. This is chosen to avoid large ventilation pipes in the patient rooms and because the ventilation needs can vary do to special needs of the patients. There are not made calculations of the sizing or energy use of the decentralized mechanical ventilation system. It is assumed the ventilation system can be stored in one of the cabinets in the entrance of the patient room.

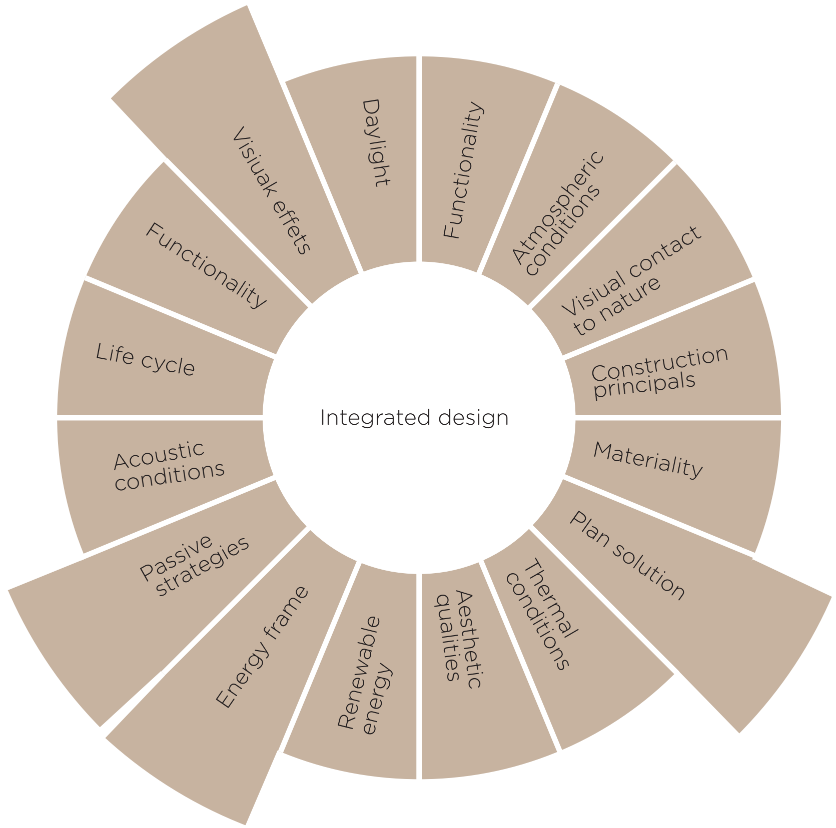
DESIGN PROCESS

ITTERATIONS OF THE DESIGN DEVELOPMENT SHOWEN THROUGH SKETCHE - SIMULATIONS - CALCULATIONS

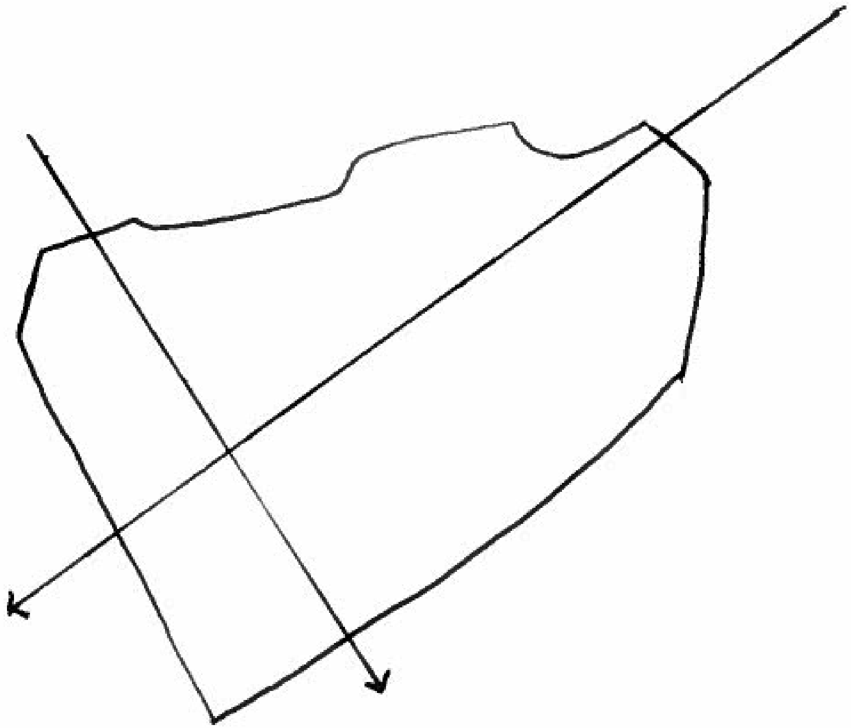
PHASE 1

The focus in this phase is on the plan solution, visual effects, and passive strategies. Optical axis has influenced the plan solutions by how the hospice is orientated on the site, and how the different functions are located. The patient rooms and the day-center should be placed to the south, while the support facilities and staff areas should be placed to the north. The optical axis should create two main views as well, and be used to make direction both inside and outside the building. Beside the optical axis, the plan solutions have been influenced by an inspiration of the additive system that Jørn Utzon has used in many of his projects. An additive system is consisting of squared modules, which can be added to each other within a grid system. The additive system was used to try making a more compact plan solution, when the sites has a limited area. To make the building more compact is was chosen to divide the function into two floors, which should generate more space to the patient rooms. This created the posibility to implement a private inner courtyard in shelter from the western wind, which extend the time of the use.

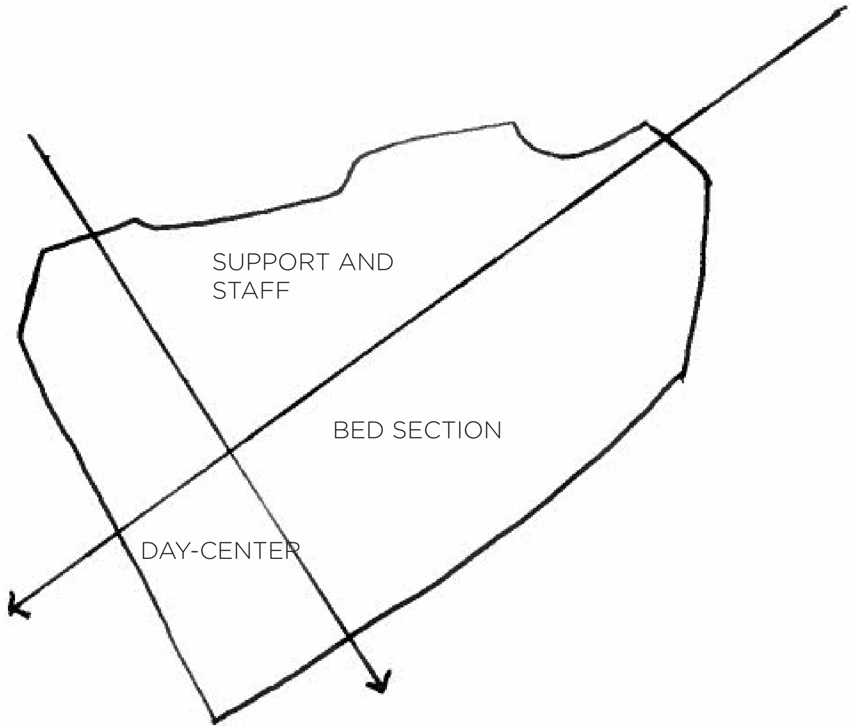
Finally the passive strategies have had an influence on this phase according to, how to reach the energy class 2020.



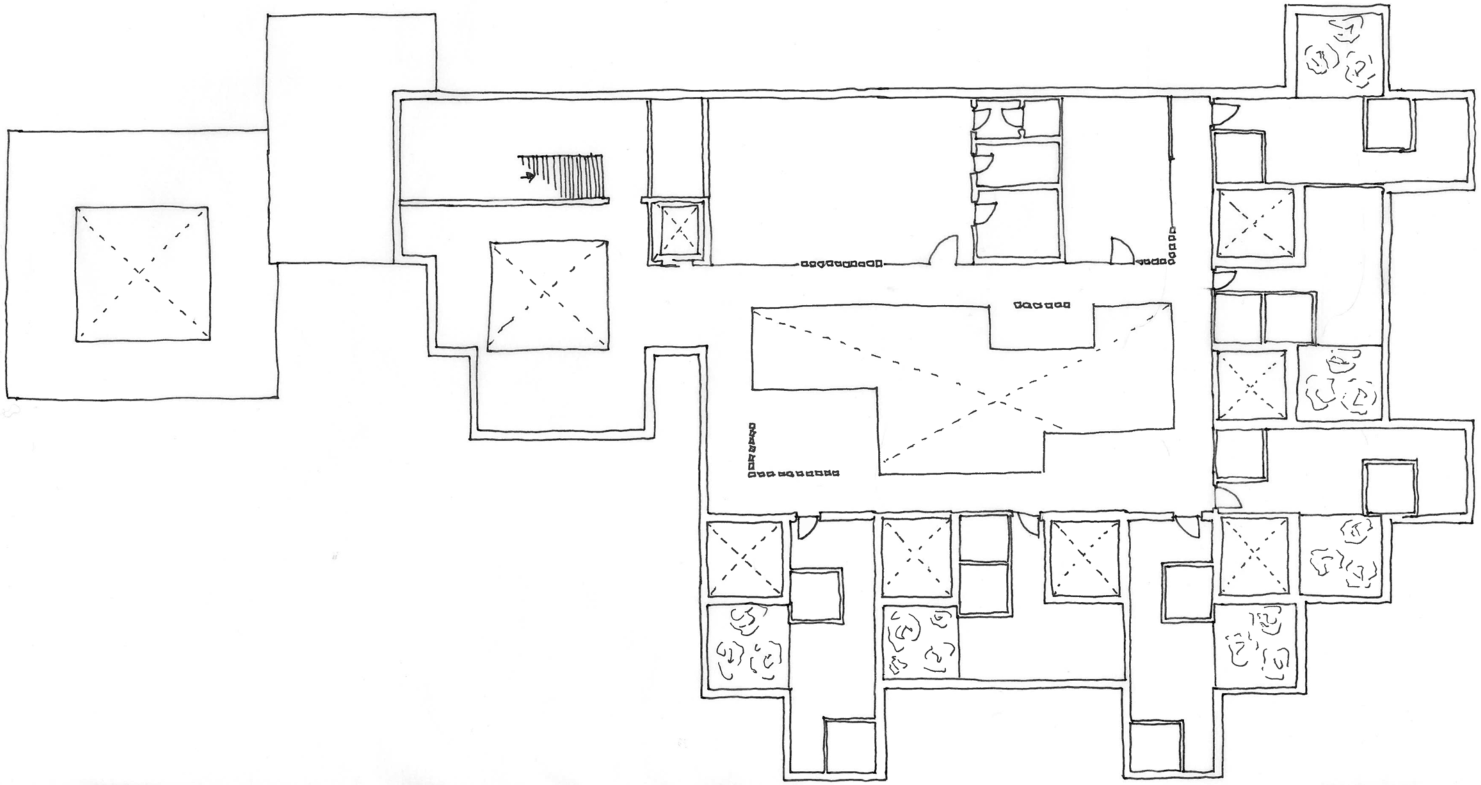
ill. 74 - Parameters infuensing the phase.



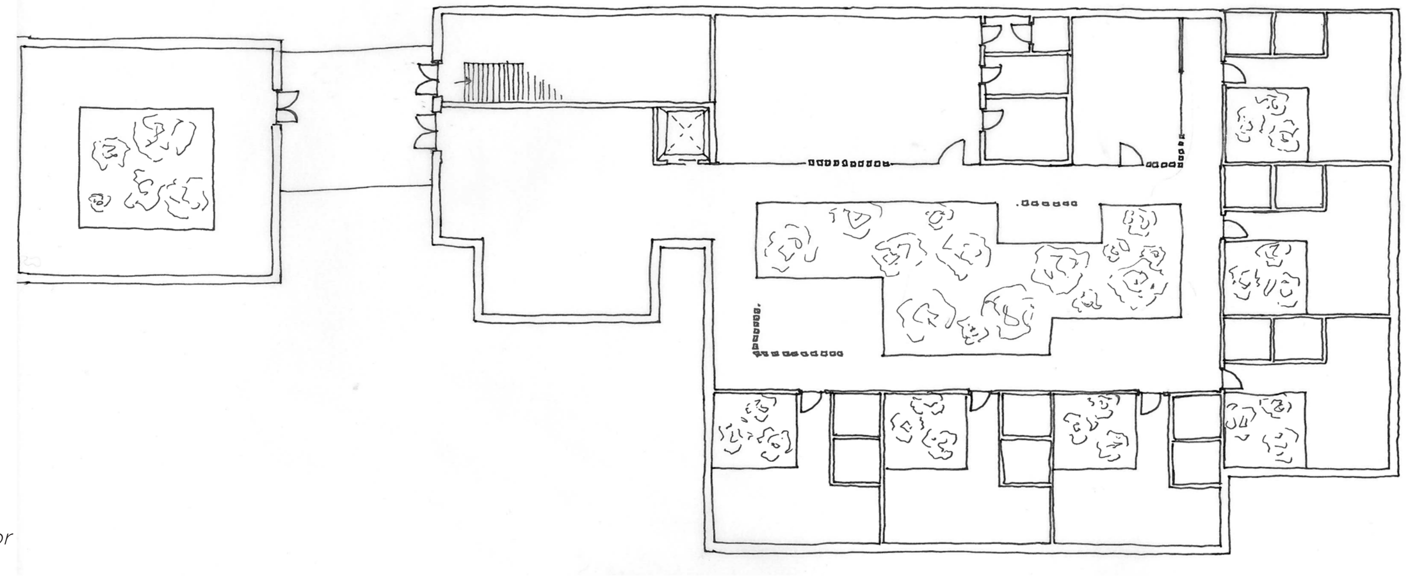
ill. 75 - Optical axis



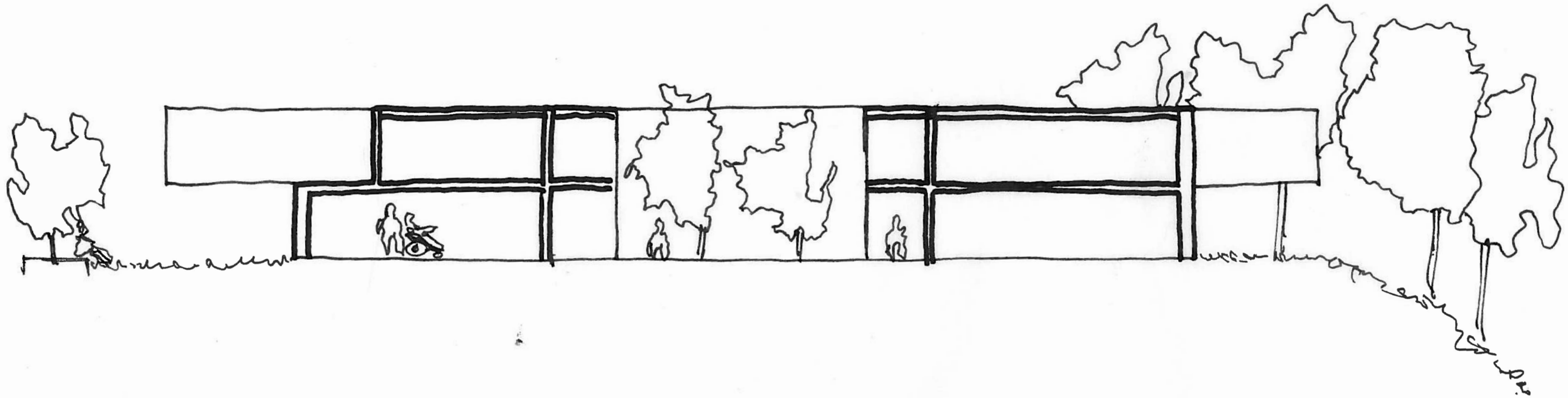
ill. 76 - Divison of functions



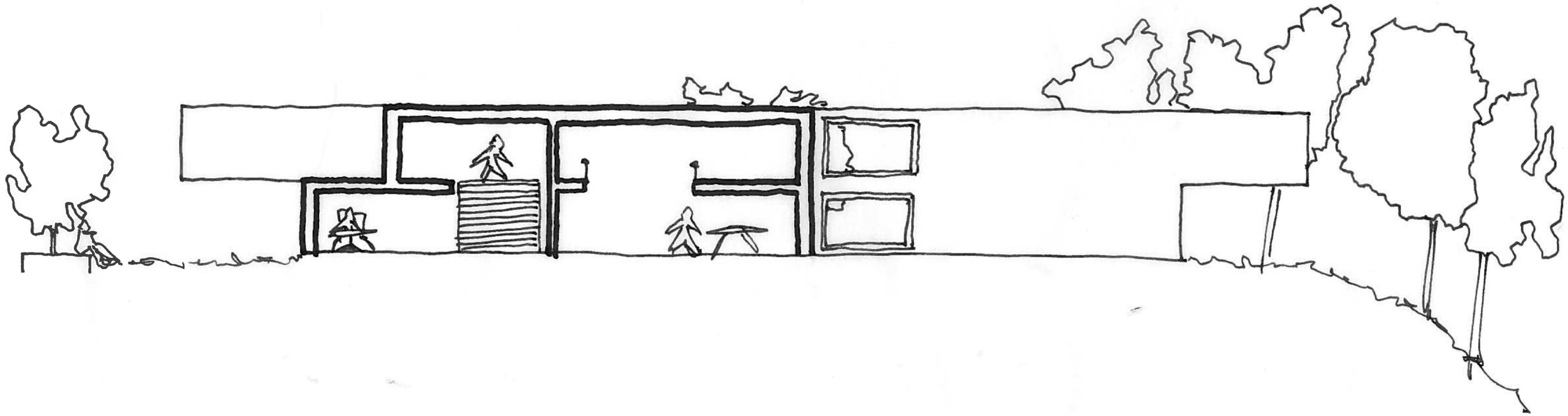
ill. 77 1´st floor



ill. 78 - Ground floor



ill. 79- Section

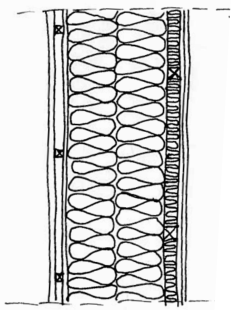


ill. 80 - Section

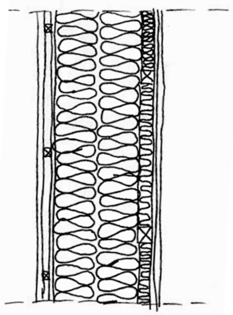
PASSIVE STRATEGIES

This project is orientated north/south, which can make it more difficult to ensure the desired high quality of the indoor climate. For this reason, passive strategies have been considered from the beginning, as well as the possibility of using the site and its surroundings as a part of these strategies. To reach the energy class 2020 the thickness of the walls has been considered according to U-values and line loss. Rockwool (Rockwool 2016) has made a recommendation of the insulation thickness in both light-weight wall and heavy walls to reach either the energy class 2015 or 2020, and it was chosen to use the recommended wall thicness for 2020 walls, but with the samallest amount of insulation and with a high insulating ability. This was chosen concerning the light conditions, and by the fact that by applying more insulation the effect on the U-value is minimal. The same considerations of U-values and line loss have been done for the roof and the ground deck. Another way to reduce the line loss is by consider the placement of the windows, and by placing them on the outer edge of the wall, the line loss will be minimal almost not existing. By placing the windows on the outer edge of the wall, it also creates the possibility to use the window openings as a window sill.

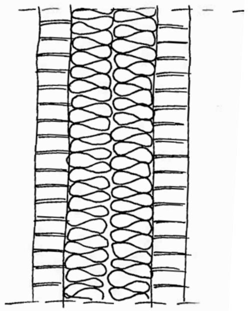
Solar radiation will become a problem according to overheating on the southern façade, and to avoid this solar shading will be necessary, and different solutions have been disused. The trees at south is used as passive solar shading, but this will properly not be enough to lower overheating. An overhang or permanent solar shading could be used to solve this problem, but the solution consider the view of the fiord at south, and the experience of this and the rooms as well. That is why permanent solar shading is less desirable than the overhang, when parts of the view will be blocked by that kind of shading.



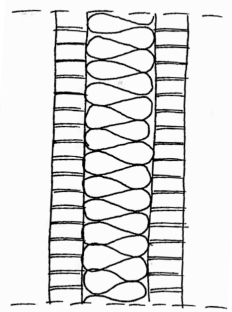
ill. 81 - Light construction 2020.



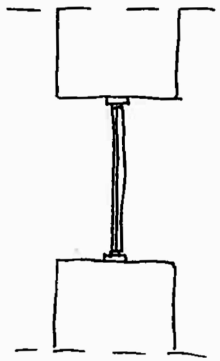
ill. 82 - Light construction 2015.



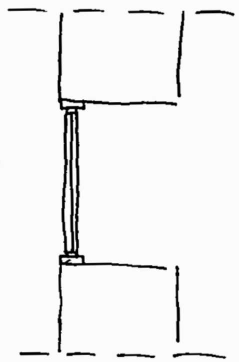
ill. 83- Heavy construction 2020.



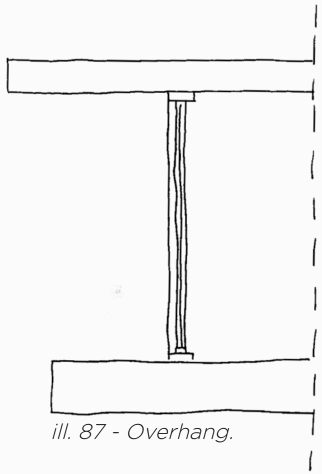
ill. 84- Heavy construction 2015.



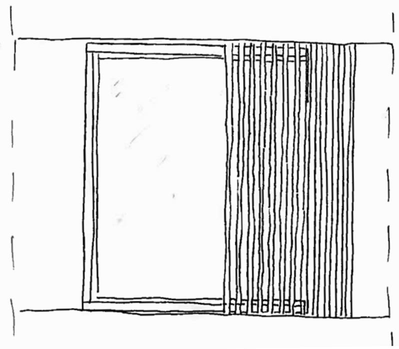
ill. 85 - Central placed window.



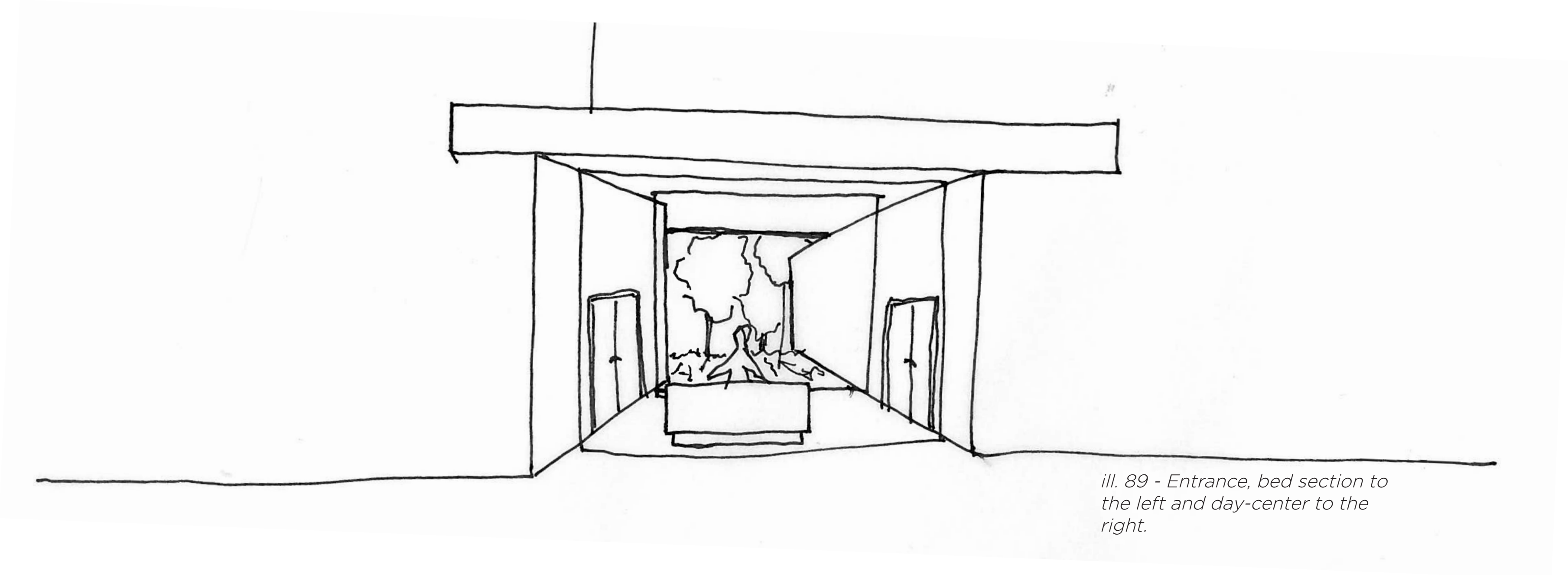
ill. 86- Placed at the outher brinck .



