MOSSØ CENTER - ROLD FOREST

A DEMENTIA FRIENDLY NURSING HOME

"A life must be lived with dignity"

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“ We borrow from nature the space

upon which we build ”

- Tadao Ando

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A dementia friendly nursing home

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PREFACE

This report is a collection of work done in 10th semester master thesis in architecture and design and the culmination of the education at Aalborg University. The report describes the elaboration of the design process to the upcoming dementia center in Rold forest, and a presentation of this proposal.

The report is divided into five sections, each of which is subdivided:

Prologue - Introducing the motivation for the project.

Program - Consisting of user, Technical research and Introduction of the site.

Design process - Describing the design phases, who led to the project.

Presentation - Presenting the final design of the Mossø Center.

Epilogue - A conclusion and reflection of the final project.

An illustration and reference list will be at the end of the program, which are both in alphabetical and chronological order. The references are listed by The Harvard Style of referencing.

The appendix contains additional information about sub-items in some of the sections that will be referred to continually. The theory behind this report is based on scientific articles and technical requirements. Furthermore, it is based on practical experience learned through interviews from field studies.

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This report has been developed by group 10. The group would like to start with the recognition of a number of people who have supported the project and have helped to elucidate professional aspects of the project.

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ABSTRACT

This report addresses the development of Mossø Center in Rold forest, a dementia friendly nursing home. The design is developed in an integrated design process with a holistic approach, with a focus on a user with special needs due to cognitive impairment. Dementia is a fatal illness and is the 5th leading cause of death in Denmark. It is estimated that up to 89.000 Danes suffer from this illness and the number is expected to increase with 7.700 each year.

The focus in this report has been to create a professional and modern nursing home, that addresses the challenges and daily tasks in a dementia friendly nursing home. To get a better understanding of the needs and the daily life of the user, a comprehensive program were developed at the start of the project. This program contains laptop studies of the illness, and field studies and interviews were conducted in Northern Jutland. On the foundation of the ideas proposed in healing architecture, a choice to use nature as an active reliving element in the design led to the decision of the location of the site. Extensive research was done on site, to understand the strength, weaknesses, opportunities, and threats occurring on site. The site was visited in the winter, spring, and summer month. This gave a wide understanding of the qualities of the nature on site.

The following design process was based on the program and in an integrated design process, merged with knowledge of the user, the qualities on site, and with technical calculations in an architectural concept. This concept reinterprets the classic Danish farmhouse and creates a building that in its contrast to nature fits into the area and its history. The Mossø Center consists of 5 dementia housing units and one regular housing unit for elderly, all arranged around, and with a focus on the heart of the center. The heart contains a daycare center, a downtown where the functions of the city are located and a silence space for meditation and reflection. The center is designed to be a functional nursing home, in such a way that the residents can make it their own and call it home. The use of natural light and nature in a functional and logical plan aim to create a calming and stress-free environment with a good indoor climate.

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Motivation

The Danes are living longer and that means the elderly population above the age of 60, is expected to increase with 31,6 % from 2017 to 2040 (Nationalt videnscenter for demens, 2015).
The increase in the population is of course a positive development, but it also means an increase in the people affected by dementia. It is estimated that the population group 65+ affected by dementia will increase with 6 % (Nationalt videnscenter for demens, 2015).

In Denmark dementia is the 5th leading cause of death and living with dementia can be a long difficult phase at the end of life.
Dementia is a disease that affects many Danes and it is estimated that between 300.000 and 400.000 people are close relatives to one who struggle with dementia. (Nationalt videnscenter for demens, 2015).

The dramatically increasing number of dementia patients and the large group of relatives affected by the person with dementia, has led the government to allocate 470 million DKK to the developing of a more dementia friendly society (Aftale om den nationale demenshandlingsplan 2025, 2016)

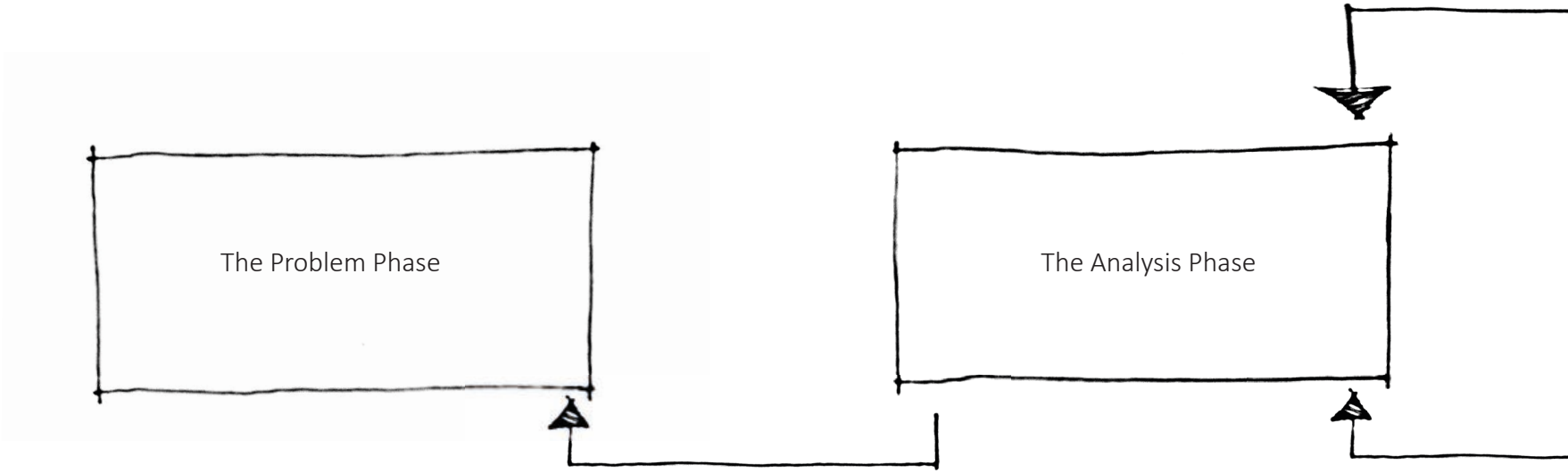
Research-informed and Evidence-based design

The terms; research, research-informed and evidence-based design have various of definition. In this report following definitions are used.

Research is based on quantitative and qualitative research:
Qualitative research is used when limited knowledge about a concept or a phenomena is known. Qualitative research typically consists of interviews and observations, until the “saturation point” is reached. The frequent information can be further confirmed, by focusing on the information through a quantitative analysis.
Quantitative research is a systematic review on randomized studies, consisting both of meta-analyses (analysis who look at all the results from the same type of research) and quasi-experimental studies (combined analyzed data from multiple studies, as if they were made as one). In form of sensitive analysis, the usage of quantitative analysis can be seen as inappropriate or unethical, therefore some information is best gained through a qualitative investigation. (Stichler, 2016)

Research-Informed design:
Research-Informed Design uses only published research, making it precise in the information chosen, but miss the holistic overview gained through Evidence-based design, described further down. Research-informed design is a guidance for decision making, by using the best research available in relation to a design process and features for it. (Stichler, 2016)

Evidence-Based design:
Evidence-Based design is considered to be a judicious and systematic usage of evidence, to help decision making when designing. It uses multiple forms of evidence, varying from the best research in the field, experience from a vendor, values and practice examples. The value of the evidence is not necessarily the same, as the method and analysis or review of the evidence mostly have to be based on recognized and proven trials. Therefore, the best type of evidence, can be based on published research studies, as it have been reviewed by one or more experts.(Stichler, 2016)

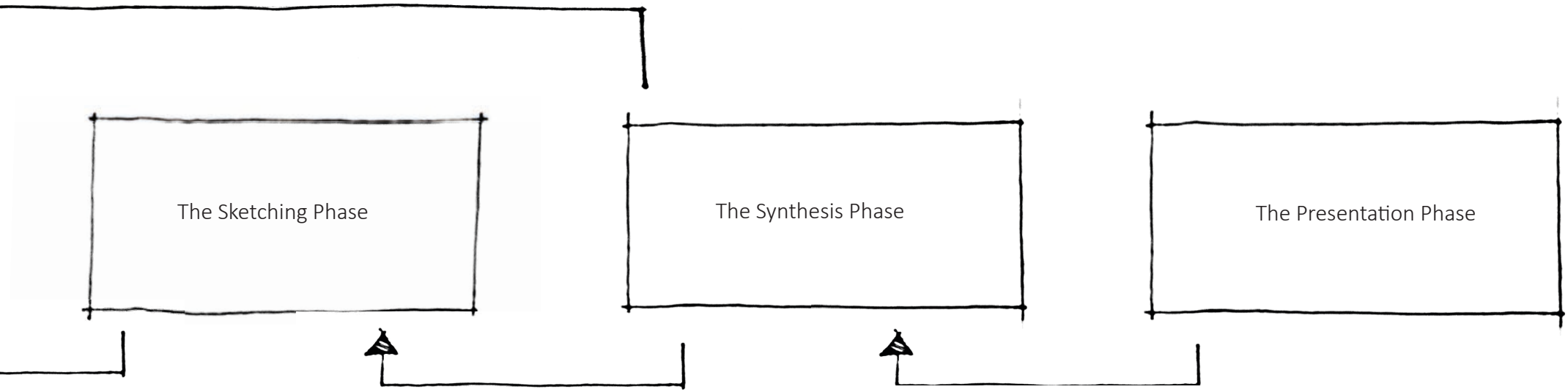


Integrated Design Process

In design and in architecture, a basic method is the Integrated Design Process (IDP). The method is separated into five phases, each phase with a specific focus, linked together in a nonlinear approach. The method is developed by Mary Ann Knudstrup and focus on analyzing and reflecting, to reach a higher quality in architecture and design and improve the projects. (Knudstrup M. 2004)

The problem phase
A problem is outlined based on facts and data about the chosen topic. In this phase a progressive goal for the project is determined, to give the project a common target.

The analysis phase
Site and environment around the site are analyzed. In this phase user group and the client are profiled. This phase is about finding as much useful information about the project as possible. Room programs and function diagrams are made and are used to make the design parameters, setting the foundation for the sketching phase.



III. 1 Integral Design Process (IDP) Diagram

The sketching phase
A variety of different design tools are used to create and model different integrated design proposals based on the design parameters determined in the analysis phase and with a focus on sustainability.

The synthesis phase
The selection of a final proposal is based on both architectural assessments and technical calculations. The indoor climate is analyzed in Be18 and BSim and informs the design. The synthesis phase often leads to a new analysis phase in the integrated design process, until a satisfactory proposal has been achieved.

The presentation phase
in this phase the final design proposal needs to be communicated. there is a high focus on the client and how to communicate the project in the bedst way. This can be done using different visualizations tools, drawings, physical or computer models, posters and virtual reality.

Program

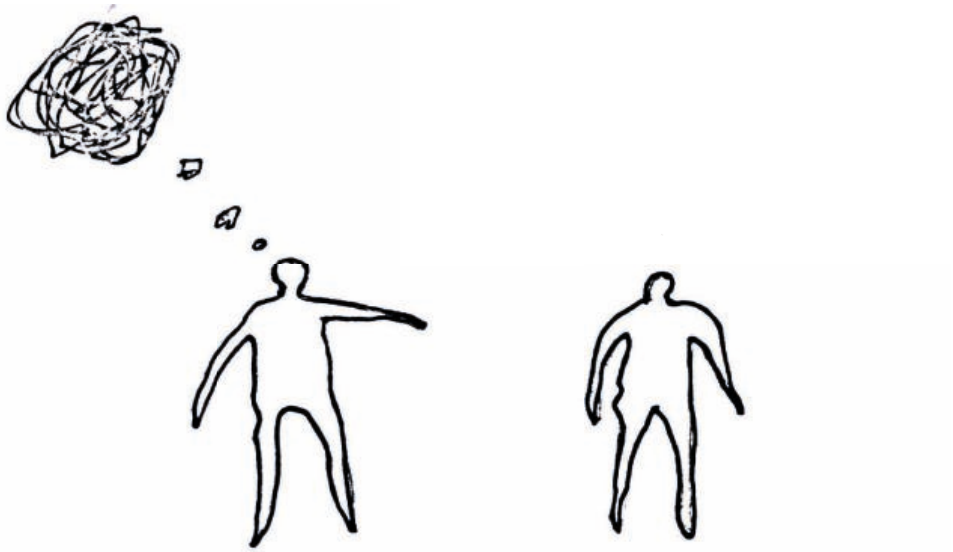
Ill. 2 Brain Sketch

The User

To ensure the best starting point for a relevant and adequate project, a number of field studies were carried out at the start of the project. Four dementia centers were visited. This provided an understanding of what a dementia center is and what functions it should have, who the residents are and the daily challenges that arise. Surveys were made and image registration of the building was performed. Conversation interviews with the employees were done, in order to understand their daily lives, challenges at a dementia center and which improvements they needed. This was carried out, to secure the projects' direction from the start, toward a focus on the residents.

Based on qualitative and quantitative data in the form of interviews, questionnaires, videos as well as articles and relevant websites, two personas were developed as a representation of the dementia residents, two for the staff and two for the relatives. This was done to accommodate the user's, challenges and needs in the upcoming design process. Well-being and good moments are of great importance when life is characterized by this illness. Therefore the influence of music and music therapy on the residents were looked into. To ensure the residents can find their way around in the center, wayfinding were investigated, to prevent the residents from getting lost. In order to secure a good everyday life for the residents, the concept of healing architecture was studied and what effects the environment and the home have on the user. In healing architecture, the focus was on the use of nature, natural light and colors. Studies were carried out how the use of nature and integration of nature can lower stress and increase the quality of life.

In continuation of this and on the basis of the experience gained in the field studies, a feasibility study was made about which plants could be used at the dementia center, how these could be used and secure green surroundings all year round. Finally, the legislation in the field was examined.



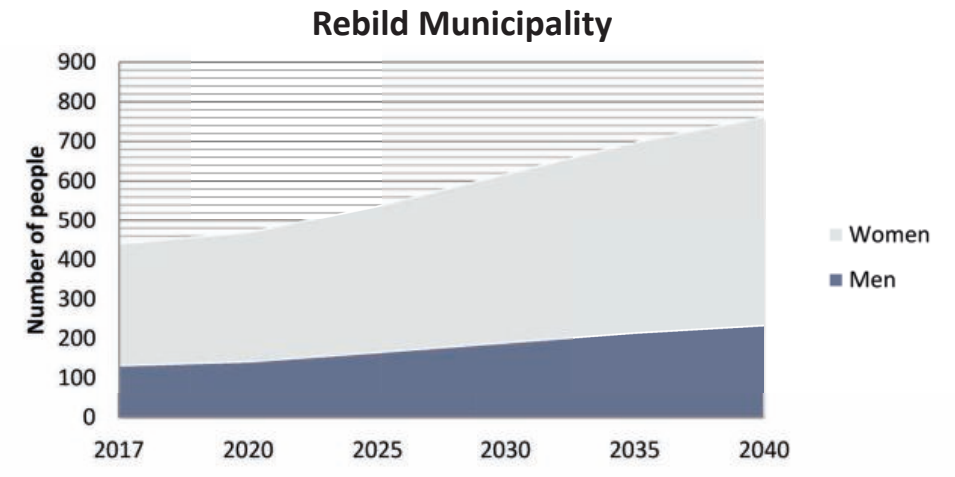
Ill. 3 Dementia

Dementia

Dementia is a growing problem worldwide. Globally it is estimated that 47 million people suffer from dementia and Alzheimer's. This number is expected to rise worldwide to over 131 million people by the year of 2050 (Nationalt videnscenter for demens, 2018).
In Denmark, it is expected that up to 89.000 suffer from dementia (Nationalt videnscenter for demens, 2018), and each year more than 7.700 are diagnosed with dementia (Sundhedsstyrelsen, 2015).

When using the term dementia, it is a term for a number of different diseases. Dementia covers a category of about 200 different diseases that cause cognitive disturbances (Nationalt videnscenter for demens, 2018). Of those who have been diagnosed with dementia, around 60-80% suffer from alzheimer, thus alzheimer is the most common cause of dementia (Association, 2019). In Denmark, the number is increasing. If one looks at the number of people who have dementia in the Rebild municipality, it can be noted that people suffering from dementia is increasing here as well. See illustration 4. This increase is expected to continue towards 2040 (Forekomst af demens hos ældre i Danmark, 2017).

Each year about 1.000 men and 2.100 women die dementia. This is a estimated loss of 1.300 years of life, of the more than 3.000 Danes who lose their lives (Sundhedsstyrelsen, 2015). Dementia do not only affect the demented, and in Denmark it is expected that between 300.000 and 400.000 people are close relatives to one who has dementia (Nationalt videnscenter for demens, 2018) and because of the nature of the disease often gives the feeling of losing their loved ones twice (Olenius, 2019).

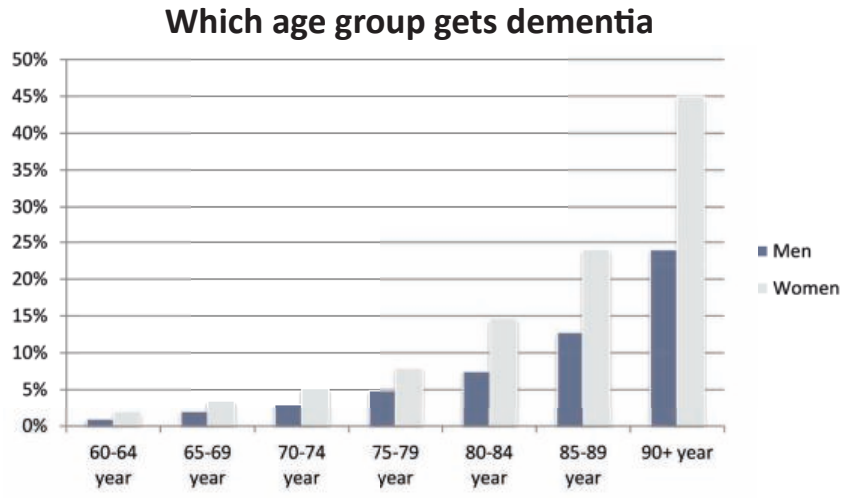


Ill. 4 Rebild minucipality (Forekomst af demens hos ældre i Danmark, 2017).

Dementia is a disease with great human consequences, both for the person suffering from dementia and the relatives. Dementia also has great social costs, both directly where dementia costs society approximately 24 billion DKK a year, (Nationalt videnscenter for demens, 2018) and indirectly because of lost production and earnings due to the affecteds reduced work capacity, this equals to 630 million DKK (Sundhedsstyrelsen, 2015).

Since dementia is a fatal disease, treatment of patients in a dementia center has a substantially different purpose than what one sees in a hospital. At a dementia center the focus is on relieving the disease and creating a dignified life for the patient in their last part of life. Because of this, the patients living in a dementia center is called “resident” or by their name and avoiding calling them patients. There is also great focus on the individual occupant having a sense of co-determination and that the apartment at the dementia center is their private home. During the time when the residents live at the dementia center, there will be an increased need for care and help, which must be done with respect for every person, so the residents can have as normal a life as long as possible (Olenius, 2019).

A way to see how dementia affects the brain, is by looking at the physical reduction of the brain mass which during the course of the disease shrinks. A healthy brain weighs between 1250 and 1400 g. A brain afflicted with dementia weighs around 1000 g. (Cairns, 2009) Dementia is divided into three stages; Light Dementia, Moderate Dementia, and Severe Dementia. The stage of light dementia is characterized by being the first phase in which shows a light impairment of function and everyday activities and complicated tasks become difficult. In moderate dementia, the cognitive impairment is so advanced that significant impairment of functional ability appears. Help in everyday life is needed from care staff or spouses and the patient should not be left alone. Severe dementia is the last stage and the patient is completely dependent on help, nursing and regular monitoring is often necessary (National Center for Dementia, 2018).



Ill. 5 (Nationalt Videnscenter for demens, 2018).

An illness not old age

Dementia can occur after teenage years (16 +), where the brain is developed, however, most of the cases are seen in the older part of the population and the occurence of dementia in the category 65+ year is expected to be approximately 6 %. Ill. 5 shows a clear increase to 24-45 % in age group of 90+ years. (Nationalt videnscenter for demens, 2018).
One does not know for sure what's causing alzheimer, there are, however several competing hypotheses (Cairns, 2009). One of these hypotheses is that stress increase the risk of developing dementia (Ricci et al 2012) as cited in (Fich et al., 2017). Stress releases the stress hormone cortisol, which lowers the volume of the hippocampus in the brain. A prolonged period of stress, can provide an extended period of increased amounts of cortisol, that can cause permanent damage to this part of the brain (Conrad 2008) as cited in (Fich et al., 2017).

Signs of dementia include a deterioration of one's cognitive functions and can cause memory problems, space and directional disturbances, lack of overview, inability to solve problems and weaken one's ability to remember people's names. Another side of the disease is that there may be an increase in turmoil and aggression. People suffering from dementia can become both linguistic impaired and physical aggressive to their surroundings. These tendencies develop gradually in the context of the disease and can be a great burden for relatives and staff (Nationalt videnscenter for demens, 2018).
These deteriorations, especially the weakening of the orientation ability and one's ability to form an overview, can cause the release of stress hormone cortisol, a substance believed to reduce the size of hippocampus and thus create a negative spiral that aggravates one's condition (Fich et al., 2017)

There are two types of stress; systemic stress and psychological stress. Systemic stress is activated when one is physically threatened, which can be caused by blood loss from injury, or pain from infections. Psychological stress can be in the form of mental, emotional elements and social rejection. Of these types, it appears that psychogenic stress has the greatest effect and releases the largest amount of cortisol (Dickerson and Kemeny 2004) as cited in (Fich et al., 2017)

A nursing home with a focus on dementia

A nursing home is a place containing a range of features to accommodate the elderly and promote personal care of the individual resident. In a nursing home where there is a specific focus on residents with dementia, the surroundings and the building have a great importance for the well-being of the individual resident and the daily routine. A dementia-friendly environment can be several things. A dementia-friendly home is characterized by being homelike, with focus on creating a safe and secure environment with interaction between the in- and outside and with a specific focus on light, colors, functions and their location. When designing for dementia patients, it is important to remember that they are people first and foremost (Nationalt videnscenter for demens, 2017). For in-depth information on a nursing home, as well as the difference between a retirement and nursing home, see appendix 1 page 173.

The nursing home is divided into a number of subgroups, which will be explained in the following text, and will be referred to in the rest of the project.

The organizational unit
In the areas between the housing units are a variety of support functions located, such as storage rooms and staff toilets, as well as space for offices and other administrative work.

The residence
The individual resident's home must express homeliness. A large number of studies points out that a non-institutional arrangement has a positive effect on the resident, in the form of increased quality of life and greater well-being. To be homely it should be possible for residents to help put their own mark on their home. Patients with dementia often have difficulty with large spaces. In these cases, a room divider can be used as a tool to divide the dwelling into smaller and more manageable areas that the resident considers appropriate (SBi, 2015).

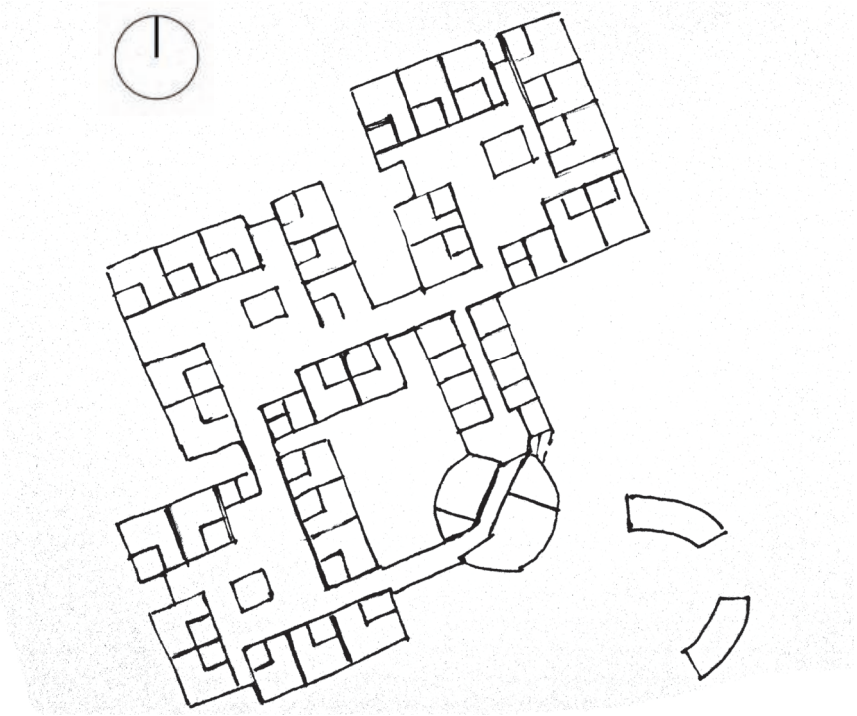
The housing unit
The housing unit consists of 6-12 individual resident homes. It is important that the housing units do not become too large, as it can create a confusing environment for the resident. The apartments should surround a common area with a kitchen, dining area and TV room. In the common area, niches should also be included so that residents can retreat, but still be part of the community. It should be possible, as it is in the residents' own home, to put a personal touch on the common areas. The common areas should have a size where smaller activities can be kept in a familiar and safe environment. (SBi, 2015)

Downtown
Downtown is the area that imitate the functions of the city, here is the opportunity to get a haircut, buy articles such as toothpaste and medicine, there is a pharmacy, a workshop and space for other activities. In this area the daycare center is located and other facilities could be: a music room, bar, café, workshop, hobby room, wellness, and a fitness room. The daycare center should also work as a place for external users with a relief agreement with the center, and can engage in social activity with the residents in the center. In the transition periods before the elderly is getting a permanent home, the center is also a place where the person with dementia can get used to the center, the other residents and the staff and in this way reduce the upheaval it is to move to a dementia center (Olenius, 2019).

Case studies: Nursing homes

As part of the research phase, a number of different nursing homes were visited in North Jutland, around the chosen site. The selected centers were both new and old buildings, in which elderly residents both with and without dementia lived. The reason for visiting both nursing homes and dementia centers was to see differences between these. During the visits, insight was given on how a center functions and the staff's experiences, which gave an indication of which things worked and what could be improved.

Ill. 6 Case Studies - Map of North jutland



Ill. 7 Case Studies - Ådalscentret floor plan sketch

Ill. 8 Case studies - Ådalscentret residence

Ådalscentret

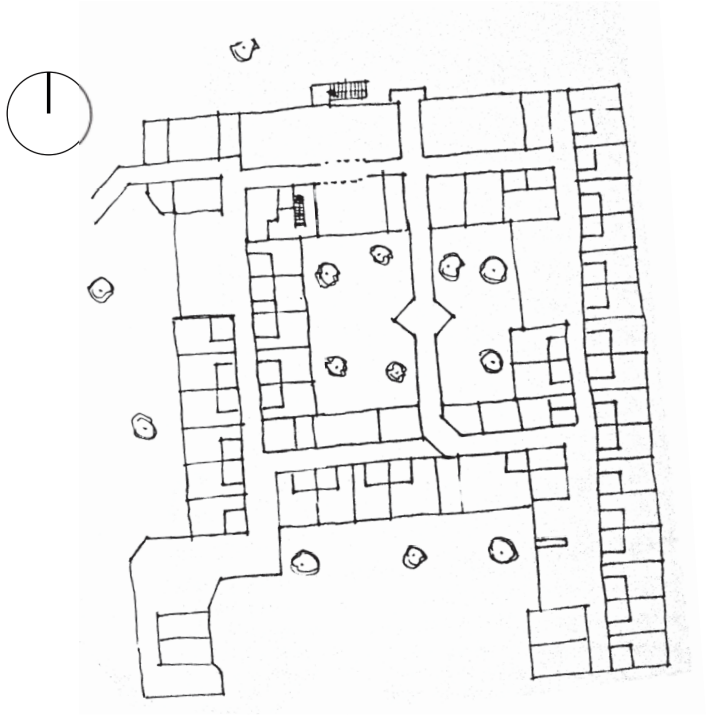
Architect: Krogh Madsen Arkitekter A/S
Location: Kronhjorten 1, 9530 Støvring
Year: 2010

The visit at Ådalscentret in Rebild municipality on Tuesday the 29th of January.
Ådalscentret has three housing units, with 10 dementia friendly apartments of 70m^2. A daycare center for the residents at Ådalscentret and citizens, who do not have a housing unit, but is affiliated with the nursing house and need care and support due to their health status. These citizens may be future residents waiting for an apartment.
Each apartment consists of a large living room/bedroom with a room divider in the middle, a small hallway with kitchen and a small dining area and their own toilet and shower facilities with washing machine and dryer.
Ådalscentret houses 30 full-time residents, a staff of 55 people and around 20 citizens associated with the daycare center. (Boligselskab, n.d.)
Ådalscentret houses a large number of different functions and is in its own way a small community with an office wing and housing units with their own common areas around an outdoor courtyard. The common areas consist of a kitchen area with dining facilities, TV area, staff toilet and storage room.

Ill. 9 Case studies - Ådalscentret toilet and bath

Ill. 10 Case studies - Ådalscentret common rooms

Ådalscentret also consists of a daycare center, with attached kitchen and meeting room. At the daycare center, a number of different activities are held, such as christmas lunch and bingo. There are also a number of visiting animals and babies associated with the center, which the residents can interact with. They also often have an evening of singing as a social event.
Ådalscentret has a good collaboration with the kindergarten on the other side of the road, their singalong events and small plays are performed in the daycare center.
The whole complex is interconnected and the residents are free to walk around and visit each other.
The nursing home is very technologically advanced, with push buttons to get out of the front entrance. Each housing unit is also equipped with a movement sensor that records if the resident is getting up during the night. This gives the staff a better chance to help the resident before they risk falling or are otherwise getting injured. There are also sensors on the external doors and in a wire around the entire area. This makes the staff aware when someone is leaving the area.



Ill. 11 Case studies - Østermarken floor plan sketch

Ill. 12 Case studies - Østermarken common rooms

Østermarken

Architect: n.a.
Location: Øst Blvd. 5, 9600 Aars
Year: 1971, Renovated 2004

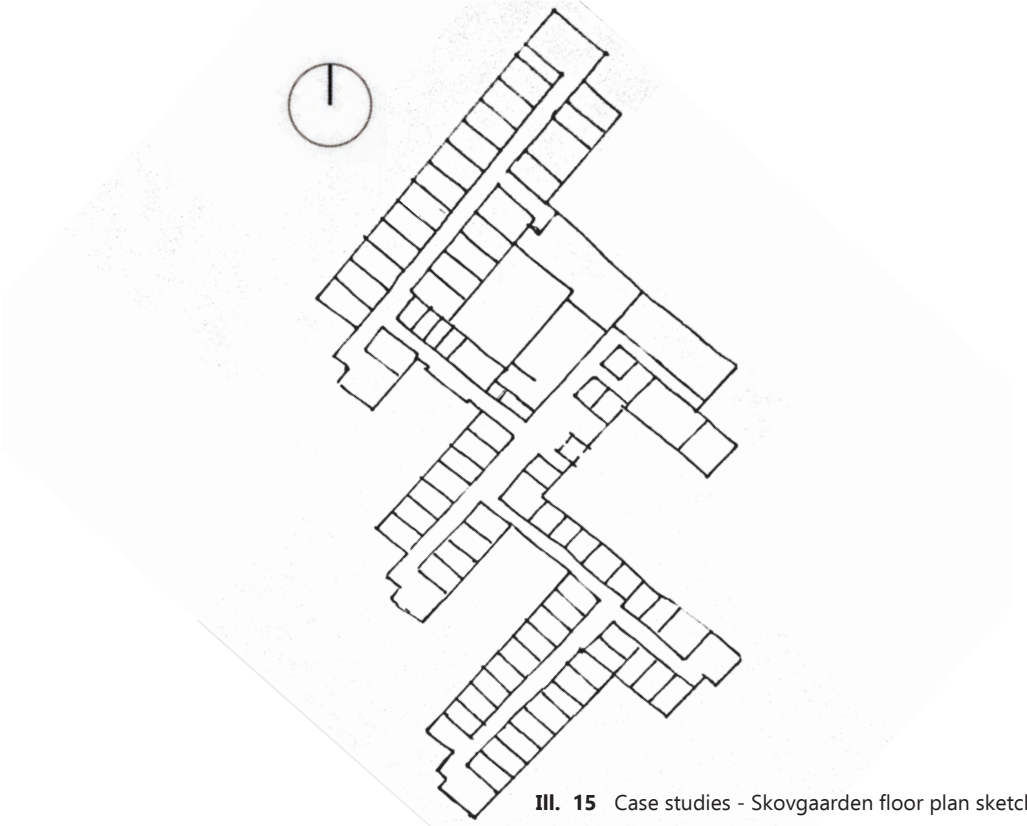
Care centre Østermarken were visited on Tuesday the 29th of January.
The care center has 69 residents and around 50 staff, divided into six housing units, with two houses for dementia people. (Vesthimmerland.dk, n.d.)
Østermarken is located in the eastern part of Aars, surrounded by a primary and a vocational school, enclosing the center with life and activity. The center houses both elderly with somatic diseases and dementia. This allows spouses to move in together, but into each of their department, giving the possibility of easily visiting each other.
The center does not have a large variety of functions in house, however, they have a large multi-room, where relatives and friends can visit to talk, play board games or knitting evenings can be held. Furthermore, there is a good collaboration with the surrounding schools, as the students either entertain, visit the elderly or take the residents for a walk.

Ill. 13 Case studies - Østermarken seating corridor

Ill. 14 Case studies - Østermarken common rooms

Music, singing, and dancing are popular among both the residents and the staff because everyone is happy- "..even the most grumpy puts on a smile" (Sæderup, 2019).

A large focus has been set for the outdoor areas, which consists of a small terrace in front of each apartment, which continues toward a larger garden. The garden have ramps and stairs, which enable the dementia people to train their walking skills. A lot of fiberglass animals are placed outside, as some of the residents have a close relationship to animals and thereby bringing animal life to the center. Large well-functioning kitchengardens are placed in the inner courtyard, which the residents benefit greatly from and use as an outdoor activity in the summer.



Ill. 15 Case studies - Skovgaarden floor plan sketch

Ill. 16 Case studies - Skovgaarden Treatment animals

Skovgaarden

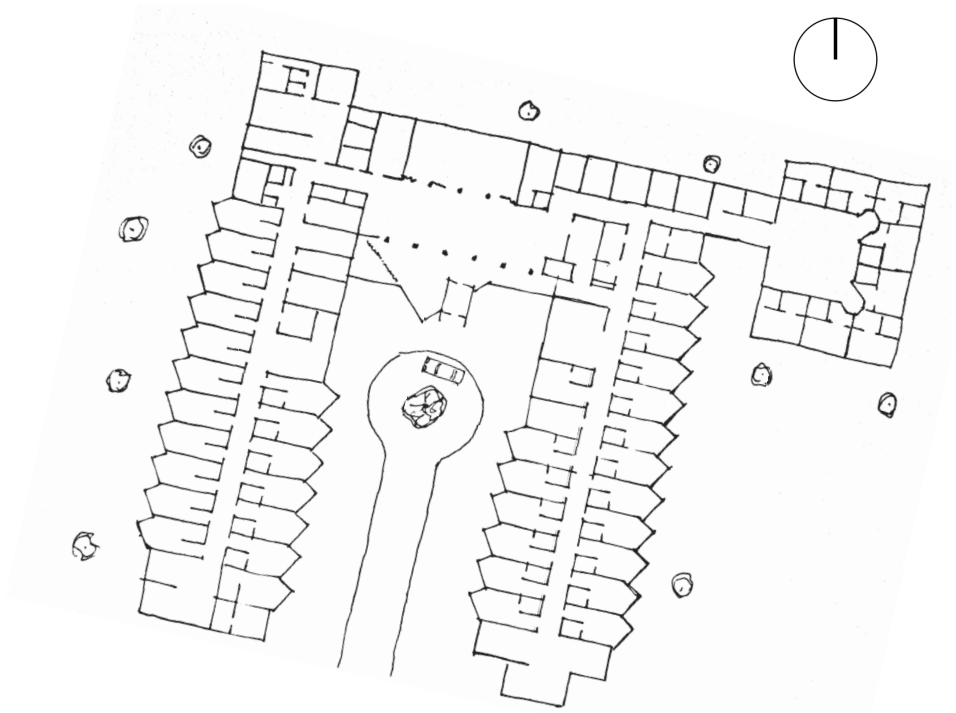
Architect: n.a.
Location: Timandsvej 25, 9560 Hadsund
Year: n.d.

Visit at Skovgaarden wednesday 30th of January.
The nursing home consists of 66 residents and 85 staff, divided into seven housing units (Mariagerfjord.dk, 2018). In our visit, we saw how the residents with dementia lived in their different housing units. The staff was good to emphasize what worked and what could be improved. Skovgaarden is located at the south-western part of Hadsund, with Linddalene north from the center. Linddalene is a middle-sized forest which is frequently used for walks and outdoor activities when the weather permits. Residential housing encircles the nursing home from west, south and to the east, enriching the area with life.
The main part of the center was designed as an elderly home but was later transformed into a dementia center. Even though the center is not perfectly designed for residents with dementia, the staff have made the best possible framework for them. A new housing unit, Under Bøgen, has later been built in continuation with the former center, with focus on residents with dementia.

Ill. 17 Case studies - Skovgaarden downtown / Shops

Ill. 18 Case studies - Skovgaarden common hallways

The visitors at the center are both relatives, friends and entertainers. Furthermore, elderly citizens and future residents are welcome at the daycare center and are actively invited to events. This makes them feel comfortable around the staff, the residents and the building's atmosphere. The daycare center Krogen, offers a variety of activities both for the residents and the visitors, such as painting, song and music, crafts, trips and so on. Skovgaarden provides a lot of in-house activities and functions for the residents to participate in and making the center feel like a small city. A hair salon in a dedicated room, where residents can make an appointment. A hairdresser from the city will come by once or twice a week. Another facility the residents are fond of, is the store in where they can buy smaller things, such as toothpaste, shampoo, yarn and other smaller items used in their everyday life.
The store gives the residents the feeling of buying the things they need themselves, instead of getting them delivered. A workshop and a sensory room are also available for the residents but under supervision of the staff. A newly formed bar area has been met positively by the residents, as they can enjoy a beer or a drink when the bar opens every tuesday. Larger events such as music/song, dance, and bingo are being held in the large common room near the entrance of the center.



Ill. 19 Case studies - Aabybro care center floor plan sketch

Ill. 20 Case studies - Aabybro care center entrance

Aabybro care center

Architect: n.a.
Location: Vestergade 30, 9440 Aabybro
Year: 1976, Renovated 2004-05

Visit at Aabybro care center on Tuesday the 5th of February.
The center is divided into five smaller housing units, each with a common kitchen-dining area and some of them with their own terrace. The housing unit consists of 8-10 apartments with their own cozy living room/bedroom, toilet/bath and a small hallway with a kitchenette. Furthermore, two of those apartments are slightly bigger, enabling spouses to move in together or residents to get a larger apartment for themselves. Aabybro care center has between 45-47 residents and 50 staff (Aabybro-plejehjem.dk, n.d.).

The center is formed like a horseshoe, with the opening toward the south, giving plenty of light to the apartments. The first room met in the center, is a large spacious common area, with several small niches in the outer edges of the room. Furthermore, the common area can be opened up, towards a large living room, providing an opportunity for both larger and smaller events.

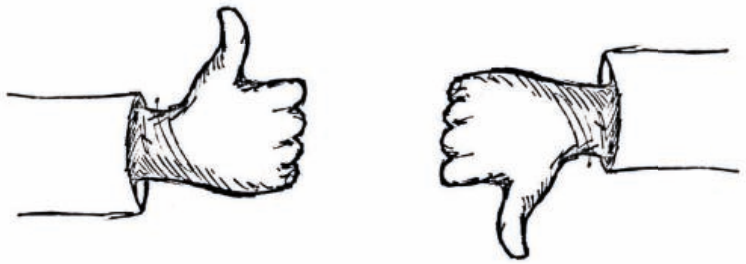
Ill. 21 Case studies - Aabybro care center common room

Ill. 22 Case studies - Aabybro care center entrance to residential

The large living room has a place for diversity, as there in one corner is room for lecture and service to be held and in the other corner a small bar. A sensory garden has been established in connection to the new dementia unit to the east, which allows for the stimulation of the senses and the cultivation of vegetables in the greenhouse.

The Aabybro care center has a great focus on green elements and quiet surroundings, which provides a safe environment for its residents. Furthermore, homeliness is a focal point of the center and is of great importance as it is the home of the residents and therefore it must be possible to make it as homely for the residents as possible.

The staff area is in the center of the top arch of the horseshoe, providing short and quick access to the housing units. The need for larger depots and documentation space is gradually reduced, due to technological solutions, such as the use of tablets that facilitate their workflow.



Ill. 23 Do´s and Dont´s

Do´s and Dont´s

Do´s

Storage space, in a well thought out size - some suppliers only sell in larger quantities.
Treatment animals of fiberglass or toy animals - can have a calming effect and create joy for the residents.
Soundproof housing units - some residents can be active at night and have a risk of waking the whole housing unit.
Room dividers in large common areas - the nursing home can host a wide variety of events, which governs the need for at flexible room size, to create a calm atmosphere.
Lifting crane in the ceiling, in the apartments with a link to the toilet- helps the resident and staff to reduces the risk of injury.
A place for seating in hallways - gives the elderly the opportunity to take a rest and thereby avoiding strain.
Workshop and hobby areas - many elderly people are skilled with their hands and this can bring great joy to the residents.
Virtual Reality (VR) room - provides the opportunity to go out into the world without leaving the center.
Common areas before exits - distract the door seeking residents from leaving the center.
“Hotel room”: a multi-room where staff or relatives can stay overnight.
Electronic rocking chairs can play music and cradle the residents - can be soothing and relaxing for the resident.

Dont´s

Location of artificial light - dark areas can be perceived as holes in the ground.
Direct view from the housing unit to the parking lot - can give the resident the feeling of being left behind.
Have easily openable patio doors - can give the resident the possibility to leave the nursing house and increase the possibility that they do harm to themselves.
Use hallways or common areas as the office for the staff- the new personal data-act makes it impossible to use these places legally for daily tasks with sensitive data.

(Case study Ådalscentret 2019)
(Case study Østermaken 2019)
(Case study Skovgaarden 2019)
(Case study Aabybro plejehjem 2019)

Ill. 24 Personas

Personas

When designing social sustainability in a dementia center, it is important to have the users in focus and include both the staff, the residents and the relatives. To integrate and represent the users behavior and perspective, there has been made six personas. A persona is a fictitious person, based on research and interviews, to get an insight in their desires, walking patterns, style, inadequacies and needs. The personas will be used to evaluate ideas and help in the decision making. Furthermore, the personas have mainly been based on qualitative data, such as interviews, ensuring an in-depth profile. The full profiles of the personas can be found in appendix 2 page 174.

Pros and cons

The usage of personas, is a way of converting facts, interviews and research into manageable information, making it easy for a team to navigate toward a common goal (Garcia, 2016). Furthermore, problems such as personal experience or opinions are easier avoided, as the focus is targeted on the users and involvement of those. The tendency of using personal opinions is when the persona becomes too fictionary and the representation of the wished user is unclear, leaving open gabs for the process to fall into. On the other hand, blinding oneself from possible possibilities and openness for creative ideas, when the goal becomes too structured and strict, therefore, a balance is needed when the personas are used.

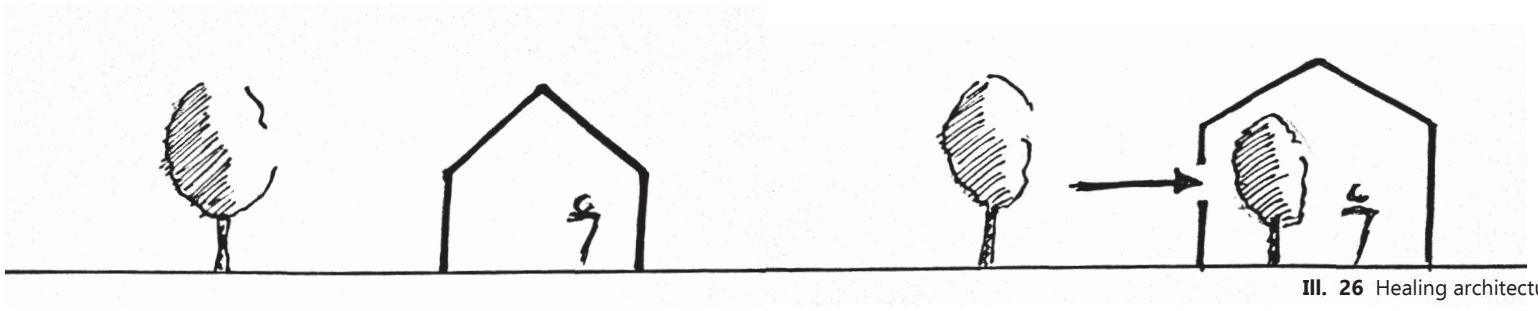
Ill. 25 Healing architecture 1

Healing architecture

In 1987, Roger Ulrich's discovered the healing power of nature (Olmsted, 2014). In Ulrich's study, he showed something as simple as having a view to shrubs and trees, instead of view to a wall, had a visible effect on the use of medication and discharge date (Ulrich, 1987).

A similar study conducted by the Department of Neuropsychiatric Science of the University of Milan. The effect of the morning sun was analyzed. The patients with an east-facing window had an average of 4 days fewer in the hospital than the patients with a west-facing window (Benedetti et al., 2001). Natural light is also of great importance for residents with dementia. Access to natural light can help the residents keep the daily rhythm, especially morning light has a positive influence on dementia residents, and sufficient daylight or treatment light can counteract depression, and lower the need for pain medication by 22% (Frandsen et al. al., 2009).

Healing architecture is a relatively new term and indicates that the building environment positively affects its users, both on health and mental well-being, by reducing stressors (Podbelski, 2017). Therefore it makes sense to use the concept healing architecture in the planning and designing of a dementia center, as the residents are weakened both mentally and physically. Furthermore, people with dementia tend to be easily overstimulated and can, therefore, benefit from environments that provide support and relieve discomfort.



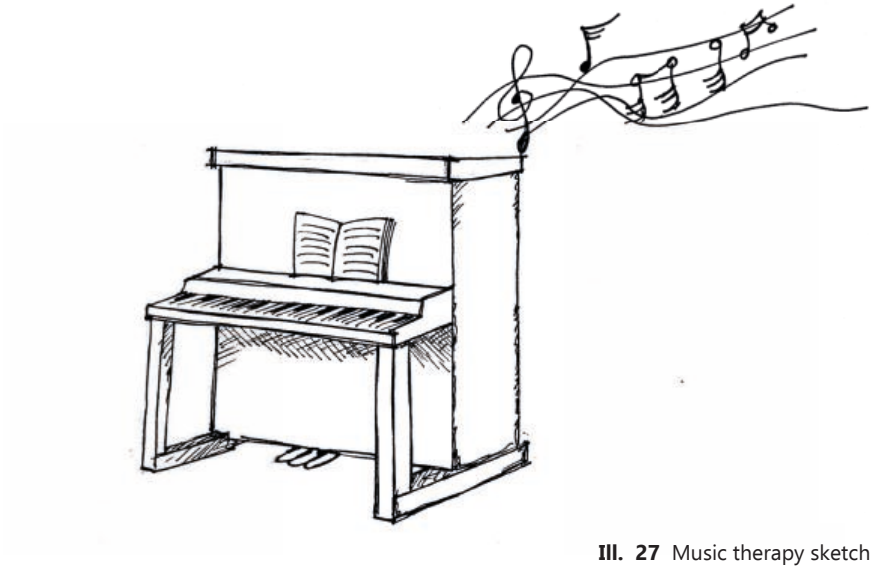
Ill. 26 Healing architecture 2

A number of strategies that can promote stress relief can be (Podbelski, 2017):

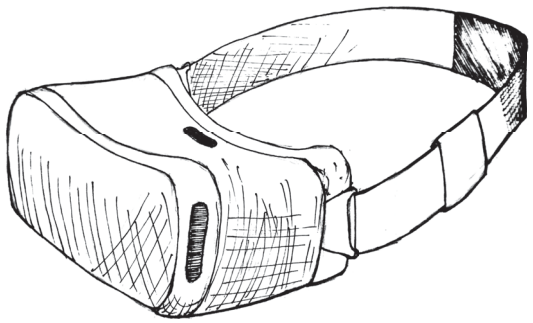
- Reduce or eliminate genes such as noise, poor air quality, glare and lack of privacy.
- Make a connection between the patients and nature, e.g. by having physically and visually access to nature.
- An increased opportunity to have control over one's own surroundings, such as being private or social and the light and sound level.
- Positive distractions that can lead the focus, e.g. in the form of a fireplace, art, or soothing music, lights or videos.
- Usage of colors to support emotions and feelings such as warmth, hope, reflection and so on.

Good air affects our well-being and personal comfort, therefore, a good atmospheric indoor climate is important when considering healing architecture. The use of scents such as orange can also have a soothing effect. It is recommended in healing architecture that hospitals use a well-dimmed ventilation system to reduce odor (Frandsen et al. al., 2009). The consequence of the inadequate ventilation system was also seen during the case studies referring to the nursing home skovgaarden.

Positive involvement of the outside space can have a calming and relaxing influence on the residents suffering from dementia (Frandsen et al., 2009). Living greenery can be supplemented with picture and videos of nature and in that extent, VR glasses and sensory rooms can be used as a supplement in the winter time. The outdoor gardens and green areas should be placed in such a way, that the residents and guests of the house, can use them actively in their daily life (Frandsen et al., 2009).



Ill. 27 Music therapy sketch



Ill. 28 Virtual reality glasses

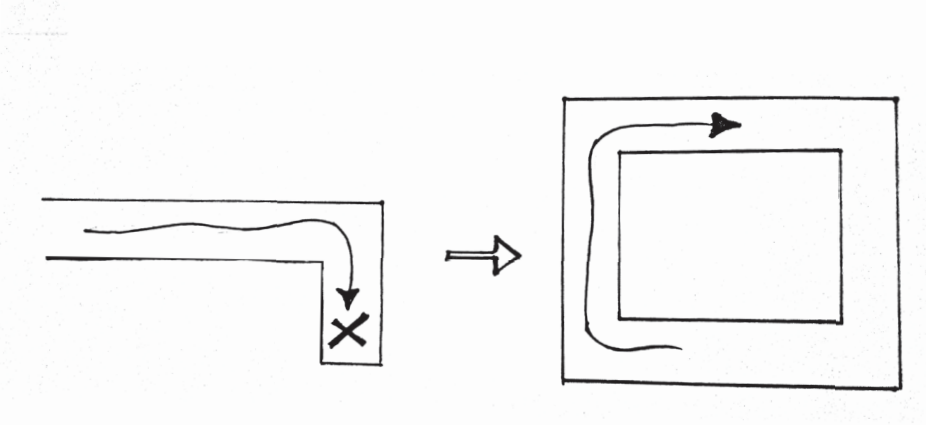
Sensory room and Stimuli's room

The preliminary investigations on the users, concluded that a variety of instruments can be used to give residents with reduced cognitive functionality, daily moments of high quality (Voigt Rasmussen, 2019). Instruments such as music therapy, VR glasses or sensory rooms can help the staff bring back the residents old memories and feelings and create moments of joy (Olenius, 2019).

A sensory room can be many things. It can be a room where the interior is from a specific time period that the resident know and can recreate feelings and experiences in. The room can also be equipped with big screens that can simulate windows towards an environment that resident knows. A sensory room can be used by more residents simultaneously and the experiences can be shared. Further clarification on sensory rooms can be seen in Appendix 3 page 186.

Virtual reality can give demented people a personal experience and can for example give them a possibility to see the ocean, a sunrise or have a walk through a forest. The experiences are independent of time and place and offer the resident the possibility of being outside the center and have experiences they would not have had the possibility to have otherwise. Further clarification of virtual reality can be seen in Appendix 3 page 186.

Music therapy can be used both individually and as a group. This can be used in different forms, such as listening to or playing music, as well as singing can help activate the brain and recreate old memories, see Appendix 3 186.



