DEMENTIA- & BRAIN CENTER

AARHUS, DENMARK

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Content

Abstract

This master thesis presents a proposal for the new Dementia- & Brain Center in the northern part of Aarhus. The project aims to create a frame for people diagnosed with dementia in which they can feel home, happy and safe. Aarhus wants to do something about the rising problem dementia is. [Aarhus kommune 2015] By building a new house for people with dementia, it is possible to integrate new thoughts and improve the resident's quality of life.

The project seeks to mimic the life they had before dementia, where they were able to control themselves and had the freedom to life their life as normal person. In addition to this the project strives to activate and stimulate the resident's senses by integrating qualities from the life they have had before dementia.

Reading Guide

The aim of this report is to present our proposal for the new Dementia- and Brain Center in Aarhus. The report is structured and made clear by dividing it into specific chapters. The first chapter in the report is the presentation showing the final proposal for the project. The presentation is followed by the analysis and process which is presented to support the decisions made for reaching the final design. These chapters each consist of underlying sections all helping to create a better understanding of the project. To sum up and consider the process and the proposal the epilouge consists of a conclusion and a reflection.

The list of all literature, illustrations and photos are placed at the end of the report. The references to the literature has been used and listed according to the Harvard method. The illustration and photo list states whether or not they we're done by the authors or not.

The drawings in the report are not placed in scale. To see the drawings in scale look in the attached drawingfolder.

Preface

MOTIVATION

Over the last year's dementia has reached public awareness because of a rising number of people identified with the disorder. Many people are currently experiencing it among family, friends and neighbors, which make it seem more important to care and respect the disorder in means of helping to make life easier for the people affected by it. The disorder is very age-related and as the statistics show it's quite evident how the problem is developing. An estimation, based on the past years and current situation, indicates that over-80-year-olds with dementia will rise from 6% to 12% over the next 30 years. This makes us realize how there's a bigger risk it might be us selves suffering from the disorder in our late years [Kruse, Andreas, 2014]. These results are also based on the fact that the group of elderly only gets bigger and bigger as we get better to take care of them. Another aspect, important to mention, is that there's a rising number of younger people who gets the disorder. Often because of stress-related problems, which makes sense in a time where career mean more than ever. [Kis, Fremtidens Plejehjem, 2016]

The disorder can potentially affect all people whether or not they have been living a healthy or unhealthy lifestyle throughout their life. This is why we have to set in now and see what we can do to improve their way of living and make their everyday easier.

What can architecture and design do to help?
How can architecture and engineering contribute to make life easier for people with dementia or other mental disorders?

INTRODUCTION

As mentioned in the section describing the motivation for the project people with dementia is a growing part of the society. These people have complex problems and difficulties in their everyday life, which is an aspect the municipality of Aarhus wants to take care of. They want to secure the best possible conditions for all people affected by the disorder; the people suffering it, their families, friends and the people around them in general.

Since 2010 a new building for people with dementia and other mental disorders has been planned. By establishing a new Dementia- and Brain Center there's an opportunity to gather all the special functions they need to improve the life conditions for people suffering from dementia, abuse and other mental disorders. It will be possible to integrate the newest knowledge concerning dementia. The ambition for the project is to challenge the regular form and experience the edge of the familiar. This will automatically challenge habits and routines and twist the people with dementia to create a new reality.

In an overall conclusion this should be the culmination combining the latest knowledge concerning dementia in a building working as the best and most contemporary frame for people with dementia. [Aarhus kommune 2015]

The Integrated Design Process

The process behind this project is based on the Integrated Design Process defined by professor Mary-Ann Knudstrup from Aalborg University. The method creates a general base for an academic approach to the project and will work as a guide securing a combination of both the architectural and engineering disciplines. The method works as an iterative process meaning the project will be developed in a certain amount loops as you gather new information as the project develops. These loops will in the end ensure an optimal design solution considering both the architectural, technical and functional qualities. The method will help achieving a holistic design proposal. As Mary-Ann Knudstrup states in the following:

''By using the Integrated Design Process the professional knowledge of architecture and engineering is integrated and optimized.'' [Mary-Ann Knudstrup, 2004, page 2]

To gain a broader and better understanding of the process it's divided into 5 phases; problem, analysis, sketching, synthesis and presentation. Each of the phases will be described in the following.

Problem

Before even beginning to think about design it's necessary to understand the problem and the project. This is usually done by researching the specific area if the problem is more or less general. Another situation could be to carefully read and understand a tender given by a certain building owner. This will automatically create a framework for the project and give an idea of what should be included in the analysis.

Analysis

In the analysis phase all necessary information is gathered and produced to create a solid understanding of the certain aspects defining the project. The analysis phase creates a frame for the design process including information about the site and geographical context. In relation to this weather data, typography, surroundings, vegetation etc., is analyzed. The location is important to consider to be able to integrate passive strategies for example. Furthermore, the subject itself should be researched and described to gain a deeper knowledge and sense of the specific problem. The more specific information and demands given by the regional, municipality or local plans is also essential to look at. What are we allowed to do? What restrictions do we have?

''At the end of the analysis phase a statement of aims and programme for the building is set up'' [Mary-Ann Knudstrup, 2004, page 4]

Sketching

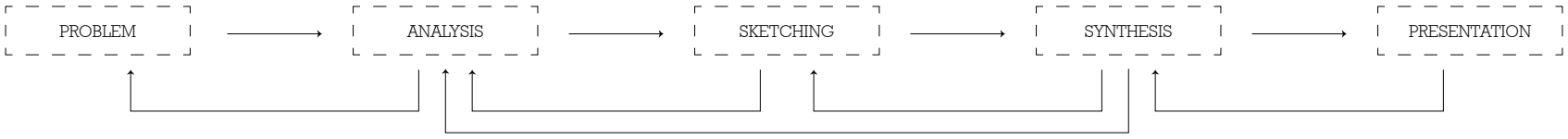
With a specific knowledge gained through the analysis phase, the sketching phase begins. In this phase the knowledge from both parts meet in a challenging process combining both the architectural vision in the shape of the building and the technical demands set by the regulations and building owner. In the sketching phase the aim is to find best possible solution using the information gathered earlier. Hand sketching, digital sketching and physical models are essential tools to express and show ideas in this phase. Problems will appear resulting in multiple iterations. Therefore, it's important to evaluate and discuss the proposals throughout the phase to progress in the right direction.

Synthesis

In this phase all elements discussed and all information gathered should flow together and result in a design solution including as many as the visions and demands as possible. The design is optimized and documented by calculations and the solution seems complete and right for the location and future use.

Presentation

The presentation phase is where the whole project and all its qualities is presented. Usually this is done through various architectural drawings such as diagrams, plans, sections, facades, visualizations etc. The architectural work is supplemented by technical materials like technical drawings and calculations, which will strengthen the concept and design solution. [Knudstrup, M.]



Ill. 1. The integrated design process [Knudstrup, M.]

Competition Brief

Introduction

This project is made on the background of a competition brief from 2015 for a new Dementia and Brain Center in Aarhus. The project is about creating a place for people with dementia to live. Since 2010 there has been plans for a new building with housing for people with dementia. Aarhus would like to ensure the best possible conditions for people with dementia and their relatives [Aarhus kommune 2015]. The competition brief states different demands and wishes concerning number of apartments, functions and parking as described in the following:

Location

The site for the project is chosen in the competition brief and is located in Aarhus on Skovvangsvej 97 & 99, 8200 Aarhus N in a quiet area on the edge between the urban and the suburban part of the city. The existing structures on the site is to be demolished to make room for the new building. The total area of the site is 24.038 m2.

Living and service area

The project comprises new construction of 125 apartments with associated service areas. The 125 apartments are divided into 3 groups:

75 single-room special housing 10 of which will be used for halfway houses
34 flexible two-room apartments
16 single-room short-term apartment
The service areas consist of training facility, wellness special day center, hairdresser, facilities for relatives, store, sensory room, and a place to get advice/information.
All the apartments have to be designed in a way that are suitable for residents with severe dementia and psychiatric disorders.
In terms of area, the apartments are expected to be approximately 9000 m2 and service areas about 1000 m2. Each property must have the same gross area, but where one-room apartments have a larger area share in their common areas, than two-room dwellings gets in their common areas [Aarhus kommune 2015].

Parking

It is expected that there will be established P- areas within the cadastre, to cover the building's parking needs [Aarhus kommune 2015]

Technological solutions and energy requirements

Dementia and Brain Center Aarhus thought of it as a visionary, comprehensive building where technological solutions at all levels supports the vision of well-being and quality of life through more opportunities for self-reliant users and better working environment.

Emphasis is placed on the building having a low energy consumption, healthy indoor environment and minimal CO2 impact, while maintaining the social aspects of the project. Aarhus municipality 360o sustainable model is expected to be a key tool in the process [Aarhus kommune 2015].

Local plan

The project site at Skovvangsvej and Abild Street is not covered by the local plan so here applies the municipal limits - 140224OF / 140212OF.
This state that the maximum building height on the site is 8.5 m and that the maximum floor number is 2. The plot ratio should be maximum 45 for the site [Teknik og miljø 2010].

PRESENTATION

PRESENTATION

The presentation consists of the final proposal. All materials for understanding the concept and atmosphere is presented through diagrams, plans, sections, facades, renders, details and construction principles.

Concept

The concept is defined by the existing typologies surrounding the site. Each of the different typologies has certain characters and qualities, which will be combined and included in the complex in a way giving the residents the best possible frame for living a life with dementia.

By creating multiple buildings on site for housing and further placing the center functions in the center, the atmosphere and character of a city environment is created.

By combining the stock-, rowhouse- and villa-typology the known forms are challenged, developed and specifically combined into a minor society with focus on movement and qualities from the life the affected ones have had until dementia became part of them.

Ill. 2. Concept

Masterplan

The new Dementia- & Brain Center is situated in the northern part of Aarhus fitting into the context as a city within the city.

Accessibility

The complex is easily accessible both by feet, bike, car and public transport. Accessing the complex by car you enter the parking lot from the south from where you can see the gable structure scaling down the building volume. The parking lot has been placed in this area because of the noise levels issued from the road south of the site. This creates a barrier and provides a more relaxed and calm atmosphere inside the complex. To enhance the blocking of noise pollution for the people living there the line of gables seen from the south is designed for visitors, which they're only used in shorter periods of time.

Entering the center by public transport you will come in from the east walking alongside the visitor's apartments. A path has been planned for this purpose. The bus stop is no longer than 200 meters away the complex which makes the accessibility easy and desirable.

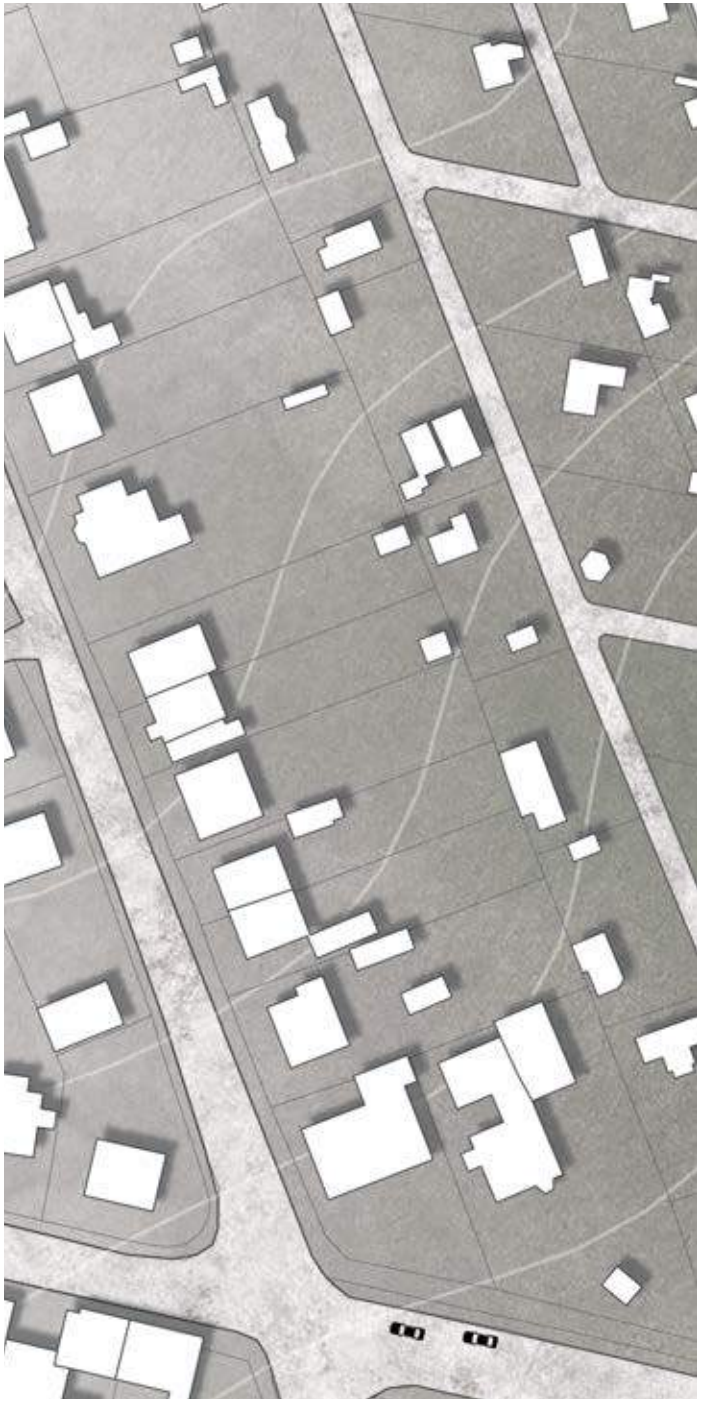
The square

Walking through the entrance you'll be met by the information on the right and the open café on the left. The café is placed near the entrance to make it accessible for anyone, both residents, visitors and civil people. By opening the café for everyone the hope is to create a more active atmosphere in this particular area. Walking through the entrance and into the village you are guided around in the area by the paths connecting the complex. Placed in the middle are the center functions consisting of fitness, wellness, hairdresser, sensory room and a room for a bigger range of activities, like relaxing, painting and reading. The functions are connected as a square creating movement and continues activity, which gives a feeling of life and satisfaction for the residents.

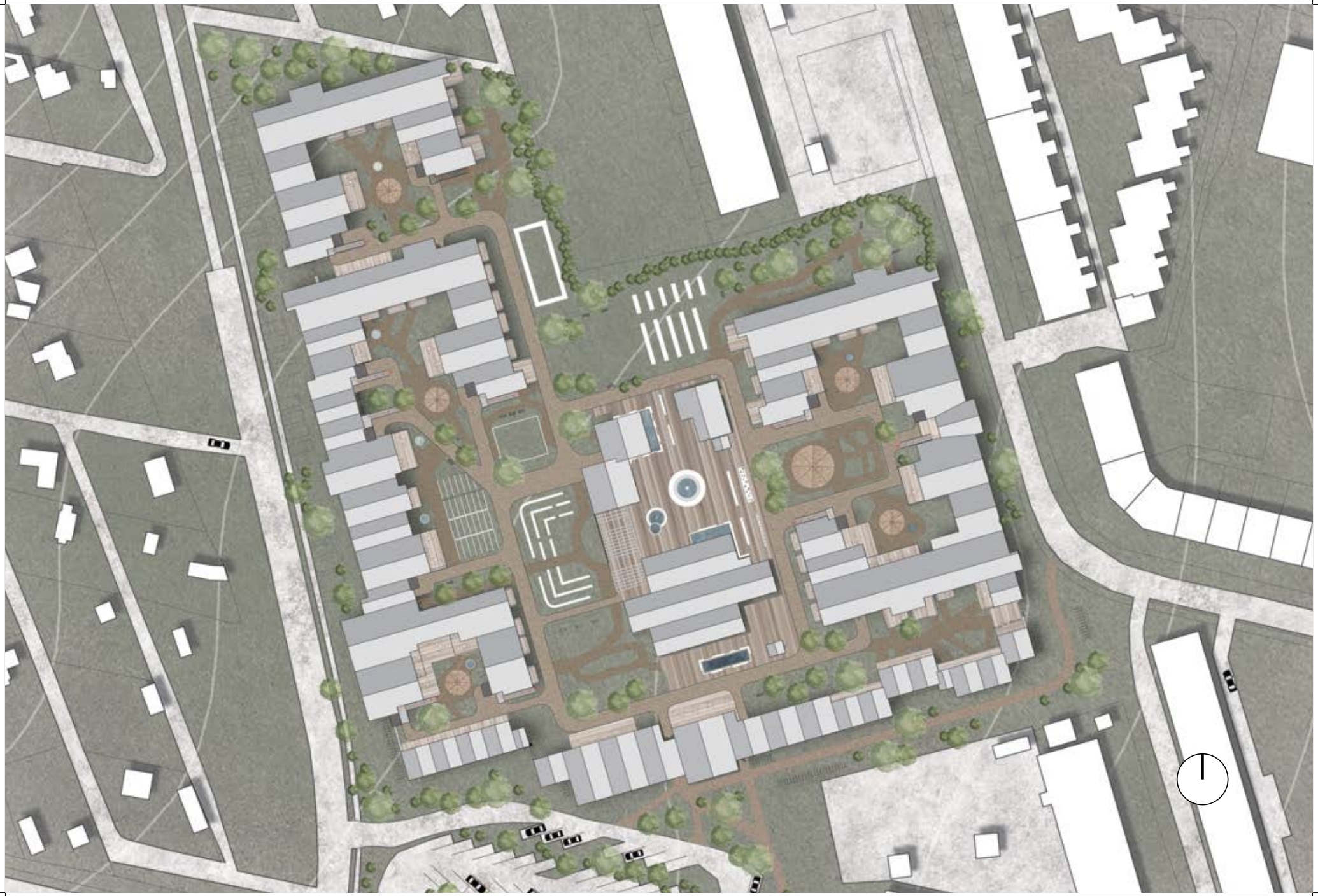
The center functions are further designed as separate volumes to create space in between the buildings as Jan Gehl has discussed and studied. The paths all lead to this square, from where the paths again lead to each of the units. Each of the units are equipped with an elevator standing out from the building. To enhance reconcilability of the units, the elevator shafts are numbered with big colorful numbers. This initiative is implemented to improve the aspect of wayfinding for the dementias living in the complex.

The gardens

Another implementation is how the dementias are stimulated through the days and weeks. This is especially considered when designing the outdoor areas and defining what kind of places the garden should consist of. To challenge and stimulate the residents senses different elements has been placed around the site. By implementing gardens with plants and flower seen to the north as well as the petanque field the smelling- and touching sense is stimulated. Furthermore, the square has been designed with a water fountain which stimulates the sight- and hearing sense. On the following page there's some references to some of the activities and functions integrated to create a fulfilling atmosphere able to keep the residents happy and moving.



Ill. 3. Masterplan



References in relation to the atmosphere

Ill. 4. Greenhouse [Willab Garden]

Ill. 5. Supermarket [Geograph]

Ill. 6. Flowers [Pexels]

Ill. 7. Pergola [Beyond Pavers]

Ill. 8. Amfitheater [C.F. Møller]

Ill. 9. Petanque [Rchavrais]

Ill. 10. Fitness [Optician]

Ill. 11. Flowers [Beautiful flowers]

Ill. 12. Pavillion [Sølund]

Ill. 13. Raised beds [Yuhiez]

Ill. 14. Snoezelroom [Drewnursinghome]

Ill. 15. Hairdresser [Marcatornet]

Ill. 16. Café [Belgiumshock]

Ill. 17. Wellness [Amrath]

Ill. 18. Grey Kolumba bricks from Petersen-tegl [Petersen]

Ill. 19. Red Kolumba bricks from Petersen-tegl [Petersen]

Ill. 20. Yellow Kolumba bricks from Petersen-tegl [Petersen]

Ill. 21. Slate [Petersen]

Ill. 22. Hjärup near Malmö, Sweden [ ]

Exterior

With inspiration from the city-project that Hjärup near Malmö in Sweden is, the exterior materials were chosen to differ from each other to create a similar expression and atmosphere. The buildings in the reference are combined but manages to stand out and get a recognizable character because of the variation of colors in the façade.

Considering the environment around the site and the materials exposed in the area and throughout the city of Aarhus it has been noticed that brick is the primary element for facades. Trying to design a project that fits into its context the choice on brick in varies colors was made.

The idea should moreover be able to help guide the residents living in the complex to find their way home. Having the same material or color on all facades might confuse the residents and result in them getting lost.

For the roofing we have chosen a dark slate tile to create a clear and elegant solution. By choosing a dark roof it's also possible to mount solar cells if needed without them taking focus from the complex. Instead they will blend in from a distance.

Ill. 23. Mat laminate flooring looking like wood flooring [flickr]

Ill. 24. White paint [3dtarget]

Ill. 25. Wooden plank

Interior

The materials chosen for the interior are all based on how people with dementia perceive spaces and act throughout the day. They are usually elderly people with impaired vision who gets confused easily when colors seem to look to much alike. This means there need to be a clear contrast from the floor to the wall and from the wall to the ceiling. Likewise, the furniture and doors must stand out to clearly stand out in the given room.

To reduce confusion and anxiety for the people with dementia it's important to consider what kind of environment they might be coming from and what sort of materials they have had in their own homes. This is important because in most cases this will automatically make them remember parts of their lives. Besides this it is necessary to keep in mind how they need a certain level of contrast and warmth in their surroundings. An impaired vision usually means that colors like blue will seem very cold compared to colors like red and orange which seems warmer and more comfortable. Considering confusion, it is important to reduce reflections, why a matte material is optimal for flooring. [Visioner for demensboliger.pdf]

The staffs everyday procedures must also be considered when choosing materials. In this case cleaning and maintenance are important aspects to have in mind. The floors should be easy to clean if one of the dementias accidently spills something or if they just need cleaning.

Laminated white ash has been chosen for flooring because it gives a feeling of being in a home instead of an institution. Besides that, it is optimal mobility-wise and it has a certain level dullness to it to reduce glare and clear reflections. For the staff's sake it is also easy to clean and maintain.

White paint has been chosen for the walls to secure that furniture and other objects will stand out and be visible for the people having an impaired vision. The white color also sets a contrast compared to the floor.

For the ceiling it has been chosen to use wooden planks, because this creates a contrast to the white walls and compliments the flooring very well. Besides the warm feeling the wooden planks give they also work noise reducing. The flooring and the ceiling are oriented the same way on long side in relation to the building to work as sort of way finder for the residents.

Ill. 26. Entering SKOVVANGEN

Ill. 27. View from the garden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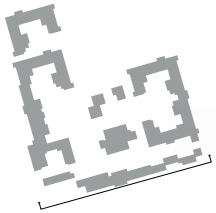
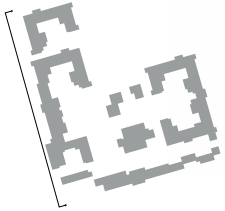
SKOVVANGEN





Ill. 28. South elevation

Ill. 29. West elevation

Ill. 30. North elevation

Ill. 31. East elevation


7
9
9

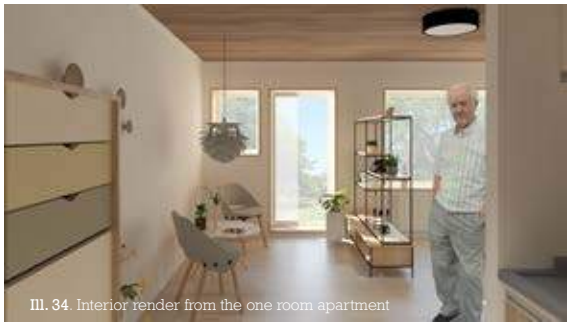
Ill. 32. Section A-A

Ill. 33. Section B-B

One room apartment

The one room apartment is designed in a clear and foreseeable way making everyday life easier for the resident. It's important to be able to survey the apartment you are living in when your living with dementia, which is why the apartment is designed as open as it is. This choice has been made to prepare the one room apartments for the different stages a person with dementia may be having when moving in. The design of the apartment is inspired by the one highlighted in the case study; Future nursing home. When you enter the apartment you will be able to locate the kitchen and living area. When you walk into the center of the apartment you will be able see everything; bed, bathroom, living area and kitchen. A requirement in the apartment design was that the resident should be able to see the bathroom door directly from the bed.

The apartment in the case study has a wall dividing bedroom and living, which is a good thing for elderly without dementia. In this case that wall have been removed to increase the clarity in the apartment, because it is designed having the most critical stage of dementia in mind.



Ill. 34. Interior render from the one room apartment

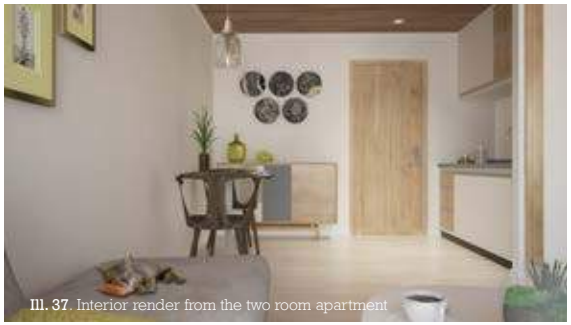
Ill. 35. One room apartment plan drawing

Ill. 36. Interior render from the one room apartment

Two room apartment

This apartment is designed to cover a broader specter of the stages people with dementia can be in. The overall design is similar to the one room apartment. The changes from the one to the other is the size and the wall between the bedroom and the living area. People in the earlier stages will be pleased to be living in an apartment where you are able to close the door to the bedroom. This way it is possible to control the level of privacy for the ones that can manage an apartment with more than one room. In the earlier stages people with dementia are often able to manage most of the daily activities themselves, why this apartment would be desirable to live in.

The apartment is furthermore dimensioned for couples. It could be a situation where one part of the couple still was completely healthy and the other in an early stage of dementia. If the couple is still able to live together and love each other even though they might have trouble and problems because of the disorder, it would be desirable for the couple to live in an apartment like this. The healthy part would be able to call for help if something happens, and they would get to live together for as long as possible. The bedroom is therefore designed to fit to beds, where it is possible to place them together and apart. The apartment works and can please a big variety of situations, which is a quality in a center like this.



Ill. 37. Interior render from the two room apartment

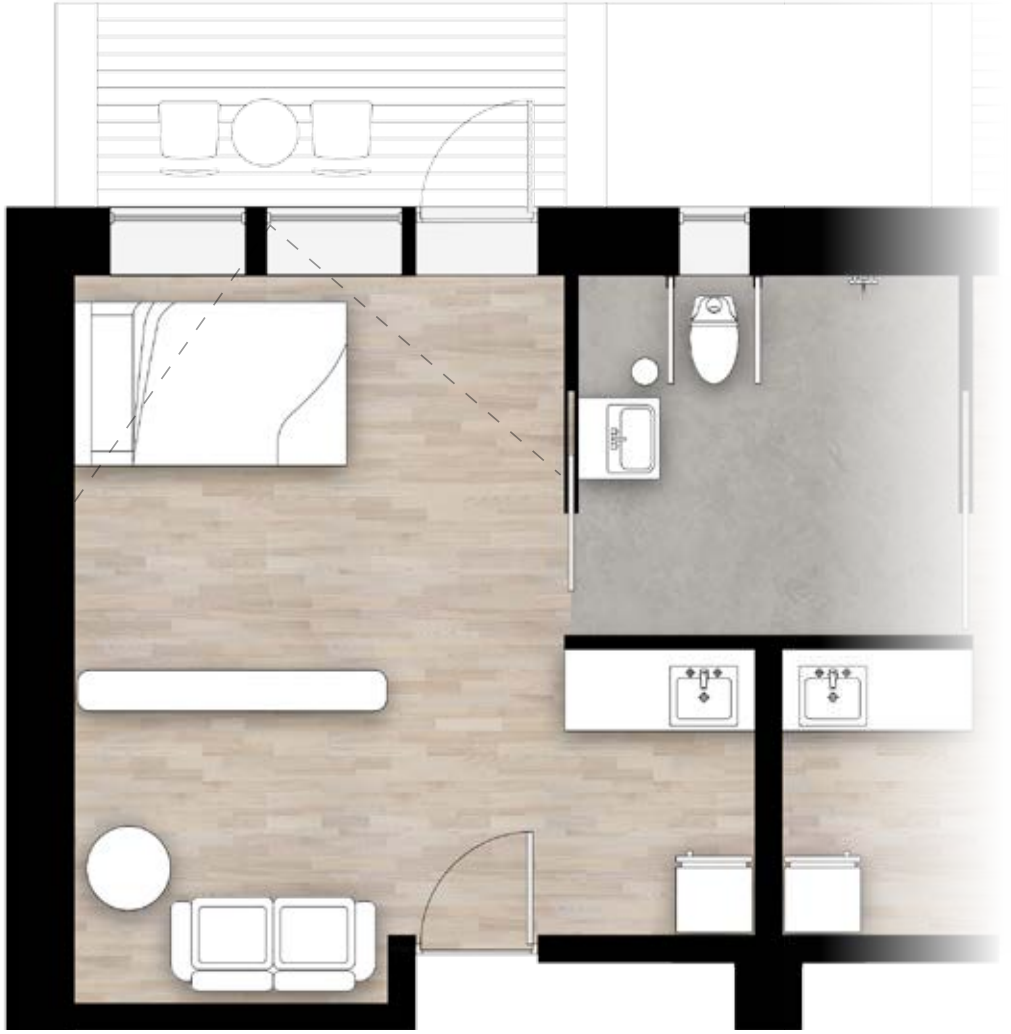
Ill. 38. Two room apartment plan drawing

Ill. 39. Interior render from the two room apartment

Short term apartment

The short term apartment is basically designed like the one room type only a little denser. Even though it is fairly small there is still a certain spatiality in it to furnish it with a living area and space for the bed. The apartment is very easy to grasp as you can see everything from everywhere. The bathroom in this type of apartment covers two apartments which means there is two doors to it. It has been designed this way to minimize the area of square meters having the short term concept in mind.

Ill. 40. Interior render from the short term apartment



Ill. 41. Short term apartment plan drawing

Ill. 42. Interior render from the short term apartment

Common area

Openness and warmth is two of the keywords applying for the common areas in each unit. Each unit is designed with a lounge area and a kitchen area to open for the possibility of socialization. The size of the unit reach from 3 to 6 apartment all with additional common area. By having this area, the residents have the possibility to choose whether or not they want socialize and interact with the other others in the unit. Giving them this opportunity they will still have the feeling of control which is important for them.

Wayfinding has also been optimized inside the units, like the paths and elevator shafts managed to help in the outdoor environment. From the common area it is intended to ease and help the residents find their own homes on their own. Therefore, each entrance has been given a different character or color and additionally signed with a number. The entrance to the apartments is designed to be a niche to give the resident a little space to place something of their own possessions helping them to recognize their own entrance.

Ill. 43. Interior render from the common area

Ill. 44. Interior render from the common area

Ill. xx. Interior render from the common area

Unit overview

This plan shows an overview of the northern apartment complex. It gives an overview of two units, each unit contains six apartments with an common area for each and a shared staff area. Each unit also have their own entrance and an outdoor terrace. All the apartments is made accessible with wheelchair and each room has a turning radius of 1,5 m, and there is no high difference inside the building and each unit have their own elevator to allow for easy access to the first floor.

Living room

The living room is combined with a small kitchen with a sink and a small refrigerator, this is included in the apartments to give a feeling of living in a normal home and gives some extra opportunities inside the apartment. The apartments facing towards the facility also have their own terrace that allows the occupants to sit outside.

Bedroom

In the single room apartments the bedroom and living rooms is separated by a bookcase and in the two room apartments by a sliding door and a thin wall that can be removed if needed. This makes the apartments flexible and allows them to be changed depending of the user's wishes or needs. The room is designed so that there is enough space around the bed for a caretaker to help the elderly in bed or for a person in a wheelchair to get in to the bed by themselves.

Staff area

The staff area is primarily for the staff working in the unit, with their own room for relaxing. There is also storage for the whole floor where things for the apartments, or extra wheelchairs can be stored. There is also a laundry room for washing close. The fire escape also allows the workers to get to the second floor without having to go outside.

An overview of the whole complex can be found in the drawing folder drawing A104.

Ill. 45. Unit overview

Room program

	Function	Area [m²]	Number of rooms
Living area			
	Special housing unit (One Room)		75
	• Living Room/Bed-room	23	
	• Bathroom	5	
	Flexible two room apartment		34
	• Living room	16	
	• Bedroom	16	
	• Bathroom	6	
	Single room short term apartment		16
	• Living Room/Bed-room	22	
	• Bathroom	7	
	Hallway	60	24
	Storage	5	12
	Common area	43	24
	Staff room	11	12
	Technical room	12	12
	Laundry room	8	12
	H.C Toilet	5	12
	Fire escape	12	6

Service areas	Cafe + Kitchen	145	1
	Grocery store + Storage	140	1
	Food stand	7	2
	Training area		1
	• Entrance	5	2
	• Lounge	14	2
	• H.C Toilet	5	2
	• Changing rooms	66	2
	• Fitness room	115	1
	• Wellness	107	1
	Activity room	78	2
	Workshop/Library	42	1
	Hairdresser	30	1
	Greenhouse	143	1

Staff area	Entrance	8	1
	Reception	6	1
	Toilet	3	1
	H.C Toilet	4	3
	Meeting room	25	2
	Office	9	4
	Hallway	26	1
	Technical room	11	1
	Changing rooms	21	2
	Storage room	22	1
	Garbage room	6	1
	Guest room	13	24
	• Technical room	8	2
Total Area m²		10682	

Ill. 46. Room program

Fire plan

When designing a building complex it is important to prioritize the users' safety in fire situation. The fire strategy needs to be considered as a design parameter, where accessibility of fire routes for emergency services have to be clear and easy accessible.