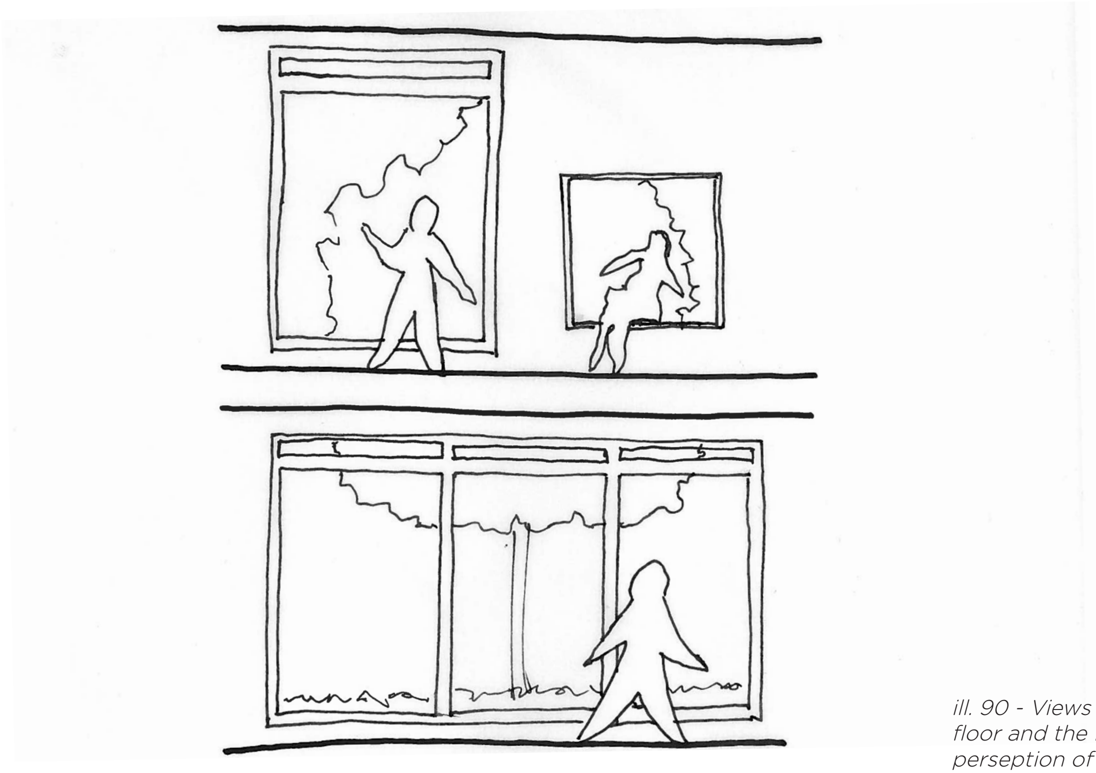
ill. 87 - Overhang.



ill. 88 - Permanet solar shading



ill. 89 - Entrance, bed section to the left and day-center to the right.



ill. 90 - Views form the ground floor and the first floor, and the perseption of the view and trees

CONCLUSION

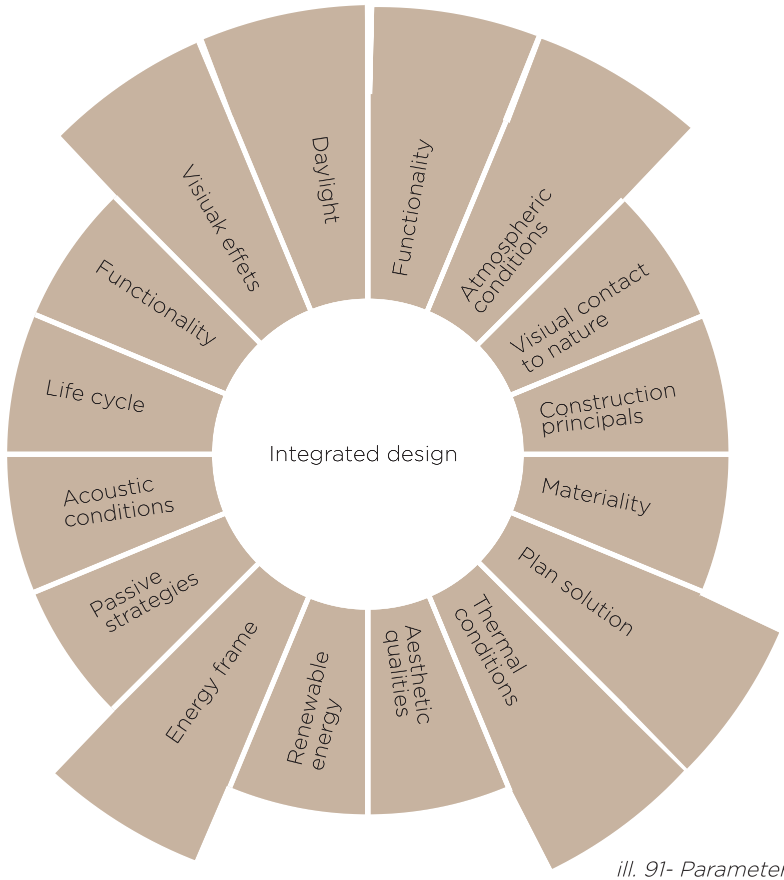
The footprint of this configuration obtains too much space on the site, and do have the desired expression form the outside, because of the fragmented 1´st floor. The inner courtyards create an introvert building composition, which do not incorporate the building in nature as desired. Furthermore, the many comers of the building envelope and the inner courtyards create a large line loss.

In the further development the passive strategies will be used.

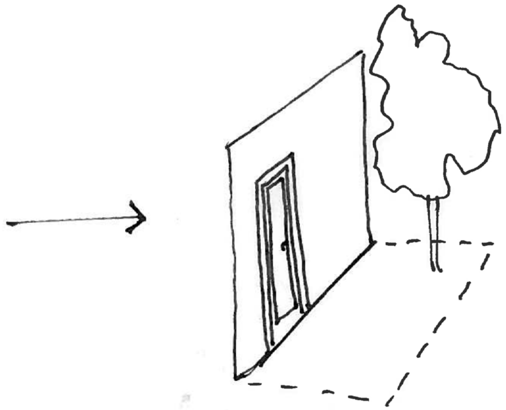
PHASE 2

To decrease the footprint of the building and to utilize the southern part of the site a new organization of the site was made upon the concept by using an oval shape, with a center point in the middle of the site instead of the central axis. The oval shape should provide with an embracing appearance of both the site and the building. The building should be shaped upon the oval at the southern part of the site, while the rest should be implemented as a part of the outdoor areas see ill. 94 and ill. 95.

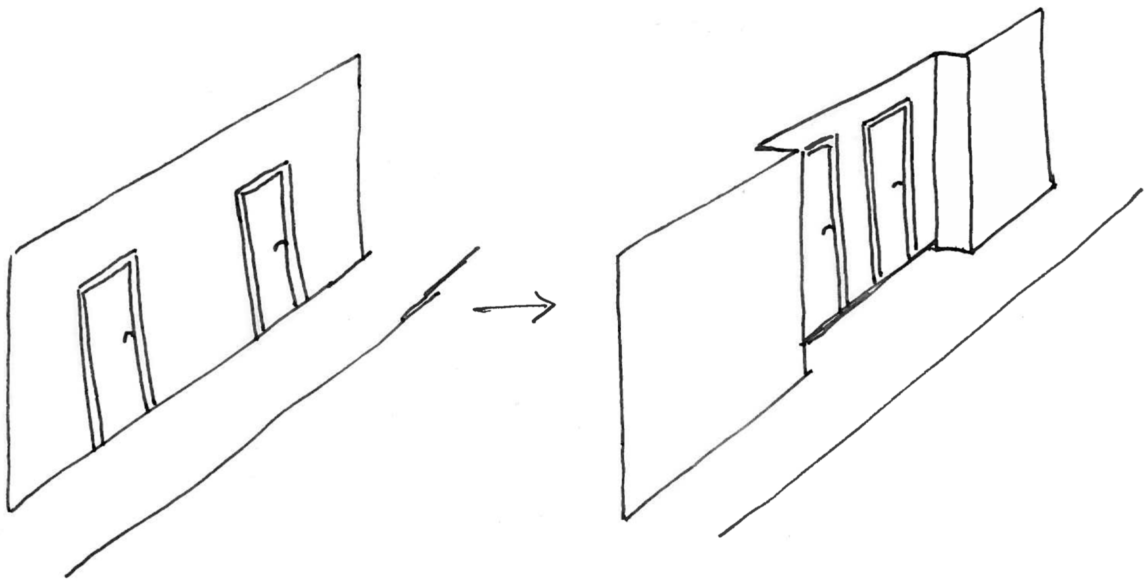
A new division of the four function areas was made in this phase see ill. 96. To secure all the patient rooms with a view of the fiord, these were placed on the first floor facing south, while the kitchenetts and the rooms for relatives are placed at north. In the ground floor see ill. 99 the support and staff areas have been placed along with a day center, and an atrium which is a gathering point between the different areas and as an entrance to the hospice. This division will provide the hospitalized patients with more tranquility on the first floor see ill. 98, and those patients and relatives who want to be part of the everyday activity in the day-center can use these facilities through their stay at the hospice. By looking at the sections ill.100 and 101 it is shown how the patient rooms become part of the treetops, which create the effect of staying at a treetop house, and be a part of the seasonal changes. In this plan solution, the internal courtyards have been replaced by balconies in front of each patient room see ill. 92, and sheltered from the wind by the construction. Furthermore, the straight hallways have been provided with small niches see ill. 93 .



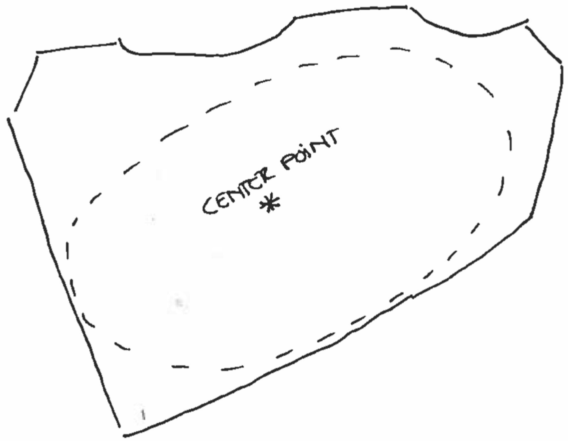
ill. 91- Parameters infuensing the phase.



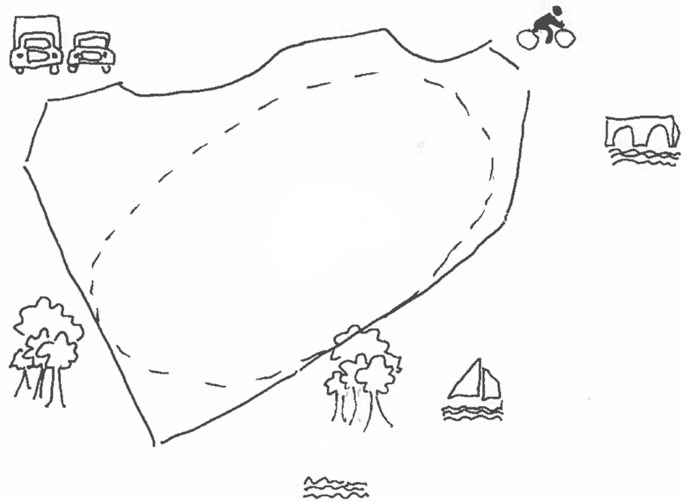
ill. 92 - The inner courtyard is transformed into a balcony.



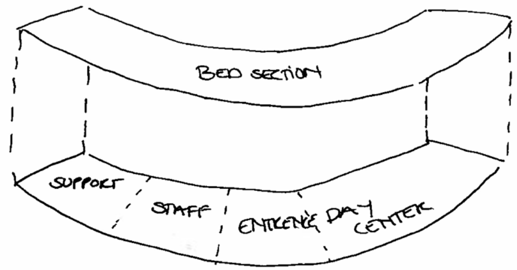
ill. 93 - Niches refract the straight hallway.



Ill. 94 - The center axis have been exchanged by a center point in the middle of the site. The centerpoint is surrounded by an oval, which should function as an embraching movement used to shape the building.

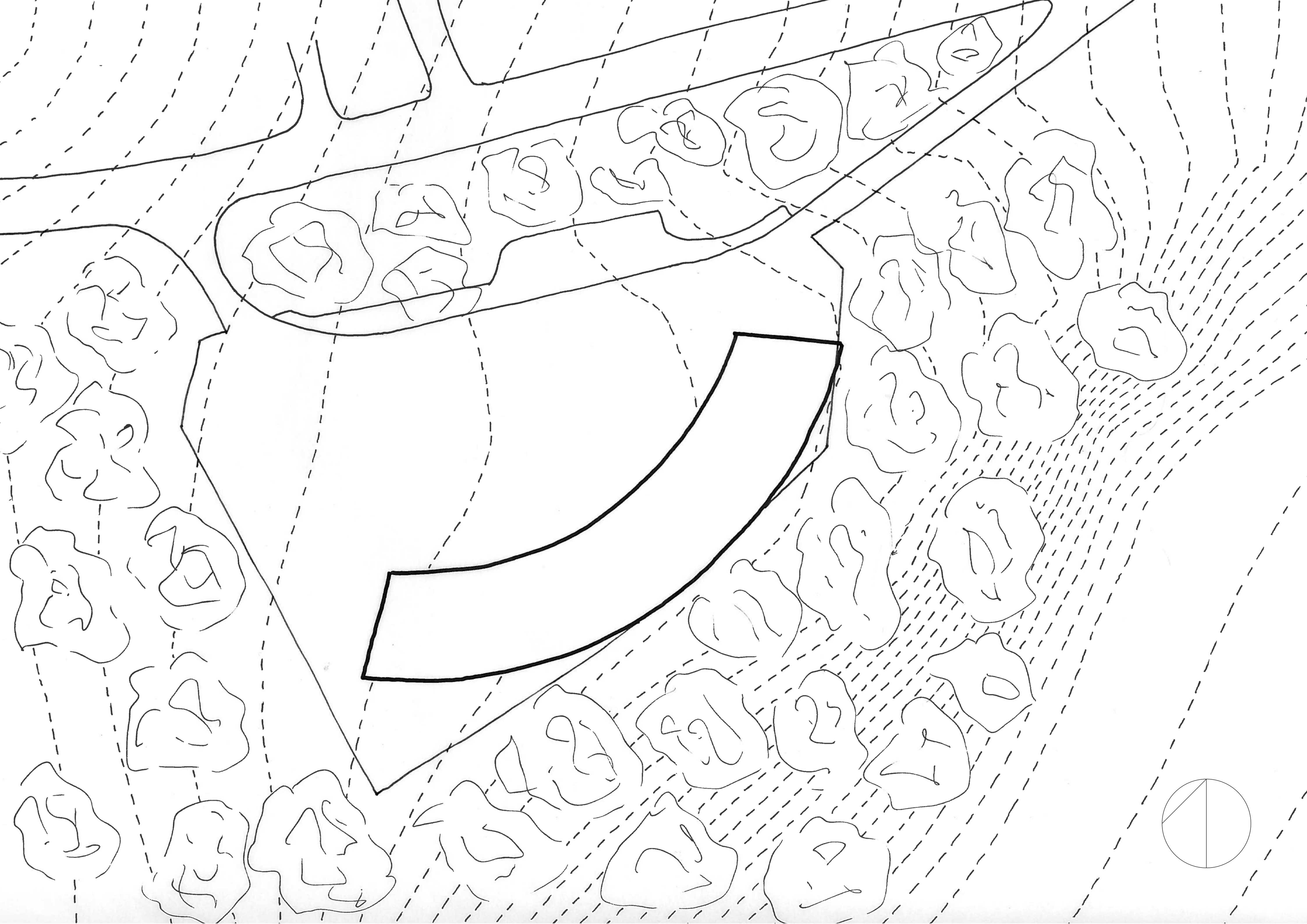


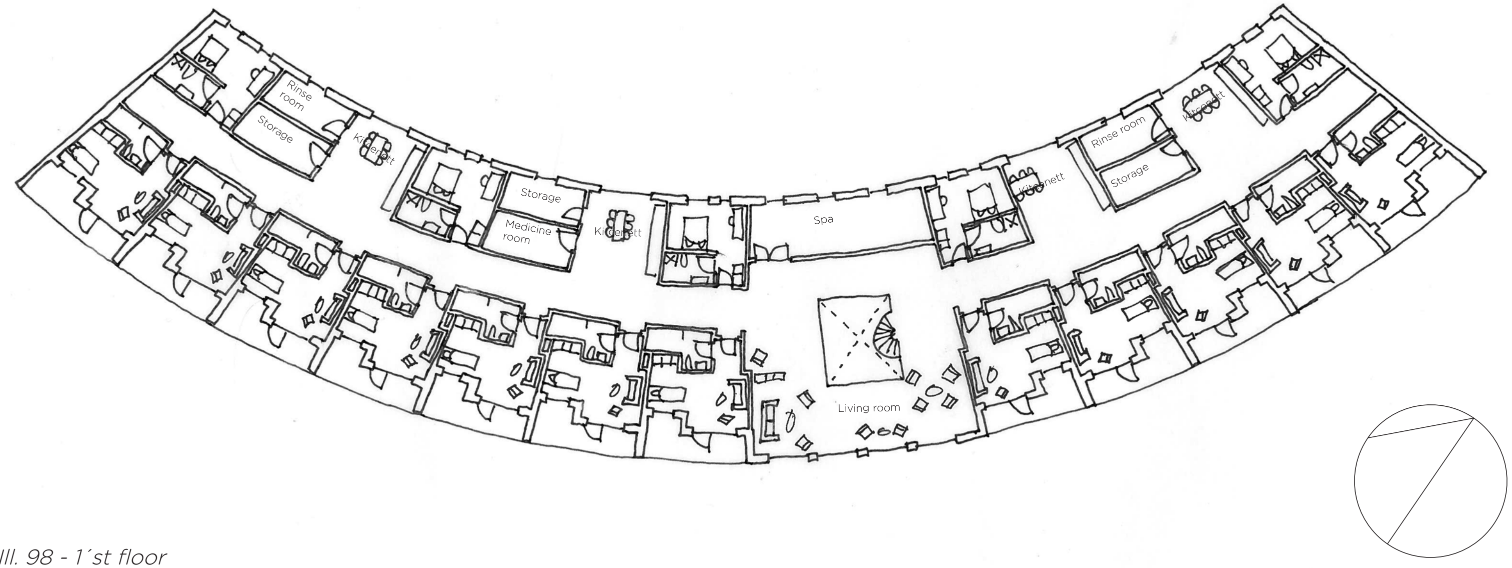
Ill. 95 - The diagram show the views from the site.



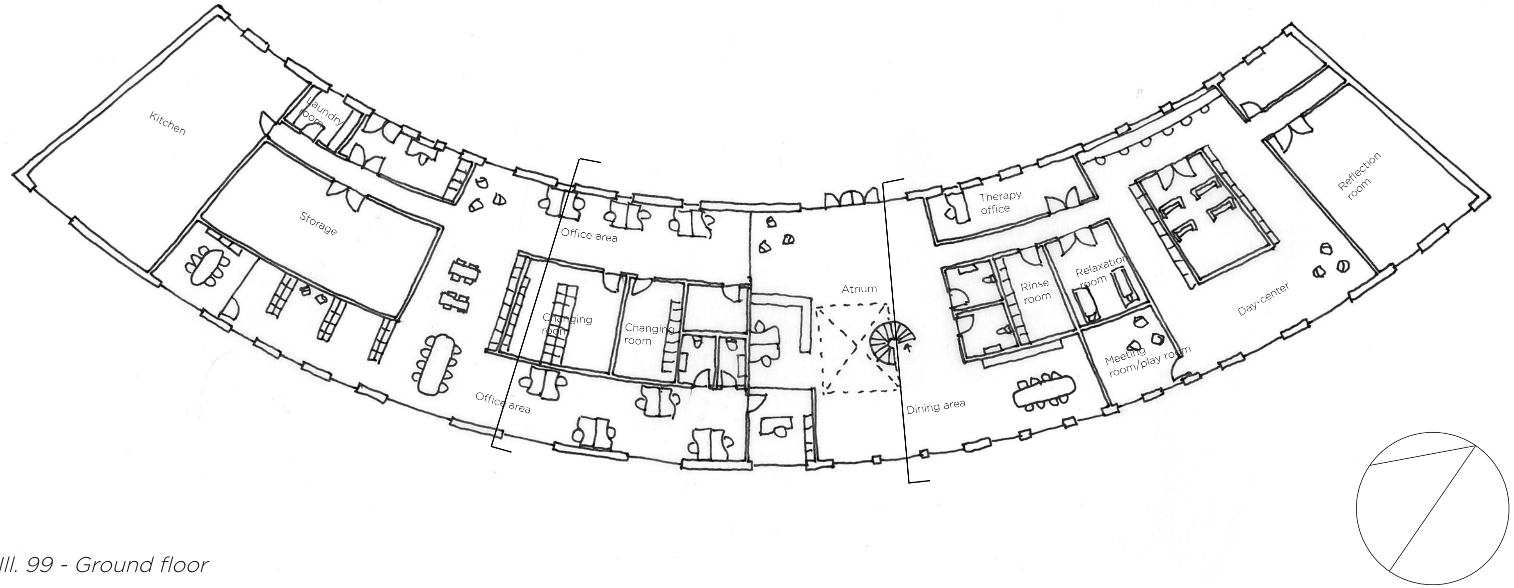
Ill. 96 - The boulding should be divivded in diffrent segments, and the diagram above shows how it is intened to divide these.

Ill. 97 - Masterplan

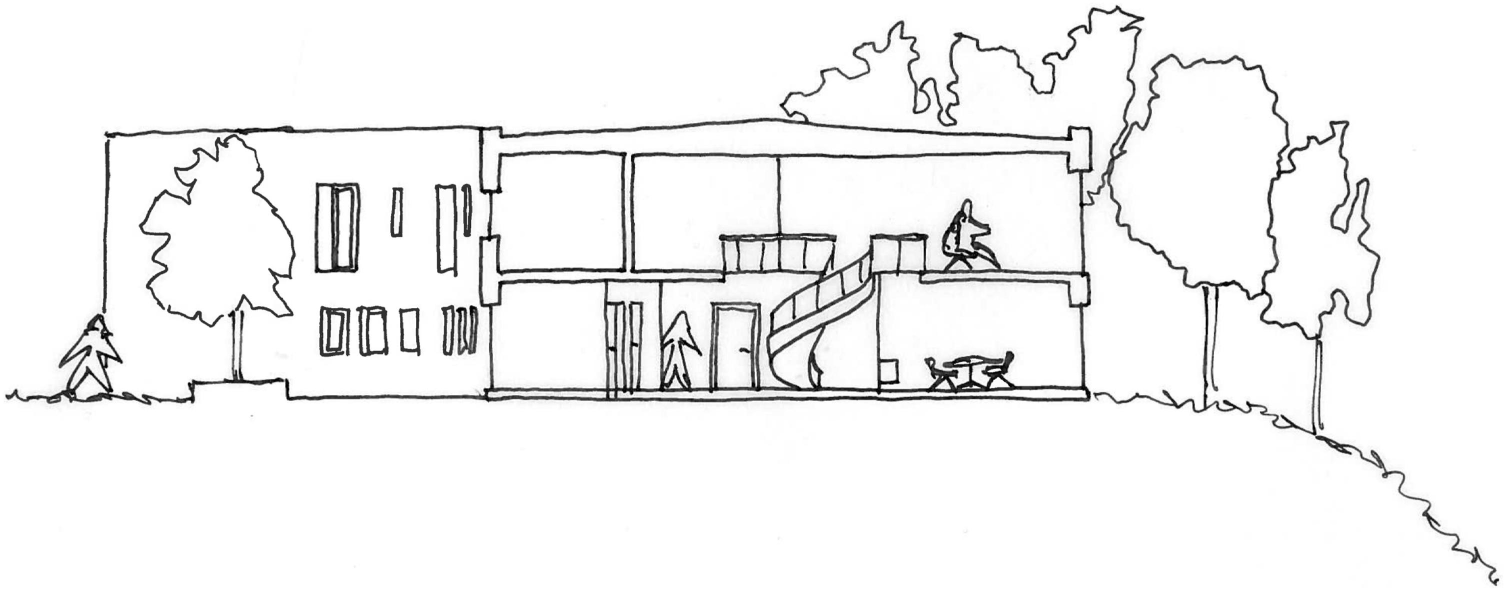




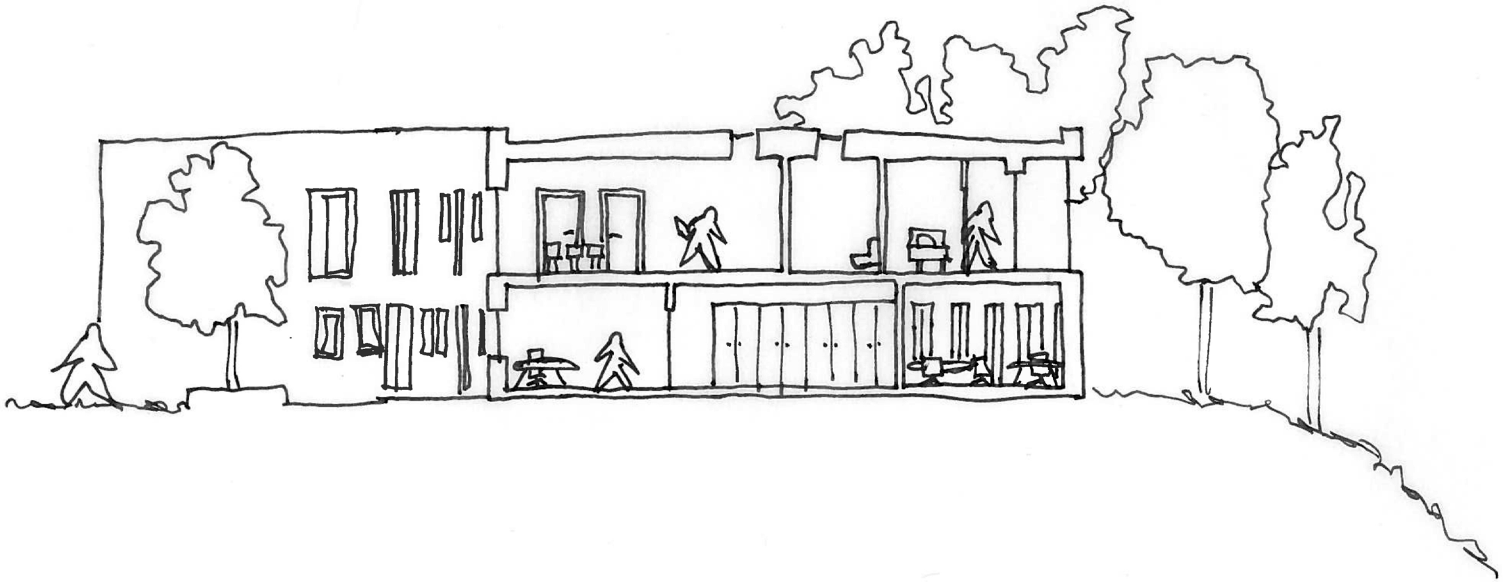
Ill. 98 - 1´st floor



Ill. 99 - Ground floor

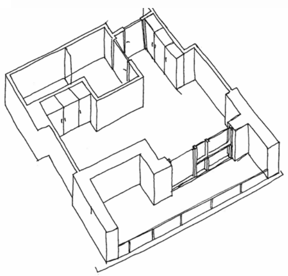


Ill. 100 - Section



Ill. 101 - Section

Ill. 102 - Patient room.