Ill. 29 Wayfinding

Wayfinding

One way to help residents in a dementia center is to have small and manageable housing groups, where it is easy to get an overview from the apartment door to the common areas. Here, the use of materials and room size can help increase architectural recognition and ther by make it easier for residents to navigate around (SBi, 2016).

Some residents will have the urge to wander and be door-seeking, which may be due to physical or mental disturbance. Reducing the number of places to make decisions and intuitively directing the resident in one direction can act as a stress relief. Placement of common areas, living room or kitchen at intersections can help the resident navigate and make the intersection a hallmark and there by help the resident find there way around the center (SBi, 2016).

Using colours in the form of different composition, contrasts and shades of colour, can help people with dementia to orientate themselves. This can help the residents of a dementia center to make them more independent. Placement of signage must also be used with the user in mind, e.g. the use of colours, numbers and large readable letters, supplemented with pictograms can reinforce wayfinding. However, these must be chosen with care, as they may appear abstract for the resident (Høeg, 2008, as cited in SBi, 2016). The location of this signage should be placed at a certain height so that it is clearly visible to the demented. People with alzheimer have a tendency to look down and therefore signs should be placed close to the door handle (SBi, 2016).
In order to clarify the individual dementia's apartment, it may be helpful to place personal objects in front of the apartment, as this may clarify that this is their home. These objects can be things with an affective value, such as paintings, photos or a piece of furniture (Marquardt, 2011; Høeg, 2008, as cited in SBi, 2016).

Legislation and guidelines

Legislation for a dementia center
In connection with this master thesis, it will be relevant to examine the legislation on the use of force against citizens with dementia in connection with the development of a dementia center. More specifically, this project will look at "Service loven" chapter 24 (Hørby, 2018) on the use of force.

Service lovens §124a states that a person with significant or permanently reduced mental function can be given a personal alarm and location systems unless the person with dementia do not want this. This can be used as a tool to increase the safety of the demented, as this alarm and location system can also be used as a calling device if the need for help should arise, Service loven § 125 stk. 2. Furthermore, the systems may also be implemented, for the sake of the people with dementia own or others' safety. A door lock and/or door alarm, which hinders door opener or require help with the opening of this, Service lovens § 125 stk. 3-4.

Guidelines for death
For many people with dementia, the dementia center is the last place they call home in life, therefore there are certain precautions for the decease, e. g. "obituary", "select and press hymn booklets", "fill in the go submit death report and other public documents". Furthermore, there are some practical tasks (Netdoktor.dk, 2014) that can be difficult in the situation. These can be assisted by a layman who can also coordinate appointments with a priest, church and possibly graves (Vigs, n.d.).

When resigned to a deceased resident, it is determined by the relatives, unless otherwise requested by the deceased, whether they should be sung out or carried out silently in the evening. Here, the residents at the center get the opportunity to participate in the singing or participate at a distance (Retningslinjer omkring dødsfald, 2013). Sometimes the furniture of the deceased stays at the center, by a donation from the relatives or if none of the relatives want these or any other agreements have been made (Olenius, 2019).

Sub conclusion: The user

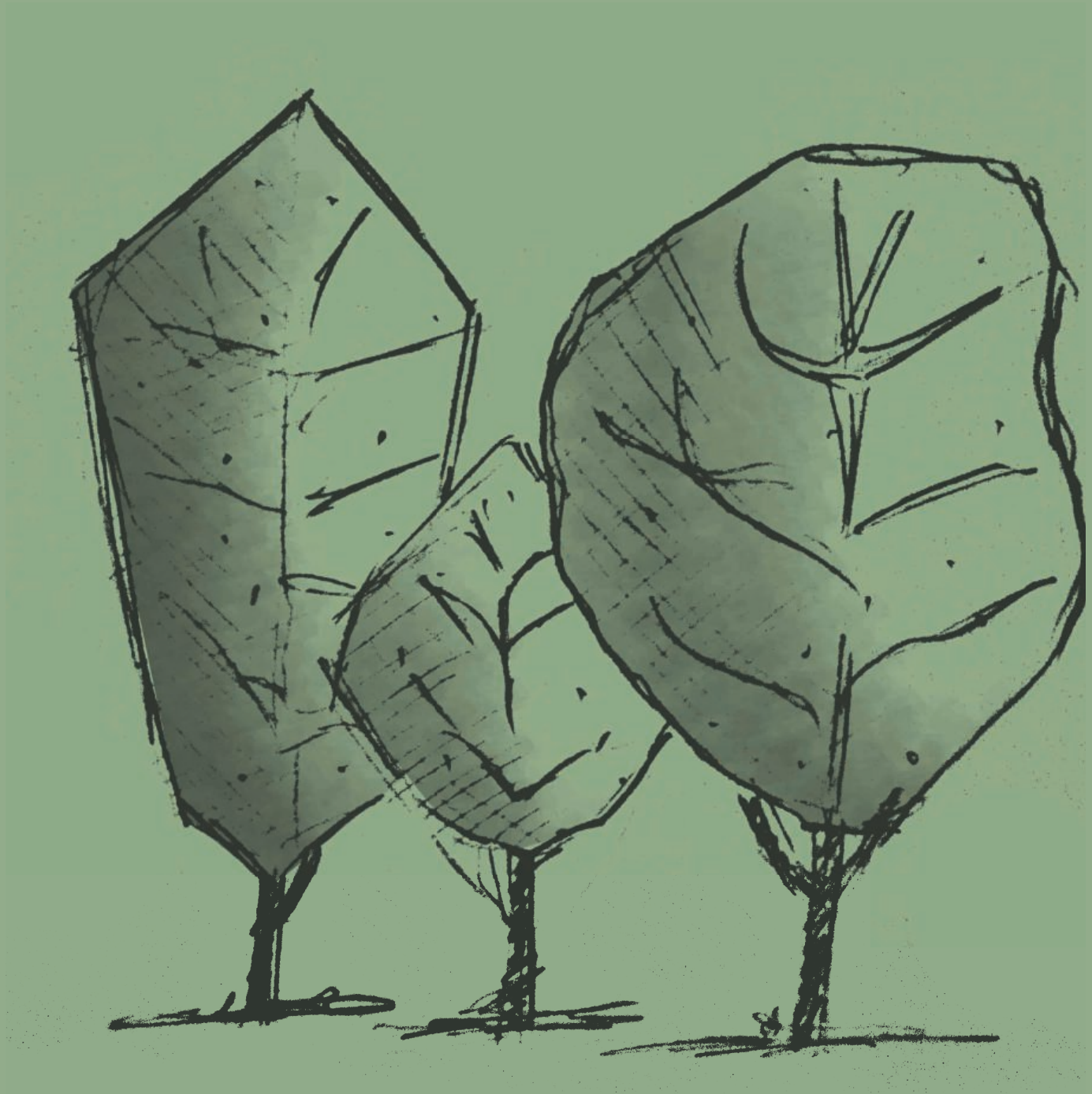
A series of laptop studies were made to get an initial understanding of the character of a nursing home. What the difference is between an elderly center and a nursing home and what characterizes a resident with dementia.
Articles and statistics gave the group an idea of the increasing need for dementia centers in Denmark, as well as their high functional and atmospheric requirements. This was the starting point for the subsequent field studies where a number of dementia centers were visited. Knowledge from the previous studies provided background knowledge to enter into a constructive dialogue with the staff and management at the selected dementia centers.

This dialogue, through interviews and questionnaires, provided a solid base for the preparation of six persona's. Furthermore, during the field studies, experiences were made, which made a number of do's and dont's for the further design process. Based on experience in field studies, further studies were conducted in healing architecture and how architecture can affect well-being and create quality of life for residents and staff.

Due to the residents being cognitively disabled and incurable, music therapy, sensory room and VR glasses are used as tools in an actively relieving effort. Furthermore, it is desired to activate the dementia center's outdoor areas. There should be room for an outdoor kitchengarden, which must be part of an activity for residents with green fingers.

Due to residents' disease, navigation can seem hard to the residents and be stress-promoting. Wayfinding is therefore a key word in the development of an upcoming plan, which must allow the residents free movement within the center's safe framework.
On the basis of the residents' cognitive state, there is a need to understand the Danish legislation on the use of force and monitoring to the extent necessary to secure residents against causing self-harm.
Since a dementia center is often the last residence for the residents, the legislation on deaths was also examined and emphasis is placed on the possibility that the residents and/or the relatives can decide whether the deceased must be sung out or carried out in silence during the night.

User group studies provided an understanding of the need in the upcoming dementia center. Based on this, a number of wishes were prepared for the upcoming project site, where nature is used as an active relief element and a need for easy access to the center for residents and users of the upcoming daycare center had to be pressent. This clarifies the need for a location with good infrastructure and access to the highway and possibly the Danish State railways. The location must not compromise on the natural surroundings, because it is the aim that these must help to alleviate pain treatment and create opportunities for outdoor activities in nature in the project.
During the user survey, it was also made clear how much stress is involved as a dangerous condition that can develop and promote dementia. Therefore, from the start it was a desire to locate the site in a natural quiet and peaceful place that can be enjoyed by the residents. Finally, it was wanted that the project site had a distance to the study town of Aalborg, so that ongoing investigations in the area could be made.

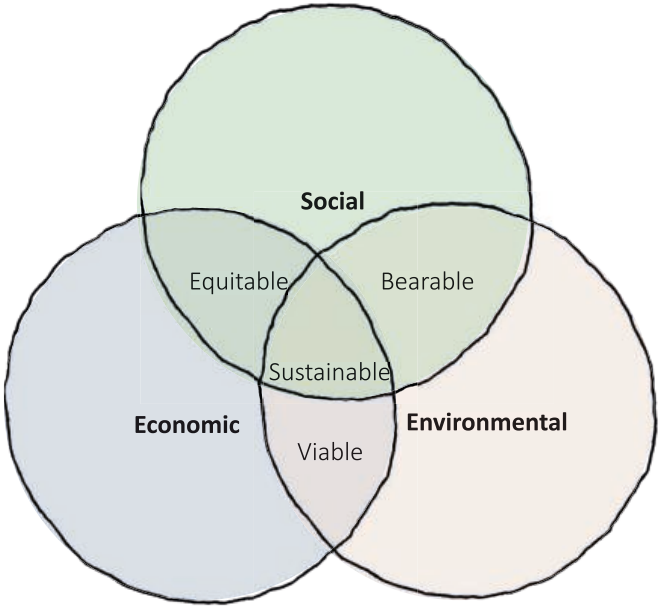


Research technical

Ill. 30 Sketch trees

Technical research prior to the project

Study within the technical aspects of the project has been developed to create an interdisciplinary understanding to ensure the continued unification of creative and professional technical knowledge.
On the following pages, various types of zero energy houses were investigated. Sustainable architecture is one of the fundamental elements of this study. For this project, various passive and active strategies were investigated in order to gain a understanding of the possibilities and the solutions that could be implemented. The project is subject to a number of legal requirements, which cannot be compromised, therefore legislation was examined and a focus was placed on the particularly vulnerable residents and the requirements that are related to this type of users.



Sustainable architecture

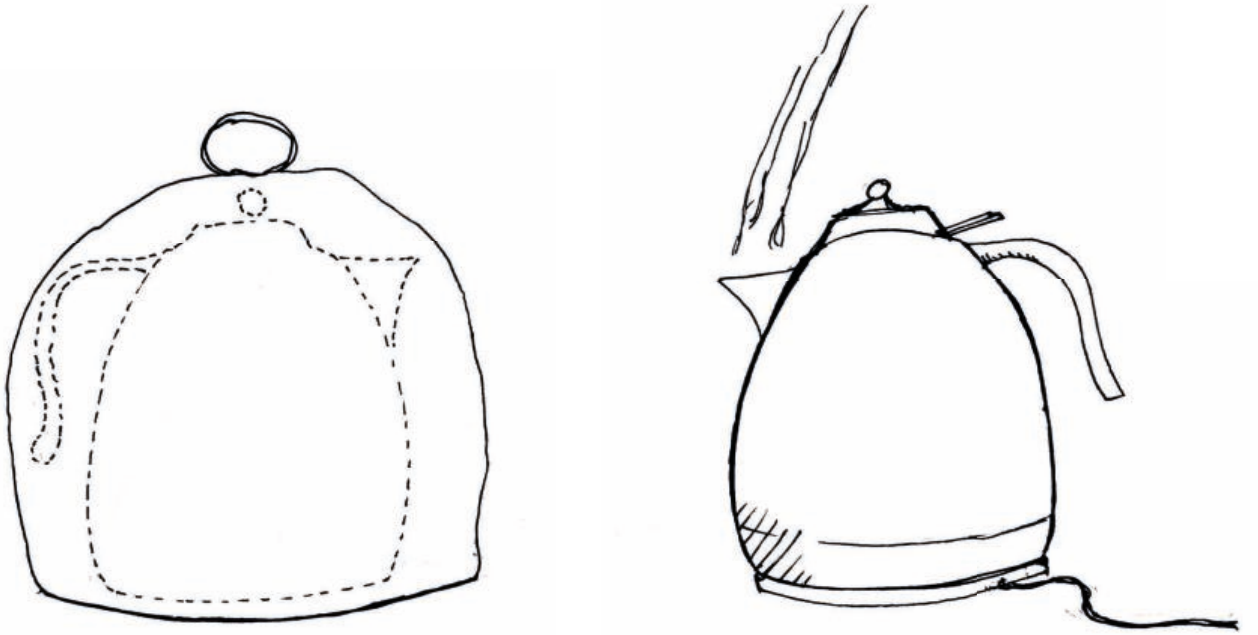
III. 31 Sustainable architecture (Circular Ecology, 2018)

Through many years of unsystematic use of resources, it is necessary in the future to utilize sustainable methods, especially in the construction industry which accounts for approximately. 40% of energy consumption (Pourdehqan et al., 2015). To design sustainable architecture, this requires an understanding of what it is and what elements it consists of. When sustainability is to be implemented in architecture, it can be divided into three categories: environment, economy and social sustainability, which must be balanced equally. (Circular Ecology, 2018)

Environmental sustainability takes into account the use of materials, and therefore the choice of material and the amount. Other considerations such as the treatment of the material and how it is produced, as well as the energy used to transport them, can be of great importance when selecting a material (Pourdehqan et al., 2015; Circular Ecology, 2018).

Economic sustainability requires countries and businesses to use its resources efficiently and responsibly. Here, it is considered what effect the choice of materials can have financially in the short and long term, looking at maintenance and replacement cost over a buildings lifetime (Circular Ecology, 2018).

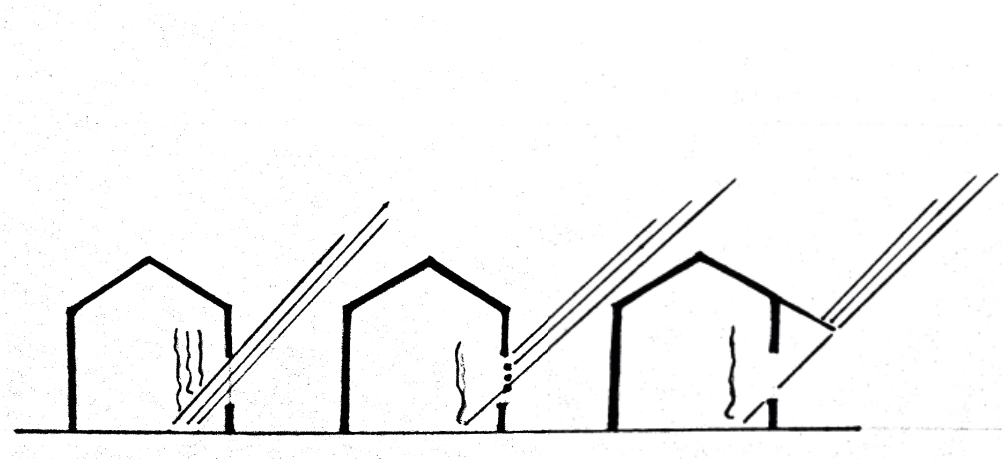
Social sustainability wants to preserve and maintain tools that contribute to the prosperity and well-being of social participation. Different user groups and how they will develop in the long term must be taken into account (Pourdehqan et al., 2015).



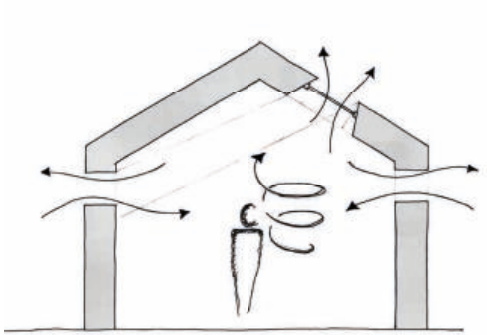
Ill. 32 Passive and active strategies

Passive initiatives and active strategies

As part of Denmark's international climate commitments and national objectives (Energistyrelsen, n.d.), this project will follow suit and seek energy-efficient solutions. The target for the energy framework will follow the current 2018 requirements, which is 30 kWh/m^2 per year for housing (Bygningsreglementet.dk, 2018g). In order to achieve low-energy construction, passive strategies must be integrated. By integrating passive strategies, effective solutions can be created that prevent emerging issues. An example may be in the form of large window sections, which provide plenty of daylight, but at the same time can cause overheating. This can be avoided by using shade elements or shielding for the windows.
Subsequently, possible active solutions must be looked at. These provide renewable energy on the site and reduce the energy needed from the grid. Four active strategies can be implemented; heat pumps, photovoltaics(PV), thermal collectors and windmills. Each of these active strategies have different levels of efficiency (Knudstrup et al., 2014).



Ill. 33 Passive initiatives Shade elements



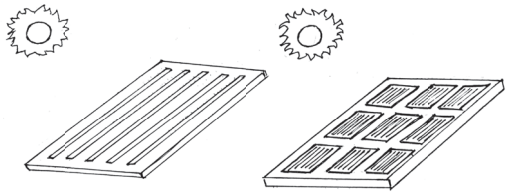
Ill. 34 Passive initiatives 2 Natural Ventilation

Passive initiatives

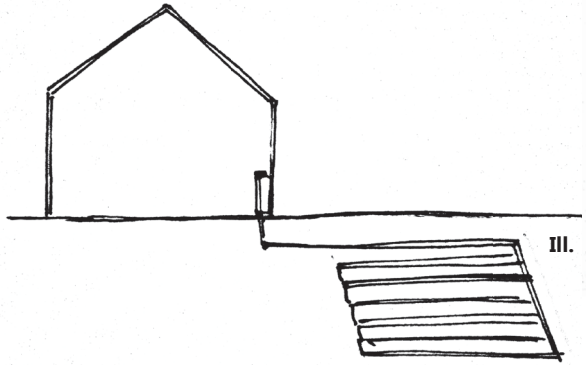
The following passive strategies can be implemented.
For new buildings, **the form** must first and foremost be looked at. A compact building has its advantage of a better hold on to the heat, as the area of the climate screen is smaller and the heat loss is minimal. A disadvantage of making a compact building is by not taking sufficiently regards for overheating (Persson, et al., 2006). Another way to reduce heat loss and thereby save the amount of energy needed for heating is by increasing the amount of insulation in the **building envelope.** In addition to increasing the amount of insulation, usage can be made of heavy materials/construction, which have a high thermal mass and thus can be used as energy storage. A high thermal mass helps to even out the temperature and reduces the energy demand for heating and cooling during the day (SBi anv. 213, as cited in Knudstrup et al., 2014).

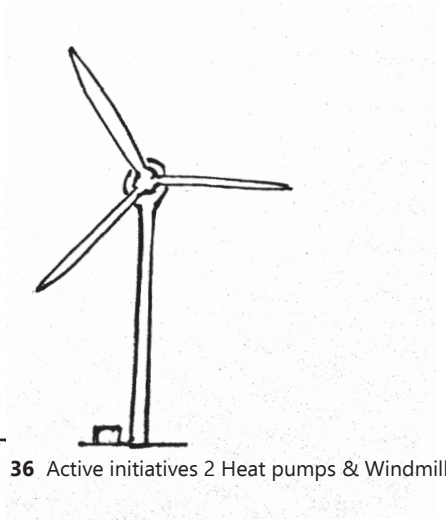
When the interior spaces are designed, it is important to incorporate the use of **natural light**, as it both helps to form a spatial experience and provide passive heating during the day. With good utilization of the natural light and passive solar heat, energy can be saved in the form of artificial lighting and heating in the rooms. Here, one can consider, for example, strategies for the window, such as orientation, location, size, reflection and view, depending on what experience is desired in the room (Knudstrup et al., 2014). To supplement the use of natural light, it is an advantage to integrate **shade elements**, both on the inside and outside of the building. Depending on its location, inside and/or outside, has different effects and expressions. For example, interior shading can reduce solar heat by 10 to 20%, where outdoor shade can reduce solar heat by up to 70 to 90% (SBi anv. 202, as cited in Knudstrup et al., 2014). In addition to integrated shade, the surroundings must also be considered, as, among other things, deciduous trees have their advantages. In the summer they shade with their crown of leaves and vice versa in winter, where the branch stands bare and lets the sun pass through.

Energy can also be saved, by using **natural ventilation**. Natural ventilation can be achieved through various strategies, such as single-sided, crossflow and stack ventilation, each of which has its own advantages and disadvantages. Natural ventilation also allows the users to control when they feel ventilation is needed (Heiselberg 2007, as cited in Knudstrup et al., 2014).



Ill. 35 Active initiatives 1 PV & STC





Ill. 36 Active initiatives 2 Heat pumps & Windmill

Active strategies

Active strategies are the next step in the process, to reduce the amount of energy supplied. Here, use can be made of different types of **heat pumps, solar photovoltaics(PV), thermal collectors** and **windmills**, where for each of these are different levels of efficiency (Knudstrup et al., 2014).

Heat pumps are an efficient unit and are popular for single-family homes, as 1 kWh of electricity can be converted into 3 kWh of useful heat and thus reduce the heating requirement (Knudstrup et al., 2014). Different types of heat pumps are ground source based and air/water based . Ground source heat pumps are expensive to install and require a lot of space but have high efficiency and with good planning; the price can be reduced if it is included, in connection with an excavation of the construction. The air/water heat pump has low efficiency, but on the other hand, it does not require much space and can easily be installed after the building is built. A disadvantage of the air/water heat pump is that it must use energy for defrosting in winter (Pavlov and Olesen, 2014).

Another solution is thermal collectors, which money and energy can be saved on hot water and utility heat. Here it is possible to integrate them at the roof or facade, or place them on the ground, but where the most optimal will be as high as possible, to avoid shadows (Dyck-Madsen & Bøndergaard, 2012, as cited in Knudstrup et al. ., 2014).

PV has become a more popular way of producing renewable electricity in Denmark. photovoltaics work almost like thermal collectors and operate best without being overshadowed as efficiency will drop and aesthetic works best if they are integrated into the building. There are three different types of photovoltaic, where the price follows efficiency and not necessarily the aesthetics (Dyck-Madsen & Bøndergaard, 2012, cited in Knudstrup et al., 2014). Monocrystalline, which is the most expensive but, has the highest efficiency. Polycrystalline, with a medium price and efficiency. And thin films, which there are several different types of, which have the worst efficiency, but require fewer resources to manufacture, are cheapest and where some types are flexible (Katic, 2007).

Building regulations

The building regulations are examined for provisions that must be considered in connection with the project. Bolow is a selected number of provisions, which are expected to be most relevant for the project.

(2) Access conditions / § 48 - § 62 (Bygningsreglementet.dk, 2018a)
§ 49 - There must be easy access from the road, to buildings, living areas, and parking areas, without the need for additional aids.
§ 52 - The free passage width in the outer door must be at least 0,77 m.
§ 55 - The users of the building must be able to move around freely on their own.
§ 56, part 1-6 - There must be direct and unobstructed access to residential units, common areas and other functions in the building. There must be sufficient width in relation to the entrance, where the smallest free width must be 1,3 m. For doors, mouldings must not be higher than 2,5 cm and have a free passage width of at least 0,77 m.

(5) Fire / § 82 - § 158 (Bygningsreglementet.dk, 2018b)
§ 85 - From table 1, for the determination of user categories, it is determined that the dementia center is in a category 6 and must, therefore, comply with provisions associated with this category.
§ 96, subs. 1 part 3-4 - In the case of larger living rooms and sleeping places, escape route and panic lighting must be installed for exits, both in the living room, hallways and rooms that can lead to exits.
§ 98 - Rescue openings must be designed and dimensioned so that people can easily escape. These escape routes must be able to be used without the need for keys or special equipment.

(18) Light and view /§ 377- § 384 (Bygningsreglementet.dk, 2018c)
§ 379, subs. 1-2 - Living and working rooms must have sufficient daylight. This can be documented when the glass area without shading, is at least 10% of the floor area or proven daylight of 300 lux at half the relevant floor area. In working areas, the relevant area is considered where the job is located.

(19) Thermal indoor climate and installations for heating and cooling systems /§ 385 - § 392 (Bygningsreglementet.dk, 2018d)
§ 385-386 - The thermal indoor climate in buildings must be health and comfort satisfactory.

(22) Ventilation / § 420 - § 452 (Bygningsreglementet.dk, 2018e)
§ 420 - Air quality and moisture conditions must be satisfactory and must be dimensioned according to the use of the room.
§ 421, part 1-3 - Ventilation systems must be dimensioned in accordance with DS 447, 428 and 452.

Guidance for housing groups at a dementia center

The living conditions of the elderly with dementia require special conditions. It must be homely and functionally for the residents and an everyday life for the staff must be able to function smoothly. Therefore, there have been investigated the details, examples and requirements that should be considered in the planning and design of a dementia center.

The common areas in residential areas should include facilities that can provide the framework for a daily life that can allow for social interactions between residents. The common living and dining rooms must be a supplement to the private homes, since not all people with dementia have just as easy to handle social communities (van Liempd et al., 2010, as cited in SBi, 2016). Research and experience, shows an appropriate numbers of residents are between 6-8 in each housing group, to lower noise levels, fewer stimulations and conflicts (SBi, 2016). At the end of the housing group, the exit should be invisible or less appealing. For doors to apartments, the doors should appear clear and in contrast to the wall, so that it can be clearly seen it is an entrance (SBi, 2016).

By walkways there should be view to the outside, as it may make it easier for people with dementia to navigate. Walking areas should be short and with small niches and sitting groups. To help the demented people navigate around, coating of floors, plants and art can be used as markers and thus used as a navigation element. Furthermore floors should be light, plain and matte materials, to avoid glare or illusion of water on the floor. (SBi, 2016).

The kitchen in the common room must be designed to the extent it needs to be used. If the kitchen is arranged as kitchen-dining room, there must be separation between the kitchen and dining area, either in the form of a table or half wall. In connection with the kitchen, there must be storage space for warehouse items, kitchen utensils, trolleys, etc., so that they do not occupy space in the kitchen. Scents and sounds from the kitchen can stimulate appetite in some and by others it may be too intense sense influencing, and thereby create unrest and inappropriate behavior. For dining places, research has shown that more well-being is created if there are smaller seating tables where the residents with dementia can sit for themselves or in smaller groups (SBi, 2016). Outdoor areas associated with the indoor areas, need to be in direct level transition (SBi, 2016).
The toilet in private apartments must be able to be used by resident with dementia with rollator or wheelchair, with the possibility of staff assistance (SBi, 2016). A private residential should be planned as a large room, with the possibility of division. There must be sufficient space, with the possibility of different furniture arrangement and with room for personal belongings, so that the residence can feel homely. The bedroom / sleeping area should be planned with the option of rotating and moving the bed around. The apartment should also be planned with a maneuvering area of 2.1 x 2.1 meters at important places. In addition the residential must be homely, it must also serve as a good and safe working environment for staff (SBi, 2016).
From the private apartments and common areas, it must be possible to have a view to the outside in a standing, sitting and lying position. It must be possible to shield for direct sunlight, as it can create sharp shadows, and avoid glare and overheating. The light must be adequate and well-placed, for equally distributed light.(SBi, 2016).

Walls should appear calm, without reflections and strong colors, as this can cause confusion. Soundproofing between private houses should be good, and if the heavy construction is chosen, it must be ensured that the suspension of the images does not become a nuisance to the neighbor (SBi, 2016).

Ill. 38 The five building energies

Net Zero Energy Building

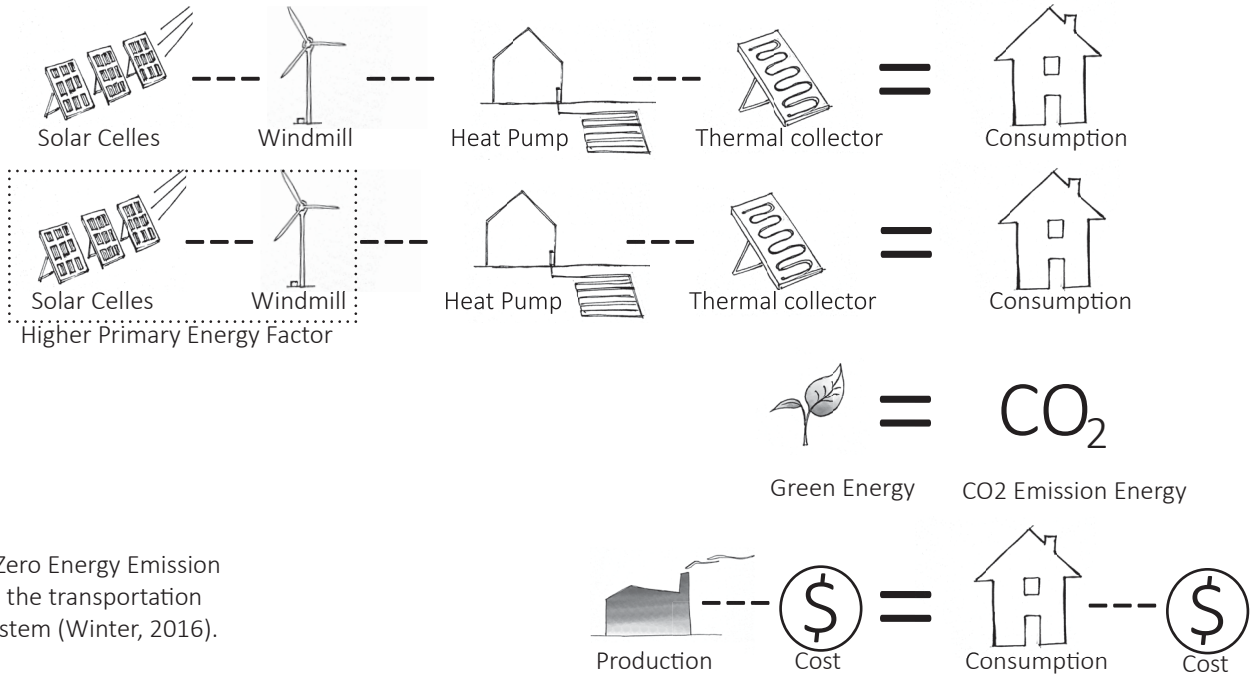
An increasing demands in the construction sector, has created a focus on more energy-efficient buildings. Among these are the concept of Net Zero Energy Buildings (NZEB), which in addition to low energy consumption, produces its annual energy consumption in the form of electricity, heating and cooling on the site (Winter, 2016; Goodier, 2019). When assessing the energy balance in a building, it is often seen; heating, cooling, ventilation, hot water and lighting, as the most dominant energy needs (Working definition of NetZEB approach, nd.).
Four definitions of Net Zero Energy are assessed (winter, 2016).

Net Zero Site Energy
For every energy unit consumed annually, it must also generate this energy unit on site (winter, 2016).

Net Zero Source Energy
In addition to covering the annual energy consumption spent on the site, energy produced must also cover the transport and lost energy in the energy system (winter, 2016).

Net Zero Energy Costs
The annual bill for energy consumption must be zero (winter, 2016).

Net Zero Energy Emissions
As many energy sources emit pollutants, Net Zero Energy Emission uses only emissions-free energy. It also covers the transportation of this energy, both to and from the energy system (Winter, 2016).



Ill. 37 (NZEB 1)

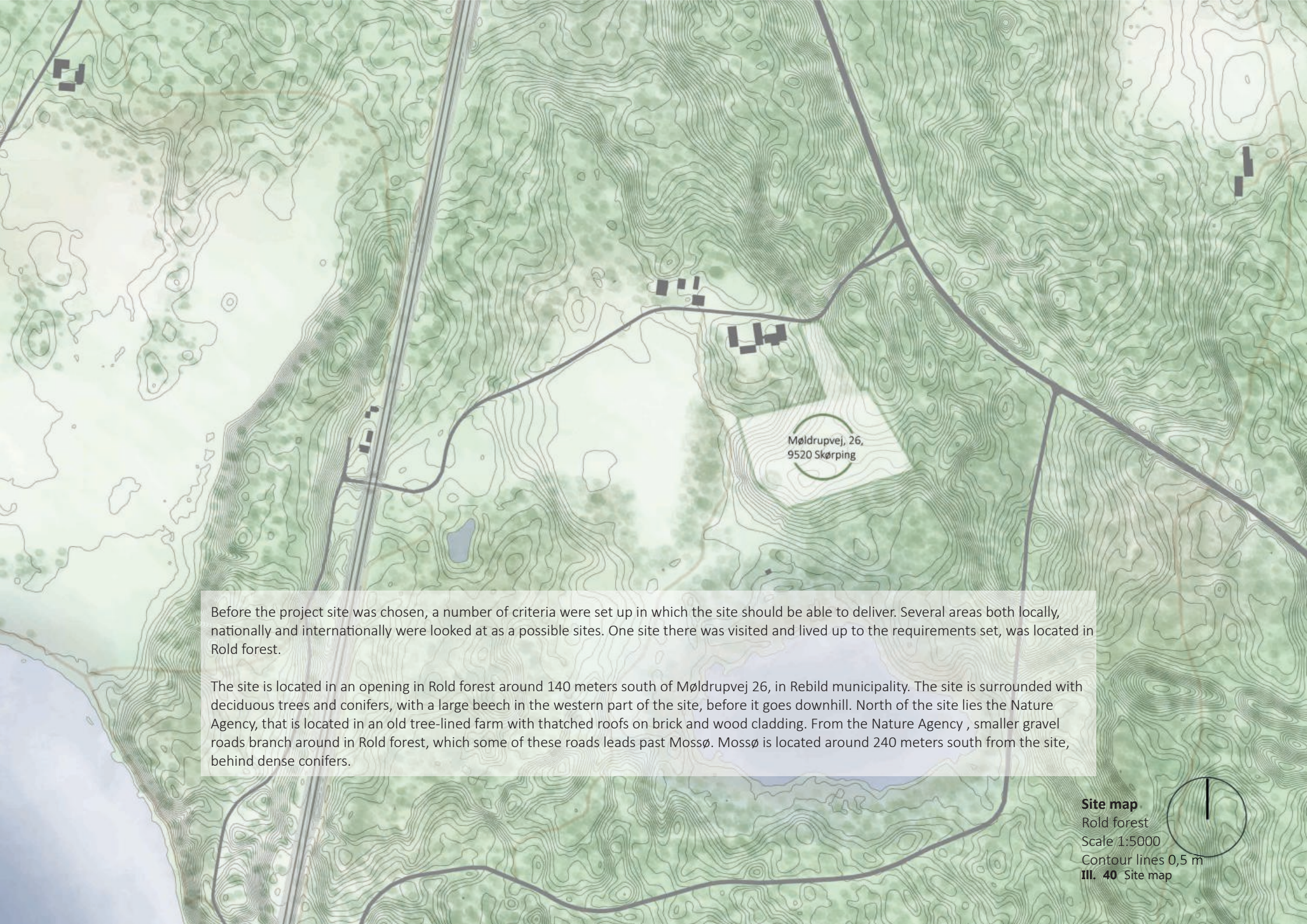
Sub-conclusion: Research

The residents are the primary focus of the project and the technical design of the physical framework is important for the project's success and a functional building for the center's residents. The technical framework for the project also contributes to giving the project a direction since integrated design is the cornerstone of the project. Sustainable architecture has been the main focus during the entire A&D education. A sustainable focus for the upcoming dementia center is of importance, due to its location in a highly protected nature area.

Based on sustainable architecture, a focus is also placed on passive and active solutions. The passive strategies will be supplemented with one or more active solutions to ensure Net Zero Site energy consumption.
The upcoming dementia center must meet the requirements of the 2018 building regulations and as far as possible, aim at the 2020 goals. In the end, SBi is used to ensure a focus on the user and the recommended guidelines that ensure a well-functioning building.
It is important that the development of the physical framework and the indoor climate are done with the user in mind and the technical choices are taken from this vision.

Site introduction

Ill. 39 Site introduction



Before the project site was chosen, a number of criteria were set up in which the site should be able to deliver. Several areas both locally, nationally and internationally were looked at as a possible sites. One site there was visited and lived up to the requirements set, was located in Rold forest.

The site is located in an opening in Rold forest around 140 meters south of Møldrupvej 26, in Rebild municipality. The site is surrounded with deciduous trees and conifers, with a large beech in the western part of the site, before it goes downhill. North of the site lies the Nature Agency, that is located in an old tree-lined farm with thatched roofs on brick and wood cladding. From the Nature Agency , smaller gravel roads branch around in Rold forest, which some of these roads leads past Mossø. Mossø is located around 240 meters south from the site, behind dense conifers.

Site map
Rold forest
Scale 1:5000
Contour lines 0,5 m
Ill. 40 Site map

Ill. 41 Road leading to site

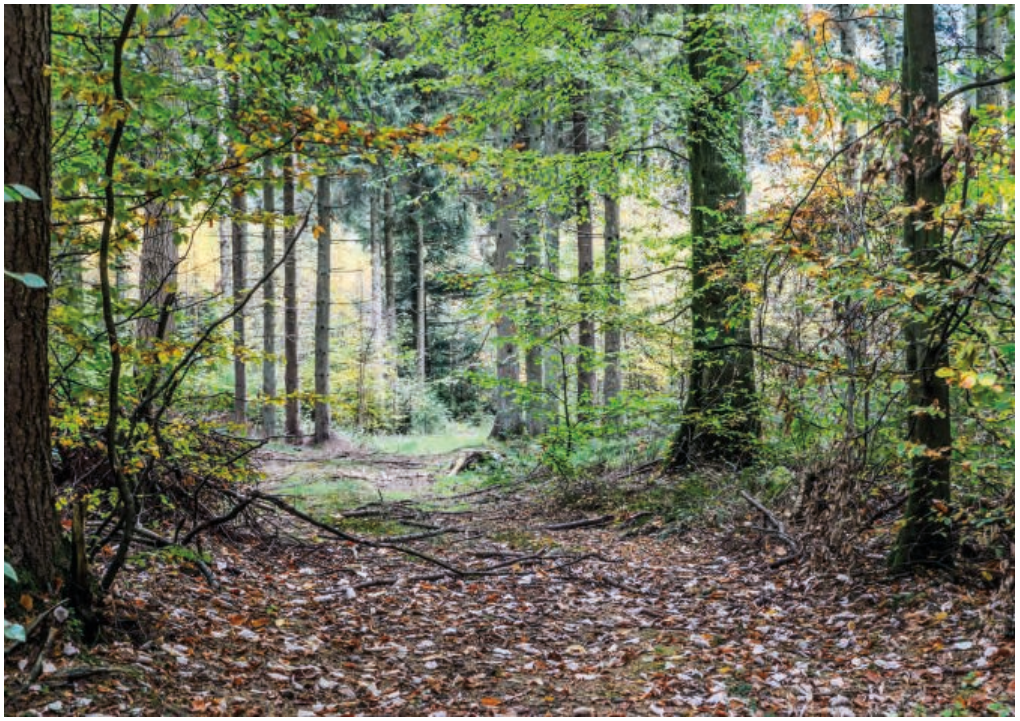
Ill. 42 Site summer north

Ill. 43 Site summer north/east corner

Ill. 44 Site summer south/west corner

Ill. 45 Landmark - Old oak tree summer

Ill. 46 Landmark - Old oak tree winter



Ill. 47 Rold forest 1

Ill. 48 Rold forest 2

History of the site

The site is located at Møldrupvej, 26, 9520 Skørping, in Rold forest. It is only 3 km from the train station in Skørping and is located near some of Denmark's most beautiful nature but still close to public transportation.
130 meters north of the site is the Nature Agency's buildings, which manage approximately. 200.000 acres nature areas in Denmark. With its 700 employees, distributed over Denmark this makes the Nature Agency a national unit, while also having a local presence, as a department under the Ministry of Environment and Food (Denstoredanske.dk, 2019)
550 meters to the west of the site is the railway line that connects Aalborg with Aarhus. It is in a distance with visual contact, but only with minor sound pollution. The site in Rold forest, which in the past has been considered to be the largest forest i denmark with its 80 km^2 in 2004. 25% of the forest is state-owned and 75% of the forest is privately owned. (Roldskov.info, n.d.). The terrain around the site consists of moraine hills, where the highest is between 60 and 113 meters above sea level and carries the imprint of the ice that covered the landscape over 18.000 years ago when reindeer and mammoths lived in the area (Naturstyrelsen.dk, 2019).
Rold forest is rich in nature, and the lime-rich soil has created great biodiversity and has led to the area in 1998 was appointed an international nature conservation area (natura 2000- handleplan, 2017). In the woods, one can find several water sources and experience red deer (Naturturist. com, 2018).

Ill. 49 Rold forest 3

Ill. 50 Rold forest 4

In the Viking age and the former Middle Ages (750-1100), a creative form of forestry among the farmers created a tradition of using vanris, (Vanris is a phenomenon only seen in beech in North Jutland). Together with the cattle that lived in the area, it created a large number of very crooked beech trees, which could be used for firewood. In 1805 when the protection law was introduced, these trees were allowed to grow, which to this day can be experienced everywhere in Rold forest, as the very crooked trees have formed a "magic forest"(Naturstyrelsen.dk, 2019).

Rold forest has always been associated with fear and unhappiness. The dense forest has been the scene for a long and bloody tradition of poachers, and violent robberies (Naturstyrelsen.dk, 2019).

To get a better understanding of Rold forest an analysis, into Rebild municipality plan and vision was launched, to understand the guidelines and plans for the area. Rebild municipality has a focus on protecting the nature and using it as a quality. More informations about Rebild municipality plan for the site is in Appendix 4 page 187 Rebild municipality plan and vision.

Ill. 51 Møldrupvej 30, 9520 Skørping

Ill. 52 Møldrupvej 28, 9520 Skørping

Ill. 53 Møldrupvej 26, 9520 Skørping

Ill. 54 Møldrupvej 26, 9520 Skørping

Types of buildings in the area

To get a better understanding of the building style near the site, the existing building styles and heights were investigated. The different styles of buildings can be seen in ill. 51 – 56. in the area a building has an average height of 5 meters and there are also a number of 3-length farms around the site, which tells about an old agricultural area.

Ill. 55 Møldrupvej 26, 9520 Skørping

Ill. 56 Jamborettepladsen, 9520 Skørping

Ill. 57 Project site, 9520 Skørping

The map above Ill. 57 shows the buildings around site, their character and their placement in the area compared to the site at the project. by taking a closer look at the buildings it is shown, that they primarily are made of wood and bricks.

Site analysis

In order to gain an understanding of the project area, a number of analysis and studies were carried out at the start of the process. Initially, the surroundings were examined and the distance to areas around the site was mapped.
The microclimate was defined and investigated, and wind and sun scape was made. From the beginning, the infrastructure had been in focus, both the surrounding road network, highways and the train station in Skørping. The infrastructure on the site and in the forest was also of great importance for optimal utilization of the area's qualities for the residents.

The site is located in the forest, but the forest is more than just trees. In some areas, the trees create dark and closed areas, while in others it creates open and inviting spaces. This gives the possibility for long views into the forest and to Mossø, in the winter month. The forest also acts as a green noise barrier against the roads and its traffic. The many possibilities the forest around the site brings was the reason why it was chosen and analyzed. To get a phenomenological understanding of the area and why this particular area could create quality for the future users', an analysis was made. Using the Gordon Cullen's Serial vision and the spirit of the place (Genius Loci) was investigated with a a Strengthen, Weaknesses, opportunities, and Threats (SWOT) analysis.

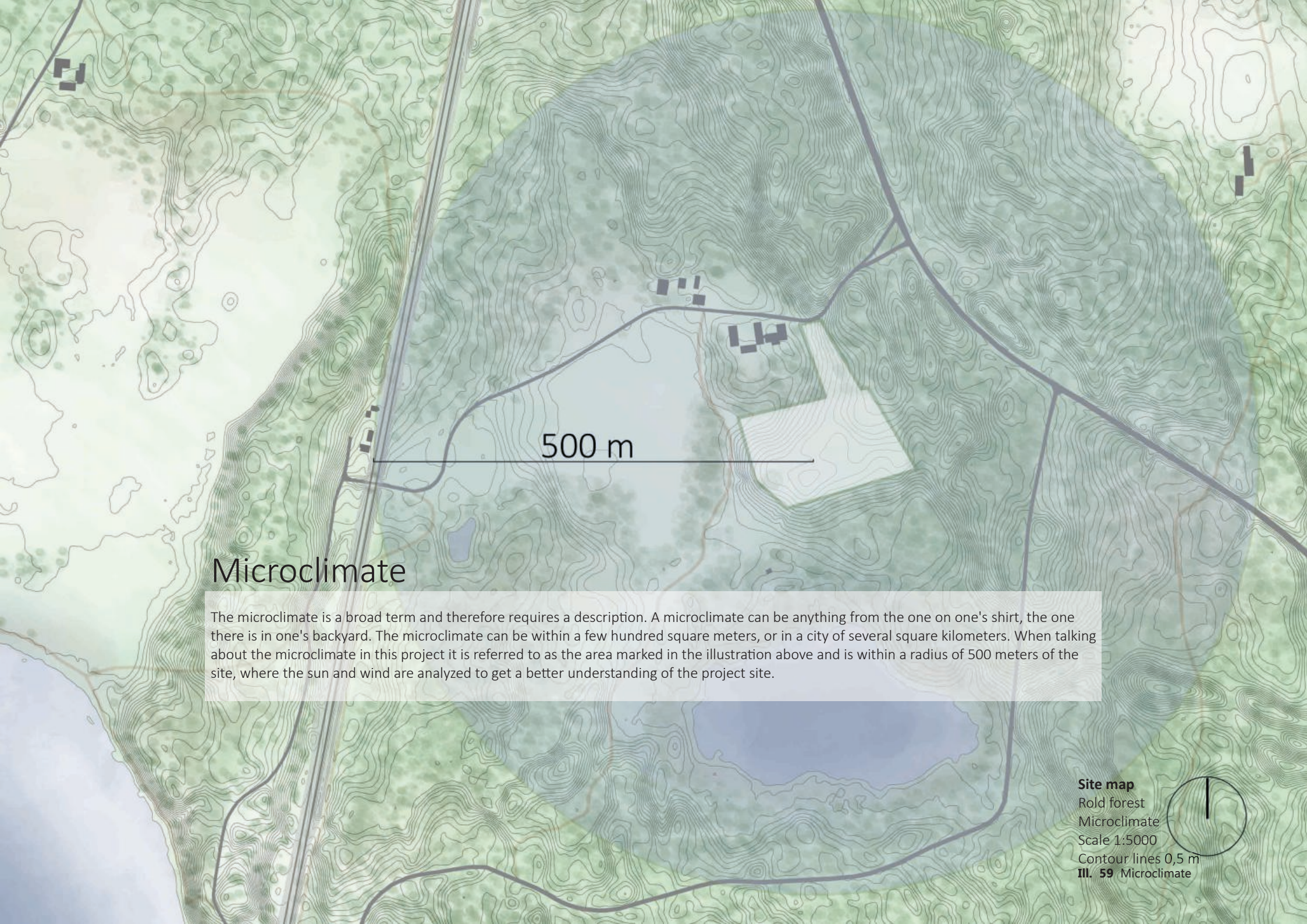
The site's unique atmosphere was explored from the German philosopher and phenomenologist Gernot Böhme's principles of the sensation of the atmosphere. The atmosphere of the site was experienced over a day, which presented a new understanding of the area in the evening, night and morning. As the chosen area is located in a state forest, an interview with the local forest manager was made, to get a clear understanding of the meaning of this classification. The interview gave a different understanding of the users of the forest and its situation. Finally, the materials in the area were examined and an initial material study was conducted.

Construction size

The site is located in Rebild municipality south of the Nature Agency in Rold forest and is around 20.000 m². The size of the building is planned to be around 7.000 m², with a nearby parking space of 1.500 m².

Site map
Rold forest
Construction size
Scale 1:5000
Contour lines 0,5 m

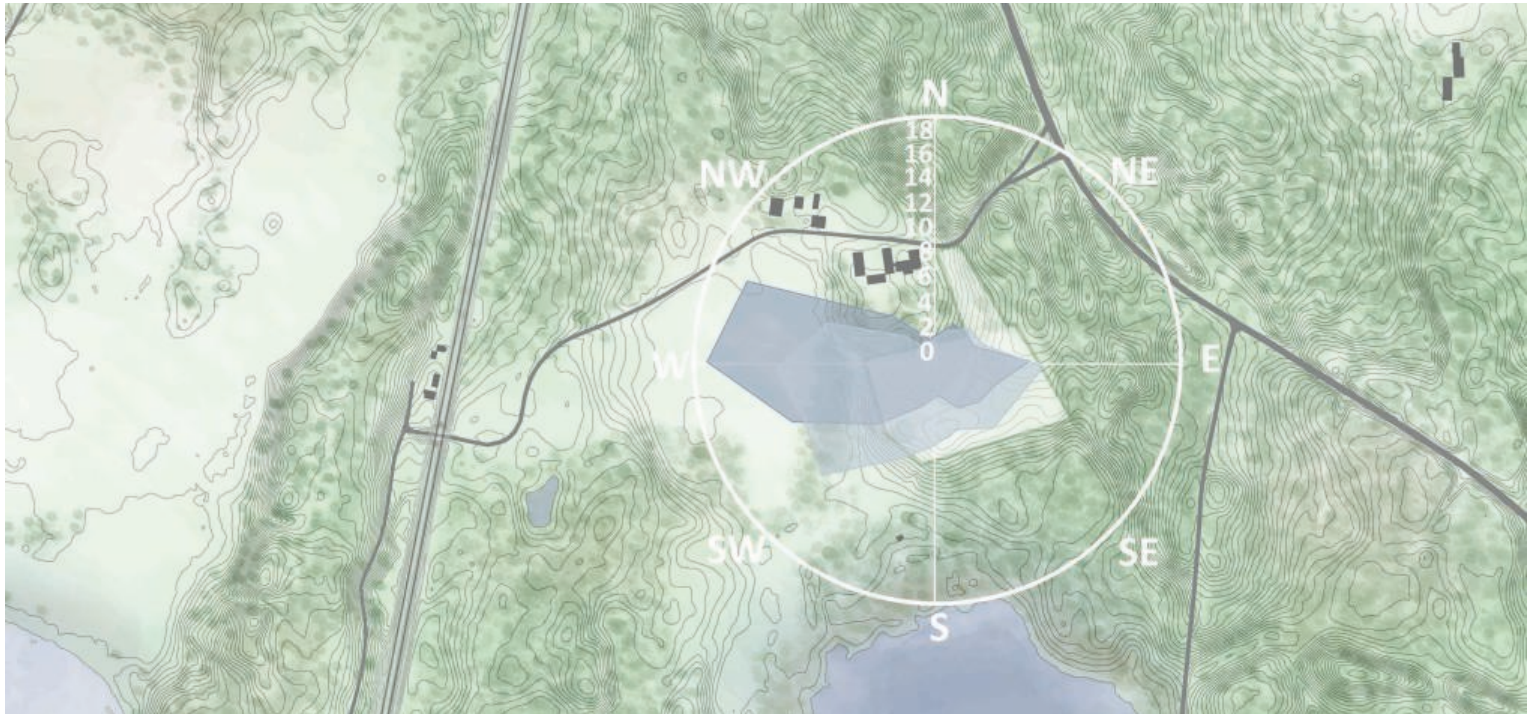
Ill. 58 Project site construction size



Microclimate

The microclimate is a broad term and therefore requires a description. A microclimate can be anything from the one on one's shirt, the one there is in one's backyard. The microclimate can be within a few hundred square meters, or in a city of several square kilometers. When talking about the microclimate in this project it is referred to as the area marked in the illustration above and is within a radius of 500 meters of the site, where the sun and wind are analyzed to get a better understanding of the project site.