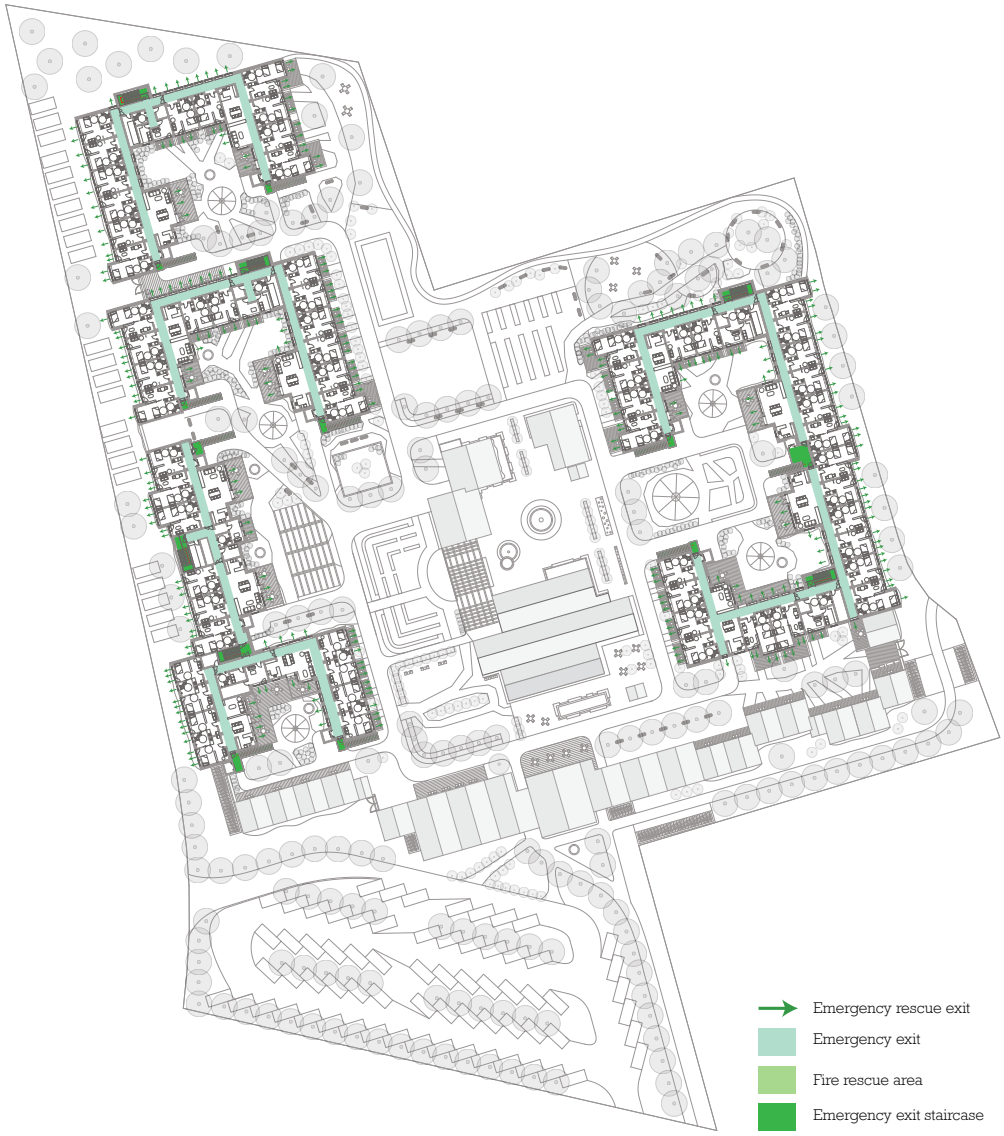
There are three openings into the dementia village, which will be used for emergency services. Furthermore the main walking path has the necessary dimension for fires truck and enough spaces for fire rescue area, which fulfil the fire requirement. [Hovedstadens beredskab, 2016]

Base on the fire requirement there needs to be an emergency exit per 25 meters; therefore, on the first floor one unit (with 6 or 4 apartments) will have two emergency exits. In addition the windows will be used as emergency rescue exits and to ventilate smoke from fire.

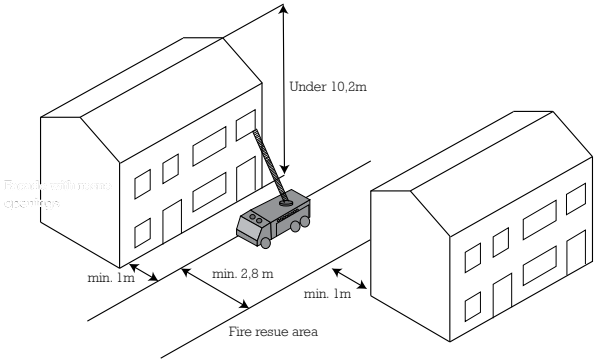
On this section, you will have a look over the fire strategy for the project site.

For a bigger scale of the fire plans see the drawing folder image A601 and A602.

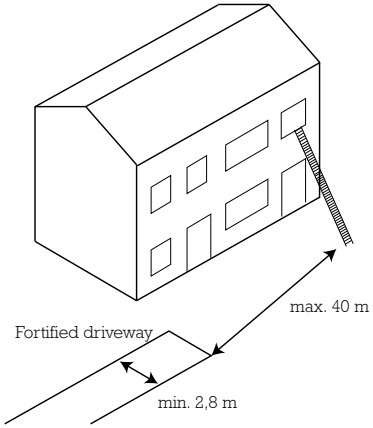
Ill. 47. Emergency exits for ground floor



Ill.48. Emergency exits for first floor.



Ill.49. Requirement for fire rescue.



Ill.50. Fortifed driveway.

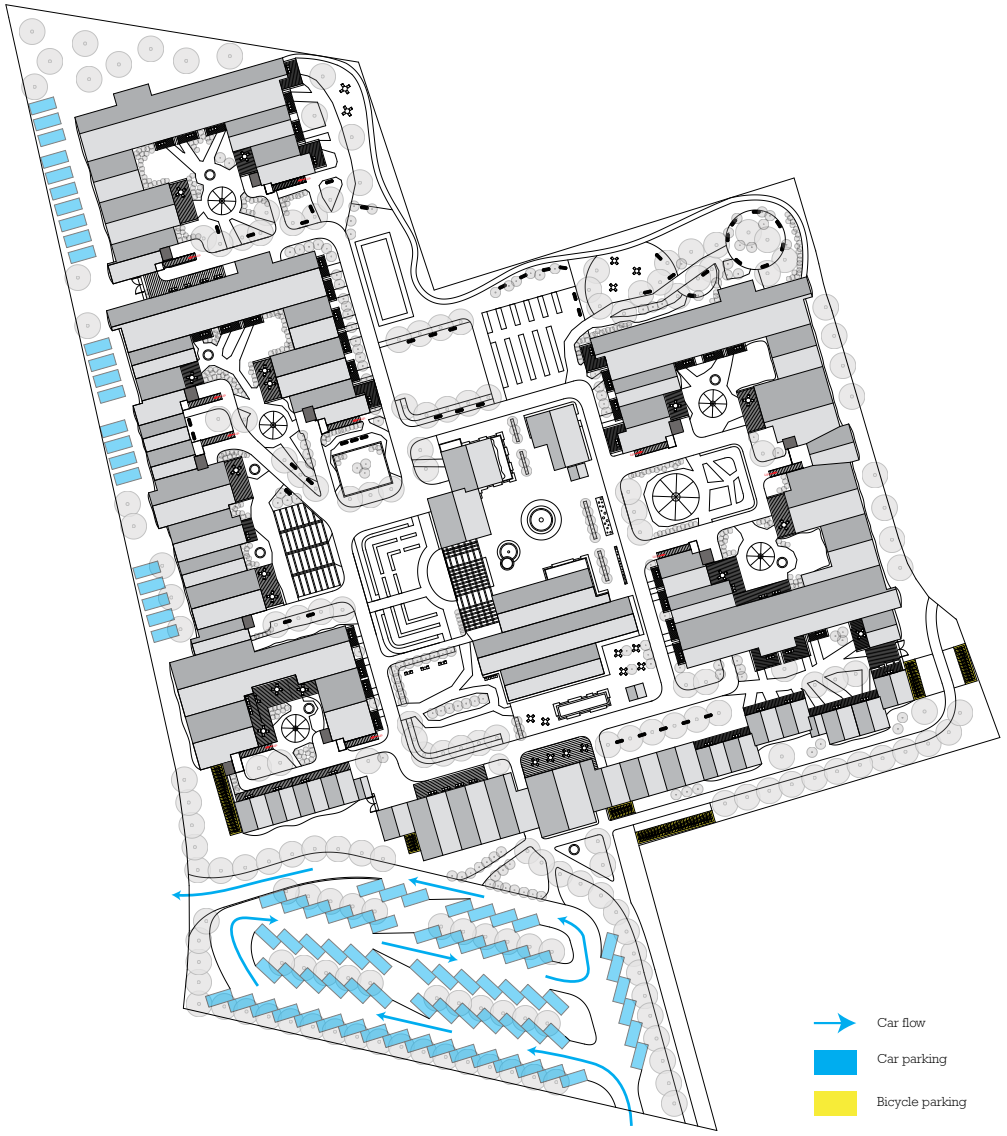
Parking

Requirement for parking is different from municipality to municipality, therefore the need of parking in this project is based on a standard instruction for parking lots. For nursing home the need is 0.7 per. apartment; therefore: 0,7 * 125 apartments = 87,5 car parking. [HFB,2009] To ensure enough car parking in unexpected situation, therefore more parking lots were added. The total amount of car parking are 91, and they are mainly located in front of the main entrance.

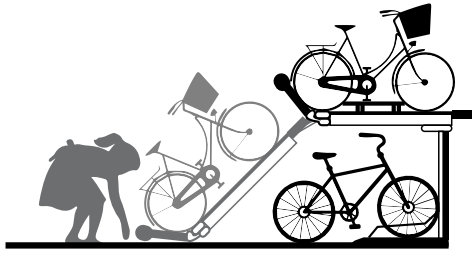
On the other hands since it is a global issue, where the climate is changing and causes natural disaster. The people have to resize own living behaviour towards a sustainable society, where people need to limit the use of natural resource as much as possible. The issue doesn't not only about using a large amount of natural resources, but people also produce toxic and unhealthy substances as CO2 to the environment, where car is an a important factor on lowing current production.

Besides having car parking there are also bicycle parking, since people are more and more attentive about the global issue and slowly change their living behaviour. The ideal future image is that there will be almost no private car and instead using public transport or bicycle. The site is also located near public transport.
Moreover it is an idea to loan out the bicycle, when the residents want to take a ride around or to the closest forest with their relatives.

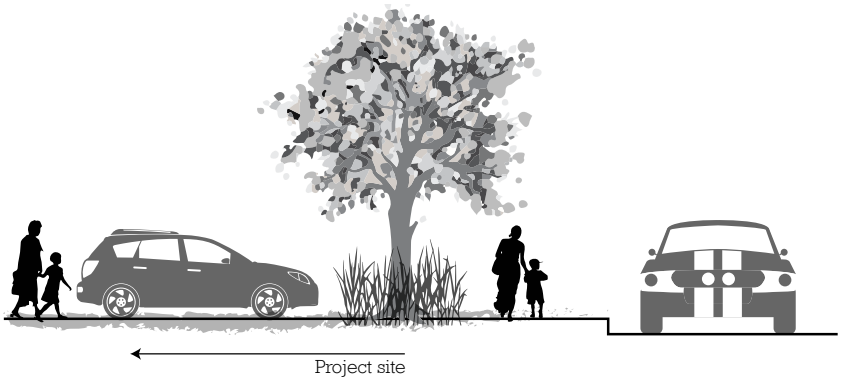
The requirement for number of bicycle parking is 2 per 100 m2 and the total area of the building complex is around 11000 m2: (11000/100)/2 = 55 bicycle parking. As it says earlier that in the future people will use bicycle more, therefore there are placed more bicycle parking than 55 needed parking. The total amount bicycle parking are 134.



Ill. 51. Parking plan

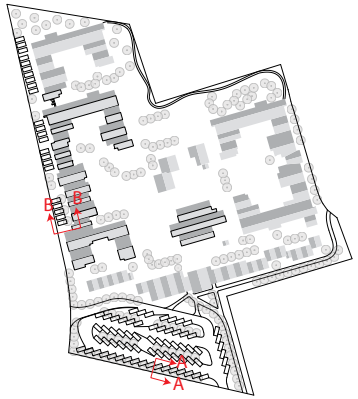


Ill. 52. Double deck bike rack. It is a space saving bicycle parking.

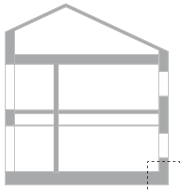


Ill. 53. Section AA

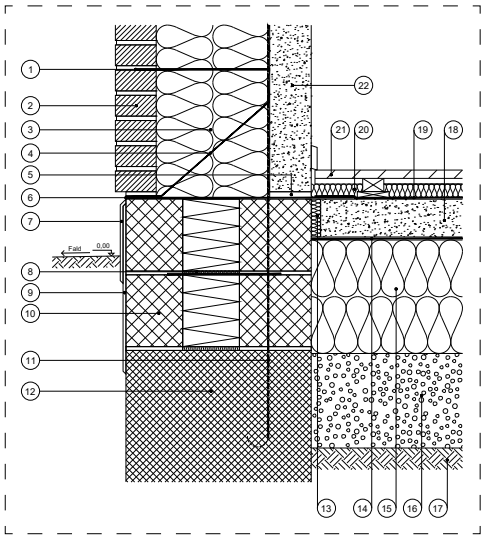
Ill. 54. Section BB.



Ill. 55. Section plan

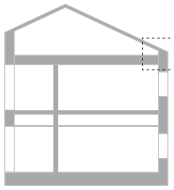


Ill. 56. Foundation

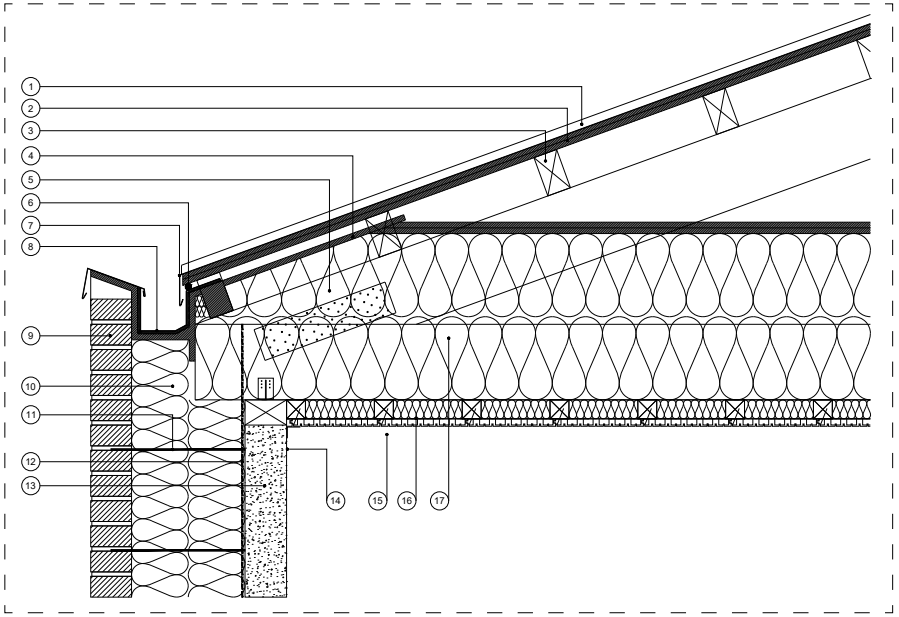


1. Brick tie
2. Brick 108 x 54 mm
3. Insulation 2 x 150 mm
4. Moisture barrier
5. Mortar joint
6. Moisture / Radon barrier
7. Plinth plaster
8. Tie / Joint insulation
9. Plaster
10. Leca termblokke 390 mm
11. Roof anchor
12. Concrete foundation
13. Edge insulation 25 mm
14. Casting surface
15. Insulation 2 x 150 mm
16. Clay aggregate 250 mm
17. Ground
18. Reinforced concrete 100 mm
19. Moisture barrier
20. Joist 35x56 mm / Insulation
21. Laminated floor 22 mm
22. Concrete 110 mm

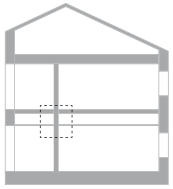
For the roof and foundation it is important with a low U-value. U-value is used to measure how effective elements of a buildings envelope is as an insulator. That is, how effective they are at preventing heat from transmitting between the inside and the outside of a building. To ensure a low U-value inspiration for the details was taken from the examples in rockwool *Den lille lune* [den lille lune, 2012] The U-value for the foundation is 0,09 W/m^{2}K and the U-value for the roof is 0,06 W/m^{2}K.



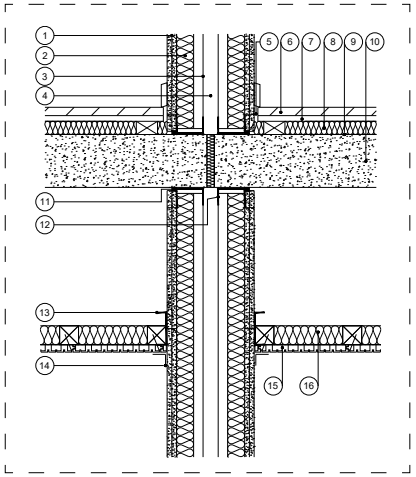
Ill. 57. Roof



1. Roof felt with triangular profiles
2. Plywood 2 x 15
3. Tile battens 60 x 100
4. Wind board
5. Rafter 45 x 220
6. Snow stopper
7. Eaves drip
8. Gutter
9. Brick 108 x 54 mm
10. Insulation 2 x 150 mm
11. Brick tie
12. Roof anchor
13. Concrete 110 mm
14. Filler tape
15. Linear panel 20 mm
16. Batten 50x50 mm / Insulation
17. Insulation 2 x 220

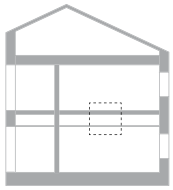


Ill. 58. Partition wall

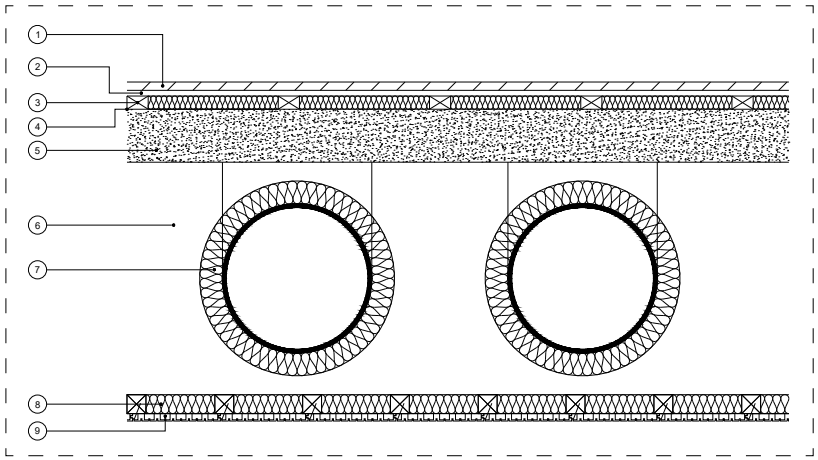


1. Plasterboard 2 x 12,5 mm
2. Insulation 45 mm
3. Stud pr. 450 mm
4. Empty cavity 40 mm
5. Joint min. 10 mm
6. Laminated floor 22mm
7. Sound insulation plate 15mm
8. Joist 35x56 mm / Insulation
9. Moisture barrier
10. Reinforced concrete 140 mm
11. Rubber joint
12. Top and bottom rail
13. Wall rail
14. Filler tape
15. Batten 50x50 mm / Insulation
16. Linear panel 20 mm

For the internal walls and the floors, it is more important that they provide some sound insulation between apartments. For the internal walls the firm *knauf* [Knauf, 2016] was used. They are specialized in manufacturing drywalls. The ceiling is inspired from the firm *Stil-acoustics* [stil-acoustics, 2016]



Ill. 59. Floor slap



1. Laminated floor 22mm
2. Sound insulation plate 15mm
3. Joist 35x56 mm / Insulation
4. Moisture barrier
5. Reinforced concrete 140 mm
6. Suspended ceiling 615 mm
7. Ventilation Duct with fireproofing insulation 7(
8. Batten 50x50 mm / Insulation
9. Linear panel 20 mm

Air quality

It is important to ventilate properly inside the building to get a satisfactory indoor environment regarding smell, temperature and the level of CO_2. The ventilation rate is calculated based on two factors, the CO_2 level and the olf level. The two are calculated separately and the one requiring the highest air change rate will be used to determine the size of the air ducts. The calculation is based on formulas found in CR1752. See appendix 4 for the calculations and results.

Ventilation Aggregate

To estimate the size of the technical room and get the date necessary for the energy calculation, the ventilation aggregate had to be determined. To do this the air flow calculation previously mention was used to determine the size of the ventilation aggregate. Each unit has its own aggregate and the calculated air flow rate the aggregate has to handle is 1,1 m^3/s and the chosen aggregate has a capacity of 2 m^3/s. To find the right aggregate for this situation a program called systemair A/S was used, the chosen aggregate is Danvent DV20 see ill. To insure that the technical room was big enough the room was made twice as long as the aggregate and 2,5 times as wide to account for the ducts, and for maintenance.

Duct sizing

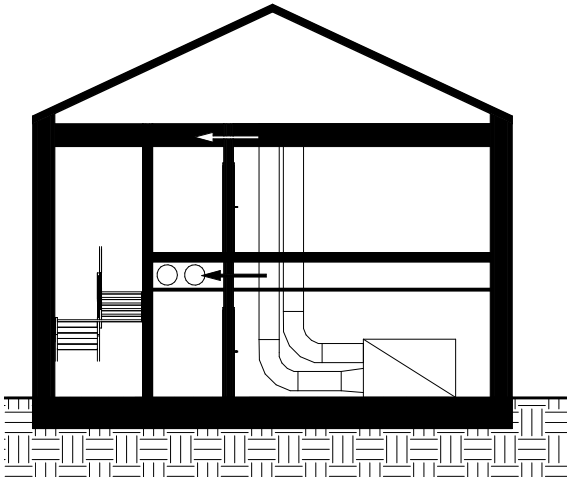
The size of the ducts was determined to find the necessary space for the suspended ceiling. With duct, sizing the idea is to find the necessary cross dimension. The dimension of the ducts is a compromise between the desire for small ducts, to save on space and the need for small velocities which results in a bigger duct bud a reduced duct noise.

The recommended intervals for the mean velocity is:
Connection ducts 2-3 m/s
Distribution ducts to the rooms 2-4 m/s
Main ducts 6-8 m/s
[B. H. Petersen, 2005]

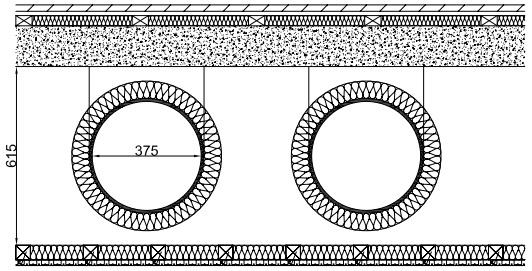
The size of the ducts is calculated using Revit, and to test the results one section of the ducts is calculated using the formula below. Ill on the next pace shows a drawing of the duct system. The recommended circular cross section is calculated based on the desired velocity and the calculated airflow, using the formula.

$q=v*A$
$A=\pi*r^2$
$r=\sqrt{(q/(v*\pi))}$

q is the flow rate [m^3/s]
v is the desired velocity [m/s]
A is the area of the duct [m^2]
r is the radius of the duct [m]



Ill. 60. Ventilation Shaft sketch

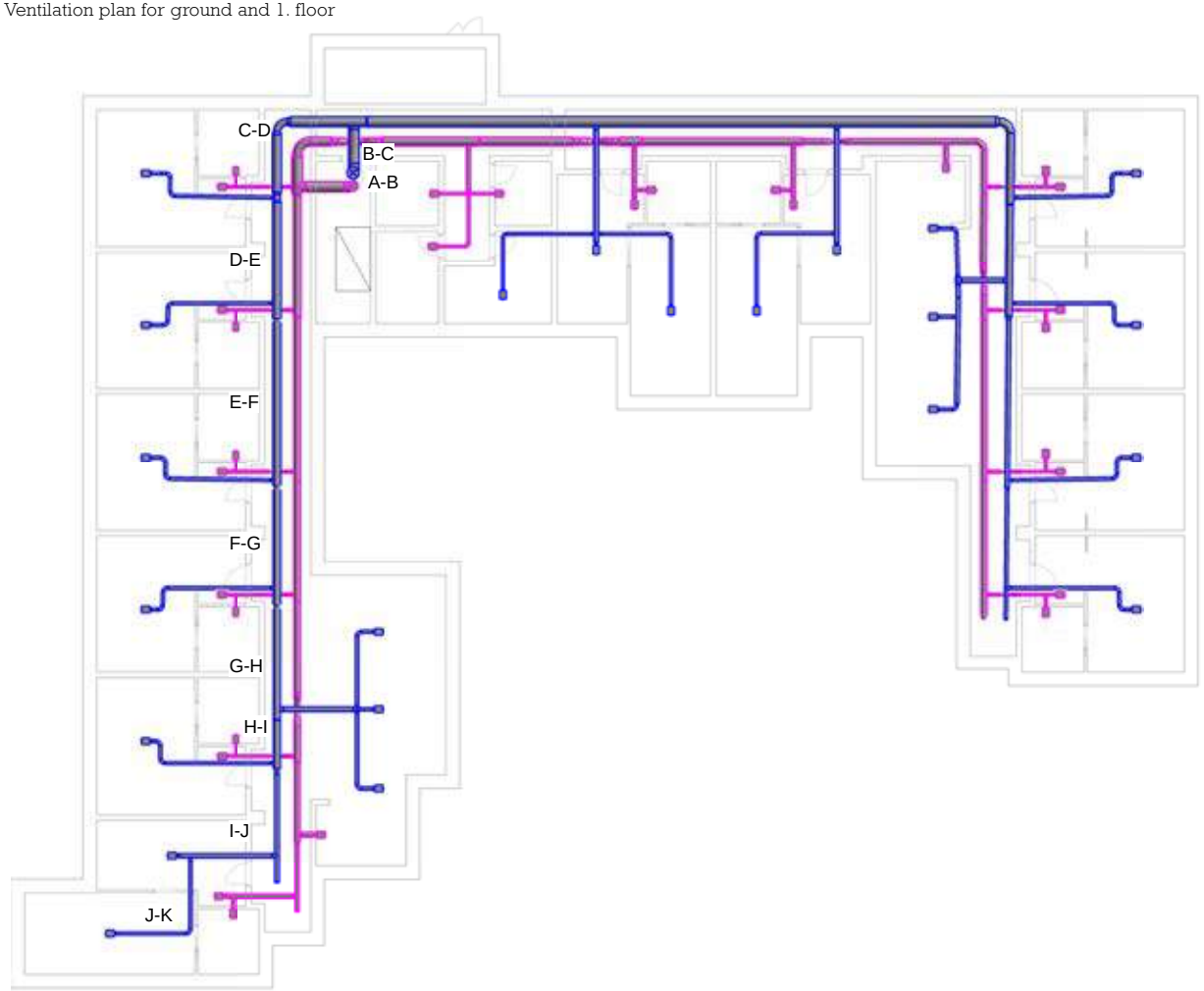


Ill. 61. Deck with ventilation

Ventilation Aggregate	Capacity	Effect	Heat recovery	Height	Width	Length
	[m^3/h]	[kW]	[%]	[m]	[m]	[m]
Danvent DV20	2880 - 7200	1,8	87,3	1370	1270	2390

Ill. 62. Ventilation aggregate

Ventilation plan for ground and 1. floor



Duct	Flow rate q [m3/s]	desired velocity v [m/s]	Radius of the duct r [m]
A-B	1,060	8	0,205
B-C	0,530	4	0,205
C-D	0,243	3	0,160
D-E	0,219	3	0,152
E-F	0,195	3	0,144
F-G	0,172	3	0,135
G-H	0,148	3	0,125
I-J	0,077	3	0,090
J-K	0,053	2	0,092

Ill. 63. Mechanical ventilation duct plan

A N A L Y S I S

ANALYSIS

Through the analysis phase a broad understanding of the project and the case will be developed. The phase is divided into three sections; **framework**, **definitive research** and **site analysis**. This is done to create a more clear way of reading and understanding the content.

FRAMEWORK

The following section will give an overall understanding for the project by framing different research in aspects such as space, atmophere, tectonics and dementia including specific considerations to have in mind when optimizing everyday life for the people living with dementia.

Ill. 64. Nordic identity - Tverrfjellhytta [Villrein]

The interpretation of the architecture in the northern countries have been dominated by contrasting tendencies throughout the last couple of decades. When discussing northern architecture, it's difficult to use definitive words to describe it because there is no such clarity in the style, even though its exposed, recognized and used as inspiration all over the world. At an exhibition held at Louisiana – Museum of Modern Art the aspect of architecture in relation to identity, tradition and atmosphere in the northern countries was discussed. At the exhibition three general themes were debated and showcased.

What is Nordic Architecture?

Nordic architecture can be different things depending on where you come from. Cultural personalities vary from place to place, but when overall conclusions are made there are certain similarities. Interpretation of the site has had a great importance for the architecture that have been built the last couple of decades. The place can be considered as a scenery in different layers physical as well as psychological creating a more definitive process and way of designing. Peter Zumthor states that the architectures relation to the place is a tribute to the landscape.

Another theme of importance is the welfare system in the northern countries. In the exhibition this aspect was showcased to manifest the necessity to consider health and well-being. The welfare system is often what foreigners relate to the northern countries. The Nordic welfare model is seen as something that helps define what Nordic culture and identity is. Reinterpretation of the traditional buildings, typologies and functions which are mixed in new ways create new institutions and new ways of living for people in given situations.

The third thematic deals with how the city and the urban space is designed and transformed. In the northern countries there is a long tradition bringing old, scenic elements into the city. Over the last couple of years this tendency has turned from only creating an atmosphere into something more useful. Landscape and townscape are no longer two extremely different things, but two sides that complement each other. The wish is to create sustainable spaces with multiple applications. [New Nordic, 2012]

Dementia

''For people with dementia, sensory experiences play a central role. This applies especially to how we experience space. As people's cognitive faculties start to decline and the memory of recent events fade away, what remains are direct sensations. As the disease progresses, these become increasingly important. When we design architecture for people with dementia, we must therefore take a step back and consider what is fundamental about the spaces we live in.'' [Eckhard, 2014]

Everyone has a relationship with the environment they are surrounded by. We manage to move around in space without even noticing how we relate to places, objects and people. This also applies to people with dementia even though their perception of time and space has changed. Despite of this sudden change of perception they still have a sense of what is happening around them, what is important and what gives meaning in their lives.

Dementia is a general term used to describe many different varieties of mental disorders all dealing with mental affliction and progressive deterioration of cognitive faculties leading to loss of competencies we all need in everyday life. The disorder lies as a burden on one's shoulders often accompanied by apathy, depression, aggression, sleep disorders and delusion. These problems are crucial factors in the patient's life, but they also affect the patient's family and friends, because they have to react to how the respective person act. [Steinhagen-Thiessen, Zens & Heinig, 2014]

People affected by the disorder often change their approach and way of being. They start to act more or less like children wanting to have everything their way, and if someone argues against them they might start yelling and so on. Each individual acts differently which makes the disorder a complex problem when it comes to caring and deciding whether or not the respective person should be handled as an inpatient or an outpatient.

Healing architecture

The focus on healthcare and the environments framing our lives has over the last couple of decades reached a higher level of importance after specific research has showed that we are able to improve multiple aspects in healthcare and recovery during the way we design space. The specific research has been made to be able to develop how the impact of architectural design can improve the process and life for the patients. Throughout the many different processes and researches it was concluded that architects have the possibility, with help from specialists in the specific area, to create spaces which would optimize and better the patient's quality of life, satisfaction, treatment time, sleep patterns and level of private and social wishes. [Lawson, 2010]

With this information in mind an overall picture has been made for how the environments should be designed. A description in simple terms for clients and architects will be presented in the following to understand.

It's important for the patients to feel like they are having a certain amount of control themselves. Therefore, it is important to design spaces in which they can decide whether they want to socialize or be alone. This opportunity could or should be applied in the patient's apartment, in the waiting room, in the meeting room and other places where it might be wanted. Being in control is also important when it comes to comfort and control. Having the opportunity to change the heat, noise and amount of light in the room will help to reduce stress levels, which is an important factor when discussing recovery time.
Designing the building with spatial legibility is vital for people with dementia. It should be easy to find your way around in the building. Everywhere we go we create our own mental map. If it's difficult and confusing to walk around in certain places we get stressed, because we can't build that mental map. Making different hierarchies and identities could be a solution in making spatial legibility easy for the users to follow and understand.

For the interior appearance it's an important factor for the patients to feel like they are home. Making an atmosphere by hanging pictures and paintings on the walls, letting light in, designing the spaces with a variety of different colors and textures. Creating a frame they feel comfortable in will help reduce stress and anxiety. In addition to the interior appearance it is important to design the building in a way so that the users have certain views. In relation to this comes the amount of daylight entering the building. Patients who have a view and gets the right dose of daylight recover more quickly. Bryan Lawson states the following based on research;

''Daylight is good for us. It results in chemical changes in our bodies that enable our self-healing systems to operate effectively.'' [Lawson, 2010]

Ill. 65. Caring [MDhealth]

Light

Light is an essential factor for life and how we perceive our surroundings and environments. Through the choice of materials and how architecture is done it's possible to aid perception to how the atmosphere should be in the specific place. Light plays a vital role in how we perceive spaces because of how it creates contrasts and differences in materials and as the sun moves throughout the day the shadows move and changes the room.

Good daylighting is especially important for people living with dementia because it can help reduce stress and confusion. People with dementia are often elderly people with an impaired vision, which only makes good lighting an even bigger necessity in a building for people suffering this mental disorder.