Ill. 103 - Bathroom

Ill. 104 - Entrance to the patient room.

FACADE DESIGN

DAYLIGHT, BE15, AND BSIM

The façade proposal in this phase was made upon the passive strategies of solar heat gain and heat loss. The southern façade should have large window areas to exploit the possibility of solar heat gain, while the window area should be reduced at the northern façade to avoid a high level of heat loss see ill 107 and 108. This proposal should be used as a starting point for the further design development through closer investigations in Be15 and Bsim.

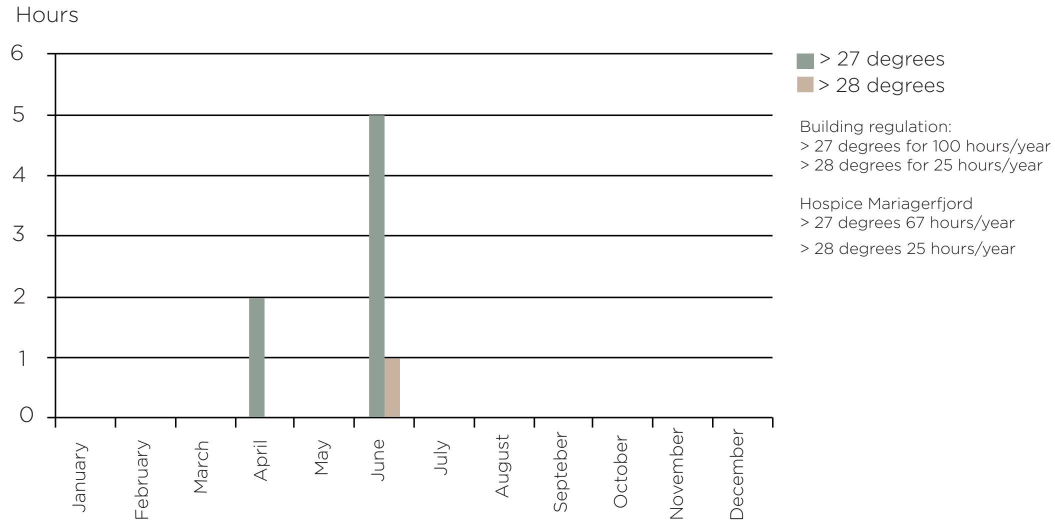
Be15 is used to get an overview of the overall energy consumption, and the first result showed a smaller amount of overheating in the building. To understand the result of the Be15 calculation a Bsim model was made of the atrium, when it is assumed that the atrium is the most critical room in the building, because it both have the largest window area at south and at north. It was chosen to make a Bsim model of one patient room as well, to ensure that the patient rooms have a high quality of indoor environment. The simulation of the atrium showed a larger amount of overheating 132 hours above 27º and 59 hours above 28º see graph ill. 106, this is probably caused by the large window area at the south, and the fact that there are no solar shading or overhang in the atrium, like the patient rooms which are covered of an overhang. The patient room has 7 hours above 27º and 1 hour above 28º see graph ill. 105.

The overheating was reduced by implementing external curtains with a low solar shading factor (By og Byg anvisning w202), and by including venting in the atrium and other common areas. These parameters can reduce the overheating significant, but it is not enough to get below the 25 hours above 28º which is required by the Danish building regulation 2020. To reduce the overheating the window area should be reconsidered, and reduced in a new façade design.

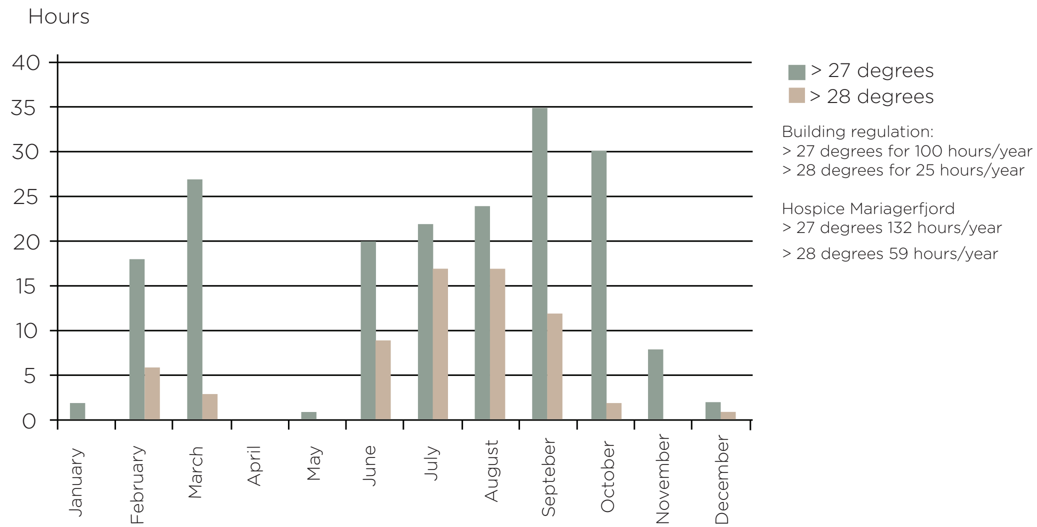
Within the hospice it is desireble to use mechanical ventilaton all year, when most patients is sensitve to draft. The patient room is the most important rooms which is vetilated by mechanical ventilation, and if it is nessesaty to use venting it should be in the common areas and not in the patient rooms. The ventilation is dimensiond by olf see appendix 3.

Because of the large windows area especially at south, a high daylight factor in both the atrium and the patient rooms are achieved. The atrium is a large room and the concern has been to drag light deep into the room. To do so the room is cross lit by windows orientated towards south and north, as well as the opening creating a connection between the ground floor and the first floor provides the ground floor with a great amount of light. As the Bsim shows a larger amount of overheating in the atrium occur, and the window area needs to be reduced without compromising with the amount of daylight see ill. 110 to 115. Thereby a skylight can be implemented in the atrium just as the skylights in the patient room because light coming from above is more efficient than side light.

The patient room also contains large windows toward south but because of the overhang there are no overheating and the great amount of daylight and the visual contact to the nature can be obtained. The light in the bathroom is provided by a skylight and the amount of light is on such a high level that the size of the skylight can be reduced to avoid overheating.



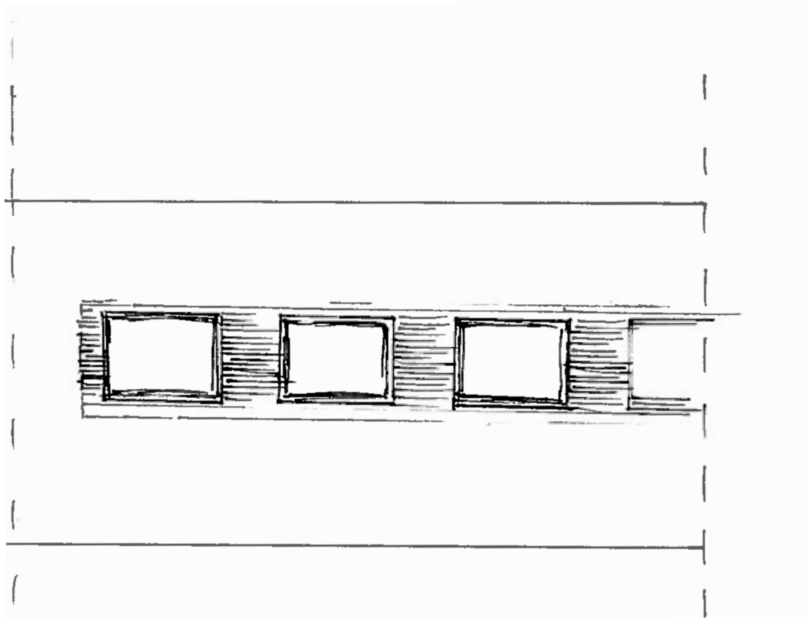
Ill. 105 - Overheated hours in the patient room



Ill. 106 - Overheated hours in the Atrium

The diagrams to the left shows the overheated hours through the year in the patientroom (the upper diagram) and in the atrium (the lower diagram). The diagram of the atrium shows the amount of overheated hours after implementing external curtains and venting.

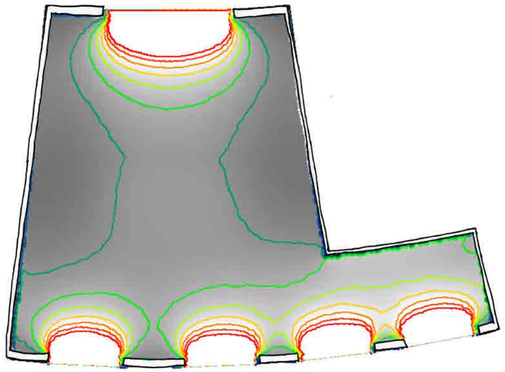
The numbers is from the Bsim simulation of the atrium.



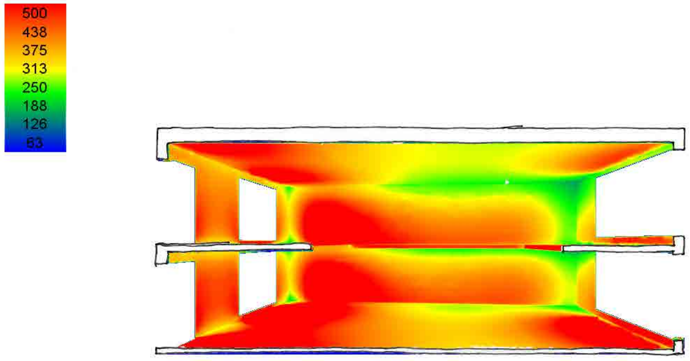
Ill. 107 - Segment of the northern facade with a band framning the horizontal widows

Ill. 108 - Segment of the southern facade with lager window areas to exploit solar heatgain.

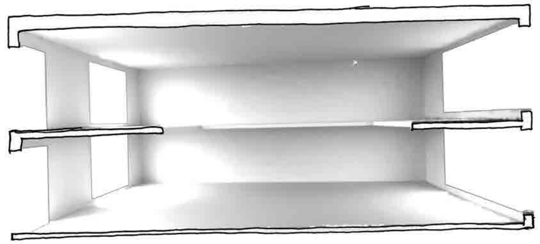
Ill. 109 - Band of bricks frame the windows at north.



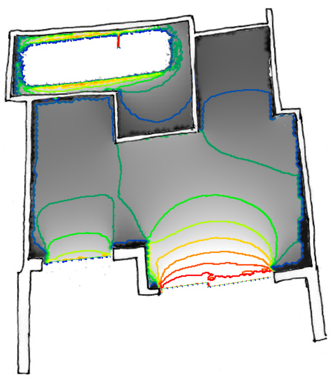
Ill. 110 - *Daylight factor in the atrium.*



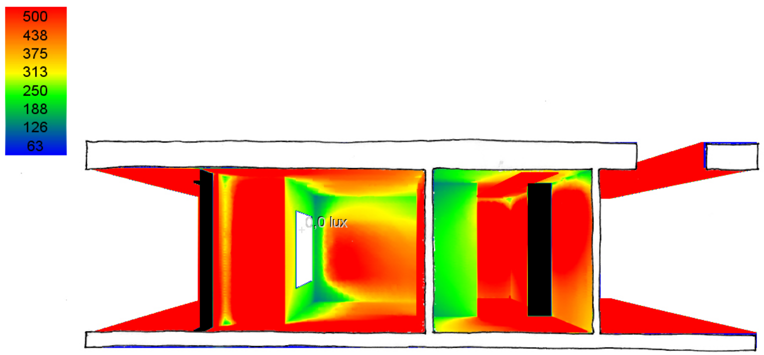
Ill. 111 - *Lux on the surfaces in the atrium.*



Ill. 112 - *Illustration of light and shadows in the atrium.*



Ill. 113 - *Daylight factor in the patient room.*



Ill. 114 - *Lux on the surfaces in the patient room.*

Ill. 115 - *Illustration of light and shadows in the patient room.*

CONCLUSION

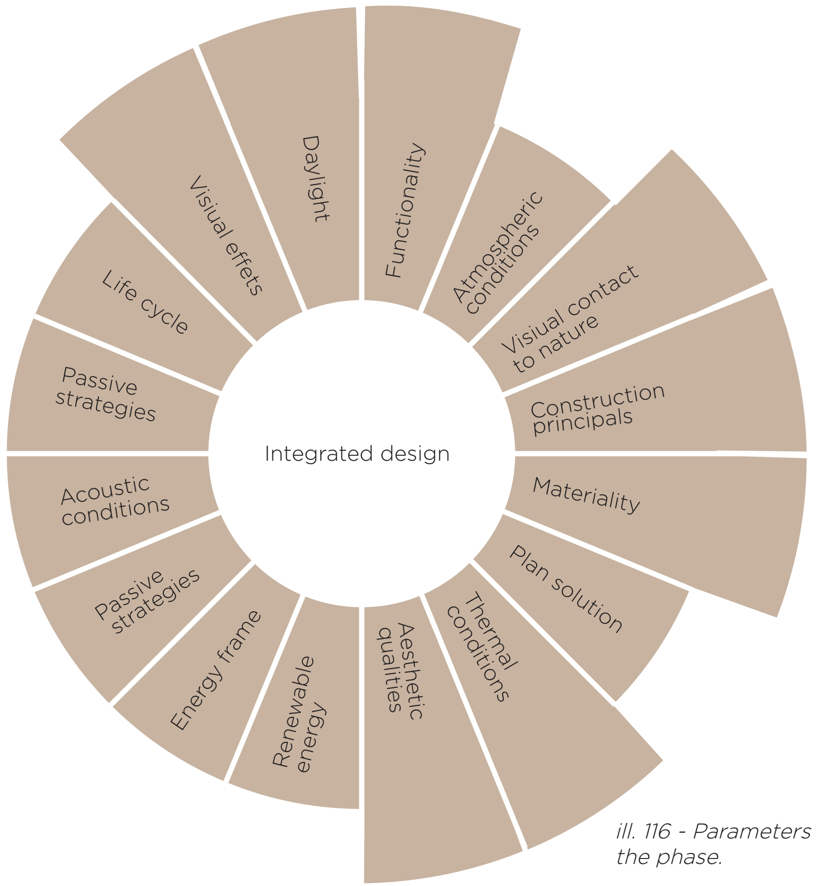
A lack of fire escape and technical rooms must be implemented in the further development of the plan solutions, as well as the organization of the functions in the ground floor must be reconsidered. Especially the placement of the kitchen should be considered according to unnecessary noise form the transportation of food between the kitchen and the dining area. On the first floor the kitchenettes obtain too much space, and it is not necessary to have four of them. The area could be utilized for another purpose. The ends of hallways can be opened up, and the view of the nature at east and west can be utilized.

Furthermore the façade has to be redesigned both according to the aesthetic parameters and the thermal conditions.

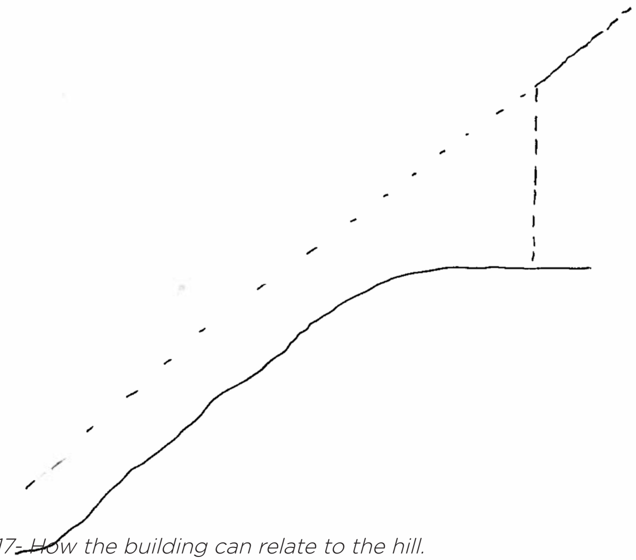
PHASE 3

From the previous phase the circular shape is kept, and further developed with a higher focus on the landscape and the use of this in the building design. The building both relate to the hill at south and the smaller height difference in the landscape between east and west see the conceptual sketches ill 117 ill 118 and the sections ill 123 to 125. Light studies have been made according to the implimentation of skylight at north, and this have had an influence on the inclination of the roof as well as the landscape has. Also, the plan solution and organization is developed further from the previous phase as shown at the sketch ill 119. Manly the changes of the organization are the placement of support- and staff facilities, they will be facing north/south instead of east/west, this have been chosen according to the placement of the kitchen. It would be advantageous to place the kitchen in the middle of the building, both according to the mechanical ventilation and according to the noise of the transportation back and forth from the kitchen, which would disturb the office area in the previous plan solution see the new plan solution ill. 122.

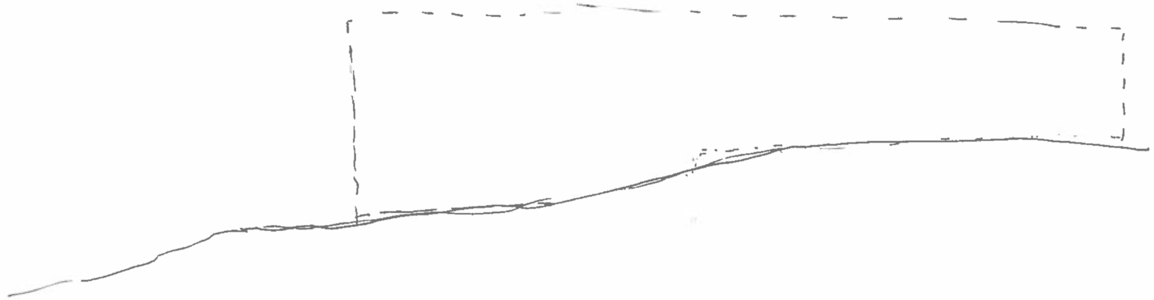
Beside complimenting the landscape in the building shape, the landscape is implemented at the site, therefore it is chosen to plant more trees at the northern part of the site see ill. 120. This emphasize the perception of the forest, which is part of the atmosphere of the new hospice. When arriving to the site one should experience the hospice as a home in the forest.



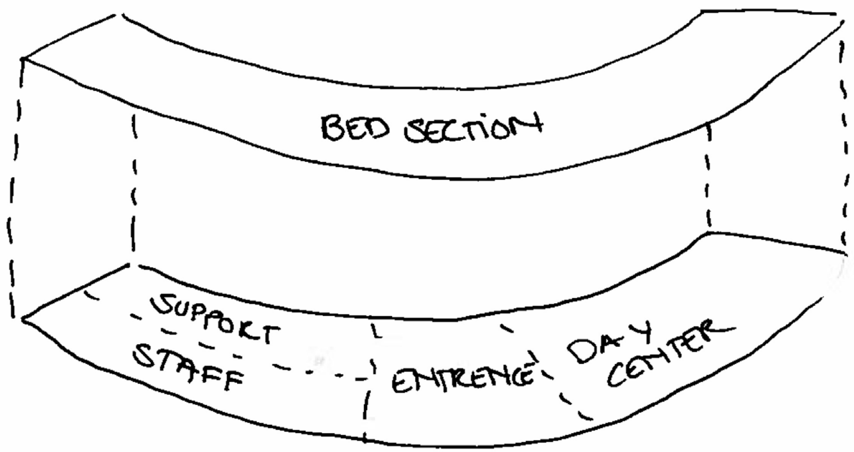
ill. 116 - Parameters infuensing the phase.



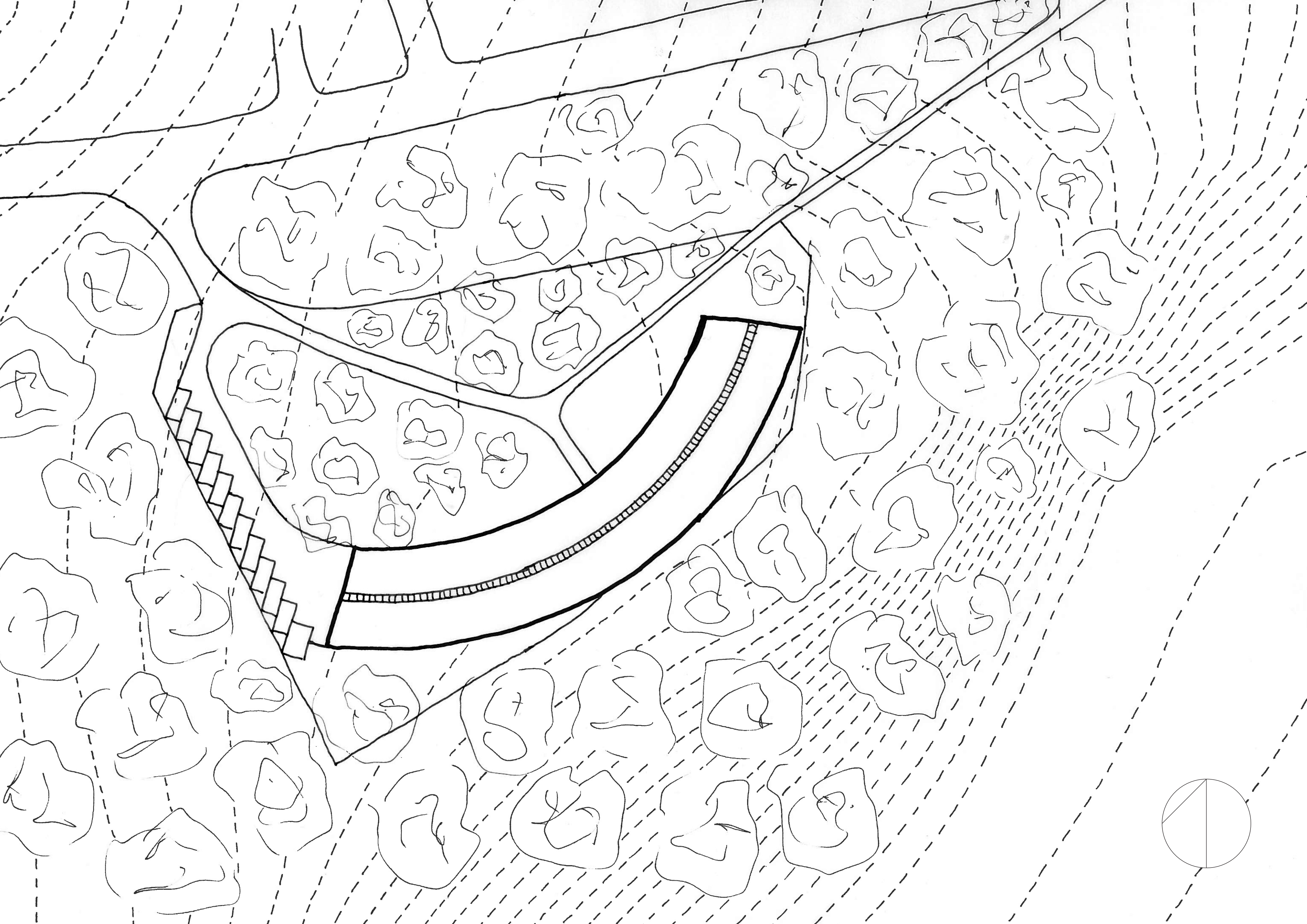
Ill. 117- How the building can relate to the hill.