Site map
Rold forest
Microclimate
Scale 1:5000
Contour lines 0,5 m
Ill. 59 Microclimate

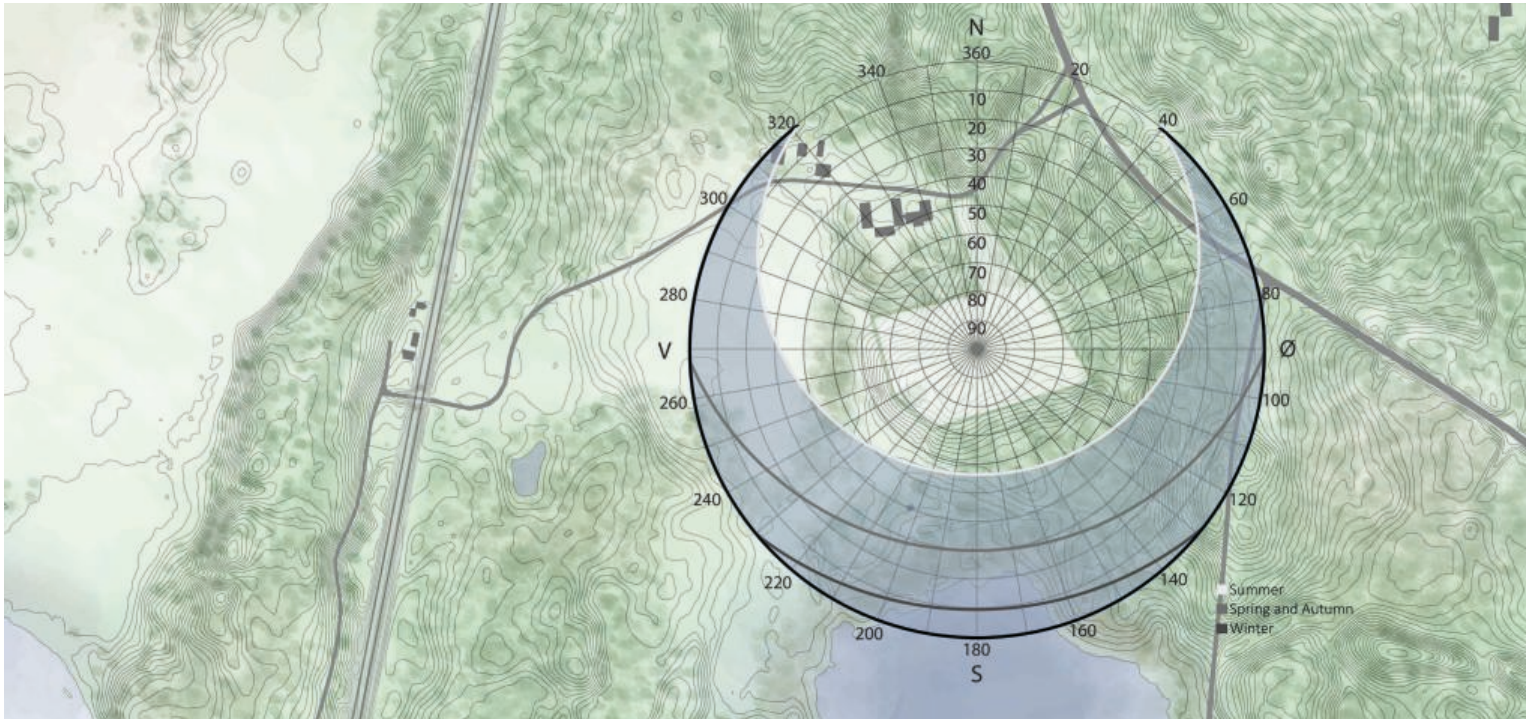


Ill. 60 Windscape (Windfinder.com, 2019)

Wind Direction Distribution in %
Dark blue: Juni
Light blue: Year 2018

Windscape

The wind in the area has been investigated, to prevent possible turbulence and genes. From wind and weather statistic site, Windfinder, the average wind direction have been examined for a year. Furthermore, the winds from the summer month have been investigated, in order to see which wind direction is dominant in this period. These months are desired to further investigate, to activate the outdoor areas around the building. It can be seen that the dominant direction is west and that in june it blows from the west 20% of the time (Windfinder.com, 2019).



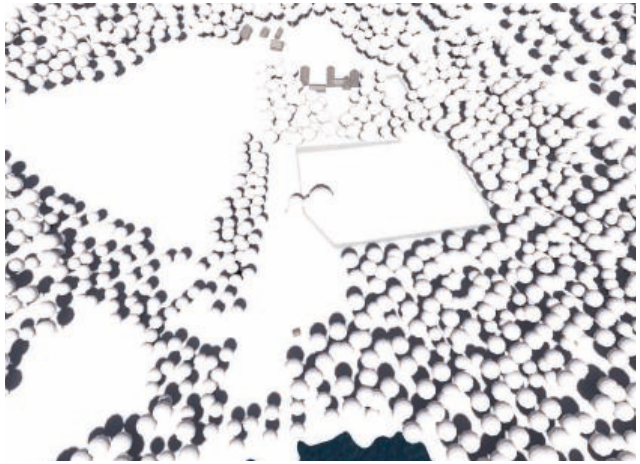
Ill. 61 Sunscape (A & D.Ark08.2010- Extension of the Art, 2010)

Light Grey : Summer
Grey : Spring and fall
Dark Grey : Winter

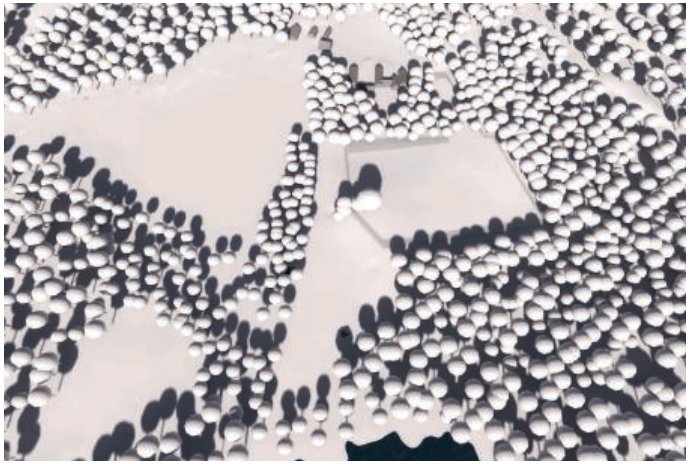
Sunscape

Natural light is important to achieve a good indoor climate. This is especially important when designing a building that focuses on people and their health. At a dementia center, light is important because it affects the residents' personal well-being and the overall well-being of everyday life (Olenius, 2019).

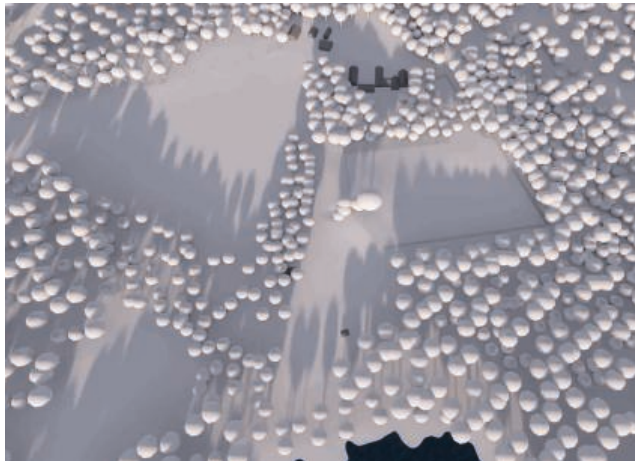
To get an understanding of where and when it is possible to use natural light, and where the sun lies in the sky during the year, an analysis of the sunscape was examined. In the analysis, it is taken into account that the sun in North Jutland has a very varying solar height from 10 to 57 degrees. Due to the location of the site, it must be taken into consideration when designing windows and openings in the building. To draw the sun far into the building during the winter months and how to shield in the summer months to prevent overheating in the building (A&D. Ark08.2010- Udvidelse af Kunsten, 2010).



Ill. 62 Summer solstice 6/21- 2019



Ill. 63 Equinox 3/23- 2019



Ill. 64 winter solstice 12/22- 2019

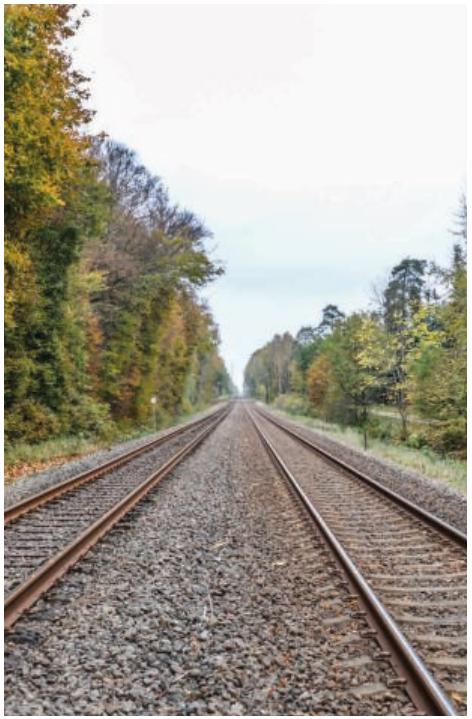
Natural light and shading conditions

A 3D model of the site and its surroundings was made, based on maps, pictures, and standards for Danish trees. In a future design process, a dialogue would be made with Rebild municipality, about pruning trees around the site. The area on the project is highly protected and is therefore desirable to preserve as much of the nature as possible.

On the basis of this, a model was made where the trees around the site were included, in order to ensure a precise simulation of the surrounding forest in the analysis.
Studies were made for summer solstice 6/21- 2019 at 12:00, equinox 3/23- 2019 at 12:00 and winter solstice 12/22- 2019 at 12:00.

Ill. 65 Paved road 80 km/h

Ill. 66 Gravel road 20 km/h



Ill. 67 Railway 98 km/h (LETH, 2010)

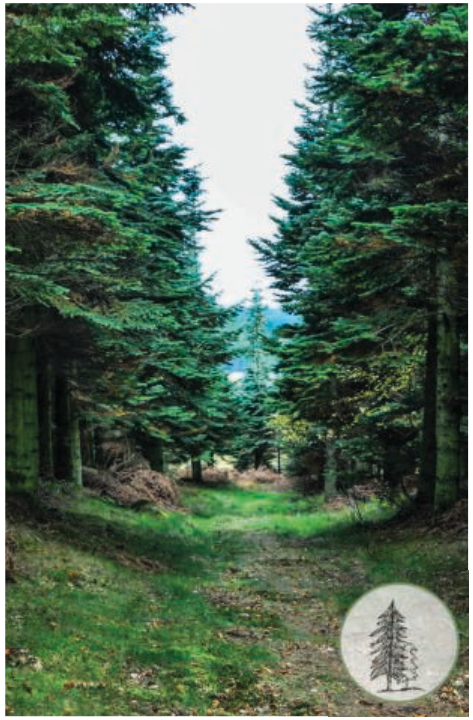
Ill. 68 Gravel Paths 5 - 8 Km/h

Infrastructure around the site

The site is located in Rold forest and despite its location in the forest, there is a strong infrastructure around the site. 550 meters to the west lies the railway line going both north through Aalborg and south through Århus. The railway is marked with both light and dark gray, see Ill. 69, with a station in Skørping only 3 kilometers (5 minutes by car) from the site. If one drive approximately 15 kilometers west, one will reach the E45 highway. The highway is not shown in Ill. 69. 200 meters to the east runs the paved road, Møldrupsvej, which is marked on the map with dark gray. Around the site there is a number of larger and smaller gravel roads and trails marked with brown and there is also a number of minor animal trails which are not marked on this map.

Ill. 69 Site infrastructure map

Ill. 70 Green area Oak



Ill. 71 Green area Needle

Ill. 72 Green area Beech

Ill. 73 Green area Birch

Green Area

Rold Forest consists of a large forest with a wide variety of wood species, and large marsh and grass areas.
Registration of the vegetation in the immediate area (600.000 m^2) around the site was made in the autumn of 2018. To understand the area the method Serial Vision designed by British architect and urban designer Gordon Cullen was used. Two routes were laid over the area, one from east to west, and one from south to north, and on these routes, the various dominant plants were registered. The area around the site, consists of forest of beech and oak, as well as needles and birch forests, in the low-lying areas around Mossø and in the area west from the site one finds moss and grass areas. Although forestry is used in the forest area, the forest is open to the public; north of the site, there is an area that is dedicated as dog forest, south lies Mossø, east of the site lies a dense forest of beech and needle, which shields from Møldrup road, west of the site opens up meadows with birch and low vegetation.

Site map
Rold forest
Green area
Scale 1:5000
Contour lines 0,5 m
Ill. 74 Green area site Map

Ill. 75 The Nature Agency 1

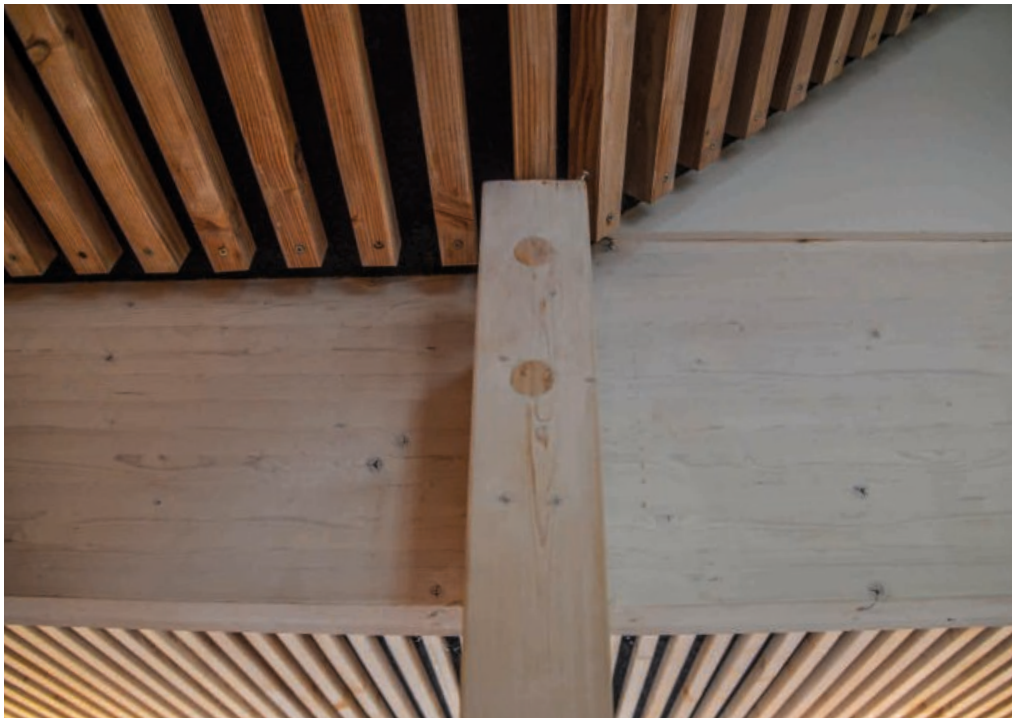
Ill. 76 The Nature Agency 2

Interview : Forest manager Bendt Egede

As part of our study of the area, an interview was made with Bendt Egede Andersen, who is a forest manager and works for the Nature Agency, which has an office located close to the site.

During the interview it was clarified that the area is rich in both animals and plants, and it is possible to see everything from stag as well as deer. Moreover the forest hosts a variety of different activities like horse riding, mountain biking and sometimes people uses the area for skiing too (Egede Andersen, 2019).
During the interview, the cultural history of the area was illuminated and especially the story of the old beech tree standing on the site, on top of an old burial mound was of interest. Also, the political stance about the forest has changed from cultivation plantation forest, where a large area is being cleared at once, to cultivating nature forest where the forest is allowed to stand more intact. This will take up to 100 years before this will be visible in the forest, but we are on the way with this change.

Ill. 77 The Nature Agency 3



Ill. 78 The Nature Agency 4

During the last 200 years, much has also been done to get more forest in Denmark. The goal is that 25% of Denmark should be covered with forest currently that number is around 14% (Egede Andersen, 2019). However, there is an expectation that more forests will be needed in Denmark, due to the development around the climate problem, and the forest is a good and efficient way to absorb and store CO2.

The interview gave a deeper understanding of the area, and the various groups that use the site, and the forest around the site. The full interview can be seen in Appendix 5 Interview page 188

Gordon Cullen: Serial vision

The methods to gain an understanding of the site was "Serial vision" designed by the British architect and urban designer Gordon Cullen. The method takes its starting point in a phenomenological approach where the visual experience is the focus of an area.

The analysis is made by going through an area, registering the visual contrasts that are created in the different areas, the different types of areas and the transition between these areas. The analysis looks at contrasts in the area, change of light and shadow, openings and closed areas (Cullen, 1961).

Gordon Cullen's analysis tool has been developed to analyze the city but is used in a forest area in this project. This was not without skepticism. During the first field studies on the site, it was clear that, like the city, the forest comprises many of the basic elements and there is an argument that the forest in many ways is as designed by people as the city was.

In order to get an understanding of the site and the area, two routes were laid down over the area; a blue route that goes from east to west and a red route that goes from south to north. Through these routes, registration of scale and density, different gestures and character, closed and open areas, as well as transitions between those, including visual impression, to understand the site.

The analysis gave a better understanding of the different changes throughout the area. The area consists of smaller sub-areas, with their own character, greenery, and expression. Buildings in the area were also analyzed with a special focus on the Nature Agency´s buildings, consisting of a combination of old farm buildings and new office- and administration buildings, designed with great respect for the context.

Site map
Rold forest
Serial vision
Scale 1:5000
Contour lines 0,5 m

Ill. 79 Gordon cullen Serial vision

Ill. 80 Blue route 1

Ill. 83 Blue route 2

Ill. 86 Blue route 3

Ill. 81 Blue route 4

Ill. 84 Blue route 5

Ill. 87 Blue route 6

Ill. 82 Blue route 7

Ill. 85 Blue route 8

Ill. 88 Blue route 9

Ill. 89 Red route 1

Ill. 92 Red route 2

Ill. 95 Red route 3

Ill. 90 Red route 4

Ill. 93 Red route 5

Ill. 96 Red route 6

Ill. 91 Red route 6,1

Ill. 94 Red route 7

Ill. 97 Red route 8

A good atmosphere

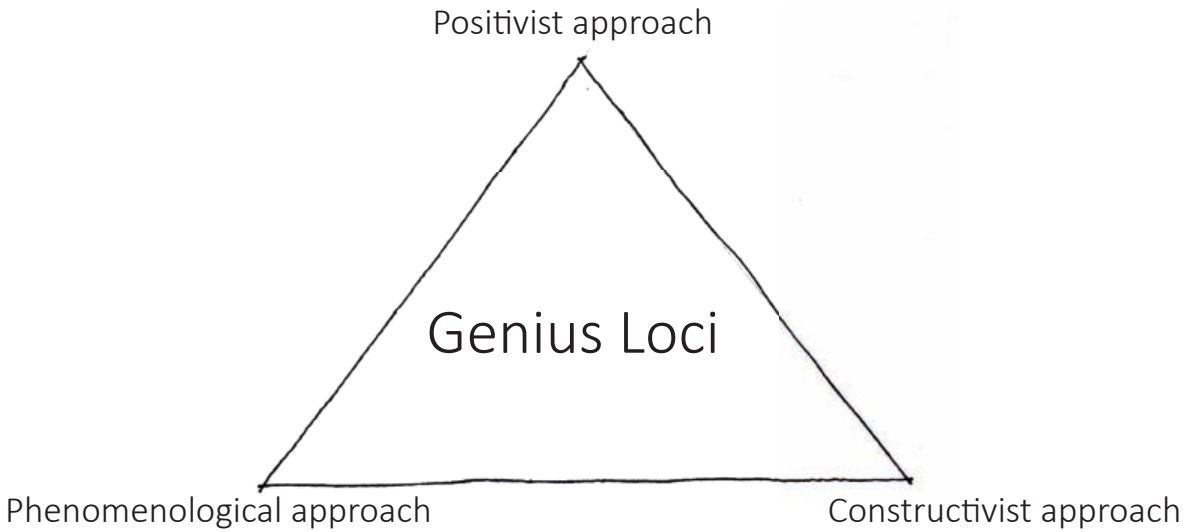
Originally, "the atmosphere" was used as a term for wind, weather and other meteorological phenomena. Since the 1800s, the meaning of "the atmosphere" was given a different meaning, and one began to use it to describe a mood and a feeling of a place (Frølund, 2016).
The idea of the atmosphere as a concept, that is described with the senses, emotions and the body, in an environment that is either manmade or natural, was first introduced by the two German philosophers, Hermann Schmitz and Gernor Böhme (Frølund, 2016).
Gernor Böhme describes the sensation of a place, first and foremost as an emotional-bodily unity and connection to its surroundings. Here he gives the example of the experience of the cold, where the body feels the cold as "I am cold", the cold is thus indefinite. The sensory experience that is felt on the body is the way we experience the atmosphere (Frølund, 2016). The concept of atmosphere in the book "The theory of atmospheres and its applications" is described as the intermediate between the objective conditions and the subjective conditions (Böhme, 2017).

The atmosphere is experienced subjectively on the basis of a bodily and sensual assessment, where the physical and mental experience goes hand in hand and affects each other. The phenomenological analysis of the atmosphere on the site must therefore, be expected to bear the mark of the group' members gender and experience, since it is analyzed on the basis of these. In appendix 7 page 194, the full analysis of the site can be seen.

As part of a better understanding of the atmosphere on the site, an analysis was conducted that ran over 16 hours. Sensory impressions were obtained during the morning, day and night. The analysis focused on sound on the site, the thermal and visual experiences, scents impressions and “other”. “Other” is things that made an impression during the analysis. It has been taken into consideration, that the analysis was made on the 16-17th of february and that a winter experience of the site was made. This experience differs from one made in the summer mounth. The sounds of birds in the forest were less than expected, and the thermal experience was influenced by the season. Overall the experience from the analysis was calm and peaceful and experienced as being in a time pocket. The analysis can be viewed in full length in Appendix 7 page 194.

An investigation of a different view on the site was compiled. This gave an understanding of where to expect long and short view, in order to determine where to place different functions in the Mossø Center. Long views are desired for common areas, where short views are desired for more private functions. The full study can be found in Appendix 6 page 191.

Ill. 98 Site atmosphere



Ill. 99 Genius Loci sketch

Genius Loci - Sense of place

To get a better understanding of the spirit of the site and get a phenomenological understanding of the area surrounding the site, an analysis of the spirit of the place was made. There were several things to be taken into consideration, as it is not simple to find the spirit of the place. As a start, the site's patina was investigated; there were traces of contemporary activities and traces of past historical activities on the site. Then the dimensions and materials of the site-aesthetic enjoyment, conversations and security were assessed. Beyond the physical Genius Loci also lookes into the sociocultural: what people do in the area and what do they use the site for, and to gain an understanding, that everyone does not necessarily like the place (Ehlers, 2015).

An analysis of the Genius Loci, the spirit of the place can be done in a scientific way, by describing the site from three approaches; Positivist, Phenomenological, and a Constructivist approach. (Ehlers, 2015)

- **The Positivist** means seeing the place as “a thing”, with a focus on the objective conditions of the place and describe the physical structures of the place that can be measured and weighted.
- **The Phenomenological** approach sees the place as an experience and describes the place based on experiences and emotions.
- **The Constructivist** approach sees the place as a social construction and describes the places power relationship and interest’s contradictions on the site.

These three approaches can not stand alone, as each approach is in deficient with itself. Therefore, there is a need to develop a strategy to combine the approach of the sites physical elements, the emotional dimensions and the contextual elements, such as economic and political structures and to converge them (Ehlers, 2015).
The analysis was made focusing on understanding the potential of the site. The area was previously visited in the fall, where the phenomenological analysis method, Serial vision of the English architect Gordon Cullen, was made. Pernille Ehlers in the "Method booklet character of the place" (Ehlers, 2015), explains the importance of a thorough understanding and positivist review of the area to keep it objectively.

SWOT analysis

Subsequently, a Strengthen, Weaknesses, Opportunities, and Threats (SWOT) analysis was performed, which was supposed to supplement and strengthen the phenomenological understanding of the area, and thus made in the same area as Serial vision, but with a greater focus on the site itself. The SWOT analysis was prepared on an ongoing basis in the area around the site between saturday, february 16th at 16:00 to sunday morning, february 17th at 08:10. This provided a more in-depth understanding of the site as the site was experienced at different times of the day, thus emphasizing the specific strengths, weaknesses, opportunities, threats, and certain traits that only come into effect at specific times of the day. The full investigation can be seen in Appendix 7: Genius Loci field studies page 194.

The **strengths** were the pleasant calm, the wind in the trees and the birdsong from the forest. The site seems very open and peaceful, as it is elevated on a hill, with long views to the west and a large beech tree marking the slope of the hill and clearly defining the area.

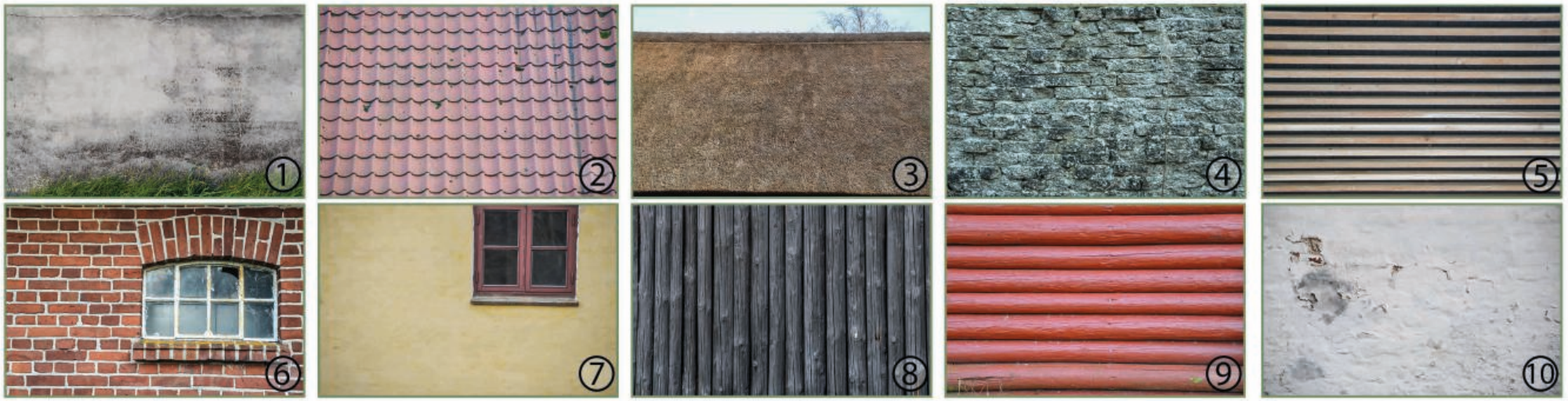
The **weaknesses** was the westerly wind, which goes directly over the site and makes the area exposed to the wind. The wind in the trees sounds like a busy road in the background and the train is relatively close, which runs about every half hour. The moss, wet areas, uneven terrain and numerous mole shoots can cause problems when walking around the area.

Of the sites **opportunities** the group recognized good prospects to the west, where there is a view of water, the forest and a sunset down behind the forest or the large beech tree. There is the possibility of lighting path systems around the forest edge, which can become a natural sense path, with the sound of the wind in the trees, bird singing and the smell of moss and fresh nature. In the morning there is the opportunity to enjoy a cup of coffee while the forest wakes up with bird singing and the dew falling from the trees.

Of the possible **threats**, the group noticed problems such as the road and the train path, which both could easily be heard in the non-noise polluted area. The forest can be very dark towards the evening, which may seem gloomy or threatening. The wind and the cold can be a nuisance in the area, as well as the large slope to the west, which can complicate walking both to and from the forest. Crows scream that echoed around the quiet forest and scouts that go around, can be disturbing and frightening.

Finally, the site was looked at, based on a more constructivist approach, which looked at the places power relations and interest contradictions in the area.

The area is characterized by being divided into private (75%) and shared state forest (25%). This gives areas that are characterized by being used for forestry, and other areas are designated for more recreational use. Besides that Rold forest is protected by Natura 2000, the Nature Agency also has an office in this area. They carry out tasks along the Danish coasts, nature areas and in the Danish forests. The Nature Agency also assumes the role of manager and mediator between the different users, who are general forest users, riders and mountain bikers and nature conservation groups of the area. There are conflicts of interest in the forest, but these are met with dialogue between the different parties, and this ensures a place that everyone want to use (Egede Andersen, 2019).
A registration of the characteristic features of the site was drawn up and is a description of the elements that were particularly important in giving the place character.



Ill. 100 Material from site

Materials characteristics

Around the site, the amount of buildings is limited. The buildings in the near proximity are located north, south, and west from the site. The buildings are characterized by old Danish style, red brick, and limed masonry. The Nature Agency has a few buildings that are of more recent date and built in treated wood, with a burned expression, and with a thatched roof. The thatched roof links the new building to the old buildings. West from the site, there is a concrete bridge from 1940.

Ill. 101 Materials characteristics

Sub-conclusion: Program

A comprehensive study of the site concluded that this could be the right place for this project, as it provides a natural calm atmosphere. Subsequently, a number of studies were prepared to gain a deeper understanding of the project site. The microclimate was examined in order to understand the physical parameters. The infrastructure was also important for the project, as it is a dementia center with a daycare included. This necessitates easy contact with the rest of the municipality and access for relatives to connect with train or by car to ensure a good everyday life for the residents.

Based on the field studies, it was decided to design space for the partner of dementia patients to live, so that couples could move to the center together. In this report the place is called the somatic section.
In order to ensure an active relief effort, there was a desire to use the theory of healing architecture, as this project is about the last place of residence for the residents.

For residents who are terminally ill, the effort is made to create space for quality of life, with the desire to use nature as an active tool to achieve this. The nature and rich history of the area was therefore important to understand so that it could be involved in an active relief effort. At the initial feasibility study, it was clear that the spirit of the area (Genius Loci) hit something that was initially undefined but had high quality for the area. A number of phenomenological studies were therefore conducted.
Gordon Cullen's analysis tool Serial vision was placed over the project area, where the sites Genius Loci was subsequently examined, based on a positivist, phenomenological and constructivist approach. The goal was beside a better understanding of the places Genius Loci, to also gain an understanding of the place’s patina. As a supplement, the site's atmosphere was explored using the two philosophers' Hermann Schmidt and Gernor Böhme theory. Their philosophy is that the atmosphere should be experienced using their own body. This led to an overnight stay at the site being conducted, which opened for a new understanding of the area on days, evenings and nights.
A material study of the areas buildings was analyzed, which provided an understanding of the site's patina. This clarified a narrative that is already underway in the area.
The analysis of the area plastered the project site and choice of location and gave a deep understanding of the area's qualities, including strengths and weaknesses. Concluding there is a desire to develop a building that architecturally belongs in its surroundings.

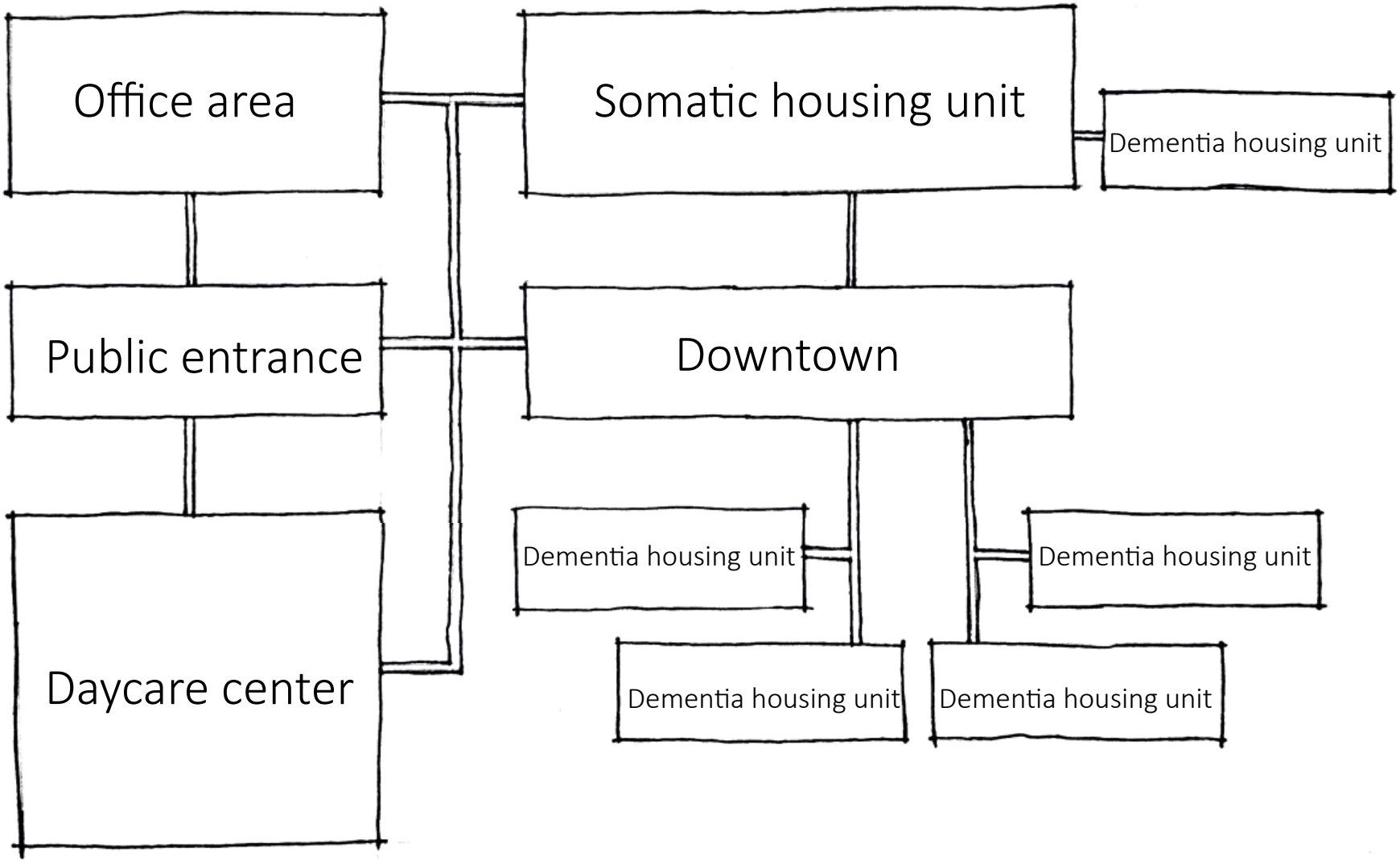
Conclusion program

Room program

Name	Size	Number	Light	Light requirements (Lux)	Ventilation needs (l/s pr. m^2)
Dementia center	7000 m^2	1	Daylight / Artificial lighting	300/500	
Staff /organizational unit	586 m^2	1	D/A	500	
Downtown /daycare center	1569,5 m^2	1	D/A	300/500	
The housing unit (dementia)	764,5 m^2	5	D/A	300	
The housing unit (somatic)	1022 m^2	1	D/A	300	
Staff /organizational unit	586 m^2	1	D/A	300/500	
Entrance	51,5 m^2	1	D/A	300	0,92
Gusest toilet	5 m^2	2	A	300	(Minimum 15 l/s)
Handicap toilet	6 m^2	1	A	300	(Minimum 15 l/s)
Meeting room	110 m^2	1	D/A	500	5,18
Office	26,5 m^2	8	D/A	500	1,21
Changing room	21,75 m^2	2	A	300	9,44
Depot	3,5 m^2	2	A	300	0,35
Staff toilet	3 m^2	2	A	300	(Minimum 15 l/s)
Copy room	10 m^2	1	A	300	1,57
Multifunctional hallway	140 m^2	1		300	0,72
Downtown /daycare center	1328,5 m^2	1	D/A	300/500	
Calm niche	26 m^2	1	D/A	300	1,54
Changing room	5,5 m^2	1	A	300	3,78
Dining area / Cafe area	78 m^2	2	D/A	300	2,04
Gym / multifunctional room	73 m^2	1	D/A	300	5,45
Hairdresser	15,5 m^2	1	D/A	300	4,05
Hobby room	28,5 m^2	1	D/A	300	4,44
Hotel (room for relatives)	45 m^2	2	D/A	300	0,35
Kitchen	76 m^2	1	D/A	500	1,08
Living room (large)	87,5 m^2	1	D/A	300	2,18
Living room (medium)	58 m^2	1	D/A	300	2,18
Living room (small)	31,5 m^2	1	D/A	300	2,02

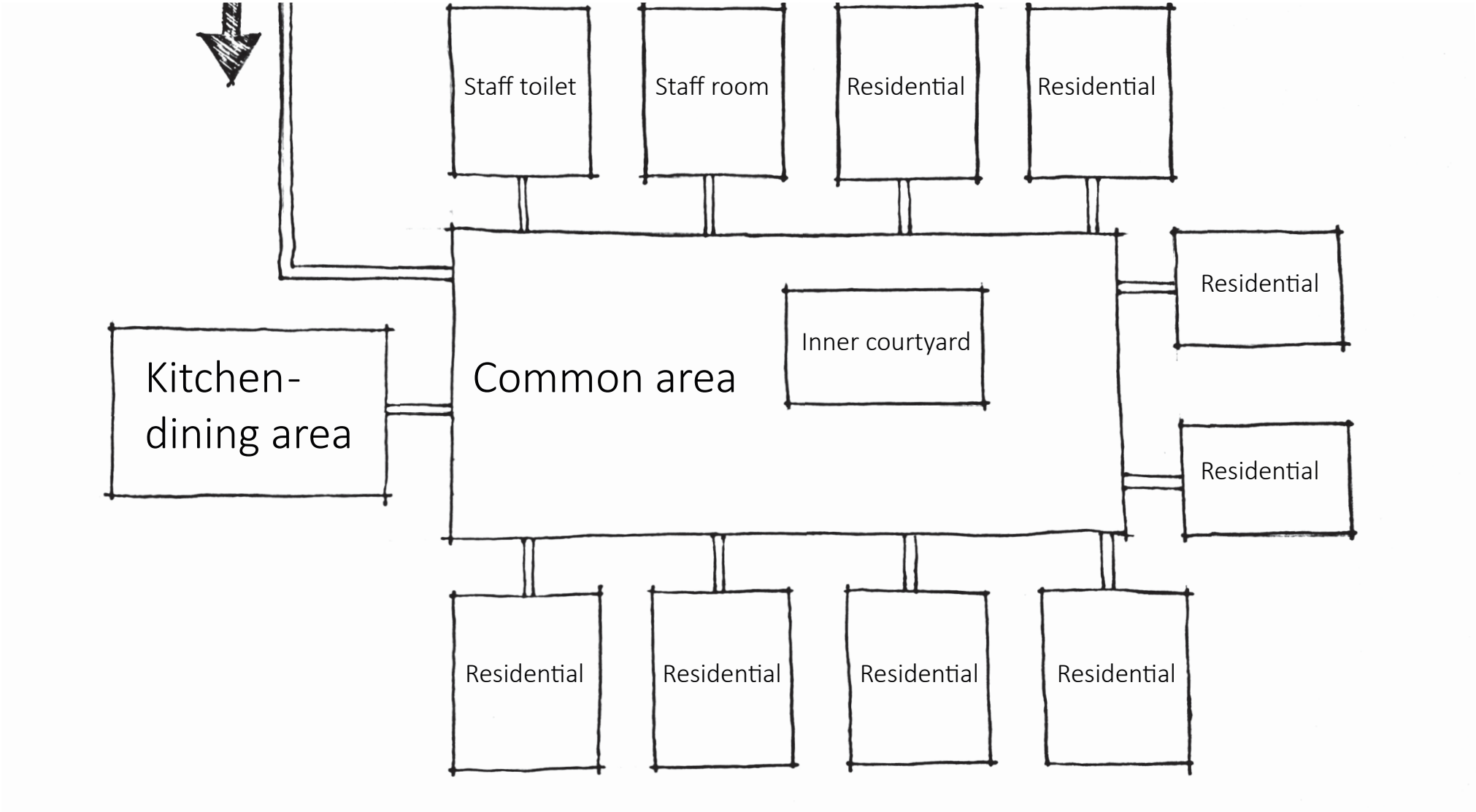
Name	Size	Number	Light	Light requirements (Lux)	Ventilation needs (l/s pr. m^2)
Downtown /daycare center	1328,5 m^2	1	D/A	300/500	3,43
Pharmacy	12,5 m^2	1	D/A	300	2,70
Shop	15,5 m^2	1	D/A	300	1,93
Sensory room	24,5 m^2	1	D/A	300	4,52
Silent space	64,5 m^2	1	D/A	300	3,70
VR-room	13 m^2	1	D/A	300	(Minimum 15 l/s)
Toilet	3,5 m^2	2	A	300	1,09
Wellness	29 m^2	1	D/A	300	2,08
Workshop	38 m^2	1	D/A	300	0,45
Multifunctional hallway	477 m^2	1	D/A	300	
Housing unit (dementia)	764,5 m^2	5	D/A	300	0,53
Common room	67,9 m^2	5	D/A	300	0,64
Depot	12 m^2	5	A	300	(Minimum 15 l/s)
Staff toilet	4,5 m^2	5	A	300	2,58
Office	12,5 m^2	5	D/A	500	
Residential	49,5 m^2	40	D/A	300	
Housing unit (somatic)	1022 m^2	1	D/A	300	0,35
Depot	24 m^2	1	A	300	1,15
Common room	103 m^2	1	D/A	300	
Residential	49,5 m^2	12	D/A	300	0,50
Multifunctional hallway	203 m^2	1	D/A	300	
					0,35
Residential	49,5 m^2	52	D/A	300	(Minimum 15 l/s)
Redroom/livingroom	28 m^2	1	D/A	300	1,89
toilet and bath	10 m^2	1	A	300	
Kitchenette and semi-private niche.	11,5 m^2	1	D/A	300	
					0,35
Basement	241 m^2	1	A	300	0,35
Laundry & medicine depot	200 m^2	1	A	300	0,35
Depot and utility room	41 m^2	1	A	300	

Chart of functions: Dementia Center

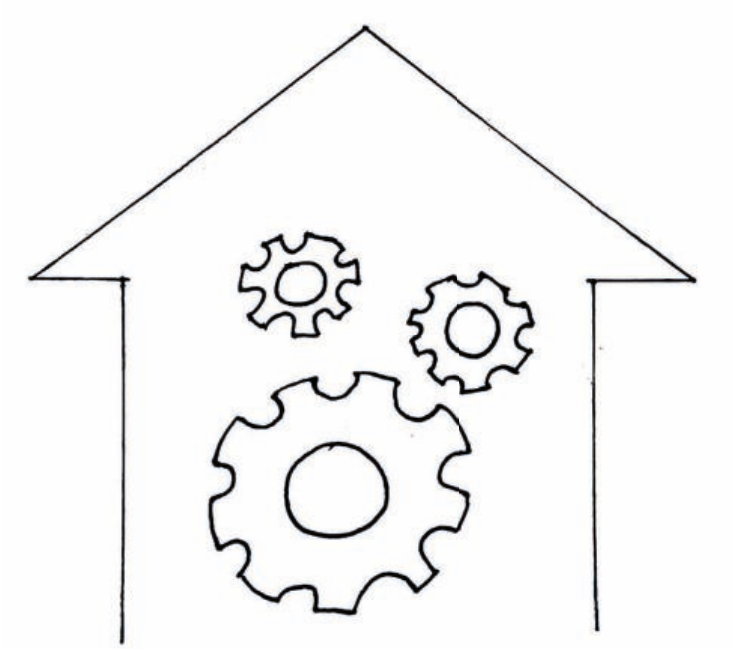


Ill. 102 Chart of functions: Dement center

Chart of functions: The housing unit



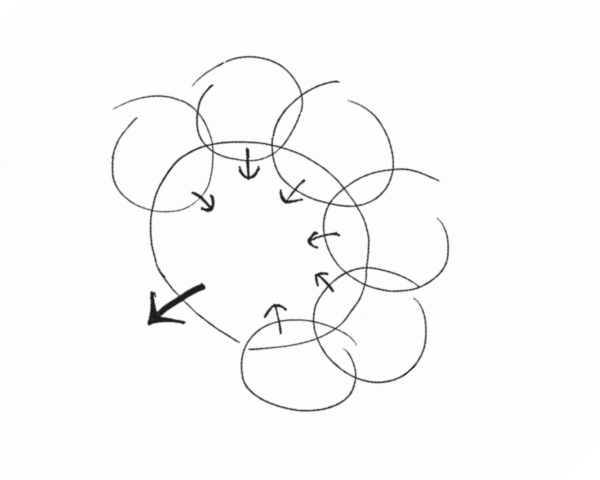
Ill. 103 Chart of functions: The housing unit



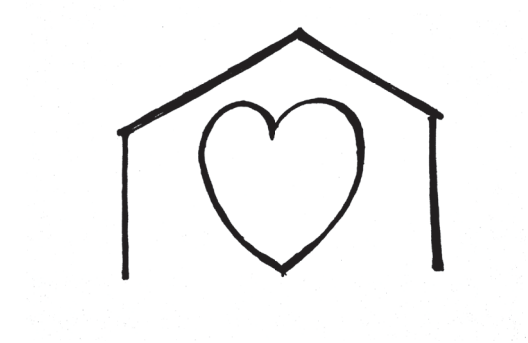
Ill. 104 Technical

Technical conditions

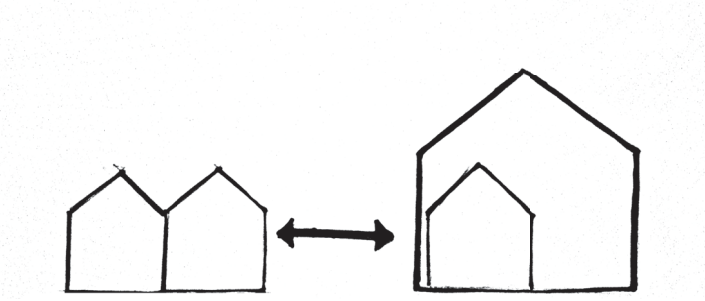
Category	Description	Regulation
Thermal temperature	The indoor temperature must exceed. BR18 § 386 Danish standard DS 469	>100 hours above 27 degrees >25 hours above 28 degrees Between 21- 23 degrees
Atmospheric	The CO2 concentration in rooms must not exceed category A. DS_CEN_CR 1752, 2001	800 ppm
Visual	Sufficient daylight shall be documented by the following manner. BR18 § 379 subs. 2	Glass area of minimum. 10% of the relevant floor area. 300 lux in at least half of the relevant floor area.
Acoustics	The reverberation time should not exceed. BR18 §369	>0,6 s
Access	Door steps maximum height. BR18 § 51 Quality level A: Free passage area through a door. BR18 § 52, table 2. A free distance beside doors. BR18 § 52 A manoeuvring area for a common wheelchair. BR18 §54 Passages must have a minimum width, for unobstructed passage. BR18 § 56	2,5 cm 1,07 m for 1 door 0,87 m & 0,2 m for 2 doors 0,5 m 1,5 m x 1,5 m 1,3 m
Fire regulation	The building must be divided into fire sections and fire cells. BR18 § 84 The building must be planned to ensure the safety of the residents in the building. BR18 §91 Sufficient, clear and easy-to-use escape routes. BR18 §94 - Easy to identify. - Easy to use. - Direct access to terrain. - Escape routes are dimensioned for number of users. Minimum sizes for fire openings. BR18 § 97-98	Fire alarm. Sufficient escape routes. Sufficient rescue openings. Maximun 25 m to the nearest exit. Escape routes of minimum 1,8 m, application category 6. For two hospital beds 2,4 m, application category 6. Minimum height 0,6 m & width 0,5 m. One rescue opening per 10 person started.
Energy frame	Energy requirements kWh/m^2 year. BR18 § 474 Ventilation systems that only support one dwelling must have a heat recovery value. BR18 § 483 Specific power consumption at ventilation systems. BR18 §484	2018 = 30 kWh/m^2 year. 85% Constant flow: 1.800 J/m^3 Variable flow: 2.100 J/m^3 Story buildings: 1.500 J/m^3



Ill. 105 Community



Ill. 106 Homely



Ill. 107 Multifunctional

Design criteria

Technical strategies	Functional strategies	Social strategies
Daylight: Glass area must at least be 10% of the net floor area ore minium 300 Lux on 50% of the relevant floor area. *Artificial lighting:* Artificial lighting must be used in such a way, a smooth and soft lighting of the dementia center is available 24 hours a day so that dark shadows on the floors do not occur. *Sustainability:* The choice of materials should reflect both a environmental (LCA) and a economic (LLC) sustainable starting point for the project. *Indoor climate:* BR18 and SBI will be used together with the concept Healing architecture, to ensure a healthy and attractive indoor climate in category A. *Ventilation:* Natural ventilation must be considered in the design. Mechanical ventilation is designed according to the needs of the given rooms, and is primarily used during the winter months. *Outdoor areal:* Flow design is used as an active tool, to prevent turbulence and wind tunnels on the centers outdoor areas.	*Functions of the organizational unit:* Should provide necessary room and function, so that the staff can solve the daily tasks and have a focus on the residents. *Functions of the daycare center:* Act as relief for the municipalities resident with dementia and a place for the centers resident. *Functions of downtown:* Fills in the role of the city and give the residents the opportunity to go to e.g. the hairdresser without leaving the center's safe frame. *Functions of the housing unit:* Designed with a focus on the balance between residents privacy and the health care tasks, associated with ensuring a safe everyday life. *Functions of the residential:* Must give the residents the greatest sense of security and independence possible based on their situation and in the sense it is the residents home. *Wayfinding:* Signs, furnishings and color choices are designed based on the knowledge of the residents' reduced cognitive function, and the recommendations from the SBI.	*Indoor/outdoor space:* The nature is drawn into the building. Outdoor areas are activated with free access in the center's protected yard, rooms and gardens. *Transitioning spaces:* Should be created between the various main elements of the center that must have a clear understanding of the different areas. *Outdoor areas:* Should support the quality of the interior spaces and secure a close contact with nature from all social spaces. *Private vs public areas:* A balance between public and private places, and good opportunity for the vulnerable resident to retire into private and semi private spaces on their own request. *Healing architecture:* Is used to increase the quality of life and reduce stress among residents and employees. *Multicare-room:* VR, sensory and music therapy rooms are used as activities to increase the quality of life for the residents.

Problem definition

This master thesis will revolve around the design of a new dementia center, which functions as a hospice for the terminally ill patients with dementia in different stages. Stress is known to cause and accelerate dementia, therefore, the center should aim to be as stress-free as possible with the use of nature as an active tool to achieve this. In this project, special attention should be placed on the balance of quality of life, personal freedom, and security measurements, securing the safety of the residents. Furthermore, there should be a focus on creating a building adapted to the characteristics associated with people having dementia and their changing mood. The dementia center should include both social and private spaces linked together in such a way, that the residents is giving the choice of the level of interaction with the social life at the center.

An additional focus should be on creating a functional building which can function as a home for the residents, but also as a functional workplace alleviating the daily task for the staff and ensuring time for personal care. The center should also be designed on the knowledge, that dementia can be a long term illness affecting the whole family. Space for relatives should be integrated into the design of the building, to ensure that the relatives can be part of everyday lift at the center.

Vision

The vision is developing a future dementia center with a focus on sustainable design and active involvement of nature as it shall act as a part of the active relief effort for the terminal ill residents. A center where functionality and patient safety do not compromise the residents ability to create a place they can call home.