Architects and designers should maximize the quality of daylight while minimizing fluctuations considering the indoor climate and comfort for the patients. Primary elements in dementia-friendly lighting is to use daylight wherever it's possible, expose people to the 24-hour cycle of light and dark and use sufficient ''domestic style'' fittings to help promote recognition of place. In comparison to the regulations it's a good idea to increase the levels to twice the normal because it will help decrease anxiety and confusion. These elements should be taken into account, because the natural is free and it's the best quality of light we can get. [McNair, 2014]

Ill. 66. Light in the forest [tes]

Tectonics

The term tectonic originates from the Greek word tekton, meaning carpenter or builder. The term refers to multiple variations of craftsmanship including architecture and construction in which tectonics has been described as poetics in construction as well as the art of joinings. For a project to stand out constructional technique should be visible and show as part of the design solution to create and enrich a specific spatial character. This is expressed and defined by Frampton in his opinion:

''It is my contention that the unavoidably earthbound nature of building is as tectonic and tactile in character as it is scenographic and visual, although none of these attributes deny it's spatiality.'' [Frampton, 1995]

Many wise men like Frampton, Semper, Sappho, Grassi and more have been discussing and reflecting upon the term of tectonics throughout time. Marcus Pollio Vitruvius wrote ''The Ten Books of Architecture'' during the height of Ancient Rome and created a solid base for the following discussions. Even though Vitruvius might not have been familiar with the specific term tectonics he still managed to describe his thoughts upon the most important aspects of a successful piece of architecture. His thought has stood time and been a base for most architectural work. His reflections resulted in a triangle defined as the Vitruvian Triad, in which firmitas, utilitas and venustas creates the idea of holistic thinking. Firmitas describes the construction and how it should stand robustly. Utilitas describes functionality and how the building show be able ease the daily use of it. Venustas is the beauty and spatiality which makes us comfortable both mentally and physically. [Vitruvius, The Ten Books of Architecture]

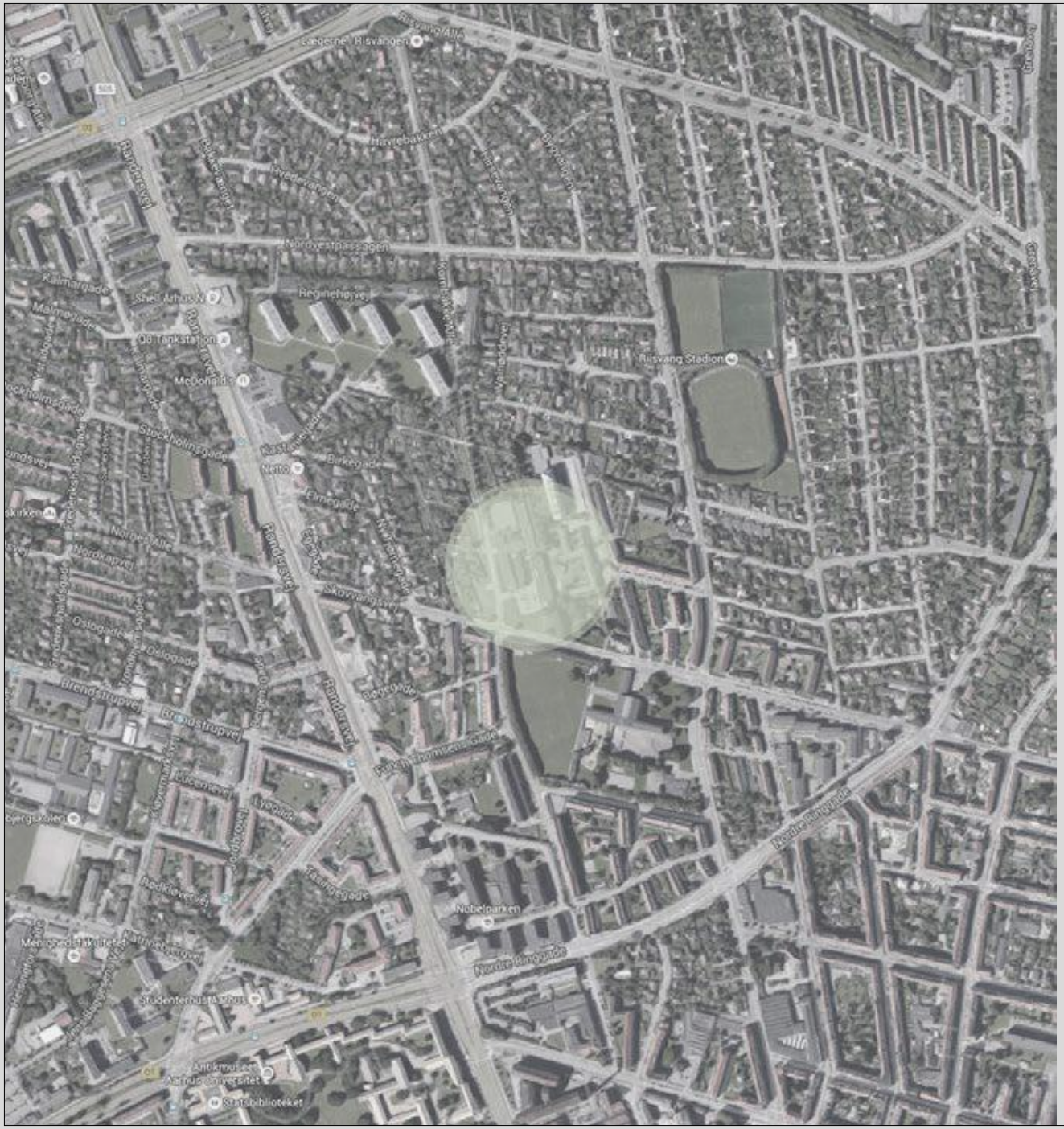
Today things have become more complicated. Technology keeps developing which make it harder to follow. We are still considering the three elements defined in the Vitruvian Triangle, but from where we are technologically in the present we have to integrate and consider sustainability as a fourth element.

Ill. 67. Tectonics [vwcarch64]

SITE ANALISYS

This chapter deals with the context and will outline specific aspects of the site. The analysis will give an overview of the location's structure such as infrastructure, close by activities and functions, vegetation and leveling of the terrain. In addition it is important to analyze climatic conditions, since the aim for the project is to design a sustainable building. Lastly, the site experience on human-eyes level is needed to understand the atmosphere.

Ill. 68. Map indicating where the site is situated in Denmark



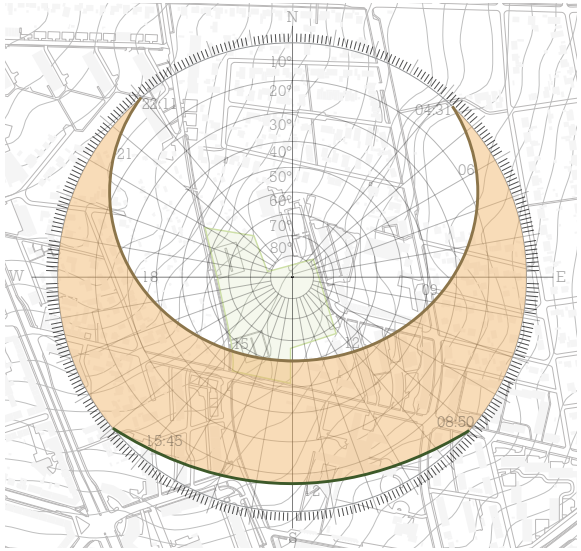
The site is situated in the northern area of Aarhus, which is the second largest city in Denmark with over 375.000 inhabitants. Moreover Aarhus located on the east coast of Jutland in Denmark. [Wikipedia, 2016. Aarhus] The city has a location with plenty of potential close to the sea and multiple green areas. The active and more busy environment of the city is placed side by side with the green nature, and it is easy to move around the in city. [Aarhus Kommune, 2016. Dit Aarhus]

The site was earlier known as a neighborhood for working-class people, in which there is a mix of storey buildings, row-houses and villas. Nowadays the project area has been transformed into an area with a mix of people from different society-classes. [Aarhus Kommune, 2016. Lokalcenter Abildgården]

On the site there are one elderly-home building and one administration building, which belong to local-center Abildgaarden. These buildings will be demolished in advantage for the new center. The existing buildings were built 1974 consisting of brick-walls and built-up roof construction. [Aarhus Kommune, 2016. Skovvangsvej 99]

Ill. 69. Map of the context

SUN



Ill. 70. Sun path [Gaisma]

Observations of the sun path shows that the sun's position in Aarhus is highest from May to August, while the lowest position is located between November and February.

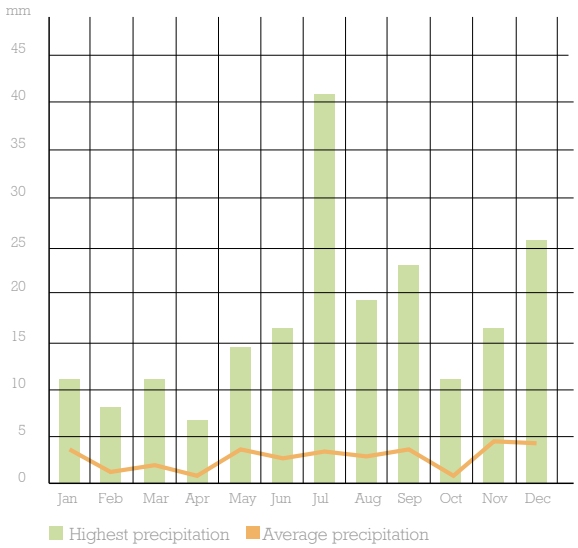
Moreover during summertime the sunrise will happen earlier and the sunset will happen later in a day compared to wintertime. The sun's azimuth and altitude change noticeably in different seasons. Understanding the sun path is relevant to ensure good indoor environment according to shadows and overheating.

TEMPERATURE

Ill. 71. Temperature [Zoover]

The average temperature for average maximum temperatures is about 10°C and 4°C for average minimum temperatures. Normally the maximum temperature will be measured, when the sun is highest, and the minimum temperature will typically be measured at night. From the diagram it shows the hottest month is July and August with an average maximum temperature of 20°C, while the coldest month is February with an average maximum temperature of -1°C.

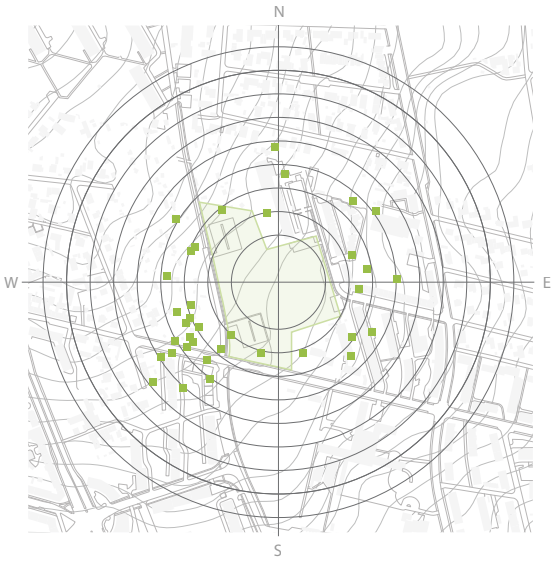
PRECIPITATION



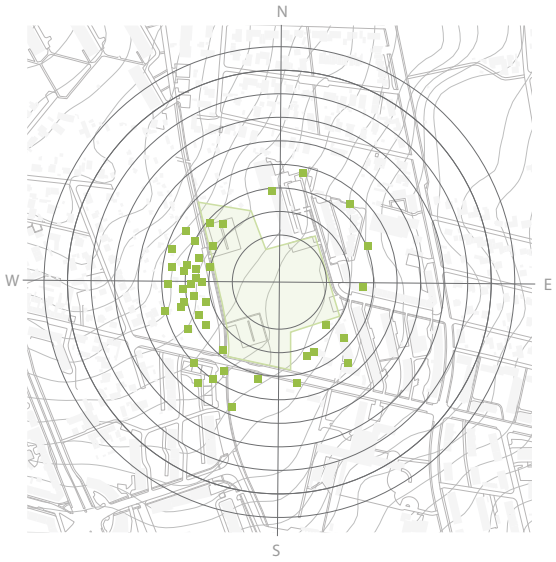
Ill. 72. Precipitation in Denmark [DMI]

Information data for precipitation in Aarhus is from 2015, and the measurement shows that most rain is received in July, but the highest average precipitation data is in November and December. As it can be observed there are not a big amount of rainy days, which is why flood risk is minimal.

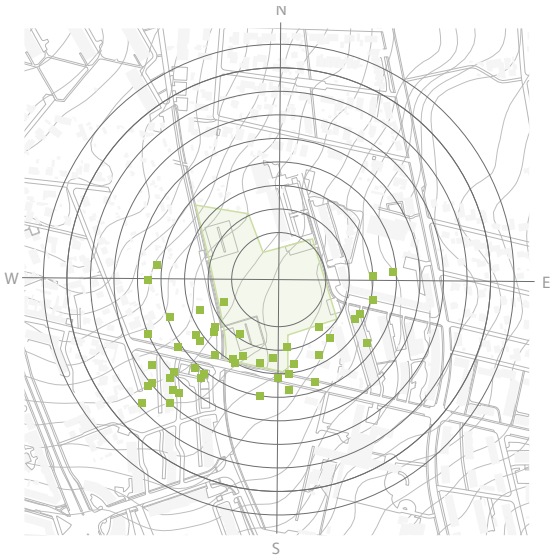
WIND



Ill. 73. Wind data for March



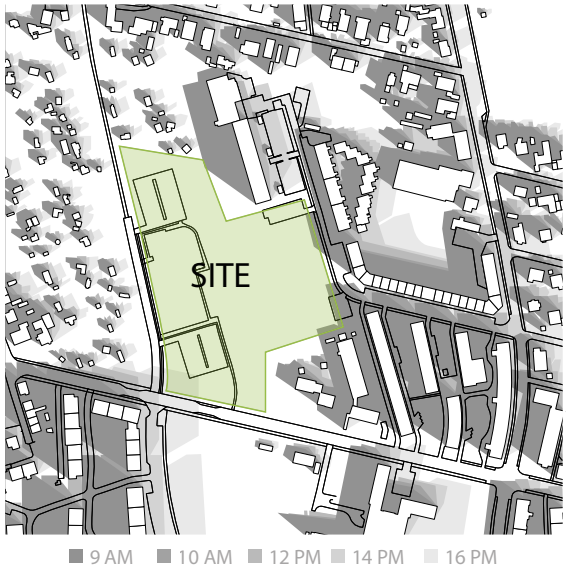
Ill. 74. Wind data for June



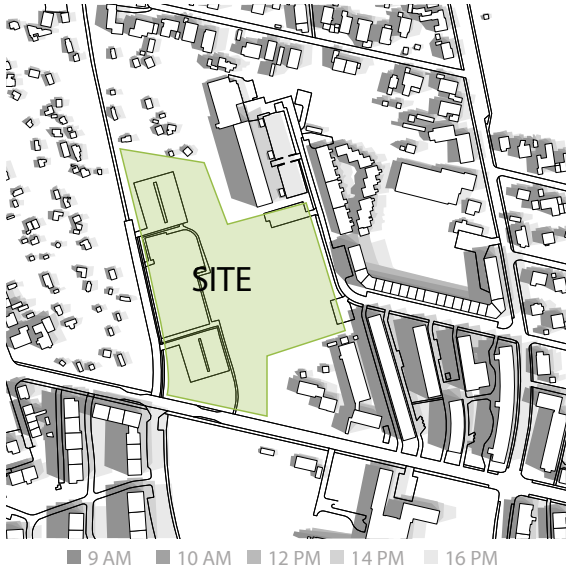
Ill. 75. Wind data for December

As it can observed from the diagrams, the most dominant winds come from west and southwest, where the average wind speed is varying from 0,2 to 16 m/s. In relation to the site it can get some shielding from surrounded buildings, but wind shelter need to be considered, if there will be any outdoor spaces.

Furthermore there are wind digrams for each month in 2015. These are placed in appendix 1.



Ill. 76. Shadows in 21st March



Ill. 77. Shadows in 21st June

Ill. 78. Shadows in 21st December

The shading simulation is made for different dates of the year; 2st June, 2st December and 2st March. These dates are the longest, shortest and something in between the longest and shortest day.

Moreover these dates are taken from different weather seasons as summer, winter, autumn and spring. For autumn and spring the sun's azimuth and altitude is the same, therefore only simulation for one of them is needed.
These simulation diagrams have been made to see where there is most sun and shading on the site. As it shows there are almost 100% sunlight and no shading on the site in June and March, where in December there is some shading in the south-west corner and south-east corner of the site around afternoon.
The simulation is needed to see when and where to place solar cells, and which orientation the outdoor areas should have. The brightest areas shoould be exploited for improving a living quality and reducing energy consumption.

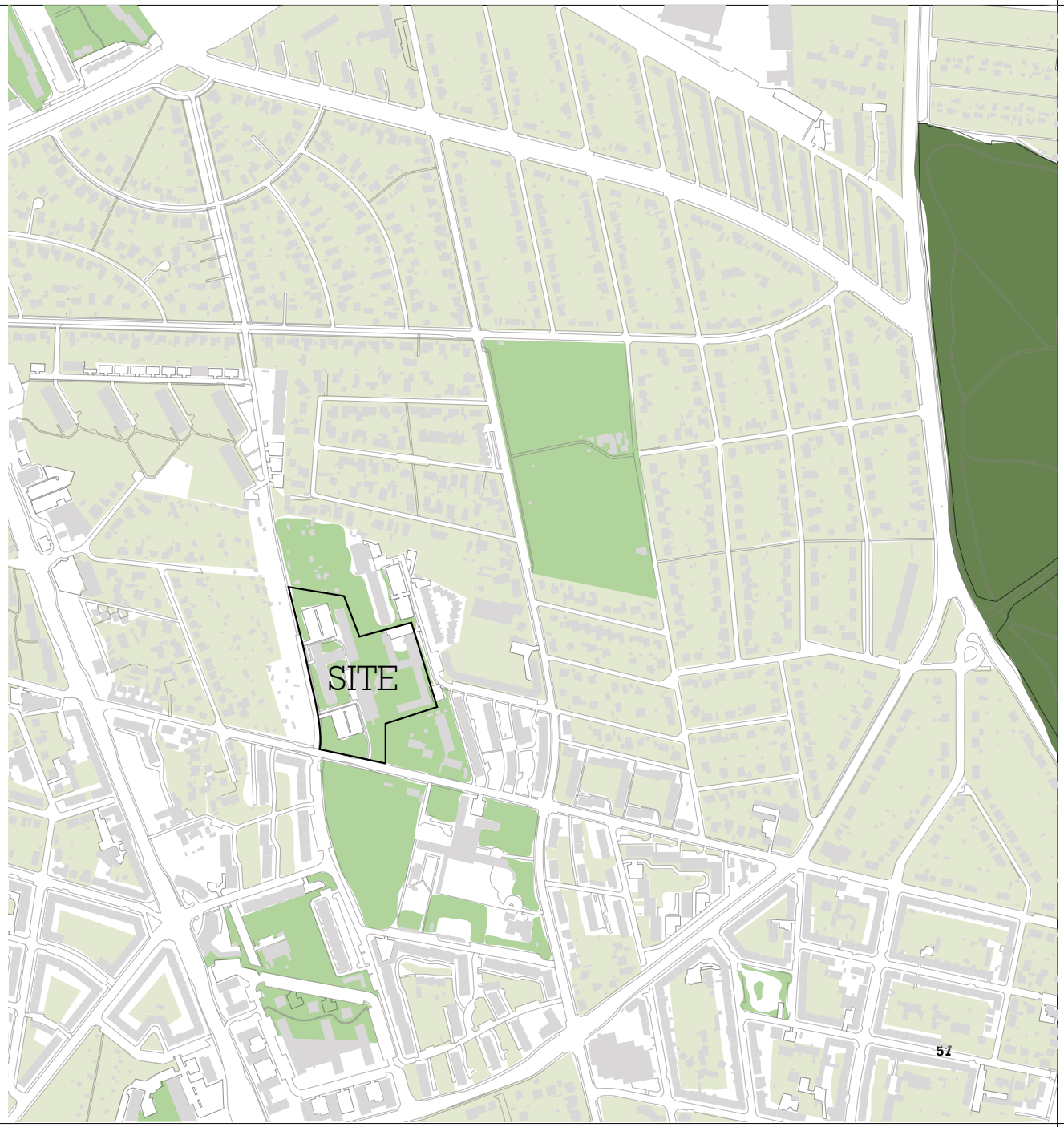
Greenery

The project site is located in the northern part of Aarhus, which mainly contains of residential areas. As it shows on the diagram the site is surrounded by a lot of greenery, but most of these areas are private grounds.
The green structure is divided between public-, semipublic and private green structure. The forest, which is located about 1 kilometer away from the site, is the biggest public green area nearby.

The semipublic area is understood as a place used by people with an intention. For example an area for students is a semipublic area, where the ground belongs to a school.

Even the surrounding green structure looks quite intense from above, but it is mostly private areas. Therefore, green areas are fenced or hidden away from the roads. When passing some areas in eye level height they does not look as green as they do from above.

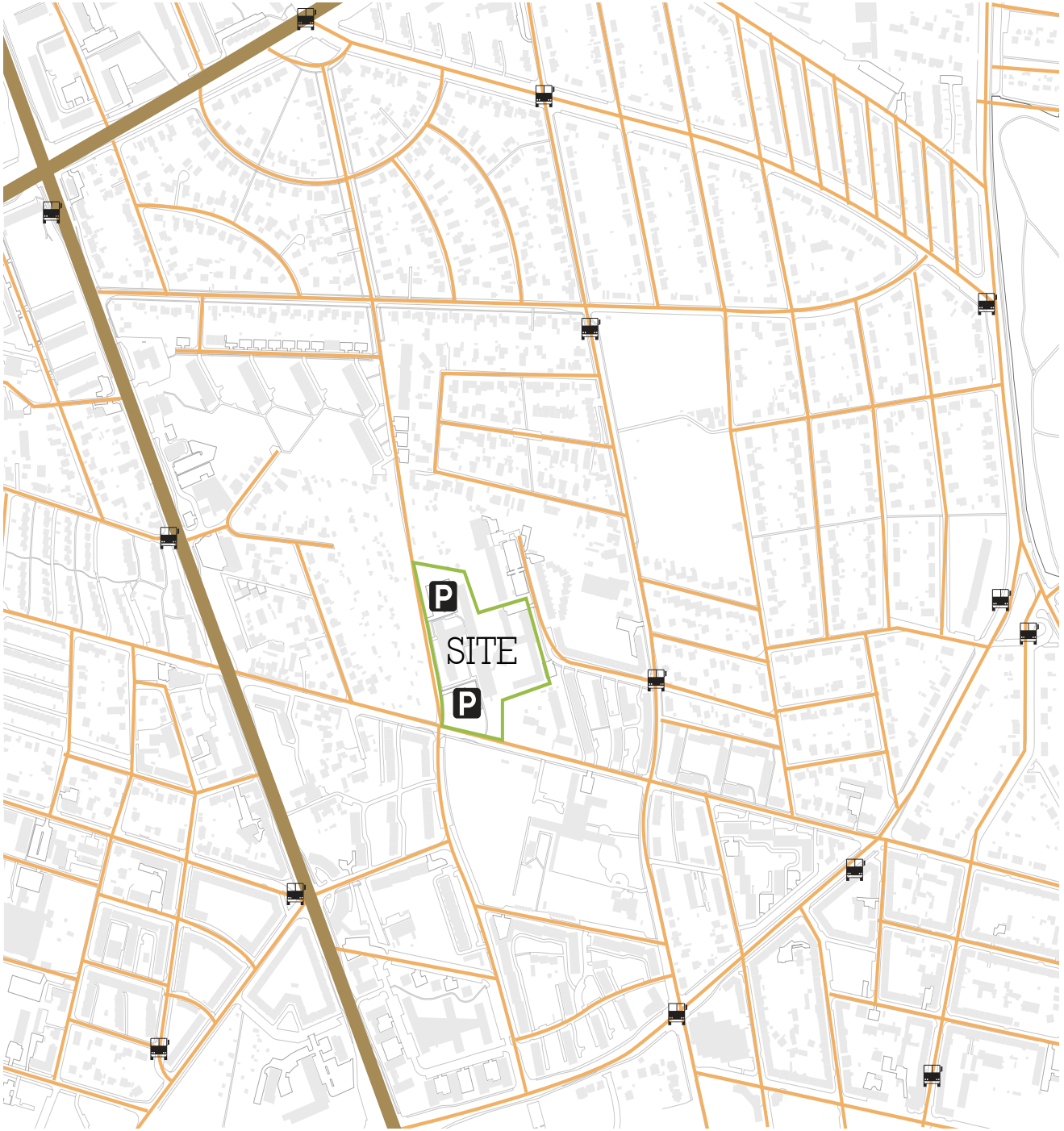
An overall observation for the situation shows it is a good location for the new project, because it is placed in a green and calm neighborhood.



Ill. 79. Diagram indicating the surrounding greenery

Infrastructure

The local area is easily accessible by car, bicycles and bus. There is an easy bus connection from the area to the center of Aarhus city. Less than 500 meters from the site is the closest bust-stop which makes getting around by public transport fairly easy. The roads around the site are local traffic roads with low speed limits, and pedestrian and cycling routes parallel to the road. In addition the site contains two parking lots, which need to be more integrated in case of creating outdoor spaces. An overall observation of the area is made. It seems to be a calm residential area, which will be a good area for the new project.

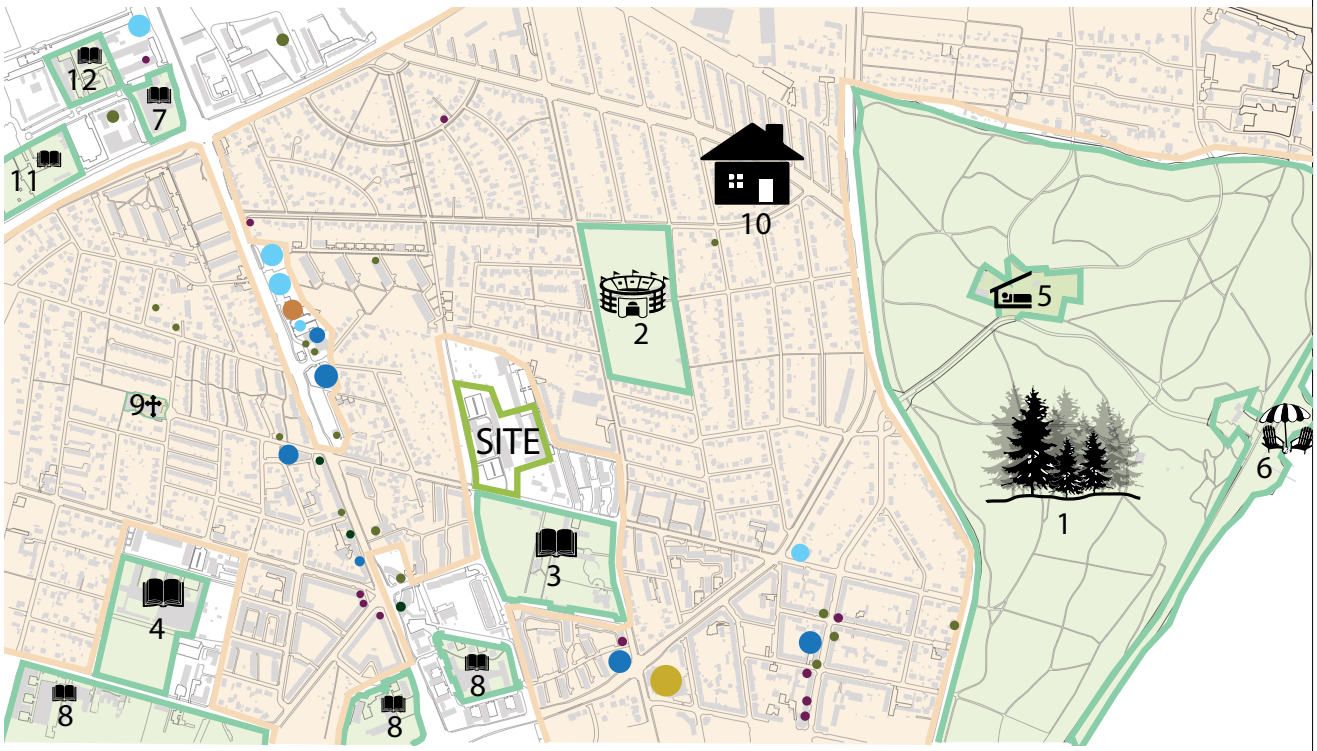


Ill. 80. Infrastructure in the surrounding areas

Functions

Even the site is located outside of Aarhus center, but there are still a lot of useful services and facilities close by as restaurants, supermarkets, Trøjborg center, gas stations, banks, stadium etc. Furthermore the site is surrounded by education facilities and the closest one is Skovvang School, which is a primary school. Not so far away from the site there is a big recreational green area and a beautiful beach, moreover on the opposite direction with the same distance from the site there is a church.

Base from all these observations the site has a very ideal location, because it is located inside a residential area, but still it is really near relevant facilities. The users of the new building can easily go to these places by foot or by bikes. In addition if the users want to be closer to nature or practicing religion, then in their free time they can go to the forest, beach or attend to activities in Christianskirken church nearby.



1. Forest
2. Risvang Stadium
3. Skovvang School
4. Katrinebjerg School
5. Danhostel Aarhus
6. Beach
7. Aarhus Academy
8. Aarhus University (Psychological Insititute)
9. Christianskirken Church
10. Residentitial Area
11. Via University College
12. Aarhus Tech

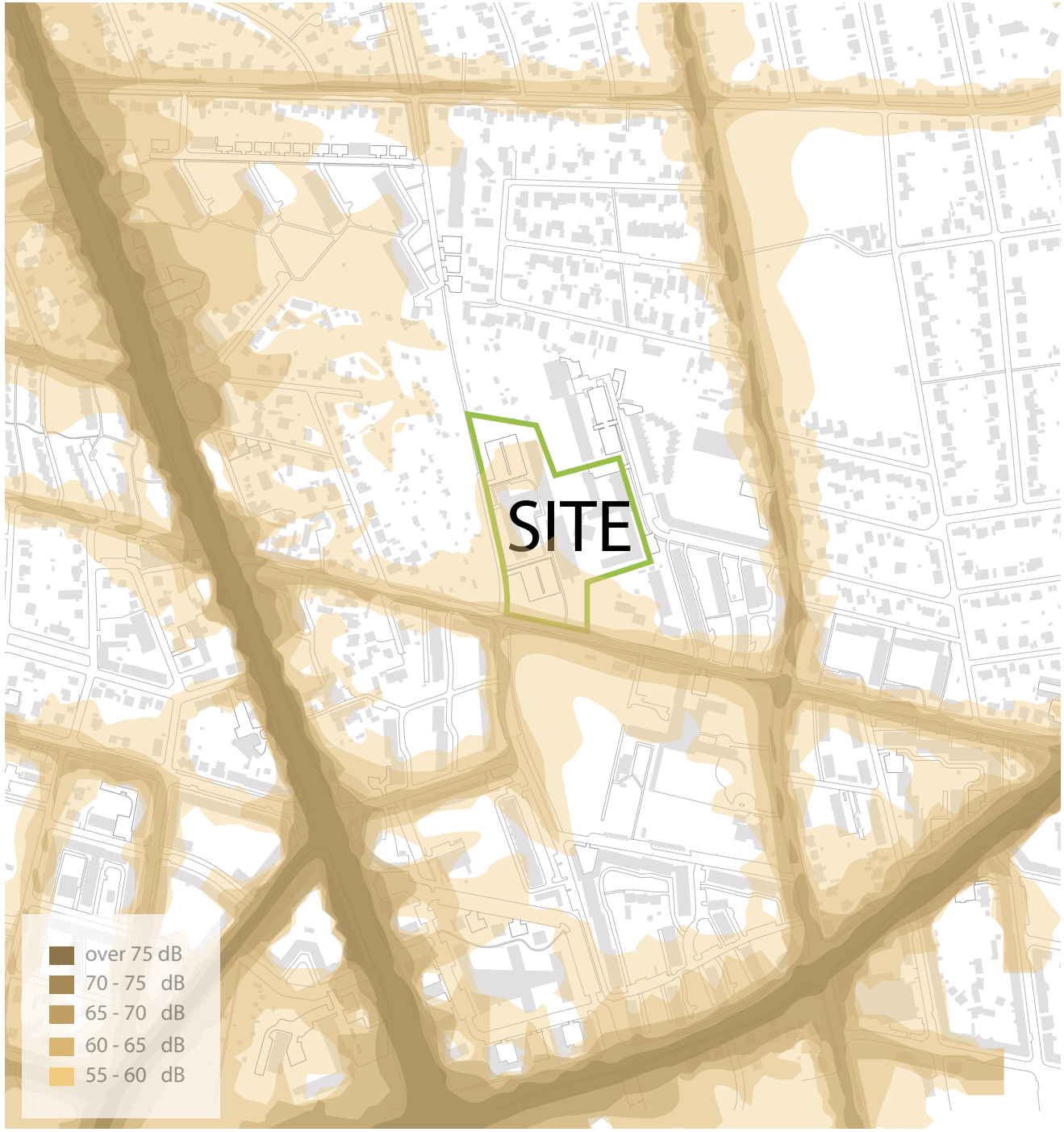
Gas Station
Supermarket
Restaurant
Fastfood restaurant
Mall center
Shops
Bank

Ill. 81. Display of functions in the area

Soundscape

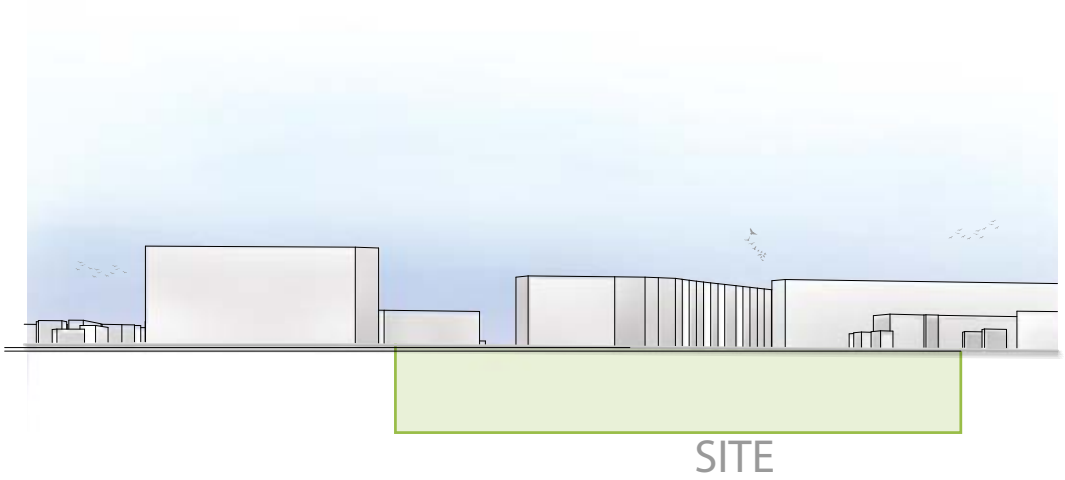
The most common noise issue in residential areas is noise pollution from traffic. There is no upper limit on, how much traffic can pollute near residential area. According to the municipality's website, new buildings must not be exposed to a noise level of 55 dB from roads and railways.

As it shows on the diagram the road, which defines the edge of the project site on south side, pollutes with 65 – 70 dB during the day. Together with this road the road on west side let the noise pollution from traffic travel deeper into the site with 55 – 60 dB. This must be taken into account, when designing outdoor spaces.