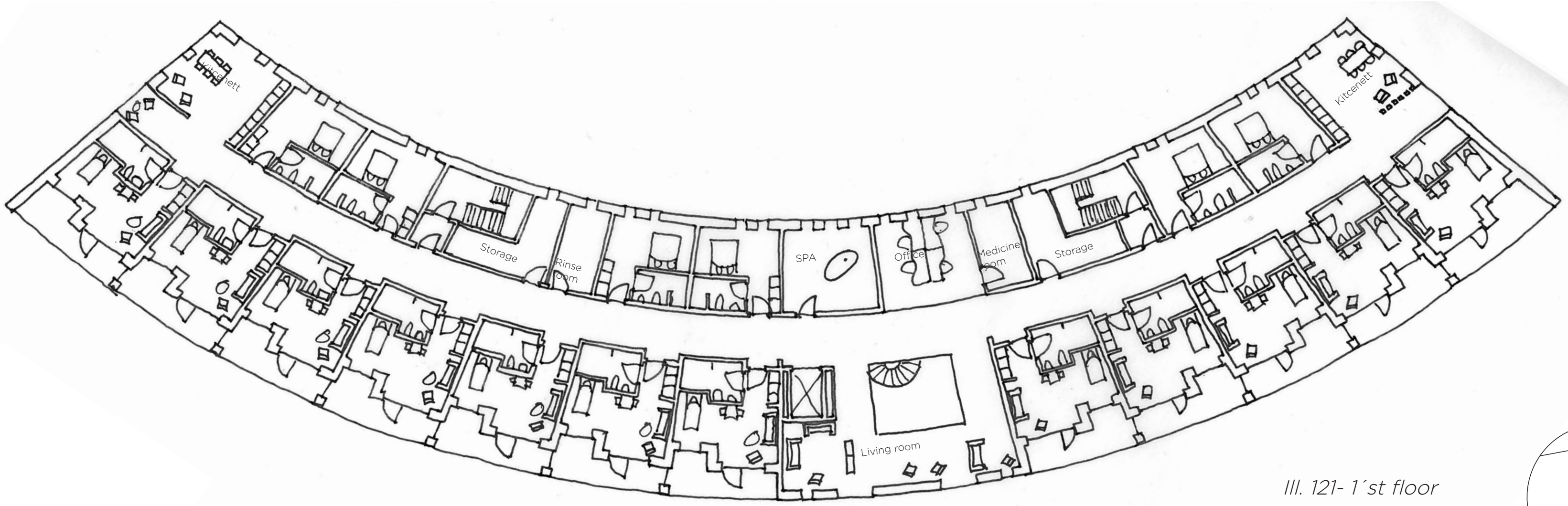


Ill. 118 - How the building can relate the landscape.

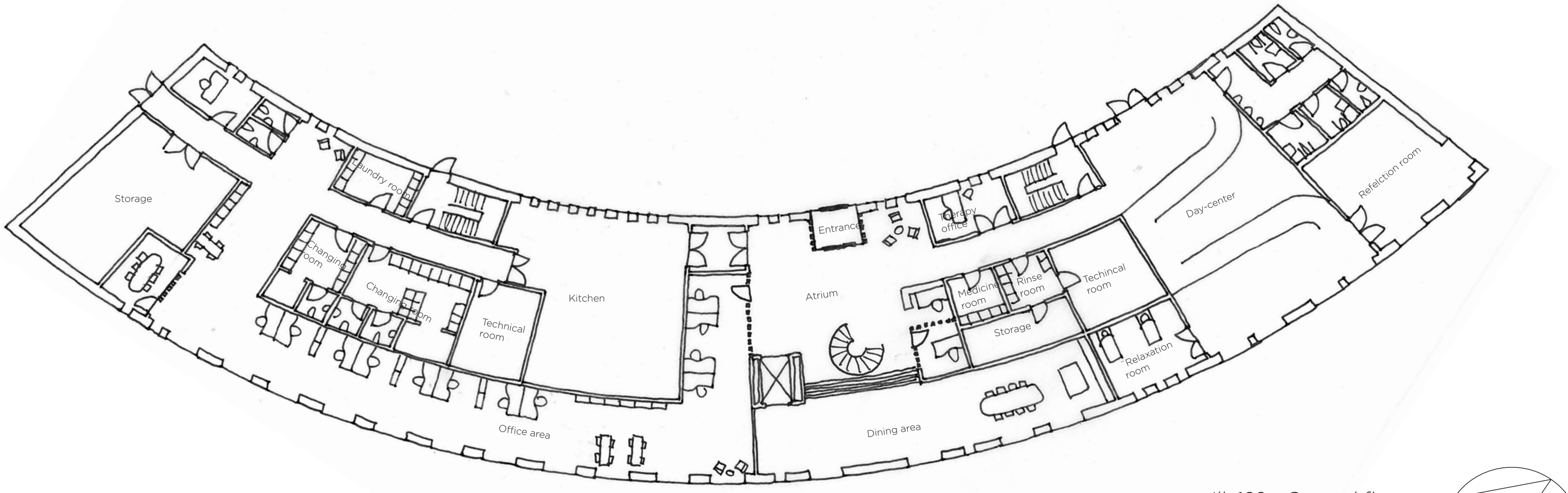


Ill. 119 - Division of the functions



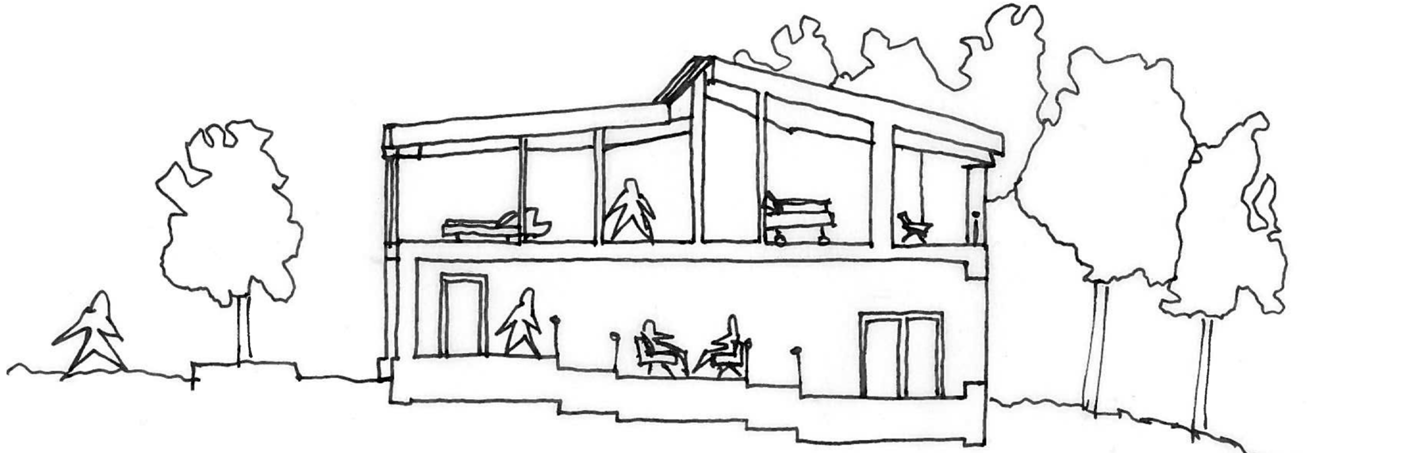


Ill. 121- 1´st floor

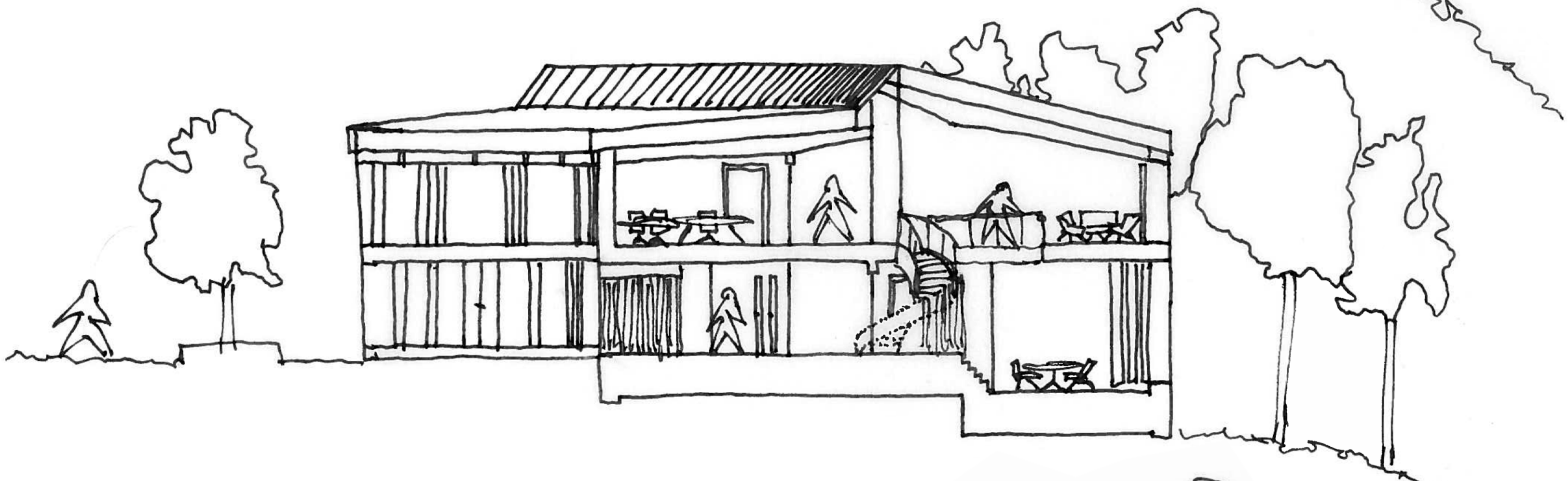


Ill. 122 - Ground floor

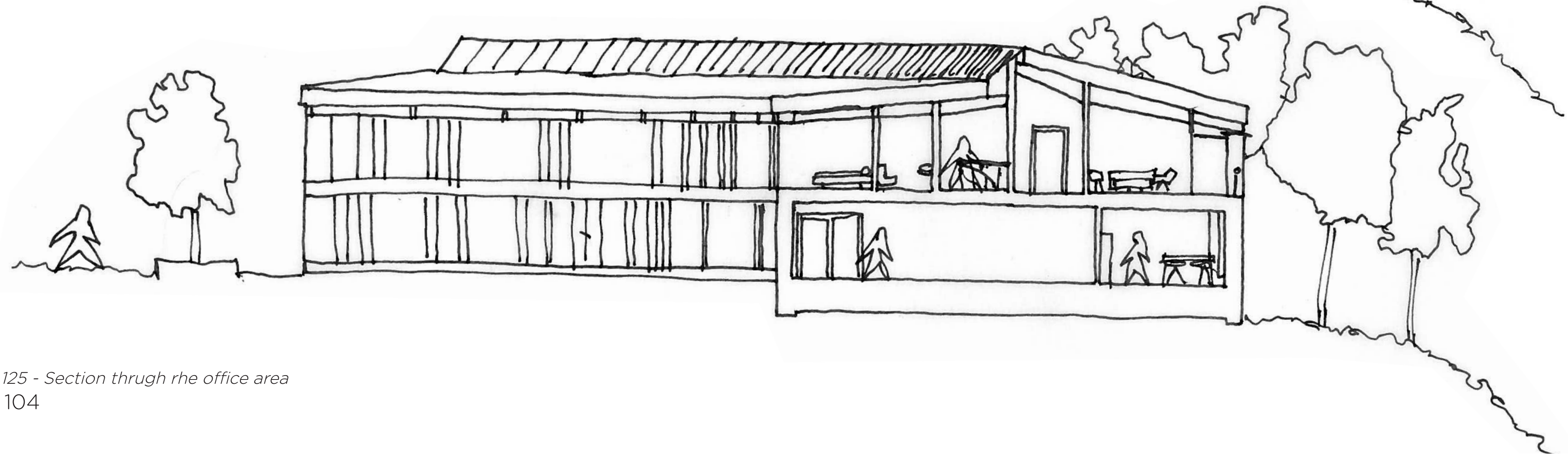
Ill. 120 - Masterplan



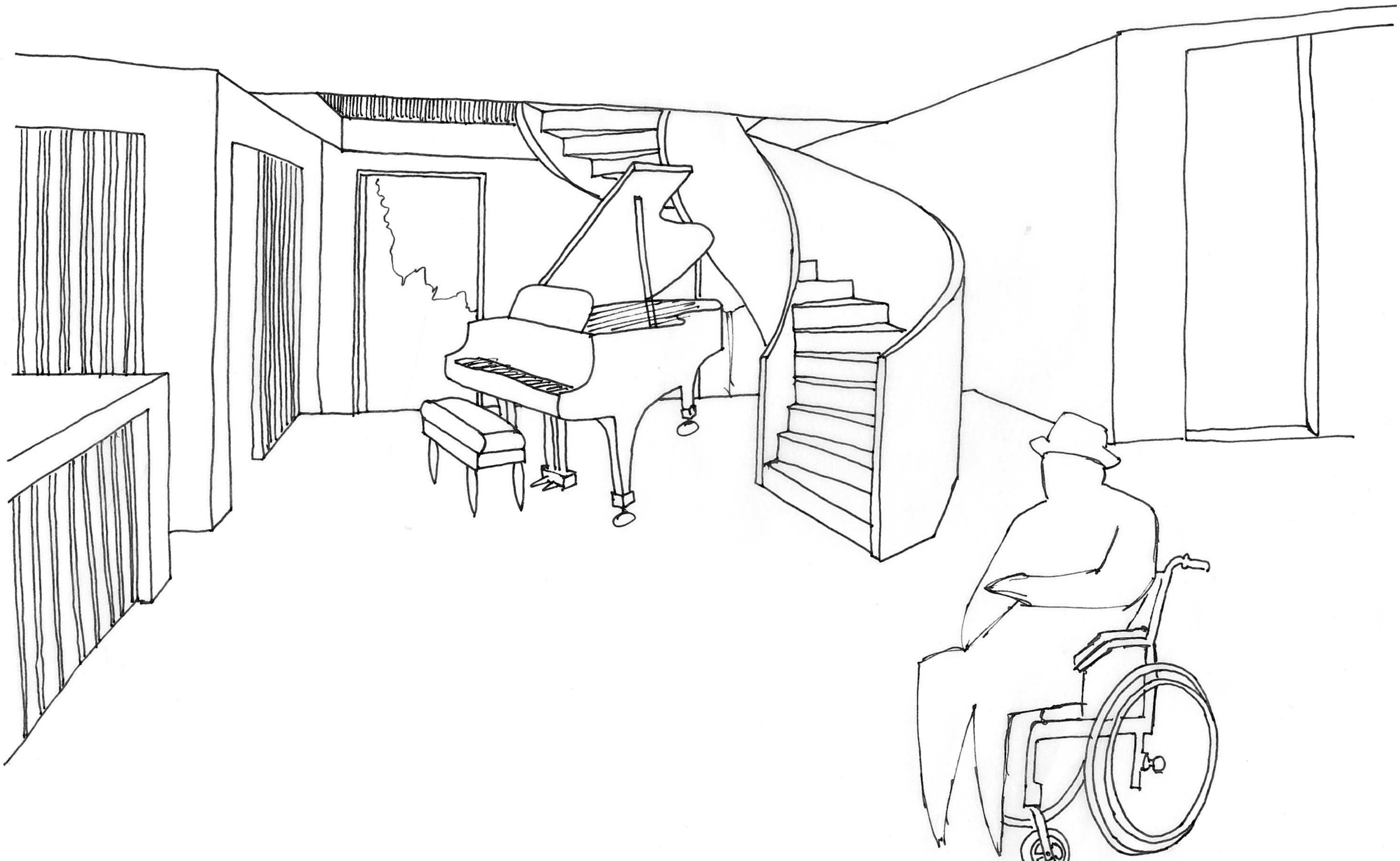
Ill. 123 - Section through the day-center



Ill. 124 - Section through the atrium



Ill. 125 - Section thrugh rhe office area



Ill. 126 - visualization of the atrium

THERMAL AND LIGHT CONDITIONS

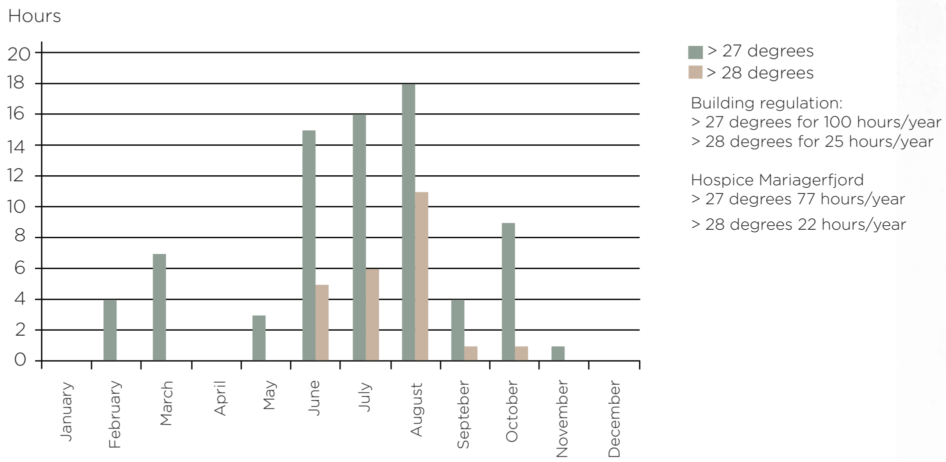
From the previous phase the Bsim model showed that overheating would appear more than allowed in the Danish building regulation which is 100 hours above 27 degrees and 25 hours above 28 degrees, therefor the window area at south have been reduced. This had a considerable effect on the amount of overheating, but it did not reduce it enough, therefor other parameters had to be considered. The first parameter there was implemented was solar shading by way of dark external curtains with a low shading coefficient, these will operate as a mechanical operation system in the warm season, but it is possible for the users to overrule with an analog system, and it is possible to to use the curtains analog all year. These did neither reduce the overheating enough, so in the end venting was implemented, even though it was not the first intension. The natural ventilation is only implemented in the common areas, the administration and in the support area as an analog system, where it is the users who decide when the windows should be open or closed. This is chosen considering that the hospice appears as a home for ill people, and some of them are sensitive to draft, and by implementing venting as an analog system the user satisfaction will be higher, than if it was a mechanical operating system. To be able to use venting the windows must be able to open, and a new design of the windows was made as shown at ill. 129.

Beside the opening area, the window was designed in this phase as well, and it was decided to make the window frame cover all the opening. This decision was made upon the idea that by implementing a softer material like wood, it would have an atmospheric effect on the spatial experience, and invite the users to use some of the window frames for stay, as shown in the sketch ill. 130.

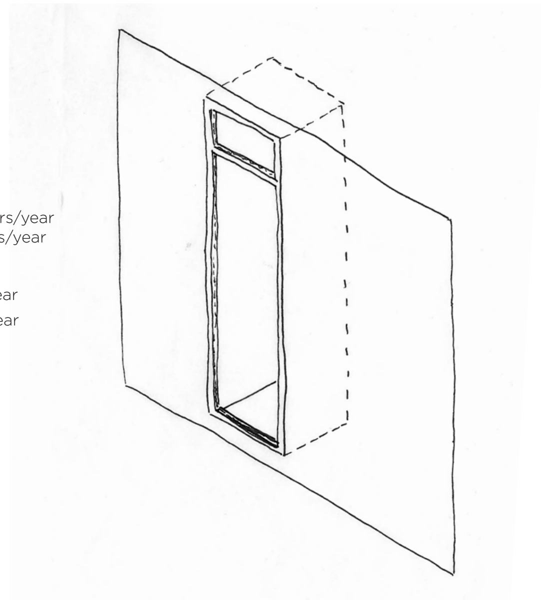
A redesign of the light intake was made by serval investigations in 3D models and simulations in Velux visualizer (appendix 7) the focus in these investigations have been to bring light deep into the hallways of the first floor as well as in the bathroom and the entrance of the patient room. In phase 2 the flat roof were contained with two skylights, one in the hall way and one in the bathroom. These skylights had no inclination and provided the rooms with a high amount of light, but do to the non-inclination of the windows resulted in a high heat gain. To minimalize the heat gain a skylight of 60 degrees with an orientation towards north was implemented. The implementation of this skylight have had a great impact on the inclination of the roof and the treatment of the wall separating the hall way and the bathroom. As shown on ill. 134 this solution provides a great amount of light to the hallway as well as a playfull light that changes through the day, providing the patients and their relatives with an understanding of time.

The section at ill. 135 and 136 shows a various of light in the patient room. By letting in light from north and south the sensation of the light is different, than if only the room was lit by one light form side. The skylight towards north provide with a more diffuse light. By having different light intakes with various orientations several experiences are achieved within a small amount of space.

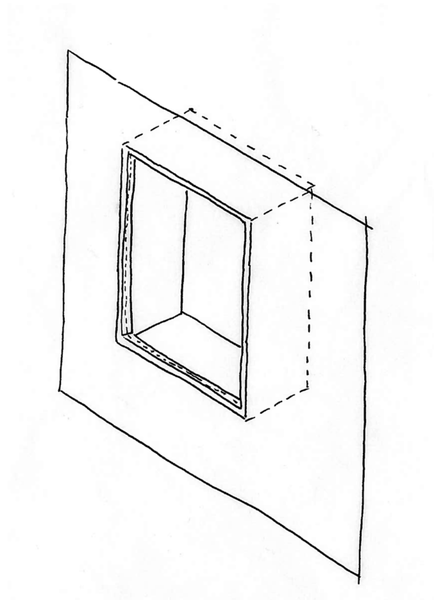
By applying skylights in the atrium, the light conditions have increased signifyingly. see ill. 131 - 133.



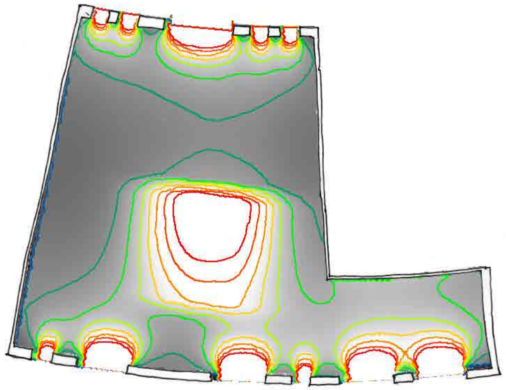
Ill. 128- Overheated hours in the Atrium



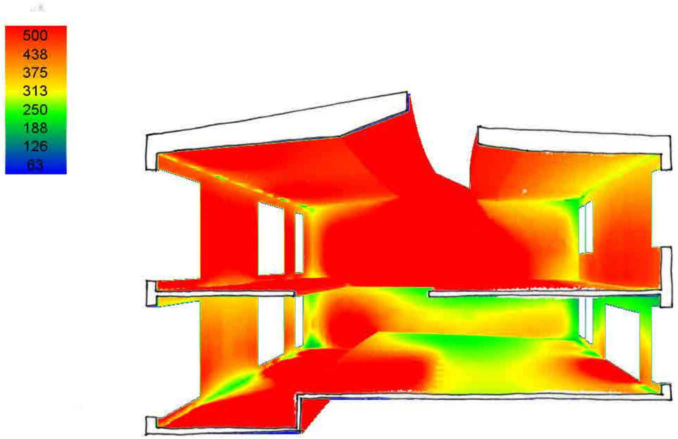
Ill. 129 - Vertical window with opening in the top.



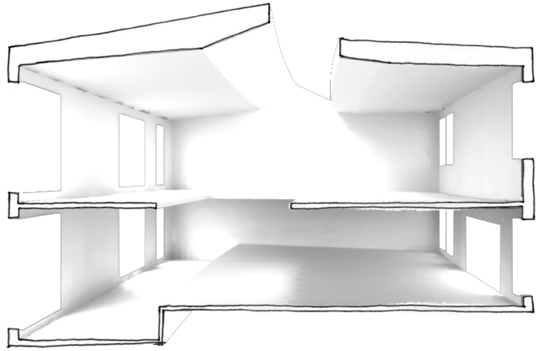
Ill. 130- squraed window with one big opening.



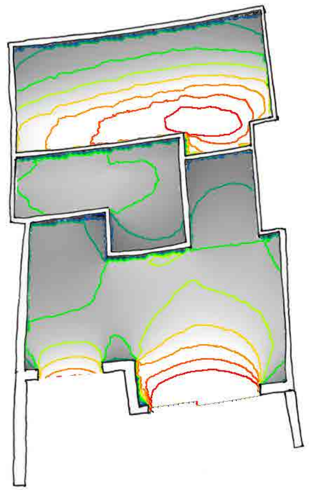
Ill. 131 - Daylight factor in the atrium.



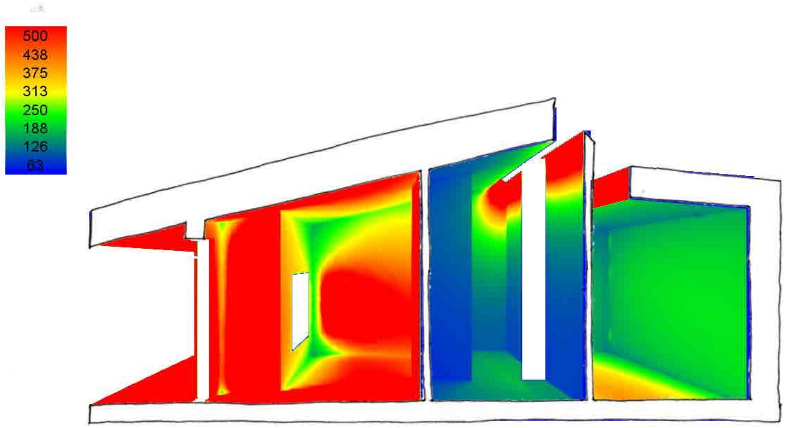
Ill. 132 - Lux on the surfaces in the atrium.