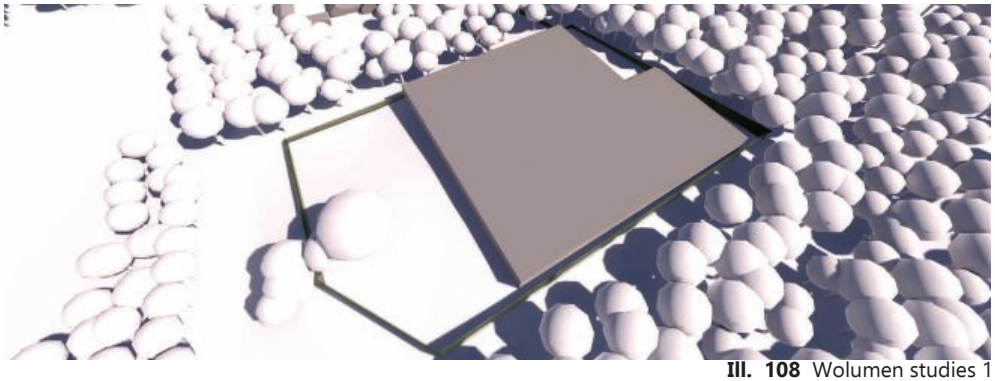
Design Process

Introduction

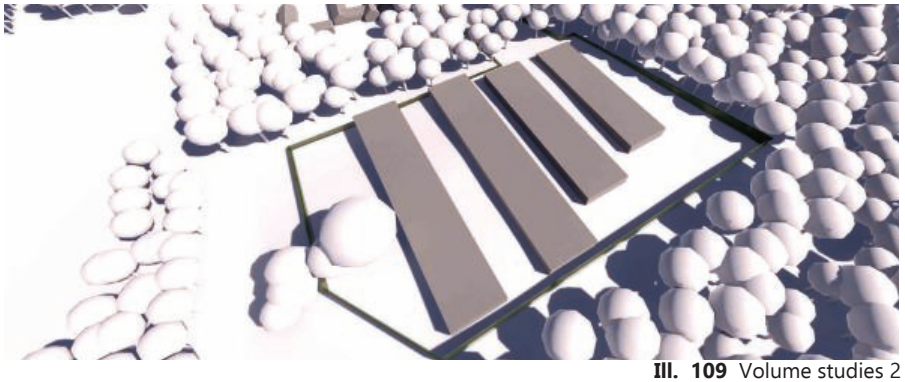
The following description deals with the design process of the dementia center, "the Mossø Center", and has been carried out based on the program. The design process follows the integrated design methoed based on the problem definition. The integrated design process deals with the five-phase; The problem, the analysis, the sketching, the synthesis phase and final the presentation phase. This chapter will deal with the analysis, sketching and synthesis phases, and describe the development of the design. The finished design is presented in the presentation chapter.

Design process/development of the building

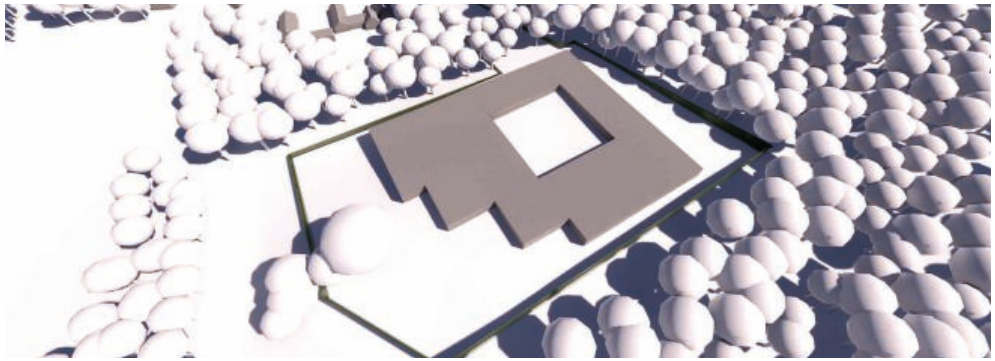
In the initial design phase, the site was analyzed and clarifying studies were carried out, to get a better understanding of the user group. Those were concluded in an initial program, which formed the foundation for the subsequent design process. In the initial investigations, volume studies were conducted and case studies of four chosen dementia and nursing homes in North Jutland were examined. In the initial sketching process, several open and undefined ideas were made. During the analysis, many ideas and concepts were outlined and recorded, in order to embrace a wide range of possible designs.



Ill. 108 Wolumen studies 1



Ill. 109 Volume studies 2



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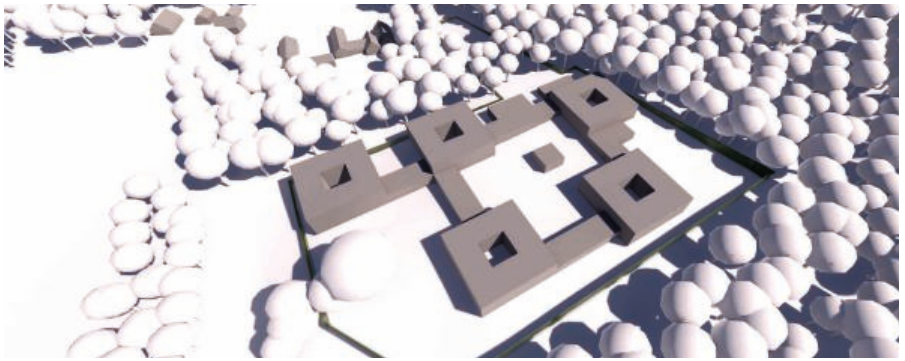
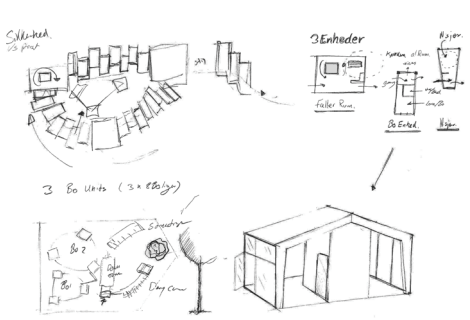


Ill. 111 Wolumen studies 4

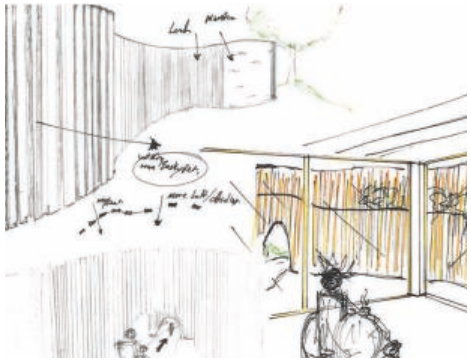
Volume studies

Volume studies were made in Sketchup, in order to clarify the building's size of project, in relation to the surrounding context. The project site is 20.000 m^2 and the future Mossø Center is planned to be around 7.000 m^2. This gives a building percentage of 35%, which is 10% lower than the maximum building percentage for an institution in Denmark (Nielsen and Andersen, 2018).
A 3D model of the site was made, based on a LandCAD map of the area. In Sketchup, the sites' geographical position was set, to get a realistic view on the light and shadow conditions.

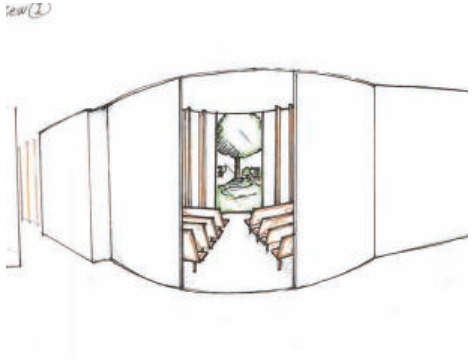
To get an idea of the size of the future building on the site, a square of 5*5*5 meters were made, which equals to 25 m^2. 280 squares were placed in different constellations, simulating the size of the building as further described in Appendix 8 page 200 .
From these constellations, four examples are shown at the top of the page. Models in two levels were tested in a lesser extent, because the municipality plan underlines a maximum building height of 8,5 meters for the area, as further described in Appendix 4 page 187. These studies gave an understanding of the size of the area and the volume of the building, compared to its surroundings.



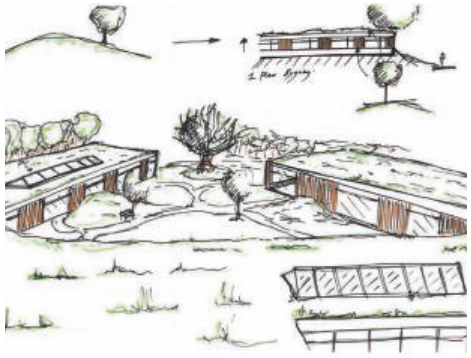
Ill. 116 Sketch phase 1 0,1



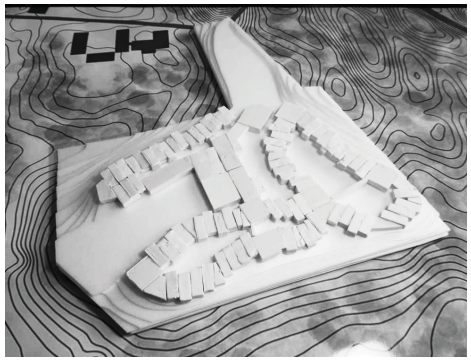
Ill. 118 Sketch phase 1 0,2



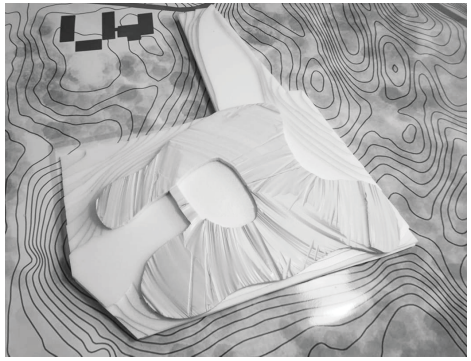
Ill. 117 Sketch phase 1 0,3



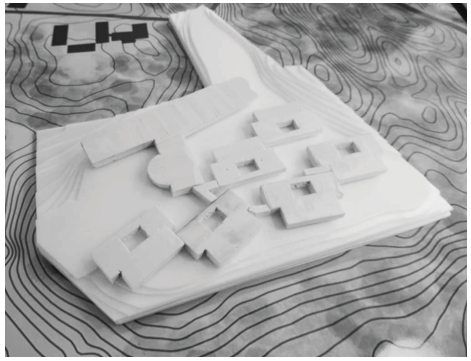
Ill. 119 Sketch phase 1 0,4



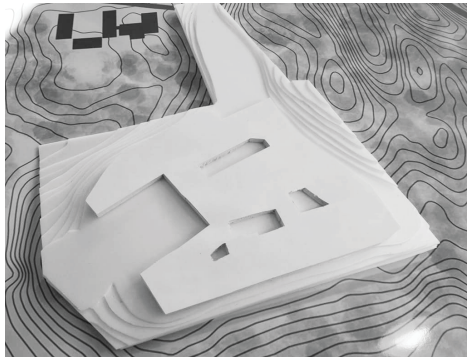
Ill. 112 Physical model 0,1



Ill. 113 Physical model 0,2



Ill. 114 Physical model 0,3



Ill. 115 Physical model 0,4

Phase 1: Iteration

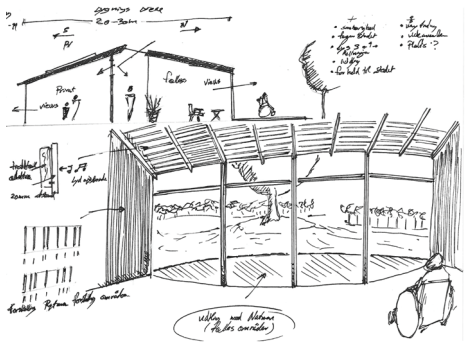
On behalf of the initial investigations, the first ideas were investigated and manifested into more concrete concepts. A number of workshops were carried out with a directed focus on various challenges located in the program. An example of this could be the views to nature as a quality in the building.

The workshops were concluded into six concepts, where plans and views were further investigated and physical models were made to analyze the spaces inside and outside the building. The initial concepts from the workshop were collected and assessed on aesthetic and technical design criteria, where the strength and weaknesses of each proposal were described and discussed.

Ill. 120 Physical model 0,5

Models

Because of the location and topography of the site, an analysis was made to investigate the opportunities to incorporate the building on, in or above the site. This was done by using physical and 3D models. Due to the elderly and fragile user, it was chosen that the building should be in one plan and operations was made to the site to ensure this. These operations were made in such a way that the least amount of damage was caused to the site and its qualities.

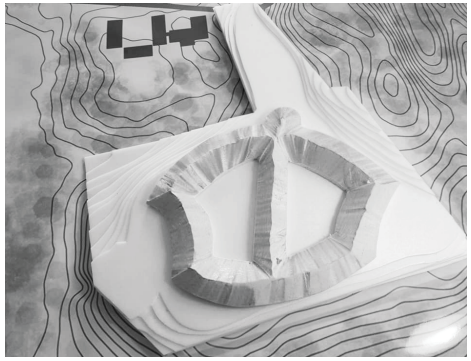


Ill. 121 Sketch phase 1 0,5

Ill. 122 Sketch phase 1 0,6

Ill. 123 Sketch phase 1 0,7

Ill. 124 Sketch phase 1 0,8



Ill. 125 Physical model 0,6

Ill. 126 Physical model 0,7

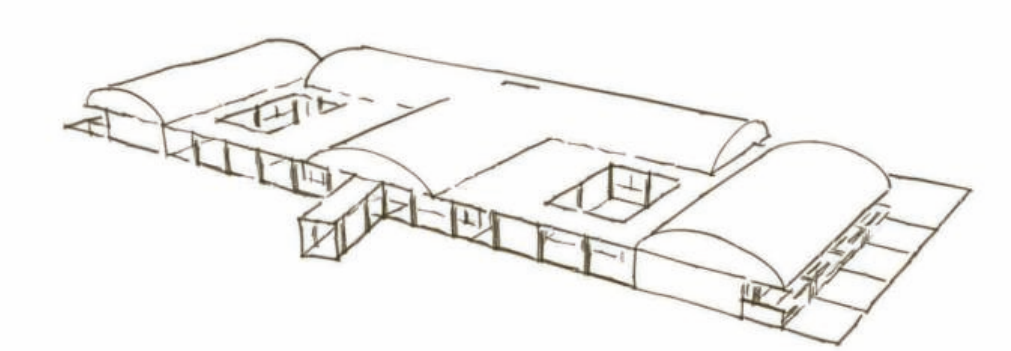
Ill. 127 Sketch phase 1 0,9

Ill. 128 Sketch phase 1 1,0

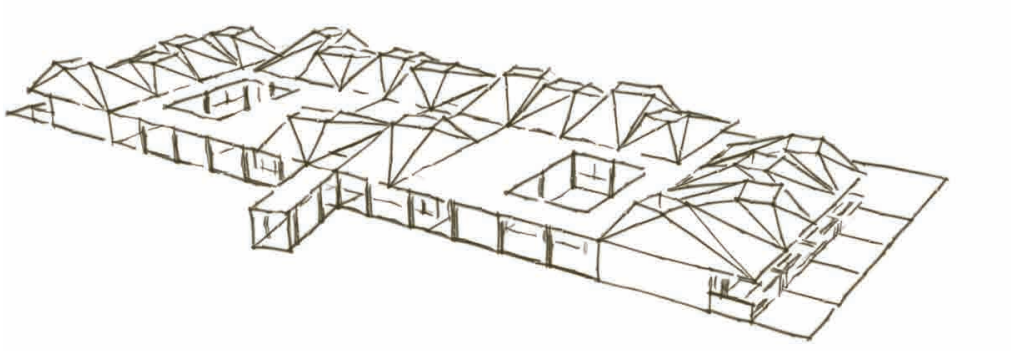
Phase 2: Shape

The qualities of each of the concept were discussed and from those, two main concepts were formed. These concepts were further investigated in sketches, physical and 3D models and presented at the midway criticism. This led to constructive criticism of the two concepts and helped reach a final concept.
In this phase, the first more concrete calculations were made in BSim, BE18, LCC, LCA, and Velux, which further developed and drove the design forward. A combination of technical calculations and the use of persona tested the design in such a way, that the user was always represented in the process.

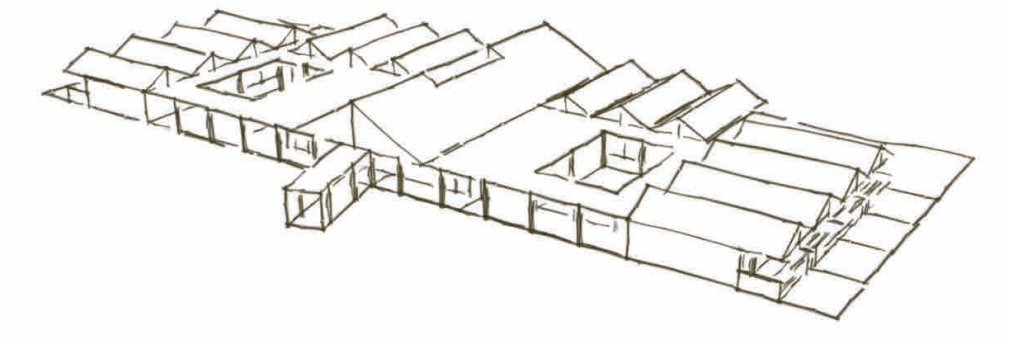
An analysis of the roofscape was made. This was done together with the initial facade investigations looking into different solutions, which was criticized on a number of different criterias, such as aesthetics, color, maintenance, and tactility. The different options were also assessed to their link to the site history of the area. In this phase, the different materials were also investigated through LCA and LCC.



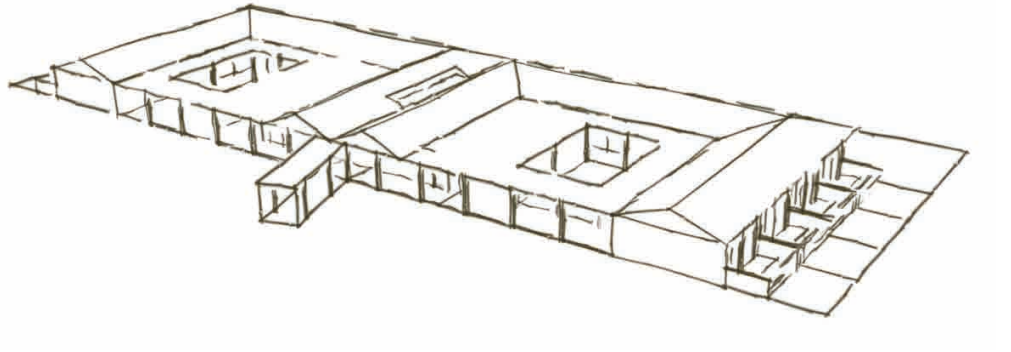
Ill. 129 Roofscape 0,1



Ill. 130 Roofscape 0,2



Ill. 131 Roofscape 0,3



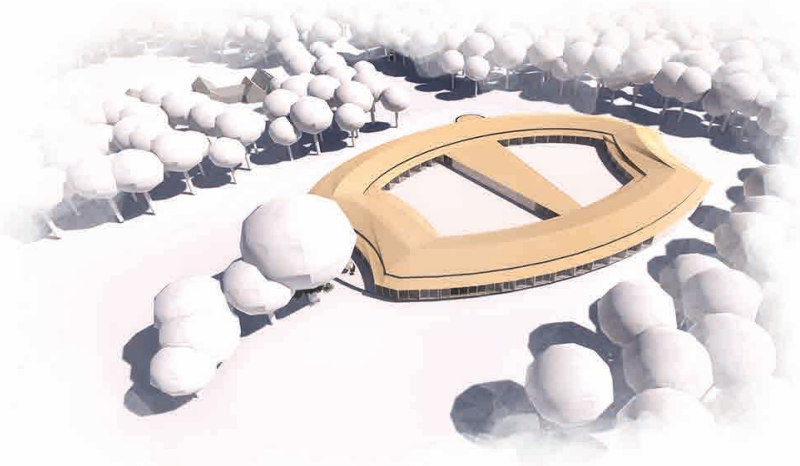
Ill. 132 Roofscape 0,4

Roof analyze

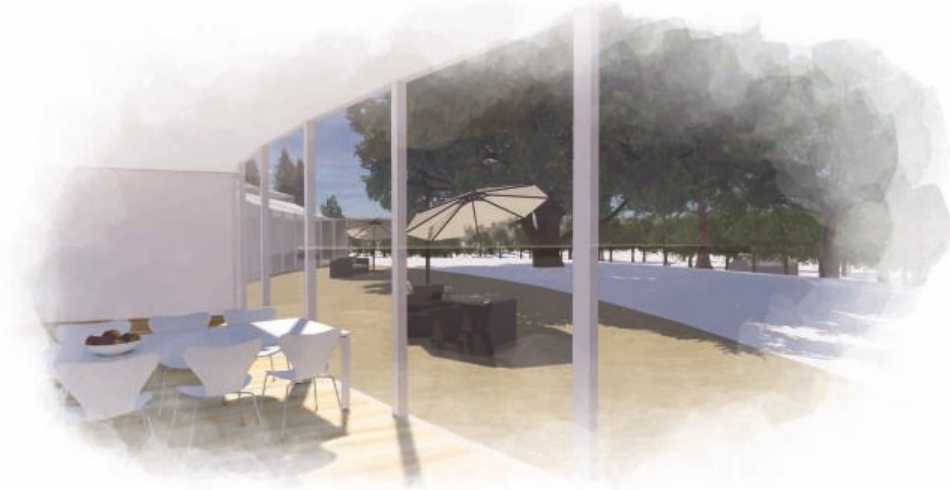
An investigation in different roofscapes was made in 3D modeling and physical models. This was done parallel to photovoltaics calculations(PV), to investigate the opportunity to implement active strategies on the roof to reach a Net Zero Site Energy Building(NZSEB).

These investigations were done while the plan was under development. From this investigation, the classic saddle roof was chosen, due to its link to the classical Danish farmhouse and the opportunity to gain large roof surfaces toward the south where pv could be implimented.

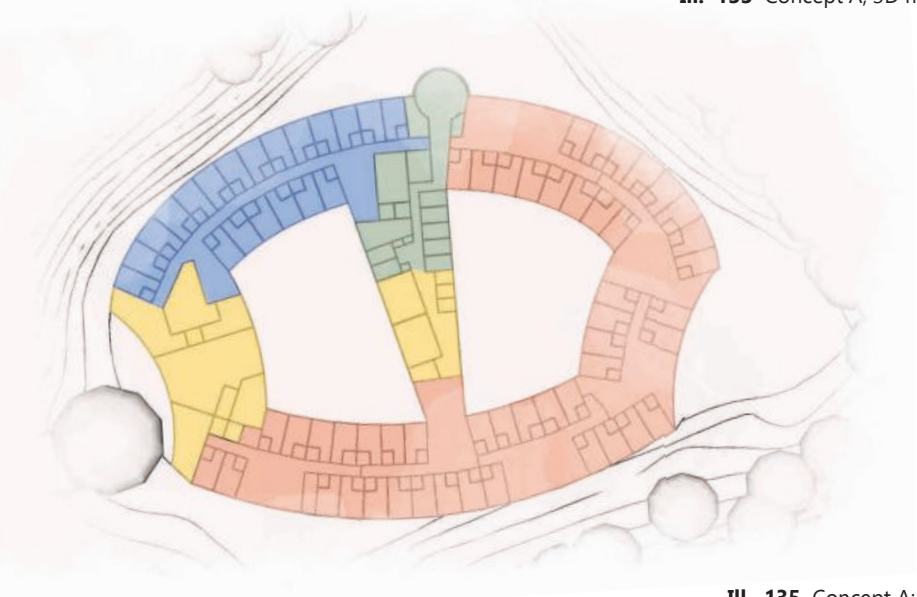
Concept A



Ill. 133 Concept A; 3D model



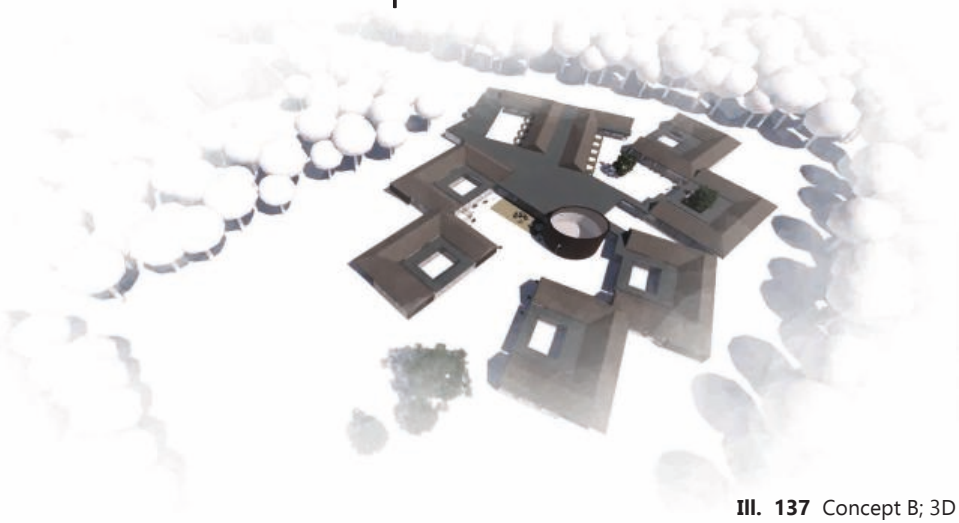
Ill. 134 Concept A; visualization 0,1



Ill. 135 Concept A; Plan

Ill. 136 Concept A; visualization 0,2

Concept B



Ill. 137 Concept B; 3D model

Ill. 138 Concept B; visualization 0,1

Ill. 139 Concept B; Plan

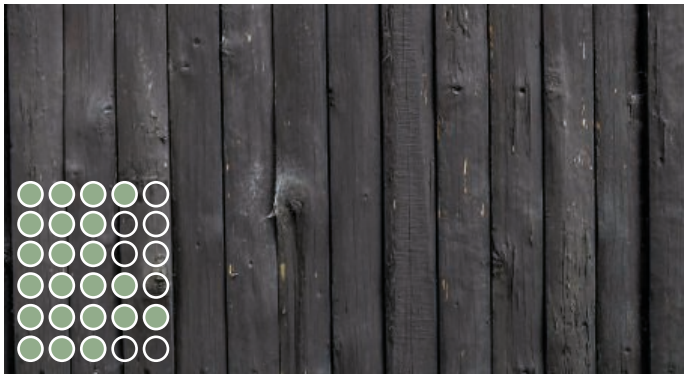
Ill. 140 Concept B; visualization 0,2

Material assessment

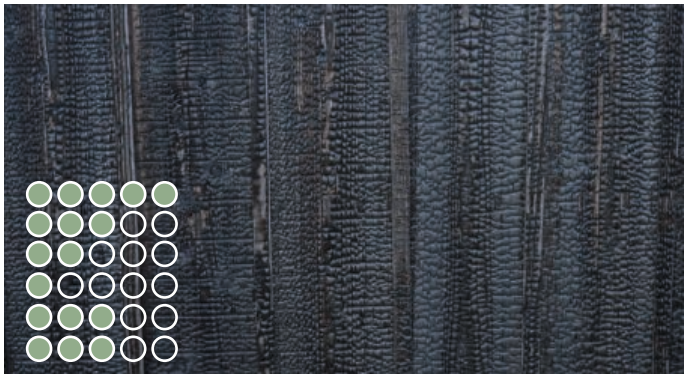
When new buildings are being built, the material used has an important role, as it accounts for a large part of the overall expression. Therefore, several different materials have been investigated and assessed. As the preference of materials can be different between personal preferences, a assessment matrix were set up. This made the assessment of each material individually and thereby achieve an objective assessment of the materials.

The materials are assessed on characteristic such as aesthetics, maintenance, tactility and color options. In addition the materials connection to the "History and spirit of the site" were also assesed. "History and spirit of the site" have a high priority in the assessment of the materials, as it was important that the new building were connected to the surrondings. The investigation gave an overview of different materials and their qualities.

Ill. 141 Material assessment: Untreated wood



Ill. 142 Materials assessment : Treated wood cladding

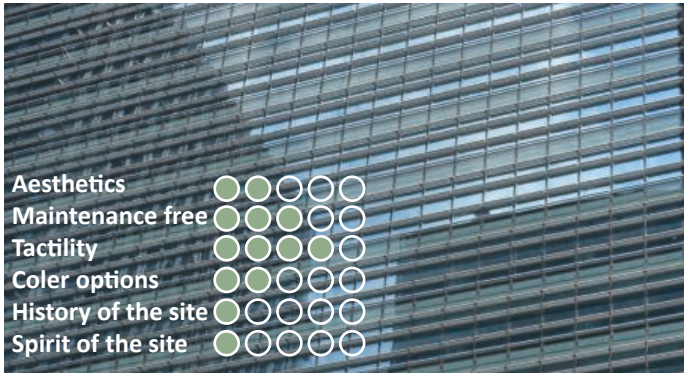


Ill. 143 Material assessment: Shou-sugi-ban (burnt wood cladding)

Ill. 144 Material assessment: Red brick

Ill. 145 Material assessment: Concrete bricks

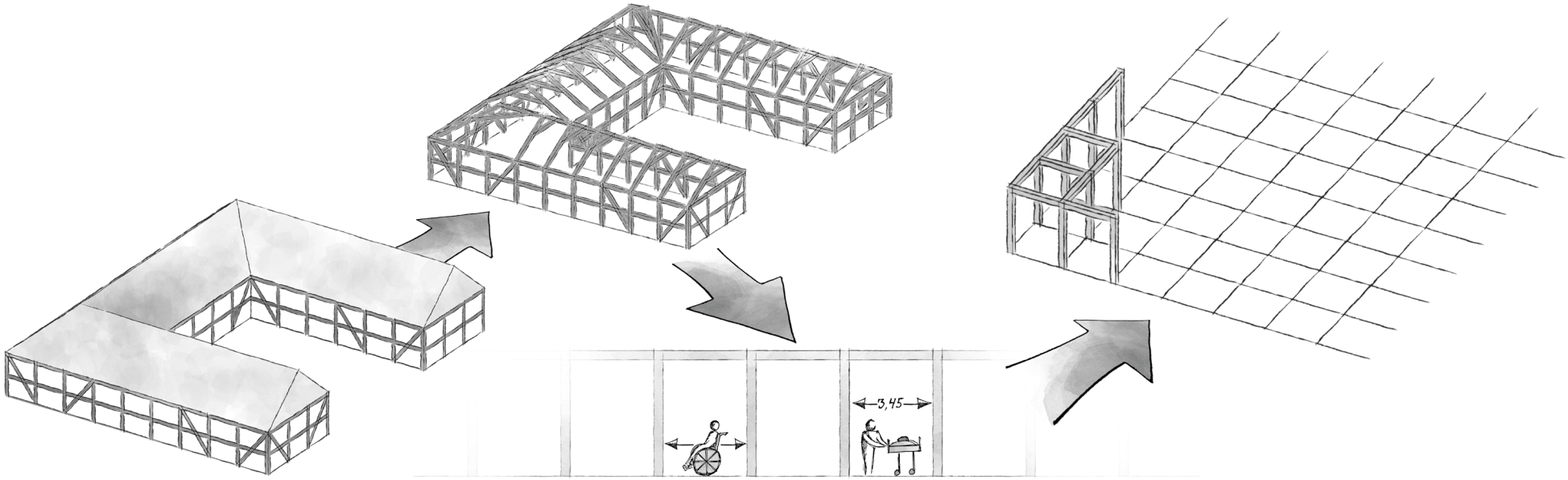
Ill. 146 Material assessment: Steel cladding



Ill. 147 Materials assessment: Glass facade

Ill. 148 Materials assessment: Concrete

Ill. 149 Materials assessment: Thatch

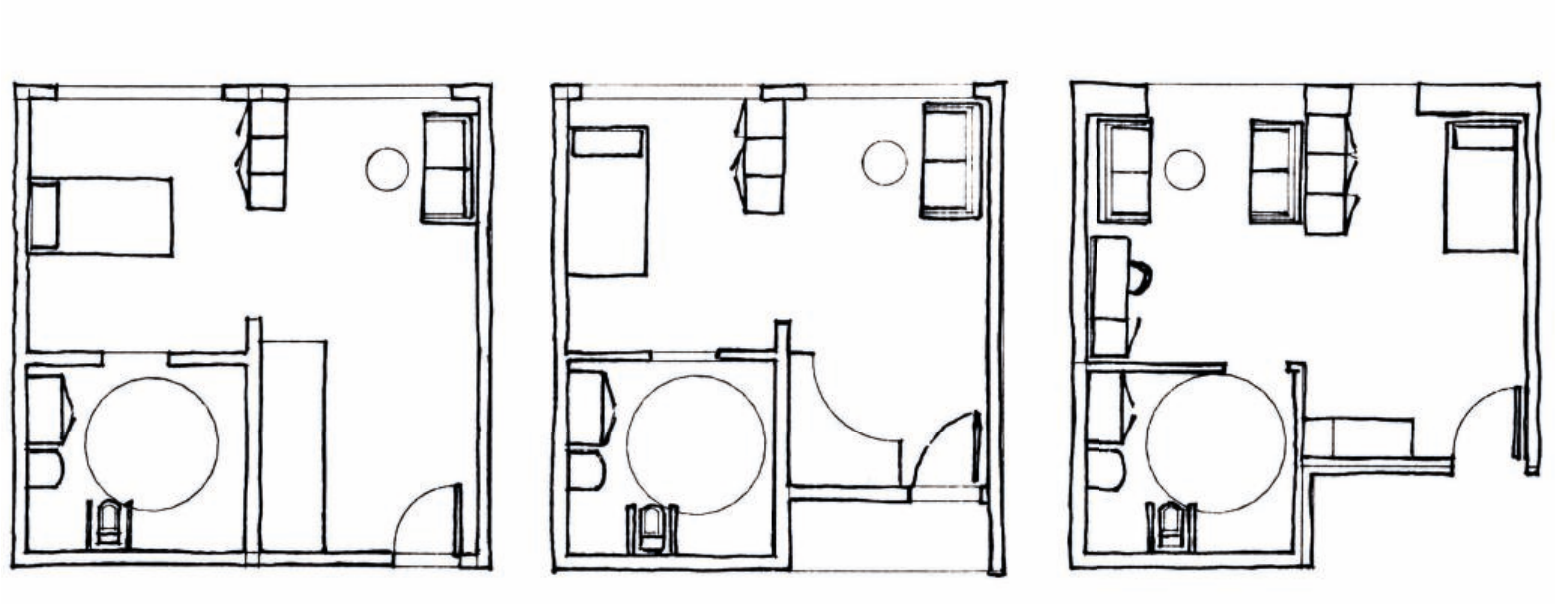


Ill. 150 Grid concept

Phase 3: Detailing

From the midway criticism, concept B were further developed in the intention of creating a strong link to the classical Danish farmhouse. The form of the three-length farmhouse is protective with a natural community and an opening that gives the form a direction with a directed view. The concept creates a scaling from the private to the social areas, where nature is always present. The plan and the inner courtyards are made by following a grid. This grid is inspired by the Danish timbered houses redesigned to fit the users need. This gives a structure and recognizable plan layout, that secure good wayfinding for the residents.

The concept was tested duing the detailing phase, by using personas for keeping a focus on the future residents of the building.
A more in-depth investigation was conducted in LCA and LCC to inform the environmental impact of the building and to keep a sustainable focus in the design phase.

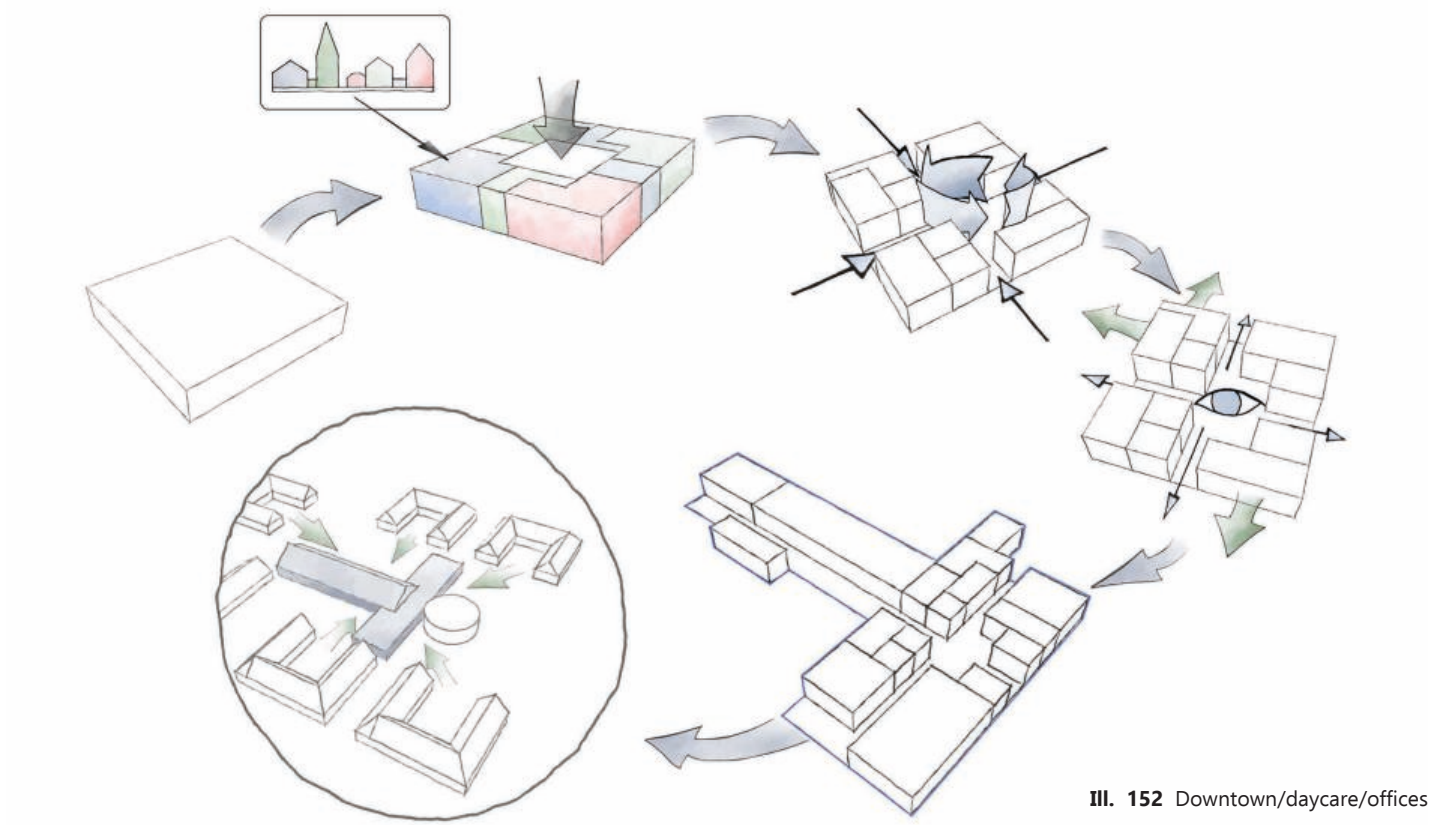


Ill. 151 Housing sketches

Phase 4: Detailing housing unit

A detailing of the housing unit was made to clarify the plan layout of the housing unit. Analyses into the specific demand and recommendations for a dementia nursing home were done in sketching and 3D modeling. The development of a number of different residential plans, that was shaped by placement and orientation was examined. Later it was decided to use a standardized housing unit to get a transparent and functional plan. In this phase, the windows were further investigated and different shading solutions were tested. In this phase, it was also chosen to implement roof light to get a lot of natural light into the building and secure view to the sky for bedded residents. These solutions were analyzed in Velux and BSim. A fixed solar shading was investigated in BSim but performed poorly in the west orientated residential. Based on this, a flexible solar shading was developed with inspiration from the Nature Agency and integrated into the facade and can be hidden away in the winter month, to allow more natural light into the building.

On the basis of the experiences gained at the field studies and the recommendation of the healing architecture, an investigation of the acoustics indoor climate was made. An inner wall between the residential and the common area was designed to reduce noise pollution. It was decided in the design criteria, that a good indoor atmosphere should be to reach category A. This was done to ensure what the vulnerable residents were not exposed to larger thermal fluctuations, that can cause discomfort and lead to illness. In this phase the fire regulations and safety were incorporated into the design, to secure as safe evacuation in case of fire.

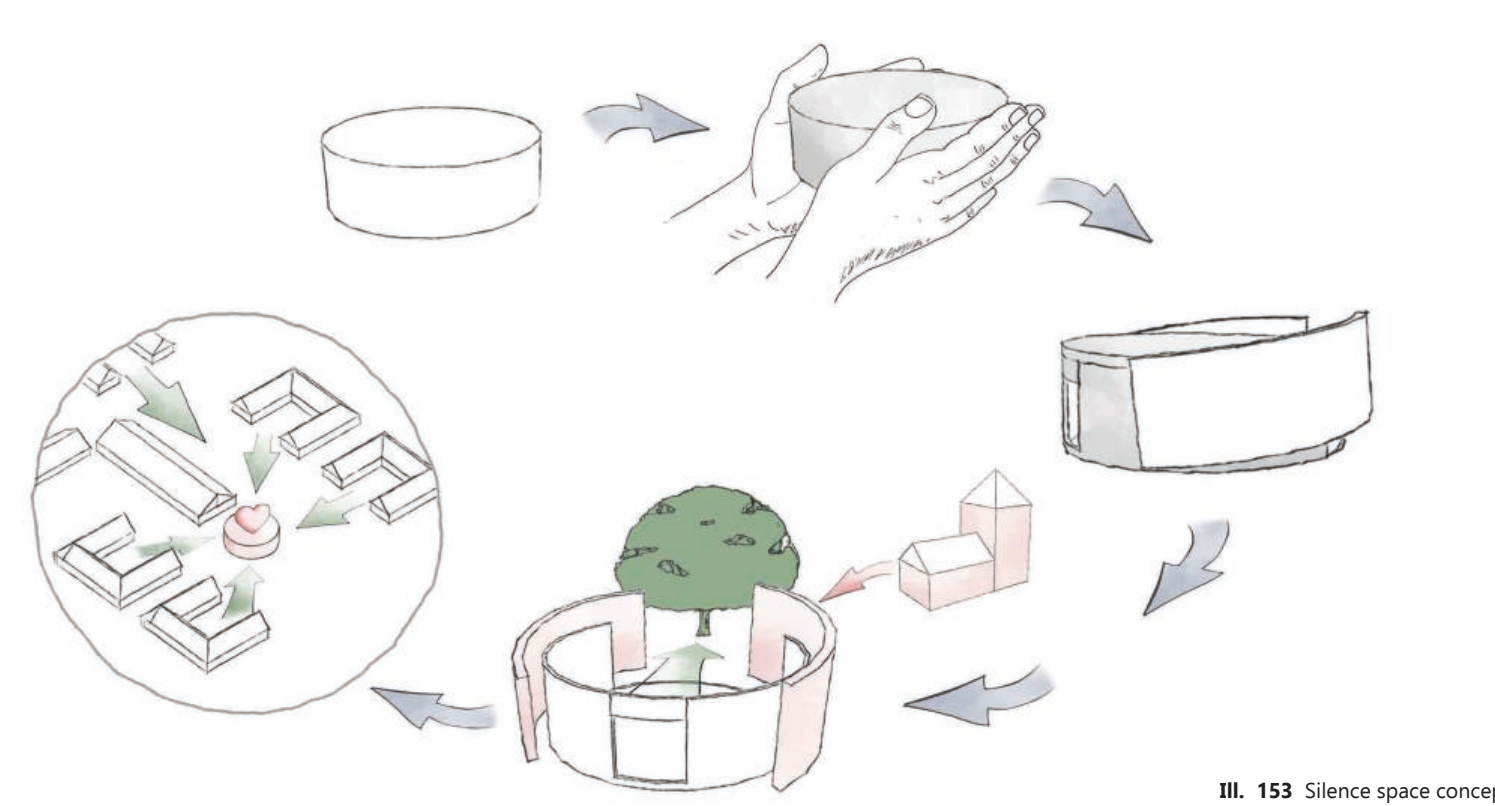


Ill. 152 Downtown/daycare/offices concept

Phase 5: Detailing downtown/daycare/offices

In the heart of the center is downtown and daycare located. This area contains functions that reflect the city and gives the residence the possibility to experience the elements of the city in a safe environment. The daycare center is an offer for the elderly citizens in Rebild municipality and is primarily focusing housing activities for people with dementia. The daycare center also gives the possibilities for future residents to experience the center and thereby get familiar with the center and staff, before moving in.

Mossø Center also has a support area with offices for the staff of the center. This is located in such a way, that it is the first thing one meets when coming to the center. The offices are designed to create a good and functional working environment with flexible solutions there should support staff and help them be flexible in an ever-changing daily life at the center.

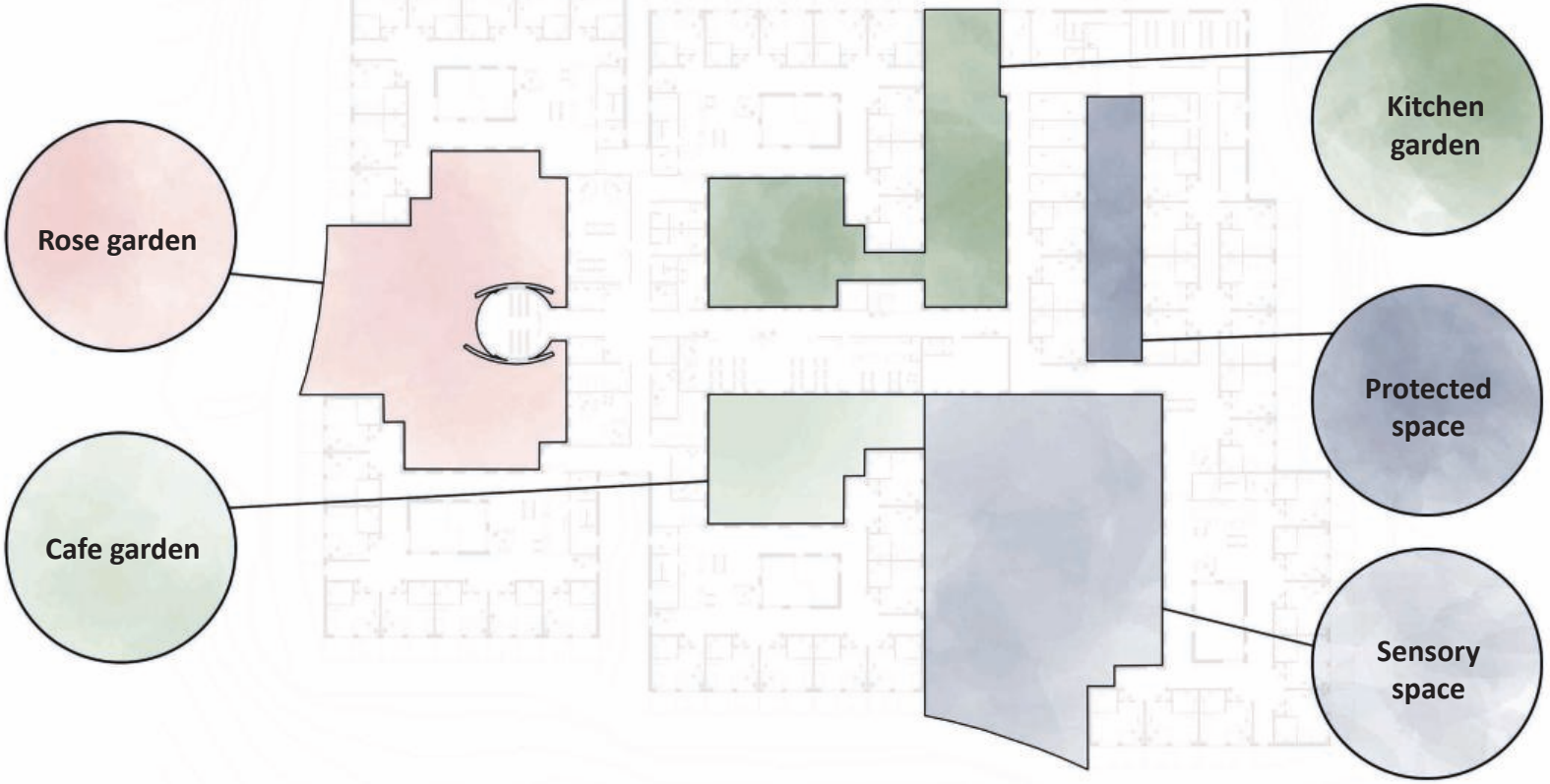


Ill. 153 Silence space concept

Phase 6: Silence space

A silence space is located in the heart of the Mossø Center. This space is designed to be a space for a wide range of emotions, that can be experienced at the center, due to the situation of the residents. During the case studies it become clear, that dementia is a fatal illness and due to that, most people moving into the dementia center, will have their final time there. This is a natural part of life and a situation is best handled with honesty and respect. The silence space is a place where both residents and relatives can reflect and be alone with their thoughts. This space can, therefore, function in many ways and be used for worship, community singing or sing out diseased residents.

Both the form and the material in the silence space stands out in contrast to the rest of the center. The use of stone and concrete creates a weight to the room that invites for calm thoughts and reflections. The room opens up toward the natural landmark of the area, the old beech tree, and in the evening time, the sunset in the west, behind the tree where light is filtered through into the silent space.

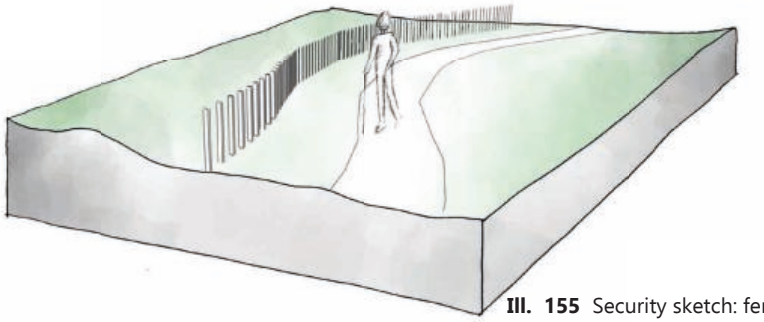


Ill. 154 Courtyards plan

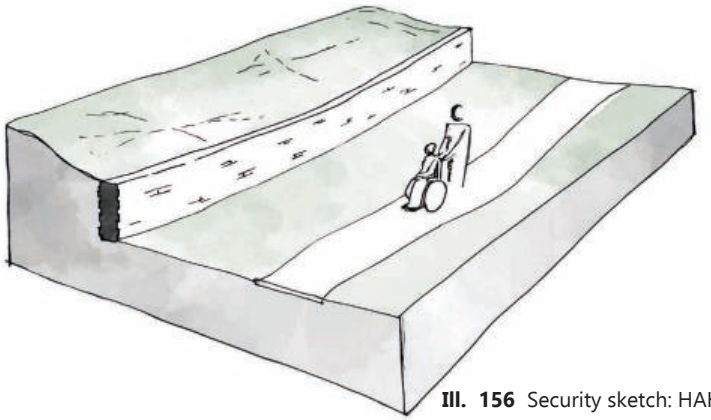
Phase 7: Definitions of courtyards

Mossø Center is designed in such a way, that five protected courtyards are formed, each with their own characteristics. The protected courtyards reflect the functions of the room they are located nearby and by that securing wayfinding for the residents.
The rose garden is placed around the silence space and is designed with rosebeds and benches with directed views toward the tree or the reflective pool. In this garden, the focus has been to create a calm environment, with time for reflection.
The protected space is in the inner courtyard between the somatic residential and it is designed to create an allotment environment, short views and small communities are formed over the hedges.

The sensory space is located near the centers gym and focuses on the proprioception link and the stimulation of the senses. This area doubles the active space in the summer month, where different outdoor activities can be held. The sensory space contains a fountain and flower beds to active the hearing and smell and is equipped with a sensory path to activate the sense of touch for the residents.
An interactive **cafe garden** area is located near the café and dining area. This area focus on creating an environment where residents and guest of the center can interact and get something to eat and drink. The last protected courtyard is a **kitchen garden** which is located near the kitchen and is designed to be handicap friendly and caters to the residents with green fingers.



Ill. 155 Security sketch: fence



Ill. 156 Security sketch: HAHA fence

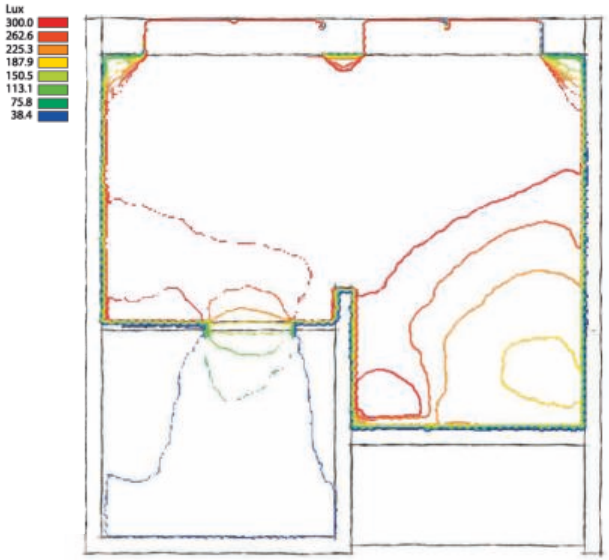
Security on site - zones and barriers

An interesting challenge in this project, was the balance between; the need for safety and protection of the residents, and the risk of creating an environment that keeps the residents as prisoners. To get an understanding of the legislation and the challenges an analysis where made in to the legial framwork of the projekt. This where done in the chapter legislation for a dementia center, through interviews and in the case studies. On the this the following security measures were developed.