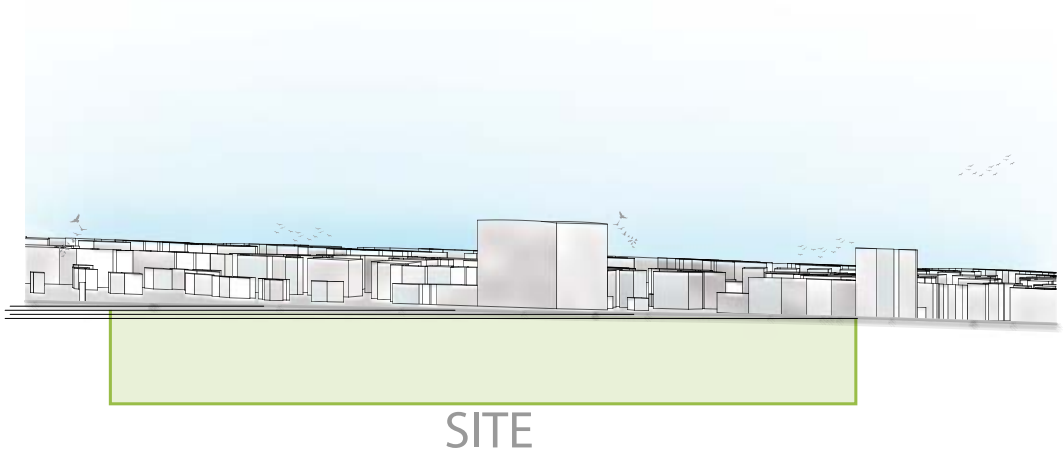


Ill. 82. Noiselevels

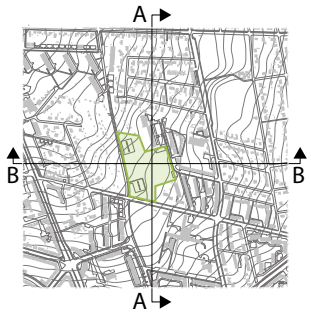
Topography



Ill. 83. Section showing the topography on site A-A



Ill. 84. Section showing the topography on site B-B



There is a small height difference on the site. At section AA the height difference is approximately 0.60 meter, which seems to be plane, considering the lengt of the site.

At section BB the height difference is bigger, which is about 1.5 meter. During the visit of the siteit was possible to feel the height difference even though it did'nt stress or feel extreme.

All in all the site is quite plane, because the relation between dimension of the site and the height difference is gradual. The project has a big focus on the dementia, which is mostly elderly people. They can have trouble moving around in terrain with height differences. In this case the terrain is not a problem for the residents who will be living there.

Atmosphere

To get an understanding of the site and the context it is necessary to visit the site a walk around to feel the place through a route around and between the buildings.

From the observation there are a lot of things happening in the surrounding neighborhood, which moves from large scale to small scale. In addition there is no uniform material in the area, but a range from wood cladding, concrete to brick buildings. The area seems to be green and you can sense that it is located in a residential area with a very calm environment.

1. On the opposite side of the south edge there is a dominant area with 6 floors apartment building in brick. The relation between it and the site has an adaptive ratio, which creates a comfortable space experience.

2. A paranormal view to the site on the south side. There is no crossing on the road for pedestrian, which need to be considered to create easy accessibility for the new project.

3. A view out of the site on the west edge, which lines up to allotment houses. As it shows on the picture, there is an empty green lawn, which seems not attractive.

4. It is the entrance to Abildgaarden 99 elderly homes. The atmosphere looks sad and the entrance appears quite anonymous.

5. The parking lot on north area. From here the big concrete apartment building with 7 floors can be spotted.

6 – 9. Towards the boundary in the east there is a height difference about few meters downward to west.

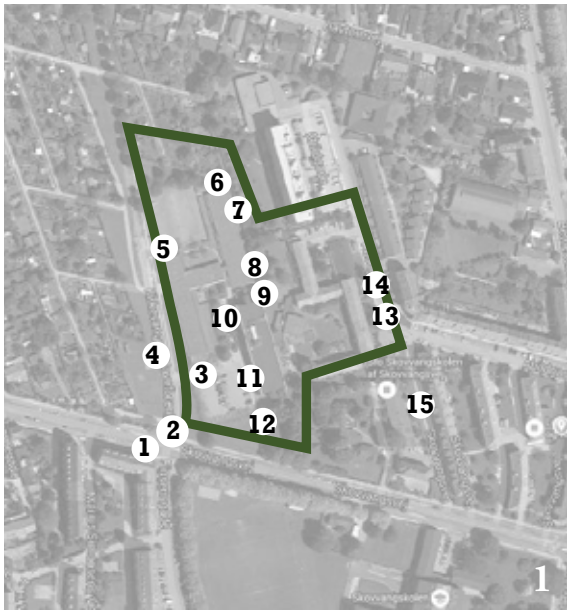
9 – 11. View of Abildgaarden 99 in a closer distance.

12. View to the site from east side. There is also an entrance from this side into Abilgaarden 99.

13. View of the big concrete apartment building from east in closer distance.

From the pictures it shows that the site is placed between many different scales and typologies, where allotment houses in west and north, different and large apartment buildings towards east, and lastly a school and large brick apartment buildings on south area.
In the existing situation the site contains of two parking lots and the buildings on the site is standing without a special relation to the ground, because the site is lacking of continuous flow connection, therefore outdoor areas are not in use efficiently, where some areas don't have pavement and don't appear attractive for the users or the visitors of Abildgaarden 99. The plan for the project is to demolish all the existing buildings and create both good inside and outdoor environment for the users and visitors.
In addition the area for garbage is placed just right outside the entrance without any try on hiding them, which have a bad influence on the expression and experience of the site. Moreover it is not attractive for the users or visitors to look out to garbage area combine with a parking lot, while they are working or relaxing on the balcony.

The overall expression of the site is that it doesn't look attractive and welcoming for the visitors and it looks quite sad for the users. This must taken into account when designing the new project.



Ill. 85. Diagram illustrating where the photos on the following are taken

Ill. 86. The atmosphere on site

DEFINITIVE RESEARCH

During this section aspects such as sustainability, different initiatives, indoor climate and spaces will be described. The kind of research done here will create some more definitive and specific thoughts which will be considered throughout the process.

Furthermore the roomprogram is to find in this section. This will define the different rooms and the sizes of these.

Ill. 87. Sustainability [oneillandbrennan]

Sustainability

This chapter will look at the general terms of sustainability and which elements of sustainability that will be focused on and how they will be implemented in this project.

Today there is no single explanation of what sustainability is, but in 1987 with the "Brundtland Report - Our Common Future" the UN tried to establish a common understanding of the term sustainability, it was defined as a process where, we should fulfil the needs of the present without compromising the conditions for future generations. The definition of Sustainability was divided into three sub categories. Social, environmental and economic sustainability [un-documents, 2015].

Environmental sustainability
Environmental sustainability focuses on the environment and the impact the building has on it. To have the least impact on the environment it is important to use the right materials and consider where they come from, and what can be done with the materials when the building has to be torn down [Bygherreforeningen, 2013].

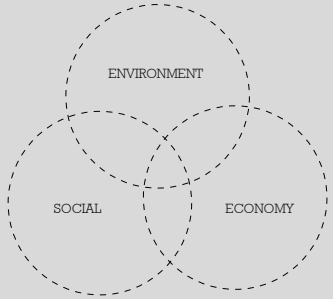
Economical sustainability
When looking at economic sustainability in architecture, we look at the cost of the building from the building is constructed to maintenance, cleaning and the cost of demolishing the building. In the economy of the building, there is also the energy cost. Using fossil fuel for energy isn't just bad for the environment but also for the economy of the building. Therefore, to get good economic sustainability the building should be nearly self-sufficient when it comes to energy. Creating a building with a good economic sustainability also means saving money and possible lower rent for the people living there [Bygherreforeningen, 2013].

Social sustainability
Social sustainability concerns the living conditions, there are two aspects to this the living conditions inside each apartment, where it is important to consider the indoor environment and user behavior, so that the user can control certain technical aspects of their own apartment, this could be things like the ventilation system and the temperature. The second aspect is the social living conditions where it is important that the users feel a sense of belonging and security in the community, this can be achieved by creating areas that bonds the community together and gives them a common place to meet. By creating a community with different user groups, it is important to consider how these different groups interact with each other and create a flexible environment, where the different groups can benefit each other.

To ensure good economic sustainability the materials and indoor environment will be considered in the design process from the beginning, it is also important to think about the energy consumption.

The economic sustainability will be more of a reflective process in this project, the economy will be considered when choosing materials, but the focus will be lie on the social and environmental aspects.

Social sustainability relates both to the private and social aspects of the building. Therefore, the interior and exterior design must be considered when optimizing the quality of life and offering the framework for social interaction [Bygherreforeningen, 2013].



Ill. 88. Three aspects of sustainability

Zero energy

Buildings today must be constructed to automatilcally avoid unnecessary consumption of energy, while not compromising on the indoor environment. The goal for 2020 is that all public buildings are nearly zero energy buildings, the energy used for heating, cooling, ventilation and domestic hot water per. m² heated floor area cannot exceed 20 kWh year [Bygningsreglementet, 2016].

The definition of a Net zero energy building (NetZeb) is a building with a greatly reduced energy demand. The energy demand from the building is balanced by an equivalent generation of energy from renewable sources on site. In contrast to a zero energy building a Net zero energy building is connected to one or more energy infrastructures, when the generation of energy on site is greater then the building load the excess electricity and heat is exported back in to the energy grit [Sartori, Napolitano & Voss 2011].

The energy goal for this project is to reach zero energy by relying on passive strategies as much as possible to decrees the energy demand. First after optimizing the building with passive strategies active strategies will be applied to improve the buildings energy demand.

Passive and active strategies

The first step in creating a zero energy building is to reduce the energy consumption by implementing passive strategies, after that energy from renewable sources can be implemented. Passive strategies takes advantage of natural energy from nature such as sunlight or wind power to reduce the energy needed from non-renewable sources.

Sunlight can be used as a source of heating but during the summer there is a chance of overheating, therefore direct sunlight should be blocked. There are a couple of solutions to block the direct sunlight, the optimal solution blocks the sun when it's in a higher altitude and allows the direct sunlight in when it's at a lower altitude in the winter. Another way of using the suns heat is to use materials with a high thermal mass, they have the ability to store energy and release it gradually during the day.
To get a good indoor air quality and keep the temperature down it is important to ventilate, a good strategy to save on a buildings energy need to ventilate with natural ventilation during the summer months, natural ventilation works by having a pressure difference and is caused by thermal buoyancy.

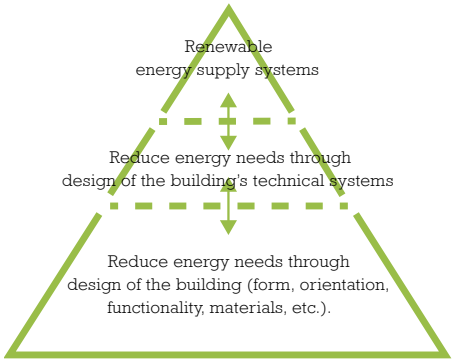
Active strategies take into account electrical and mechanical systems, and aims to reduce the energy demand, either through energy producing systems or hybrid systems. One energy producing approach is the use of solar thermal collectors or photovoltaics that takes advantage of the energy from the sun to produce electricity. A different strategy is to use heat pumps that takes advantage of the heat in the air or the ground. Heat pumps run on electricity but the gain to lose is around three times as much depending on the modes. [Designing Buildings Wiki, 2016]

Another active strategy is mechanical ventilation with heat recovery. Ventilation is necessary to remove the stale air inside the building and because of the cold climate in Denmark, natural ventilation is only realistic in the summer months. Normally the heat inside a room would be lost when ventilating but with heat recovery, the heat from the exhaust air is used to preheat the fresh air, this can help reduce energy consumption and running cost. Depending on the model of heat exchanger, it can recover up to 98% of the heat from the exhaust air [Designing Buildings Wiki, 2016].

In this project, we will focus on integrating hybrid ventilation. This means that in the summer months only natural ventilation will be used except in the kitchen and bathrooms where mechanical ventilation is needed the whole year around. In the wither months mechanical ventilation with heat recovery will be used.

Passive design strategies		Conduction	Convection	Radiation	Evaporation
Winter	Promote gains			Promote solar gains	
	Resist loss	Minimize conductive heat flow	Minimize external air flow Minimize infiltration		
Summer	Resist gains	Minimize conductive heat flow	Minimize infiltration	Minimize solar gains	
	Pormote loss	Promote earth cooling	Promote ventilation	Promote radiant cooling	Promote evaporative cooling

Ill. 89. Passive design strategies



Ill. 90. Strategy for design of zero energy building

Energy

It can be a challenge to create a low energy building without some architectural compromises. Therefore, it is important to incorporate the technical aspects in the early stages in the design process to integrate the technical aspects in the design. The energy goal for this project is to create a Danish low energy building meeting the requirements for a class 2020 building. To fulfill this goal the buildings supplied energy for heating, ventilation, cooling and domestic hot water per. m^2 heated floor area cannot exceed 20 kWh year. [Bygningsreglementet, § 7.2.2]

Thermal comfort

Thermal comfort includes the temperature inside the building, and sets rules for overheating, which can be an issue in newer buildings. With the large solar gain and airtight envelope the maximum limit for overheating is 100 hours above 26° and 25 hours above 27° per year.

Besides the maximum temperature limit, the thermal comfort should comply with the Danish building regulations which refers to Danish standard. The aim for the thermal comfort is a 10% predicted dissatisfaction (PPD) which equals a category II in DS/EN 15251 [Danish Standard. 2007]. This category includes the following parameters:

Winter Clothing, 1.0 clo
Temperature range 20.0 °C – 25.0 °C
Summer Clothing, 0.5 clo
Temperature range 23.0 °C – 26.0 °C

Atmospheric comfort

Atmospheric comfort is about the air quality of the indoor environment inside the building. The quality of the air decreases as the building is in use because of the pollution coming from people, equipment and materials. This includes both the smell and the CO_2 emission from people. According to DS/EN 15251 [Danish Standard. 2007] category II the recommended CO_2-level above the outdoor concentration is 500 PPM. The outdoor concentration is 350 PPM.

Acoustics

To achieve a good indoor climate acoustically it is important to consider materials, dimensions of space and soundproofing between apartments since people with dementia can be quite loud at times. It is also important to soundproof to the outside. At the same time, it is important to prevent sound transmission in building construction and from installations such as ventilation ducts.

Daylight

Good daylight conditions, is very important for our health, mood and well-being. A good indoor climate requires good lighting conditions, both daylight and direct sunlight. Sunlight is also necessary when it comes to passive heating. However, this must be balanced to avoid overheating. Therefore, it can be necessary to integrate solar shading as part of the design.
Well lid space is not only a matter of high lux levels, but just as much about distributing the light in the room, the quality of the light both direct and diffuse light. The light level together with light qualities must be analyzed and evaluated through the design process.

Feeling secure

It is important for people with dementia to feel secure in their surroundings. One way to create security is to design a space that is simple and easily manageable, with easily understood details. It is also important to take safety into consideration when designing.

Practical problems like getting around can lead to more serious problems like social and physical problems. To depend on others for support can be a way to human contact but in most cases, it is one side and rarely leads to good social interaction. People who can't move safely around without assistance is more likely to isolate themselves to avoided awkward or uncomfortable situations.

Outdoor areas

Access to outdoor arears has a positive impact on the well-being of people with dementia. However, in many cases people with dementia can have trouble with orientation and get lost, therefore, it is important to create outdoor arears that is in a safe space where they can't venture outside the facility. There are many benefits from creating an enclosed garden area, the residents can be allowed to go outside without needing help from the staff, and it eliminates the need for locked doors. By minimizing the number of locked doors, many frustrations from feeling trapped can be minimized [Day 2000].

The doors to the outside should also be easy recognizable, it is difficult for people with dementia to recognize a door if it is the same colour as the wall. When the residents venture outside on their own it should be easy for the staff to observe them from the inside and to be able to see if anyone needs assistance.

The garden layout should consist of clear paths so that the resident can find their way around. This helps with orientation and minimizes the risk of getting lost. As a minimum the people with dementia should have the possibility to find easily recognizable spots like a water fountain for example. Along the paths there should be small spaces where it is possible to stop and rest [Henriksen, Møller & Knudstrup 2007]. The garden and paths should be designed in a way so that it is usable for all the residents, from people that can walk by themselves to people in wheelchairs who needs help getting around.

The garden should have different elements like areas with grass, flowers, fruit trees, different kinds of animals and so on. The different elements in the garden can help the residents remember their own garden and home, which will make them feel safer. The different elements in the garden can also help stimulate their senses and thereby contribute to creating prosperity and welfare [Landmark, Kirkehei, Brurberg & Reinar 2009].

Interior public space

People with dementia have a tendency to wander around, sometimes not even knowing where they are going. Therefore, it is important to create a building layout minimizing the risk of them getting lost or ending in a dead end. One way is to create a short and closed looted hallway with easy recognizable features that makes it easier to orientate oneself [Day 2000].

To create a good living environment for the individual, all the daily activities should be able to be carried out inside the individual living unit. Each living unit should be able to function individually from the other living units and the rest of the care center. This is because people with dementia can't handle to be around too many people at a time. The optimal number of residents in a unit reaches from 3-6 people, which also creates smaller and more managable rooms. This number is based on the experiences of people working at care homes that we visited, and the case studies that we did of other centres for people with dementia.

It can be a good idea to design different social facilities in connection with the care home. Common facilities can help bond the residents, their families and people from the outside coming in for rehabilitation. Different functions could be café/restaurant, common activities, sensory room, workshop for hobbies, fitness, wellness, separated staff room and conservatory/pavillion.

A café/restaurant can be good for both the residents and their families. The families can use the café/restaurant when they come to visit and the residents can come there with other residents, which can help them evoke memories of past social activities [Van Liempd, Hoekstra, Jans, Huibers & Van Oel 2010].

A common activity room is a flexible room that can be used for many functions, like different types of games, dancing and physical activities and other types of gatherings. Exercise and physical activity in a relaxed and more playful setting can have a positive influence on people with dementia and can help to reduce psychological symptoms. Exercise can also help bring back memories and bring people together [Nationalt Videnscenter for Demens, 2016].

A sensory room can be a help for people with severe dementia who can't take part in other activities. The room can be decorated with different types of stimulants, like music, touching and smelling. It can be objects that helps a person remember their childhood, or familiar shapes or colours. Relatives will be able to be with their family in a whole new way and interact with them in a more relaxed setting [Holthe, 2011].

A workshop for different hobbies can help the residents pursue hobbies they enjoyed in their earlier days like working with wood, sowing, cooking or painting. It can help to create a feeling of homeliness and give a sense of purpose in everyday life.

A wellness room with a bathtub and a relaxing indoor environment with lots of daylight can help create the frame for a good bathing experience for people with dementia. Often bathing can be a negative experience for a person with dementia, and a wellness center can help change that [Landmark, Kirkehei, Brurberg & Reinar 2009]. People with dementia also needs human contact and a wellness centre gives the opportunity for another form of human contact the other activities in their daily life. People with dementia is often restless and wellness can have a calming effect on that aspect.

A conservatory or a pavilion is a good place for people with dementia during the wither months where it is harder to get out side. A conservatory or pavilion gives the feeling of being outside with lots of daylight and plants, and gives the residents the chance to follow the changing seasons. People with dementia needs a lot of daylight because it gives energy and helps them to get a natural day rhythm [Marshall, 2010].

Interior private spaces

The private living quarters have to give the opportunity to make it feel as homely as possible, and let the user decorate it as they feel like. For many this is the last home they will have, and therefore it has to feel like home for them.

According to the building regulations, a residence must consist of a living room, kitchen and bathroom/toilet. Furthermore, all rooms in the home must comply the requirements and recommendations regarding space for staff and use of aids from the labour inspection [de Place Hansen, 2014].

Orientation in the individual home is very important because people with dementia have a hard time orientating themselves. It is a good idea that the resident can see the bathroom door from their bed, that way they will have an easier time getting from the bed to the bathroom [Landmark 2009]. It would also be desirable if the resident was able to see the common area from their apartments. That way they will be reminded to use the common area, and socialize whenever they want to. It also has to be easy to get from the common area and back to their own apartments. Therefore, the door to each apartment needs to have different looks or have something placed next to the door so they are easy recognizable [Day 2000].

In the living room and bathroom, it is important to make room for manoeuvring with a wheelchair and other service functions. Some residents need help in the bathroom, therefore there has to be room for aids, and workplace on both sides of the toilet and sink.

The living room/dining area should be designed in a way that the residents can choose to sit in smaller groups or at the same table all together. This allows the residents to be themselves and still be part of the community. This can also be in form of small niches in the wall. It is important already in the early stages to take into account that several smaller living and dining groups as they take op, more space. As a general rule there should be minimum 15 m^2 pr. resident for living and dining area [Van Liempd, Hoekstra, Jans, Huibers & Van Oel 2010].

Like in the apartments, it is important that there is enough space for people in wheelchairs to get around in the common area. There should be a close connection between the common area and the kitchen. Many elderly have a reduced appetite and a close proximity to the kitchen meaning that the elderly can smell the food as it is being prepared. This will help build up the appetite. An extra value could be to design the kitchen in a way giving them the opportunity to come and help prepare the food.

Light

Natural daylight and a high daylight level is an important part for people with dementia and helps with their wellbeing. To be able to see the sun also helps with a sense of time and the changing of the seasons. Therefore, it is important to orientate the windows in the common rooms towards south, east or west. Rooms that are orientated to the north does not have the same opportunity to follow the sun which stimulates the people with dementia less than when they can [Møller & Knudstrup, 2008]. Although the direct light is very important there should also be the opportunity to shield for the sun, especially in the summer months where the sun will increase the temperature and create a sharp contrast between the light and dark areas in the room. This can cause discomfort for people with dementia, as they cannot distinguish between a dark shadow and an object [de Place Hansen, 2014].

With artificial lighting, it is also important to remember to create even light levels in a room to avoid the contrast between light and dark arears. People with dementia can have problems orientating themselves in time and space, therefore it is important to place artificial lighting in the right areas to give optimal light levels. As people get older it can be harder to register the light therefore they can need op to three times as much light as a younger person [Day 2000].

Room Program

The room program is created based on the existing competition program from Aarhus municipality in 2015 and consist of constructing 125 new housing units with connected service area that are suitable for people with dementia and citizens with mental disorders.

The 125 new housing units are divided into 109 social care homes and 16 municipal short-term homes. The apartments are divided into the following types:

75 single-room, special housing, of which 10 will be used for halfway houses.
34 flexible two-room apartments.
16 single-room short-term apartments.

The homes have an estimated area of around 9000 m^2 with each apartment having the same gross area. And a service area of around 1000 m^2

Housing units
To improve the living conditions for the residents the apartments will be divided into housing units with 3-6 apartments in each, surrounding a central common area. This creates the base for better interaction and friendship among residents with dementia. And it minimizes the risk for frustration and conflicts between the residents [Marquardt & Büter, 2014].
Depending on the source the number of apartment's pr. living unit warries from 6-12 apartments (Høeg, 2008) to 5-15 apartments (Marquardt & Büter, 2014). Our aim is to keep the number of apartments around 4-6 pr. unit. This number is based on the experiences of people working at care homes that we visited, and the case studies that we did of other centers for people with dementia.

It is important to remember when designing living spaces that every individual is different and not everyone can handle living in a unit with the common room area as the center. Therefore it will be a good idea to design a variety of units that can function without the central area. On the other hand, there can be people with the need for more socializing and it could be an idea to look at ways of combining living units if the need arises.

In a survey carried out by servicestyrelsen survey it states that the residents likes to have the staff in their common area but they can't be too dominating in the room and use it as their own personal rest room. Therefore, it is recommended that they have their own staff room in each housing unit [Møller & Knudstrup 2008]

Single-room special housing
The majority of the apartments is single-room most residents of nursing homes does not have a need for more than one room and would rather prioritize the space for the common areas. Many people with dementia also have trouble orientating themselves in more than one room so for them the single room solution is the best.

Flexible two-room apartments
The Flexible two-room apartments is meant to be an alternative to the single room with a flexible floor plan so that the room can be turned in to a single room if the user no longer can handle a two room. The wall separating the livingroom and the bedroom is meant to be a flexible walls or dividers on wheels that makes it easy to remove. A married couple can also use the two room apartments, where one of them suffer from dementia.

Single-room short-term apartment
The purpose of short-term accommodation is to ensure that the citizens can get the care, help and training they need in case of a sudden emergency where an increased need for help that cannot be met at the home of an individual. Persons with an increased need for care can be provided with short-term accommodation for a period. After the stay, the person will either go back home or they will be offered a senior housing or sheltered housing, if they still cannot manage to live by themselves.

Function	Space	Area m^2	Number of Units
Special Housing Unit (with one-room)		5400	75
	Living/Bedroom	40	
	Bathroom	8	
	Hallway	-	
	Storage	5	*units
	Common room / Kitchen area	17	*units
	Staff room	2	*units
Flexible two-room apartment		2448	34
	Living room	25	
	Bedroom	15	
	Bathroom	8	
	Hallway	-	
	Storage	5	*units
	Common room / Kitchen area	17	*units
	Staff room	2	*units
Single-room short term apartment		1152	16
	Living/Bedroom	40	
	Bathroom	8	
	Hallway	-	
	Storage	5	*units
	Common room / Kitchen area	17	*units
	Staff room	2	*units

Function	Space	Area m^2	Number of Unit
Service area		1298	
	Training facility	150	1
	Special day center	200	1
	Relative's facilities / Guest room	212	/units
	Laundry room	100	/units
	Store	88	1
	Sensory room / Snoezelrum	200	1
	Hairdresser	50	1
	Wellness room	150	1
	Workshop	88	1
	Cleaning room	60	/unit
Staff area		242	
	Meeting room	30	3
	Administration	150	10
	Dining room	20	1
	Storage	6	1
	Wardrobe/shower	30	2
	Toilet	6	2
Extra functions			
	Caretaker room	-	
	Tool shed	-	
Total area m^2		10540	

Ill. 91. Room program

SUMMARY

Throughout the analysis a platform for the project has been created. To get a clearer understanding of the contents the analysis includes it is divided into three overall sections; framework, technical research and site analysis.

FRAMEWORK

Describing northern architecture can be a difficult task to do because it has been dominated by multiple contrasting tendencies over the last couple of decades. Through the exhibition at Louisiana northern architecture has been discussed and showcased in relation to place and identity. During time the site and how the building related and fitted into its surroundings has had great importance, whereas the importance of our health has taken over as of today. The welfare system in the northern countries is seen as a big quality from all over the world. The wish is to make people happier and increase everyone's quality of life.

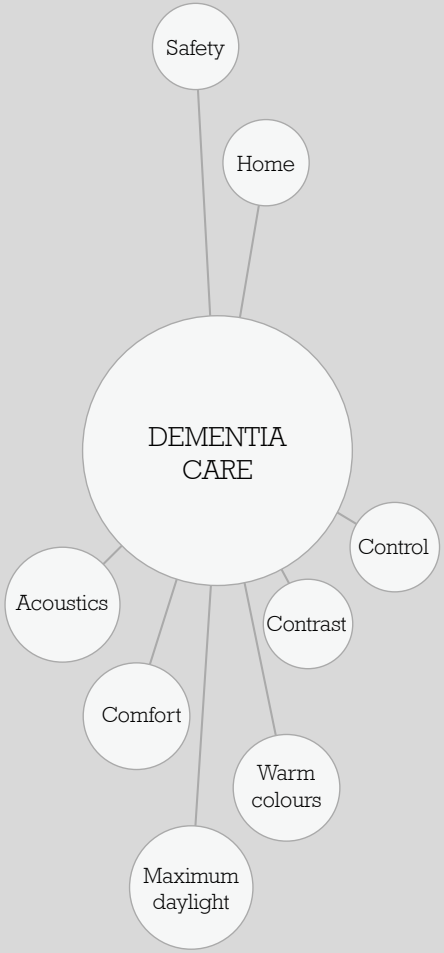
Quality of life is something everyone should part, also the people who might have certain health issues. In our case we are designing a center for people with dementia. Dementia is a disorder causing issues and problems for an increasing number of people every day. The disorder doesn't only affect the respective person but also everyone around; family, friends, caretakers and so on. The disorder causes mental affliction resulting in loss of competencies we all need on daily basis. This is why it's important to consider and really think about how we design a building for kind of user group. To create an environment good for healing and comfort, many different kinds of research have been made. These studies show how it's important with a lot of daylight, control your own life in case of social interaction and adjusting warmth, light and noise. Furthermore, it's important to design the building so that it's easy to move around without getting lost and create places with views both from the inside and the outside.

TECHNICAL RESEARCH

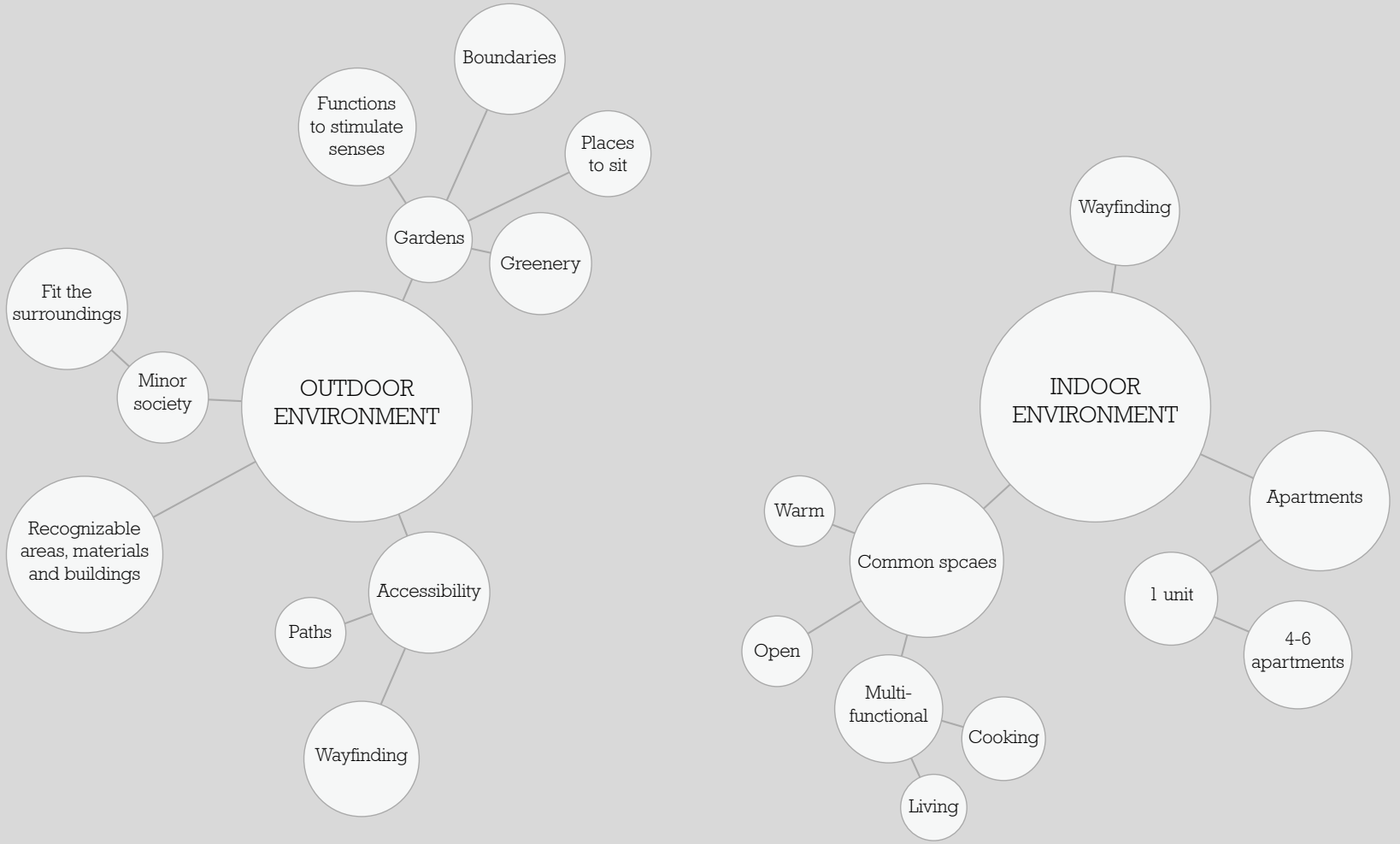
Sustainability has become such an important aspect in architecture and design, which is why it has to be thought of from the very beginning on a design process. There's no single explanation of the term but in 1987 with the Brundtland Report a general understanding was made by three categories; environmental, economic and social sustainability. These must be thought of in each and every design solution to secure health, optimal and future use. To make sure the three categories are met it's necessary to consider how it's possible to integrate sustainable initiatives, whether it's passive or active strategies. These can furthermore be the solution for the demands for the indoor climate concerning energy, daylight, acoustics, thermal and atmospheric comfort. All these aspects should in the design solution add up and complement each other.

SITE ANALISYS

The site is situated in the northern part of Aarhus, in an area defined by housing resulting in a more or less calm atmosphere. The surroundings combine a great mix of greenery, activity, openness and difference in materiality, creating an experimental frame for a project in which the architecture and known form should be explored. The site is quite close to the center of Aarhus and easy to access by car, bus and bike. Even though the site is placed in a residential area there is still a certain amount of noise mainly coming from traffic. In relation to the site noise only affects from the southern part of the site. The weather is another aspect to consider when designing a sustainable building. In the case research and observations concerning solar exposure, temperatures, precipitation and wind have been made.



Ill. 98. Brainstorm on dementia care



Ill. 99. Brainstorm on outdoor and indoor environments

CASE STUDIES

The case studies done in the following section will highlight some projects and their qualities. This is done for inspiration and examples on how others succesfully have designed spaces that works.

De Hogeweyk

De Hogeweyk, Netherland

This project is situated in Weesp, which is a smaller suburban municipality southwest of Amsterdam. The building has the size of an urban block cladded with different surface materials to create the sense of different and more personal homes.

This particular project is the first of its kind focusing on creating as many everyday activities as possible. The people living in the building, the people living with dementia, cannot leave the site. Therefore, it has been vital for the building owner to create an atmosphere as similar to the real world as possible. A supermarket, a doctor's surgery, hairdresser, restaurant, a theatre, small shops and so on has been implemented to give the residents the feeling of a more or less normal life.