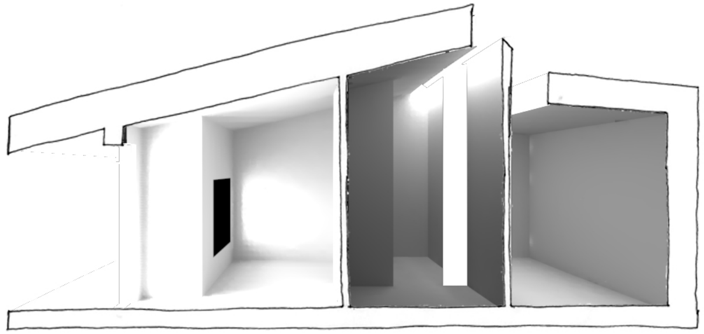
Ill. 133 - Illustration of light and shadows in the atrium.



Ill. 134 - Daylight factor in the patient room.



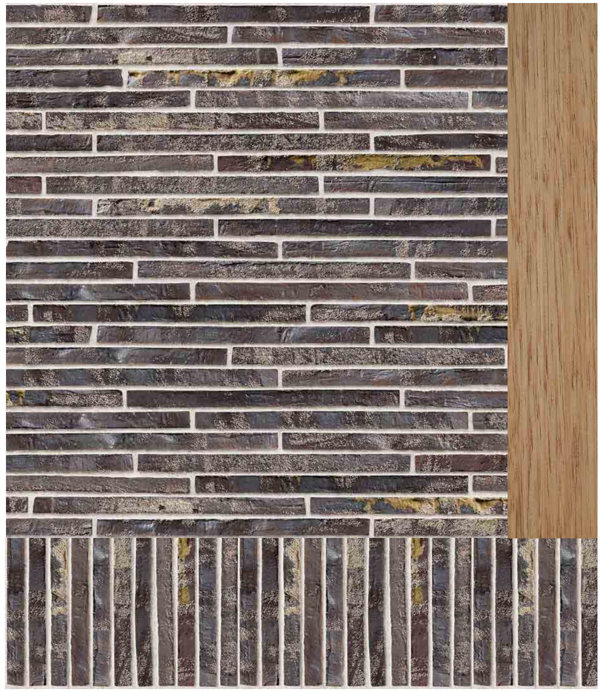
Ill. 135 - Lux on the surfaces in the patient room.



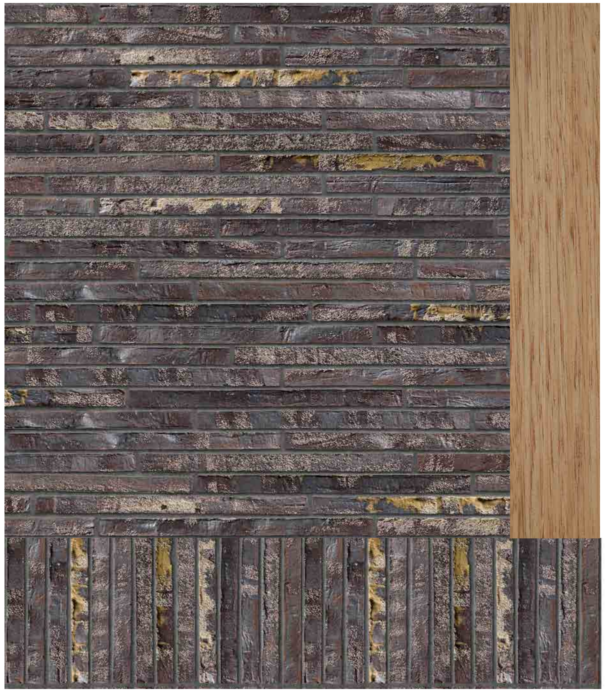
Ill. 136 - Illustration of light and shadows in the patient room.

MATERIALITY

It was early in the process chosen to use bricks as the external material, because of the idea that bricks are a local material which most people can relate to, when this is a material that most single-family houses are made of in Denmark. The chose was at the same time made upon the fact that it is a durable material, which have a long lifetime (taenkitegl.dk 2017). In this phase, the color of the brick, and the mortar, the brick type, and the direction have been investigated. As shown at the illustrations ill. to xx ill. xx it was chosen to use elongated bricks to emphasize the horizontal direction in the building, and by flipping the brick vertically, emphasize the construction and the openings in the building shape. As a starting point two different colors of the brick it was chosen and compared. A dark gray and a light gray was the chosen ones, and through investigations of the material on the façade in the 3D model, and these studies made it clear that the light gray brick was the optimum choise. The light gray made the building seem lighter, which emphasize the building shape and it will be more visible between the trees on the site, while the dark gray brick made the building seemed heavier on the site, and would dis-appear between the trees. Then it was chosen to use a light mortar joint color to emphasize the lightness in the façade, and to underline the soldier course.
The windows and internal elements are made of beech wood, and this material was chosen because the building is located in a forest of beech, and it would be a clear reference to the site. Sidewise the wood creates a contrast to the bricks, and become a softer and warmer element in the façade and inside the rooms. The wide internal window frames will be viable in the façade when the building have a curved shape, while the inside embossed by the beech in the flooring, lamellas and in the stairs.



ill 137 - Petersen brick K57 with light mortar joint, and beech wood.



ill 138 - Petersen brick K57 with dark mortar joint, and beech wood.

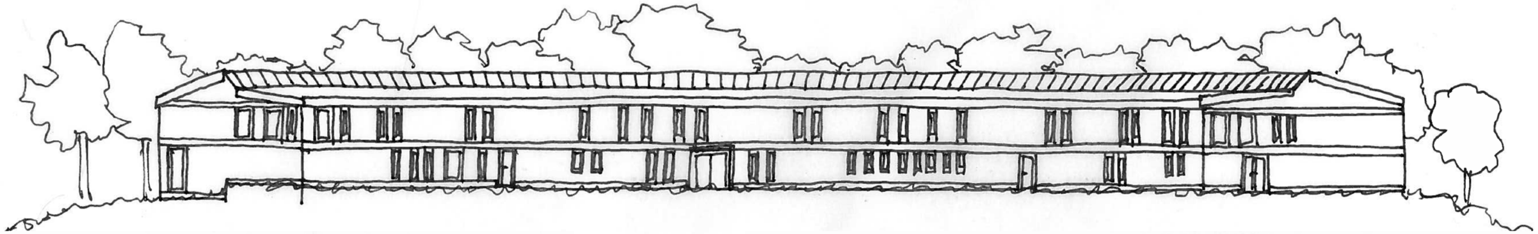
ill 139 - Petersen brick K91 with light mortar joint, and beech wood.

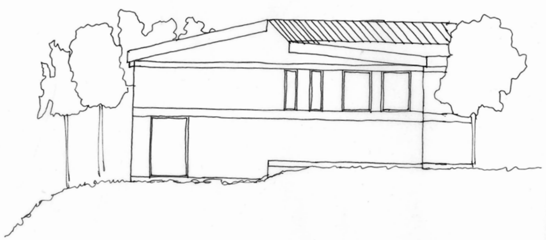
ill 140 - Petersen brick K91 with dark mortar joint, and beech wood.

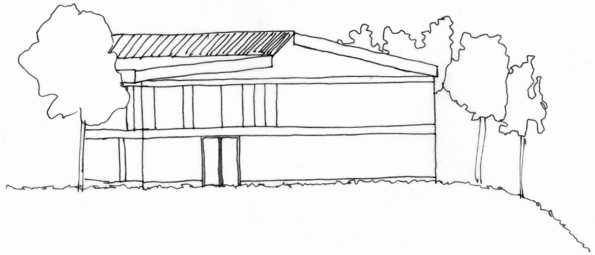
CONCLUSION

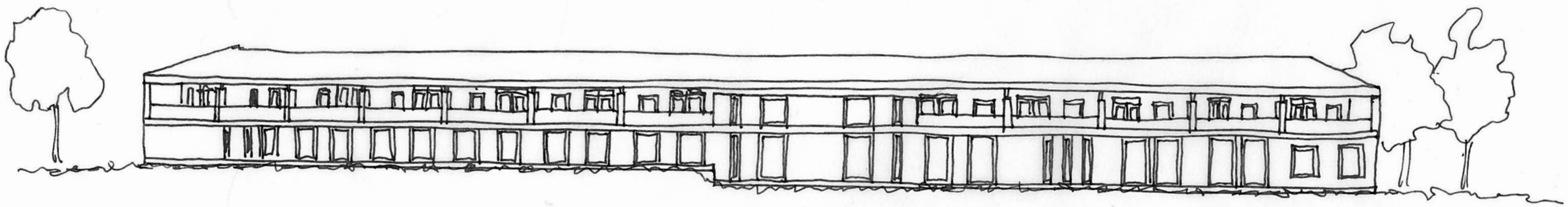
The thermal conditions should be investigated more closely according to venting and solar shading in the atrium to ensure a good indoor environment in the final design proposal. This also influence the design of the window openings, which should both consider the possibility the air change rate, and the aesthetic expression. Furthermore, details of the construction joints should be developed.

The infrastructure at that site should be developed, to avoid confusion of which road to use, when entering the site by car.


ill. 141 - Northern facade.


ill. 142 - Eastern facade.


ill. 143 - Western facade.


ill. 144 - Southern facade.

CLOSING

CONCLUSION - REFECTION

CONCLUSION

Hospice Mariagerfjord is the result of a design process with a focus on palliative architecture, indoor climate, and the creation of a homely atmosphere. The hospice is situated in a scenic area where beeches surround the building, and this emphasizes the sensation of the forest and the perception of the house in the forest. The building is placed at the southern part of the site to utilize the view of the fiord and to enhance the tranquility by placing the building as far from Hobrovej as possible. The patient rooms have been placed advantageously according to light conditions and according to the connection with the nature facing south, as desired. The shape of the building embraces the site and the arrival, providing a welcoming atmosphere. The entrance is marked by a cover of lamellas, which clearly define where to enter the building. We have succeeded to create an outdoor space that set the tone for relief of pain and reflection, which is enhanced in the indoor spaces. Our investigations of palliative architecture, have taught us how to work with architecture that affect the human body and mind, by working with the elements of materiality, tactility, light conditions, air and temperature, functionality, nature and atmospheres.

Furthermore the building reach the energy frame of 2020, which was our goal. This primly done by using passive strategies form very beginning of the design process. Even though passive strategies reached the energy frame it was chosen to cover the electricity use by implementing photovoltaics.

REFLECTION

The focus if this thesis has been to design a hospice upon the theories of palliative architecture. Especially the functionality of the building, and the creation of a homely atmosphere, and indoor climate have been the top priorities for the project. The indoor environment has been investigated closely according to thermal and light conditions, while the acoustic performance of the building has been implemented on a principal level. The sound transmission between the patient rooms, the relative rooms and in the reflection room have been considered according to the wall thickness, but this could have been investigated more closely by simulations. Furthermore, the room acoustics is implemented in the choice of the ceilings, where acoustic panels are used, and this could as well have been investigated by simulations.

Through the Bsim simulation of the atrium, it showed that venting was necessary to reduce the overheating. This was not part of the original ventilation strategy, and for that reason, only a ground rule calculation was made for venting in the atrium. This could have been investigated for all common rooms, and by more profound calculations to verify the air change rate through the window openings. Furthermore, the design of the windows and the openings in these could have been developed along with these investigations.
In addition to the Be15 calculation, the final result indicates that the building envelope could have had a less amount of insulation do to the fact that the transmission loss through the building envelope excl. windows and doors are way lower than 4,7 W/m2 as the Danish building regulation 2020 require. This has briefly been considered according to a graph indicating the amount of insulation in proportion to the effect on the U-value, and this effect the wall thickness and the light intake.

The overall flow of the plan solution of the hospice have the desired flow and organization of functions. The layout of the patient rooms has been the top focus according to the creation of a homely atmosphere, by light intake, material compositions and subdivision within a flexible plan. This level of detailing is also represented in the atrium, in the kitchenettes and the hallway on the first floor. It would be desirable to reach the same detail level in the day-center, the reflection room, the spa, and the terrace on the ground floor

When drawing in the 3D program Revit, it is difficult to work with correct measures in consideration of the measurement of the brick bond, when working with curved wall elements. The measurements of the building should have been more accurate to ease the work of the mason.

REFERENCE

LITTERTURE - ILLUSTRATIONS

LITTERATURE

BOOKS

Knudstrup, Mary ann, 2010, ”The Intergrated design process”, Aalborg University

Dikson, Thomas, 2002, “Integrated design”, Arkitektskolens forlag

Cosgrove, Denis 1999, “Mapping”, Reaktion Books, London

Riis, Vita (2001) “Arkitekturanalyse og Vurdering” in ”Design Gennem 200 år”Engholm, Ida & Riis, Vita Gyldendal A/S Copenhagen s. 206-213

Birkmann, Svend and Steiner, Kalve, 2015 “Interview – Det kvalitative forskningsinterview som håndværk”, Hans Reitzels forlag

Bihl-Nielsen, Anja, Birklund, Ragner, Dalgaard, Karen Marie, Graven, Vibeke, Halager, Lisbeth, Hansen. Finn Thorbjørn, Overgaard Hjort, Anne Charlotte, Kjeldsen, Karen Marie, Kopp, Kirsten, Hauge Kristensen, Nanna, Due Madsen, Lisbeth, Moestrup, Lene, 2017, ”Hospice – Æstetik, Eksistens og omsorg” Munksgaard

Real Dania, 2009 ”Program for det gode hospice i Danmark”,PDF

Frandsen, A. K., Mullins, M., Ryhl, C., Folmer, M. B., Fich, L. B., Øien, T. B., & Sørensen, N. L, 2009, ”Helende arkitektur”, Aalborg University

Kjeldsen, Kjeld, 2012 ”New Nordic – Arkitektur og Identitet”, Louisiana Museum of Modern Art

Lund, Nils-Ole, 2008 ”Nordisk Arkitektur ”, Arkitektens forlag

Fanger, P.O, 1970, ”Thermal Comfort”, McGraw-Hill Book Company

Bell, James and Burt, William, 1995, “Designing Buildings for Daylight”, Construction Research Communications Ltd.

WEB SITES

Dmi, 2014 Fremtidige klimaforandringer I Danmark, Danmarks Klimacenter rapport nr. 6 2014; Klima-,Energi of bygningsministeriet http://www.klimatilpasning.dk/media/854031/dmi_-_klimaforandringer__2014_.pdf

Ehlers, Pernille, 2001, “Fotokartering By og Fotografi”, Real Dania, Dansk Byplan,
Dachttp://www.byplanlab.dk/sites/default/files1/Fotokarteringsheet281210.pdf

Videbæk, Tove ”General information hospice-information”, Hospice forum Danmark
http://www.hospiceforum.dk/page433.aspx (12.02-2017)

REHHA, 2015 “Palliativ arkitektur”
http://arkitektur-lindring.dk/, (11.04.2017)

(Aalborgkommune.dk G), bilag F - parkeringsnormer http://www.aalborgkommuneplan.dk/bilag/bilag-f0.aspx (22.03.17)

Energistyrelsen, 2015: http://bygningsreglementet.dk/file/554542/baeredygtigt_byggeri.pdf

The Danish Building regulation 2015, Br15.dk
http://bygningsreglementet.dk/

INTERVIEWS

Hansen, Herdis, Interview see appendix 4 - 09.02.2017

Kristensen, Bodil , Interview see appendix 5 – 08.02.2017

DANSK STANDARD

DS 474, 1993, Forlaget Fonden Dansk Standard

DS 447, 2013, Forlaget Fonden Dansk Standard

DS 490, 2007, Forlaget Fonden Dansk Standard

DS 700, 2005, Forlaget Fonden Dansk Standard

ILLUSTRATIONS

Ill. 1-3 – Owen illustration

Ill. 4 – Dansk arkitektur center, http://www.dac.dk/Images/img/facebook/(28069)/28069/kingo1.jpgIll. 5 – pinterest , https://s-media-cache-ak0.pin-img.com/736x/51/3a/72/513a7211031e05e589f31d6682d31908.jpg

Ill. 6-10 – Owen illustration

Ill. 11-14 – Owen illustration with inspiration from (Realdania, 2009, Det gode hospice)

Ill. 15-21 – Owen illustration

Ill. 22-33 – Owen pictures

Ill. 34 – Owen illustration and pictures

Ill . 35 – Owen illustration and pictures from http://snohetta.com/project/2-tverrfjellhytta-norwegian-wild-reindeer-pavilion

Ill. 36-44 Owen illustrations

Ill. 45-46 screenshots from Be15

Ill. 47-61 Owen illustration

Ill. 62-65 bricks: http://www.petersen-tegl.dk/visualisering/ wood flooring: http://dinesen.com/da/downloads/ lamellas: https://pixabay.com/da/m%C3%B8nster-lodret-tekstur-v%C3%A6g-771949/ Sandstone: http://www.inpro.dk/tt-706c/

Ill. 66 - 144 Owen illustrations

APPENDIX

APPENDIX 1

PHOTOVOLTAIC PANELS

To cover the required electricity for the building and the daily electricity use for lighting, computers etc. with photovoltaic panels, the Be15 number for El. For operation of the building is multiplied by 2, when Be 15 do not consider lighting in the calculation for housing. The needed area of photovoltaic panels is calculated below.

El. For operation of the building: 4,6 kWh/m^2/year

4,6 kWh/m^2/year * 2 * 2036 m^2 = 18.731,2 kWh/year

Area of photovoltaic panels to cover the electricity use

$$A = \frac{\text{annually requriment}}{D * E * B}$$

B: Module efficiency (12%)
D: System factor (high efficiency instalation 0,8)
E: 15° angled roof facing south

$$A = \frac{18.731,2}{0,8 * 1097 * 12/100} = 177,8\ m^2$$

APPENDIX 2

VENTING FOR THE ATRIUM

Example of calculation of venting by the calculation metod of Sbi 213

Window area at north:

A_{window} (2,25 * 0,650) = 1,625 m^2 * 4 windows = 6,5 m^2

Window area at south should be at least the same as at north

A_{window} = 6,5 m^2

Total window area:

A_{window} = 6,5 m^2 *2 = 13 m^2

For housing it is assumed that maximum 60% of the window area is able to open

A_{eff} = 60% * 13 m^2 = 7,8

$$A_{eff} = \frac{7{,}8}{189\ m^2} = 0{,}04 = 4\%$$

1,5% = 0,9 l/s pr. m^2 = 4% = 2,66 = 2,4 l/s pr m^2

2,4 l/s pr m^2 * 189 m^2 = 453,61 l/s

453, 61 l/s * 3,6 = 1632,96 m^3/h

$$\frac{1632{,}96\ m^3/h}{926\ m^3} = 1{,}76\ h^{-1}$$

APPENDIX 3

PEOPLE LOAD

The air change rate is calculated considering olf.

Hospice

Room	Area, m2	Room Height, m	Volume, m3	Number of persons	Olf per person	Olf from person	Olf per m2	Olf from building	Pollution load (q), olf	1Experi-enced air quality (c), decipol	E.a.q of outdoor air (c_i), decipol	Necessary air flow, (V_l), l/s	Air change rate (n), h^{-1}	Air flow rate (m^3/s)
12 x patient room	256	3,25	832	12	1,2	14,4	0	0,1	14,5	1	0.04	152,6	0,66	0,15
12 x toilets	84	4	336	6	1	6	0	0,1	6,1	1	0.04	64,2	0,68	0,06
6 x relative rooms	102	2,65	270,3	6	1	6	0	0,1	6,1	1	0.04	64,2	0,85	0,6
6 x relative toilets	36	2,8	100,8	3	1	3	0	0,1	3,1	1	0.04	32,6	1,1	0,3
Hallway	160	3,5	560	5	1,2	6	0	0,1	6,1	1	0,04	64,2	0,4	0,6
Kitcehnetts	47	2,65	124,55	3,5	1,2	4,2	0	0,1	4,3	1	0,04	45,2	1,3	0,4
SPA	24	2,65	63,6	2	1,2	2,4	0	0,1	2,5	1	0,04	26,3	1,4	0,02
Office 1. floor	26	2,65	68,9	2	1,2	2,4	0	0,1	2,5	1	0,04	26,3	1,3	0,02
Depot 1 floor	55	2,65	145,75	0,5	1,2	0,6	0	0,1	0,7	1	0,04	7,3	0,18	0,007
Fire stairs	56	5,15	288,4	0,5	1,2	0,6	0	0,1	0,7	1	0,04	7,3	0,09	0,007
Atrium	307	4,9	1504,5	10	1,2	12	0	0,1	12,1	1	0,04	127,3	0,3	0,12
Distant depot	63	2,5	157,5	0,5	1,2	0,6	0	0,1	0,7	1	0,04	7,36	0,16	0,007
Office grownd floor	304	2,5	760	10	1,2	12	0	0,1	12,1	1	0,04	127,3	0,6	0,12
Laundry room	12	2,5	30	0,1	1,2	0,12	0	0,1	0,22	1	0,04	2,4	0,27	0,002
Changeing rooms	45	2,5	112,5	4	1,2	4,8	0	0,1	4,9	1	0,04	51,5	1,65	0,05
Toilets grownd floor	56	2,5	140	4	1,2	4,8	0	0,1	4,9	1	0,04	51,5	1,32	0,05
Kitchen	124	2,2	310	4	2	8	0	0,1	8,1	1	0,04	85,2	0,99	0,85
Small depot	50	2,5	125	0,5	1,2	0,6	0	0,1	0,7	1	0,04	7,3	0,2	0,007
Daycenter	229	3,45	790,05	5	1,2	6	0	0,1	6,1	1	0,04	64,2	0,29	0,064

The method which have been used to calculate the air change rate and the air flow, are calculated throgh these equations.

Pollution load: (q) = olf per person * number of persons + olf per m^2 * room area

Experienced air quality: $c = c_i + 10 \frac{q}{V_l}$ where c_i is the depending on where the building is placed (pulluted area or not)

Nesscesary air flow: $V_l = \frac{10 * q}{C - C_i}$ where c is depending on the percentage dissatisfied.

Air change rate: $n = \frac{V_l * 3600}{1000l * V_l}$

Air flow rate: $AFR = \frac{V_l}{1000l}$

(Air change rate calculation - Saksager, Jensen, Skjøttgaard, Mikkelsen, 2016, “Sustainable Architecture“)

APPENDIX 4

INTERVIEW - HERDIS HANSEN

2017.02.09 – referat - Hospice Ankerfjord

Nøgleord for det gode hospice: Natur, Æstetik og Hjemlighed
Symbolik: Solen står op i øst og velsigner os med en ny dag i livet.
Omsorgen deles 50/50 mellem patient og pårørende – der er også en efterproces for de pårørende, og de inviteres til minde dag hvert år.
Sengen vender mod naturen, og det har en stor psykologisk påvirkning på patienterne.

Det er vigtigt at ligge vægt på dagligdagens små glæder og basale værdier. Påskeliljen vokser op af jorden og springer ud. Fuglene bygger reder og får unger, ungerne vokser sig store. At spise sammen betyder meget for oplevelsen af mad, især når man er småspisende og har kvalme. Det er vigtigt at sengeliggende kan være en del af fællesskabet, og derfor skal der være plads til at flytte hospitalssenge rundt i hele bygningen.

Der skal være små nicher og områder der omkranser de pårørende i fællesområderne, som skal smagfulde og æstetiske. Hospicet skal favne både de yngre og ældre generationer samt høje og lave klasser i samfundet.
Sanser: Det er vigtigt at stimulere alle sanser, og dufte har en meget stor indflydelse på oplevelsen af bygningen og de funktioner der er rundt omkring. Akustikken har også stor betydning for rummene og den oplevelse man får, når man træder ind i bygningen, men også i de forskellige afdelinger.
Sanserummet: fungere som et varmt og omsluttende rum – man fordyber sig og vender tankerne ind ad. Der er en helt særlig ro og Atmosphere som bliver defineret af lyset (moderne mosaik/farvet glaskunst), rummets udformning og akustikken. – Finn Thorbjørn Hans filosof i undring, leg og læring (Sanserummet bruges ugentligt til undringsværksted for personalet)
Sansehaven: Naturens elementer bliver forstærtet (vand, lys, vækst) duft og sæsoner kommer frem her. Det er meget hjemligt i henhold til haven og dens dufte og plantevækst. Det er et sted hvor man kan filosofere over livet, og åbner nemt op for minder og samtale.

Ved at have forskellige rum der kan noget forskelligt, kan man nemt nulstille en patient, der har brug for at komme i nogle andre omgivelser.

Rumfordeling:
Fællesrum; spiseområde, der var lavt til loftet, som fik en til at føle sig tryg. Flyglet er placeret under "kuplen", hvor der højt til loftet, og giver mulighed for at føre musikken op på overetagen. Der skabes nicher og små zoner i det store rum, som kan noget forskelligt. De små køkkener på patientstuegangen fungerer som små møderum mellem familierne og være et frirum for de pårørende (her kan de pårørende udføre en konkret handling, eks. Lave kaffe, varme mad ect.) De pårørende har også mulighed for at ordne vasketøj og andre dagligdagsgøremål, som kan virke aflastende og befriende.
Legerum: Der er både legerum for de mindste og for de større børn. Disse rum fungere som aflastning for sorgen hos børnene (børn hopper ind og ud af sorgen). Legerummene skal være så almindelige som mulig, da det har stor indflydelse på børnene, at omgivelserne kommer til at virke så hjemlige som mulig.