Security measures:

- A resident with a special high risk of wandering outside the protected environment can after an agreement with relatives, attach a GPS sensor, that activates when the resident leaves the center and also functions as a panic botton.
- A sensor in the residents apartment that alarms the staff if a resident has woken up in the middle of the night, gives the staff a possibility to take action if it is a resident that is extra fragile or poor walking.
- Plan design – community before exit and a natural focus on the community.
- Plan design – wayfinding: a focus on a manageable and a passable environment.
- Double doors by the entrance.
- Double open mechanism on exterior doors and garden gates.
- Urban barriers along the division of the center, such as “HAHA fence” with a height of 900 mm, a handrail free fence with a height of 900 mm appealing against climbing and a sensor along the barrier, that can alarm the staff if the fence is climbed.

Ill. 157 Window sketch



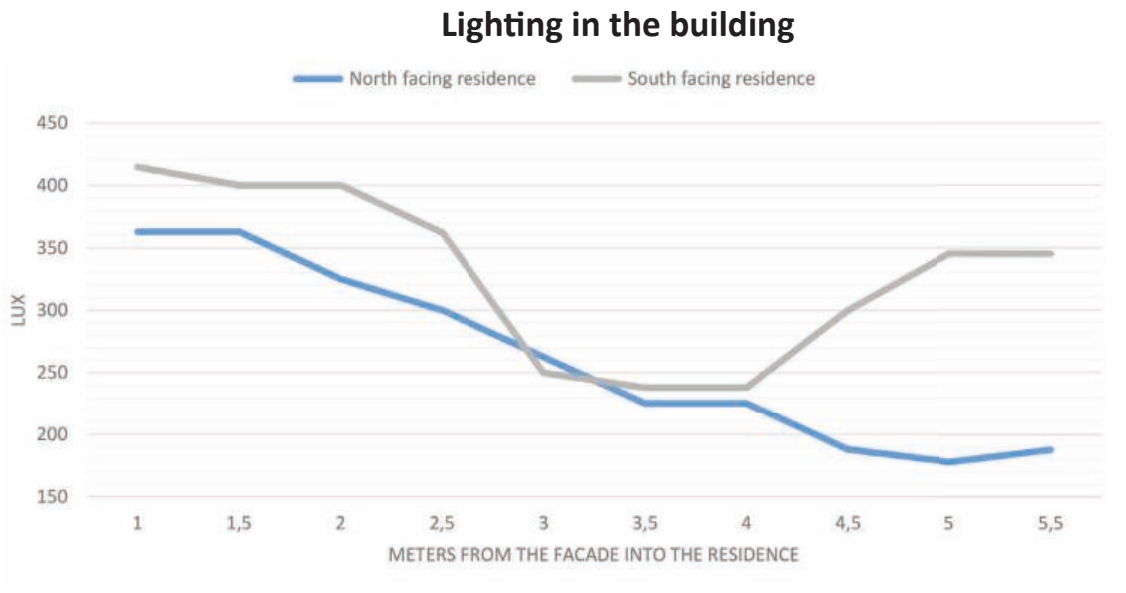
Ill. 158 Velux analyse

Lighting calculations in the building

A good indoor climate is largely dictated by a good visual indoor climate. An adequate daylight level in the building is important for both the residents and the staff and is of high priority when designing to reduce stress and create healing architecture (Podbelski, 2017). Healing architecture also has a high focus on using natural lighting to create a good and well-functioning visual indoor climate that reduces stress and have the opportunities to create good views to nature (Frandsen et al., 2009).
The use of daylight also helps the residents keep a daily rhythm, where natural light creates a clear sense of time and ensures that the residents are active at the times of the day when there are most activities and most staff present. This ensures a safe and rich daily life for the residents. A good visual environment also helps to ensure that the staff can, in a good and sound manner, solve their tasks, and the amount of errors is reduced (Frandsen et al., 2009). Moreover, a good indoor climate helps to secure the possibility of a good and satisfactory working environment for the staff which in the end also benefits the residents. There is an increased need for a good visual indoor climate due to the project's specific occupant.

A poor visual indoor climate may impair the everyday life of the residents. Placement of natural and artificial light is of great importance and when placing the windows in the home there was great attention to the fact that the location must ensure the possibility of looking out to nature for both the residents in wheelchairs and bed-ridden residents. On the basis of field studies, recommendations and analysis, a skylight were implemented in the home to ensure that bed-ridden residents can look up to the sky, and get more natural light into the building.

During field studies, it also became clear that light had both a very positive quality for the residents, but could also pose a challenge, especially the location of the lighting and focused lighting, could create dark areas on the floor and walls, which could create an illusion about holes in the floor to some residents can be very stress causing.



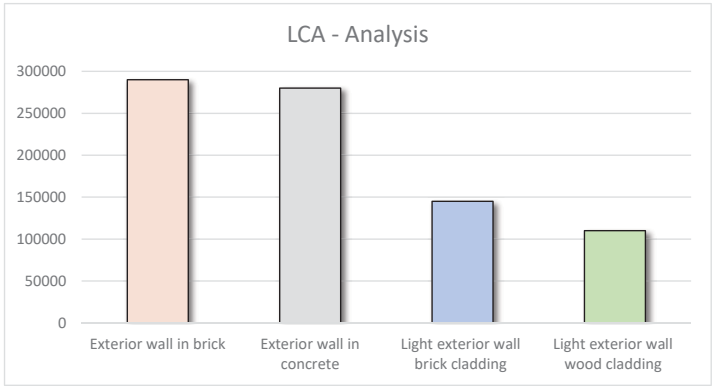
Ill. 159 Light diagram

There was a great focus on the lighting in the hallways and the common areas must have uniform lighting, which can be done by supplementing natural lighting with artificial lighting. This must ensure an even and good visual indoor climate throughout the building.
The dimensions of the windows from the home are designed in such a way that the resident is given a choice about exposure and has the opportunity to determine how visible or hidden he or she wants to be from the center's outdoor areas.

Under the Building Regulations 2018 specific guidance on light and vision, it can be seen that the visual indoor climate must fulfill 1 out of 2 set requirements. The first requirement; that there must be 300 Lux on at least half of the relevant floor area. Can't this be fulfilled, the sum of the glass area with corrections must be at least 10% of the total relevant floor area of the room (Bygningsreglementet.dk, 2018).
Analyses were made of the residential, as it is the building's most important room. Residential facing south, west and north were simulated in velux. In the residential phasing south and west there were sufficient daylight with lighting above 300 lux on more than half of the relevant floor area, however, the residential facing north only fulfill the demant of at least 10% of glass area of the total relevant floor area.

The glass area of north-facing windows and doors constitutes 40% of the relevant floor area.
The glass area of south-facing windows and doors constitutes 30% of the relevant floor area.

The analysis shows that in the most critical residential at the dementia center, there is sufficient natural light, and thus meeting the requirements for a good visual indoor climate. However In the dementia homes to the south, there is a risk of high lighting if no forms of solar shading are implemented. This was investigated in Bsim and possible design solutions to meet this challenge are prepared and analyzed in Velux as well as Bsim. This was implemented to secure a good thermal- and visual indoor climate in the south-facing residentials of the dementia center.



Ill. 160 LCA diagram

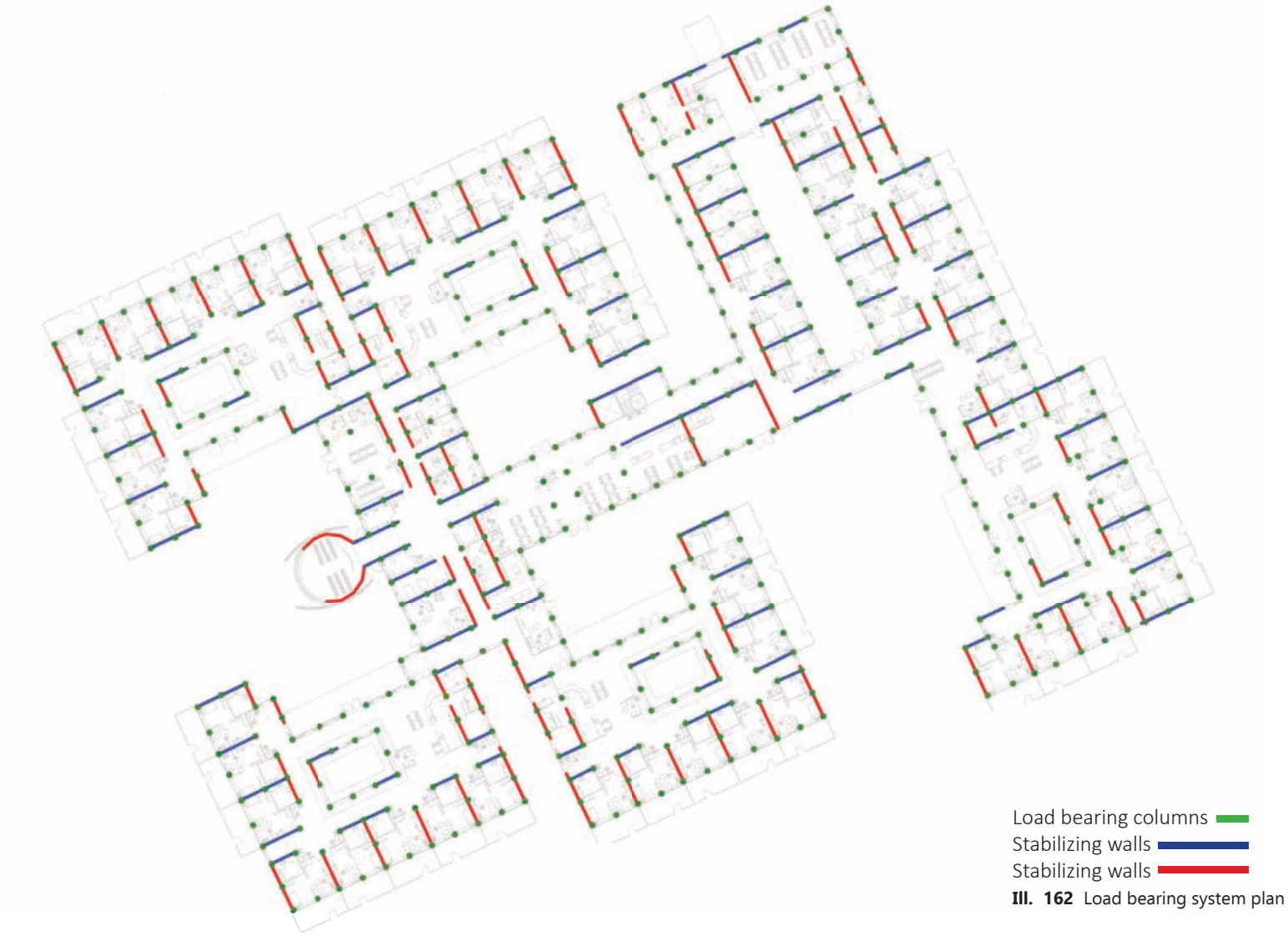
Ill. 161 Facade analysis

Facade analyzes

The choosing of materials is very important in relation to creating a building, that fits into its surroundings in Rold forest. Some of the first analyzes of the area, the types of buildings in the area and the history of the site, gave the facade analyzes a starting point. The forest around site have been an important factor in opening the posibielitet to the use of local wood as a primary element in the construction.

An analysis of the materials in LCA gave an understanding of which material the outer wall could be made of, and the environmental straining differences between; concrete, bricks and a light wood construction. A outer wall made of light wood with either a wooden or bricks cladding. where also analyzes, an visualization of the different proposals was made. See ill. 161

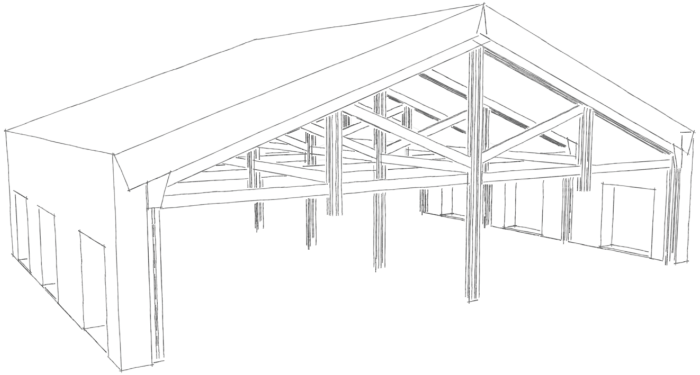
Based on the analyzes, a decision of the façade being a combination of dark and light wood, was made. It was decided to use heat treatet wood to lower the use of toxic chemicals in the facade, furthermore, the construction should be constructed in FSC labeled wood. The wood cladding changes direction and the darker wood sweeps from the foundations up the façade and become the roof. The building is characterized by using two different types of wooden cladding and creates a story by pulling the dark wood out and pushing the lighter wood in, of protected communities. The dark wood creates a protective shield towards the forest and the lighter wood underlines the smaller community between the residentials, which is reflected in the buildings plan. The difference between the dark and the light wood creates a rhythm in the façade which defines the façade of the Mossø Center.
At the heart of the center the Silence Space is located. This part of the building is different in both shape and material. The space stands as a contrast to the wooden construction and is build out of a concrete wall and brick cladding. The choice of material underlines the buildings function and is created as a space for calm reflection and silent thoughts.



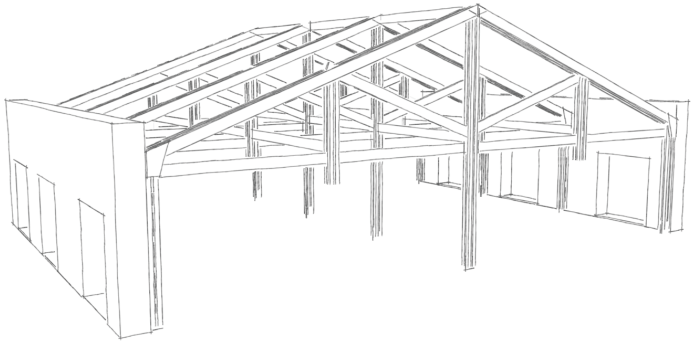
Ill. 162 Load bearing system plan

Columns, load bearing and stabilizing system

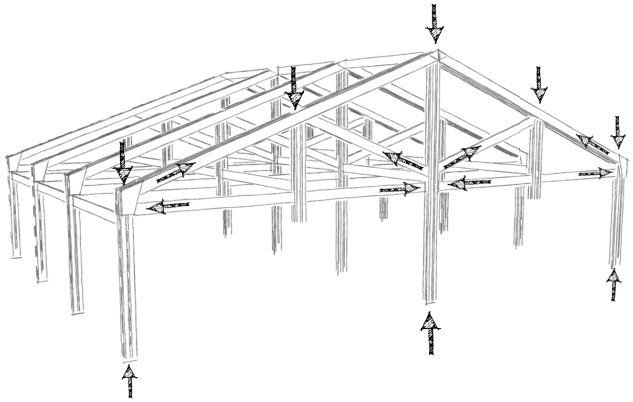
The bearing construction and the stabilizing walls was continuously considered through the design process and in this process there was made some analyzes about different designs of pillars and a bearing system on a conceptually level. Illustration 162 shows a schedule of the bearing pillars and stabilizing walls. The pillars is made in a grit of 6,9m*6,9m that is made in continuation of a modular system of 0,3 m which also shows all the deviations from the grid. All through the building this grid is used, and in the big common areas in the daycare and the café area the bearing construction is visible. The visibility of the bearing construction is from the common areas to the private space toned down to emphasize a calm atmosphere.



Ill. 164 Construction system 0,1



Ill. 165 Construction system 0,2

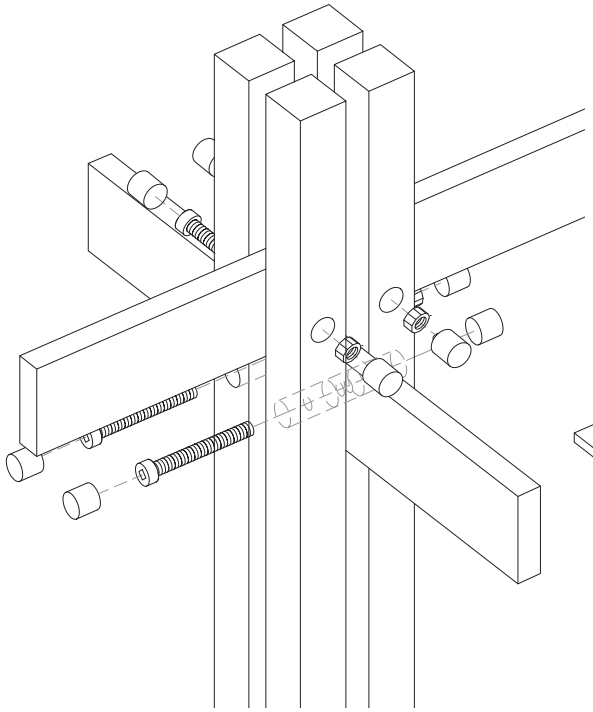


Ill. 163 Construction system 0,3

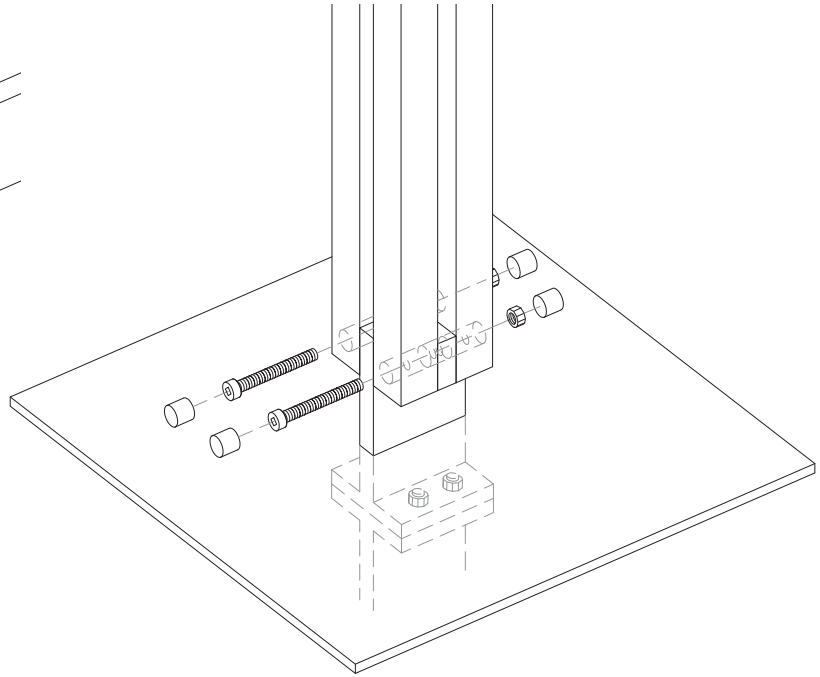
Wood construction detail

The Mossø Center is designed in a grid system, which always goes up in 0,3 meters. The grid is scaled to fit the physical needs of the user based on recommendations and measurements from field studies and based on that, a grit at 6,9 *6,9 meters is chosen. From this grit the load-bearing system is placed.

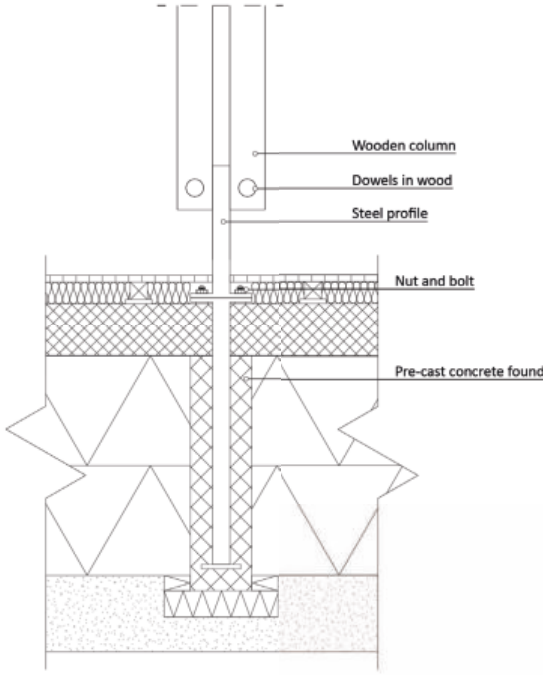
The wooden columns are arranged in a visible and honest structural system. This is done to create a visual story that highlights the transition from the social and common areas of the building to the more private areas where the load-bearing system is toned down. The construction detail of the system is the same and used throughout the building.



Ill. 166 Construction wood detail 0,1



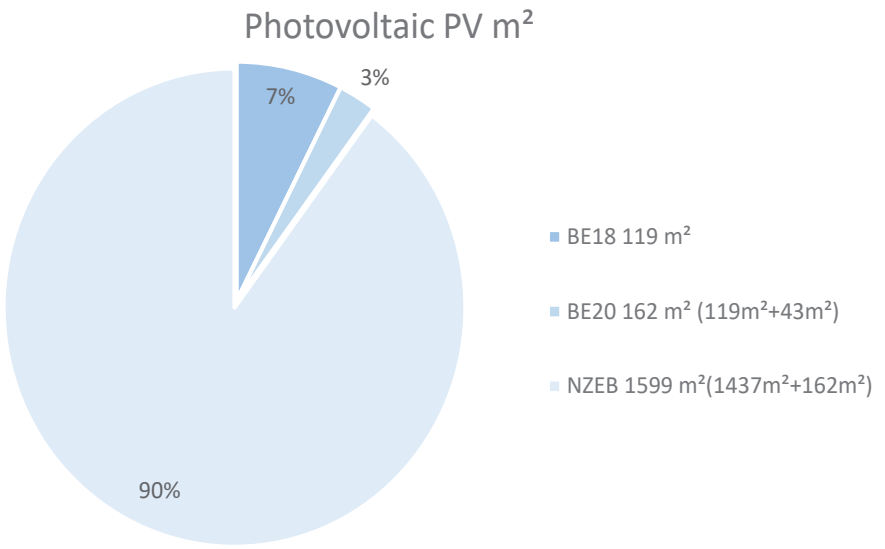
Ill. 167 Construction wood detail 0,2



Ill. 168 Construction wood detail 0,3

The use of wood in the structural system is chosen to make a strong reference to the old Danish farm, houses located in the area. The wooden columns consist of four smaller columns bonded together and lifted from the floor, with a gauge steel shoe lifting the columns up from the floor and by that giving the columns a light expression.

Wooden beams goes from north to south and from east to west and are weaved through the columns in a transparent system which tells a story about how the different loads goes through the system and how the construction is put together.

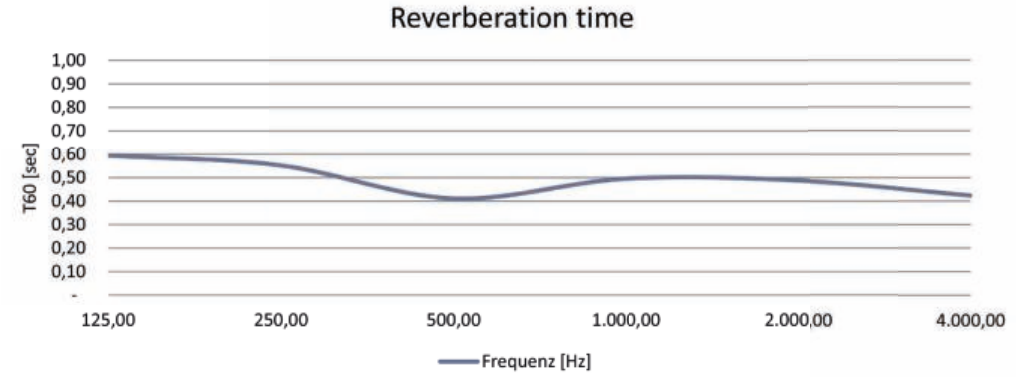


III. 169 Photovoltaic diagram

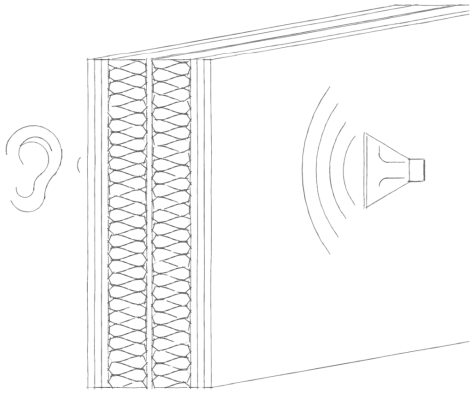
PV calculations

In the priliminary part of the process, the possibility of designing the project as a NZSEB was investigated. In that extension some PV calculations was made to investigate the need, the number of square meters and the placement of the PV on the building. In the beginning these calculations were based on a number of assumptions, which, during the design process, became more specific. This helped inform if the roof should be 0°, 15° or 30°, and how many PV had to be implemented to achieve a NZEB. See appendix page 9 page 201. During the analyzes an investigation of different types of solar cells were made. These different types of solar cells are monocrystalline with an effeciency at 15-18 %, polo crystalline with an effeciency at 10-15 % and thin film with an effeciency at 4-10 % (Slupinski, 2017). Based on the analyzes, monocrystalline was choosen because it is the most effecient but also because of the color options and the possibility to integrate them in the roof. The different roof pitch were analyzed and the nessecary area was calculated as well as the peak performance for PV. In the chart below the conclusion og the analysis is shown. It shows that for the building should be implemented 1599 m² PV to be able to provide enough energy to cover the buildings electricity needs and achieve a NZEB.
Finally a calculation of the price for the PV system where calculated. The price for a PV monocrystalline per square meters is 2221,85 DKK. By adding this to the 1599 m² that was needed for the building, it will cost 3.552.738,15 DKK inclusive installation, (Billigsolceller, 2019).

Total energy need for the building =	235.082,20 kWh per year	Total area covered by solar cells	1437 m²			
Energy covered by saddle roof (30 degrees)	171.889,98 kWh per year	Solar cells on roof (30 degrees)	1014,1 m²	129,04 kW peak	0,1272 kW/m²	64 %
Energy covered by flat roof (0 degrees)	63.192,22kWh per year	Solar cells on roof (0 degrees)	422 m²	71,46 kW peak	0,169 kW/m²	36 %



Ill. 170 Reverberation graph



Ill. 171 Inner wall concept

Acoustics

The acoustic indoor climate was investigated, because field studies showed that some dementia people woke up during the night and were able to wake up the entire residential unit due to noise. The field studies also showed that the common areas had resounding noise that disturbed normal conversations. These disturbances are to be avoided and because of that, the demands to the acoustic in the common areas and the residential are higher than normal. With sound class A (DS 490, 2007), which is the highest acoustic condition, the residents are only occasionally disturbed and normal conversation can easily be understood (Jensen, n.d.).

The demand to reach an acoustic indoor climate of class A from DS 490, is achieved with a reverberation time under 0,6 seconds, between 125 – 4000 Hz (DS 490, 2007). There are also requirements to the threshold in airborne sound between the residential on 63 dB (DS 490, 2007). This is achieved by implementing an inner wall between the residentials and between the common area and the residentials. A wall of 225 mm will achieve a sound classification between 60-65 dB (Gyproc.dk, 2017) are shown in Illustration 171. The partition will prevent discomfort for the neighbors, if pictures are hung on the wall. Furthermore, silencers will be put on the valves to avoid noise pollution from the vents.

The residential needs to feel like home for the resident and functional for the staff. There are worked with choice of materials and surface treatment on inside surfaces, and acoustic panels are implemented in the ceiling to achieve a reverberation time below 0,6 seconds. The investigations were made without furniture and people, implementing this will further improve the acoustics indoor climate.

Illustration 170 shows that there are achieved a constant reverberation time between 125-4000 Hz in the residential, that secure the possibility to have conversations.

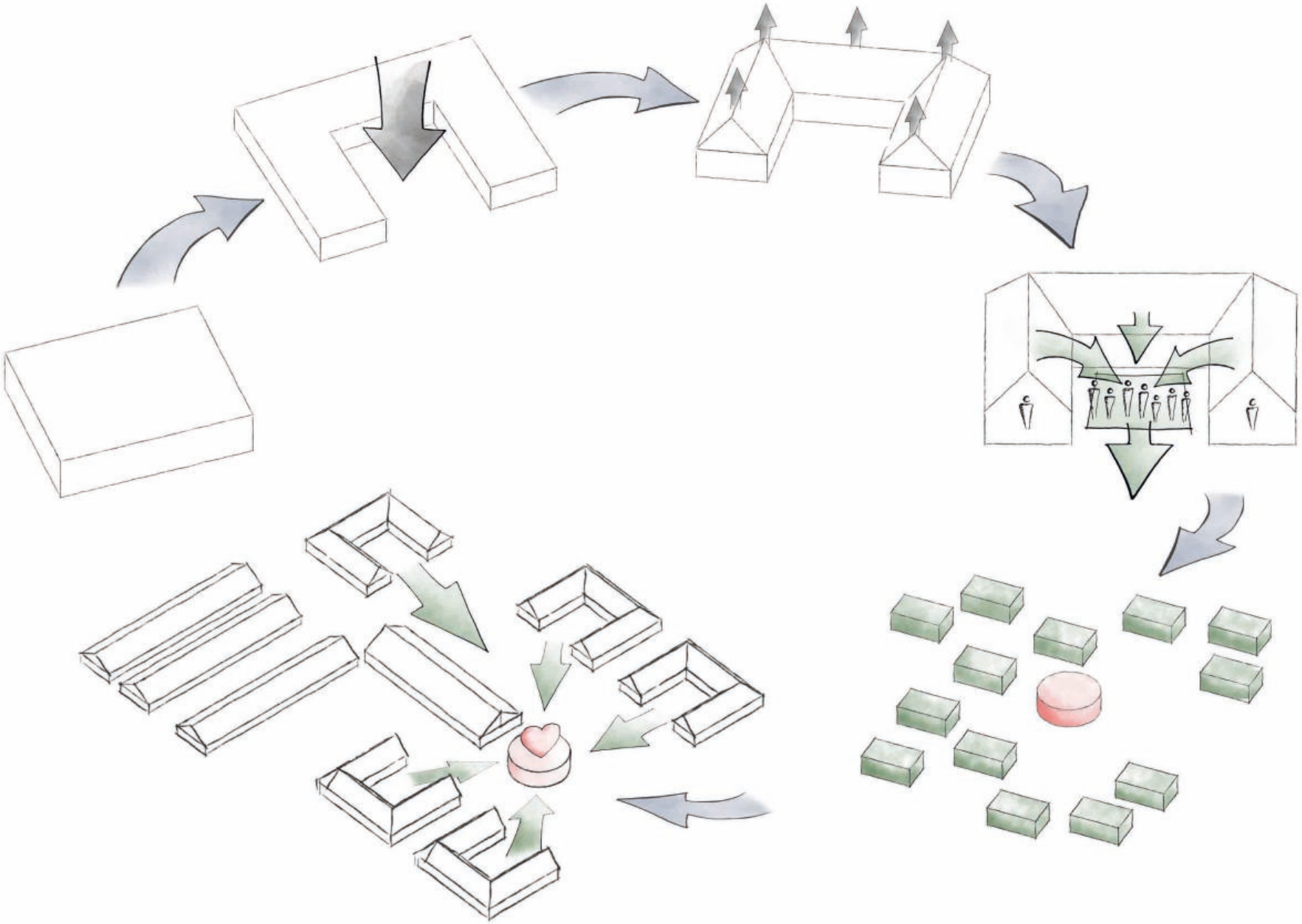
Presentation

Introduction

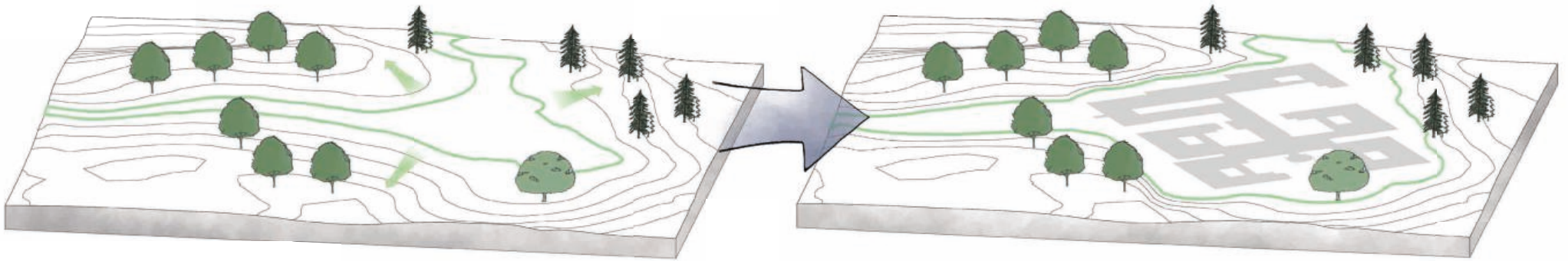
In the following section, the Mossø Center will be presented. The center as a whole is one building, divided into four sections consisting of; entrance with offices, daycare and downtown, somatic hosuing, and dementia housing.

The Mossø Center is designed with five residential housing units, consisting of eight dementia friendly residentials. Furthermore, the center is designed with 12 elderly residentials, which enable couples to move into the center together, however in their own residential, due to the nature of the illness. A downtown and daycare center has been implemented with the intention of giving the citizens with dementia in Rebild municipality a daycare offer, this also enables future residents to get to know the Mossø Center before moving in. The daycare center can house approximately 30 visitors, with space for relatives and staff. The staff area is located near the entrance. The staff mainly consists of 41 social and health assistants. In addition, there are a doctor, psychologist, physiotherapist, priest, social worker, music therapist, janitor, management, two kitchen and two cleaning staff. This gives a permanent staff of 54 personal with additional 12 trainees.

The presentation begins with the concept and describes the building from the outside and in, with visualizations, plans, sections, and elevations. In the end of the presentation there is a technical description of the project, consisting of detail drawings, calculations, and diagrams. Finally the project is concluded in the epilogue with a conclusion and reflection.



Ill. 172 Concept diagram



Ill. 173 Landscape diagram

1

Ill. 174 Visualizations 0,1

Ill. 175 Master plan roofscape

2

Ill. 176 Visualizations 0,2: Entrance

Ill. 177 Master plan and section cut

3

Ill. 178 Visualizations 0,3: Dining area

Daycare & Downtown
Scale 1 : 500

Ill. 179 Daycare & Downtown

4

Ill. 180 Visualizations 0,4: Housing unit

III. 181 Housing unit

Section cut BB
Scale 1 : 200
Ill. 183 Housing unit: Section cut 0,1

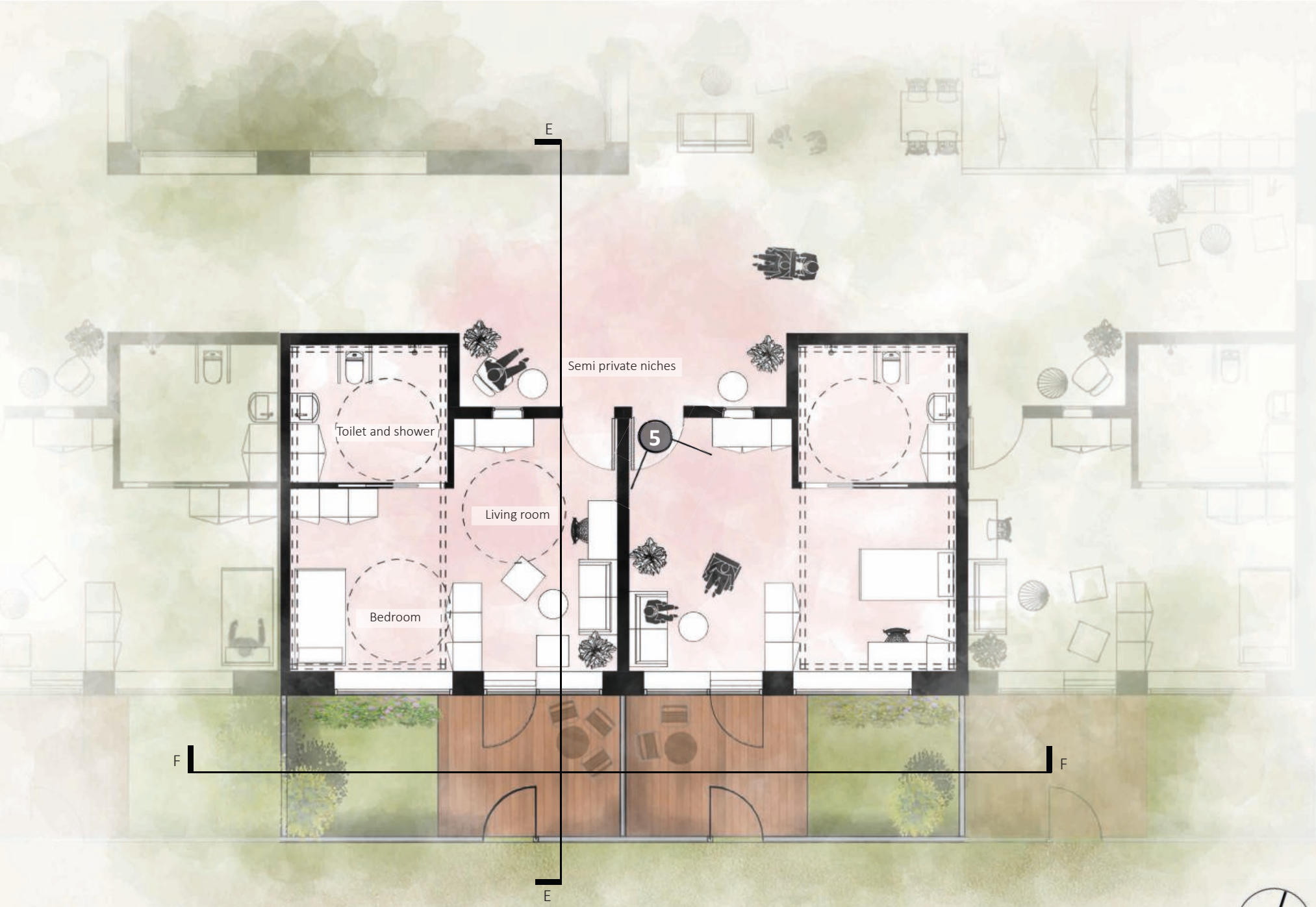
Section cut CC
Scale 1 : 200
Ill. 182 Housing unit: Section cut 0,2

Elevation DD
Scale 1 : 200

Ill. 184 Housing unit elevation 0,1

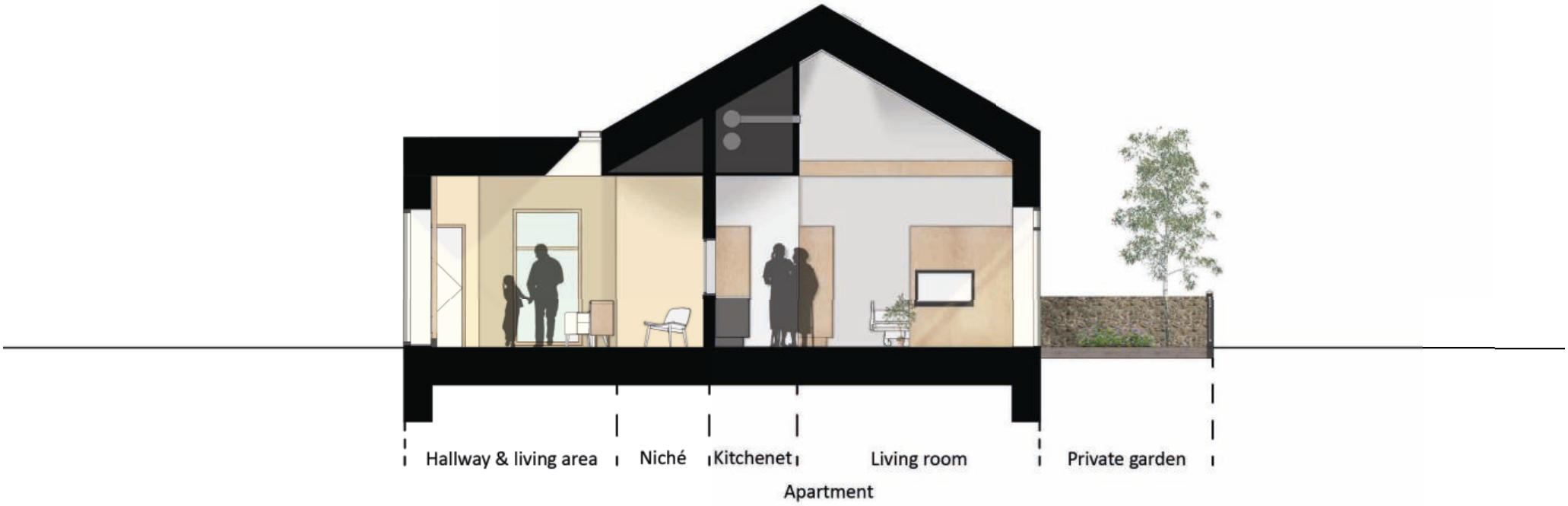
5

Ill. 185 Visualizations 0,5: Residential



Residence
Scale 1 : 100

Ill. 186 Residential plan

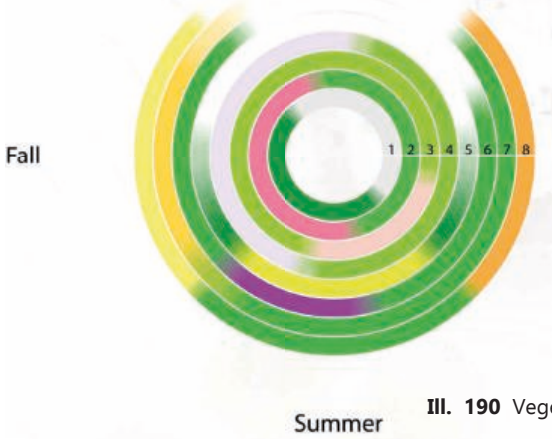


Section cut EE
Scale 1 : 100

Ill. 187 Residential section cut 0,1

Elevation FF
Scale 1 : 100
Ill. 188 Residential elevation 0,1

Ill. 189 Material diagram



Ill. 190 Vegetation

(1) White spring – Erica carnea silvery (Sans Secret, 2019a).
(2) Rose- English roses (Sans Secret, 2019b).
(3) Hordeum jubatum – Foxtail Barley (Sans Secret, 2019c).
(4) Cortaderia selloana – Pumila (Sans Secret, 2019d).
(5) Helianthus annuus – Vincent's choice (Sans Secret, 2019e).
(6) Clematis – Aotearoa (Sans Secret, 2019f).
(7) Acer palmatum – Koto-no-ito (Sans Secret, 2019g).
(8) Betula ermanii – Grayswood Hill (Sans Secret, 2019h).

Ill. 191 Urban plan

6

Ill. 192 Visualizations 0,6: Sensory space

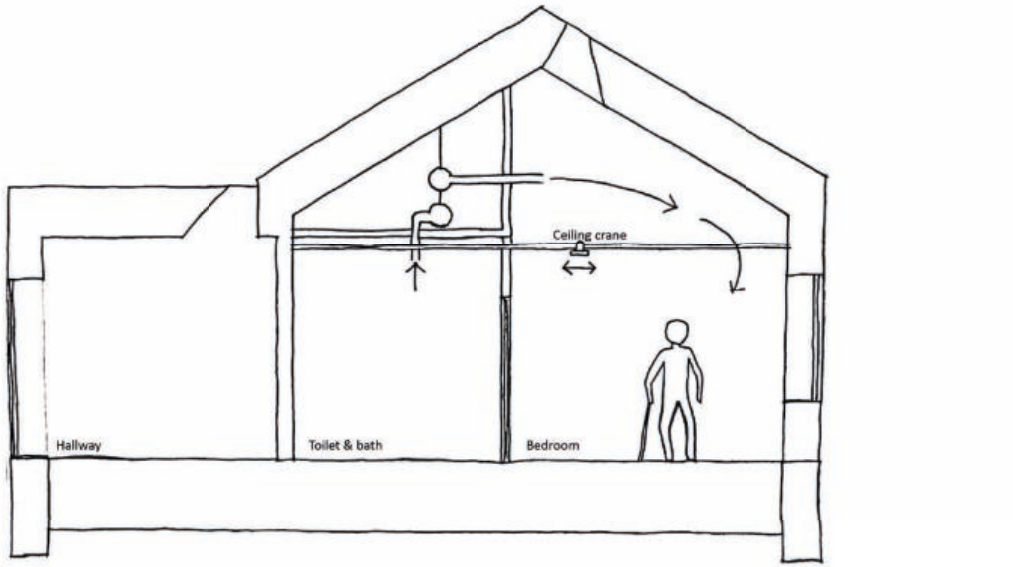
7

Ill. 193 Visualizations 0,7: Kitchen garden

8

Ill. 194 Visualizations 0,8: Silent space inside

Ill. 195 Visualizations 0,9: Silent space outside



Ill. 196 Mechanical ventilation section cut

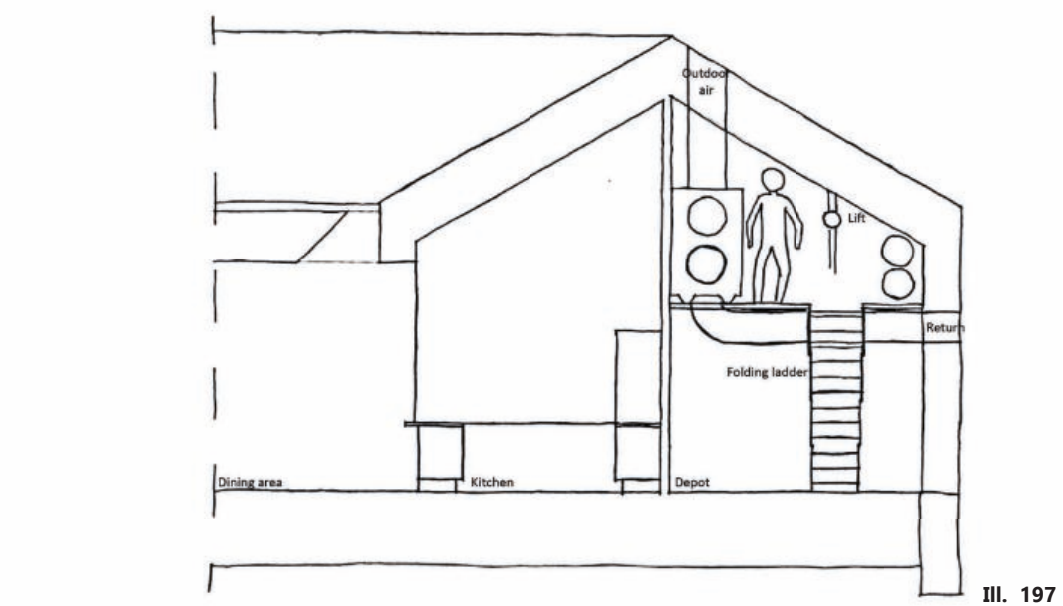
Mechanical ventilation

At the Mossø Center there is a desire to achieve an indoor climate class A from DS CEN CR 1752. In order to achieve this requirement for the atmospheric indoor climate, the number of dissatisfied people must be a maximum of 15%, which corresponds to a CO2 concentration of 400 ppm above the outside air (DS_CEN_CR 1752, 2001). Based on the building regulations 2018 §§ 420- 452 under guidance, section 1.7, it is described that the outside air concentration can be assumed to be 400 ppm. This gives a CO2 concentration of the indoor air at a maximum of 800 ppm. An example of calculating a minimum air change for an apartment will be reviewed in steps. First, CO2 production is calculated for one person, where the average metabolic rate is set to 1,2 met, equivalent to sedentary activity, as read from Annex D (informative) table D.1- Metabolic rates of different activities, in DS CEN CR 1752. CO2 production is determined for an activity level of 1,2 met with the following formula:

$$Q_{v,co2} L/h = 17 * M\ met$$

$$20{,}4 \frac{L}{h} = 17 * 1{,}2\ Met$$

17 = Constant
M = Metabolic rate [met]
Qv,co2 = CO^2 production pr. person I [l/h]



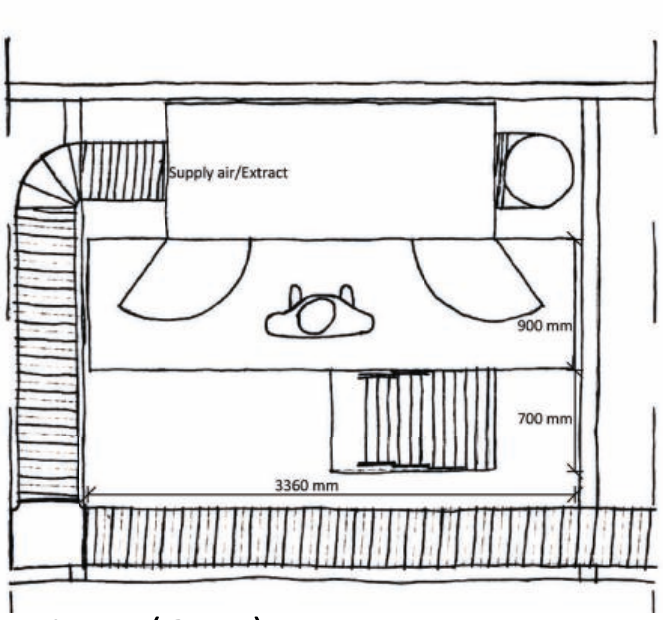
Ill. 197 Ventilation System section cut

When CO_2 production is known for one person, an air change can be calculated. It is assumed that a resident is in the apartment 100% of the time and a staff member 10% of the time. The calculated air change is calculated in h-1, where the CO2 production and the concentration in the air must be converted to the same unit. The conversion of units is entered in the original formula:

$$n\ h^{-1} = \frac{\left(\frac{N * Q_{v,co2}\ L/h}{1000}\right)}{C_o \frac{m^3}{m^3} * (10^{-6}) - C_i \frac{m^3}{m^3} * (10^{-6}) * V} \qquad 0{,}21\ h^{-1} = \frac{\left(\frac{1{,}1\ * 20{,}4 L/h}{1000}\right)}{800 \frac{m^3}{m^3} * (10^{-6}) - 400 \frac{m^3}{m^3} * (10^{-6}) * 132\ m^3}$$

n = Air change [h-1]
N = Amount of people
Qv,CO_2 = CO_2 production pr. person.
COo = CO_2 Start concentration in the room [m^3/m^3].
COi = CO_2 Concentration of the inlet air [m^3/m^3].
V = Room volume [m^3]

The air change for an aparment is 0.21 h-1. For all rooms at the Mossø Center, the following calculation will be made for the air change, where the activity level may vary. The calculated air changes can be seen in the space program. The need for ventilation in rooms can vary in both times and loads. Here, a variable airflow (VAV) is chosen as a strategy, in order to adapt the user's need and thus save energy used for ventilation (Exhausto.dk, n.d.)



Ill. 198 Ventilation system plan

Mechanical ventilation (SEL)

The pressure loss in the ventilation duct will be investigated to secure that a chosen ventilation system ventilates a necessary amount of air flow. Bygningsreglementet 2018 states some legislative requirements for the specific electricity consumption to air transport. For the chosen ventilation strategies variable air volume (VAV), the electricity consumption may not exceed 2.100 j/m^3. (Bygningsreglementet.dk, 2018e).