The project has been praised by the Dutch Alzheimers Foundation and the initiators concludes that the project is successful because of its clarity in design promoting orientation and use of "real" materials to minimize the artificiality of the surroundings. [Utne]

Ill. 92. Outdoor area at the De Hogeweyk-complex [Detail]

Ill. 93. Facades of De Hogeweyk facing the surroundings [Detail]

Future nursing home

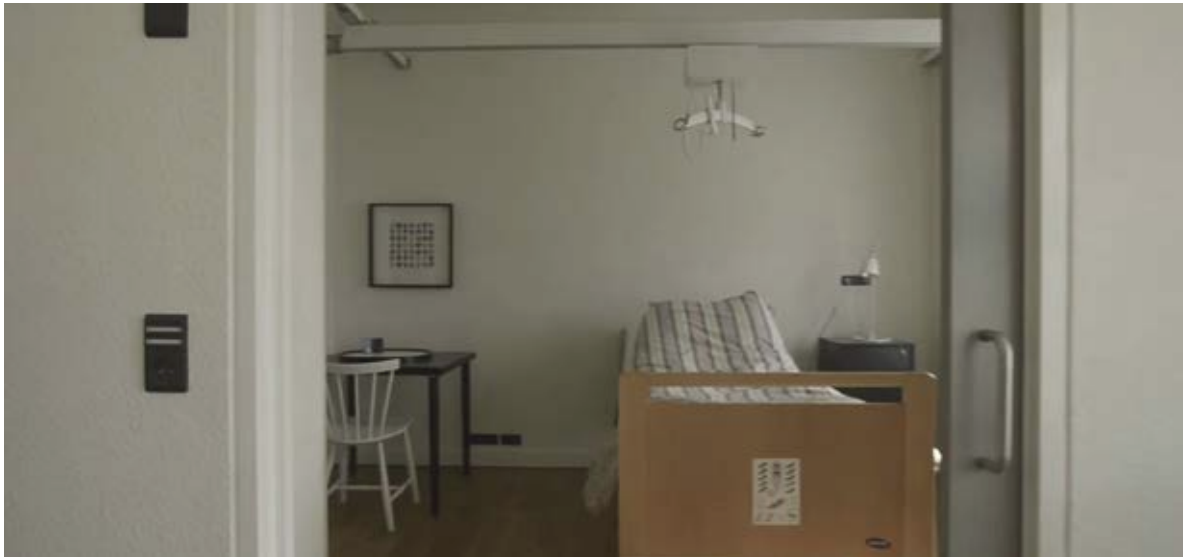
Nørresundby, Denmark

The future nursing home in Nørresundby was a specific, ambitious project from the start. The municipality of Aalborg wanted to create the optimal frame for the elderly part of society. This includes integrating the newest knowledge in technology, safety, freedom and living conditions in general. The project is trying to set a higher standard for future nursing homes, as we want maintain or even improve life quality for everyone. [Fremtidens plejehjem]

The apartments are designed with a kitchenette, living area, bedroom, bathroom/toilet and a small storage room. The bedroom and living area are placed towards the outside to create views and provide a higher amount of daylight. The bottom of the windows is placed at a height allowing the residents to be able to enjoy the view while sitting down. This is especially important if the resident have to use a wheelchair to get around.

The apartments in this project have great spatial character considering ceiling height and daylight. They seem comfortable being in. A way to safe space and hereby create a room more useful and configurable is by using sliding door, which takes no extra space.

Furthermore, the newest technology has been integrated here. A sensor system has been built into the floor. If the resident allows the caretakers to keep an eye of him or her, this can be turned on. The technology will then activate an alarm if the resident falls or goes to toilet in the middle of the night securing immediate assistance from the staff. Besides this each apartment has a lift system, in the bedroom and bathroom, integrated minimizing heavy lifts for the staff. [Fremtidens plejehjem]



Ill. 94. The bedroom seen from living room [Fremtiden plejehjem lejligheder]

Ill. 95. When entering [Fremtidens Plejehjem lejligheder]

Dementia nursing home

Aalborg East, Denmark

This project is a recently won competition about a complex for people with dementia. The project is situated in Aalborg, wherein the complex fits the context and creates a safe and secure environment for the residents. The thought behind the project is to create a home for people with dementia where they feel home and safe. They aim is to give the residents an extended life quality despite of the disorder. The project has been developed with inspiration drawn from the project in De Hogeweyk, which was described earlier. The intention is to create a frame for the residents which mimics the life they knew before they were diagnosed with the disorder. Dementia became part of these people's life's unwillingly and it can be hard for some to accept that fact. Because of that the atmosphere should seem no different from the ''real world''. Their families and friends should be able to come and visit whenever they feel like it and such.

The project is built up by organized units consisting of 6 apartments and an additional common area with a kitchen and living room. The way the units are placed on site results in spaces optimal for gardens each consisting of a special character. All the unit are oriented towards each other, which creates a center inside this complex. In this center the architects have placed some of the center functions to create life and daily activity. By placing these activities as a more or less separate building in the middle of complex the residents need to go outside if they want to go play music in the music room for example. The residents will automatically do so many daily actions just having to go play music; put on their shoes, put on their jacket, maybe pack a bag, walk outside and inside. This mimics the ''real life'' instead of just walking down the hall. [Jesper Korf]

Ill. 96. Birds eye view of the complex [Jesper Korf]

Ill. 97. Outdoor area showing life and activity [Jesper Korf]

VISION

By building a new Center for people with dementia, it's the vision to create a frame aiming to make everyday life easier and more meaningful for the people affected by the disorder.

Aarhus wants people to experience how dementia is an important thing to care about. The Center should be a naturally integrated part of it's surroundings, which means it's supposed to relate to the shapes and materiality in the surroungdings as well as having certain activities from the life they have been living up until the disorder sat in integrated as part of the Center.

The main vision is to create a frame fulfilling the patients lives despite of dementia.

DESIGN PROCESS

DESIGN PROCESS

Throughout the following chapter the process behind the final concept and design will be presented. To get a better and more manageable understanding of the different aspects dealt with it will be presented in chronological phases as it would seem confusing otherwise. Furthermore it has been divided in to section; architectural and technical approach.

The process have been iterative, which means we have had to change things throughout the sketching phase as we gained new knowledge.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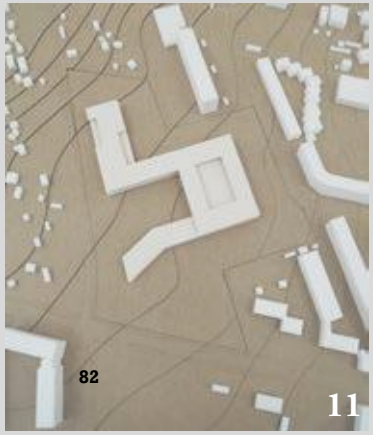
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The initial phase

During the initial phase of the process the site was explored and tested by building and placing physical models in our context model. By doing this a better understanding of the site was gained as square meters and building height constantly was considered and additionally related to the surrounding buildings.

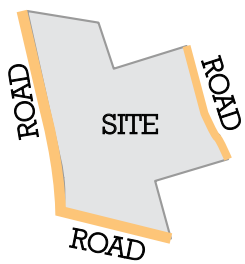
As seen in model 1-4 on the next page, these proposals are all very organic. These ideas were made with the thought of creating some interesting and new environments for the people who is going to live there. People with dementia needs to be challenged a little every day to keep their minds active, and by designing and organic building they would have to think and be aware of where they are going. The spaces would seem new for them and they would have to find new ways. This would be the case for both indoor and outdoor areas. The ideas stayed in the sketching phase as they got re-evaluated. Designing a home for people with dementia, people who gets confused easily. It shall not be too complex or difficult to find your way around the building complex and the entrances to the different units. If the design is too complex, it will cause fear, stress and confusing for people with dementia. Therefore it is not the right way to stimulate them with complex/organic building design.

The next line of ideas, seen in model 5-11, is made as singular volumes in a stricter geometry. The thought behind these was to design a building easy to manage and get around in for the residents and the staff. In these proposals there would be no need to go outside as all functions would be to find somewhere in the one building. Model 5-7 defines outdoor areas open to the surroundings which make the complex seem more friendly and less controlled. An aspect concerning this openness is the safety of the residents, who might want to go out exploring the city and thereby get lost. The following proposals, 8-11, creates closed gardens for the residents to wander around in. These are still created a singular volumes optimizing the workday for the staff. Zooming out a little bit we realized and remember that we're designing this complex for the people living with dementia and not the staff.

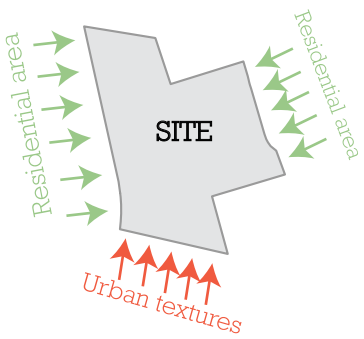
Zooming out, taking a closer look at the surroundings and considering the residents well-being and everyday life generated a thought of splitting the singular volume into minor buildings to create a minor society on the site. As seen in proposal 13-15 this creates spaces and paths between the buildings and makes the complex mimics the normal life as the residents have been living up until they got diagnosed with dementia. Before the diagnosis they would have to walk outside to go the supermarket or the hairdresser. The quality in getting outside is seen as an essential aspect as it stimulates so many senses for the dementia. With the concept of splitting the buildings we went on to look into how the apartments layout should be designed to work and seem homely for the residents.

Zoning diagram

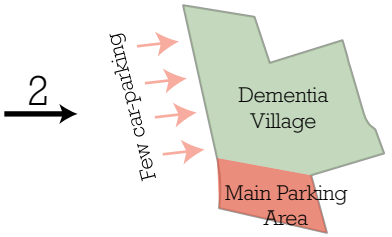
When everything is unclear at the beginning of the sketching phase and people don't know where to begin, it is a good starting point to gather knowledge gained during the analysis phase and be aware of the quality/potential on the context. To put the first milestone for the sketching phase a zoning diagram is made to determine the most important criteria. The zoning diagram is illustrated systematically in this section.



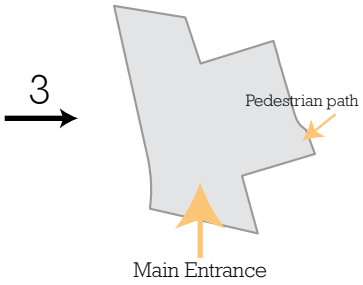
Ill. 100. The site three boundaries towards a road.



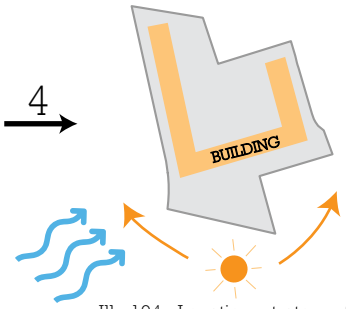
Ill. 101. The site is placed between residential area and city area, where in this case there is a slightly contrast between them in term of noise, textures and living style.



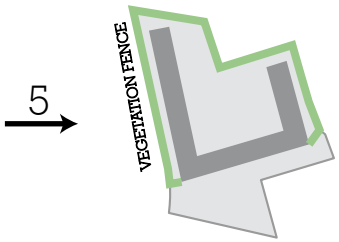
Ill. 102. The project will referrer better to residential quite area, therefore the dementia village will be placed a bit away from the boundary towards city area. Towards the city area there will be the main parking lots to have a break area between city and the dementia village.



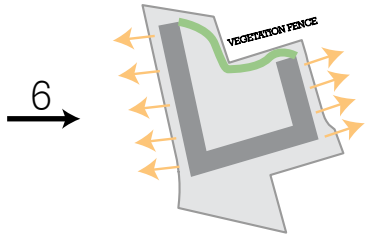
Ill. 103. The main entrance is facing against the parking area/the city, where there will be a walking path for pedestrian, who is coming by public transportation.



Ill. 104. Location strategy for the building envelope to ensure good outdoor spaces inside the dementia village in term of wind. The building is rotated according to the sun.



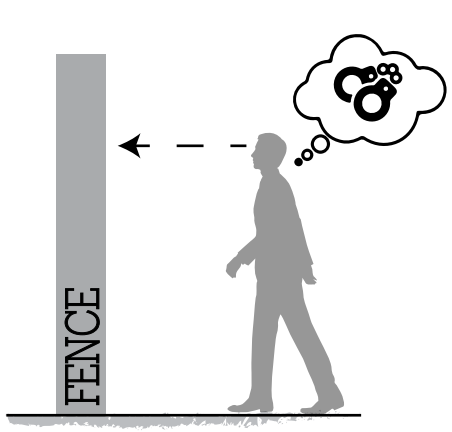
Ill. 105 It is an issue that people with dementia, when they "escape" from nursing home and then get lost. That situation is a dangerous situation, therefore in this step there will be a vegetation fence around the site. The thought was that it is more comfortable for people to look out to greenery than look out to the outside world and then feel trap.



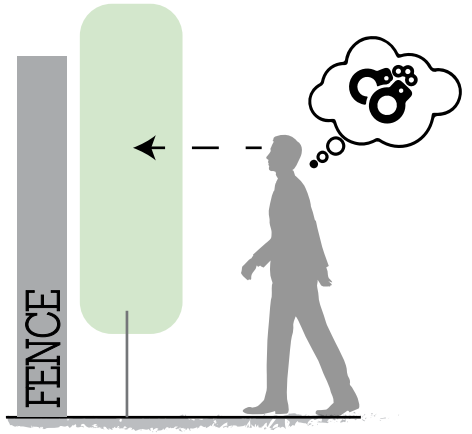
Ill. 106. On the other hands there will no activity on the west and east side between the fence and the apartment, therefore the users will feel more trapped than with no fence. Base on this the vegetation fence get removed and the apartments are moved out almost to the edge. Fence design is on the next page.

Fencing

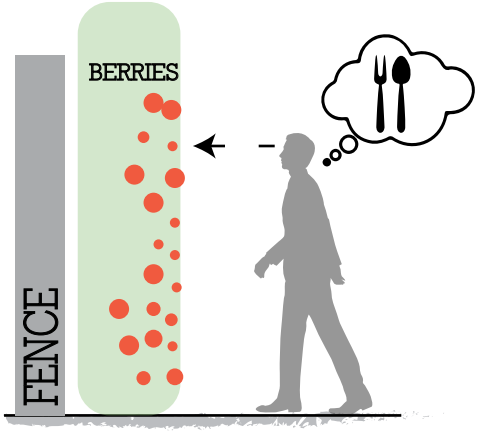
One of the biggest challenges when designing for people with dementia is, how to avoid them getting lost, because they don't have ability to find back. Seeing from another aspect, it is not acceptable to keep people locked Therefore finding a solution, where it is a safe living environment for dementia and at the same time don't make them feel trapped. In the north part of the site there are no buildings to block the way out, therefore a kind of a fence need to be presented. The result is that to make an organic shaped fence, which take an active part of the users' everyday life. There will be berries, flower and different kind of vegetables on the fence, to stimulate the human five senses. With the meandering shape of the fence, the monotone, 90 degree and straight view of the fence will be avoided. With the solution the fence will not seeing as a passive object with an only purpose to block and hold the users inside, but as a vertical vegetable wall example or a beautiful shrubs with wild berries. The shape of the fence can be seeing in site plan.



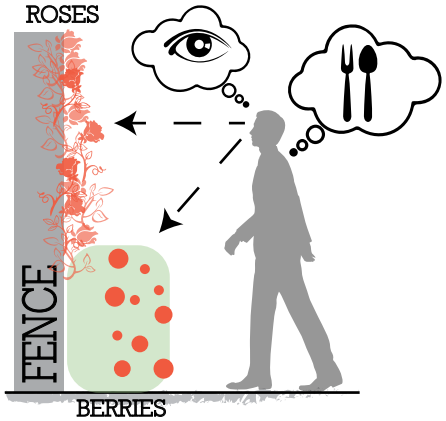
Ill. 106. A ordinary fence with no stimulation only a purpose on blocking and keep the users inside.



Ill. 107. Vegetation fence is a little bit better than a normal fence, but it is still just a wall with greenery cover.



Ill. 108. A low degree of sense stimulation kind of fence.



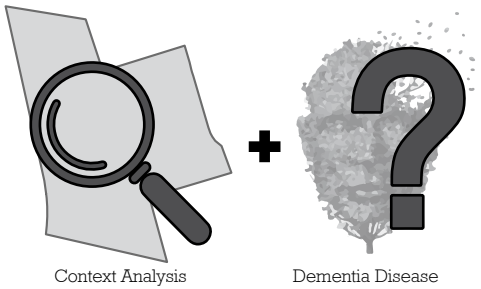
Ill. 109. The users can enjoy the flower, pluck berries and taste them.

Ill. 110. The fence is no more 90 degree, it contains of vegetable- and flower jars, where the users can water or take a little but care of them. It is no more an ordinary fence, but an active part of everyday life.

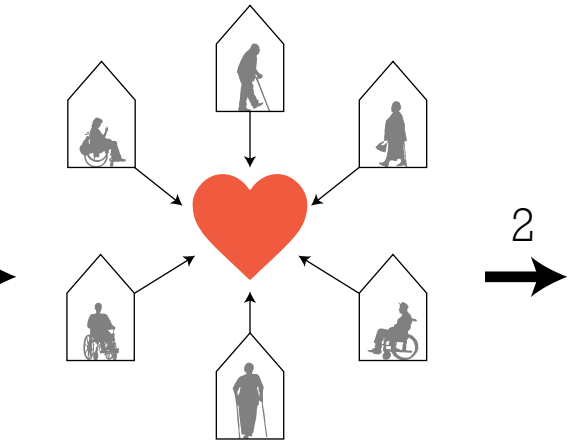
Building complex development

The last step is mainly viewed from helicopter view to have a big picture on building shape, connection with context and negative spaces between the building complex. To have a better understanding about indoor and outdoor spaces, it is necessary to move further and zoom in on how functions need to be connected.

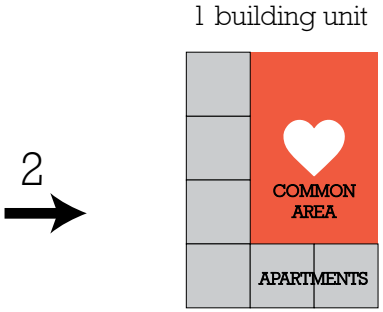
Designing a home/living environment for people with dementia contains a lot more effort than designing buildings for normal elderly ex. in a nursing home, because their lack of abilities to take care of themselves and behave as a normal human. There are a lot of requirement/guide on how to design spaces and homes for people with dementia, which have a big influence on the building layout and how functions are connected to each other. It is a goal to create a living environment, where they can live their life as normal as possible. In following pages, show roughly the development for process of building complex.



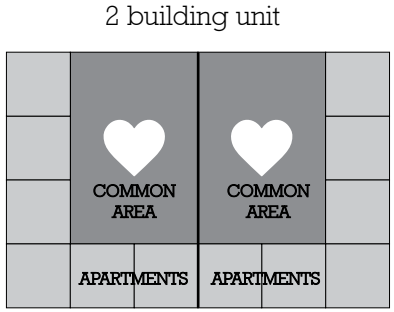
Ill. 111. STEP 0:.Analyses and observations provides a basic for design criteria. Moreover, they help gaining necessary knowledge to make right decision throughout the design process.



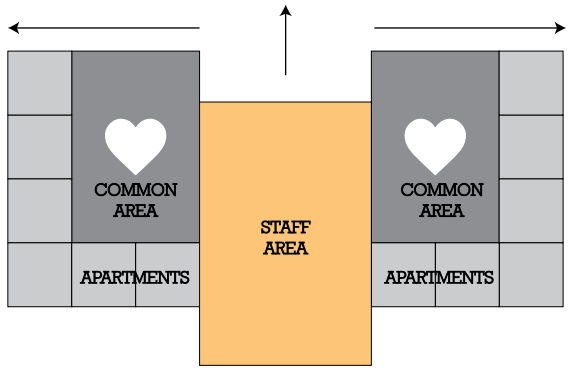
Ill. 112. STEP 1. One of the most important requirements is that the apartments need to be divided into 4-6 apartments pr. unit with common space. Beside that all the apartments need to have easy accessibility to common space.



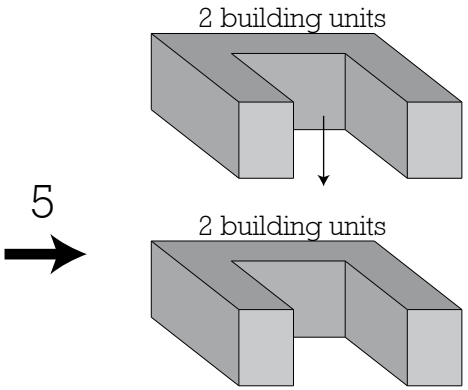
Ill. 113. STEP ". The apartments are arranged in a way that it is possible to know where the common area is.



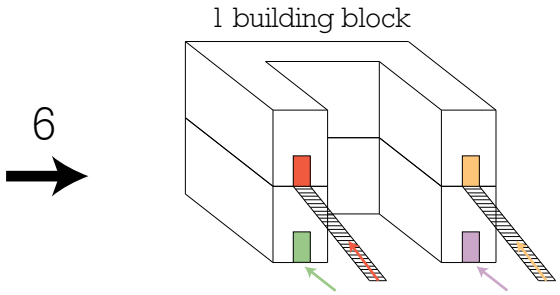
Ill. 114. STEP 3. Merging 2 building units together. With this placement, it is possible to create a semi private outdoor space.



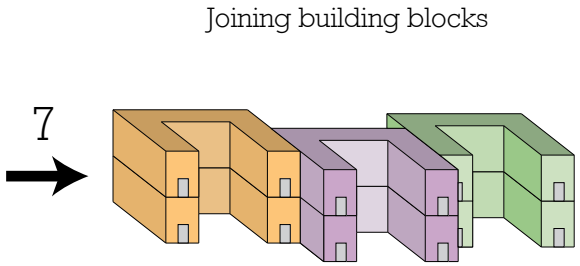
Ill. 115. STEP 4. The two units are splitting up and connected through a staff areal, which will serve for both units. Functions inside the staff area are: staff office/bathroom, emergency fire exit, laundry room, storage and technical room.



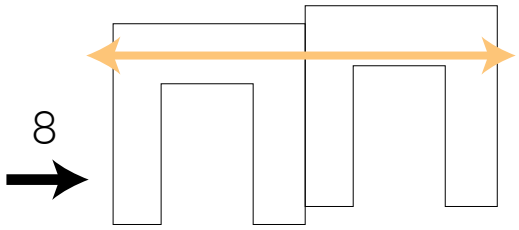
Ill. 116. STEP 5. Placing the units on each other. It was time to think about connection in 3D.



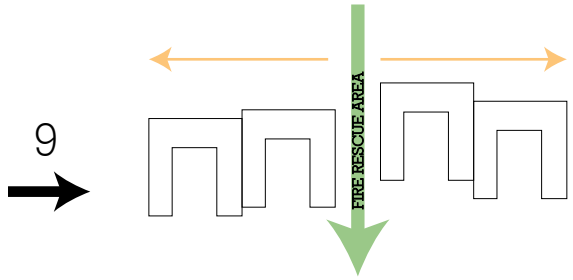
Ill. 117. STEP 6. Each unit has their own entrance to break the hospital feeling as much as possible, where every functions are placed in one building or buildings with indoor connection. In real life, if you want to visit fitness or café, you need to go outside you home. Moreover it will helps the residents with dementia remember better.



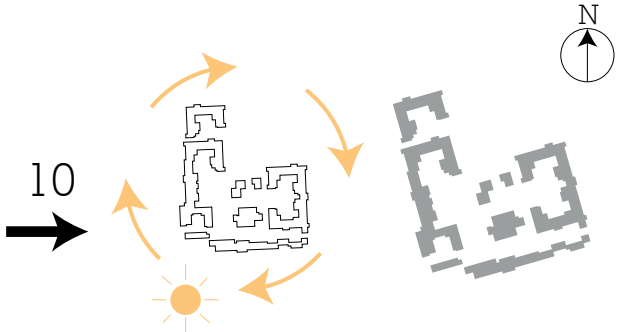
Ill. 118. STEP 7. Joining building blocks with each other, where each have their own semi private outdoor spaces.



Ill. 119. STEP 8. For practical reason it is necessary to create a corridor, which is continuous through building blocks.



Ill. 120. STEP 9. Splitting in building complex containing of building blocks, to create opening into the dementia village. The main reason is because of fire emergency situation.



Ill. 121. STEP 10. Rotation of the building complex according to the sun and the site boundaries. It is important that there are no apartment, which is facing north.

Apartment plans

The complex is comprised of three types of apartments:
The single room apartments
The two room apartments
And the short term apartments

When designing for people with dementia it is important to remember that there is different variations of dementia and that some people can handle more than others and that should also be reflected in the design of the plans.

From the analysis we learned that people with dementias have certain needs when it comes to the layout of the apartments. There should be around six apartment's pr living unit and the apartments cannot be too complicated to navigate, furthermore there should be easy access form the apartment to the common area. Naturally the apartments also have to be designed to accommodate the dens of elderly people and the staff working there.

Entrance and Kitchen

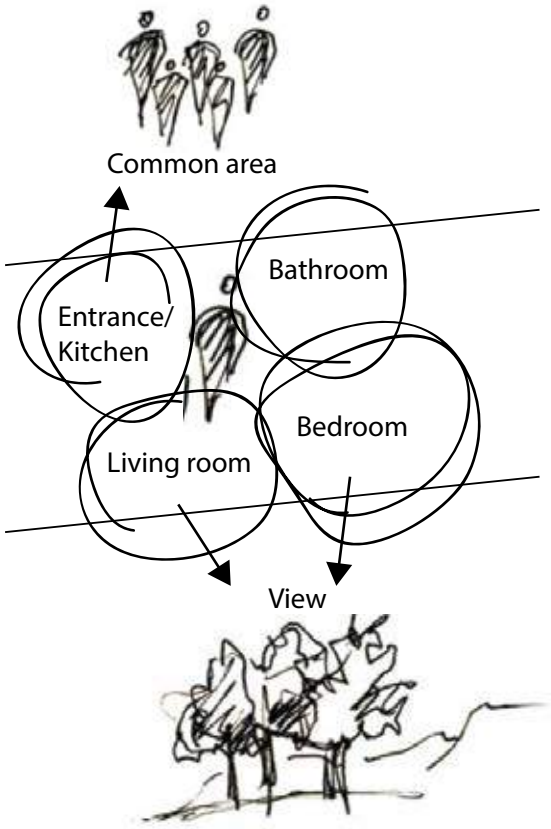
The entrances to each apartment have to be emphasized in a way that makes it easy for each individual resident to recognize where he or she lives, here the example seen in the future nursing home in Nøresundby coud be an example of a good way to do this. In many case the residents cannot handle a traditional kitchen, and therefore it could be an idea that the kitchen can be visually concealed, and that it uses as few squaremetres as possible.

Bedroom and bathroom

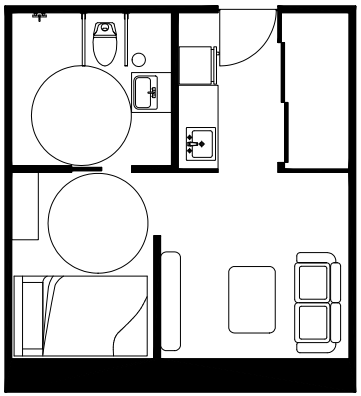
The bedroom and bathroom is design so that it is possible to turn with wheelchair and to diagonal transfer from wheelchair to toilet or to the bead. The bedroom is dimensioned so that it allows turning with wheelchair between bed and bathroom as well as access for nursing staff to help from the opposite side of the bed .

Flexibility

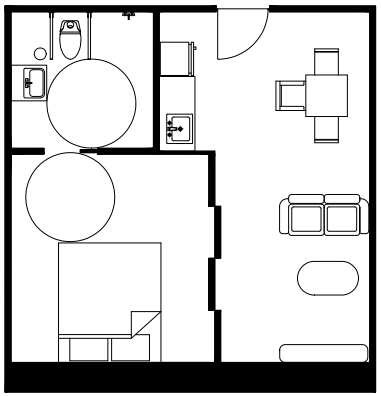
Flexibility is an important aspect of apartments for people with dementia because that have different needs and being able to change the apartment to accommodate those needs is a plus.



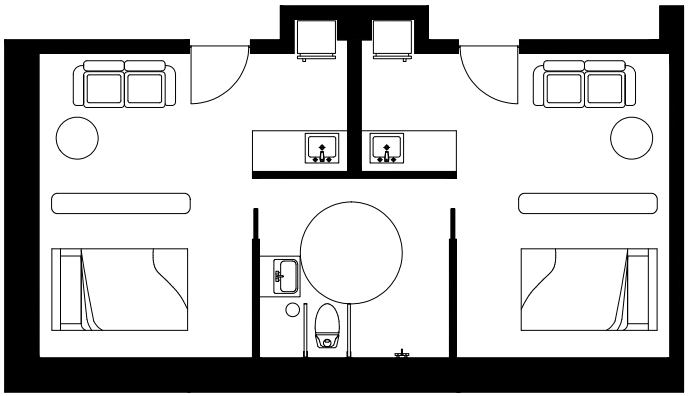
Ill. 122. Concept



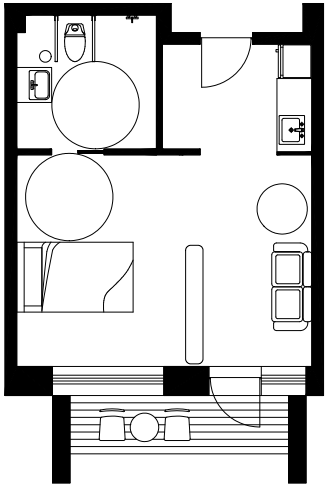
Ill. 123. First single/shortterm room proposal



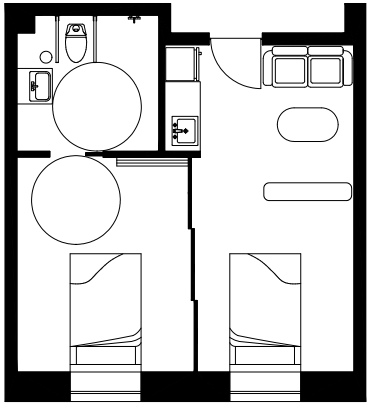
Ill. 124. First two room proposal



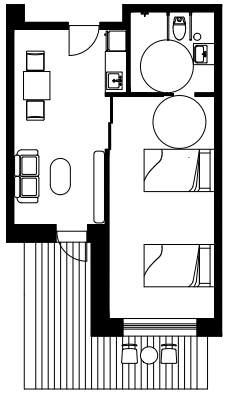
Ill. 125. Final shortterm



Ill. 126. Final single room apartment



Ill. 127. Second proposal two



Ill. 128. Final two room proposal

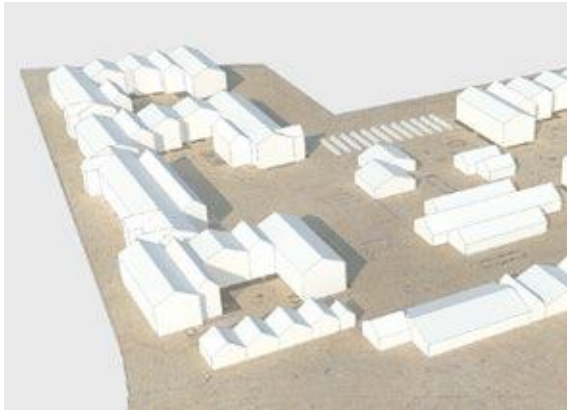
Roofing

Having the overall plan for the complex designed, the shape of the roof was to be developed to create the expression wanted. With inspiration from the context, in which the shape of a gable is seen everywhere, and the case study, Dementia Nursing Home, described earlier in the report, we chose to explore the quality in this form to see what kind of expression it would give.

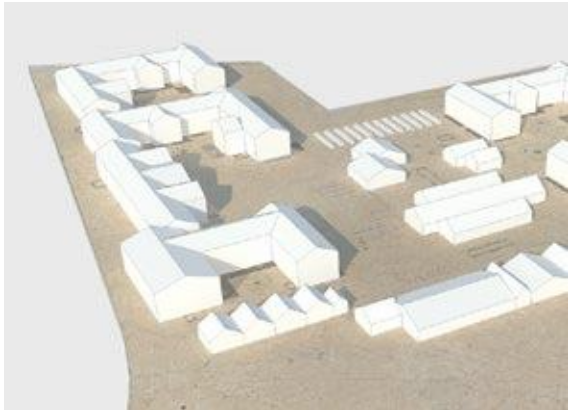
In the first model all the roofs are oriented in the north-south direction to follow the surrounding blocks. This proposal works well when entering the complex from the south, because the gable structure manages to scale the volume down, creating the expression of a minor society. Coming from the west the volumes seem more closed because of the bare façade. The same things apply for the second and third model. The model is different in the way that the rooftops are defined by the longer direction of the building. The inside of the garden looks more dynamic than the first proposal because the gables are facing the center here. In the fourth proposal the idea was to differentiate the apartments and the common areas. Giving the apartments the character of a house it is thought to express a homelier look. The complex did not manage to work and give the wanted character in this proposal, because too much was happening to the volumes. People with dementia needs clearance and this proposal looks more messy than good. The expression from the east and west corresponds very well in relation to the buildings towards the south and creates the same scaled-down-expression as them.

The fifth proposal explores the rooftops by orienting them in the east-west direction. In this case the expression wanted is reached. The gable structure and the down-scaled volumes is seen from all sides fitting, giving and adding character to the context. The inside of the complex also manages to create the expression of a minor society with a varying and dynamic sense of place.

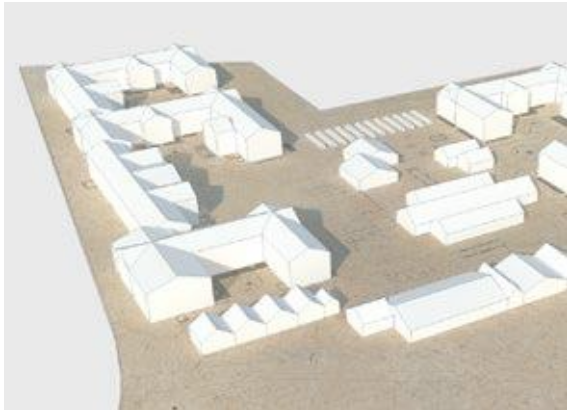
The last model creates pointing roofs, trying to create something twisted and new in the area. The roof can be seen as a reinterpretation of the gable structure, even though the strength in the form is weakened. The view from the garden also lost part of its character in this proposal.



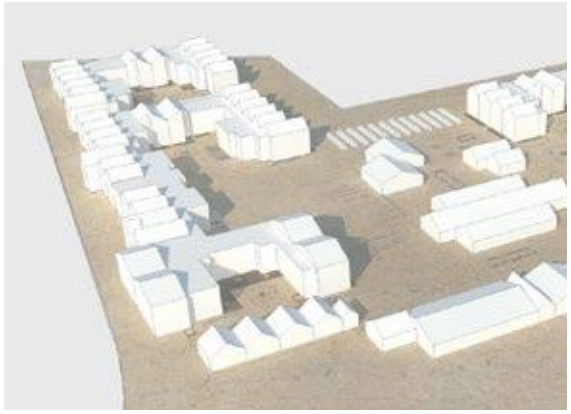
Ill. 129. The rooftops are oriented norht-south.