Et rum som et bibliotek er godt, hvis der er nogle der har brug for at kunne lukke døren.

Depoter er MEGET VIGTIGE. Der måtte godt være små depoter på stuegangene. Ankomst, den store indgang facer receptionen, hvilket giver en god velkomst og det er også her gæster hænger jakkerne (føles meget hjemligt) den var synlig og her er også en lille zone, hvor man kan sætte sig og vente. Først mødet du receptionen, og så møder du udsigten.

Patientstuen:
Størrelse 60 kvm. Bad, soveafdeling, stue og gæsteværelse samt entre.
Stuens størrelse er lavet ud fra størrelsen på en almen ældrebolig. Det virker lidt som en lejlighed, hvor patienten selv kan personliggøre stuen enten med egne effekter eller med kunst fra gangene, som de kan få hængt ind på stuen.

Det vigtigste møbel er natbordet (det indeholder alt hvad der betyder noget ved slutningen af livet)
Badeværelset skal STORT, og det har her to døre, således at gæsterne ikke forstyrre patienten om natten, når de sover.
Foldedøren der adskilte soveafdelingen og stuen fungerer godt, da patient-

en selv kan bestemme hvor stort rummet skal være.
Orientering er vigtig i forhold til natur. De private terrasser fungere rigtig godt, da det giver mulighed for alle patienter at komme ud, og mærke naturen helt tæt på.

Kontor: Mere plads, stationære arbejdsstationer. Der skal være medicin rum, sygeplejekontor, lederkontor, sekretærområde, mødelokale, frivillige kontor, terapeutrum, storkøkken, værksted og blomsterværksted, omklædning, stordepot, vaskerum, teknikum.

APPENDIX 5

INTERVIEW - BODIL KRISTENSEN

Referat – Kamilianergården 08.02-2017

Hospice i dag: Liggetid gennemsnit 16 dage, flere og flere ligge mellem 2 og 4 døgn. Patenterne er mere komplekse i dag end da man startede hospice i Danmark, derfor er der brug for mere behandlende udstyr på stuerne. Det er plejende personale, som skal tage sig af patienterne, derfor skal man huske på at det er en arbejdsstation. Ca. 50/50 af sengeliggende og mobile patenter. 15% - 20% bliver udskrevet igen. Kamilianergården er delt i to etager, og dette fungerer godt ifølge Bodil Kristensen, da det giver kortere afstande mellem patientstuerne og de øvrige funktioner. (Rønde har meget lange afstande)

Citat Bodil Kristensen: "det er ikke tilladt at give op, man skal kæmpe for det, og det er lægernes fornemmeste opgave at behandle så længe som muligt." – "I dag behandler man mere end hvad godt er, patienten og de pårørende kunne få en bedre afslutning, hvis man stoppede behandlingen før, og gik over til lindrende behandling i stedet for"

Patientstuen: Skal være rummelig både som arbejdsstation men også personligt for den enkelte patient. Den indeholde: en seng med mulighed for at der kan sættes en ekstra seng ind (dobbeltseng) uden at de forstyrre personalets arbejde. Der skal være en lille sofagruppe, som skal invitere til at familien kan være samlet på stuen. Tv og tv-møbel, disse skal placeres således at man kan komme rundt med kørestole og andet plejeudstyr. Alle møbler skal kunne om arrangeres, således patienten kan indrette stuen efter eget ønske. (Iltudtag og sug skal dermed og kunne flyttes rundt) store vinduer, som ikke går til gulv (af hensyn til indkig) Det er vigtigt at vinduerne skal kunne åbnes, så patienterne kan få fornemmelsen af den friske luft, og høre fuglene udenfor. (De skal også kunne åbnes ifht. Når en patient dør). Det er en god ide at have vindueskarme, hvor patienterne kan sætte deres personlige ejendele. Loftet: det er vigtigt at der er liftskinner i loftet, disse kunne skjules bedre end den er på Kamilianergården. Lyset skal kunne dæmpes, og lyset i gangarealerne må ikke være for skarpe i forhold til lyset på stuerne. Loftets udformning er vigtig da mange af patienterne er sengeliggende. Der skal min. Være 16 stikkontakter på hver patientstue til behandlingsudstyr, telefon, computer og lamper. Der skal være plads til opbevaring af sengelinned, håndklæder og småt behandlingsudstyr, derudover skal være skabsplads til patientens tøj og andre ejendele. Det ville være en rigtig god ide, at placer et lille køleskab på hver stue og evt. et lille køkkenbord. Farver: skal være varme og i de støvede toner.

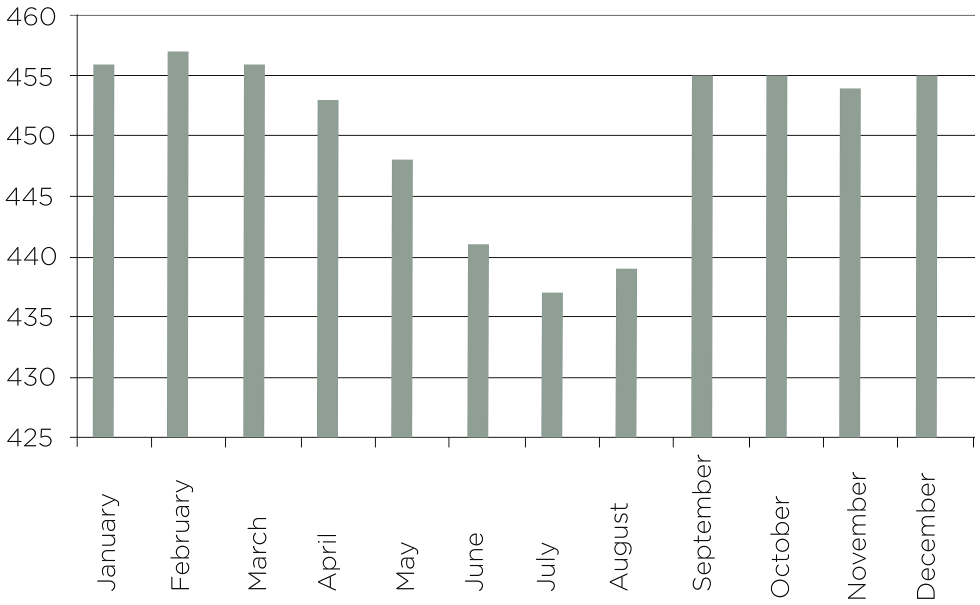
Fællesarealer: Små nicher er vigtige i forhold til uofficielle møder, et pusterum for de pårørende mm. En fællesstue, spisestue giver sammenhold mellem patienterne, og disse giver også mulighed for at en patient kan have hele familien til middag eller til eftermiddagskaffe. Det er også vigtigt at implementere overnatningsmuligheder for pårørende både i ekstra gæsteværelser, men også på selve patientstuen. Musikterapi er også vigtigt. Et spaområde som giver en wellness oplevelse for de patienter, der har mulighed for det. (Her er det også vigtigt at der kan komme en seng ind) Køkkenet er en vigtig del af fællesområderne, der er her patienterne mødes, og der er altid tilknyttet en frivillig, således at småspisende patienter bliver mere inspireret til at spise. De kan sidde og smånippe til lidt forskelligt. På Kamillianergården er der et anretter køkken, der fungerer rigtig godt i forhold til madlugt (der er mange patienter der har kvalme, og ikke bryder sig om lugten af mad). Der skal være små depoter på alle etager og et stort, der kan indeholde de store ting. Derudover er det nødvendigt med min et vaskerum.

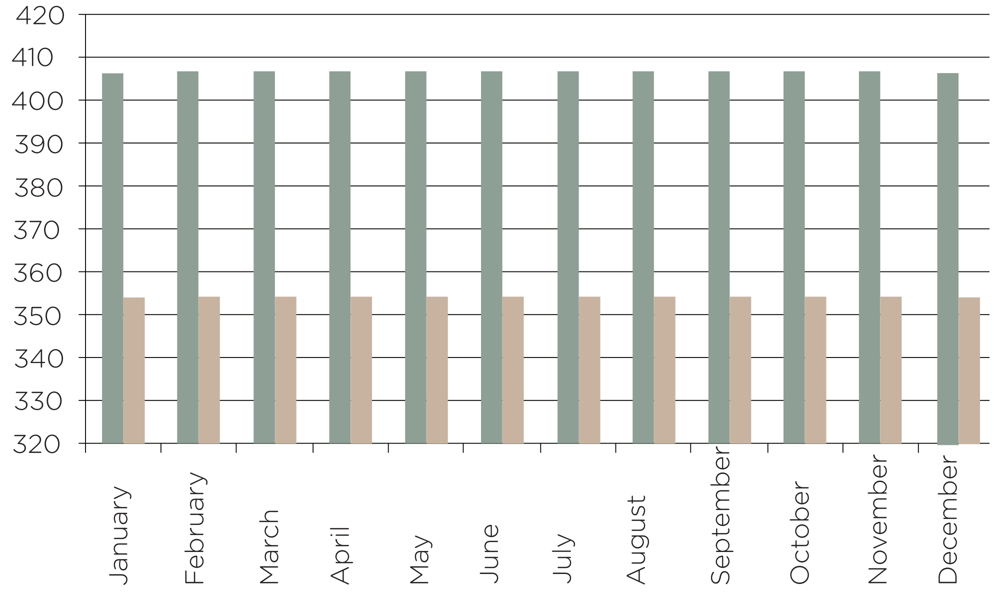
Personaleområde: Der skal være god plads til kontorer, der ved vagtskifte kan rumme omkring 15 personer. Der skal være mødelokaler i forskellige størrelser og have forskellig karakter alt efter hvad de skal bruges til. Nicherne rundt i bygningen skal bruges som uofficielle møderum bl.a. mellem personale og pårørende, hvor de større mødelokaler kan bruges til store møder med hele familien.

Materialitet: Gulvene må ikke være ujævne (fuger mellem fliser, kan være svære at gøre rene, og det kan være svært at køre en kørestol hen over klinkegulve.), derfor er Bodils forslag at man eksempelvis bruger linoleum. Trægulve virker hjemmelige, men det er vigtigt at overveje vedligehold af disse, da der sker mange uheld i hverdagen. Man skal undgå at fremhæve institutionsudtrykket, og dermed prøve at fjerne slanger, udstyr og kliniske kolde overflader. INGEN PANGFARVER – det kan patienten selv tilfører stuen hvis de ønsker det.

APPENDIX 6

B-SIM SIMULATION CO2 LEVEL





APPENDIX 7

LIGHT ANALYSIS

The appendix contains eight different light simulations of the patient room in connection to the hall way. The simulation are made in Velux visualizer and shows the amount of daylight in the plan with a still height of 850mm. as well as two sections, one showing the relation between light and shadow on the surfaces and this creates an understanding of how the light are scattered and illuminance the surfaces of the room. The other section is also illustration the illuminance of the surfaces in the room but in a more graphical way, providing an understanding of the amount of lux on the surfaces. As illuminance are measured in the lux this illustrations provide a more exact understanding of the light condition.
The simulations are set up in columns of four different periods of the year. The chosen periods are summer and winter solstitial (june and December) and equinox (March and September) all simulations are made at 12 o'clock. Normally one simulation of the daylight factor would be enough because the daylight factor represents an average of the amount of the daylight throughout the year with the settling of overcast. But our simulations shows a varies of the daylight factor do to the time of the year and that is way four different daylight factors are represented.
As showed on the illustrations ill.xx to the right eight different sections are made covering the development of the especially the skylight and the inclination of the roof together with the height of the room. They are all listed from one to eight with one being the first proposal and eight being the one presented in the representation.

1.
This proposal contains large windows towards south offering the main part of the patient room a great amount of light without direct glair because of the overhang. The roof is flat and contains to skylights one in the bathroom and one in the hallway. These skylights provide a high amount of light and because of the size and orientation this can course overheating.

2.
The windows towards south are untouched in the proposal but the inclination of the roof has change to create the possibility of having a skylight in 90 degrees facing north with a little overhang. This solution solves the problem of overheating but the skylight is less efficient than the one in proposal one.

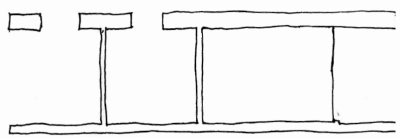
3.
To create a more efficient skylight the little overhang is removed to provide more light. There is a visible effect but the results are not sates faring.
4.
Upon the knowledge from the book designing with daylight a skylight of 60 degrees and orientated towards north are implemented. This proposal begin to take the skylight of the hall way into consideration and creates one overall skylight for both the bathroom and the hall way. This solution effects the inclination and the height of the rooms end especially the height in the bathroom does not fit well with the human scale and the homely atmosphere.

5.
The heights of the room are decreased and this makes it easier to drag light deep down the room but the room height in the hallway becomes too low.

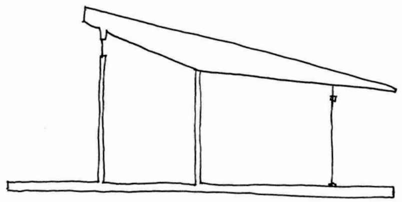
6.
A new roof construction is made to increase the room height in the hallway. This solves the problem of the room height but the amount of daylight wanted are not quit obtained yet .

7.
This proposal contains a new skylight with an inclination of 30 degrees and an orientation towards north. Besides the new inclination are now covering both the hallway and the bathroom. The skylight is split in the middle by the way and the top window separating the hallway and the bathroom. By this solution the daylight factor rises radical and the desired amount of light are achieved.

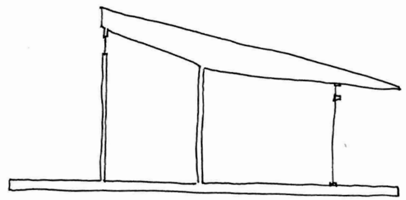
8.
In the last proposal the top window in the wall separating in hallway and the bathroom are removed to enhance the privacy of the patient room. This interference does not affect the amount of daylight considerable and this solution seems optimum.



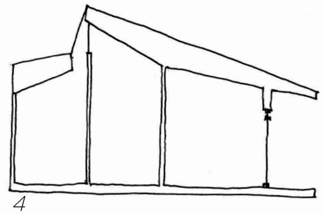
1



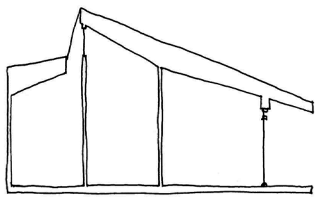
2



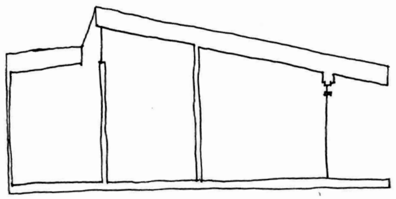
3



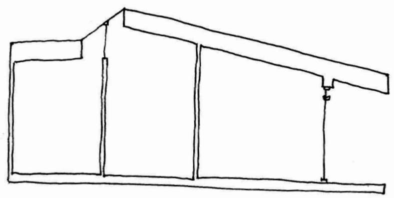
4



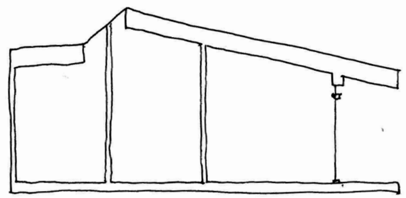
5



6



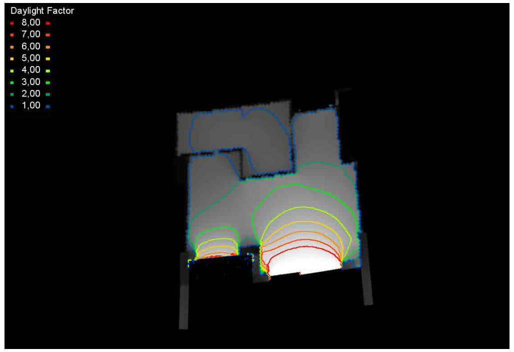
7

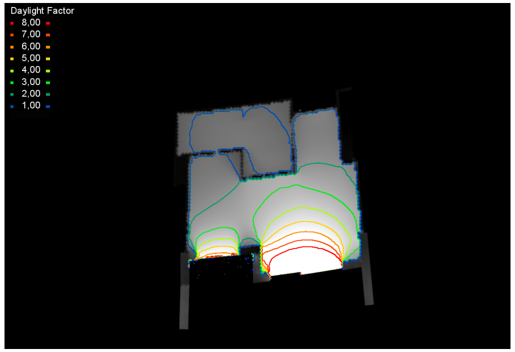


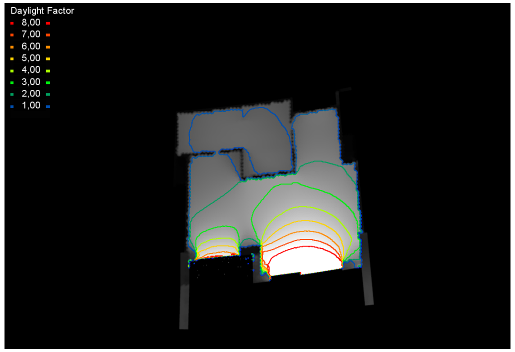
8

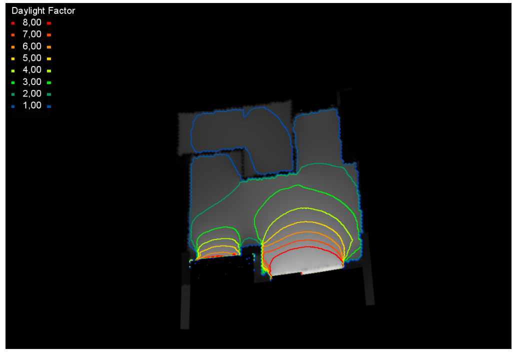
Patient room

March | June | Septemer | December

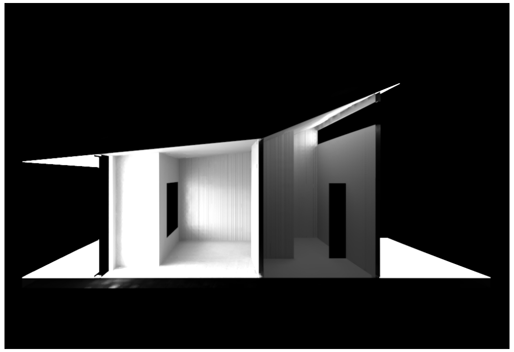
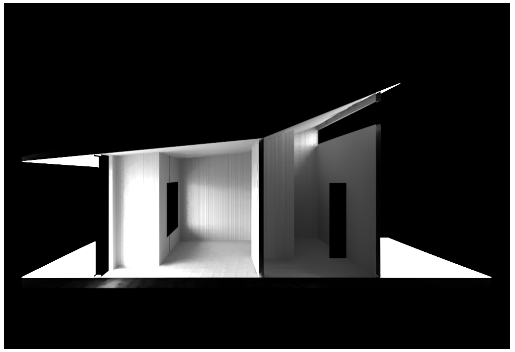
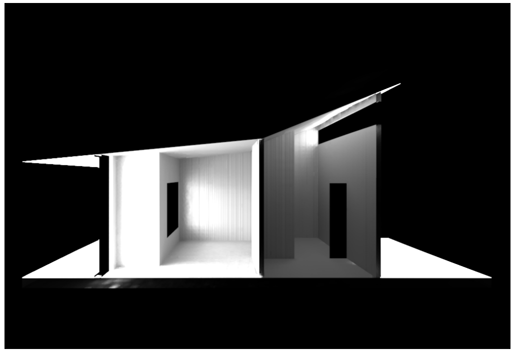
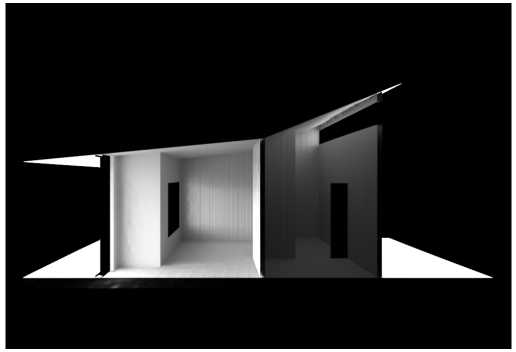