The pressure loss and the specific electricity consumption for the ventilation ducts are being investigated for a housing unit, which is estimated to have the biggest pressure loss. If the pressure loss for the longest and thereby the most loaded distance, is possible to ventilate with the necessary airflow it will also be possible to ventilate shorter distances. The housing unit is investigated because of the focus on the residents and therefor a sufficient air flow is wished for every apartment. To reduce the amount of pressure loss, only one ventilation system is used per housing unit instead of one large ventilation system. This reduces the total energy consumption for the entire building and it also secures, that fewer residents will be affected at the same time if a ventilation system has to be repaired. To avoid noise pollutions and too much resistance in the ventilation ducts, these are sized with a max. speed at 5 m/s as a rule of thumb (Hyldgård, 2007). The minimum requirements for heat recovery in a ventilation system is estimated to 85% according to Bygningsreglementet. The manufacturer, Nilan has a system that comply the minimum requirements for the heat recovery.

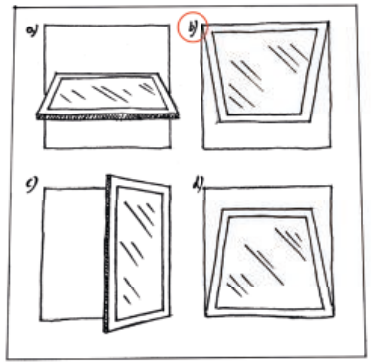
ΔPt,in =Pressure loss from inlet [Pa]
ΔPt,out =Pressure loss from outlet [Pa]
t =Heat recovery of the ventilation unit [%]
SEL = Specific energy consumption [j/m^3]

$$SEL = \frac{\Delta P_{t,ind} + \Delta P_{t,ud}}{\eta_t} \qquad 1373\ j/m^3 = \frac{598{,}5\ Pa + 568{,}5\ Pa}{85\%}$$

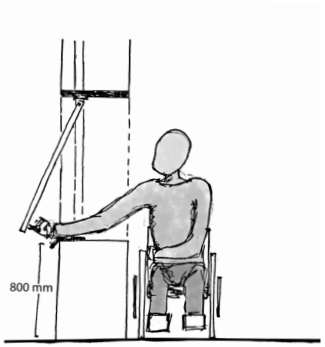
The specific electricity consumption for air transport have been calculated to 1.373 j/m^3, which meets the requirements stated in Bygningsreglementet 2020 (Bygningsreglementet.dk, 2018f) on max. 1.800 j/m^3. Appdendix 10 page 203.

Ventilation duct plan
Scale 1 : 500

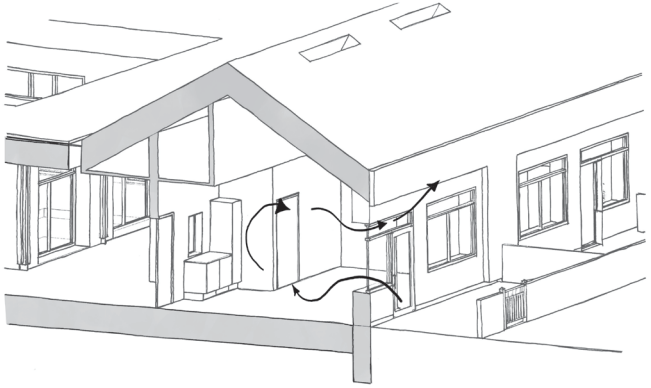
Ill. 199 Ventilation duct plan



Ill. 200 Residential windows



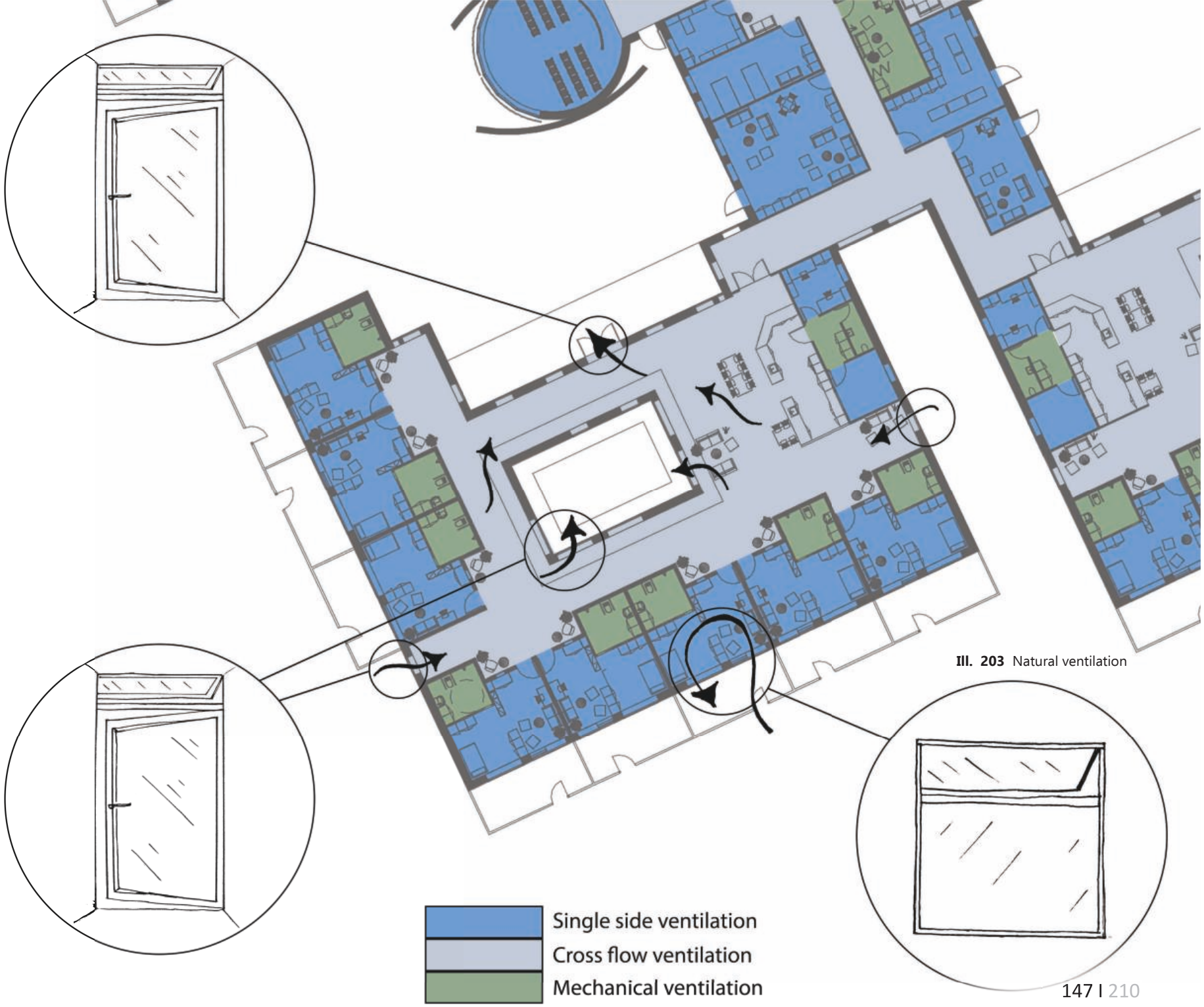
Ill. 201 Handicap-friendly windows



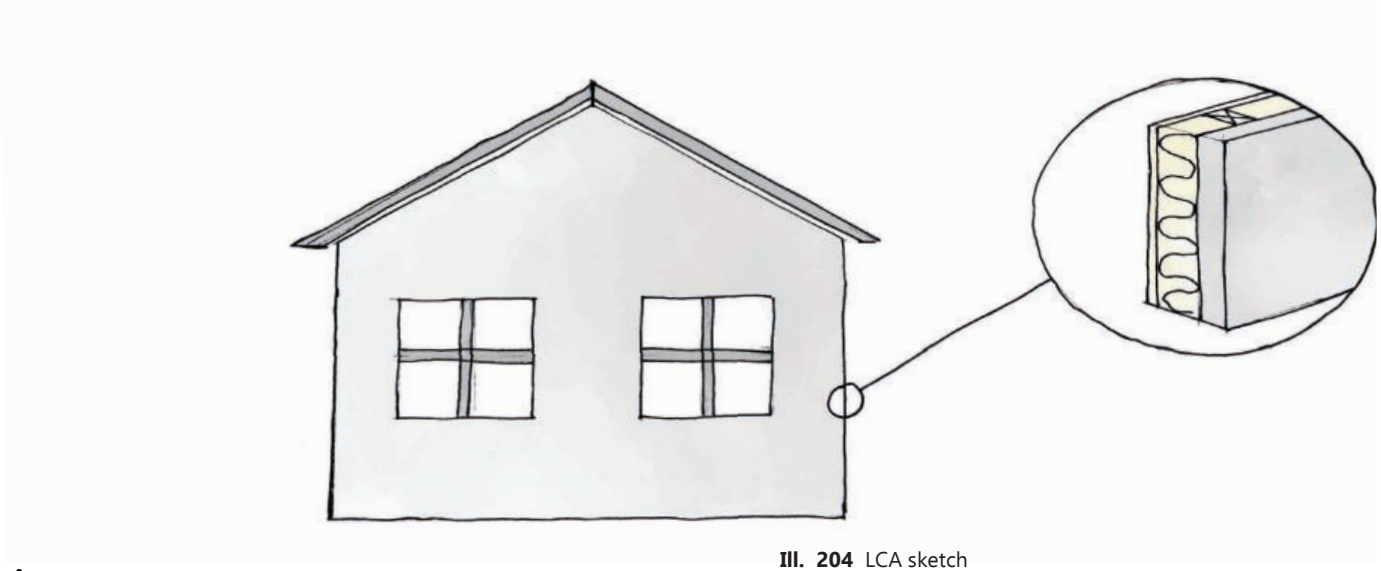
Ill. 202 Single-sided ventialtion

Natural ventilation

An analysis has been made on the possibility of implementing natural ventilation. Natural ventilation is not used as primary ventilation but implemented to give residents a say regarding the thermal indoor climate. The possibility of using the single-sided, cross flow and stack ventilation was investigated, then single-sided ventilation was selected. A rule of thumb when implementing the single-sided ventilation, is that the depth of the room should not exceed the height of the room.
In the calculations, it is assumed that the outdoor temperature is 12 degrees and inside temperature is 22 degrees. Danish standards advise a ventilation rate of minimum 10 l/s (DS_CEN_CR 1752, 2001). The calculation takes the fragile resident into account, thus there is a focus on ensuring a comfortable indoor climate.
Recommendation from the Working Environment Authority state that air velocity does not exceed 0,15 m/s (Jensen, 2018).
For single-sided ventilation, an air change of 0,64 h-1 can be achieved with an air flow of 23,7 l/s, which gives a speed of 0,1359 m/s and thus is possible to use natural ventilation to achieve a satisfactory air change, without the risk of drafts. Appendix 11 page 205.



Ill. 203 Natural ventilation



Ill. 204 LCA sketch

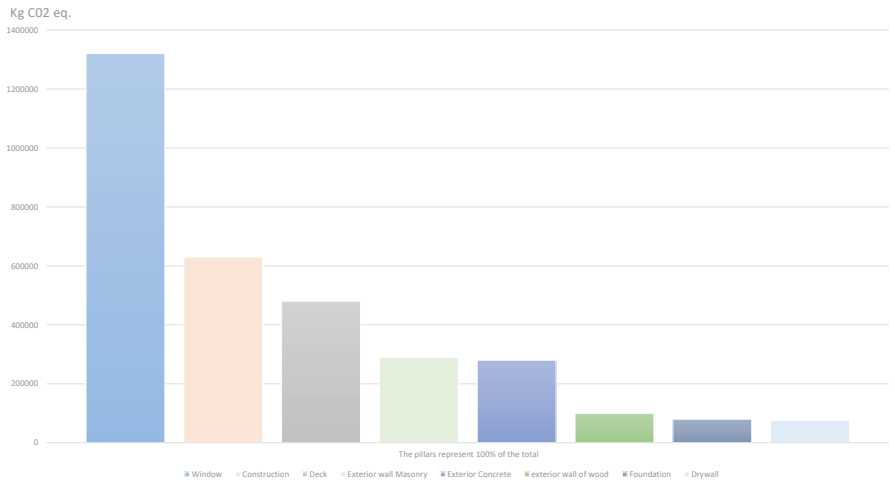
LCA

Life Cycle Assessment (LCA) – is an analysis tool that evaluates the material throughout the buildings lifetime and can be used to assess the environmental impact. The analysis has a lot of elements, from raw production materials, behavior, maintenance and repair, and in time, demolition and removal of the remaining elements. An LCA was conducted early in the process to gain an understanding of the buildings environmental impact. In the analysis of the impact of different walls, LCA uses the following parameters; GWP (Global Warming Potential), ODP (Ozone Depletion Potential), POPC (Photochemical Ozone Creation Potential), AP (Acidification Potential), EP (Eutrophication Potential), ADPe (Abiotic Depletion Potential Elements) ADPf, (Abiotic Depletion Potential Fossil Fuel), PEtot (Primary Energy) and Sek (Secondary Energy).

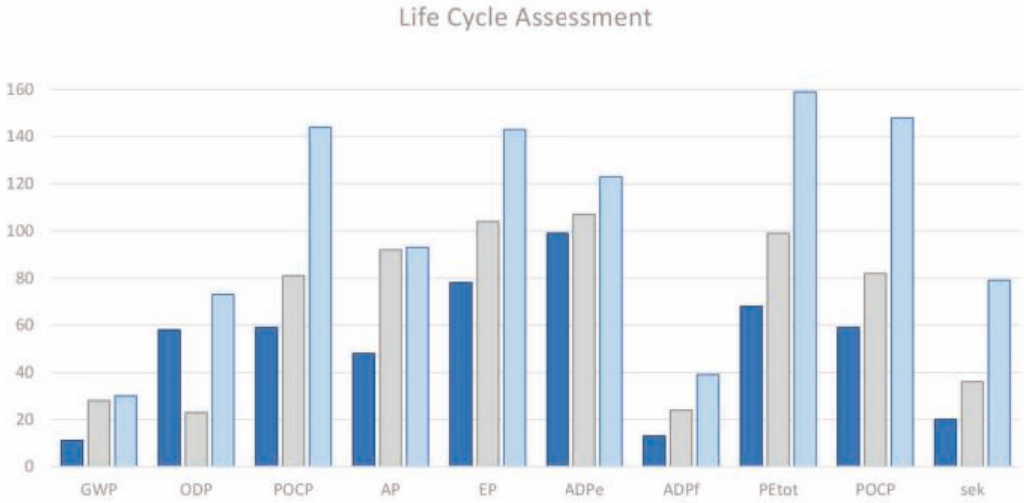
The first calculations will u-values of the exterior walls. These will have dimensions that achieve the same transmission loss, in order to ignore this factor in the subsequent calculations, see Appendix 2. The calculation period is 50 years. The building is analyzed through five phases;

Life Cycle phases	Production	Construction process	Use	End of life	Outside of System Boundary
Processor	Raw materials Transportation Production	Transportation Erection/mounting	Use (50 years) Maintenance Repair Renovations Energy consumption for operation Water consumption for operation	Dismantling/demolition Transportation Waste treatment Disposal	Potential for recycling Secondhand

(Nygaard and Rasmussen, 2015)



Ill. 205 LCA impact

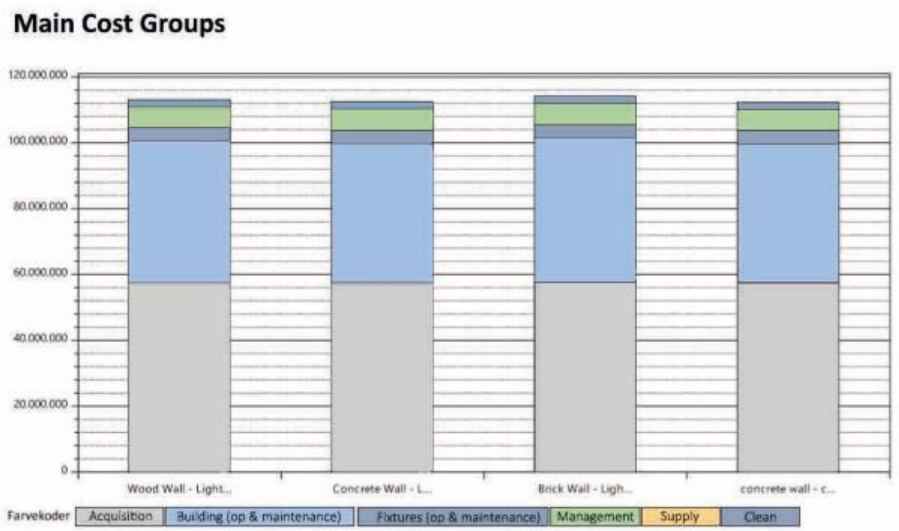


Ill. 206 LCA assessment

LCA- Environmental sustainability

Conclusion:
The building is analyzed in main elements and the analysis show that the aluminum windows and the doors have the biggest impact in regards to global warming potential and the interior walls in plaster are the least polluting. Three exterior walls have been evaluated, all with an u-value of 0,094 m²k/W. In the preliminary design process an LCA was made, which can be seen in Appendix 12 page 206.
Throughout the design process, LCA was used to evaluate different proposals. Three constructions were initially evaluated and the conclusion was that wood has the lowest environmental impact and only had a negative impact in ODP, which probably is due to the fact, that in order to use tree, you have to cut down trees and minimize the amount of trees in the forest. This issue can be solved by using FSC marked wood.
Based on this analysis, it is an advantage to use wood as the main element in the construction of the dementia center. Exterior walls of bricks would have the biggest environmental impact. The analysis shows that the aluminum windows have a big impact and alternative solutions should be considered. If wood is chosen, FSC wood should be considered and if possible using local trees from Rold Skov Savværk A/S as this would reduce the impact from transportation.

Subsequently the possibility to use the qualities of a light tree construction, but to make a shift and contrast using cladding of bricks is evaluated, which can be seen in Facade analysis, page 112.



Ill. 207 LCC, main cost groups

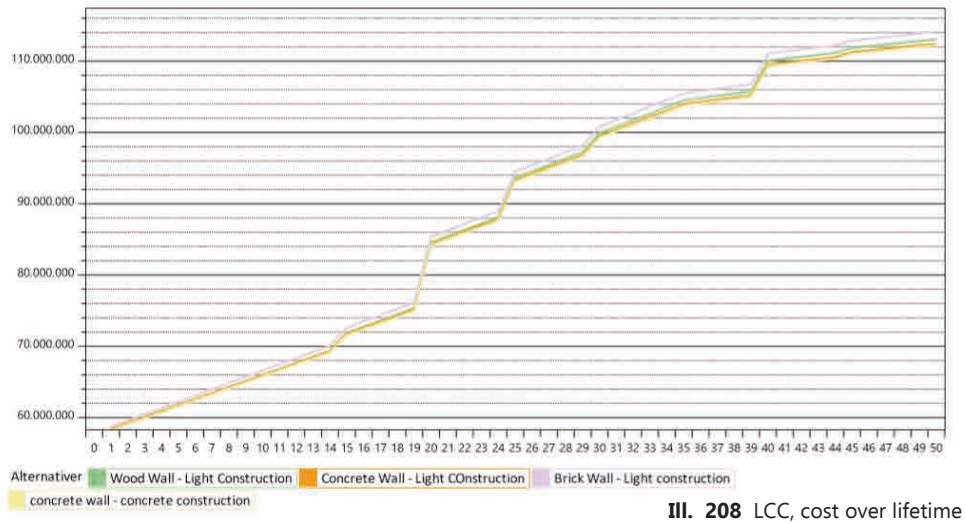
LCC

LCC helps give an overview of the cost using different setups and can be used to secure that the quality is good in the project as a whole. It also makes sure that the long term consequences is considered in the design process and secure a financially sustainable project. LCC was made to test four types of exterior walls on a 50 year period. The program is made up of the following; Project information, assumptions, account plans, data entry, conclusion and a report section.

The application is comparing lifetime and maintenance of different materials.The application is equipped with standard data from different building parts that can be used in the analysis, but additional data was also put into the application. In the project information the investigation is described. The assumptions decides the general preconditions of the calculations used in the analysis, like the calculation period and which rates and prices are used. This analysis has been made using a nominal rate with a calculation rate of 2,0%.

In the account plan one decide what materials are used in the calculation. The prices of the land, management, supply and cleaning are chosen. Standard values for all the walls, because the investigation is focused on finding the difference between different exterior walls in a 50 year span. The calculation frame is described below. In the data entry the unit price and the quantity is analyzed, which can be seen in Appendix LCC 13 page 208.

Based on the above, a specific description of the price on acquisition, operation cost and maintenance cost was examined.
Result: After the calculation of the project proposal, a preliminary and a main calculation are performed, these are more in depth analyzes. This was done to enlighten which materials were best when looking at the lifetime of the building. After the calculation of the project proposal, a preliminary and a man calculation is performed, as these are more in depth analyzes.



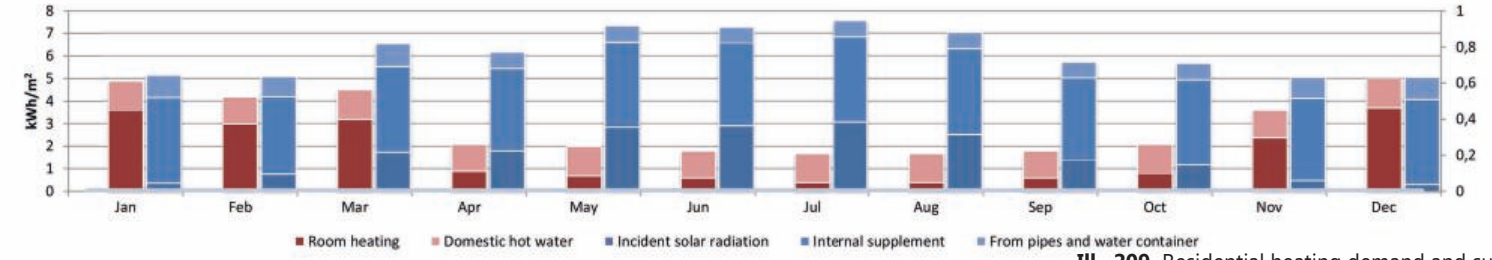
Ill. 208 LCC, cost over lifetime

LCC

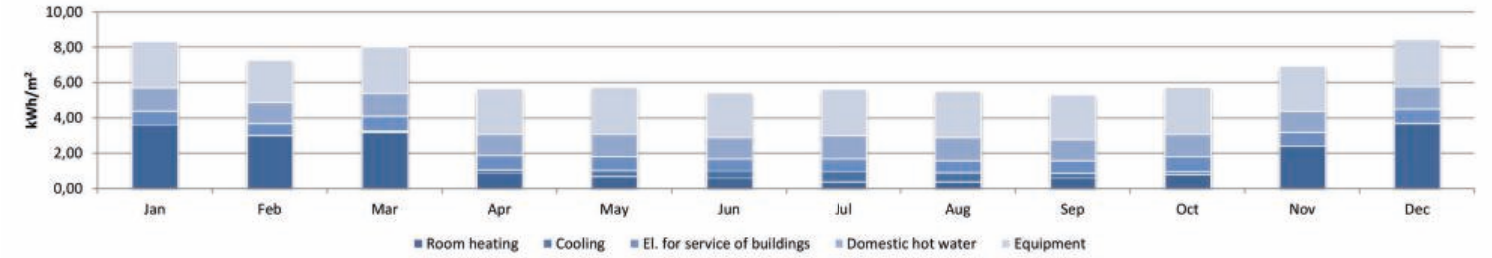
Conclusion:
The key figures show that the exterior wall made of tree as light construction has the lowest acquisition cost of 57.379.706 DKK. During the calculation period it shows that the heavy concrete wall has the lowest net present value of 112.228.841 DKK. This is because the yearly maintenance and cleaning cost is lower for the concrete wall, with a yearly cost of 596 DKK/m^2. The analysis shows that the concrete wall is 1.887.830 DKK cheaper than the most expensive wall, which is the exterior wall made of bricks.
Despite a higher price of operation and maintenance, the tree construction is chosen. This is done because of the desired link to the site and the surrounding buildings, as well as an examination in LCA shows that a wooden construction is the most environmental friendly.
The tree construction is the cheapest in the acquisition price, and would therefore be an ideal choice if only the price of acquisition would dictate materials used.

The conclusion of the analysis was done to become more aware of the overall finance of the building and the projects financial sustainability.

Type	Acquisition	Operation and maintenance	Annual expenditure (DKK/m^2/year)	Present value
Exterior wall in construction wood	57.379.706 DKK	43.063.813 DKK	601 DKK	113.047.636 DKK
Exterior wall in lightweight concrete wall	57.595.831 DKK	42.229.246 DKK	598 DKK	112.429.195 DKK
Exterior wall in brick	57.896.019 DKK	43.616.535 DKK	606 DKK	114.116.671 DKK
Outer wall in heavy concrete wall	57.439.426 DKK	42.185.297 DKK	596 DKK	112.228.841 DKK



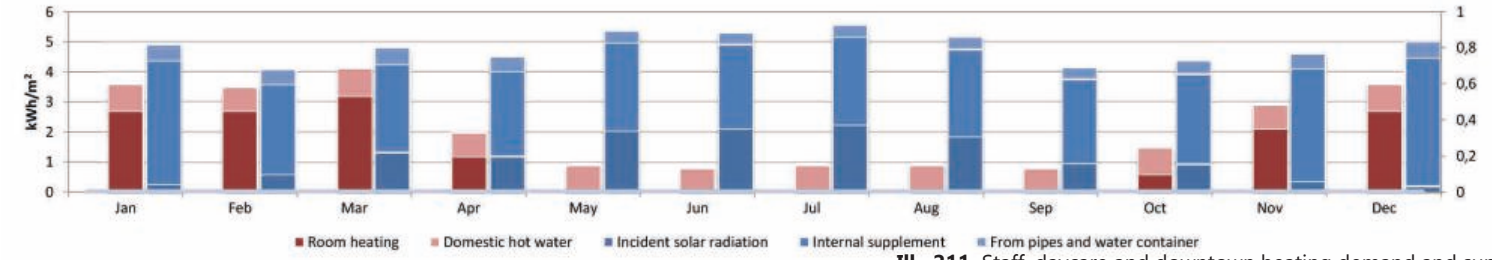
III. 209 Residential heating demand and supply



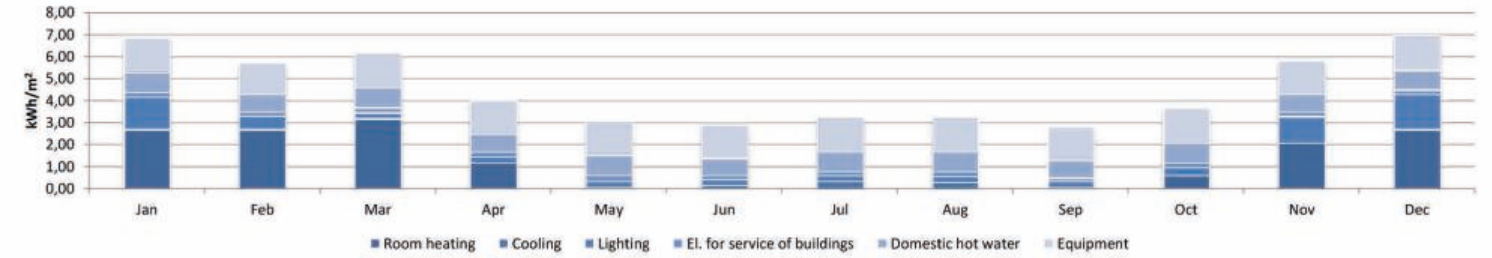
III. 210 Residential energy distribution

Energi frame BE18

Due to the fragile character of the reside nts, the project has a large focus on the indoor climate. Thus the calculated energy frame of the building is focused on achieving the 2018 requirements.
The energy frame is documented through the calculation application BE18. Through a design- and detail-oriented process, BE18 has continuously been updated to ensure compliance with the requirements. To support the desire to utilize the experience of spaciousness, the surrounding forest and to de-stress the user of the building, it has been attempted to be as close to the requirements as possible. If the energy framework cannot be achieved with passive solutions, active solutions will be implemented.
The dementia center is divided into two types of buildings, because of the different requirements in residential and office spaces. One type of building consists of a nursing home that is labeled as “Multi-storey”. This consists of five dementia housing units and one somatic unit. The other type is an office spaces and daycare, which is labeled “Other buildings”. This consists of offices and staff area as well as the daycare center. This division is due to different needs, among other in the internal heat supply and supplements that is included in the final energy frame. The energy frame is different in the multi-storey and the other buildings. In the multi-storey the frame cannot exceed 30,2 kWh/m^2 per year. The other buildings cannot exceed 41,5 kWh/m^2 per year under the BR18 requirements (Bygningsreglementet.dk, 2018g).
The calculation of BE18 is based on assumptions, detailed computations and simulations. The need for ventilation is determined from the assumed amount of users in the center. An example of this can be found in the chapter, ventilation on page 141. To ensure a good indoor climate, a simulation of an apartment has been made in BSim. In this simulation values for shading, mechanical cooling and ventilation where determined. A hot water container and the use of hot water in the residence, is determined from the amount of residents(DS 439, 2009). It is assumed that cooking, laundry and the like, are being done jointly in the housing units and thus using less hot water than in normal housing. The length for piping has been measured for the building. The heat loss from the pipes have been recommended by BE18.



Ill. 211 Staff, daycare and downtown heating demand and supply



Ill. 212 Staff, daycare and downtown Energy distribution

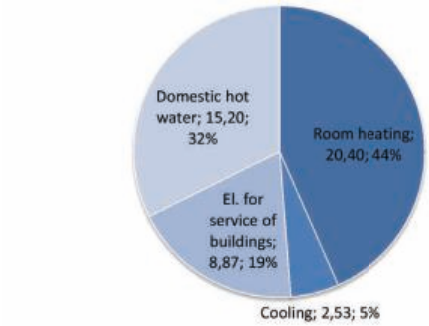
The need for electricity for lighting in the other buildings have not been specified and thus have been assumed under guidance of BE18. The specific electricity consumption for the mechanical ventilation is based on a calculation of the longest distance of the vents to ensure the ventilation can provide a sufficient air flow. The calculation of the specific electricity consumption is on page 144. The building envelope for the building is calculated with the purpose of a low transmission loss and is found in Appendix 12 page 206.

Results:

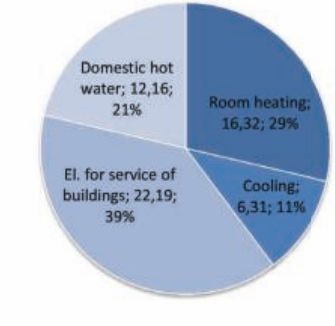
Comparing the two types of buildings there is a significant difference. The energy consumption in the apartment buildings are 20,2 kWh/m^2 on heating and 21,0 kWh/m^2 on cooling. In the other buildings the numbers are 11,9 kWh/m^2 on heating and 11.1 kWh/m^2 on cooling. This significant difference is because of the extra use of energy for heating, due to the wish of an air flow of 21°C. The electricity consumption between the two buildings are also vastly different because the energy consumption is added in the other buildings and not in the apartment buildings. The total energy frame for the Residential buildings are 43,6 kWh/m^2 per year without active solutions. With active solutions like PV (119 m^2) and heat pumps, this gives 30,1 kWh/ m^2 per year and shows that the energy frame for BE18 are achieved.

For the staff,daycare and downtown part of the building it is possible to get an energy frame of 41,4 kWh/m^2 per year and thus be within the 2018 requirements without the use of active solutions. The combined energy comsumption for Mossø Center is 235.082,20 kWh per year, this gives a year expense on energy of 528.934,95 DKK. To reach BE2020 energy requirement, 162 m^2 PV is needed to be implimentet in the building.

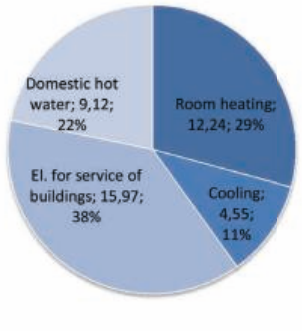
Residential



Ill. 213 Energy consumption

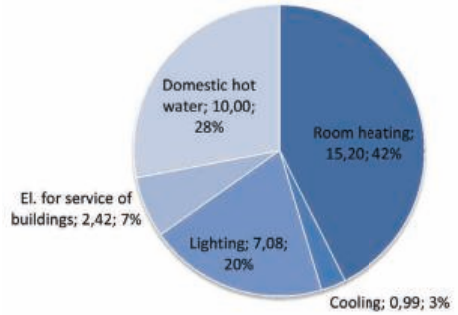


Ill. 214 Energy frame 2018

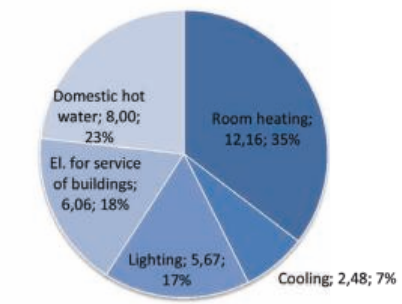


Ill. 215 Energy frame 2020

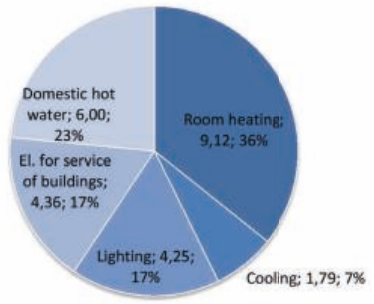
Staff and daycare



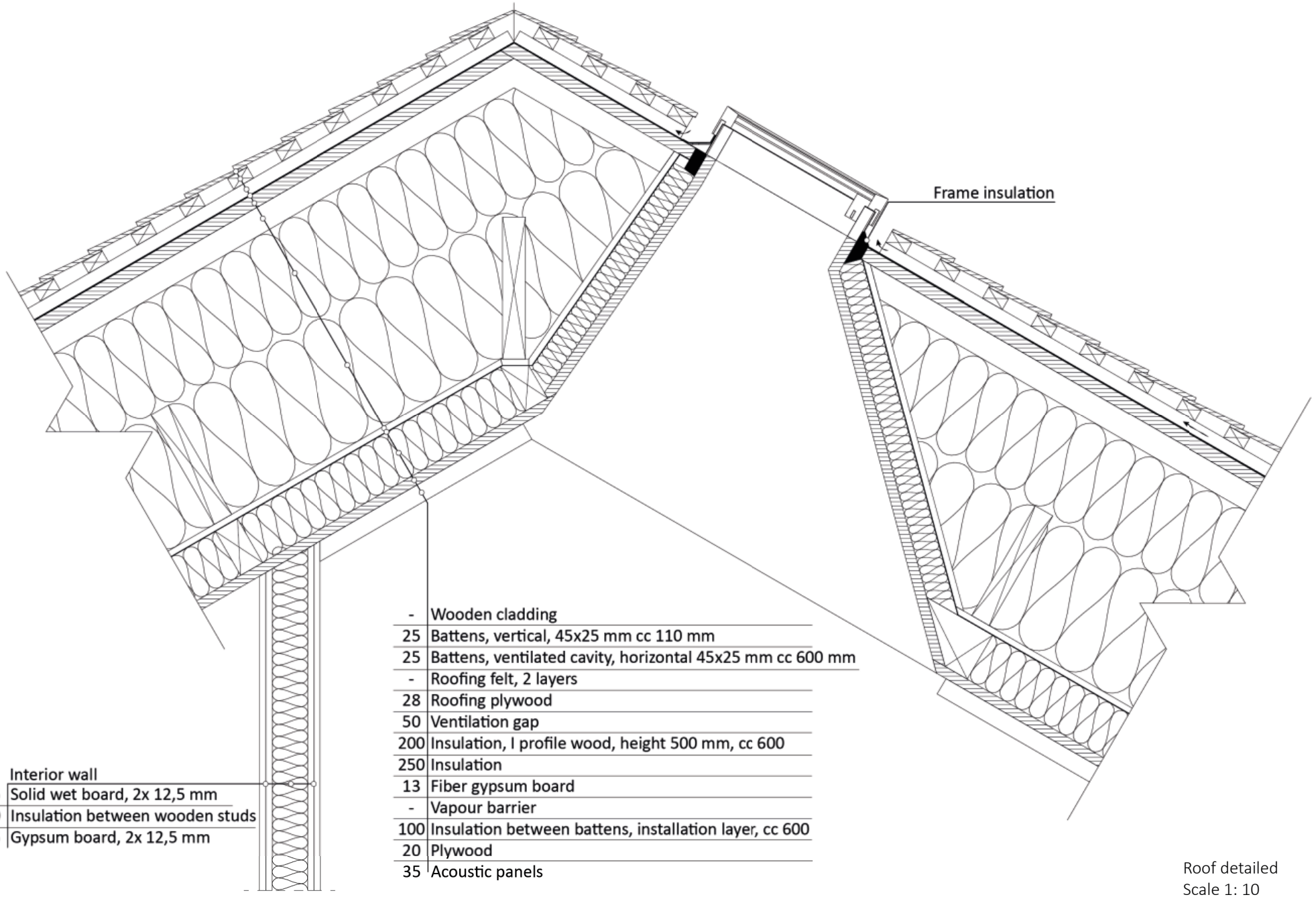
Ill. 216 Energy consumption



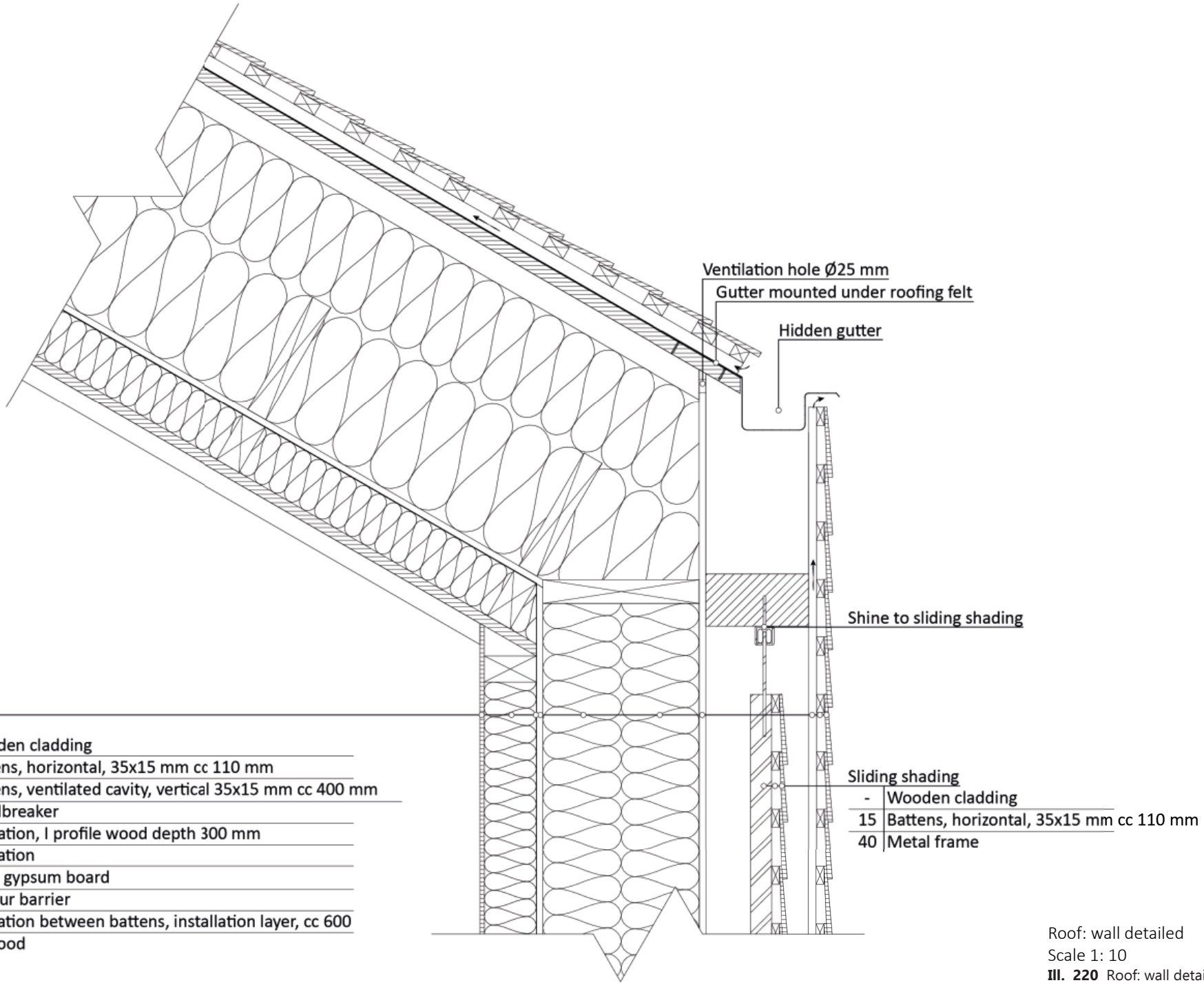
Ill. 217 Energy frame 2018



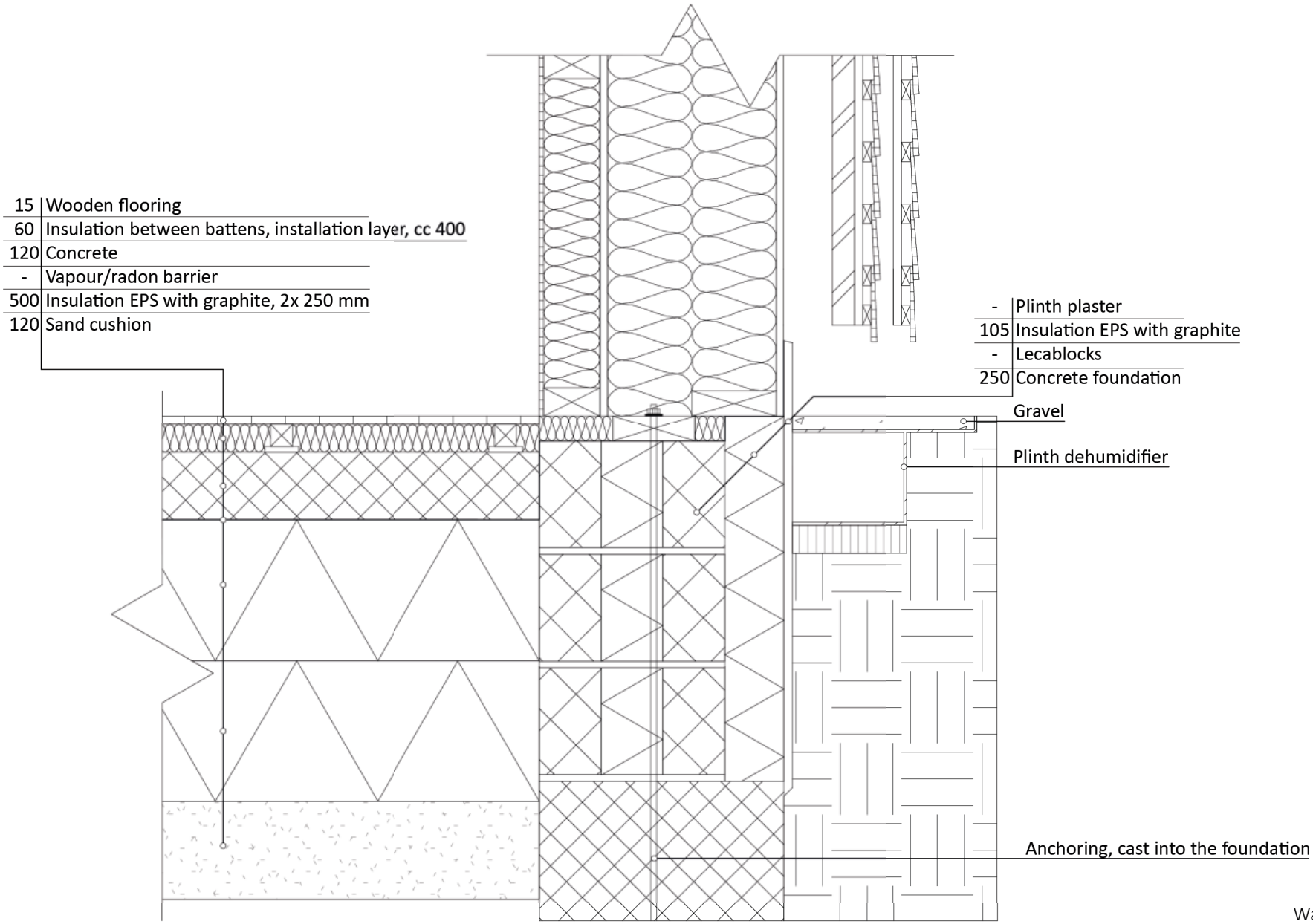
Ill. 218 Energy frame 2020



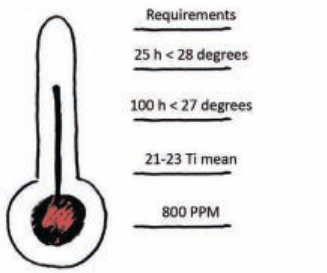
Roof detailed
Scale 1: 10
Ill. 219 Roof detailed



Roof: wall detailed
Scale 1: 10
Ill. 220 Roof: wall detailed

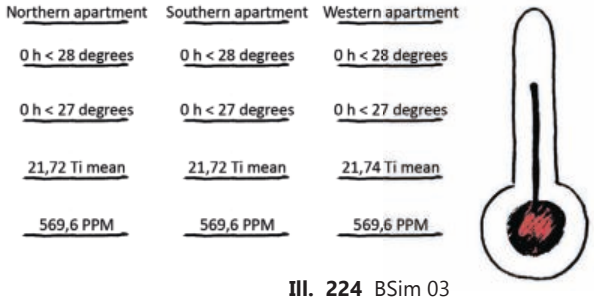


Wall: foundation detailed
Scale 1: 10
Ill. 221 Foundation detailed



Ill. 222 BSim 01

Ill. 223 BSim 02



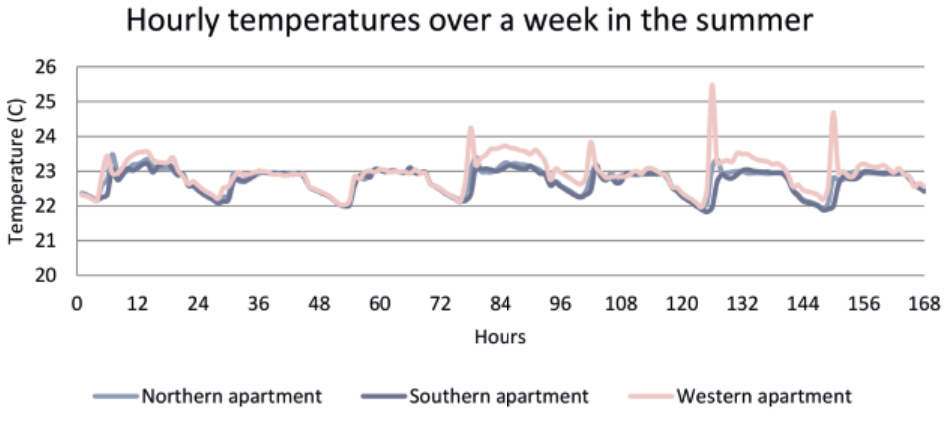
Ill. 224 BSim 03

BSim calculations

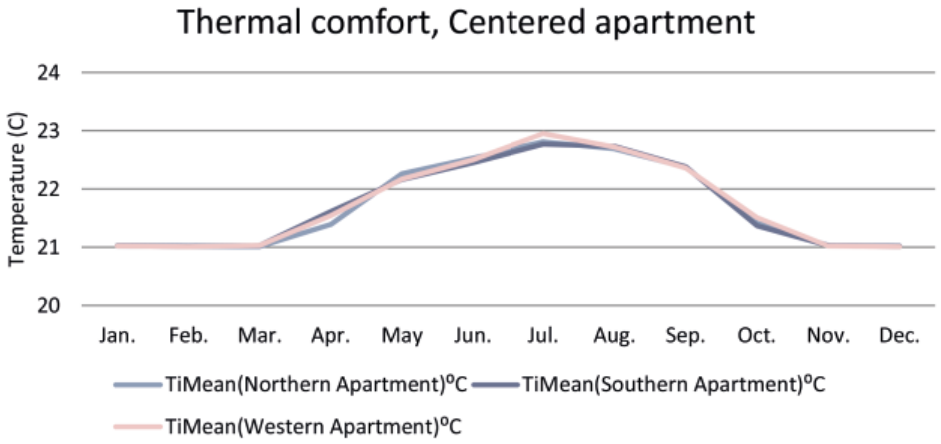
It is desired to create buildings with a good indoor climate in the Mossø Center. To evaluate the indoor climate, requirements from the building regulations 2018 (BR18) where investigated, described in chapter Technical conditions BR18, on page 87. The requirements have been made stricter to get a higher satisfaction with the thermic indoor climate of class A, which is done by having temperature between 21-23 degrees, as is advised for care homes by DS 469 (Heating and cooling systems in buildings, 2013). There are also requirements for the atmospheric indoor climate with a class A, which states that the CO^2 concentration can not exceed 800 ppm (DS_CEN_CR 1752, 2001).

Examinations of the daylight have been performed, which have helped to form the windows of the buildings in order to achieve sufficient natural lighting. Due to the building being designed for fragile users, all sorts of natural ventilation for cooling have been unselected due to the risks of drag. It will still be possible to open windows and a door manually, which is assumed will be put to use.

From these requirements a couple of tests of a dementia residential have been performed in application Building Simulation (BSim) to simulate the indoor climate. The chosen residentials is the one with the biggest risk of bad atmospheric and thermic indoor climate. Tests have been performed for residentials that where headed both north, south and west as well as tests on outer residentials and ones in between other residentials.



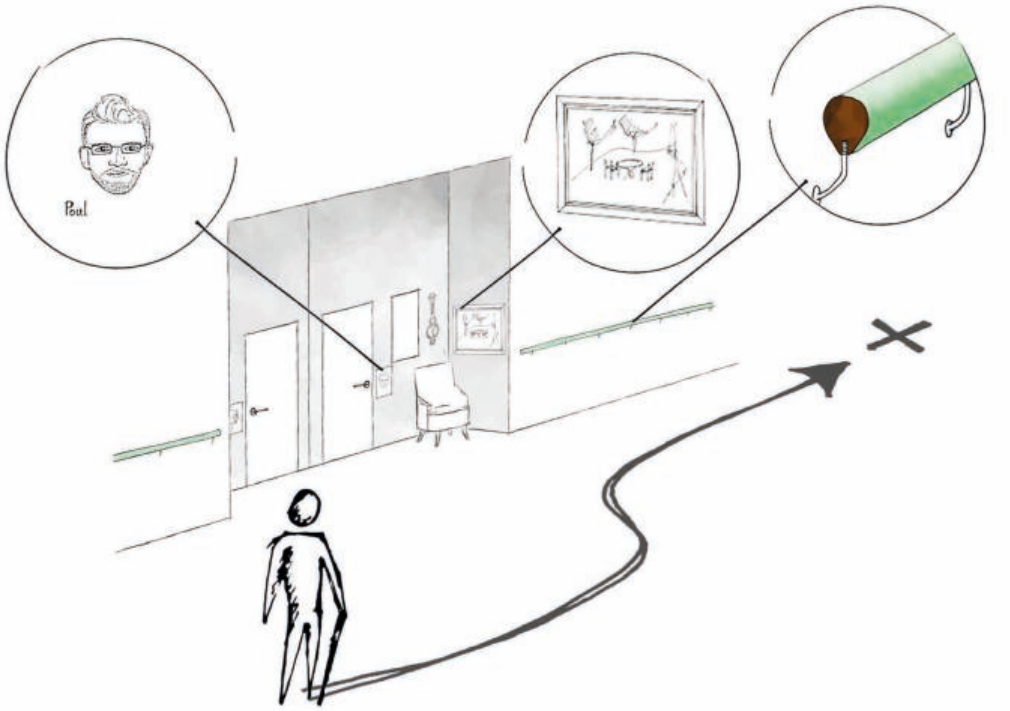
Ill. 225 BSim summer week



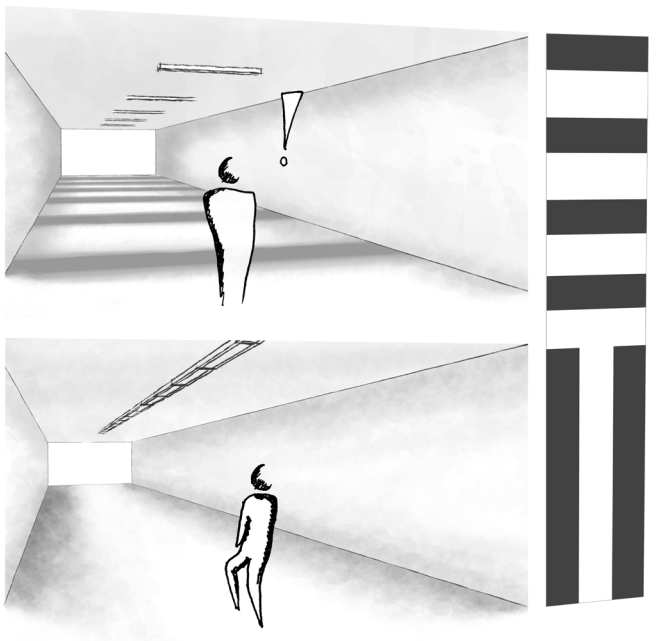
Ill. 226 BSim annual temperature

Conclusion:
To achieve the requirements of BR18, adjustments are made to the shading, mechanical ventilation and cooling. Mechanical ventilation is used all year to secure a good thermic and atmospheric indoor climate. This will be complemented with cooling from april to september to avoid high temperatures in the residential. On the outside as well as on the window elements to assist in shading will be implemented. Due to the location in Rold forest, the shading from trees have also been taken into consideration.