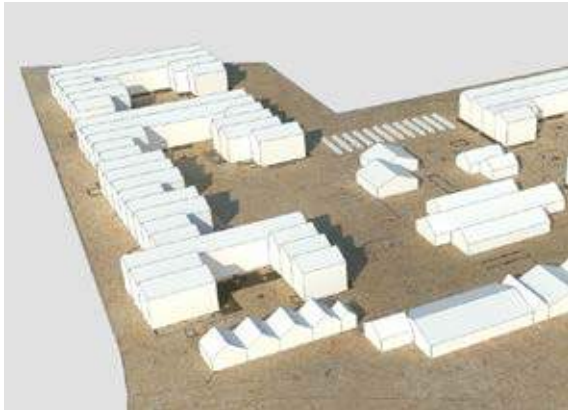
Ill. 130. The rooftops are defined by the longer direction.



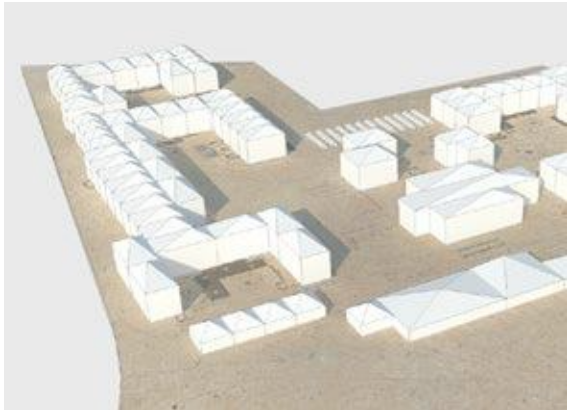
Ill. 131. The rooftops continue through each other.



Ill. 132. Each apartment has a roof top, whereas common areas are flat.



Ill. 133. The rooftops are oriented east-west.



Ill. 134. The roofs are twisted and reinterpreted.

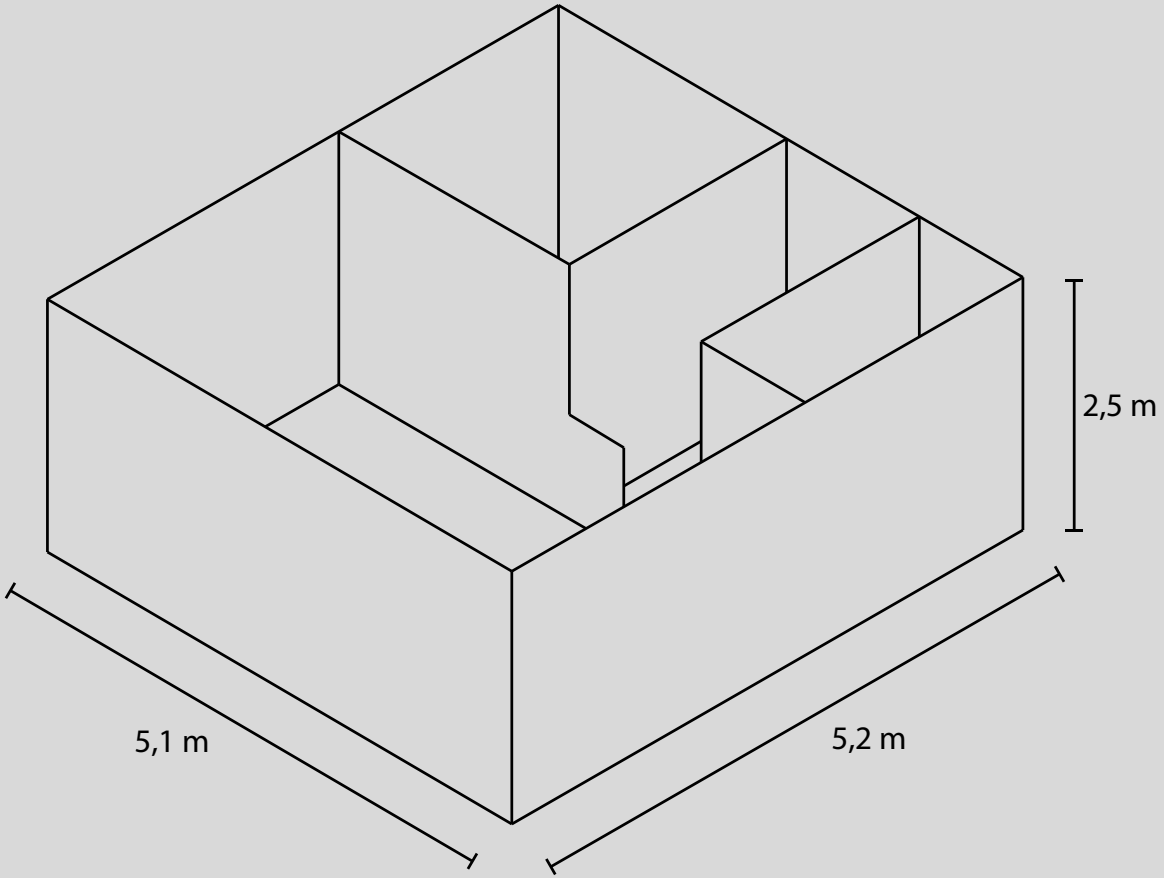
Technical studies

To achieve an integrated design it is important to consider the technical aspects of the project parallel with the design of the rooms, and use the findings to strengthen the building design.

The idea behind this analysis's is to work towards a passive design. The technical aspects of a passive design includes attempting to control the indoor environment without consuming energy. This could be done by maximizing use of solar energy for heating and light, using material to control the heat, using natural ventilation for cooling and the use of shades. Either natural or architectural to control the heat gains. The shape and orientation of the building can also be used to control the heat gain and heat loss as well as the airflow.

The following analysis shows the initial studies, carried out on a single room apartment, and examines the daylight, atmospheric, thermal and acoustic comfort inside the room. An early simulation of the energy performance and indoor environment will also be carried out.

For this study the dimensions of the room is defined as.
Width: 5.1 m
Depth: 5.2 m
High: 2.5 m



Ill. 135. Single room apartment

Daylight

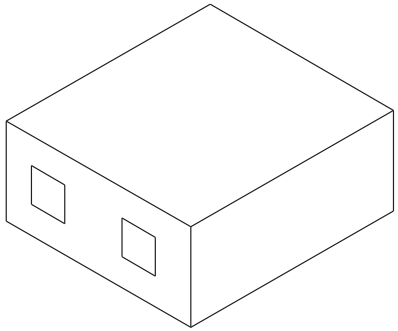
An access to good daylight and a view to the outside provide benefits from environmental cues. Views to the outdoors signaling time of day, orientation, outdoor weather conditions, and other activities, that can increase interest and stimulation as well as aid in maintaining spatial orientation and path finding. Interior daylight exposure can also have an effect on managing sleep, behavior, health and mood disturbances. There are currently no minimum requirements for daylight access in dementia-care facilities but according to Danish building regulation, the daylight will be sufficient when the glass area of a horizontal window is at least 10 percent of the floor area [6.5.2 Dagslys]. A high daylight factor means a big window area introduces a range of additional design issues that has to be considered in the design. Direction, avoidance of glare, and control of solar overheating.

Different window arears are tested in Velux daylight visualizer, in one of the single room apartments to test the impact of different window sizes. Our goal for daylight factor in the apartments in this project is an average of minimum 4%. The first step is to test how much window area is needed to reach the goal for the daylight factor. It is concluded that a window area of 30% gives a satisfactory daylight factor.

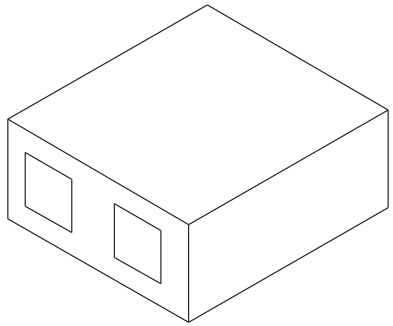
The second step tests the number of windows with a window area of 30%, to see if many small windows is better the fewer large. It is concluded that two windows gives the best daylight factor but four windows gives a more even daylight factor in the room which is desirable for people with dementia.

The third step tests the difference between high and narrow, wide and narrow and rectangular windows, to see if there is a relation between the height of the windows and the daylight factor. Windows with a window area of 30%. The higher the window the further the light travels in the room.

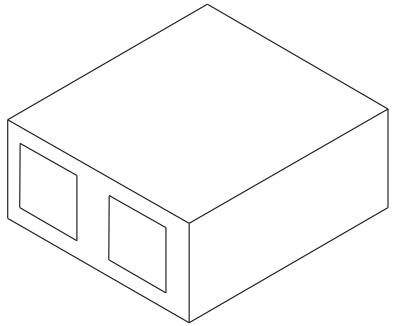
Window area	Average daylight factor
10%	1,7%
20%	3,2%
30%	4,8%



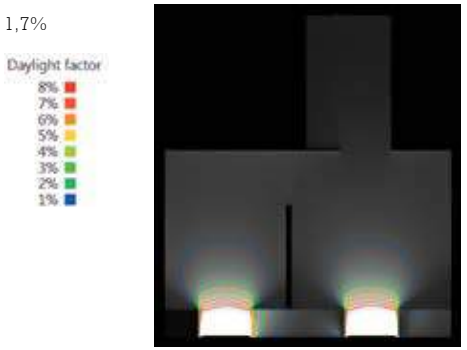
Ill. 136. Window area 10%

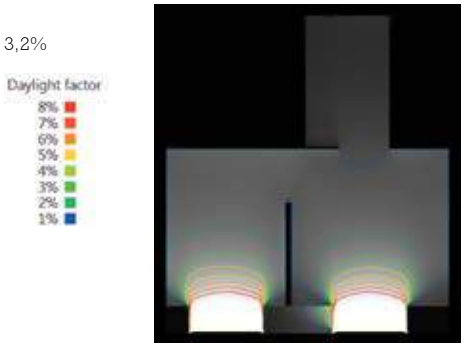


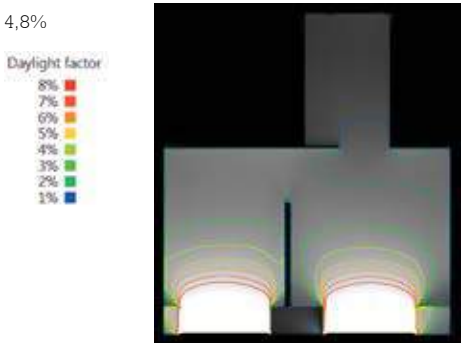
Ill. 137. Window area 20%



Ill. 138. Window area 30%

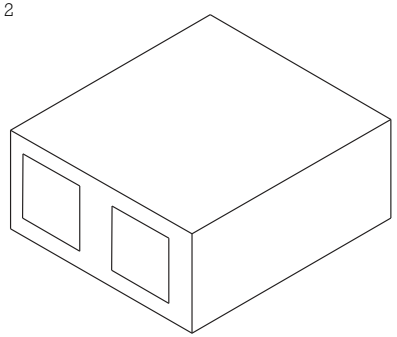






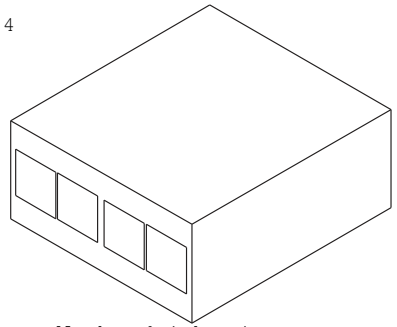
Number of windows

2



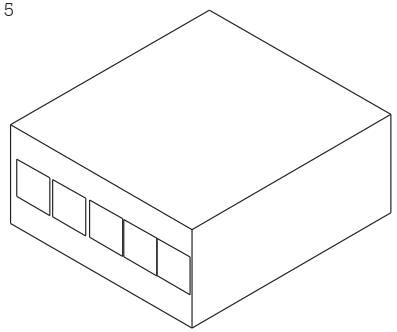
Ill. 139. Number of windows 2

4



Ill. 140. Number of windows 4

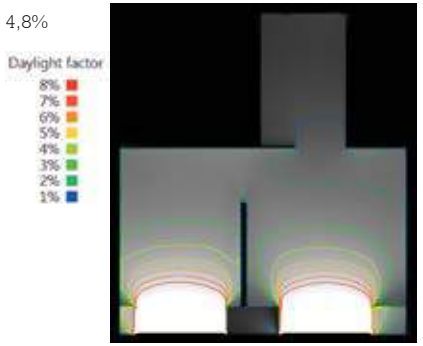
5



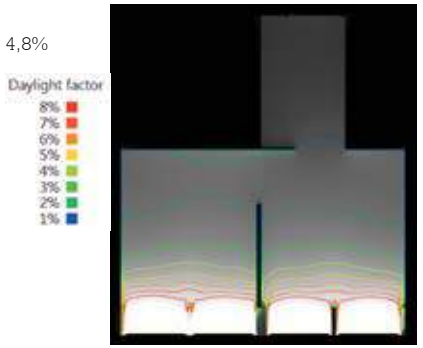
Ill. 141. Number of windows

Average daylight factor

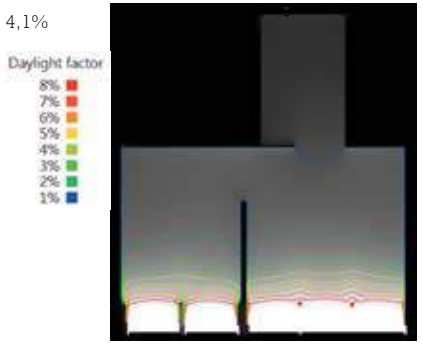
4,8%



4,8%

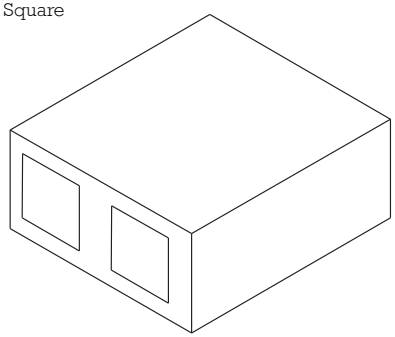


4,1%



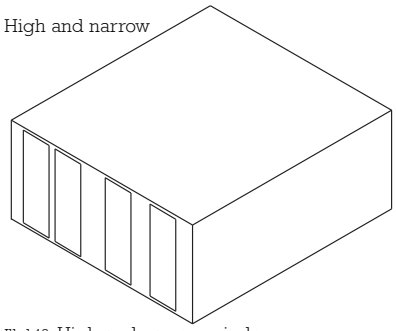
Height of window

Square



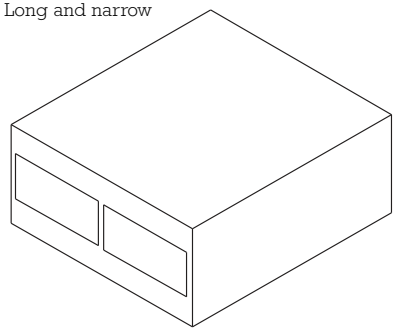
Ill. 142. Square windows

High and narrow



Ill. 143. High and narrow windows

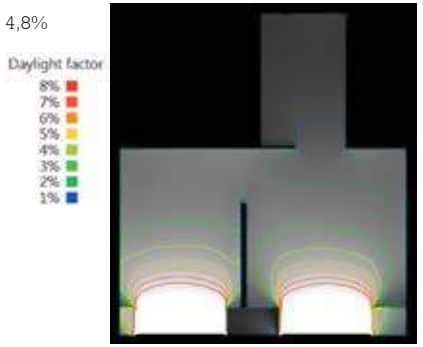
Long and narrow



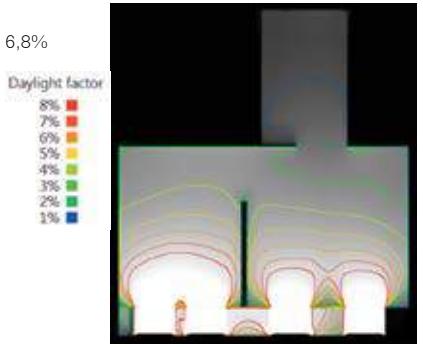
Ill. 144. Long and narrow windows

Average daylight factor

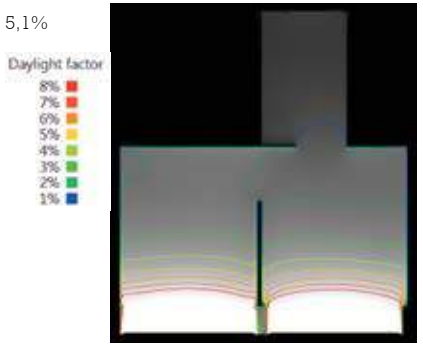
4,8%



6,8%



5,1%



Natural ventilation

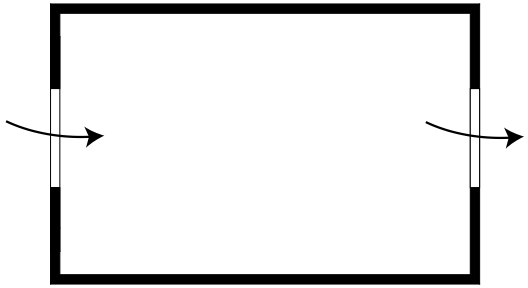
To get a good indoor environment all rooms must be ventilated to avoided overheating and keep the CO_2 levels down. By relying on natural ventilation in the summer months, it is also possible to save energy by not using the mechanical ventilation.

The needed airflow inside the apartments is based on calculations of the CO_2 and sensory pollution load inside the room. The worst pollution source will determine the ventilation and airflow. Calculated air flow rate is 0,026 m^3/s. see appendix 4.

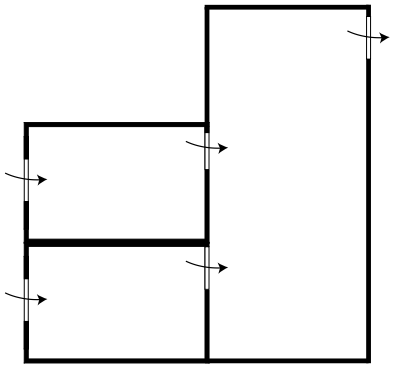
To study the effect of natural ventilation inside the apartments three different ventilation principals will be tested single-sided cross and stag ventilation. Two openings of the same size will be used for this test. see appendix 2.

The study shows that stag ventilation is the most efficient type of ventilation, but single sided ventilation also gives a satisfactory air change rate.

Ill. 145. Single sided ventilation



Ill. 146. Cross ventilation



Ill. 147. Stack ventilation

Single-sided ventilation

Opening	Window area	Hight	Pres coef.	Air flow
Inlet	0,9 m^2	1,3	0,2	0,254 m^3/s
Outlet	0,9 m^2	1,8	0,2	- 0,254 m^3/s

Cross ventilation

Opening	Window area	Hight	Pres coef.	Air flow
Inlet	0,9 m^2	1,3	0,2	0,513 m^3/s
Outlet	0,9 m^2	1,3	-0,25	- 0,513 m^3/s

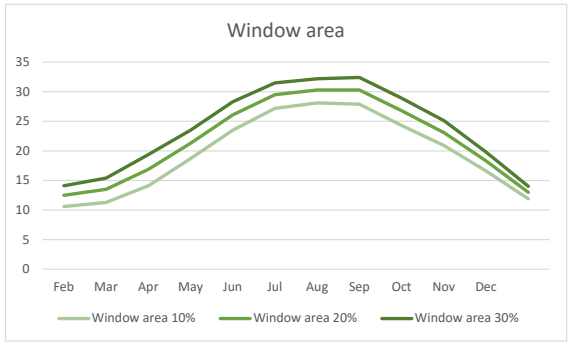
Stack ventilation

Opening	Window area	Hight	Pres coef.	Air flow
Inlet	0,9 m^2	1,3	0,2	0,694 m^3/s
Outlet	0,9 m^2	3	-0,25	- 0,694 m^3/s

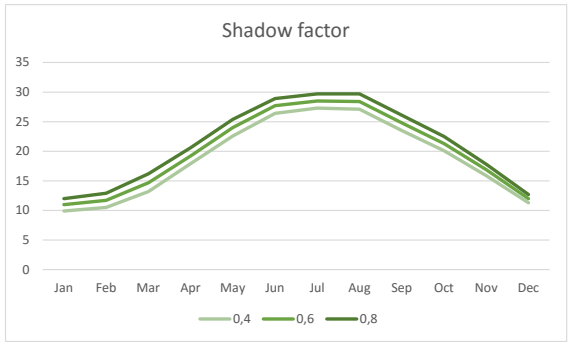
Thermal environment

It is important to consider the indoor climate inside the apartments to avoided overheating. There are a number of factors affecting the temperature inside the apartments such as internal heat gains from equipment and people These are parameters that can't be affected by the design of the building. However heat gains from the sun can be controlled in different ways, this will be tested with a 24-hour average calculation of the temperature inside an apartment, with different parameters for window area, shadow factor as well as the orientation of the apartment.

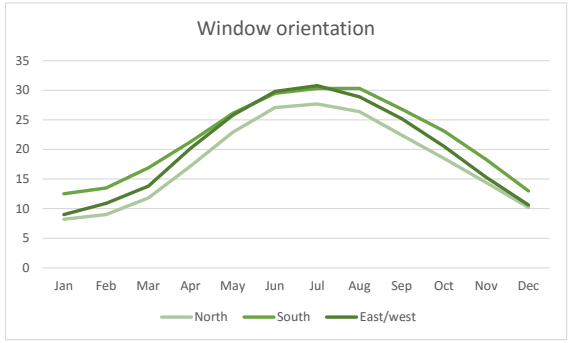
To calculate the heat load inside the apartment an excel ark is used to calculated the daily mean temperature. see appendix 3. In this study the standard heat loads from appliances including lighting is set to 3,5 W per. m^2 heated floor area. This standard is taken from SBi-anvisning 213 2008 for a normal dwellings. The calculations for window area are without shading. All the calculations are without blinds.



Ill. 148. Window area



Ill. 149. Shadow factor



Ill. 150. Window orientation

Energy and indoor climate

Be15 is a program used for estimating the energy use for the design, and is used to optimize the building and ensure that it meets the requirements of the Danish building regulations. Be15 is used to calculate the yearly energy demand for the building, including energy for heating, ventilation, and domestic hot water. The calculation is based on information on the building envelope, ventilation strategy, overheating and renewable energy. The requirement for the 2020 regulations is 20 kWh/m^2 pr. year and the result for the initial calculation on the building shows that the total energy requirement for the building is 21,3 kWh/m^2 pr. year which is above the required limit. This can be improved by further detailing the building and adding solar shading and improving the ventilation with heat recovery and natural ventilation to decrease the energy use.

BSim is used to simulate the indoor environment on an hourly basis. Like Be15 the program uses different information like the building envelope and ventilation strategies to calculate. In addition information of user behavior is needed. To evaluate the indoor environment the temperature and CO_2 level is compared to the building regulations to get the satisfied levels. The temperature must not exceed 100 hours > 26 degrees and 25 hours > 27 degrees [dS474, 1993]. For the atmospheric comfort the CO_2 concentration cannot exceed 850 ppm [DS15251].

The initial calculation of an apartment to the south shows that the temperature is way above the limit in the summer months. Ways to fix this could be by reducing the window area, changing the placements of the windows or by adding shading. The ventilation in the summer months could also be adjusted.

Be15	
Energy use 2020:	
Energy use:	21,3 kWh/m^2 pr. år
Contribution to energy needs:	
Heat:	12,6 kWh/m^2 pr. år
Electricity for building operation:	7,6 kWh/m^2 pr. år
Overheating:	0,0 kWh/m^2 pr. år

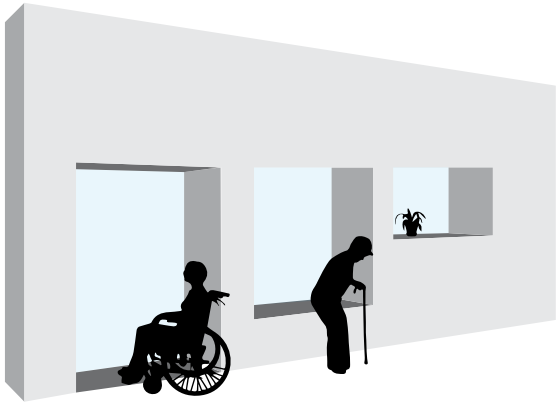
BSim
Temperature:
Hours above 26 degrees > 526 hours
Hours above 27 degrees > 203 hours

CO_2 concentration
Max CO_2 consentration in apartment 560 ppm

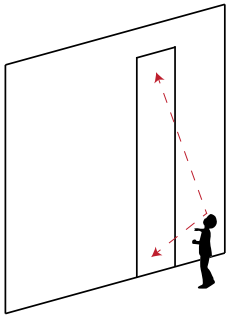
Development of the windows

Spatial experience of a room atmosphere depends on light, both artificial and natural light. In this section, the focus is natural light in the apartments. Numerous studies have showed that natural light has significant effects on the well-being of humans both physically and psychologically. As it has been mentioned earlier, natural light is an important factor for healing architecture, because it helps reduce depression, stress and confusion.

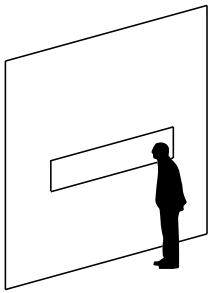
There are two kinds of natural light, sunlight and daylight. Sunlight is light rays directly from the Sun, and the position will change throughout the day and year. Moreover, sunlight contains heat, which can cause overheating inside the building especially during summertime. To avoid overheating it is important to provide exterior shading, which will keep the solar radiation from entering the building [CND, 2012]. In this section, some particular shading ideas will be presented and considered based on aesthetics of the façade and their effect on people with dementia, because some shadow patterns will confuse them. [Demens Alli



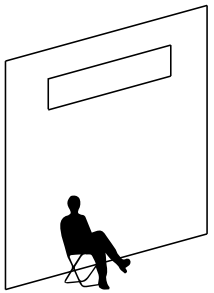
Ill. 151. The area from the wall created by window and door openings can be used to gain more spaces for apartment and can be used for sitting or as a shelf.



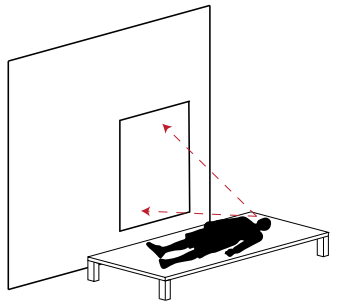
Ill. 152. With a vertical window, it allows people to look down on the street, where life is happening, and at the same time look up to the sky. Furthermore, it also brings more daylight deeper into a room than a horizontal window.



Ill. 153. A horizontal window gives a wider view compared with a vertical window, but it limits the look downward and upward. Moreover, it can cut off some of the warm sunlight and avoids overheating in room, depending on the height of a horizontal window.



Ill. 154. A separated top window can secure daylight in a room even the normal window is closed off, when the users want privacy. In addition, the opening near the ceiling can take out some of the air pollution from the room.

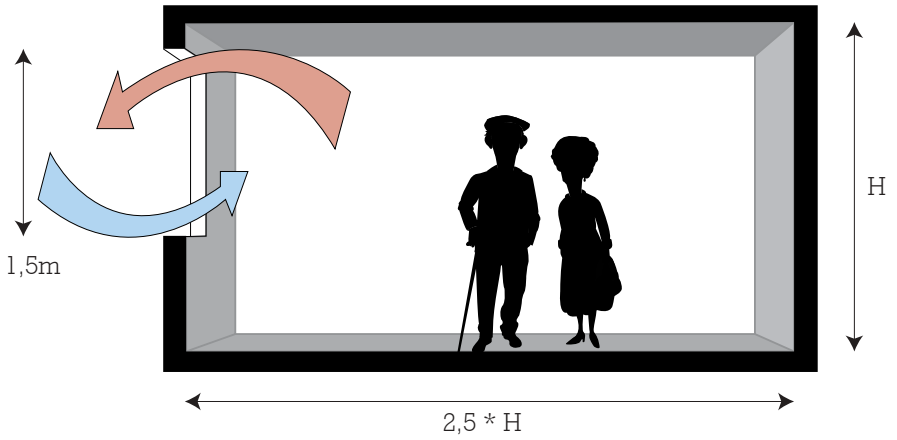


Ill. 155. It is a quality for the users, if they can look outside while laying down on bed, because some of them can be so physical weak that they need to lay in bed most of the day.

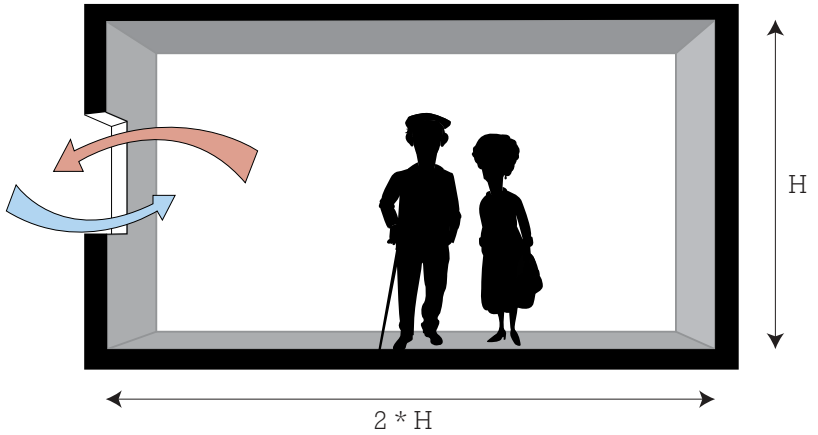
ancen, page 13] Out of all the shading ideas one type of shading will be chosen to test in BSim in terms of overheating , which will be showed as a scheme on the next couples of pages.

The other type of natural light is daylight, which is indirect sunlight rays being reflected be clouds, trees, facades etc. In overcast conditions, daylight does not vary with azimuth [Sue Wolff, page 1]. Daylight can be described in different ways, and the most practical way is to calculate daylight factor for a building or a room. The Danish Building Regulation says, if daylight factor in living space is 2 pct., it can considered being adequate [Bygningsreglementet, 2014]. However, in this project the daylight factor has been chosen to be between 4 to 5 pct. or more, to ensure good and healthy environment for people with dementia.
In this case few window types and arrangements will be chosen to be tested in BSIM with and without shading. Lastly a couple of window arrangements will be chosen base on overheating hours per year, daylight factor, their functionality and aesthetic of the façade.
Requirements for windows have becoming tighter from year to year, and since it aims to design an environmentally friendly building project, the amount of window area and their location needs to be considered carefully. To fulfil low energy building class 2020 the total amount of window area need to be maximum 22 m^2 per. 100 m^2, which means 22%. Based on this none of the window cases from this study exceed 22%.
It is a design idea to exploit exterior wall thickness of window and door areas for staying or placing things on, by doing this an amount of lost gross area from the wall can gained back and add an extra quality to the room. There are many options on window types and shapes, where each of them has their own qualities illustrated in diagrams on the previous page.

In terms of natural ventilation, all the apartments will be ventilated mainly by single sided ventilation. A thumb rule for this is showed as diagram to the right.

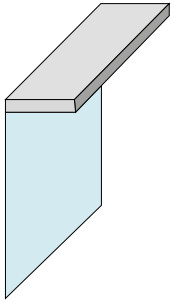
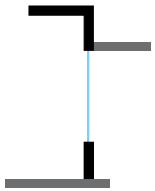
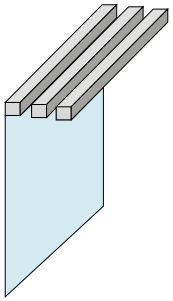
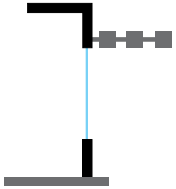
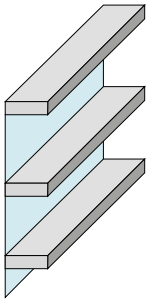
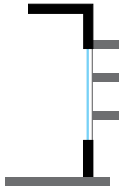


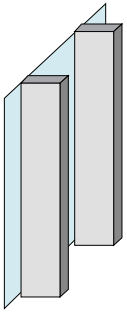
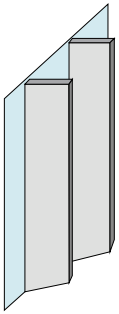
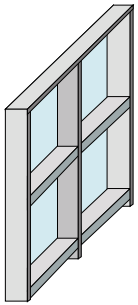
Ill. 156. Single sided ventilation is most optimal when horizontal or vertical pivot windows exceeding 1,5m in height with a room depth lower than 2,5*H. H is the height of the room.



Ill. 157. When horizontal or vertical pivot windows is lower than 1,5m, the room depth has to be under 2*H to ensure optimal single sided ventilation.

Solar Shading

	Inspiration	3D View	Section	View rectriction	Comments
Vertical fin	 Ill. 158. [Oscar]				**Ideal orientation: South** With this kind of solar shading the users have a good view to the outside. It is most optimal if combining with vertical solar shading, or the horizontal panel/awning need to be longer than the window's width with H/2 (height of the window) on each side, which will cause a quite long awning/horizontal solar shading.
Slanted vertical fin	 Ill. 159. [Pinterest]				**Ideal orientation: South** Like the first horizontal solar shading the users have a good view to the outside, but with this shading the gaps between the horizontal panels make it possible for hot air to slip through to avoid hot temperature under the shading. A bad thing with it that the shading will throw some confused shadows inside the room, which will affect people with dementia badly.
Eggcrate	 Ill. 160. [Pinterest]				**Ideal orientation: South** Solar penetration will be reduced by having some horizontal panels, and it reduces as more as the panels are getting closer to each other, or make the panels deeper. The view restriction is not as good as the other horizontal shading, because the view is disturbed or partly covered by the panels. With this shading there will also cause confused shadows like previous shading.

	Inspiration	3D View	Section	View rectriction	Comments
Vertical fin	 Ill. 161. [Pinterest]				**Ideal orientation: East/West** There some view limitation for this kind of solar shading, but in a specific angle an almost full view can reached. Moreover, their shadows will cause confusing for users with dementia like the previous shadings. Furthermore, the shading is suitable for windows facing against east or west.
Slanted vertical fin	 Ill. 162. [Yoana]				**Ideal orientation: East/West** It is the same shading system as vertical fin, but with slanted vertical fin the view is more limited.
Eggcrate	 Ill. 163. [ArchiEXPO]				**Ideal orientation: East/West** Compare to the other solar shadings this shading type has the worst view towards outside and the most confused shadows for users with dementia, because there will be many small shadows on the floor in some sunny day, which will be perceived as holes by users with dementia.