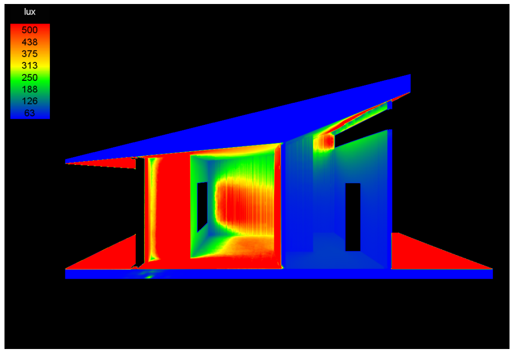


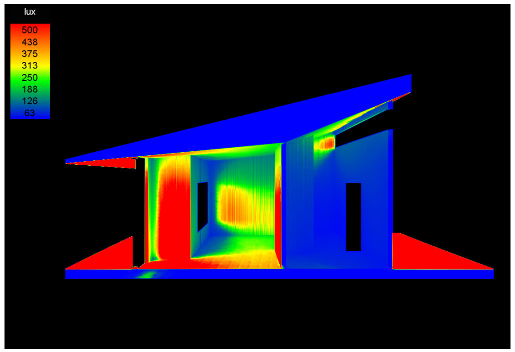


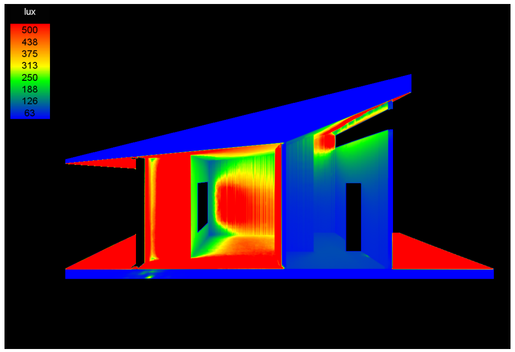
Daylight factor

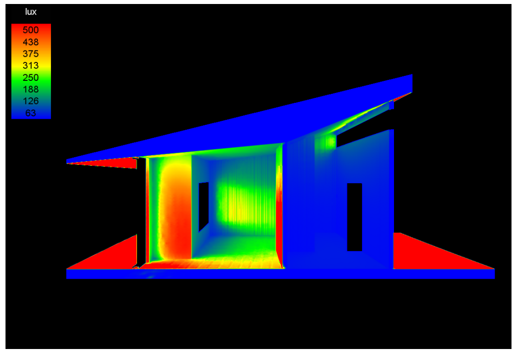





Illumenance - light shadow





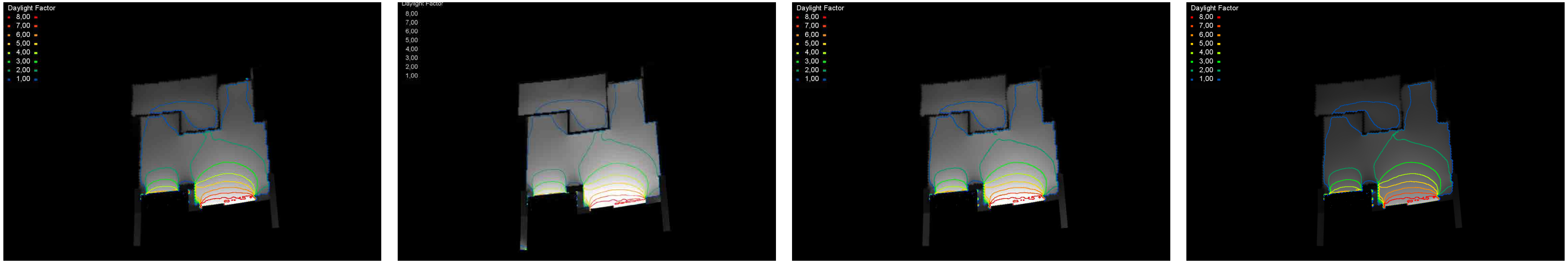




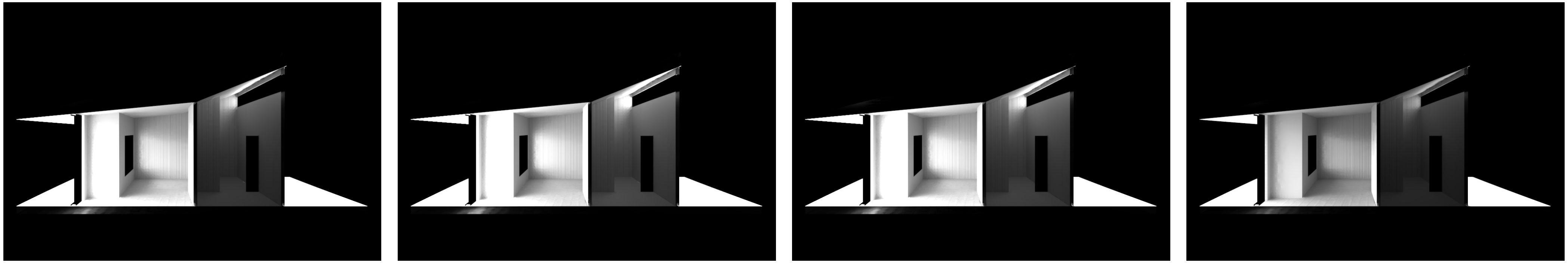
Illumenance - lux on surface

Patient room without overhang north

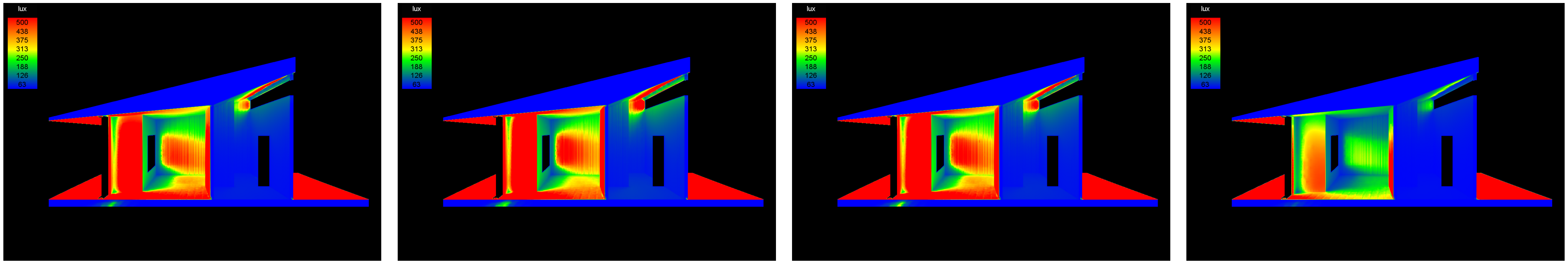
March	June	Septemer	December



Daylight factor



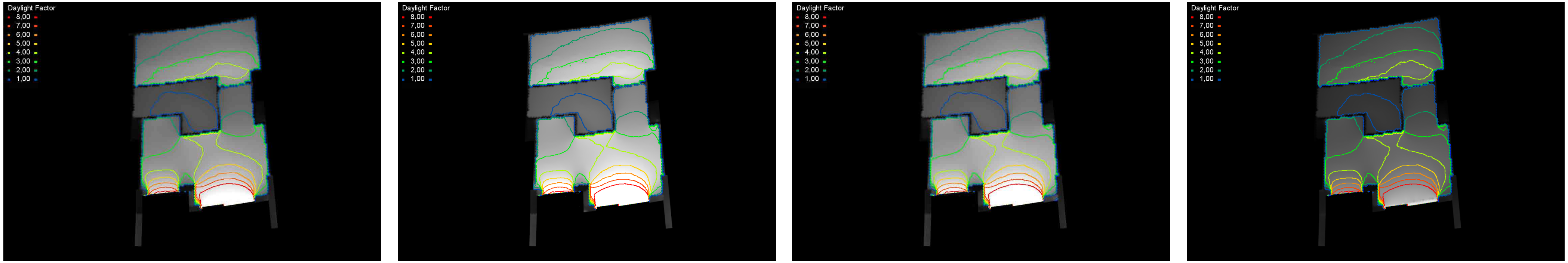
Illumenance - light shadow



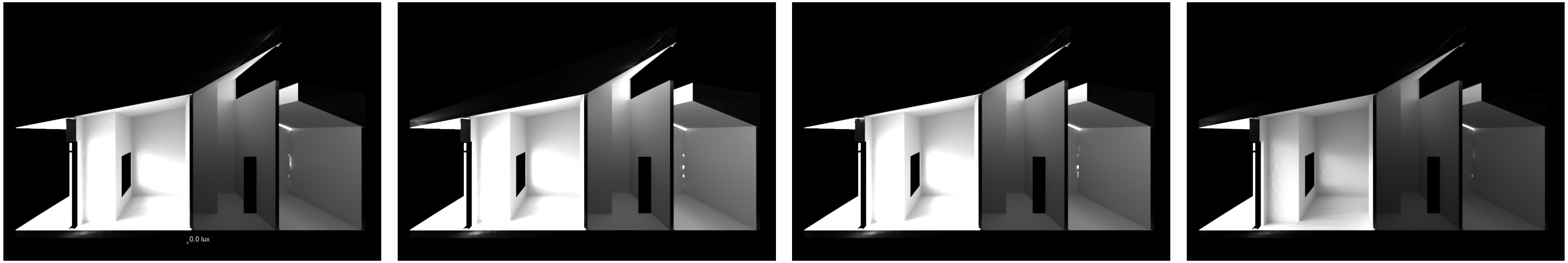
Illumenance - lux on surface

Patient room & hallway - larger floor to ciling height & window size in bathroom

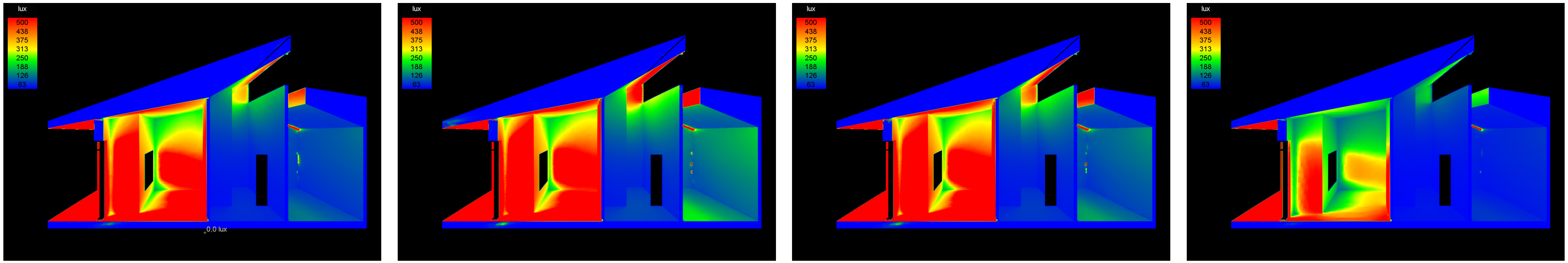
March June Septemer December



Daylight factor



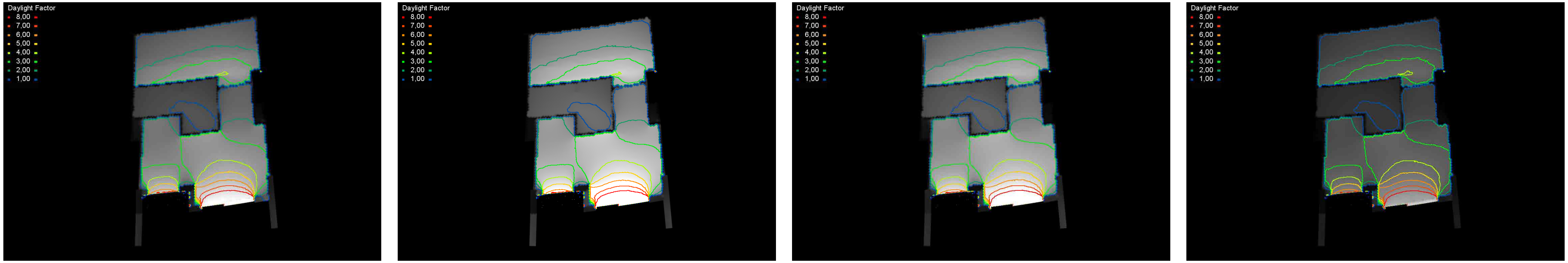
Illumenance - light shadow



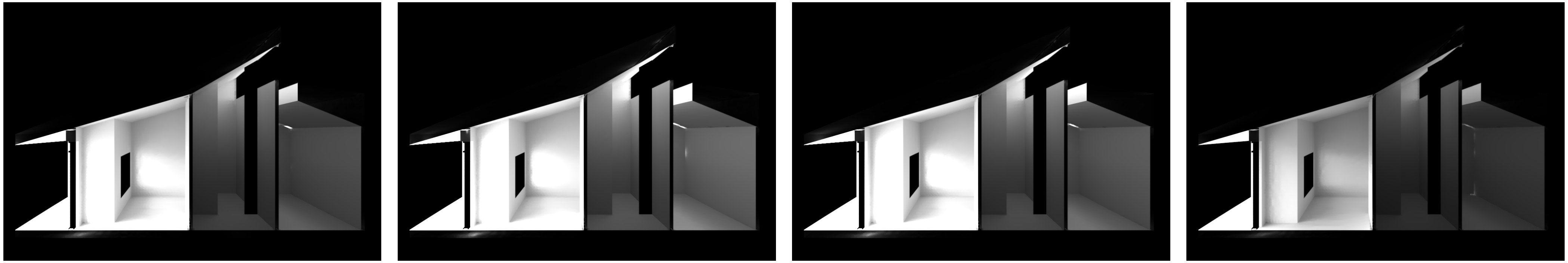
Illumenance - lux on surface

Patient room & hallway - lager angle of slope towards south. lower overhang.

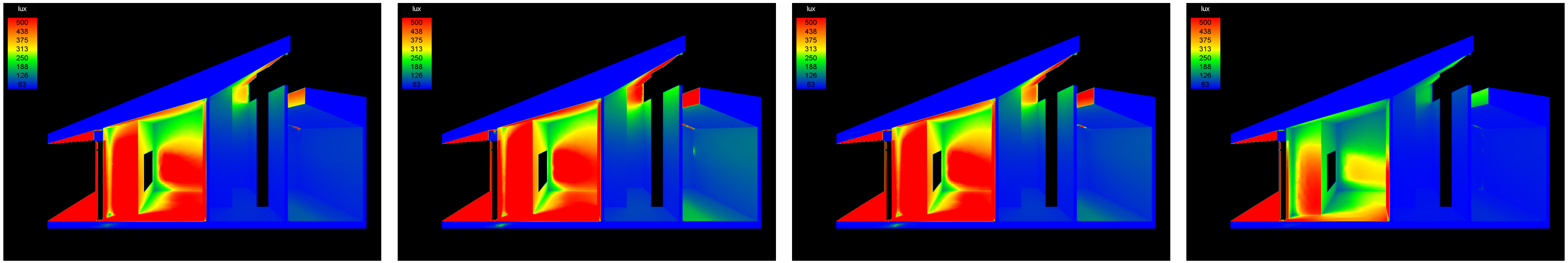
March | June | Septemer | December



Daylight factor



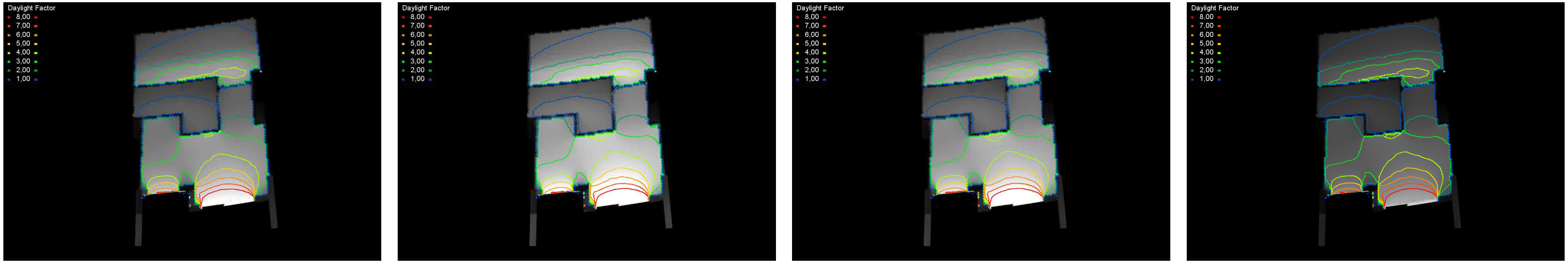
Illumenance - light shadow



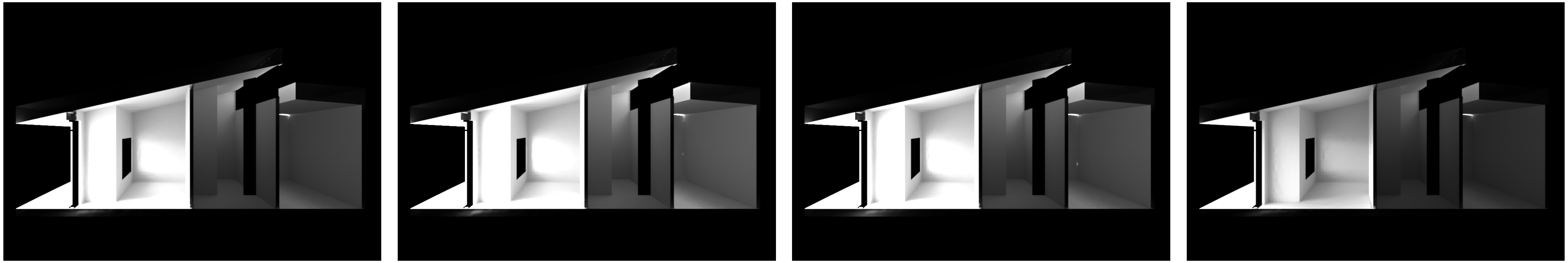
Illumenance - lux on surface

Patient room & hallway - human scale ceiling height

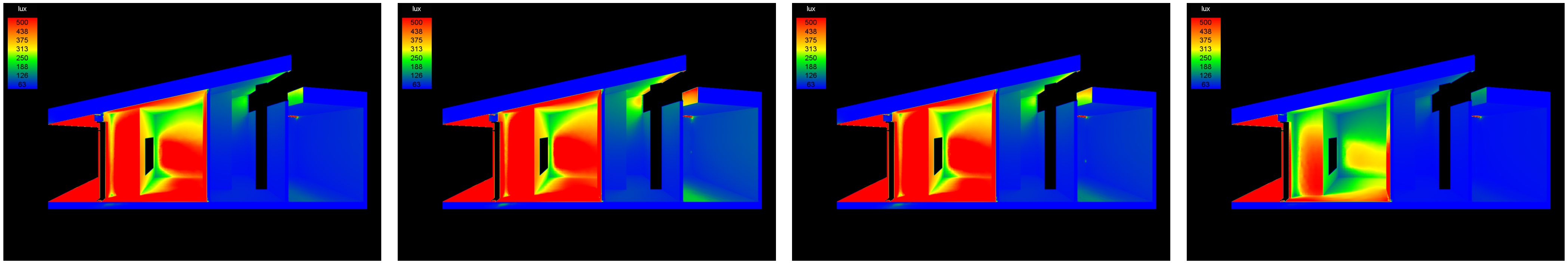
March June Septemer December



Daylight factor



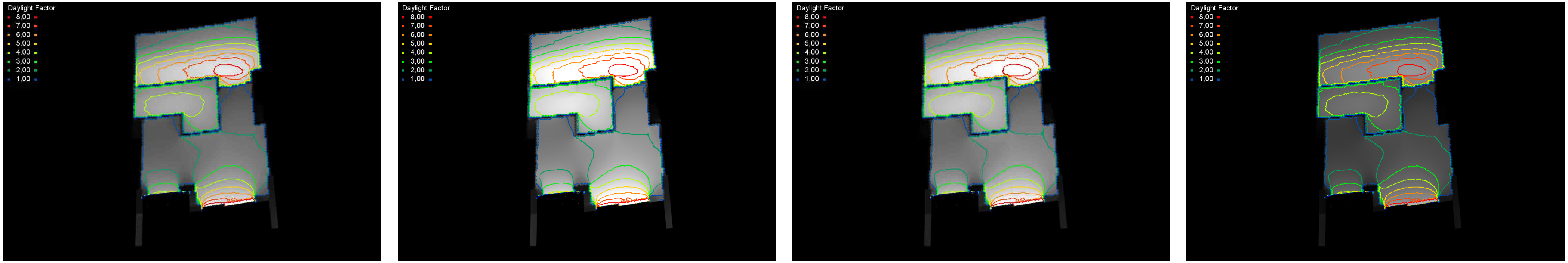
Illumenance - light shadow



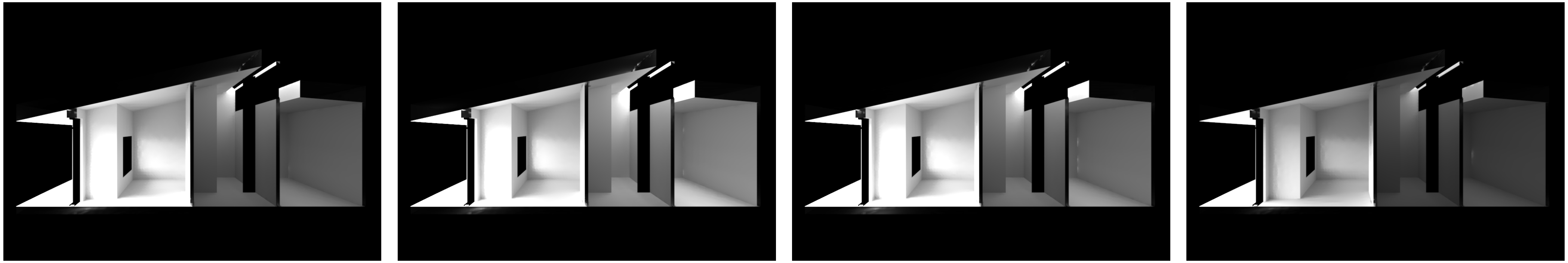
Illumenance - lux on surface

Patient room & hallway - new skylight inclination

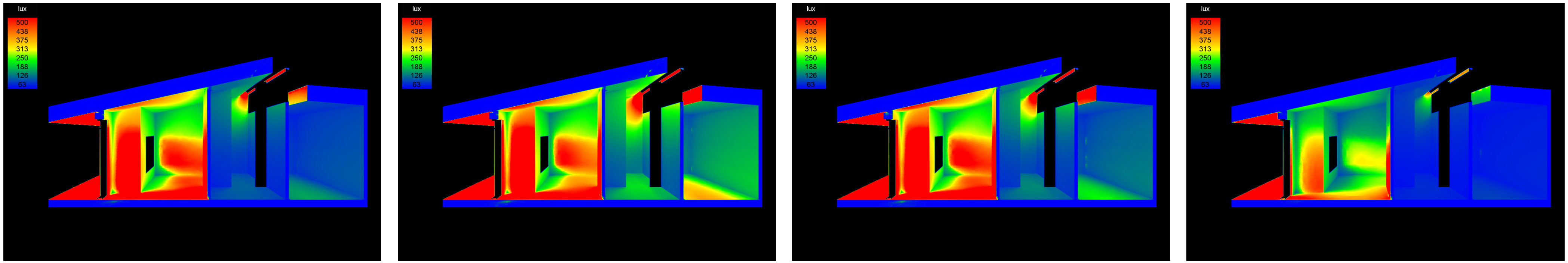
March | June | Septemer | December



Daylight factor



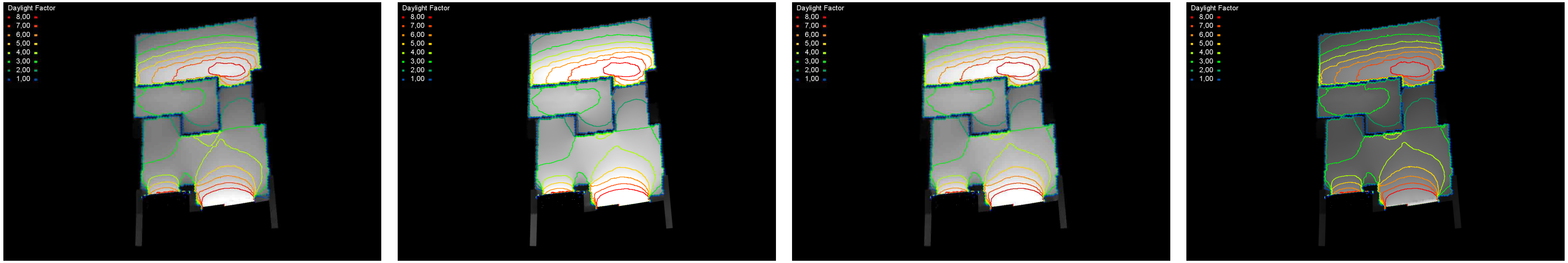
Illumenance - light shadow



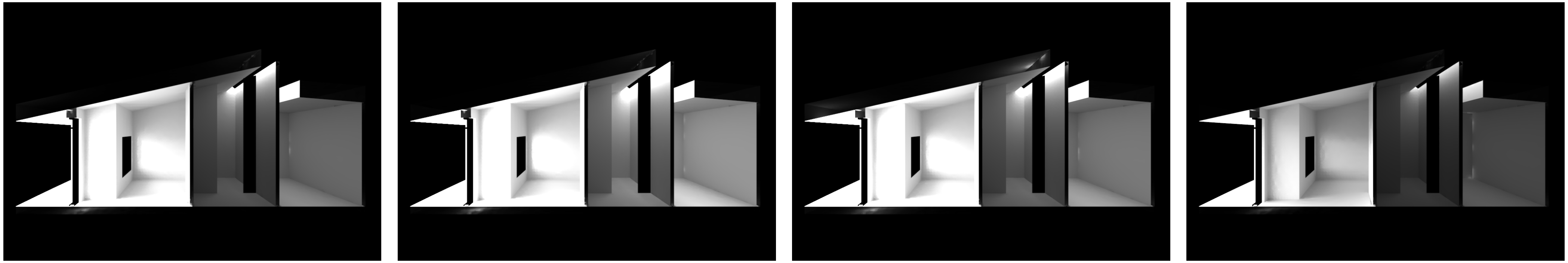
Illumenance - lux on surface

Patient room & hallway - lager angle of slope towards south. lower overhang.