On the basis of the simulation a thermic and atmospheric indoor climate have been obtained. The simulations show that the west facing residential, that is placed in between two other apartments have the biggest risk of having a poor indoor climate. By further examining of the residential it can be concluded that cooling is essential to keep the temperature above 27 degrees for less than 100 hours and above 28 degrees for less than 25 hours. Ill. 226 shows that the desired temperature between 21-23 degrees is achieved.



Ill. 227 Wayfinding

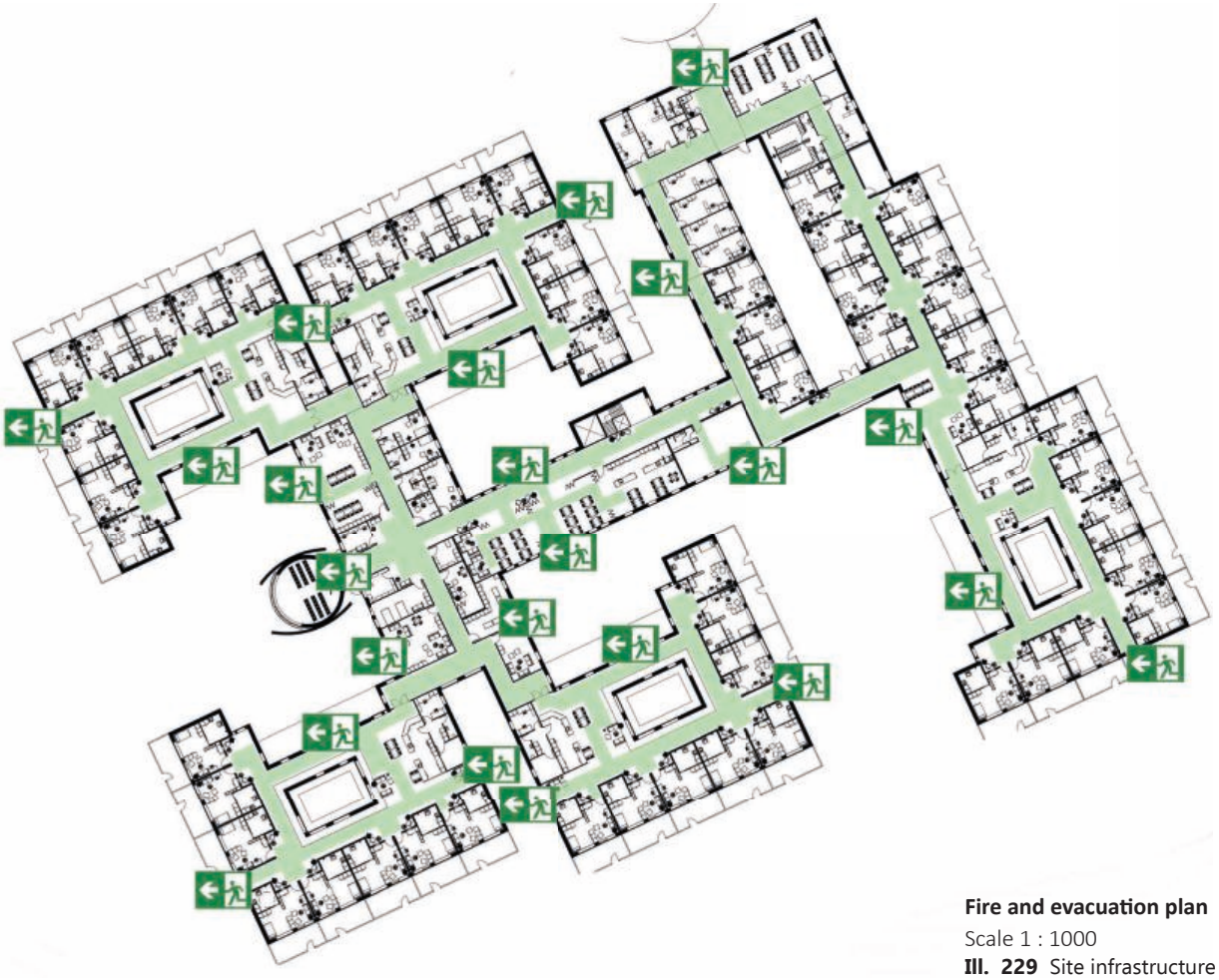


Ill. 228 Artificial lighting

Wayfinding and artificial lighting

Throughout the design of the project, a focus has been on the user and their unique situation. This is clear looking at the plan, where the data collected at the start of the project informed and shaped the plans. If one goes more into detail focusing on ensuring wayfinding, elements can be implemented to increase the resident independence and possibilities to move freely around in the center. The centers' inner courtyard are designed with their own character that increases the individual characteristics of each housing unit. Between the private and social areas, niches are located where residents can put their own personal touch, on the space in front of their residence. This is to increase the resident ability to recognize their own residence.

Next to the door handle to their residence, is placed a frame with a picture and name of themselves. It is recommended that they use a picture of their younger self, as it increases their possibility of them recognizing the picture.
Handrails are placed throughout the center and functions as a support for poor walking residents. These are individual color-coded, for each housing unit, to help navigate around in the center and individualizing each housing unit. During the field studies, a focus was on preventing dark shadows on the floor, due to natural and artificial light, that these could be experienced as holes in the floor by some residents. To avoid this, the placement of the light should be done in such a way, to prevent dark areas on the floor and to create equally distributed lighting condition throughout the center.



Fire and evacuation plan
Scale 1 : 1000
Ill. 229 Site infrastructure map

Fire regulations

The safety has a high priority in this project because of the user group of this center. A residents at the center is in the user kategori 6 (Bygningsreglementet.dk, 2018b) and because of this, the building is designed so a quick and easy evacuation can be made in case of an emergensy. The corridors at the center require a minimum width of 1,2 meter (Eksempelsamling, 2016). There is a maximum at 25 meters (Eksempelsamling, 2016) to the nearest escape route from both the private apartments and from the common rooms. Every single of the apartment units and the common rooms are designed as a fire cell which extends the time at the center in case of an evacuation.
The Mossø Center is designed in a single plan and around the center, there is a path which is designed to also function as a fire lane. This fire lane has a width at 4 meters with at least 3 meters to the facade of the centers (Brandvej, 2016). As an additional actions to raise the fire safety in the center fire-technical installations are used. These installations are in the form of fire-reducing installations, warning systems, smoke alarms, escape and panic lighting.

Epilogue

Conclusion

Through the use of IDP, Mossø Center, was developed with a focus using nature as an active reliving effort to assure the best quality of a daily life. The site is located in one of Denmarks most beautiful nature areas, Rold forest. By using healing architecture, case studies and applied research, Mossø Center have been designed from the foundation to the rooftop with a specific focus on the user. By reinterpretating the classic danish farmhouse, a link to the surrounding farms in the near by area are createt. A familiar form are used making the building recognizable and aimed to be a home, more than a center. Nature is invited in between the buildings to display the four seasons and all of their qualities.
The center consists of 40 residentials designed for dementia, divided into 5 housing units and 12 residentials for partners of dementia residents. Furthermore, the center has two hotel apartments with a multifunctional purpose. The housing units are placed with a focus on the heart of the center, where a daycare center and other social activities are located, such as a hairdresser, shops and other functions. In the daycare, 30 citizens from the municipality can come daily and be part of the community. This offer is primarily intended for people with dementia and can be used by future residence to get familiar with the center and its staff.

In the heart of the center, there is located a silence space. This room is designed both in form and choice of material to stand out from the rest of the center and is a landmark in the center. The Mossø dementia center is a place where both life and death is a part of the daily life, therefore it was important to make a room for both reflection and sorrow for both residents and relatives. The room is designed with a direct view to an old beech tree located to the west and in the evening time, the room is filled with colour, as the two forms reflect in one another.

From the middle of the center, the construction is honest and visible and tells a story about the column and the beam, and the old, danish farmhouses. The construction is toned down, when moving toward the private part of the center, reflecting the more private and calm part of the building. To highlight the characteristics of each housing unit, colours and courtyards are used to assure wayfinding and the plan is designed so a high degree of personal independence that can be achieved in a safe environment. Every housing unit also has its own private inner courtyard, which let light and air into the building, but also functions for residents who wanders and thereby the private inner courtyards are having a calming effect.

The Mossø dementia center has been designed as an energy efficient building and passive and active strategies have been implemented to reach the BE20 goal. The demand for a energy efficient building must not compromise a good indoor climate, and from the start of the project an extra focus was put on the fragile users. To insure this, a goal was set to reach category A. This was achieved by making simulations in BSim, Velux and acoustics calculations. Mechanical ventilation was implemented as the primary ventilation source, natural ventilation was implemented to give the user a possibility of control but not included in the calculations. Material assessment were made of the materials in the area and LCC and LCA were used to look at the materials in a sustainable aspect. Furthermore, calculations were made for PV to extent the active strategies to reach Net Zero Site Energy Building and thus aligning the vision of the building with the vision from the municipality of focus on nature and sustainability.
Finally the building has been designed in a single plan with focus on the residents and the staff, due to many of the residents being elderly thay can have problems walking. All through the design, there have been a focused on the people, the nature and a life that have to be lived with dignity.

Reflection

The project was chosen both for being a great interest as well as the relevance and being a natural further development of the focus of the last couple of semesters. It was soon discovered that this was challenging both because of the many different aspects and special needs for the user, but also because of the natural occurring of death in this types of buildings. From the start, it was clear that this was a very vulnerable topic and the only way to approach this project, was with honesty and a high degree of dignity. At the beginning of the project, a base knowledge was studied with theoretical articles and this gave the base foundation knowledge of the topic, in a field where there are happening a lot of research and a constant development. Based on this knowledge, field studies were made. Interviews with staff and relatives were carried out and together with case studies; it gave an insight into the daily challenges in a nursing home focusing on dementia. The user groups ever-changing character was experienced in first hand in the case studies. The residents were experienced as both vulnerable and loving but also aggressive and the case studies also showed that the staff had to be flexible in their way of handling a resident.

The design process was driven forward in an integrated design process, where sketches, physical models and calculations were used together with applied theory. A combination of calculations and the use of personas were used to develop the building's form and selection of materials and to keep a focus on assuring wayfinding and healthy interaction between the staff and among residents. From the start were examined where both healing architecture and biophilic design. Both theories talk about the use of nature and on the base of this, the site was chosen, were a close interaction with nature could be made in a secure environment. In retrospect putting a dementia center this close to a lake, could pose a danger and therefore the implementation of safety methods had to be well calculated and in a balance between the safety and freedom of the residents was a balancing act all through the project.

By using passive and active strategies BE20 was reached, supplementing PV on the centers' roof ensured a Net Zero Site Energy Building. Due to the location in the forest, problems such as falling leaves and branches can severely reduce the production of the electricity on site. Due to the vulnerable residents, a special focus was made on the indoor climate to strife for a category A. An investigation in Velux, BSim, and acoustics were made with a focus on the user and the construction was investigated in a conceptual level. In a further development of the project, specific calculations into the construction could refine the structure and clarify the story of using an honest architectural link to the history of the area. Further investigations in BSim could be made, to ensure a good indoor climate in the larger common areas. Furthermore, it could be of interest to develop the details in the dementia center, by looking into the tactility of materials used in the handrail and the flooring, to enhance wayfinding for visually impaired residents.
The silence space is also of specific characteristics and further detailing of the space and its atmosphere enabling it to accommodate a wide range of emotions could be an interesting task.

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Case study Skovgaarden- Timandsvej 25, 9560 Hadsund- Own analysis / Own Production

Case study Østermarken- Øst Blvd. 5, 9600 Aars- Own analysis / Own Production

Case study Aabybro plejehjem- Anlægsvej 2, 9440 Aabybro- Own analysis / Own Production

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List of illustrations

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Appendix

Appendix 1 Retirement homes and nursing homes

"A life must be lived with dignity" (Gitte Olenius 2019)

Retirement homes and Nursing homes:
Most elderly Danes prefer to live in their own home as long as possible and for many this can be done with the help of a spouse and relatives, even when they grow old. At some point, the need for help can be so great that the elderly can no longer live properly in their own home. Then it can be an advantage to move to a type of housing that is designed for the elderly in order to make everyday life better work. Such types of housing can be either an elderly residence that is designed for the special needs of older people with reduced physical and mental function ability. In these types of housing there is no need for 24-hour care, but will be possible to get a helper coming ones or twice a day (Aeldresagen.dk, 2019). Another solution for people with a greater need for help is nursing homes, care homes or care centers. These are living homes for people with the need of care around the clock. Moving to a nursing home basically requires the consent of the elderly and there are special rules if the elderly is sick and unable to do so (Aeldresagen.dk, 2019).
Typically, residents come from a private residence into an elderly home when the need for care arises. Then the next step for some people will be to come to a nursing home. The possibility of going to a nursing home requires a visitation, which is an assessment made on the person in need of care. In recent years, there has been a tendency for increased visitation requirements, which means that many residents are much worse off when they arrive in a nursing home (Olenius, 2019).
"Folk kommer her når hygiejnen eller det daglige/almindelige daglige livsførelse (ADL) begynder og halte og true værdigheden. De kommer typisk fra en plejebolig i hjemmeplejen " (Gitte Olenius 2019)

A dementia-friendly environment characterized by:
Homeliness
Recognizability
Safety and security
A suitable stimulating environment
Possibility to reduce needless stimuli and noise
The identity is supported by interior design, reminiscence
Clear room function
Visibility and clarity
A conscious choice of colors and contrasting colors
Various clues to support orientation e.g. in the form of pictograms or colors
Sufficient light, to avoid dark areas
Easy access to safe and stimulating outdoor areas

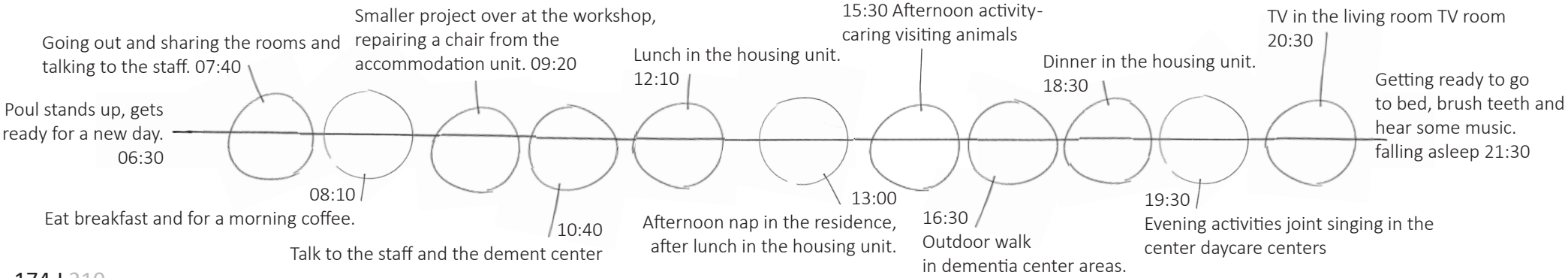
(Nationalt videnscenter for demens, 2017)

Appendix 2 Personaes

Basic information
Name: Poul Skovlund Jensen
Birth day: March 3rd 1954
Gender: Male
Status: Married to Lise Jensen
Relative: 2 children and 5 grandchildren
Education: Carpenter

Ill. 230 Persona Poul

Details about:
Poul has been a self-employed carpenter for many years and is therefore a man with a strong will and a can-do attitude. Three years ago, Poul was diagnosed with moderate dementia and unable to live alone and thus Poul moved to a dementia center. Despite Poul's cognitive impairments, Poul is still a physically strong man, with a need to work. The staff experiences Poul as a friendly and driven man that is always going somewhere. In addition, the staff has several times experienced Poul started with small projects and that Poul experiences the dement center as a workplace, where he has to go home when the clock is around 17-18. Poul is very door-seeking andand solution-oriented which challenges the staff to keep Poul within the framework of the center. Poul has lived in the city all his life and feels fear and anxiety in the evenings. Dark windows or shadows on the floor are perceived as holes you can fall into. Poul is still married to his wife Lise Jensen, who visits Poul several times during the week. There has been talk of opportunities for whether Lise could move in with Poul. Poul and Lise also have two sons and five grandchildren, who visit Poul a couple of times a month at the dementia center. Poul is very loving to people he can recognize, but to people Poul cannot recognize, Poul can either be inappropriate, loving, aggressive, verbal or physical. Poul's youngest grandson has after an episode where Poul grabbed his hand and scolded him for something fictitious, had difficulty being alone with Poul.



Key problems

- Searching and trying to leave the center several times a day
- Dark windows and shadows create anxiety that cause stress.
- Aggressive to staff and family who he does not recognize
- Starting small projects at the center, removing ceiling plates etc.
- Mood swings- changing needs to be social and private.

Design Strategies

- Meeting social areas before the exit of the center, hidden doors and locks, personal GPS alarm and sensor in the rooms.
- Evenly distributed lighting throughout the day in the walking area and having the possibility to draw white blinds in the evening.
- Pictures of the contact persons, staff and family in the residence
- Access to the workshop under supervision. Involve the resident in tasks at the center
- Easy access to social areas from housing, niches where you can retire to.

State of the Art.

- “Six in 10 people with dementia will wander.”(Alzheimer's Disease and Dementia, 2019)

- “Tries or wants to "go home," even when at home”(Alzheimer's Disease and Dementia, 2019)

- “Add extra lights to entries, doorways, stairways, areas between rooms, and bathrooms. Use night lights in hallways, bedrooms and bathrooms to prevent accidents and reduce disorientation.”(STAYING SAFE, 2016)

- "Resident may well have difficulty with new faces and either become incredibly loving or become verbally or physically aggressive towards those they do not know"(Olenius, 2019)

- “Aggressive, outward-acting behavior on the part of the demented patient is often experienced as a serious burden on relatives and staff

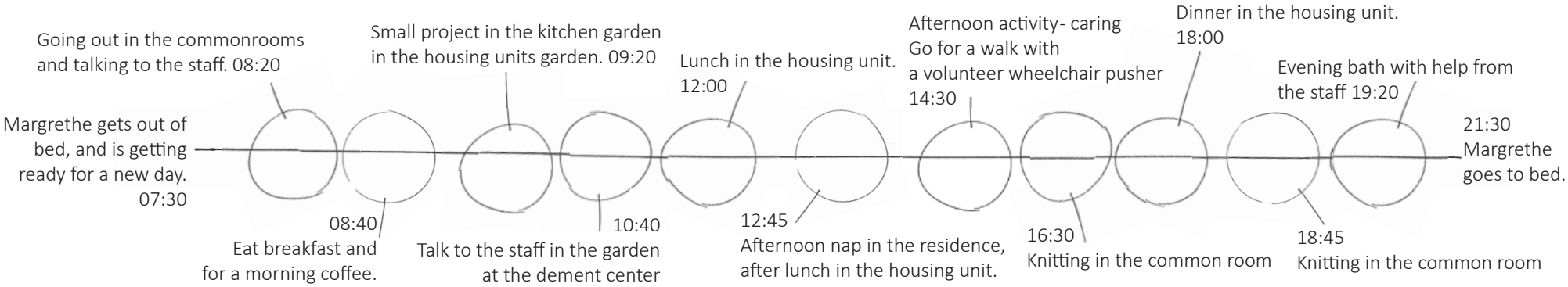
- “(Nationalt videnscenter for demens, 2018).

- “Use high contrast- highlight key features, edges and hazards, Need for higher lighting levels. “(Halsall and MacDonald, 2015)

Basic information
Name: Margrethe Westergaard
Birth day: April 4th 1931
Gender: Female
Status: Widow
Relative: 2 children and 3 grandchildren.
Education: Nurse

Ill. 231 Persona Margrethe

Details about:
Margrethe has been a departmental nurse at Aalborg University Hospital, where she was responsible for 17 employees. 20 years ago Margrethe got light dementia. After some years in home care, Margrethe's husband Ejgil died, which affected her a great deal. Two years later, Margrethe was referred to a place at the dementia center, where Margrethe moved in about 15 years ago. Over the last couple of years, the disease has developed rapidly and Margrethe is now suffering from severe dementia that affects all aspects of Margrethe's everyday life. Margrethe gets very nervous when she is in a space with many people or areas with a lot of noise. It does not take much before she gets confused and a situation gets unmanageable for Margrethe, which can result in outbreaks of either anger or depressed behavior.
Margrethe is very affected in the evening and becomes very active. She starts talking loudly, but cannot formulate a sentence which visibly frustrates her. Margrethe is walking poorly and is using a wheelchair daily. Margrethe can walk without it, but has had several accidents where she fell and broke her wrist.
Margrethe's relatives live on Zealand and only visit a few times a year.



Key problems

- Gets nervous or anxious in crowded areas
- Becoming easily confused, suspicious or fearful and is affected by noise.
- Get agitated when the sun goes down.
- Have reduced walking pace and difficulty walking.
- Confusion of night and day.

Design Strategies

- Easy access to private areas from social areas, niches which she can retire to in social areas.
- Good soundproofing in private homes.
- Areas for indoor activities that can distract the residents.
- Avoid steps where possible and non-slippery floor. Clearly defined walking surface.
- Maximize natural light to increase awareness of daytime.

State of the Art.

- “Acts nervous or anxious in crowded areas”(Alzheimer's Disease and Dementia, 2019)

- “becoming easily confused, suspicious or fearful”(STAYING SAFE, 2016)

- “Noise disturbance causes distress, Good sound insulation and absorbency” (Halsall and MacDonald, 2015)

- “Confusion of night and day “(Halsall and MacDonald, 2015)

- “[Those with dementia] tend to get agitated as the sun goes down,”(Study, 2019)

- "They start by saying some words that you know and then they go into gibberish, so it can be hard to figure out what they say"(Nationalt videnscenter for demens, 2017)

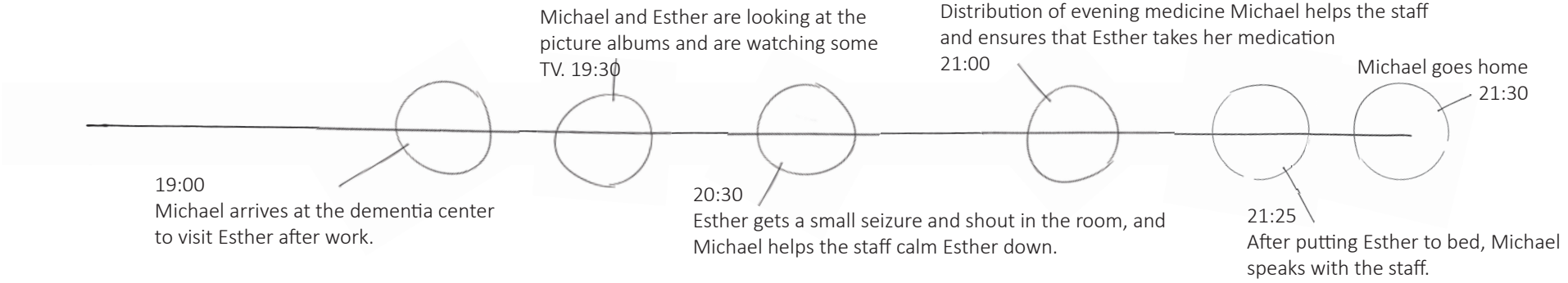
- "People with dementia often have reduced walking pace and difficulty walking... Difficulty increases the risk of falling and getting hurt."(Nationalt videnscenter for demens, 2018)

- “CIRCADIAN RHYTHM body clock Confusion of night and day “ (Halsall and MacDonald, 2015)

Basic information
Name: Michael Pedersen
Birth day: August 4th 1974
Gender: Male
Status: Married to Laura Pedersen. Together they have 4 children
Relative: Son of Esther Pedersen
Education: Gardner

Ill. 232 Persona Michael

Details about:
Michael is 45 years old and son of resident, Esther Pedersen. 6 years ago Esther was found with moderate dementia, which was a major upheaval for Esther but also for her son, Michael. Michael is an only child, and his father left Esther and Michael when Michael was only 5 years old. Therefore, Esther has always been the one strong parent figure, but suddenly the roles have changed, and it has been difficult for both of them. After the diagnosis there has been good support from the municipality, to Esther. But it took a little time for Michael to learn his rights, and what help he could get in this new situation, and it has been very much on his own initiative. This has not always been easy. The dementia center is placed on the road between
Michael and his workplace. Michael tries to visit Esther a couple of times a week on his way home, however, he has trouble finding the balance by being there for his mother, and keeping his hobbies, which has resulted in some parts of Michael's life have been put on hold.
After Esther had difficulty understanding her situation, Michael was appointed as a family guard. This happened after a water bill of almost 14.268,00 DKK and here after the staff got some clear instructions on how they should relate in the future.



Key problems

- Doubts about which help supplies his mother and himself could get.
- Despair of not knowing whether the resident is very upset or aggres sive over getting a visit.
- Doubts about rights as a family guardian and updates on the resident.
- Problems with the great responsibility that Michael feels and the balance between taking care of his mother and being with friends and family.
- Challenges of the whole family visiting at once.

Design Strategies

- Information boards and space for support group meetings at the center.
- Possibility to be private or in social areas according to mood.
- Ongoing meetings with the staff at the center, about rights and the condition of the resident.
- Possibility of meeting with the center's support psychologist who knows the situation.
- Possibility to visit the residence, common areas, and book larger visitor rooms for visits.

State of the Art

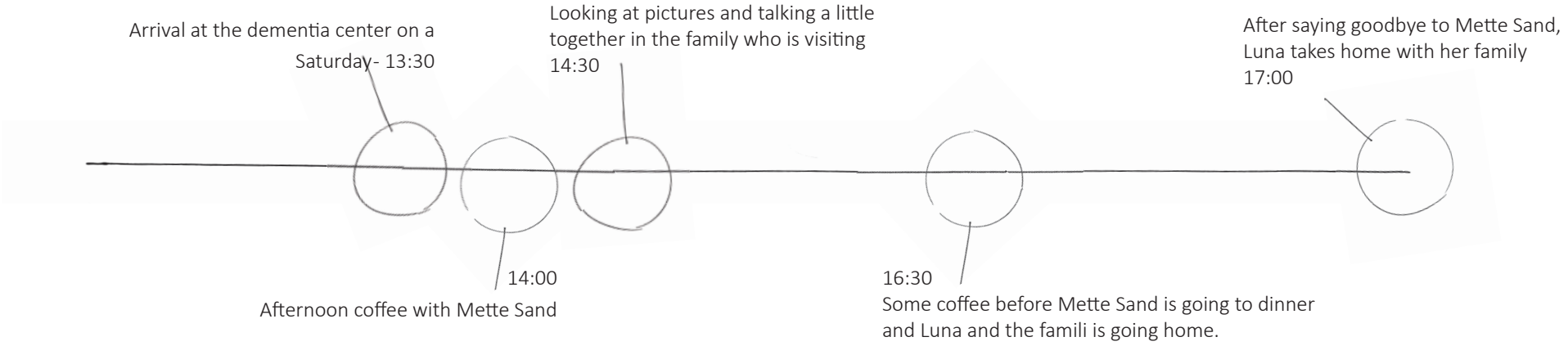
- Being a relative to a person with dementia has given me an understanding of what "old age" (life) also is, and that people with incipient dementia and relatives are in a tragic and uncertain situation that requires professional help (Anonymous, 2019b).
- When Esther Pedersen was examined and found with the disease, dementia, it became "easier" for relatives, staff etc., since there now was a clarification (Anonymous, 2019a).
- The family has been pressured on the mental level (Anonymous, 2019a).

- It is possible to get help but the system is proably designed so it is up to the relative him- or herself to take the initiative in relation to the dementeds rights. The big problem is that the starting demented and the relatives is extremely vulnerable (Anonymous, 2019b).
- It is difficult, because when the disease kicks in, a demented almost needs 24 hours monitoring and care (Anonymous, 2019a).
- "The disease can manifest itself in both passive behavior and as aggressive behavior." (Alzheimer, 2019).
- "Stick to your interests and the small and big activities you were happy with before the family was affected by illness. It is also important to have time to be with others." (Alzheimer, 2019).
- "For the period 01.01.15-31.12-15, where it appears that she should have used cold water for 14.267,57 kr, which is up to 274.50 m3 in an apartment in the nursing home" (DemensNet, 2016).

Basic information
Name: Luna Sand
Birth day: August 7th 1995
Gender: Female
Status: Single
Relative: Granddaughter to Mette Sand
Education: Student (Architecture)

Ill. 233 Persona Luna

Details about:
Luna is a 23-year-old woman. Four years ago, her grandmother was diagnosed with dementia. It has been hard to accept her grandmother's illness and that Mette is only occasionally the strong grandmother she has known all her life. Luna has often felt very alone, because there is a taboo around being a relative of one with dementia. Both Luna and her grandmother Mette come from the countryside and have previously been enjoying nature a lot. However, since her illness started she has had difficulty getting out into the nature and the views of nature aren't good at the center Mette lives in. Luna has always been very close to her grandmother and instead of going to kindergarten, Luna has always been with her grandmother. It is difficult that the roles almost have been changed, making Luna the adult. When people speak with Luna, they ask about Mette, because she is the one that is sick, but dementia is a disease that affects the whole family as well. Luna sometimes feels overlooked and helpless. She thinks her grandmother disappears in front of her and it frustrates her, that there is nothing she can do. Luna does not fully understand it and thinks it is so unfair.



Key problems

- Difficult to be relatives, to understand and accept the disease.
- The feeling of loneliness and being left to oneself in the process.
- Lack of opportunity to get out into nature or just have a view out.
- Feeling sad and have depressed thoughts (Grief) by losing one who is still alive.

Design Strategies

- Initial support groups and opportunity for psychological con versations for relatives.
- Social events with the residents and their relatives, where the relatives also learn each other and have the opportunity to form a network.
- Possibility to walk within the area, on a non-slippery surface.
- Ongoing opportunity for psychologist conversations in a safe environment and participate in support groups for relatives.

State of the Art.

- So my grandmother was not my grandmother as I knew her anymore. Only glimpses ... Like relatives and grandchildren, then I visited my grandmother for my family (mother + grandfather) and of course my own .. But my grandmother I do not know if got something out of it .. It was easy a little a duty that seemed a little pointless .. She forgot we had been there and finally she did not know who I was." (Anonymous, 2019a).

- As I experienced it, it only became easier when my grandmother came to the Ådalscenter, where they had pretty amenities and good staff geared up to handle her. My grandma was also herself and calm (Case study- Anonymous questionnaire).

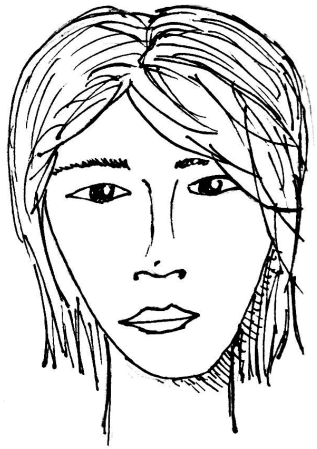
- There are bad opportunities to look at nature from rooms in the center (Anonymous, 2019b).

- When Mette Sand was examined and found the disease dementia, it became "easier" for caregivers, staff etc. as there was now a clarification. The relatives got a clear, sad message (Anonymous, 2019a).

- It's hard to see one's grandmother disappear that way (Alzheimer, 2019).

- It was as if the roles had changed. I couldn't get help with homework or ordinary everyday things. Instead, it was me to help- Thea in 19 years (Alzheimer, 2019).

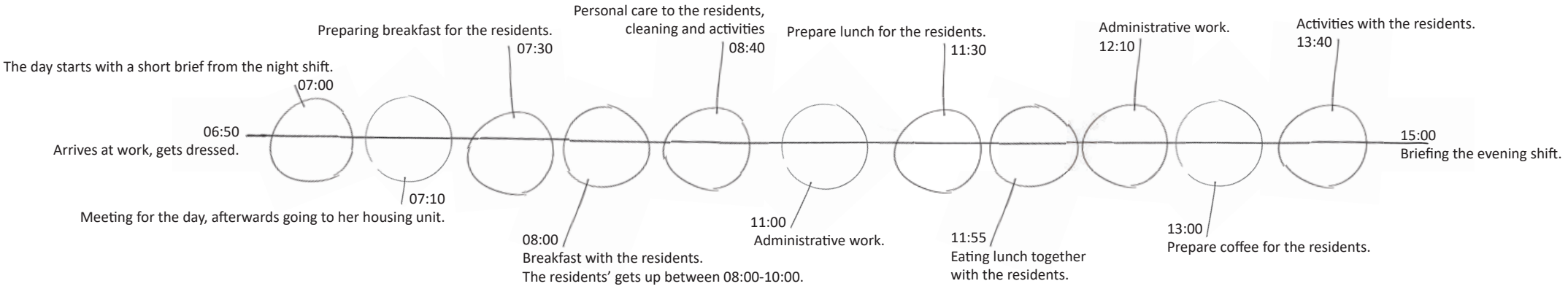
- You can say that people with dementia die twice, and they are especially difficult for the relatives, because first they disappear in front of one, and finally they die and again (Olenius, 2019).



Basic information
Name: Janne Larsen
Birth day: May 5th 1978
Gender: Female
Status: Married to Daniel Larsen. Together they have 2 children.
Education: Social and health assistant
Experience: 11 years
Motivation: Wants to make a differens

Ill. 234 Persona Janne

Details about:
Janne is a happy and outgoing person and has a lot of patience. She lives in a detached house with her husband Daniel and their two children aged 12 and 15. She is interested in the elderly and hence the demented, as it is a subject area in development where much new knowledge comes into being. The work at a dementia center can sometimes be very time-consuming, which requires good structure and overview, over both the physical framework and the tasks of the day. This means that the lunch break is sometimes divided into smaller chunks. As the center of origin was not built for dementia and it provided restrictions for the renovation for 7 years. Large rooms provide too many stimulants and are thus difficult to hold events in (Sørensen C, 2019). The renovation of the center partially solved the problem with the odor nuisances in the hallways, but some of the residents' apartments still suffer from odor nuisances in the form of confinement. Janne would like to make an extra effort for the fun at the center and would therefore like to be able to spend time in the kitchen with the residents.



Key problems

- There are neither time for breaks, nor a place to each their lunch.
- The dementia center does not have the facilities to make food.
- Bad overview of the residents.
- Bad air quality and smell genes.
- A large common room makes it difficult to have small activities.

Design Strategies

- Implementing eating areas with possibility of overview of the resi dents.
- A large functional kitchen, with storage of frost ware and comestibles.
- Good possibility of overview from one or multiple areas in the common room.
- Good ventilation possibilities, a high standard.
- Design a common room, that should be multifunctional with the possibility of dividing the room into smaller parts.

State of the Art.

- Breaks are held together with the residents of the center, partly because there is no staff room and that there isn't really time for a break (Anonymous, 2019a).

- It is positive when the food can be made in the house. (Olenius, 2019)

- It can be difficult to keep an eye on all the patients; it helps a little when they have GPS. (Anonymous, 2019b).

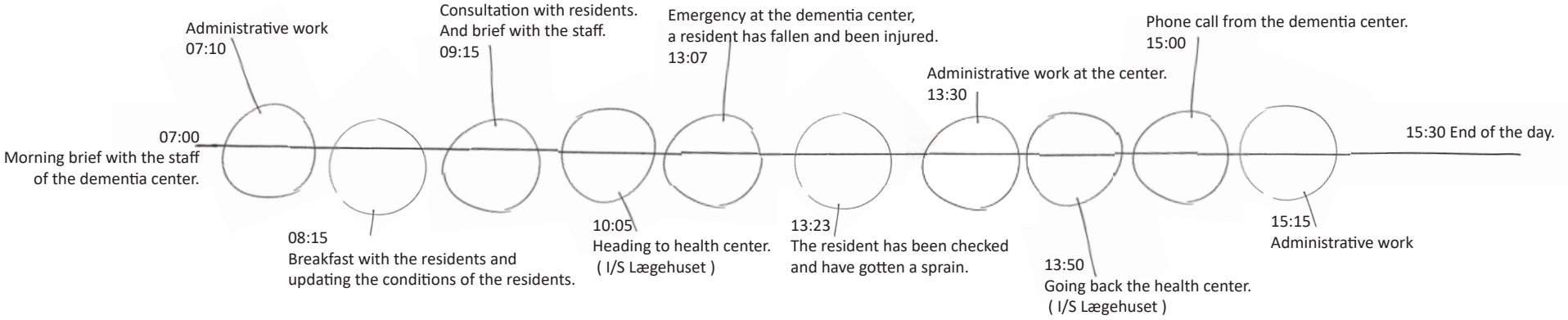
- There are often odor nuisances that are bothersome to the staff, residents and relatives (Candrain et al., 2017).

- Activities come to the center, although more variation is desired. (Sørensen C, 2019)

Basic information
Name: Susanne Østerby Hansen
Birth day: December 15th 1982
Gender: Female
Status: Single mother to a 16-year old daughter
Education: Nurse
Experience: 9 year
Motivation: Make a different and help people with problems

Ill. 235 Persona Susanne

Details about:
Susanne is a strong and independent single mother who is ready for any challenge. Susanne wants the best conditions for everyone and would therefore like to make a difference, for those who have a hard time. The disease, dementia is complex and therefore arouses the interest in how these patients can be helped. At her education, they have been taught the care of physical and mental disorders, where she has also become aware of side effects of medication in small and large quantities (Ug.dk, 2019). After Susanne moved and thus changed work 1,5 years ago, she has experienced several situations where the nursing center has not had attractive facilities or has been appropriately furnished. Besides this, the center is a little too small to be able to do the necessary work, under decent conditions. Susanne is often forced to work with sensitive data or medicine at a time, where both residents and relatives pass by. At the center Susanne is working at, there is also a small ramp inside, which was previously a staircase, and was later transformed into a ramp, but residents still tend to stumble and fall, as they may have difficulty walking and keeping their balance (Nationalt videnscenter for demens, 2018). Another problem is the amount of medication the elderly must have (Thrane, 2018), where Susanne knows the side effects of these and are seeking alternative treatments along with the staff and by using music therapists.



Key problems
- Missing possibility for privacy when documenting medicine.
- A private room to dispense medicine.
- Too little consideration for fall risks.
- Too many different types of medications.

Design Strategies
- Implementation of sufficient offices.
- A small private room nearby every common area, for fast and private dispensing of medicine.
- Avoid unnecessary steps or level shifts.
- Implementation of natural healing or other types of medication.

State of the Art.
Missing a place for staff to dispense medicine. (Anonymous, 2019b).

There are not enough rooms for administrative work. (Anonymous, 2019b).

"..there is often poor insight and appreciation of falls risk.." (George, Long and Vincent, 2007)

Patients with dementia are more prone to side effects from the medication. In addition, the consumption of different types of medication at the same time must also be taken into account. (Thrane, 2018; Gill SS et al., 2007, as cited in George, Long and Vincent, 2007)

Appendix 3 VR, Sensory room and Music therapy

Virtual Reality glasses and sense room.

In Region Southern Denmark, in 2018, one experimented with using Virtual Reality (VR) as a tool for creating joy of life with the demented. Our glasses gives the staff the opportunity to take the residents on the road far away from the dementia's fixed framework, and a journey can be made in both time and place. For example, our glasses are used in the experiment, to give "Elisabeth" a positive experience, with a bunch of preschool children, or a trip to a farm with large cows, and that is something that can be felt by both "Elisabeth" and her caregivers. Dementia continuously loses their cognitive function. But experiences such as these awaken in almost magical life joy and old memories are awakened by "Elisabeth" and other demented ones. (Voigt Rasmussen, 2019) The experiment in the region of Southern Denmark has been very difficult to measure, since dementia is a disease that is fatal, and therefore measurable positive effect cannot be achieved over a long period. However, among the patients in the experiment, there has been a conceivable improvement among the residents, if only for a short period of time, this is thus a tool that can be used to create some really good times, along with the demented. (Voigt Rasmussen, 2019) On field students during the development of the program, positive experiences were also made with the use of VR glasses, where at the Ådalscentret the leader was spoken positively for the use of VR glasses as a tool to give the residents positive and private experiences, by, for example, taking them out to a farm or out into the forest. Old memories are awakened and create moments of joy of life, and that is what we work for, the good moments of everyday life. (Olenius, 2019)

Sensory room and Stimuli's room

On our most thorough studies around the Ådalscentret, Østermarken, Plejehjemmet skovgården and Aabybro nursing home, it became registered that several places were used sensory room, and several of the staff spoke about stimuli living rooms. This can be a study designed for a unique experience, so everything in a room comes from the 1950s, with everything from chairs to wallpaper, this can create a room where the residents feel particularly at home as the stimuli room is filled with things that are well-known to them. However, there may be some disadvantages in having a room that is painted and taped to a certain style, as the dementia may be a spread both culturally and age-wise. An alternative can be a sensory room, where on large screens or with the project you can create "windows" out to the world, this can be the area that is well-known to the citizen, in that way the same room can be used by different users, and be a room with windows facing a forest for a resident, and a room with windows over the city for another resident. These sensory rooms are equipped with special light that follows the rhythm of the day, or with lighting that helps residents who have difficult to sleep, to relax. (NEDERGAARD JENSEN, 2016)

At the skovgaarden Plejehjem , the sensory room was used by both the resident, to remedy the turmoil, the resident with sleep problems or for private sessions in order to create the joy of life of the resident. The room was also used by the staff, where the light could be put on strong daylight and during a stressed guard could give the staff a boost on the energy, eventually the room could also be used to facilitate a difficult conversation with relatives, room lighting could be set to calming , thus assisting the staff in presenting difficult news. The stimulation room can also be used as a tool to help the elderly, the staff tailor the way to the care of the individual resident because there are not two residents alike. In FOA's trade journal, articles in Sanserum evoke memories with dementia, give an example with a previous wall, the resident cannot before the session remember anything about his previous profession. But when a movie is put on where bricklaying work is carried out by older ministers, and he can remember the various tools, and start and rectify mistakes, the people in the film do. The residents live up completely, says Birgit Clemmensen. (NEDERGAARD JENSEN, 2016)

A sensory room or glasses, or a combination of the two, can be tools for the staff that increase the chance of getting the good moments with the residents. And creates an everyday life with greater joy of life.

Music therapy and dementia

Hanne Mette Ochsner Ridder, professor at Aalborg University, has, in her research, shown through a large number of studies how music therapy has a positive effect on people suffering from dementia. (Ridder, 2012) Music therapy can be various music activities and therapeutic treatments, from live music or music that the patient recognize and loves. Music therapy can take place in groups and be a social element in the nursing home or as individual sections, under personal care where the specific needs of the individual resident come into focus. Music therapy can be anything from listening to a piece of music, playing music or singing a piece of music and in this context, relatives of a resident can be instructed in the use of the music, thereby helping to the treatment. (Ridder, 2012)

During the session, the elderly are activated and the music is used to activate the feelings and memories of the resident. This has an effect on the brain and can cause a number of positive effects. (Ridder, 2012)

Music therapy can reduce anxiety, apathy, depression and aggressive behavior, but increase social and cognitive skills, and boost mood. (Ridder, 2012)

Appendix 4 : Rebild Municipality Plan and Vision

As part of the analysis, it is important to know what the guidelines and plans are for the area. These can be found in local plans, municipal plans and nature conservations. The plans for the area help keeping a monotonous style for an area or development of it. The chosen site is located 130 meters south from Nature agency, Møldrupvej 26, 9520 Skørping, on a large open space inside Rold forest. First of all, it was examined whether there was a local plan, but since the area is protected by the Danish Environmental Protection Agency with Natura 2000 plans, these plans are examined (Natura 2000 handleplan 2017). Natura 2000 areas are protected by an existing Nature and Environmental legislation, however supplemented with tighter guidelines (Mst.dk, 2014).
In the chosen area for the site there is habitat, bird protection and certain types of natural areas, including specific species to be preserved (Rebild.dk, n.d.). This means that there in principle should not be built on the selected area, but with a focus on granting an exemption from this listing. Since no local plan has been made with guidelines and plans for the place, the starting point is the municipal plan and its visions instead. Rebild municipality in their municipal plan was based on the Planning and Climate Strategy of 2015, as they wanted to ensure good conditions for their vision in 2025 (Kommuneplan 2017-2029, 2017 pp 20). The overall vision of Rebild municipality consists of three sub-visions where healthy living conditions, experiences and business life are desired. The overall vision for the municipality is:

"A healthy life in a healthy municipality"
"Rebild Municipality is rich in nature, but the quality of it is not a given. The municipal plan must to a large extent protect and maintain the quality of nature and the environment, just like the quality in residential areas, trade and business life and public service must be supported and developed."
(Kommune, 2017 pp 51)

In the planning of the dementia center, the surrounding nature must be taken into account, as this clearly appears as a quality in the municipal plan and thus is to be maintained. Furthermore for new construction, a number of wishes have also been set up if building in open areas. One of the wishes is that the starting point is traditional brick-built housing, on 1.5 floors but a maximum height of 8.5 meters. However, most emphasis will be placed on the construction location and the architectural design in relation to its surrounding landscape and buildings, if exceptions or exemptions must be given (Kommuneplan 2017-2029, 2017 pp 78-79).

Appendix 5 Interview With Skovrider Bendt Egede Andersen

Intro :
As part of investigating the site, an interview with Bendt Egede Andersen, Forest manager, was conducted. Bendt is working at the Nature Agency and manages the area, the project is planned to be built on. Furthermore, he is also one of the projects closest neighbors. This interview is conducted as a conversation, where notes are written about the various questions and answers on an ongoing basis. Below is the full-length conversation. The text is based on notes from the interview and not a transcription from tapes. Questions and answers from the interview with Forest manager, Bendt. The interview is conducted on the 19th of February 2019.

Question:
Which types of plant and berries are there in the area? Are there any special plants in the area?
Answer:
We have a lot of hum berries and pores, which can be used to make schnapps. We also have a lot of different forest berries that gives plenty of opportunities for creating experiences. There are also plenty of mushrooms in the area, but you have to know which are eatable and which are not. There are a lot of things to do and experience in nature, but a guide who knows something about nature will be preferable. A nature guide is employed in the municipality as a health supervisor, who particular arrange trips for men with cancer. Here a corporation could be made with us, to use nature as a tool for nature care.
Question:
Which kind of animals are in the area?
Answer:
There are many different animals, for example there a lot of stags in Rebild forest, but they stick to the private part of the forest, as it is quieter there. This is because the mountain bikers use the roads made in the state forests as they do not have the same right to bike in the private forests. However, a lot of deer's, ravens, black woodpecker and so on, in the forest.
Question:
It is read that Rold forest consists of 25% state forest and 75% private owned forest. What is the difference between those two and their owners?
Answer:
The private forest is "only" people who have invested in the forest and have the intention of making money, either on a hunt or on wood.
The state forest is to create a forest for the state (Public for everyone). The past 30 years, the forest and the use of it, have changed with an increased focus on outdoor recreation and use it for other activities. Rebild Hills have on average 1.000 visitors a day.
Question:
How do you secure biodiversity in Rold forest?
Answer:
It is important that the forest is a breathing hole. Therefore, large areas have been laid out that function as a breathing hole or haven where you do not interfere with the forest natural growth.
Question:
What is the interplay between Forest and pollution?
Answer:
The forest has a good purpose of that it protects the groundwater under it, making it more clear than it who is under the farming land, as there are not used pesticides. Furthermore, the forest absorbs CO2 in the long term of more than 100 years, whereas fields only occupy CO2 for a short time, which then gets released. We need to make several new forests to help us with the large problem of the climate.
Question:
How is the usage of tree from the forest as a building material?
Answer:
Wood stores CO2, whereas brick and concrete only release it when produced. There is a rule in the forest, that when a tree is felled, a new one must be planted.
Question:
Are there are areas around our project site, which have a risk of flooding?
Answer:
Nothing is being flooded here, as there are calcium and gravel underneath us. We are also on top of a hill, which also prevents flooding.

Question:
What happens when the forest is to be expanded?
Answer:
There is afforestation on agricultural land when summers like this year dry out small trees, a new tree will be planted. The large forest was not affected by the drought last summer.
Question:
Are there problems with forest fires in the Danish forests, now where we had a very dry summer?
Answer:
Forest fires in Denmark are no big problem. We have a mixed forest without too large areas of conifers, as in California and Mediterranean regions. This is because the needles from the conifers are highly flammable. Forest fires are totally natural is a part of the forest cycle. A forest fire typical happens each 100-250 year, where all the small trees are burned down. The problem is when all the small forest fires are put out, then the larger pioneer trees that are adapted to withstand the small forest fires, won't have time enough to grow as large as conifers and other fast-growing trees. This creates an environment where large the large and destroying forest fires, like in California, which large forest areas and burned down.
We are also a part of what is called the western lowland with deciduous forest.
Question:
The large beech tree on the top of the hill, does it have a story?
Answer:
The large beech tree is standing on top of a barrow and creates a beautiful landscape. The tree was allowed to stay, which is a funny story: Normally we would get a complaint from the Museum in Aalborg, as a tree on top of a barrow can destroy it if it falls. But the tree was allowed to stay and thereby, functions as a great element in the landscape.
Question:
How is the nature in the forest today, compared to the previous nature?
Answer:
All nature in Denmark are created by humans and we make it how we like it. An example is the Danish moors which are protected, but not natural, as they are the Danish desert, where grazing has destroyed the area. If we didn't cut down the beech forest in the area, there would be forest again.
In Rold forest, there are also large concentrations of old beech forest, which today is above 200 years old. They have a quality which we are protecting.
Question:
The area around and in Rold forest is known for the "enchanted forest" and "troll trees" that is old beech tree. What makes those tree special?
Answer:
Our enchanted forest is total culture preservation, as it is an interesting forest. It does not grow naturally but is created by humans, by stressing the trees.
Question:
What is the vision for the area?
Answer:
My wishes are either one or another direction. My boss is Sir Ellemand and it is he who decides what is going to do, as it is the states' forest. We have a three feet of things we need is to create: Biodiversity, Create room for outdoor activities and produce tree to sell. We also have to ensure that the new forest is cultivated, as well as the forest's operation.
Question:
How is forestry run normally?
Answer:
Previously one has driven the forestry like the agriculture, which also is called clear-cutting. Here you plant e.g. conifers, who grows for 60 years after which the entire planted area is felled and we start all over again.
We have abandoned this type of forestry operation, as it disturbs the ecosystem in the forest. Instead, we let the forest grow in 80-90 years and then fell some of the trees and then have a larger variety of trees and to a further extend let the forest plant itself, in an environment they thrive. This allows the ecosystem to thrives better, as we only cut the tree we need. We help with what we can, to support the ecosystem.
Question:
How do you secure the forest from storms?