Ill. 164. Shadow from see through blinds [Velux]

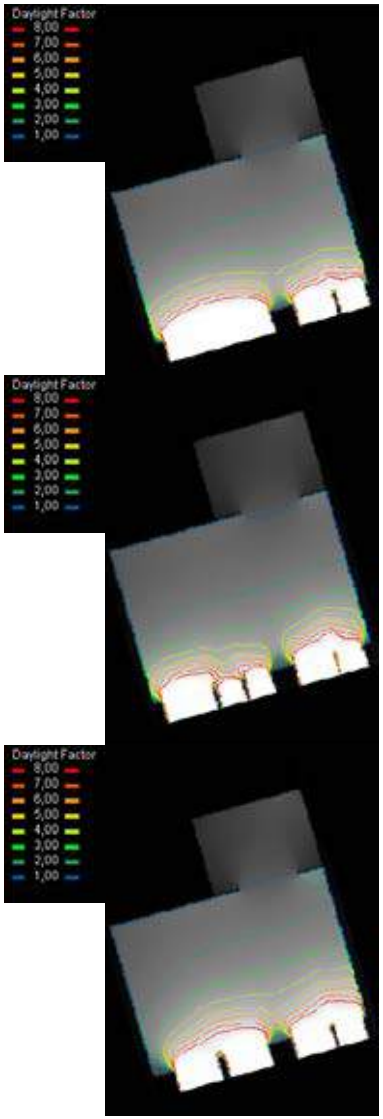
Ill. 165. See through blinds [Colorwise]

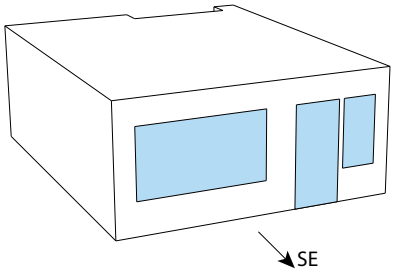
From the previous solar shading study, it shows that in term of their shadows inside a room, they will confuse users with dementia, therefore the solution for this case is to use half transparent blinds outside the windows. With this kind of shading the shadows won't be as strong as the previous solar shading, plus with it a great view and even more daylight will be achieve. (see picture above)

Moreover, they do not have a big influence on the façade, when they are not in use. A thing to remember is that colours of the blinds cannot be in black or dark blue, because the users with dementia will perceive it as holes. It is an idea to use few different colours for the blinds to bring live and dynamic to the façade, when they are in use.

The next step after choosing type of solar shading is to choose window types and window arrangement. The focus area in this project is apartments for users with dementia, therefore a several window arrangements will be studied for single room, two rooms and short-term apartments with and without solar shading. The worst standing apartment for each tree apartments get modified in BSIM to test the amount of overheated hours pr. year. Requirements for thermal indoor environment says that the indoor temperature cannot exceed 100 hours pr. year for 26°C and 25 hours pr. year for 27°C.

The data and information of the window studies can be found in annex. On the following pages, there will be a scheme, which shows the chosen window arrangements for each of the apartments [Bygningsreglementet, 2014].



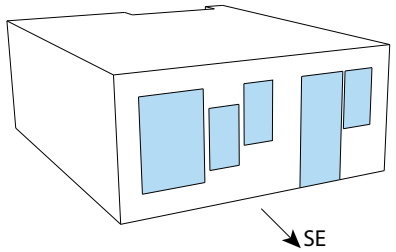


Daylight factor

Daylight Factor	Unit [%]
Apartment average	3,3
Bedroom area	5,3
Livingroom area	4,9
Kitchen area	0,4

With solar-shading

BSIM values	Unit[hours]
Hours > 21 °C	2185
Hours > 26 °C	38
Hours > 27 °C	10
Hours < 20 °C	591

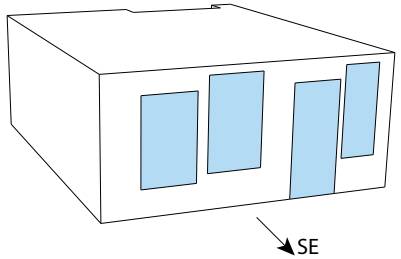


Daylight factor

Daylight Factor	Unit [%]
Apartment average	2,8
Bedroom area	3,9
Livingroom area	4,8
Kitchen area	0,4

With solar-shading

BSIM values	Unit[hours]
Hours > 21 °C	2393
Hours > 26 °C	41
Hours > 27 °C	8
Hours < 20 °C	662

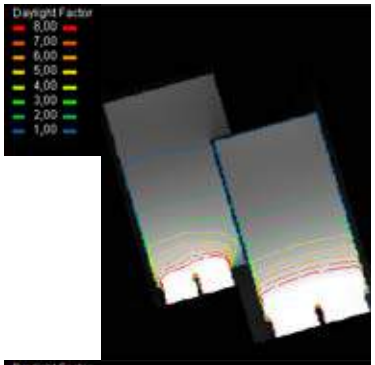


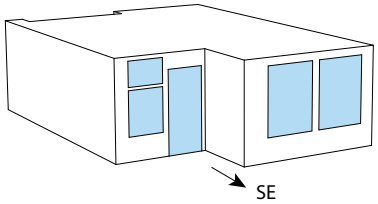
Daylight factor

Daylight Factor	Unit [%]
Apartment average	3,1
Bedroom area	4,2
Livingroom area	5,4
Kitchen area	0,4

With solar-shading

BSIM values	Unit[hours]
Hours > 21 °C	2238
Hours > 26 °C	47
Hours > 27 °C	12
Hours < 20 °C	610



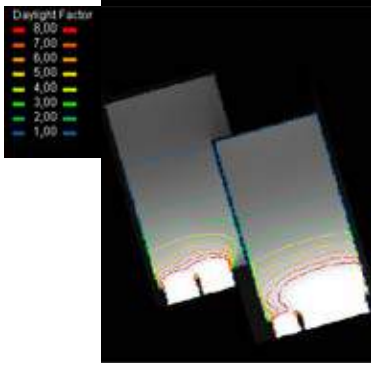


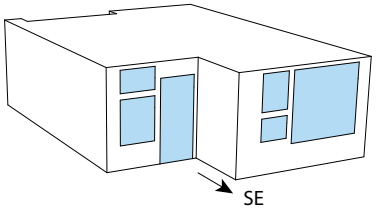
Daylight factor

Daylight Factor	Unit [%]
Apartment average	3,7
Bedroom area	5,1
Livingroom area	4,6
Kitchen area	0,4

With solar-shading

Bedroom area		Livingroom area	
BSIM values	Unit[hours]	BSIM values	Unit[hours]
Hours > 21 °C	4157	Hours > 21 °C	3810
Hours > 26 °C	80	Hours > 26 °C	94
Hours > 27 °C	15	Hours > 27 °C	22
Hours < 20 °C	71	Hours < 20 °C	0



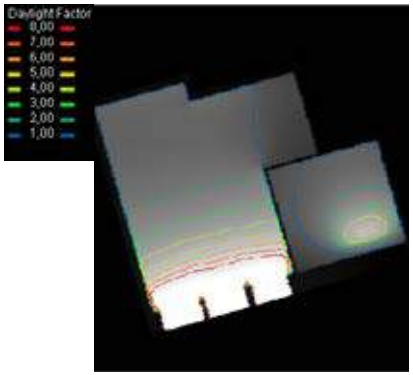


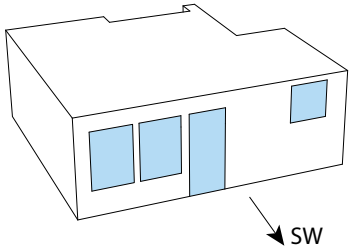
Daylight factor

Daylight Factor	Unit [%]
Apartment average	3,6
Bedroom area	5,3
Livingroom area	4,6
Kitchen area	0,4

With solar-shading

Bedroom area		Livingroom area	
BSIM values	Unit[hours]	BSIM values	Unit[hours]
Hours > 21 °C	4127	Hours > 21 °C	3799
Hours > 26 °C	93	Hours > 26 °C	100
Hours > 27 °C	24	Hours > 27 °C	24
Hours < 20 °C	74	Hours < 20 °C	0



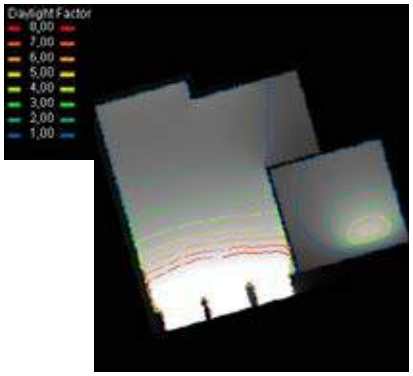


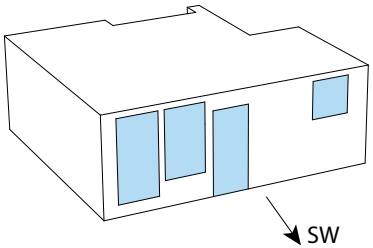
Daylight factor

Daylight Factor	Unit [%]
Apartment average	3,5
Kitchen area	0,5
Bathroom area	1,3
Livingroom area	1,1
Bedroom area	7,3
Living- + bedroom area	4,2

With solar-shading

Bathroom area		Living/bedroom area	
BSIM values	Unit[hours]	BSIM values	Unit[hours]
Hours > 21 °C	800	Hours > 21 °C	1605
Hours > 26 °C	0	Hours > 26 °C	33
Hours > 27 °C	0	Hours > 27 °C	7
Hours < 20 °C	6858	Hours < 20 °C	640





Daylight factor

Daylight Factor	Unit [%]
Apartment average	3,9
Kitchen area	0,6
Bathroom area	1,4
Livingroom area	1,1
Bedroom area	6,8
Living- + bedroom area	4,7

With solar-shading

Bedroom area		Living/bedroom area	
BSIM values	Unit[hours]	BSIM values	Unit[hours]
Hours > 21 °C	894	Hours > 21 °C	1762
Hours > 26 °C	0	Hours > 26 °C	59
Hours > 27 °C	0	Hours > 27 °C	20
Hours < 20 °C	6788	Hours < 20 °C	587

Be15

Be15 is a calculation program, which is developed by SBI11 to demonstrate that the energy requirements of the building regulations and other regulations are followed [SBI,2016]. The project is aiming to reach the 2020 building requirements in the first place, where energy consumption is maximum 20 kWh/m2 year.

The building design is divided into different building complexes with different sizes. The team have chosen the east building with apartments for users with dementia to be calculated in Be15. The result shows that the energy consumption for the east building is 18.6 kWh/m2 year, which fulfills 2020 building requirement.

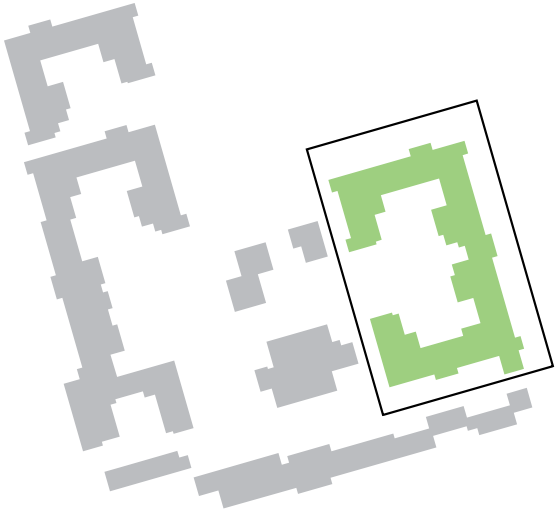
The building direction and envelope is important in order to prevent overheating. As it was described earlier in the window section, a chosen solar shading and window type for each type of apartment is designed to prevent overheating. By doing this the energy consumption will be decreased, because the building will not spend energy on regulating indoor thermal environment.

The consumption can be reduced even more, if the window areas are reduced, but considering healing architecture the right balance should be found.

After the building fulfills the 2020 building requirements it aims further to reach the requirements of a zero energy building. Therefore the use of renewable energy is needed. The main strategy for reacheing this is by using PV solar cells as the main energy source, and then geothermal energy as a supplement energy source. The calculation for the amount of PV solar is described on the next page.

Energy frame for 2020 building	
Total energy frame	18.6 kWh/m2year
Contribution to energy requirement	
Heat	27.6 kWh/m2year
El. for operation of building	1.2 kWh/m2year
Excessive in rooms	0.0 kWh/m2year
Net requirement	
Roomheating	6.6 kWh/m2year
Domestic hot water	13.8 kWh/m2year
Cooling	0.0 kWh/m2year
Selected electricity requirements	
Lighting	54,5 kWh/m2year
Heating of rooms	0,0 kWh/m2year
Heating of DHW	0.1 kWh/m2year
Heat pump	0.0 kWh/m2year
Ventilators	1.0 kWh/m2year
Pumps	0.1 kWh/m2year
Cooling	0.0 kWh/m2year
Total el. consumption	31.8 kWh/m2year

Ill.: Data from Be15



Ill.: The east building

Zero energy building - Solar cells and geothermal

To fulfil the energy consumption and achieve a zero-energy building energy from solar cells will be used in this project. In this section calculations for finding the needed amount of solar cells will be presented.

First of all the peak performance of the solar cells needed to cover the energy consumption will be calculated.

Data from Be15
Total energy consumption: 18.6 kWh/m^2 year
Total area for east building: 3272.12 m^2

Amount of apartments: 48 apartments

(18.6 kWh/m^2 year * 3272.12 m^2) + (1725 * 48 apartments) = 143 661.432 kWh/year

$E_{Solar\ cells}$ = 143 661.432 kWh/year

During master program for 2. semester the students got a recipe for solar cells calculation.
With that knowledge a annual performance can be calculated.

A: Total roof area for solar cells	=	865.84 m^2
B: Solar cells efficiency (Monocrystalline)	=	18% (high)
C: Effect in high sun $\frac{A*B}{100} = \frac{865.84m^2*18\%}{100}$	=	155,85 kW_{peak}
D: System factor Standing free or integrated	=	0.65
E: Sun radiation [kWh/m^2]	=	1067 (south/east horizontal, 20^0)

Annual performance = C * D * E = 155,85 kW_{peak} * 0.65 * 1067 = 108 089.77 kWh/year

This is what the east building's roof area with solar cells can produce per. year.

In following calculation, the needed amount in m^2 to fulfil zero energy will be founded:

$C = \frac{E_{solceller}}{D*E} = \frac{143\,661.432\frac{kWh}{year}}{0.65*1067} =$ 207.14 kWp

The area for it will be calculated:

$A = \frac{C*100}{18} = \frac{207.14\ kWp*100}{18}$ = 1150.78 m^2

1150.78 m^2 - 865.84 m^2 = 284.94 m^2

This means that there need 284.94 m^2 more to fulfill zero energy building.

As it shows there is not enough roof era to cover the energy consumption, there has been considered geothermal energy to cover the last missing energy, because there is enough space for this project site.
A good thing about geothermal energy that there is no maintenance. It is a closed system, which takes care by themselves. The only thing need to do is to clean the filter from the pump 1 time in a year.
[Bolius, 2007]

EPILOGUE

EPILOGUE

The epilogue will sum up the project, ideas and thoguhts through a conclusion and a reflection. The conclusion will build on the vision stated ealier in the report, whereas the reflection will discuss the initiatives and the sides of the project that could have been developed further.

Conclusion

The new Dementia- & Brain Center in Aarhus is a combination of new thoughts and actions considering dementia. Most people diagnosed with the disorder needs to be taken care of why they should be placed in a safe environment reflecting the life they have been living earlier. They need special care to be able to enjoy the last part of their life's instead of walking around in their own home being confused and afraid. The complex is placed in the northern part of Aarhus working as a minor society with multiple functions integrated to stimulate the resident's senses on a daily basis. By designing the center as a city in the city the residents will not feel the need go out to wander around in the real city eventually getting lost. It is important for a complex like this to feel homely and pleasing to be in.

Indoor

The aspects of healing architecture and design for people with dementia both calls for attention considering daylight. All the apartments in the complex has been designed and oriented towards west, east or favorably south due to the fact that people with dementia, or elderly in general, needs as much daylight as possible to be able to follow the circadian rhythm. The windows have been dimensioned to allow a daylight factor of 4-5 % in the apartments living and sleeping area. This also applies for the common areas, which are very open. The division creates both private and social spaces for the resident to choose whether they want socialize or be alone. In addition to the considerations about daylight, the materials have been chosen carefully to minimize reflections, because these may cause confusion and anxiety for the dementias.

The apartments are combined in units consisting of 3-6 apartment, each with additional area for common space. These units are further combined to create bigger volumes shaping semi-private and open gardens in between.

Outdoor

With the concept of creating a city in the city combined with the thoughts of making places and buildings easier to recognize the materiality varies from building to building. Together with the materiality the window design and arrangements vary likewise to enhance the recognition for the residents.
Coming from the outside entering the complex you see a form relating to the context by using the same color of bricks as well as mimicking the known form of a gable, combined to what seems like row houses. The complex is designed as a more or less closed volume on the site why the gable structure is good solution because it helps to scale the volume down. The same expression applies when looking around from inside the complex.

The outdoor areas are designed to stimulate all the senses, because being stimulated is healthy and might help generate memories from the past. The gardens are connected by paths leading the residents around to different functions integrated. In the middle of the site a square has been planned with a mix of functions like a hairdresser, a gym, a multi room and the like. These functions are placed in the middle as separate buildings to force the residents to move and do many of the daily actions they have been used to, like putting on your shoes and jacket. These actions help activate both body and mind which is an import part of life for everyone.

Reflection

Though the following a reflection, upon the development of the new Dementia- & Brain Center in Aarhus, will be described. Furthermore, some of the new actions and thoughts will be discussed and reconsidered. The intention from the beginning was to develop a project integrating both architectural and engineering knowledge to achieve a well-functioning and healthy complex with an architectural expression fitting the context.

Daylight and movement

The entire process and project has been affected by principles from both healing architecture and design for people with dementia continuously. With the knowledge gained through the analysis an idea of what should be the primary focus points were found; daylight and movement. These aspects became the two main criteria because people with dementia has to be able to follow the circadian rhythm and needs to be stimulated every day. A lot of focus was put on how the windows should be designed to create high amounts of daylight in each apartment as well as views towards the outside. The building layout can be discussed whether it is optimal for the staff or not, because the units are arranged as separate buildings. The layout forces the residents to move like they have been used to, but it might also work as a problem for staff, because they might have to move from building to building when they are on shift. The complex is designed for the residents and not the staff, which is why this decision was made. To improve the work environment for the staff we made space in each unit for them to able to be themselves and rest while being at work.

The apartments

Dealing with the apartments we came up with an idea and have made a new initiative. The one room and short term apartment works like intended and creates a well-functioning frame for people with dementia because they can survey the entire room from the bed. The two room apartment is dimensioned to be able to fit a couple which is the new initiative. This initiative has many sides and thoughts behind it. The main quality is that it is able to house a couple in which the one part is in an early stage of dementia. The couple will then get to live together for an extended period of time. As the disorder increases and the affected part gets confused and forgets who the other part is, they can no longer live together. Since dementia is a slow and steadily evolving disorder the couple might be able to live together for 5-8 years from the earliest stage where they need help to the stage where the relationship is no longer durable. The apartment will also be able to house one person, who might want a more spacious and divided apartment.

Tectonics

Considering tectonics and construction, which was one of our main aspects in our project description, we got smarter as we learned more about dementia as a problem through the analysis. The thought we had when we first started was that we wanted the construction to give the complex a certain expression. Because we learned how easily people with dementia gets confused and scared, we reconsidered this aspect, and went for a more minimalistic expression. Designing for people with dementia it is important to take a step back and think about what the minimal and most important things are.

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APPENDIX

APPENDIX

Appendix 1

Wind data

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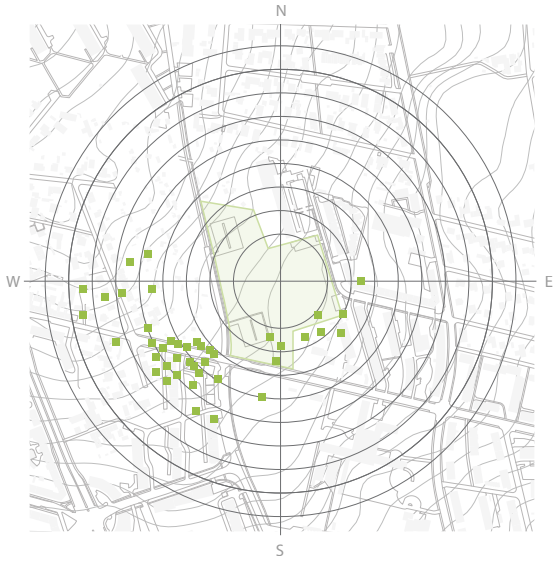

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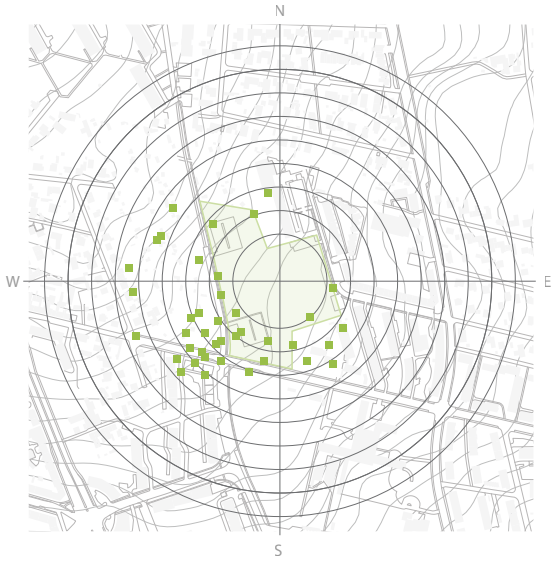

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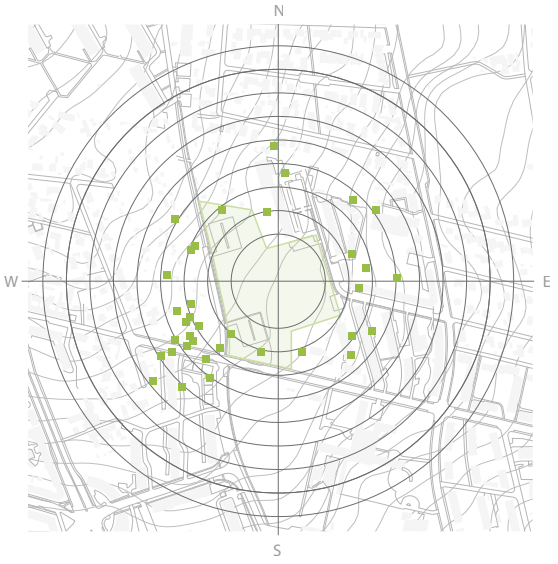

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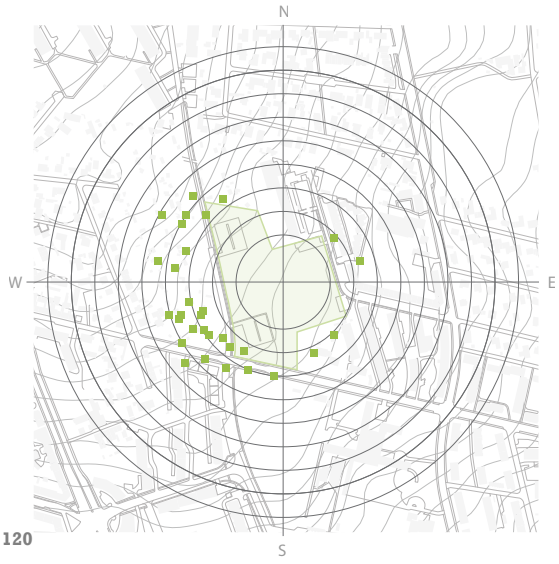

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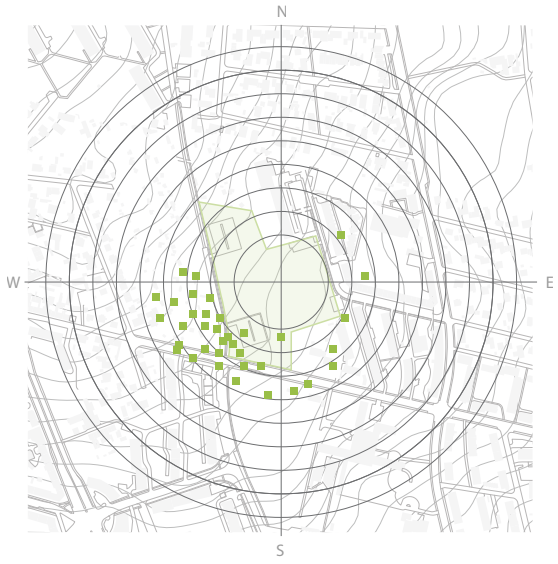

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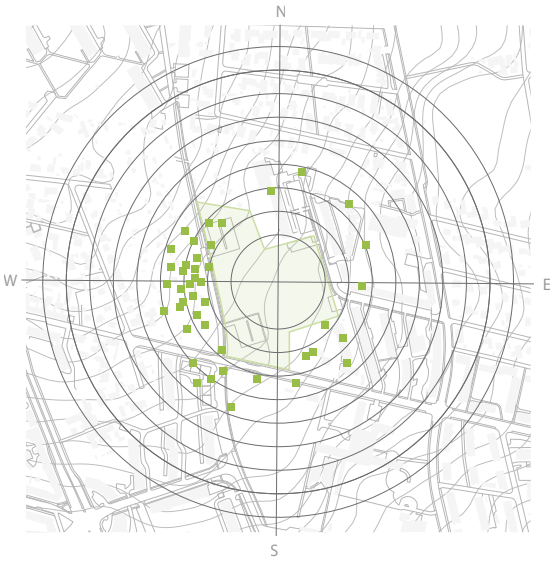

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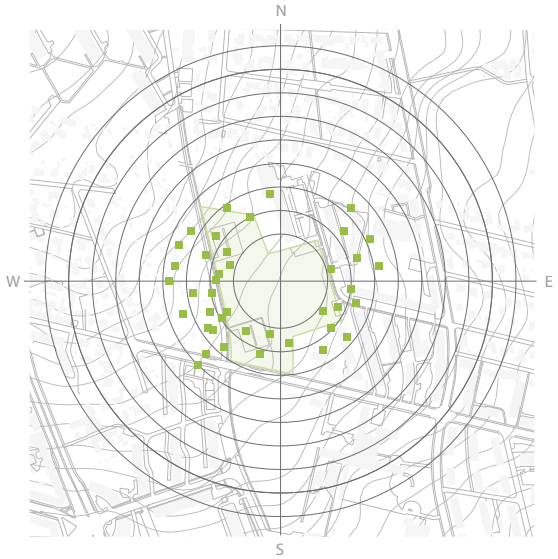

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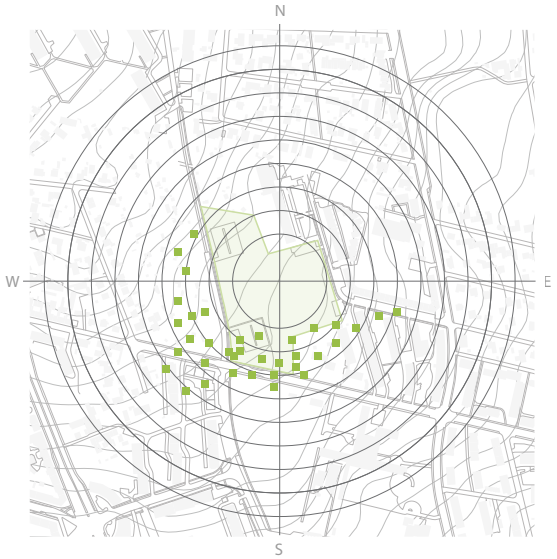

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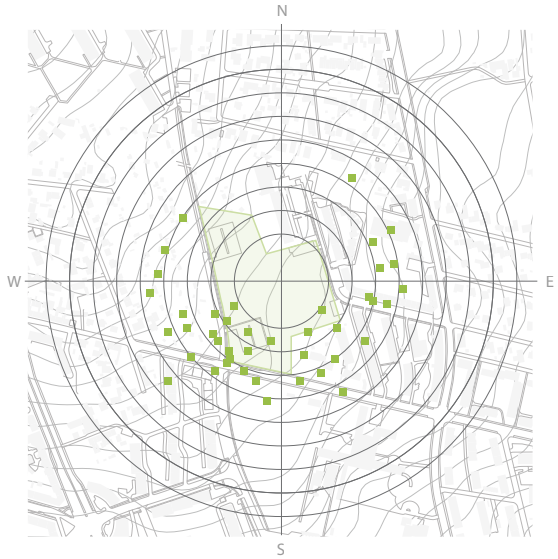

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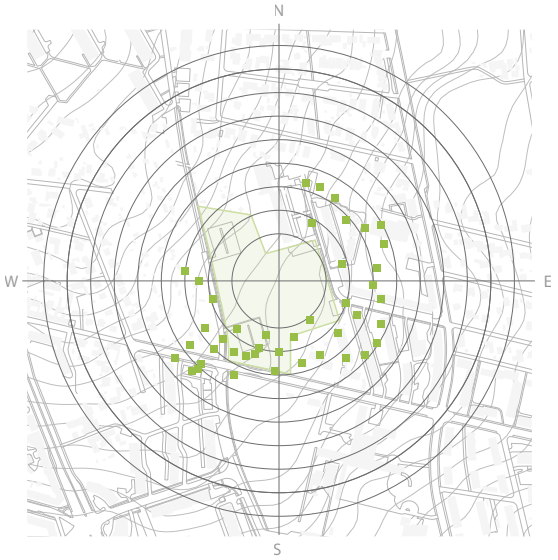

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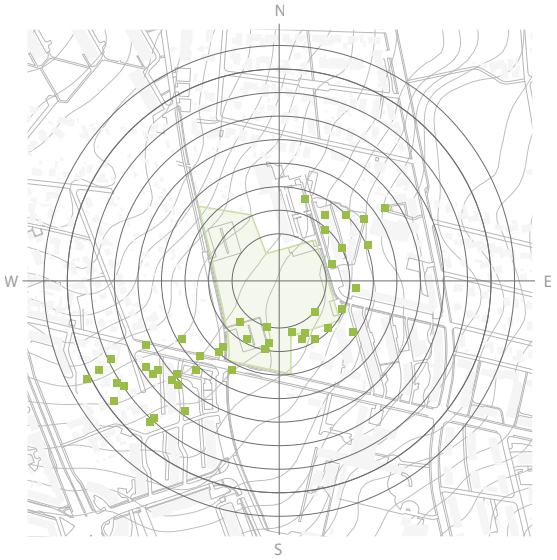
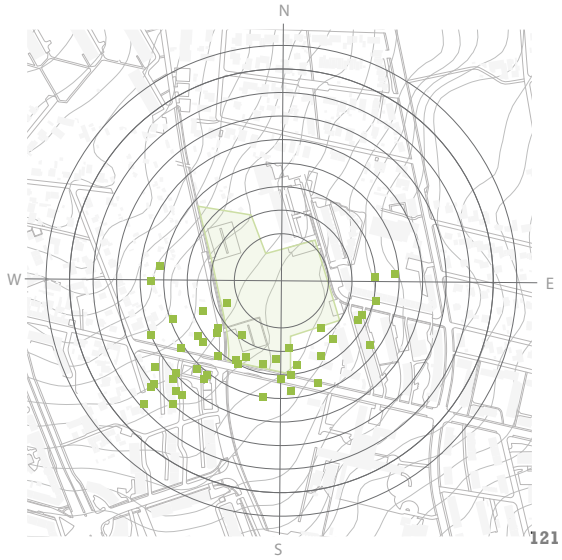


December



Appendix 2

Natural ventilation

The natural ventilation through the openings inside the apartments is calculated using the spreadsheet below. The calculation depends on the size and height of the opening and weather date. The wind Pressure coefficients used for the calculation is for an apartment to the west, the data is taken from [SBi 202, 2002, p.69].

Windward: 0,2
Leeward: -0,25
Roof: -0,4

Pressure Coefficient				**Windfactor**	0,39		**Pwind**	1,8pa		
Windward	0,2			**Vmeteo**	4,4m/s		**Pmin**	-0,7pa		
Leeward	-0,25			**Vref**	1,716m/s		**Pmax**	0,4pa		
roof	-0,4									
Location of neutral plan, Ho		1,5m					**Buildingvol.**	m3		
Outdoor temperature		16,1C					**Volume**	m3/section/floor		
Zone temperature		26C								
Discharge coefficient		0,7					**Internal pressure, Pi**	pa	0,37	0,37
Air density		1,25kg/m3								

	Area	**Eff. Area**	**Height**	**Thermal Buoyancy**	**AFR (thermal)**	**Pres Coefficient**	**Wind pressure**	**AFR Wind)**	**Wind pressure**	**AFR total**
	m2	**m2**	**m**	**pa**	**m3/s**		**pa**	**m3/s**	**pa**	**m3/s**
W1 b	0,9	0,630	1,3	0,102	0,25	0,2	0,000	0,000	-0,000	0,254
W2 t	0,9	0,630	1,8	-0,102	-0,25	0,2	0,000	0,000	-0,000	-0,254
				Massebalance	-0,00		Massebalance	0,00		-0,00

Appendix 3

Indoor climate calculation

The calculation below shows a simple calculation of the 24-hour mean temperature. The calculation was made in excel and was used to get an idea of the temperature inside a one-room apartment with differ-ent placements and sizes of the windows.