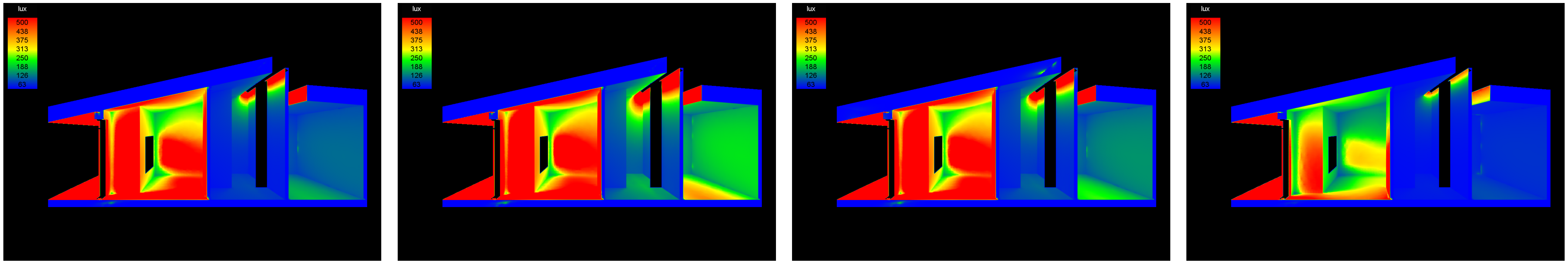
March June Septemer December



Daylight factor



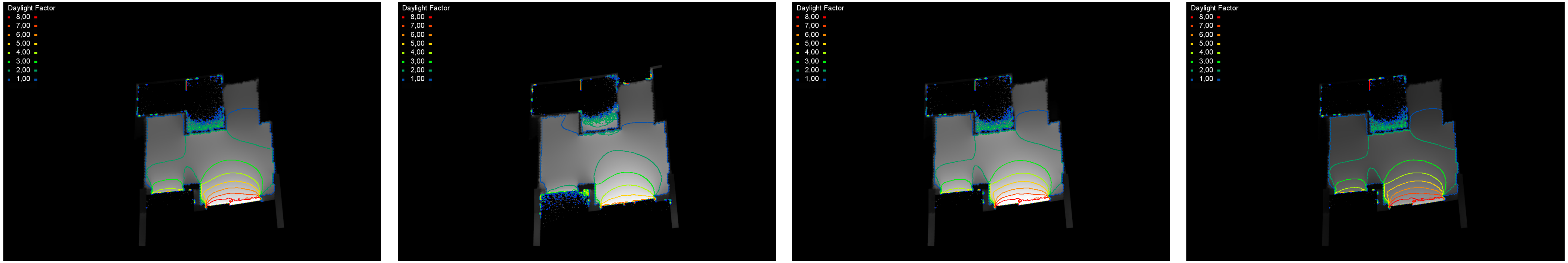
Illumenance - light shadow



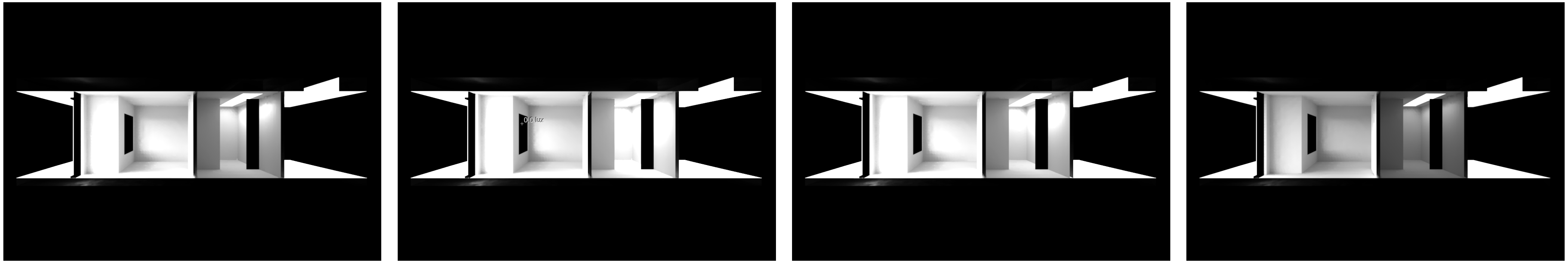
Illumenance - lux on surface

Patient room - no inclination

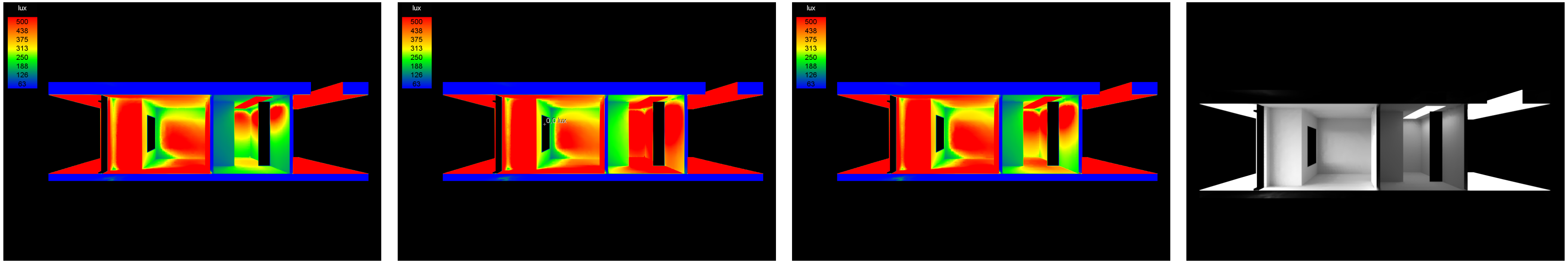
March | June | Septemer | December



Daylight factor



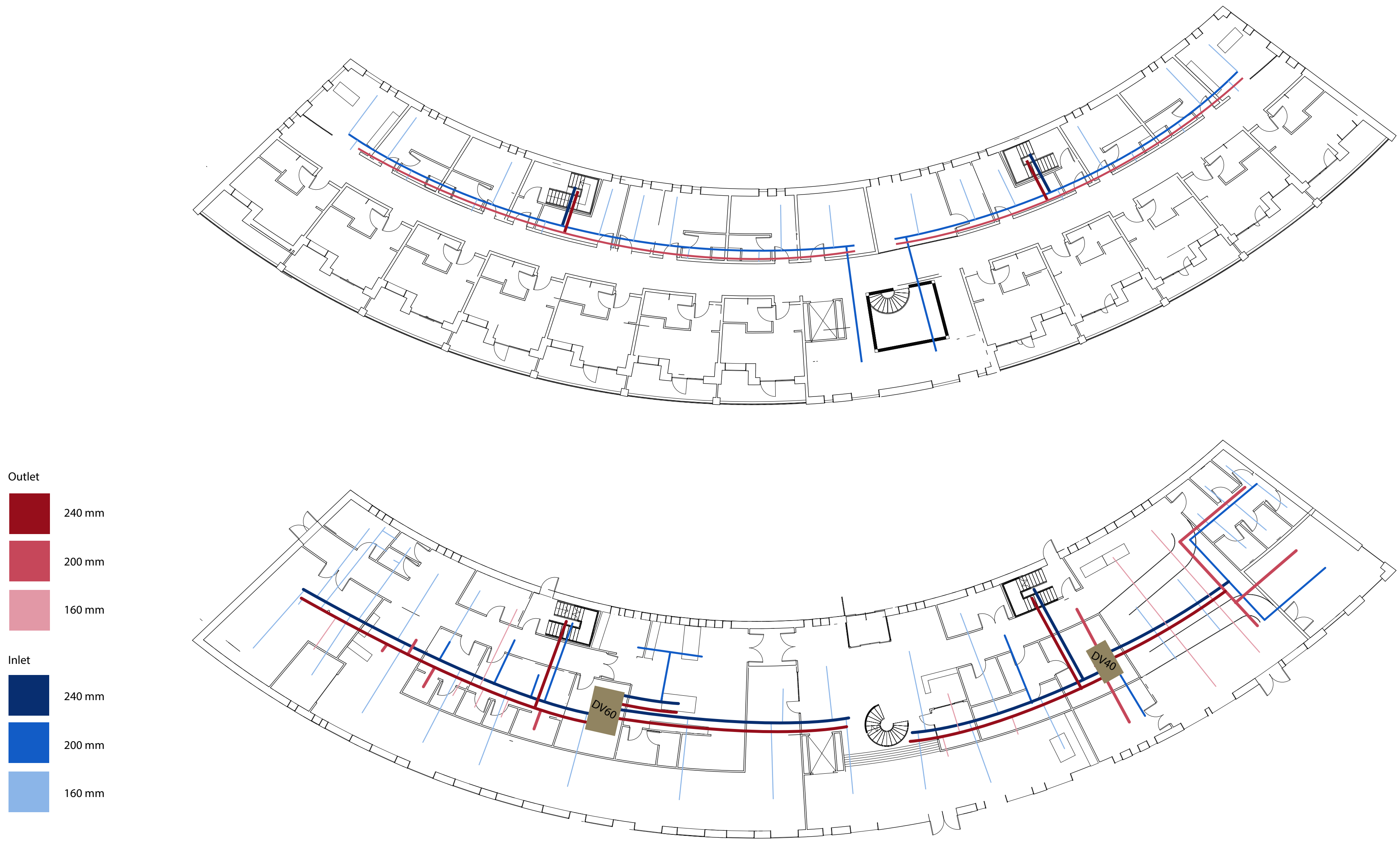
Illumenance - light shadow



Illumenance - lux on surface

APPENDIX 8

VENTILATION PIPE MAP AND CENTRAL AGGREGATE



Section	Registerd R (kp/m²)	Used R (pa/m) (Registerd R *9,81)	Σ Minor loss coefi-cent	Δpe
A-B	0,038	0,373	0,3	1,08
B-C	0,038	0,373	0,55	1,83
C-D	0,03	0,294	0,55	1,26
D-E	0,024	0,235	0,55	1,05
E-F	0,018	0,177	0,55	0,88
F-G	0,018	0,177	0,55	0,88
G-H	0,016	0,157	0,55	0,58
H-I	0,022	0,216	0,55	0,59
I-J	0,014	0,137	0,45	0,31
J-K	0,024	0,235	0	0,6
K-L	0,034	0,334	1	0

Minor Loss coeficent
Bend 0,25
Breaking off 0,3
Convergence 0,15
Sharp Bend 0,5
Outlet 1
Intake 0,35
Uniun 0,15
Enlargement 0,15

$$\Delta p = \Sigma \Delta p_l + \Sigma \Delta p_e$$

$$\Delta p_l = R * L$$

$$\Delta p_e = \xi * \frac{1}{2} * \rho * v^2$$

$$SEL = \frac{\Delta p_{in} + \Delta p_{out}}{\eta_t}$$

Section	Duct type	qv [m³/h]	Reco-mented dimension ø (mm)	Used Di-mension ø (mm)	V [m/s]	l (m)	R (pa/m)	Δpl	Δpe	ΣΔpt	output	note
A-B	Distrub. v < 4m/s	396	200	240	2,4	2,0	0,4	1	1	2	16	Breaking off [m³/h]
B-C	Distrub. v < 4m/s	380	200	240	2,3	4,0	0,4	1	2	3	161	Bend + Breaking off [m³/h]
C-D	Distrub. v < 4m/s	219	160	200	1,9	2,5	0,3	1	1	2	19,3	Bend + Breaking off [m³/h]
D-E	Distrub. v < 4m/s	199	160	200	1,8	4,5	0,2	1	1	2	16	Bend + Breaking off [m³/h]
E-F	Distrub. v < 4m/s	183	160	200	1,6	4,5	0,2	1	1	2	16	Bend + Breaking off [m³/h]
F-G	Distrub. v < 4m/s	167	160	200	1,5	2,5	0,2	0	1	1	19,3	Bend + Breaking off [m³/h]
G-H	Distrub. v < 4m/s	148	160	200	1,5	2,5	0,2	1	1	1	52	Bend + Breaking off [m³/h]
H-I	Distrub. v < 4m/s	96	125	160	1,3	2,5	0,2	1	1	1	19,3	Bend + Breaking off [m³/h]
I-J	Distrub. v < 4m/s	77	125	160	1,1	3,0	0,1	0	0	1	76,7	Bend + Breaking off [m³/h]
J-K	Distrub. v < 4m/s	0	63	100	00	0,5	0,2	0	1	1		Silence shutter
K-L	Distrub. v < 4m/s	0	63	100	0,0	0,5	0,3	0	0	0		Outlet
Sumption of pressureloss (p)											47	

DV60 anlæg

Summation of pressureloss [p]	47
Total pressure loss in and out [p]	94,6607149
Pressure loss from unit to distru. [p]	6
Total pressure loss in and out [p]	12,83327989
Vent efficiency	83%
SEL for duct [J/m3]	128,889682
Internal Unit Loss [J/m3]	207
SEL [J/m3]	335,889682

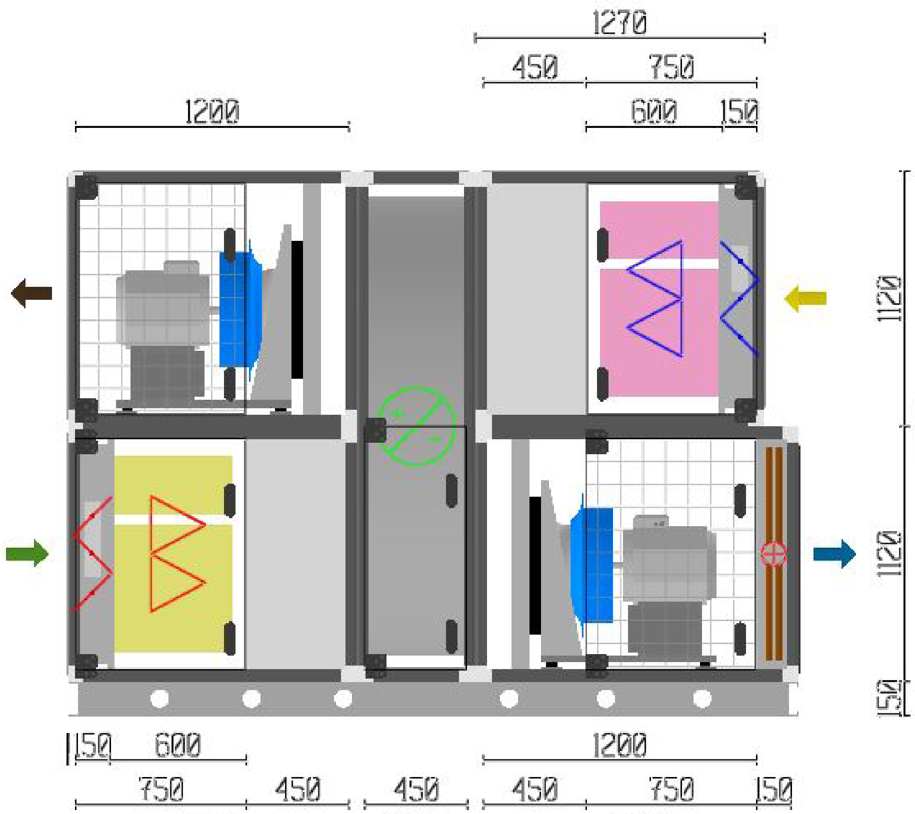
Ecodesign

	2016	Value	Limit	2018	Value	Limit
Unit type (Non Residential - Bi Directional)	Approved			Approved		
Fan with multispeed or Var.Speed Drive	Approved			Approved		
Heat recovery	Approved			Approved		
Thermal efficiency of Heat Recov. System	Approved	83.4	67.0	Approved	83.4	73.0
Pressure gauge (exclusively for 2018)	Approved			Warning		
SFP internal in W/(m³/s)	Approved	207.0	1495.0	Approved	207.0	1215.0
Calculation	Approved			Approved		
Total check	Approved			Approved		

Energy calculation

Average heat recovery:	83	%
Average SFPv (Clean filters):	1.49	kW/(m³/s)
Average SFPe (By dimensioning filter pressure):	1.75	kW/(m³/s)
Energy class	A+	

	Airflow		Heat exchanger, efficiency		SFPv value	SFPe value	Operation
	Supply, m³/s	Extract, m³/s	Temperature	Humidity	Including frequen...	Including frequen...	% of annual opera...
1: Danvent DV60							
Dimensioning working point	1.31	1.31	83.4	81.2	1.49	1.75	100



	Supply	Extract	
Air flow	1.31	1.31	m³/s
Unit size	60	60	
Face velocity (unit)	0.63	0.63	m/s
Temperature efficiency of the heat recovery	83.4	%	
Dimensions			
Length	3210	0	mm
Width	2170	0	mm
Height	2390	0	mm
Weight	1846	0	kg

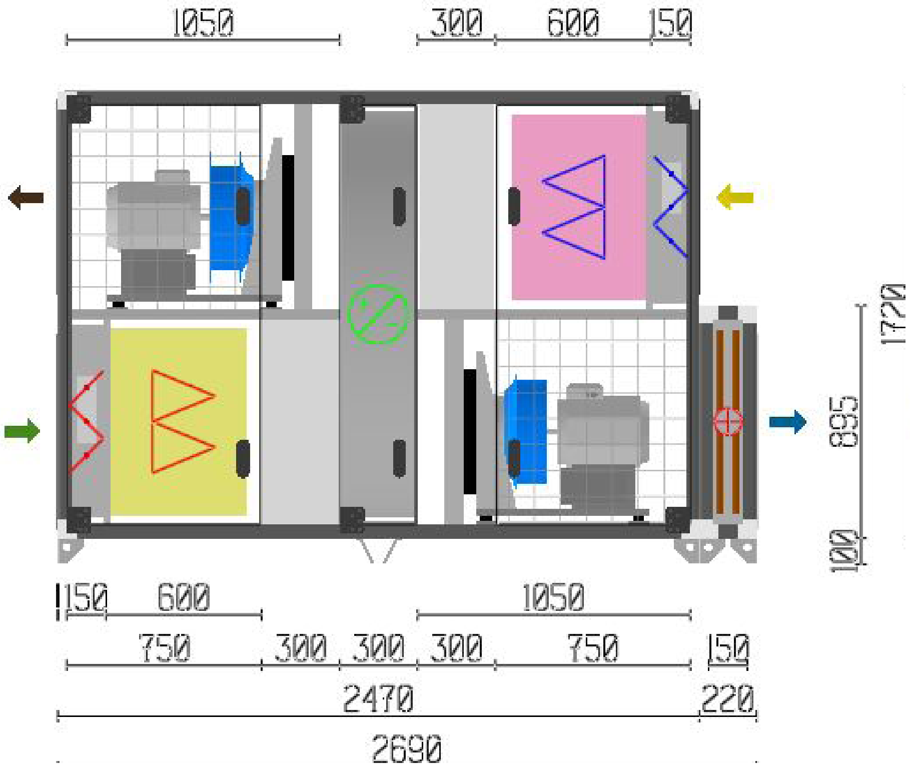
	Supply	Extract	
Sound power level	75	61	dB(A)
Fan efficiency	63.9	64.7	%
Fan speed	900	874	RPM
Operation frequency	47	46	Hz
Motor power	1.50	1.50	kW
SFPv, clean filters including frequency converter	1.49		kW/(m³/s)
SFPv, clean filters excluding frequency converter	1.42		kW/(m³/s)
Energy class	A+		

Alternative working points | Sound power level

Smaller unit size | Larger unit size

Remarks

1: Danvent DV60
Dimensioning working point
Input values for unit
Heat recovery is less than default minimum heat recovery
Warning: Pressure gauge (Ecodesign 2018)
Calculation succesful



Ecodesign

	2016	Value	Limit	2018	Value	Limit
Unit type (Non Residential - Bi Directional)	Approved			Approved		
Fan with multispeed or Var.Speed Drive	Approved			Approved		
Heat recovery	Approved			Approved		
Thermal efficiency of Heat Recov. System	Approved	83.5	67.0	Approved	83.5	73.0
Pressure gauge (exclusively for 2018)	Approved			Warning		
SFP internal in W/(m³/s)	Approved	235.0	1570.0	Approved	235.0	1290.0
Calculation	Approved			Approved		
Total check	Approved			Approved		

Energy calculation

Average heat recovery:	84	%
Average SFPv (Clean filters):	1.58	kW/(m³/s)
Average SFPe (By dimensioning filter pressure):	1.85	kW/(m³/s)
Energy class	A+	

	Airflow		Heat exchanger, efficiency		SFPv value	SFPe value	Operation
	Supply, m³/s	Extract, m³/s	Temperature	Humidity	Including frequen...	Including frequen...	% of annual opera...
1: Danvent DV40							
Dimensioning working point	0.83	0.83	83.5	81.3	1.58	1.85	100

	Supply	Extract	
Air flow	0.83	0.83	m³/s
Unit size	40	40	
Face velocity (unit)	0.65	0.65	m/s
Temperature efficiency of the heat recovery	83.5	%	

Dimensions

Length	2690	0	mm
Width	1720	0	mm
Height	1820	0	mm
Weight	1031	0	kg

	Supply	Extract	
Sound power level	74	61	dB(A)
Fan efficiency	61.5	62.0	%
Fan speed	1128	1097	RPM
Operation frequency	39	38	Hz
Motor power	1.50	1.50	kW
SFPv, clean filters including frequency converter		1.58	kW/(m³/s)
SFPv, clean filters excluding frequency converter		1.50	kW/(m³/s)
Energy class		A+	

Alternative working points | Sound power level

Smaller unit size | Larger unit size

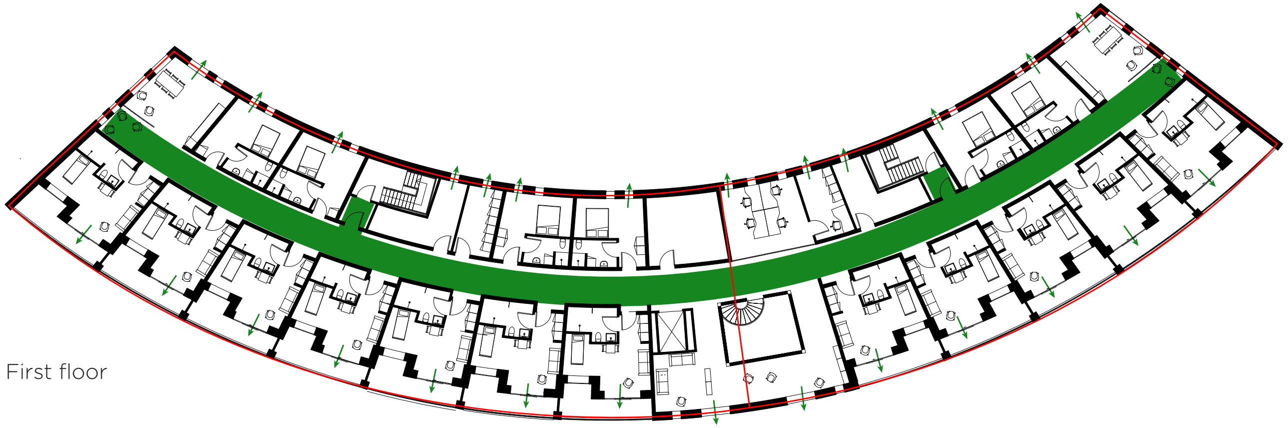
Remarks

1: Danvent DV40
Dimensioning working point
Input values for unit
Heat recovery is less than default minimum heat recovery
Warning: Pressure gauge (Ecodesign 2018)
Calculation succesful

APPENDIX 9

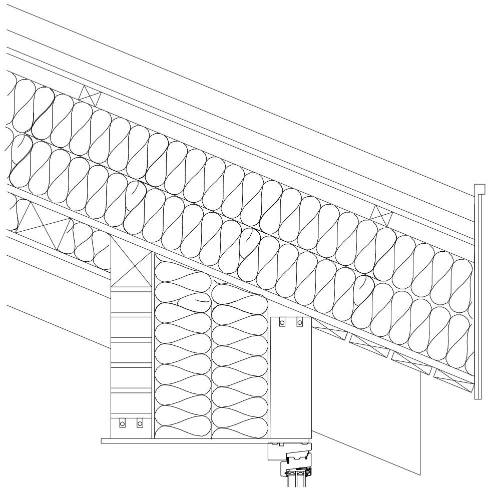
FIRE STRATEGY

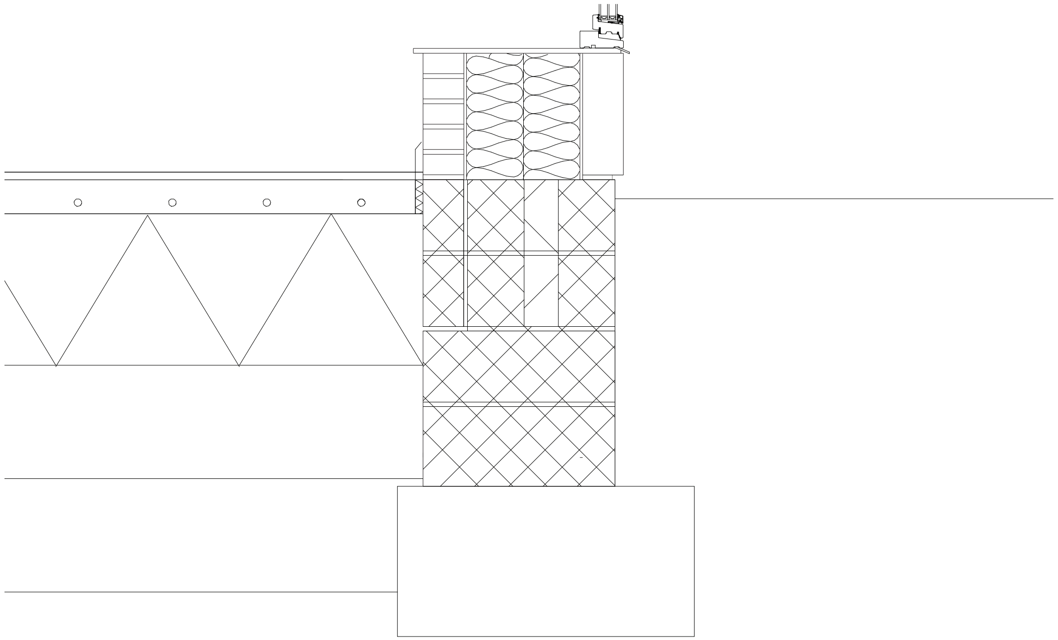
Ground floor



First floor

APPENDIX 10
DETAILS 1:20





APPENDIX 11

PARKING

Standard parking norm: (Aalborg kommuneplan 2017)
Hotels: 1 parking spot per 2 rooms
Residential care home, residential institution ect. 1 parking spot per 4 nominated institution spots + 1 parking spot per 8 staff members.
Thereby Mariagerfjord hospice have to contain a minimum of 11,5 parking spots.
This is calculated as shown below:
12 patient rooms: 3 parking spots
15-20 staff members: 2,5 parking spots
6-12 relative rooms: 3-6 parking spots.
For every 10-25 parking spots a requirement of two parking spotshas to be established for disabled. One normal spot with the dimensions 3,5x5m and one for at box van with the dimensions 4,5x8m. (Sbi 230)

APPENDIX 12
BE 15

The first page of the Be15 calculation consider the total heated floor area, the fact if the building is a housing project, office project or else, if it is one storey or multi-storey. In our case, it is a multi-storey. Our building consists mainly of a heavy construction which have a high heat capacity, but both the roof and the external walls in the patient rooms are light constructions, whit a low heat capacity, this is why it is chosen to implement a heat capacity at 160 Wh/K m2. The heat supply for this project is district Heating. Furthermore, the normal usage time is 168 hours/week, when the building is used all the time.

External walls:
The U-value of the external walls have been considered according to the recommendations from Rockwool to reach the 2020 demands, and have been calculated by the U-value scheme from Isover: https://www.isover.dk/isover-energiberegner?gclid=CIbr7MSo9tMCFVPcGQodSEUMTw. See our values at the USB.

Line loss
The line loss in the building have been set to zero, when the joints in the construction elements, should be connected as air tight that a line loos will not occur.

Windows
The windows influence the energy consumtion according to transmission loss and heat gain. The window area is considered according to transmission loss and heat gain at both the northern and southern façade. A three-slate energy window have been chosen, to avoid a too high amount of transmission loss. When choosing a window with a low U-value, the glass transmittance (g-value) will become low as well, and this will have an effect on the ability for heat gain.
The shades from the trees, overhang and building envelope has been measured, when these will have a huge impact on overheating, the possibility for heat gain. Also, solar shading on the southern facade have been implemented in the calculation.

Summer comfort:
Have been implemented to have an overall idea over overheating in the patient rooms.

Ventilation:
The mechanical ventilation has been calculated according to olf, when this was what required the highest air change rate compared to CO2. The ventilation will be effected by heat recovery, the SEL value, infiltration, the desired inlet temperature.

Internal heat supply
concerns the heat supply by people and equipment. In this case the standards for housing is used.

Lighting
is not considered in housing. This have been considered in the calculation of PV panels.

Heat desitribution plant:
A standard Heat pump has been used

Domestic hot water
A hot-water tank, have been implemented in the building with a voulume of 800 liters. This has a relative high heat loss. The connestor pipes is all with in the heated area, which means that the heat loss has a small distance with heat loss.

Photovoltiac
Solar cells have been implemented to cover the electricity use, and the area have been calculated in appendix 1. The handcalculation do not consider the shading form the trees, this is done inside the Be15 calculation, and a lager area have been used to cover the total electricity use.

See File at USB.