Answer:
We secure the forest against storms, by planting various trees. Plantations have a tendency to be more unstable forest and vulnerable to storms. This is because of the root systems of the trees and by planting deciduous trees to the west, will shield for other weaker trees.
Question:
What is the most common? Plantation or natural forest?
Answer:
In 2004, it was decided that the Danish state forest should be more natural with an ecosystem. This will take about 100 years to implement, but the change is already underway in **the forest.**
In private forests, the owner can do what they want and therefore are plantation forest still widespread.
Question:
What are the interest groups in the area?
Answer:
The interest groups of the forest are outdoor life organizations such as riders, mountain bikers, runners and general users of the forest. A couple of years back, we had skiers in the forest and in 2011, and there were around 25 km ski runs. It's important to understand which the need of the users and enter a dialogue with them, to create good cooperation. For example, if the users have a wish or need for a change, it is important to discuss what is possible and what we can do to support the possible changes. Often the users get the responsibility of maintaining the new trails. This helps to give the users a feeling of ownership of the trails that causes them to take care of the forest. As we have many users of the forest, we wish to have a positive experience of the forest and its users.
Question:
Are there interest groups who are opposites each other?
Answer:
Riders and mountain bikers, as they both sometimes use the same trails. Sometimes they discover each other's too late, which scares both parties.
We also have nature lovers, people who look at birds and the like. They are often against people who use the forest more actively. This requires a dialog between those two parties, which dreams can conflict with reality.
Question:
Where does the name "Rold Forest" come from?
Answer:
The forest is named after Rold city. The reason for the city name is unknown. The different part of the forest has different names.
Question:
Is Rold forest a remnant of the Danish primeval forest?
Answer:
In the Stone Age, one means that Denmark has been covered by 80-90% of the forest. Overuse of the forest has led to a decreasing to only 2% forest in Denmark, in the 1800s. Here a desire for planting more forest was decided and this led to Rold forest.
Question:
How does the future of forest look?
Answer:
The Danish forest is today 14%, which the goal is to cover 25% of Denmark with forest. There is a need for support for the new forest in Denmark, as the climate problem can mean that the need for more forest can increase in the coming years. The forest is a good way to store CO^2.

Appendix 6 Views on site

To get a better understanding of which views that were attractive to utilize and use later on in the design process, an investigation on the site were conducted. The focus of this investigation was to get an idea of where long views could be achieved. A view that was of special interest was the view toward west to the bog and Mossø southwest from the site. Another aspect of the views was the sound from the nearby road that could be heard. This would be important for the placing for the future planning and placing of the functions.
To the west down the hill a line of birch trees shields from the western wind, but unfortunately, also interfere the view to the open area. The area around Mossø is surrounded by dense conifers that reduce the direct view of the lake. Besides interfering with the view to Mossø, the dense conifers act as a natural shielding for Møldrupvej that only can be heard weakly at the site. In the evening the forest can appear as a dark and protective shield around the site, while the openings in the dense forest and to the west appear as a contrast.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Appendix 7 Genius Loci- Felt studier

Summary text: Field studies 16-17 feb. accommodation on site. JK

As a step in the direction of understanding the project site better, a field study was made into the spirit of the place (Genius Loci) as described in the genius Loci section. In Sense of place, an analysis was made focusing on understanding the potential of the site. The area was previously visited in the fall, where the phenomenological analysis method Serial vision of the English architect Gordon Cullen was made. Pernille Ehlers in the method booklet of the place's character, emphasizes the importance of a thorough understanding and Positivist review of the area, objectively, was made. Subsequently, a SWOT analysis was performed that was supposed to supplement and strengthen the phenomenological understanding of the area, where the serial vision was laid out over the broad area around the site. A SWOT was prepared specifically in the area and around the site. The analyses were carried out continuously from Saturday the 16th of February at 16:00 to Sunday the 17th of February at 08:10. This provided a more in-depth understanding of the site as the site was experienced at various times of the day, thus emphasizing specific strengths, weaknesses, opportunities, and threats, as well as certain features that only come into effect at specific times of the day. Of the strengths in the area, there was the pleasant calmness, the wind in the trees and birds singing from the forest. The site seems very open and peaceful, as it is elevated on a hill, with long views to the west and a large beech tree marking the slope of the hill and clearly defining the area.
Of weaknesses, there was the west wind, which goes directly over the site and blows it. The wind in the trees sounds like a busy road in the background and the train is relatively close, which runs about every half hour. The moss, the wet areas, uneven terrain, and numerous mole shoots can cause problems with walking around the area.
Of opportunities, the group offers good prospects to the west, where there is a view of the water, the forest, and sunset down behind the forest or the large beech tree. There is the possibility of lighting path systems around the forest edge, which can become a natural sense path, with the sound of the wind in the trees, birds singing and the smell of moss and fresh nature. In the morning, you can enjoy a cup of coffee while the forest awakens with birds singing and the dew falling from the trees.
Of the possible threats, the group noticed issues such as the road and the train path, which can both be heard. The forest can be very dark towards the evening, which may seem gloomy or threatening. The wind and the cold can be a nuisance in the area, as well as the large slope to the west, which can complicate walking both to and from the forest. Crows who screams, which echo around in the quiet forest, and scouts walking around, may seem disruptive and scary.

Finally, the site was looked at, based on a more constructivist approach, and there is a look at the place of power and interest in the area. The area is characterized by being divided into the private and the shared state forest, which provides areas that are characterized by being used for forestry, and other areas are laid out for more recreational use. Natura 2000 rules are protected for the area. Furthermore, the Nature Agency also has an office in the area, which has a focus on carrying out tasks along the Danish coasts, nature areas and in the Danish forests.
Registration of the characteristic features of the site was drawn up and is a description of the elements that were particularly important in giving the place character.

Time	Location	Sounds on the site	Thermal experiences	Visual experience	Scents impressions	Other
1600	J1	Sounds from the road to the east, birds and an ambulance, wind in the trees through the forest.	Cool wind from the west, mild.	Smoke from the chimney from a small wooden house to the south. Sitting on the old beech and looking down to the Nature Agency to the north.	The smell of spring, the forest and a little winter.	The wind in and around the trees sounds a bit like the road. Children playing at the red house.
1700	J2	Sounds of a train that rolls through the land and sounds from the road to the west in the distance.	Cooler now than before. Sitting down in a corner of the site so there is no wind but more humid.	Smaller area, long look to site to the west, and view to the bog.	The scent of moss and wet grass.	Possibility of a path around the bog.
1815	J3	The wind in the trees, a car who is accelerating.	It has become a little cooler, but not cold. Sit in shelter.	Dark forest all around, long look to the west.	The smell of forest, winter and coffee.	The road to the east can be heard faintly.
2010	J4	The sound of the wind in trees. The sound of the train is weak, old trees creak in the wind.	Fingers are feeling cold, temperatures around 2-3 degrees.	The forest appears as dark mass, the big tree gathers attention.	The smell of the for-est and night, night frost has subsided.	Calm and safe. Trees creak-ing in the wind, the wind has subsided.
2205	J5	The wind in the trees causes trees to creak, the wind stops, no birds can be heard.	It is getting colder and around 2 degrees. Trying to keep warm.	The moon lights up the for-est. The open area, the site, is, the open area is lit up.	The smell of night and frost, the night is upon us, the wind has subsided.	Small animals in the forest can be heard.
0700	J6	Birds sang in the woods, otherwise, everything is quiet. No sounds from the road or trains, the sound of the forest that wakes up.	A little warmer, the sun is rising, wet grass.	Forest wake up, the haze over the open area, Marsh-woman brews.	The smell of the morning.	Children- Scouts are woken up and the sound of people talking.
0810	J7	Bird song has calmed down a bit. I can hear the sound of water hitting the leaves on the forest floor, a crow cries of the forest.	The sun has started warming up the forest.	Very hazy, short view due to the haze.	Clean and fresh air of a new day.	Children in the south are playing.

SWOT Analysis of the area : 16/17 - 02 - 19 JK

Time	Place	Strengths	Weaknesses	Opportunities	Threats
1600	J1	Peaceful, calm, time is quiet in the place	The wind from the west over the open area.	The old forest. View to Mossø from the beech tree	The road the the railway tracks.
1700	J2	Calm, peaceful, the sound of the wind	Close to the train and bog, wet area.	Possibility of a path.	The train, and too few views, dark forest to the west.
1815	J3	The wind in the trees, silence and tranquility	The wind over the trees to the east sounds like cars on the road.	Calm and peaceful with the sound of the forest.	Dark forest, may seem gloomy and dangerous.
2010	J4	At night, the quiet and the wind in the trees	There is very dark in the area	Illumination of a path, peaceful.	The darkness may seem threat-ening, but also safe as a duvet.
2205	J5	The wind, the trees and the silence.	The wind across the field	Sheltered and bright area. Low sounds of the road and the train, very weak.	The wind and the cold.
0700	J6	A lot of birds singing	Too much frost in the morning, wet and cool.	Outdoor areas provide opportunities to see the forest wake	Cold and wet.
0810	J7	A pleasant silence over the area	Short look because of frost overlying the area.	You can drink coffee while the woods wake up, which can be used as a quality and as a morning activity.	Crows screaming, kids / scouts might sound a little disturbing.

The power relationship of the place and Conflict of interest in the areas.

Scout Group- Natura 2000- The Danish Nature Agency- dry land areas vs. swamp and marshes.
Privat vs. State Forest.
Visitors vs. Permanent user (couple with dog looked very distrustful towards us)
Narturen vs. man? Animals vs. People, the Use of the Forest Vs. protection

Tid	Location	Sounds on the site	Thermal experiences	Visual experience	Scents impressions	Other
16:10	1.	-Low noise from the cars on the road behind the trees. -The wind in the treetops -Weak twitter of birds	-Chilly, due to a light breeze.	-A small swedish forest cabin. -Wavy landscape. -A lot of molehill and dead leaves.	-Fresh wind and moss	-Spring colours.
16:45	2.	-Wind in the treetops. -Weak twitter from birds.	-Comfortable with a jacket on. Almost no wind.	-Surrounded by trees, moss and molehills. -A small outdoor toilet to the south.	-Moss	-A fireplace/campfire.
18:15	3.	-Wind in the treetops. -Leaves rattling.	-Medium temperature, a little windy.	-Semi bright, a contrast between the dark trees in the distance and the clear bright sky.	-Spring fresh wind	-Little outdoor toilet.
20:00	4.	-Fresh wind in the trees -Old trees creaking	-Cool, evening / night cold 2-3 degrees	-Light, no influence on artificial lighting. -Beautiful contrast between dark trees and light skies	-Snotty -A little scent from moss and grass	-Calm atmosphere.
22:05	5.	-Calm, wind in the trees. -Small animals walk around the forest and by the tent	-Cool, approx. 2 degrees -Nice temperature in the tent	-The site is well lit by the night sky. -Good visibility, can see small openings in the forest, due to the moonlight	-Has become accus tomed to the scent of nature: Fresh clean air	-The forest is open, due to the moonlight. This makes it less scary.
8:10	6.	-Birdsong, crows and sounds from smaller animals in the forest.	-Cold but no wind	-Morning moisture in the forest floor and grass. -Foggy and cloudy.	-Snotty, do not smell anything	-Peace over the area. -Open vs. closed area.

SWOT Analysis of the area : 16/17 - 02 - 19 KM

Time	Place	Strengths	Weaknesses	Opportunities	Threats
1610	1.	Openness in the area and the proximity of the forest	No shielding from the wind from east, as the site is almost the same height as the beech trees west from the site.	-Good view opportunities toward west.-The evening sun goes down behind the large beech tree.	-A small red Swedish cottage south-west from the site. -Uneven terrain and steep hill down from site, to the west. -A swamp right next door
1645	2.	-Calm area, feel down to earth.-Closed area and protected from the wind.	-Feels closed inside the trees. -Long transport, whose site should be here.-There is moss right next door.	-The road around the bog is at the same level that allows for the construction of a path.	-Level shift in some places at the edge of the forest -The forest can be difficult to navigate in (Applies to most forests).
1815	3.	-Quiet, you can easily hear the wind otherwise there is almost no other sounds. -Large and semi open area with lots of light.	-The forest may seem scary when the wind blows a lot.	-Possibility to be open to the outside in the evening, as it does not get black, due to the open space.	-When it is not cloudless and the moon does not light up, the forest may be dark?
2000	4.	-Quiet forest, without much visible wildlife (So one hare).-Good view to the west, since site is located high.-The forest is light / has light openings when the night sky is cloudless and the moon is shining	-No weaknesses, comfortable area.	-Stay outside, as the site is bright in the evening-> The building must have a distance of 15-20 meters to the trees, so the area outside will be more light and thus have a comfortable distance to the forest.	The same as in location 4
2205	5.	The same as in location 4	The same as in location 4	The same as in location 4	
0810	6.	-Quiet, do not feel trapped in the forest, due to the altitude of the site.	-Many molehills -Too much peace that does not happen so much and the sounds that can be heard become very dominant. (Can be a great quality)	-Sounds of water droplet from the large beech tree that is soothing-> A morning terrace where you can sit and drink morning coffee or have breakfast	-Echoes over the trees from crows and other birds-> Can possibly feel threatening or creepy?



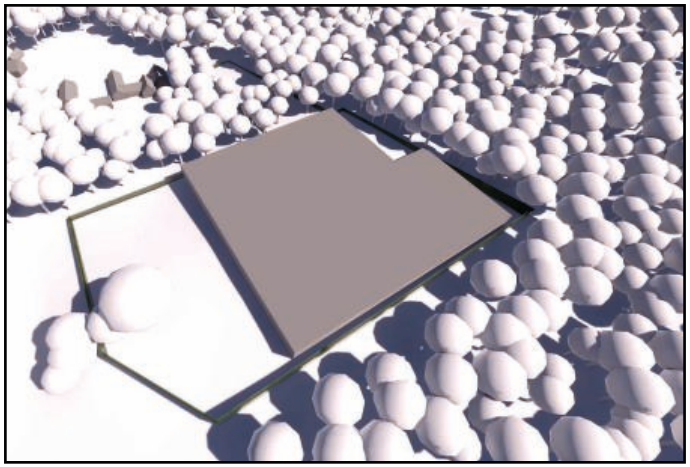
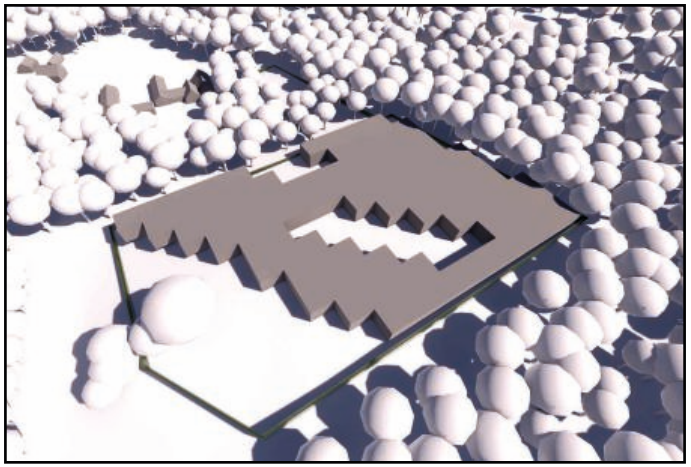
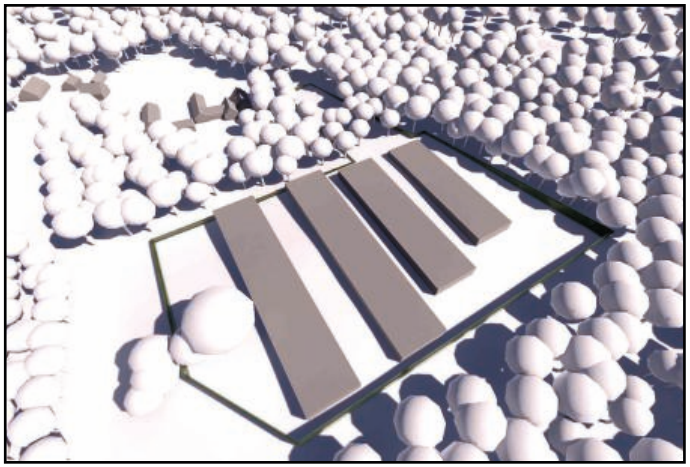
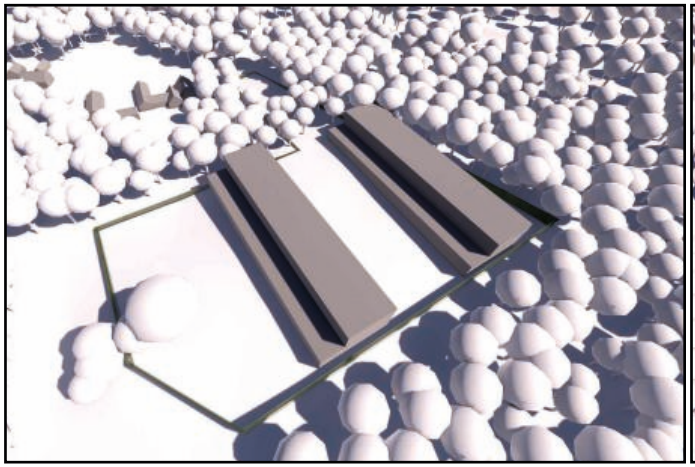
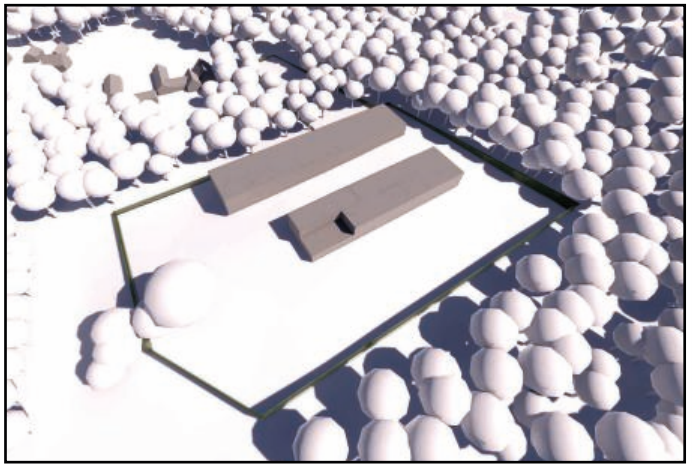
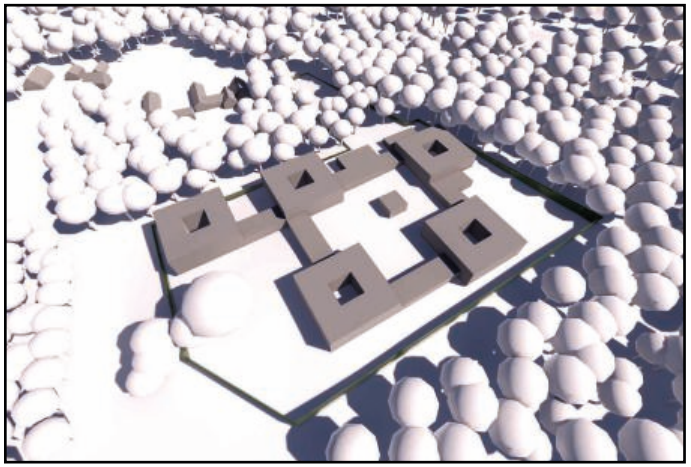
Other: To go to extremes: The forest can seem uncomfortable when going there in the evening when one can feel watched by trees -> Will look out towards the open since it is easier to keep an eye on his surroundings.

Summary of the registration and SWOT analysis:

To understand the site better and get an insight into the qualities that are on the site and around, made a Genius Loci, to find out the strengths and weaknesses of the site offers.The site offers several positive and negative qualities. After an afternoon, overnight and morning on the site, both strengths, weaknesses, opportunities and threats have been experienced on the site that can be worked on. The weaknesses and threats, of course, are that the forest can be dark, has uneven terrain and the swampy areas. Since there are no trees to the west and the wind is strongly dominant from there, wind genes will occur which must be taken into account. These issues should be prevented as far as possible.The strengths in the area are clearly more than weaknesses. These strength are, for example calm, the view and the peaceful surroundings, all of which fall naturally on the site and around. These strengths and opportunities can be difficult to find at other locations and therefore it will make sense to utilize these. The tranquil nature and the hills provide the opportunity to build paths along the edge of the site, which can be used for walks, where residents can walk either alone or with companion. Furthermore, there is also ample opportunity to construct several paths around Rold forest, both in challenging environments in the forest, around Mossø or around the swamp area west of the site.A great quality of the site is the large beech tree, which is furthest to the west on the site which stands as a symbol for that particular place.

Since the site is out in the forest, there may be a risk that it feels enclosed, as in place 2 where it feels very closed, but since the site is located up on a hill, there is good view over the western part of the forest and the swamp, which gives a liberating and clear feeling.

Appendix 8 Volume studies

Appendix 9 Photovoltaics

Monocrystalline with an efficiency of between 15 and 18%, polycrystalline with an efficiency of between 10 and 15%, and Thin film with an efficiency of between 4 and 10%. Monocrystalline solar cells were selected on the basis that they are the most efficient and are available in a color blender along the roof's color. It was calculated on roof pitches of 0 degrees, 15 degrees and 30 degree slope roofs. The required area was calculated, as well as peak performance for solar cells (PV), placed on both flat roof and roof pitch.

The energy consumption from the first BE18 calculation
The energy consumption for the residential areas:

Need Dement bolig:

$$30{,}2\,\frac{kWh}{m^2}per\ year\ +\ 1000\,\frac{kWh}{4844{,}5m^2}per\ year\ =\ 30{,}40\,\frac{kWh}{m^2}per\ year$$

The energy consumption for the Daycare/downtown and staff area:

$$41{,}5\,\frac{kWh}{m^2}\ per\ year\ = 41{,}5\,\frac{kWh}{m^2}\ per\ year$$

The combine energy consumption for Mossø Center:

$$\left(30{,}40\,\frac{kWh}{m^2}per\ year\ *\ 4844{,}5\ m^2\right)+\left(41{,}5\,\frac{kWh}{m^2}per\ year\ *\ 2155{,}5\ m^2\right)\ =\ 273{,}377.75\ \ kWh\ per\ year$$

The energy consumption after detailing the BE18 calculation

The energy consumption for the residential areas:

$$30{,}1\,\frac{kWh}{m^2}per\ year\ *\ 4844{,}5\ m^2\ =\ 145.844{,}5\ kWh\ per\ year$$

The energy consumption for the Daycare/downtown and staff area:

$$41{,}4\ \frac{kWh}{m^2}per\ year\ *\ 2155{,}5\ m^2\ =\ 89.237{,}7\ kWh\ per\ year$$

Total annual energy requirements = 235.082,20 kWh per year

30 Degree Roof angle
It has been read in relation to 30 degree roof pitch with a south-west facing roof facade that a radiation of 1130 kWh/m^2 can be expected, with monocrystalline solar cells having an efficiency of 15%. This gives an expected production of 169.5 kWh/m^2 per year (Katic, 2007).

$$235.082{,}20\ kWh\ per\ year\ /\ 169{,}5\ kWh/m^2\ per\ year\ =\ 1387\ m^2$$

It is calculated on how much energy can be expected to be absorbed on the entire roof area, on the south-west facing roofs with a slope of 30 degrees.

$$169{,}5\ kWh/m^2\ per\ year\ *\ 1014{,}1\ m^2\ \ =\ 171.889{,}95\ kWh\ per\ year$$

$$(\ 171.889{,}95\ kWh\ per\ year/\ 235.082{,}20\ kWh\ per\ year\ )*100\ =\ 73{,}11\ \%$$

The Peak performance
Yearly performance = C * E * F
Where:
C = is the peak performance of the solar cell (kWPeak), E = is the insolation (kWh/m^2) Southeast- 30, 30 degrees: 1130 kWh/m^2 , F = is the assessment of the system factor; optimal system with high-efficient inverter, building integrated: 0,8.

The yearly performance is found

$$30{,}1\ kWh/m^2 * 4844{,}5\ m^2 = 145.819{,}45\ kWh\ per\ year$$

The peak performance
C = (yearly performance) / E * F

$$C = (145.819{,}45\ kWh\ per\ year)/1130)\ kWh/m^2 * 0{,}8 = 129{,}04\ kWPeak\ = 129{,}04\ kWPeak/\ 1014{,}1\ m^2\ = 0{,}1272\ kW/m^2$$

This gives a peak performance for the solar cells placed on the saddle roof of 129.04 kWPeak, which means that on the selected southwest facing roof is produced 0.1272 kWh/m^2
In addition to the roof of 30 degrees, it was also analyzed the possibility of using roofs of 15 degrees, with an expected solar radiation of 1084 roof pitch and flat roof of 0% with an expected solar radiation on 999 kWh/m^2.
This gave the following results:

Definition	PV on a 30 degree roof slope	PV on a 15 degree roof slope	PV on a 0 degree roof slope	Unit
Sun radiation	1130	1084	999	kWh/m^2
Monocrystalline PV effect	15	15	15	%
Solar cell will produce	169,5	162,6	149,85	kWh/m^2 per year
Area required to reach Zero Energy Building	1612,84	1681,29	1824,34	m^2
Percentage of the requirement who can be reached	62,87	60,31	125,17	%
The Peak performance	302,40	315,24	342,06	kWpeak

It is concluded that a combination of solar cells on both the southwest roof surfaces and on the flat roofs. There is a need for a necessary number of m^2 solar cells and a peak performance for solar cells located at 30 degrees and 0 degree roof.
The total energy requirement of the building is 235.082,20 kWh per year. It has been calculated that by placing solar cells on the south-west facing roof of the building, it can be generated 171.899,98 kWh per year, which covers 62.87 % of the energy needed of the building. The remaining energy requirement is calculated and a number of solar cells are determined on the flat roof where the need is 235.082,20 kWh per year- 171.889,98 kWh per year = 63.192,22 kWh per year.
63.192,22 kWh per year / 149,85 kWh/m^2 per year = 422 m^2.

Finally the peak performance is calculated for flat roof. Furthermore, the amount of m^2 can expect to generate.

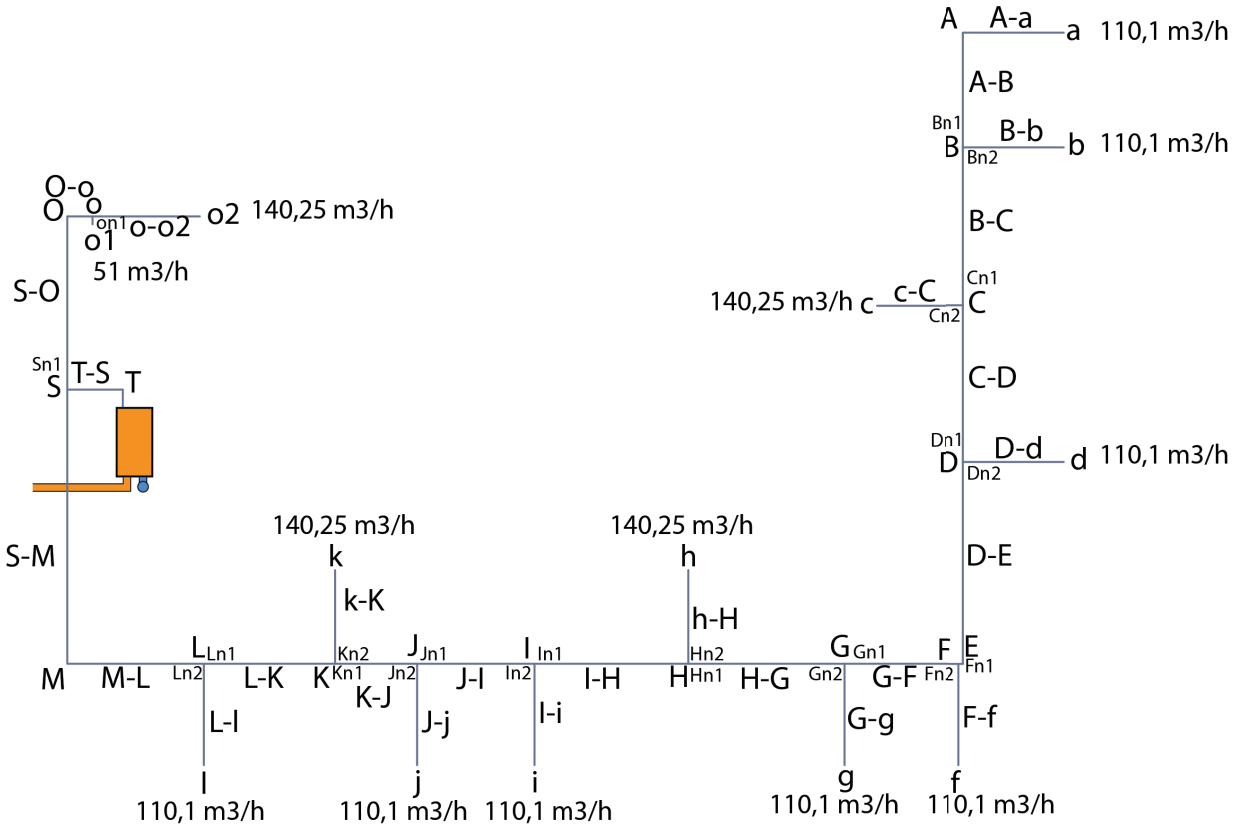
C = (yearly performance) / E * F = $(89.237{,}7\ kWh\ per\ year/999)\ kWh/m^2 * 0{,}8 = 71{,}46\ kWPeak = 106{,}26\ kWPeak/422\ m^2\ = 0{,}169\ kW/m^2$

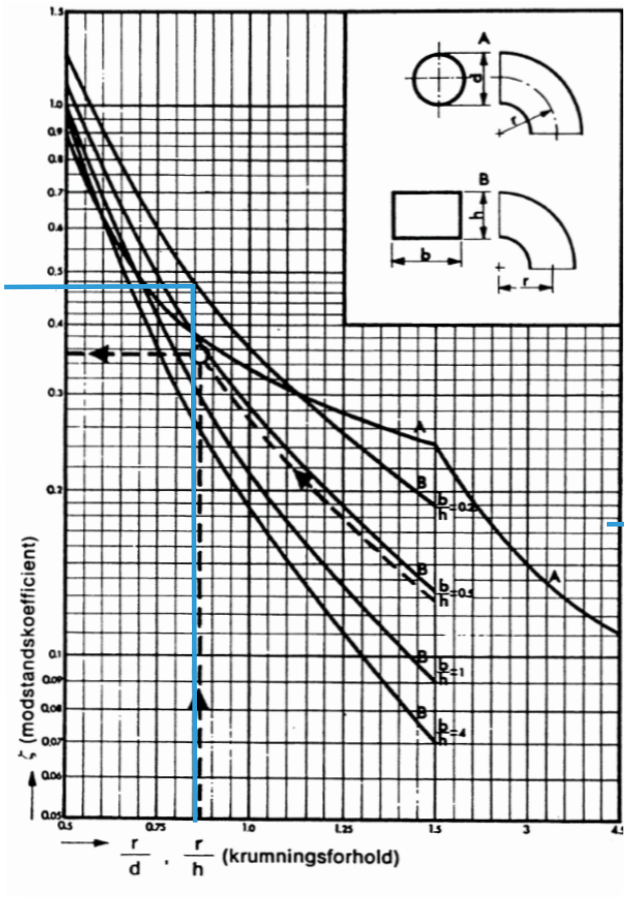
Total energy need for the building	235.085,20 kWh per year	Combined area covered of PV.	1437 m^2			
Energy covered by south facing roof, 30 degrees	171,889.98 kWh per year	Amount of PV on 30 degrees roof	1014,1 m^2	129,04 kWpeak	0,1272 kW/m^2	62,87 %
Energy covered by south facing roof, 0 degrees	63.192,22kWh per year	Amount of PV on 0 degrees roof	422 m^2	71,46kWpeak	0,169 kW/m^2	37,13 %

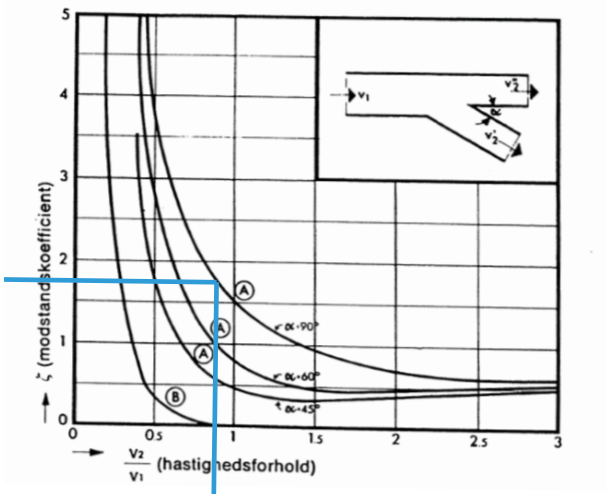
Appendix 10 Mechanical ventilation

There is a study of pressure loss in the ventilation ducts, to ensure future ventilation can provide sufficient airflow and thereby meet the requirements for the atmospheric and thermal indoor climate. The location of the ventilation system is made based on space requirements and to reduce energy consumption in transport by air to the supply and exhaust air. The study is made on the basis of an SBI nomogram, where the individual resistors of the branch fittings, bends, and constrictions have been calculated. Furthermore, pressure drops and throw lengths have been investigated for different supply fittings. A plan of the calculated housing development can be seen below.

Pressure loss diagram:

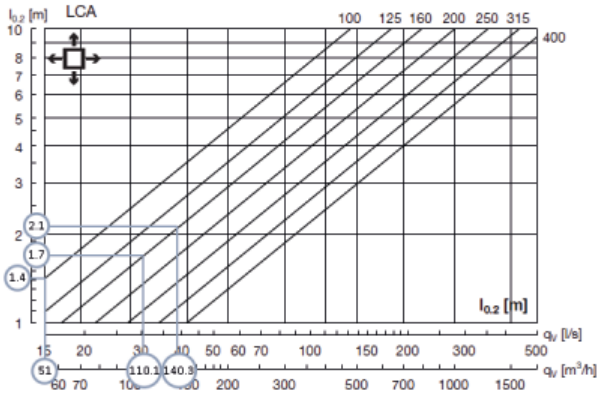






Kastelængde $l_{0.2}$

Kastelængden er angivet ved en sluthastighed på 0.2 m/s .

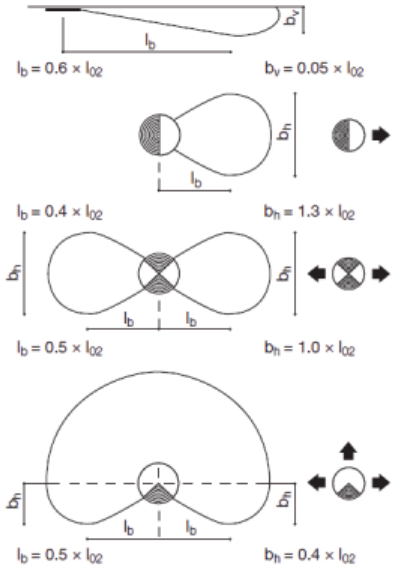


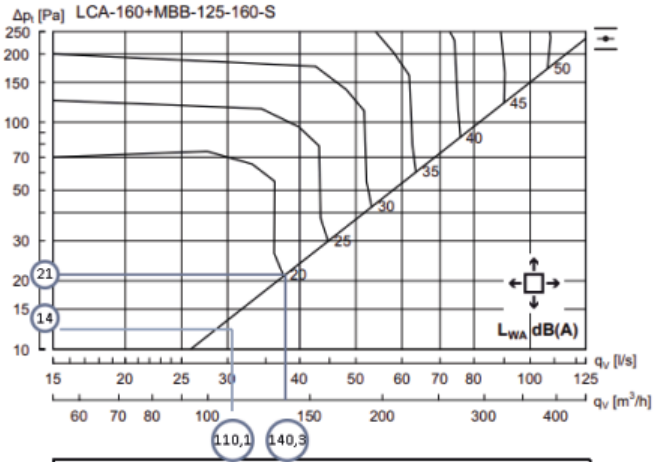
Korrektion af kastelængde $l_{0.2}$

LCA Ød	1 - vejs	2 - vejs	3 - vejs
100	2.4	1.8	1.4
125	2.3	1.8	1.3
160	2.3	1.8	1.3
200	2.3	1.9	1.3
250	2.3	2	1.3
315	2.3	2	1.3
400	2.2	2.1	1.3

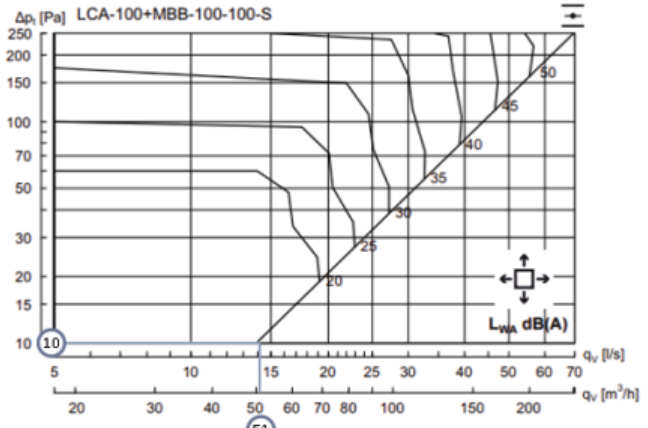
Stråleudbredelse

l_b = Afstand fra armaturet til det punkt, hvor spredningen er maksimal.
b_v = Strålens tykkelse i vertikalt plan.
b_h = Strålens bredde i horisontalt plan.





Hz	63	125	250	500	1K	2K	4K	8K
K_{ok}	13	8	1	-3	-6	-12	-17	-25



Hz	63	125	250	500	1K	2K	4K	8K
K_{ok}	9	7	3	-5	-5	-12	-16	-23

(Anon, 2017)

Appendix 11 Natural ventilation

An analysis has been made on the possibility of implementing natural ventilation. Natural ventilation is not used as primary ventilation but implemented to give residents a say regarding the thermal indoor climate.The possibility of using the single-sided, cross flow and stack ventilation was investigated, then single-sided ventilation was selected. A rule of thumb
when implementing the single-sided ventilation, is that the depth of the room should not exceed the height of the room.
In the calculations, it is assumed that the outdoor temperature is 12 degrees and inside temperature is 22 degrees. Danish standards advise a ventilation rate of minimum 10 l/s (DS_CEN_CR 1752, 2001). The calculation takes the fragile resident into account, thus there is a focus on ensuring a comfortable indoor climate. Recommendation from the Working Environment Authority is that air velocity does not exceed 0.15 m/s (Jensen, 2018). For single-side ventilation, an air change of 0.64 h-1 can be achieved with an air flow of 23.7 l/s, which gives a speed of 0.1359 m/s and thus is possible to use natural ventilation where a satisfactory air change can be achieved, without the risk of draught.

Single – sided ventilation:

Velocity of the air

Formel: $V_k = C_v * \sqrt{\frac{2|\Delta p_u|}{\Delta_P}}$

Formel: $C_v = \frac{1}{\sqrt{1+\zeta}}$

Where:

ζ = Modstandstal 0,08 (SBI 202, 2002) 70 s

Δ_p = The pressure different (Pa)

p = The density of the outdoor and indoor air (1,25 Kg/m^3)

C_v = Velocity coefficient

V_k = velocity of the air (m/s)

$$C_v = \frac{1}{\sqrt{1+\zeta}}$$

$$C_v = 0{,}9622$$

$$V_k = C_v * \sqrt{\frac{2|\Delta_P|}{p}}$$

$$V_k = 0{,}9622 * \sqrt{\frac{2|0{,}01247\ \text{pa}|}{1{,}25\ \text{Kg}/m^3}}$$

V_k = 0,1359 (m/s)

Air Flow Rate:

Formel: $q_v = C_d * A \sqrt{\frac{2|\Delta p|}{p}}$

Where:

q_v = The air flow rate (m^3/s)

C_d = The Discharge coefficient of both inlet and outlet openings (0,7)
SBI 202 58s

A = The inlet and outlet of the area (m^2)

Δ_P = The pressure different (Pa)

p = The density of the outdoor and indoor air (1,25 Kg/m^3)

Formel:

$$q_v = 0{,}7 * 0{,}24m^2 \sqrt{\frac{2|0{,}01247|}{1{,}25\ Kg/m^3}}$$

$$q_v = 0{,}02373\ m^3/s = 23{,}7\ l/s$$

Pressere Differens:

Formel:

$$\Delta_P = \rho_u * g\ (H_0 - H_1) * (\frac{T_i - T_u}{T_i})$$

Where:

g = The gravitational acceleration (9,81 m/s^2)

H_0= The Height of the neutral plan (Middle of the window)

H_1= The height from floor plan to the opening inlet the opening (m)

T_i,T_u= The indoor and outdoor temperature (k = C + 273)

Formel:

$$\Delta_P = 1{,}25\ \text{Kg}/m^3 * 9{,}81\ \text{m}/s^2\ (2{,}25m - 2{,}35m) * (\frac{295K - 285K}{295K})$$

$$\Delta_P = 0{,}01247\ \text{pa}$$

Appendix 12 : Life Cycle Assessment

U-value Calculation

The value is found using the transmission value, the thickness of the material and the materials thermal conductivity.
With the exterior walls the following values are used for overgangsisolans.

Calculation of thermal conductivity (Lamba value) in inhomogene lag.

Material	Width, h (m)	Length, l (m)	λ *(W/mK)*
Insulation	0,3	0,983	0,038
Wood (I profiler)	0,3	0,017	0,13

Exterior transmission value : R_{se} = 0,04 $\frac{m^2K}{W}$

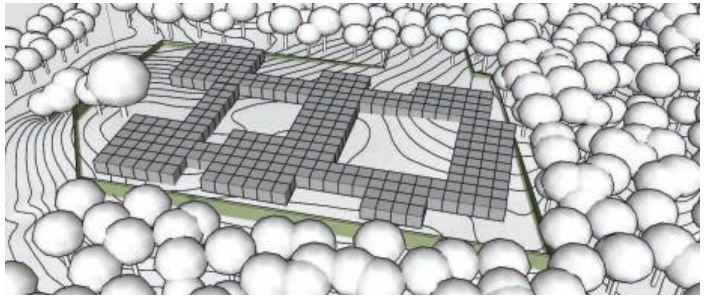
Interior transmission value : R_{si} = 0,13 $\frac{m^2K}{W}$

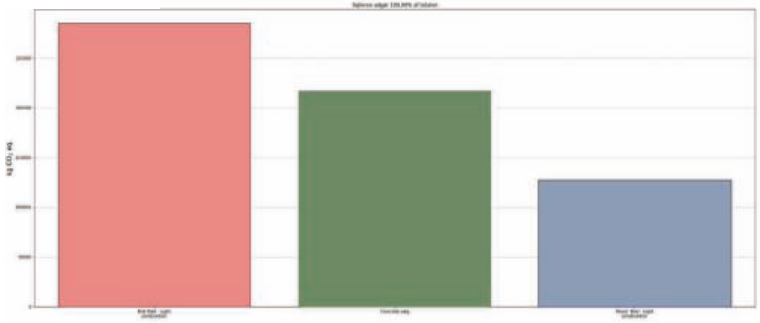
$$\lambda_1' = \frac{A_1 * \lambda_1 + A_2 * \lambda_2}{A_1 + A_2} = \frac{(((0,3 * 0,983) * (0,038)) + ((0,3 * 0,017) * (0,13)))}{((0,3 * 0,983) + (0,3 * 0,017))} = 0,0395\ w/mK$$

The U value is here calculated for a light wooden construction

$$U = \frac{1}{R_{se} + \frac{l_1}{\lambda_1} + \ldots\ldots + \frac{l_7}{\lambda_7} + R_{si}}$$

$$= \frac{1}{0,04\ m^2k/W + \frac{0,008}{0,13\ w/mK} + \frac{0,1}{0,04\ w/mK} + \frac{0,013}{0,25\ w/mK} + \frac{0,3}{0,04\ w/mK} + \frac{0,013}{0,4\ w/mK} + \frac{0,031}{0,163\ w/mK} + \frac{0,015}{0,13\ w/mK} + 0,13\ m^2k/W} = 0,094\ m^2k/W$$





Early in the design process, three external walls were analyzed as part of the initial studies on the climate screen and possible materials. These were made on the basis of an initial concept seen on the picture to the left. It could be concluded from the first calculations, that the foundation had by far the greatest impact. Based on this, the possibility of using point foundation as a possible alternative was investigated. It could also be concluded that an exterior wall in wood (blue) had the lowest global warming potential compared to an outer wall in concrete (green) or an outer wall in brick (red) which had the greatest impact. Based on this analysis, a Bsim was made and a number of possible proposals were developed in different materials. In the subsequent round, a new analysis was carried out in LCA where three constructions and a revised description of the building were included.
The three outer walls are described on the following pages.

Wood Wall - Light construction				0,480			U = 0,094
Material	**Info**	**Height (m)**	**Length(m)**	**Depth (m)**	**Thermal conductivity (λ.)**	**Amount m^3 /m²**	**Isolans (R) m²k/W**
Wood veneer		1	1	0,008	0,13	0,008	0,0615
Installations lag	With I wood profiles and insulation	0,91 + 0,09	1	0,1	0,04	0,091 + 0,009	2,5272
Fiber plaster		1	1	0,010	0,25	0,013	0,052
Insulation	Insulation with wooden profiles	1	0,91 + 0,09	0,3	0,04	0,273 + 0,027	7,40740
Wind barrier		0,91 + 0,09	1	0,013	0,4	0,01183 + 0,00117	0,0325
Air layer	20 mm cross section profile 2 * 15 * 50	1	1	0,031	0,163	0,031	0,19018
Wooden profile vertical	façade	1	0,09	0,015	0,13	0,00135	0,11538

Concrete Wall - Light construction				0,542			U = 0,094
Material	**Info**	**Height**	**Length**	**Depth (m)**	**Thermal conductivity**	**Amount**	**Isolans (R) m²k/W**
Concrete		1	1	0,12	0,8	0,12	0,15
Vapour barrier		1	1	0,001	0,23	0,001	0,00434
Mineraluld + wood	Wood (45 * 120 mm) every 500 mm	1 + 1	0,91 + 0,09	0,19	0,038	0,1729 + 0,0171	5
Mineraluld + wood	Wood (45*120 mm) every 500 mm	0,91 + 0,09	1 + 1	0,19	0,038	0,1729 + 0,0171	5
Fiber Cement Sheet		1	1	0,009	0,35	0,009	0,0257
Wood (20 * 45 mm), Every 500mm		1	0,09	0,02	0,12	0,0018	0,166
Sinus plate	Aluminium	1	1	0,001	210	0,022	0,000047

Brick Wall - Light construction				0,558			U = 0,094
Material	**Info**	**Height (m)**	**Length (m)**	**Depth (m)**	**Thermal conductivity**	**Amount**	**Isolans (R) m²k/W**
Gypsum		1	1	0,01	0,25	0,01	0,040
Mineraluld + wood	wood (45*45 mm) Every 500 mm	0,91+0.09	1	0,13	0,045	0,1183 + 0,0117	2,888
Vapour barrier		1	1	0,001	0,23	0,001	0,004
Mineraluld + wood	wood (45*45 mm) Every 500 mm	1	0,91 + 0,09	0,15	0,038	0,1365 + 0,0135	3,947
Mineraluld + wood	wood (45*45 mm) Every 500 mm	0,91+0,09	1	0,15	0,045	0,1365 + 0,0135	3,333
Fiber Cement Sheet		1	1	0,009	0,35	0,009	0,0257
Brick,	228*108*54 mm 63,13 pcs/m²	0,054	0,228	0,108	0,49	0,001329 + 0,000069	0,2204
Mortar,	12*108*54 mm	0,054	0,012				

Appendix 13 : Life Cycle Cost frame for calculation:

Appendix 8: LCC

Type	**Acquisition**	Operation and maintenance	Annual costs (DKK / m^2 / year)	Present value
Exterior wall in construction wood	57.379.706 DKK	43.063.813 DKK	601 DKK	113.047.636 DKK
Exterior wall in lightweight concrete wall	57.595.831 DKK	42.229.246 DKK	598 DKK	112.429.195 DKK
Exterior wall in Brick	57.896.019 DKK	43.616.535 DKK	606 DKK	114.116.671 DKK
Outer wall in heavy concrete wall	57.439.426 DKK	42.185.297 DKK	596 DKK	112.228.841 DKK

Type	Lifespan (year)	Maintenance (%)	Replacement (%)	Source
Exterior wall in construction wood	120	1,0	125	(Lccbyg.dk, 2019)
Exterior wall in lightweight concrete	120	2,0	125	(POMIANOWSKA, 2019)
Exterior wall in Brick	120	2,0	125	(Lccbyg.dk, 2019)
Outer wall in heavy concrete wall	120	1,0	125	(POMIANOWSKA, 2019)

Appendix 6 : Life Cycle Cost frame for calculation:

Type	Price incl. VAT (DKK)	Price excl. VAT (DKK)	Unit (DKK/m²)	Source
Line foundation, concrete	825 DKK	660 DKK	Per m	(Lccbyg.dk, 2019)
Ground deck basement	1.350 DKK	1080 DKK	Per m²	(Christensen, 2019)
Ground deck in ground level	1.045 DKK	836 DKK	Per m²	(Lccbyg.dk, 2019)
Exterior wall - Basement	1000 DKK	800 DKK	Per m²	(Sørensen, 2019)
Exterior wall in lightweight concrete	1.125 DKK	900 DKK	Per m²	(POMIANOWSKA, 2019)
Exterior wall in Brick	1.282 DKK	1025 DKK	Per m²	(Lccbyg.dk, 2019)
Exterior wall in construction wood	924 DKK	739,20 DKK	Per m²	(Lccbyg.dk, 2019)
Exterior walls moisture and heat insulation: mineral wool	1.200 DKK	960 DKK	Per m²	(Hus Plus Have, 2019)
Interior plaster wall	850 DKK	680 DKK	Per m²	(Jensen et al., 2019)
Floor structure - Construction wood	924 DKK	739,20 DKK	Per m²	(Lccbyg.dk, 2019)
Stairs inside laminated wood	389 DKK	311,20 DKK	Per m²	(Lccbyg.dk, 2019)
Bearing constructions - Concrete	1.200 DKK	960 DKK	Per m²	(Sørensen, 2019)
Bearing constructions - Construction wood	1.303 DKK	1042 DKK	Per m³	(Bygma.dk, 2019)
Roofing - Construction wood	398 DKK	318,40 DKK	Per m²	(Lccbyg.dk, 2019)
Roofing - Moisture and heat insulation: mineral wool	1.500 DKK	1200 DKK	Per m²	(Hus Plus Have, 2019)
Doors exterior wall: Aluminum	2.999 DKK	2399,20 DKK	Per item	((Bango.dk, 2019)
Windows exterior wall: Aluminum	2.435 DKK	1948 DKK	Per item	(Lccbyg.dk, 2019)
Suspended ceilings: Plaster	450 DKK	360 DKK	Per m²	(Lccbyg.dk, 2019)
Interior wall surfaces - Paintings	185 DKK	148 DKK	Per m²	(Lccbyg.dk, 2019)

Type	Price incl. Moms (Dkk)	Pris excl. Moms (Dkk)	Unit (Dkk/m^2)	Source
Drain under building (to nearest well or line): Plastic and foam plastic	280.720 Dkk	224.576 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Consumption plant (washing, washing machine, etc. including water fittings): Metal, general	649.000 Dkk	519.200 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Supply systems (meters, containers, etc.): Metal, general	41.800 Dkk	33.440 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Distribution system (pipes, valves, etc.): Iron, steel & stainless steel	330.000 Dkk	264.000 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Consumables (various drains etc.): Metal, general	19.800 Dkk	15.840 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Supply systems (boilers, heat exchangers, meters, etc.): Metal, general	88.000 Dkk	70.400 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Distribution system (pipes, valves, etc.): Iron, steel & stainless steel	22.000 Dkk	17.600 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Consumption plant (heating surfaces, heat fans, local automatic control and regulation, etc.)	880.000 Dkk	704.000 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Supply systems (ventilation centers etc.): Metal, general	1.562.000 Dkk	1.249.600 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Distribution system (pipes, valves, etc.): Iron, steel & stainless steel	2.074.600 Dkk	1.659.680 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Consumables (fittings, extractor hoods, extractor hoods etc.): Metal, general	7.250 Dkk	5.800 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Supply: Metal, general	407.000 Dkk	325.600 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Electrical engineering facilities: Metal, general	3.899.940 Dkk	3.119.952 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Communications system: Metal, general	627.000 Dkk	501.600 Dkk	Pr. m^2	(Lccbyg.dk, 2019)
Security system: Metal, general	1.498.000 Dkk	1.198.400 Dkk	Pr. m^2	(Lccbyg.dk, 2019)