Beregning af døgnmiddeltemperatur

med danske vejrdata

AALBORG UNIVERSITET
ARCHITECTURAL ENGINEERING

Projekt:
One room apartment

Rumopbygning

Konstruktioner mod det fri

Nr	Flade	A m²	U W/m²K	Bu W/K	
1	Ydervæg	13,20	0,12	1,58	
2				0,00	
3				0,00	
4				0,00	
5				0,00	
	Sum	13,20		1,58	= Bukon

Hvis der ikke vises kommentarer aktiveres disse under "Vis"

Vinduer mod det fri

Nr	Flade	Antal stk	A m²	U W/m²K	Bu W/K	Orient grader	Hældning 90/45/0	g-værdi [-]	f(beta) [-]	f(afsk) [-]	f(skyg) [-]	f(glas) [-]	Fsol [-]
1	Vinduer	2	3,60	0,75	5,40	90	90	0,40	0,90	1,00	0,90	0,93	0,30
2		0	0,00	0,00	0,00	0	0	0,00	0,00	0,00	0,00	0,00	0,00
3					0,00								0,00
4					0,00								0,00
5					0,00								0,00
	Sum	2	3,60		5,40	= Buvin							
Samlet specifikt varmetab mod det fri Bt					**6,98**	**= Bt = Bukon+Buvin**							

Konstruktioner mod gulv samt omgivende rum

Nr	Flade	A m²	U W/m²K	Br W/K	tr °C	Br*tr W	
1				0,00		0,00	
2				0,00		0,00	
3				0,00		0,00	
4				0,00		0,00	
5				0,00		0,00	
	Sum	0		0,00		**0,00**	**=Σ Br*tr**
Samlet specifikt varmetab mod omgivende rum Br				**0,00**	**= Br**		

Jordtemperatur for område valgt i "BELA
7,6 °C

Ventilation

	Type	Luftskifte h⁻¹	Rum volum m³	Luftstrøm m³/s	Densitet kg/m³	Varmekap. J/kgK	BL W/K	
1	Ventilation	1,42	65,91	0,026	1,2	1006	31,38	
2	Infiltration	0,10	65,91	0,002	1,2	1006	2,21	
	Sum	1,52		0,028			33,59	
Samlet specifikt varmetab ved ventilation BL							**33,59**	**= BL**

Kontrol
Samlet luftstrøm
liter pr. m² gulvareal
1,1

Varmeakkumulering

	Vælg varmeakkumulering	Akk.evne W/K pr m²	Gulvareal m²	Ba W/K	Beskrivelse af valgt rumopbygning
1	Ekstra tung	14	26,40	369,60	Rum med flere frie, tunge konstruktioner, fx betondæk og -loft samt skillevægge af tegl eller letbeton
Samlet specifik varmeakkumulering Ba				**369,60**	**= Ba**

BELASTNINGER
Gå til ark BELAST

Beregning af belastninger

Projekt:
One room apartment
Interne belastninger

Time	Personbelast W	Belysning W	Andet W	Sum W
1	72	0	8	80
2	72	0	8	80
3	72	0	8	80
4	72	0	8	80
5	72	0	8	80
6	72	0	8	80
7	72	0	8	80
8	72	60	106	238
9	72	60	106	238
10	72	60	106	238
11	72	60	106	238
12	72	60	106	238
13	72	60	106	238
14	72	60	106	238
15	72	60	106	238
16	72	60	106	238
17	72	60	106	238
18	72	0	106	178
19	72	0	106	178
20	72	0	106	178
21	72	0	106	178
22	72	0	8	80
23	72	0	8	80
24	72	0	8	80
Sum	1728	600	1558	3886
Middelværdi	72	25	65	**162** **=Φi**
Max. timeværdi	72	60	106	**238** **=Φimax**
Min. timeværdi	72	0	8	**80** **=Φimin**

Pr. m² gulvareal	Personbelast W/m²	Belysning W/m²	Andet W/m²	Sum W/m²
Middelværdi	2,73	0,95	2,46	6,13
Max. timeværdi	2,73	2,27	4,00	9,00
Min. timeværdi	2,73	0,00	0,30	3,03

Beregninger
Gå til ark RESULT

Eksterne belastninger

Vælg område
København

Vælg måned
Juni

Udetemperatur: døgnm	20	°C	= tu
variation	12	°C	= Δtu

Solindfald vinduer	Areal m²	Orientering grader	Hældning grader	Fsol [-]	Φs W	Φsmax W
1	3,60	90	90	0,30	236	946
2	0,00	0	0	0,00	0	0
3	0,00	0	0	0,00	0	0
4	0,00	0	0	0,00	0	0
5	0,00	0	0	0,00	0	0
Samlet solindfald i rum					**236**	**946**

Hjælp til interne belastninger

Personvarme:	Aktivitet met	Total W/person	Fri varme W/person	Antal pers	Fri i alt W
	1,2	118	**76**	1	76

Belysning: almen	Niveau lux	Glødelys W/m² g.a.	Lysstof W/m² g.a.	Lavenergi W/m² g.a.	Vælg effekt W/m² g.a.	Belysning i alt W
	200	52	16	8	8	211

Særbelysning
Kontorudstyr

Resultater

Projekt:
One room apartment

For valgt måned:	**Juni**	tu =	**20**	°C

Hvis ventilationsluften har samme temperatur som udeluften

Døgnmiddeltemperatur	ti =	**29,8**	°C
Temperaturvariation	Δti =	**3,0**	°C
Maksimaltemperatur	timax =	**31,3**	°C

$$t_i = \frac{B_i t_{i_0} + \sum B_i t_i + B_i t_{i_0} + \Phi_s + \Phi_x}{B_i + \sum B_i + B_i}$$

$$M_i = t_{i_{max}} - t_{i_{min}} = \frac{\Delta\Phi_s}{B_i + \sum B_i + B_i + B_{i,ek}}$$

$$\Delta\Phi_s = \Delta\Phi_{s1} + \Delta\Phi_{s2}$$

$$\Delta\Phi_{s1} = \frac{2}{3}[(\Phi_s + \Phi_x)_{max} - \Phi_{s,min}]$$

$$\Delta\Phi_{s2} = \Delta t_{e_s}(B_{s,ydr} + B_{s_1})$$

Supplerende beregninger

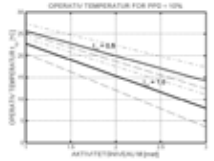
Hvis ventilationsluften har konstant temperatur lig udeluftens døgnmiddeltemperatur

Døgnmiddeltemperatur	ti =	**29,8**	°C
Temperaturvariation	Δti =	**2,1**	°C
Maksimaltemperatur	timax =	**30,8**	°C

Beregning hvor ventilationsluften har konstant indblæsningstemperatur der er Δt =	**2**	°C lavere end udeluftens døgnmiddeltemperatur

Hvis ventilationsluften har konstant temperatur på **18** °C

Døgnmiddeltemperatur	ti =	**28,1**	°C
Temperaturvariation	Δti =	**2,1**	°C
Maksimaltemperatur	timax =	**29,2**	°C



Figuren er optegnet på grundlag af regression på tabelværdier i annekis E i DS ISO 7730.

Single room apartment

CO_2-Polution

$$n = \frac{q}{V * (C - C_i)} * 10^6$$
$n = Air\ changes(h^{-1})$
$q = Pollution\left(\frac{m^3}{h}\right)$
$V = Room's\ volume\ (m^3)$
$C = Room\ concentration\ (ppm)\ 850\ for\ category\ II$
$C_i = Supply\ air\ Concentration\ (ppm)\ 350\ ppm\ (CR1752\ s.24)$

$$q = 19 * 10^{-3} * M * P$$
$M = Beklædnindg\ i\ met\ (1{,}2\ met) aktivitets\ niveau$
$P = People\ load$

$$\frac{h^{-1} * m^3}{3600\ h} = m^3/s$$

Rooms	m^2	m^3	$People\ load$	$q\left[\frac{m^3}{h}\right]$	$n\ [h^{-1}]$	m^3/s
Kitchen/Living room	26.4	65,91	1	0,0228	0,69	0,0127
Common room	98.992	247,5	6	0,1368	1,11	0,076

Sensory pollution load

$$Q_c = 10 * \frac{G_c}{C_{c,i} - C_{c,0}} * \frac{1}{\varepsilon_v}$$
$Q_c = Ventilation\ necessary\ for\ comfort\ (l/s\ m^2)$
$G_c = Pollution\ load\ (olf)$
$C_{c,i} = The\ desired\ air\ quality\ (decipol)$
$C_{c,0} = The\ perceived\ air\ quality\ (decipol)$
$\varepsilon_v = ventilation\ efficiency$

$$G_c = \frac{people\ load}{m^2} * 1\ olf + 0{,}1\ olf/m^2$$

The building is low pollution therefore the pollution is $0{,}1\ olf/m^2$ (CR1752 s. 27)

The air in the room is thoroughly mixed, resulting in that the ventilation efficiency is 1

Passive person, 1 – 1.2 met equal to 1 olf

The building is in category II

The perceived air quality $C_{c,i} = 0$ ($CR1752$ s.23)

$C_{c,i} = The\ desired\ air\ quality$ 1,4 (CR1752 s. 23)
$C_{c,0} = The\ perceived\ air\ quality\ 0$

Rooms	m^2	m^3	$People\ load$	$Q_c\ [l/s\ m^2]$	l/s	h^{-1}	m^3/s
Kitchen/Living room	26.4	65.91	1	0,99	25,97	1,42	0,026
Common room	98.992	247,5	6	1,15	113,57	1,65	0,114

$$l/s\ m^2 * m^2 = l/s$$
$$\frac{l/s}{1000} = m^3/s$$
$$\frac{m^3/s * 3600\ h}{m^3} = h^{-1}$$

The air change chosen for the different rooms in the apartments

Rooms	h^{-1}
Kitchen/Living room	**1.42**
Common area	**1,65**

Two-room apartment

CO2-Polution

Rooms	m^2	m^3	$People\ load$	$q\ \left[\frac{m^3}{h}\right]$	$n\ [h^{-1}]$	m^3/s
Kitchen/Living room	11,71	29,3	2	0,0456	3,11	0,025
Bedroom	17,63	44,09	2	0,0456	2,07	0,025
Common area	133,7	334,25	12	0,2736	1,64	0,152

Censorisk (Olf) sensoric

Rooms	m^2	m^3	$People\ load$	$Q_c\ [l/s\ m^2]$	l/s	h^{-1}	m^3/s
Kitchen/Living room	11,71	29,3	2	1,93	22,60	2,78	0,023
Bedroom	17,63	44,09	2	1,52	26,80	3,29	0,027
Common area	133,7	334,25	12	1,36	181,21	22,26	0,181

The air change chosen for the different rooms in the apartments

Rooms	h^{-1}
Kitchen/Living room	**3,11**
Bedroom	**3,29**
Common area	**22,26**

Appendix 5

CALCULATIONS OF THE APPLIANCES

Gram-Hanssen (2005) has given a connection between the size of the apartment and the electricity consumption. The following formula gives an estimate over the electricity consumption for an apartment.

One-room apartment 29 m2
340 kWh+apartment size *11 kWh+occupants*350 kWh
340 kWh+29 m^2*11 kWh+1 persons*350 kWh=1009 kWh

Two room apartment 37 m2
340 kWh+37 m^2*11 kWh+2 persons*350 kWh=1447 kWh
[Jensen, Nørgaard, Daniels, Justesen, 2011]

Appendix 6

Bsim

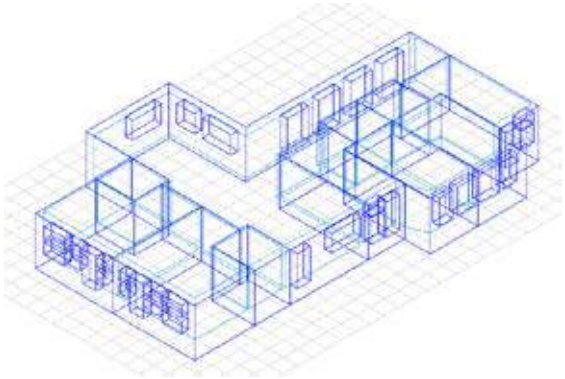
Bsim is an hourly calculation simulator sued to give an estimate of the indoor environment. This program gives a more detailed description of the indoor environment in comparison to be15, showing extreme results on an hourly basic.

The building is divided into thermal zones depending of the rooms function. This calculation is for two, two-room apartments and two one-room apartments plus a common area. The walls and ceiling is facing inwards and the thick walls and floor is facing towards the outside.

These apartments is chosen because they are thought to be the most critical in terms of overheating and therefore can be used as an representation for all the apartments.

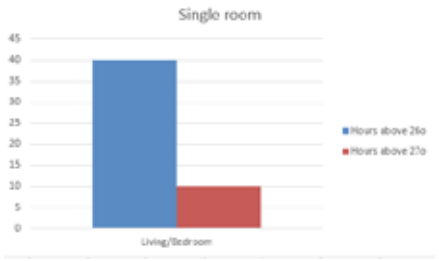
To get as realistic results as possible multiple systems has been used for the simulation, This includes equipment, heating, infiltration, people load, ventilation, and venting. The heat load for the equipment is calculated with a formula by ''Gram-Hanssen 2005'' that give the energy requirements based on the size of the apartment and the number of occupants see appendix 5. The ventilation is calculated based on a CO_2 pollution and a sensory calculation, the two is the compared and the one with the highest air change rate was used see appendix. The ventilation and heating is controlled by the temperature of the room, so the heating will not turn on before the temperature drops below 21°C and the ventilation will start when the temperature reaches 22°C for the natural ventilation and 18°C for the mechanical. To save energy a hybrid ventilation system is used with mechanical ventilation with heat recovery in the winter and natural ventilation in the summer. The equipment and people load is created after a typical retirement home.

The outline for the indoor environment inside the apartments is described on page 67.

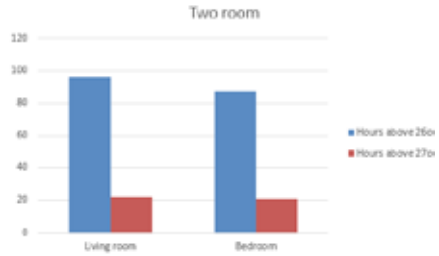


BSim model

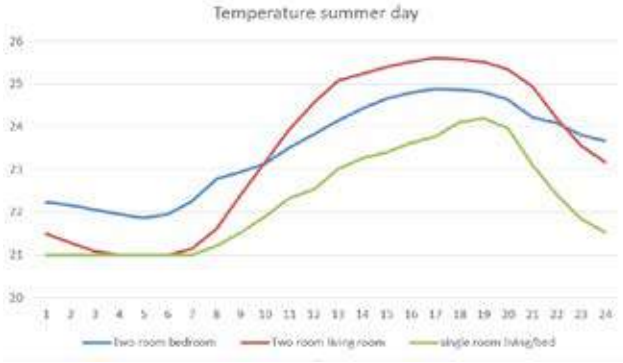
CO_2 levels



Single room apartment



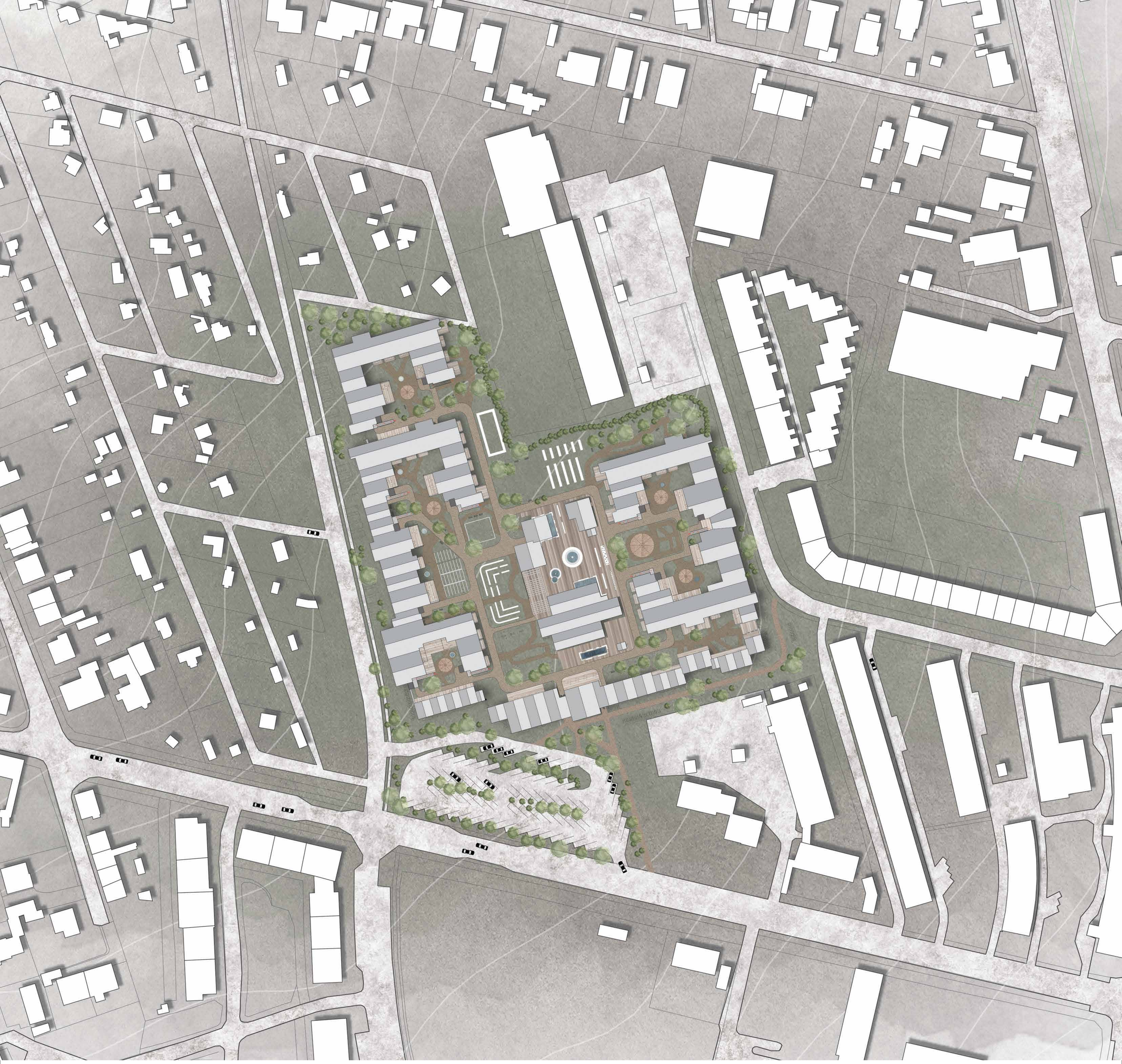
Two room apartment



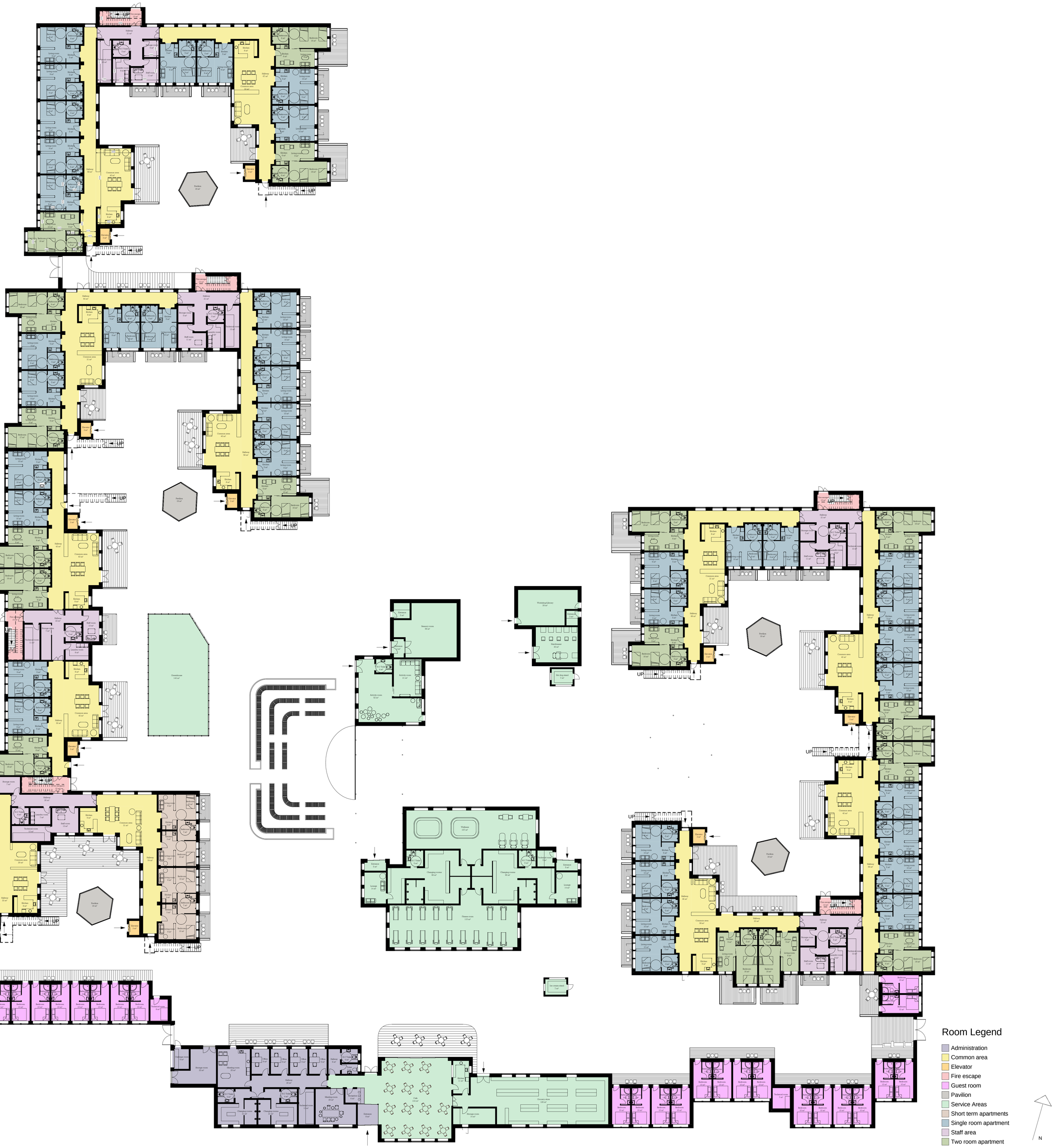
Max temperature on a summer day

	Project name: Dementia & Brain Center, Aarhus		Scale: 1:500
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A101
	Drawing: Ground floor		

AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:500
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A102
	Drawing: First floor		



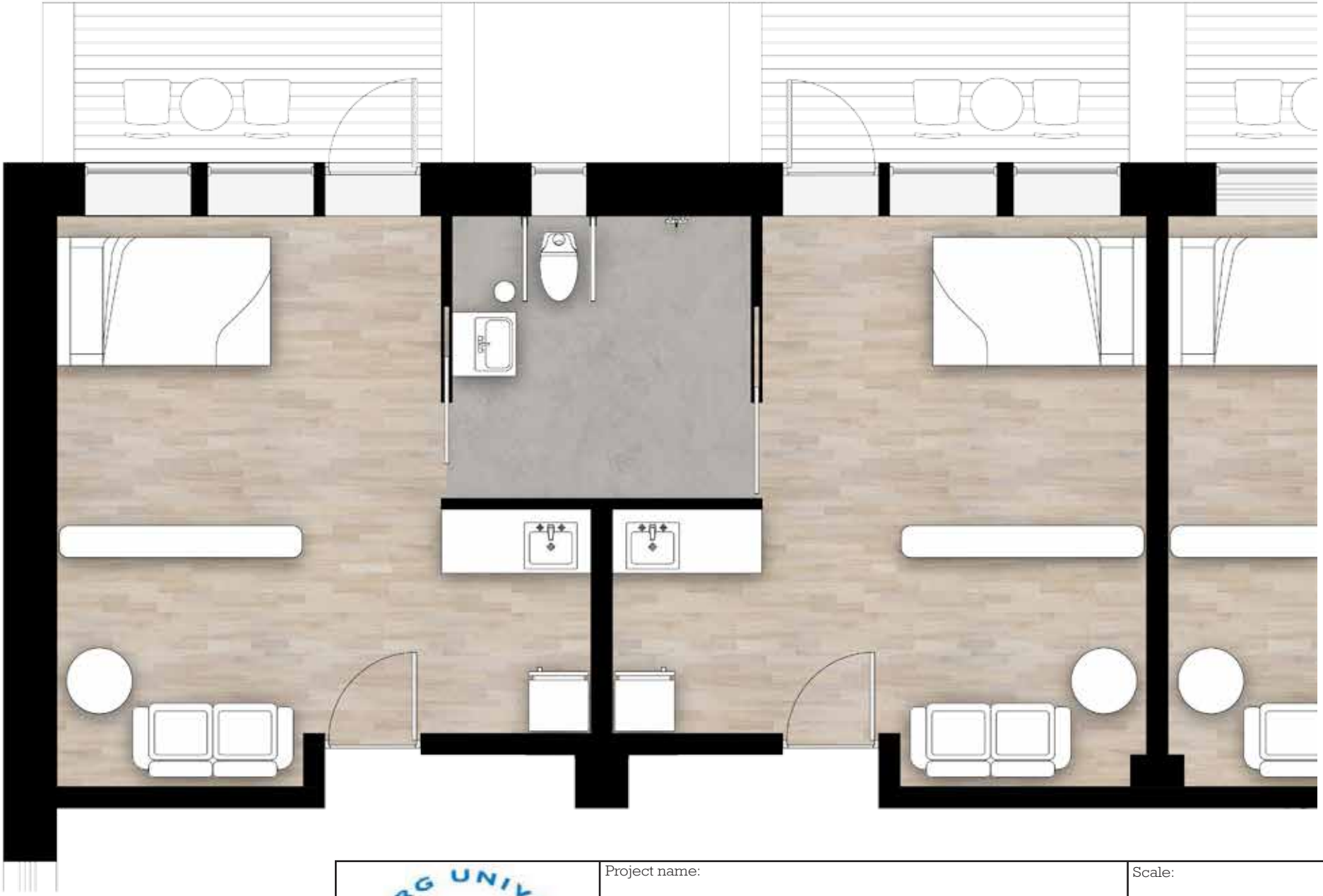
AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:500
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A103
	Drawing: Site plan		



Project name: Dementia & Brain Center, Aarhus		Scale: 1:200
Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A104
Drawing: Plan overview		

AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:50
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A201
	Drawing: Single room apartment		

AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:50
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A202
	Drawing: Two room apartment		



AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:50
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A203
	Drawing: Short term apartment		

AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:200
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A301
	Drawing: North elevation		

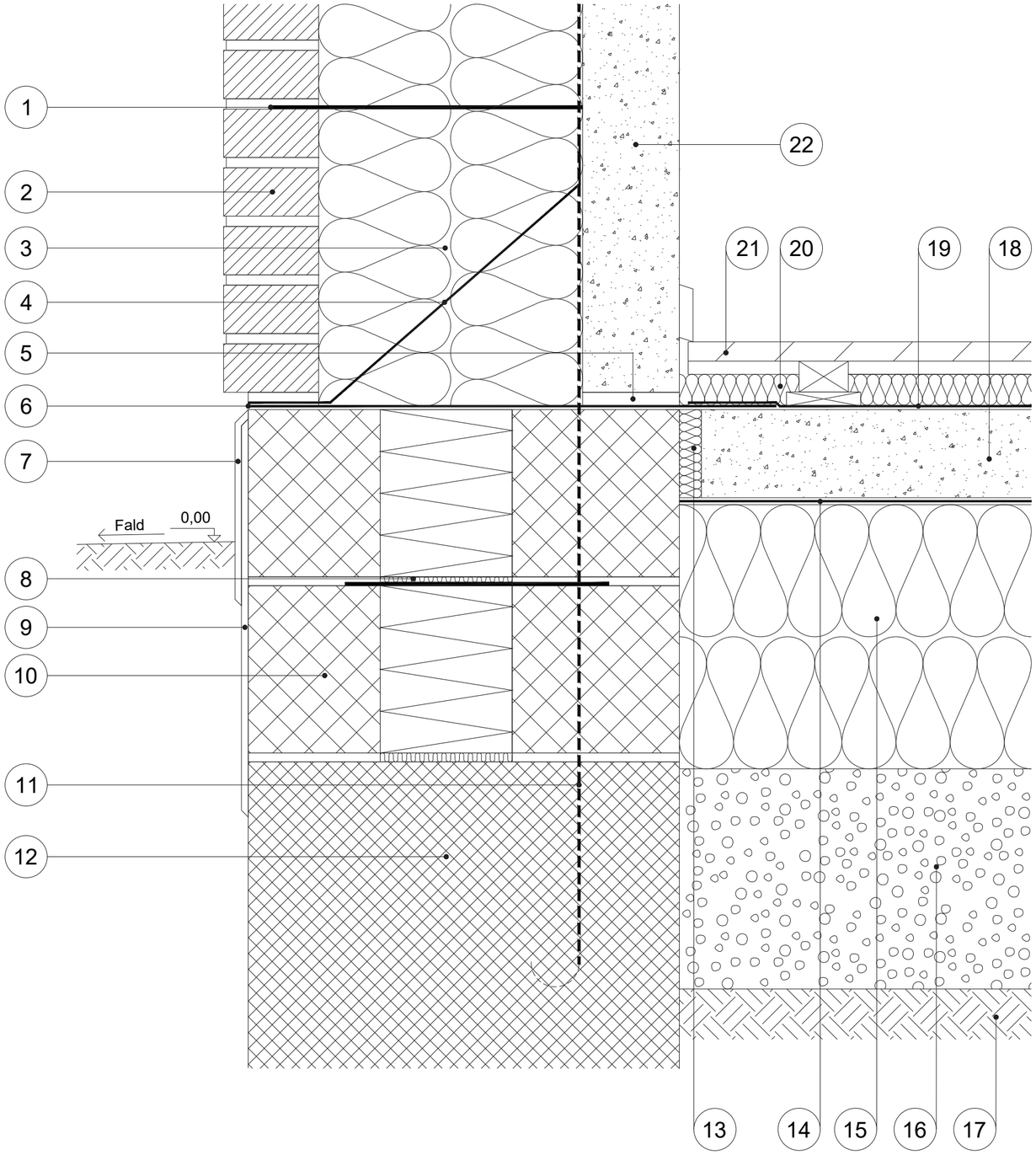
AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus	Scale: 1:200
	Drawn by: MSc04 ARC Group 23 / Date: 25/5-2016	Drawing. nr: A302
	Drawing: East elevation	

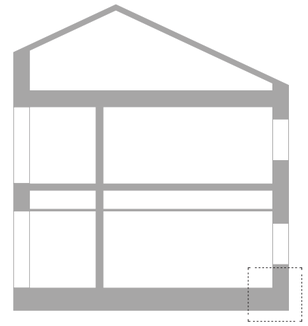
AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:200
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A303
	Drawing: South elevation		

AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:200
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A304
	Drawing: West elevation		

AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:200
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A401
	Drawing: Section A-A		

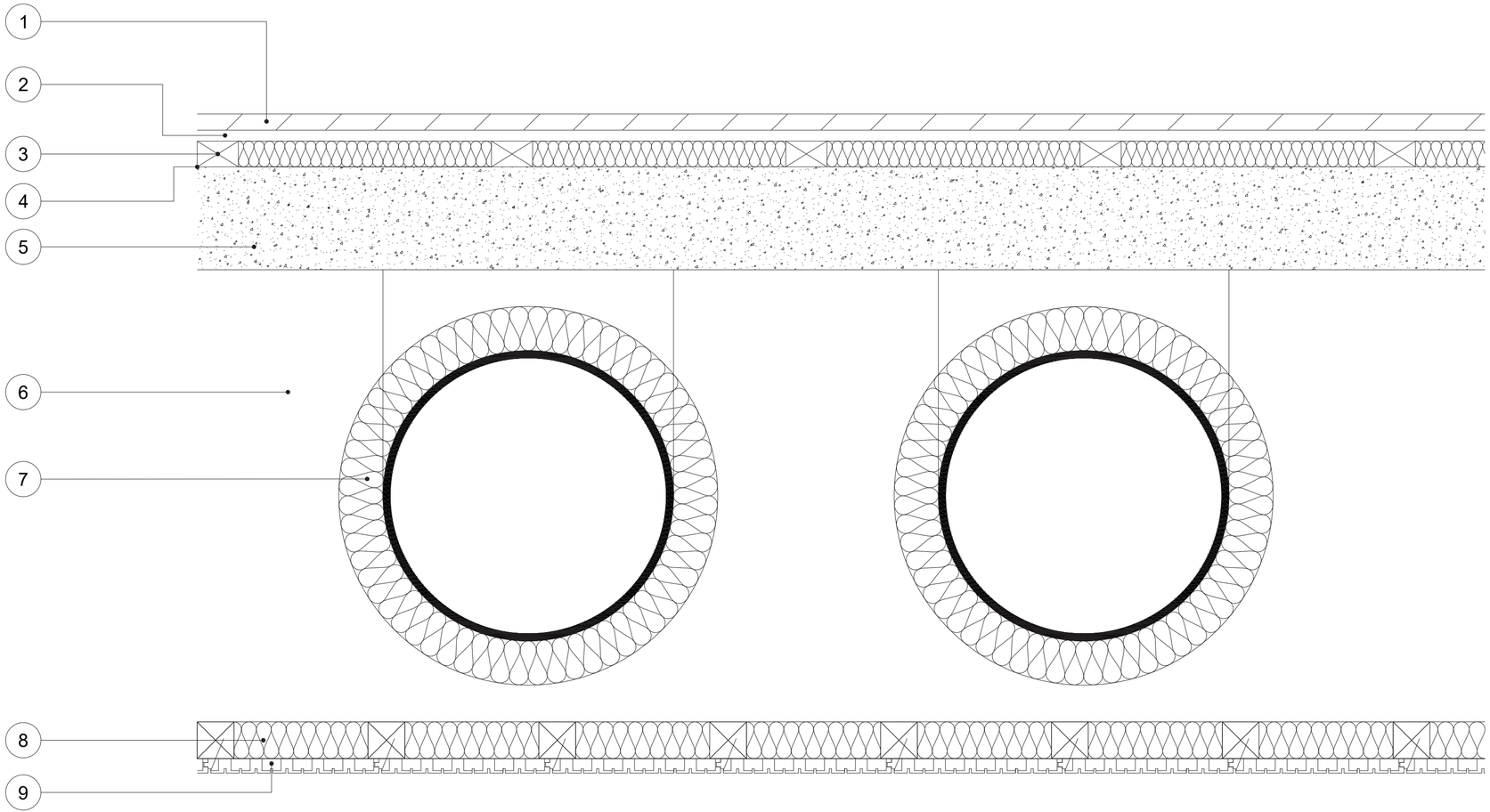
Project name: Dementia & Brain Center, Aarhus		Scale: 1:200
Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A402
Drawing: Section B-B		

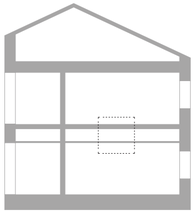




1 Brick tie
2 Brick 108 x 54 mm
3 Insulation 2 x 150 mm
4 Moisture barrier
5 Mortar joint
6 Moisture / Radon barrier
7 Plinth plaster
8 Tie / Joint insulation
9 Plaster
10 Leca termblokke 390 mm
11 Roof anchor
12 Concrete foundation
13 Edge insulation 25 mm
14 Casting surface
15 Insulation 2 x 150 mm
16 Clay aggregate 250 mm
17 Ground
18 Reinforced concrete 100 mm
19 Moisture barrier
20 Joist 35x56 mm / Insulation
21 Laminated floor 22 mm
22 Concrete 110 mm

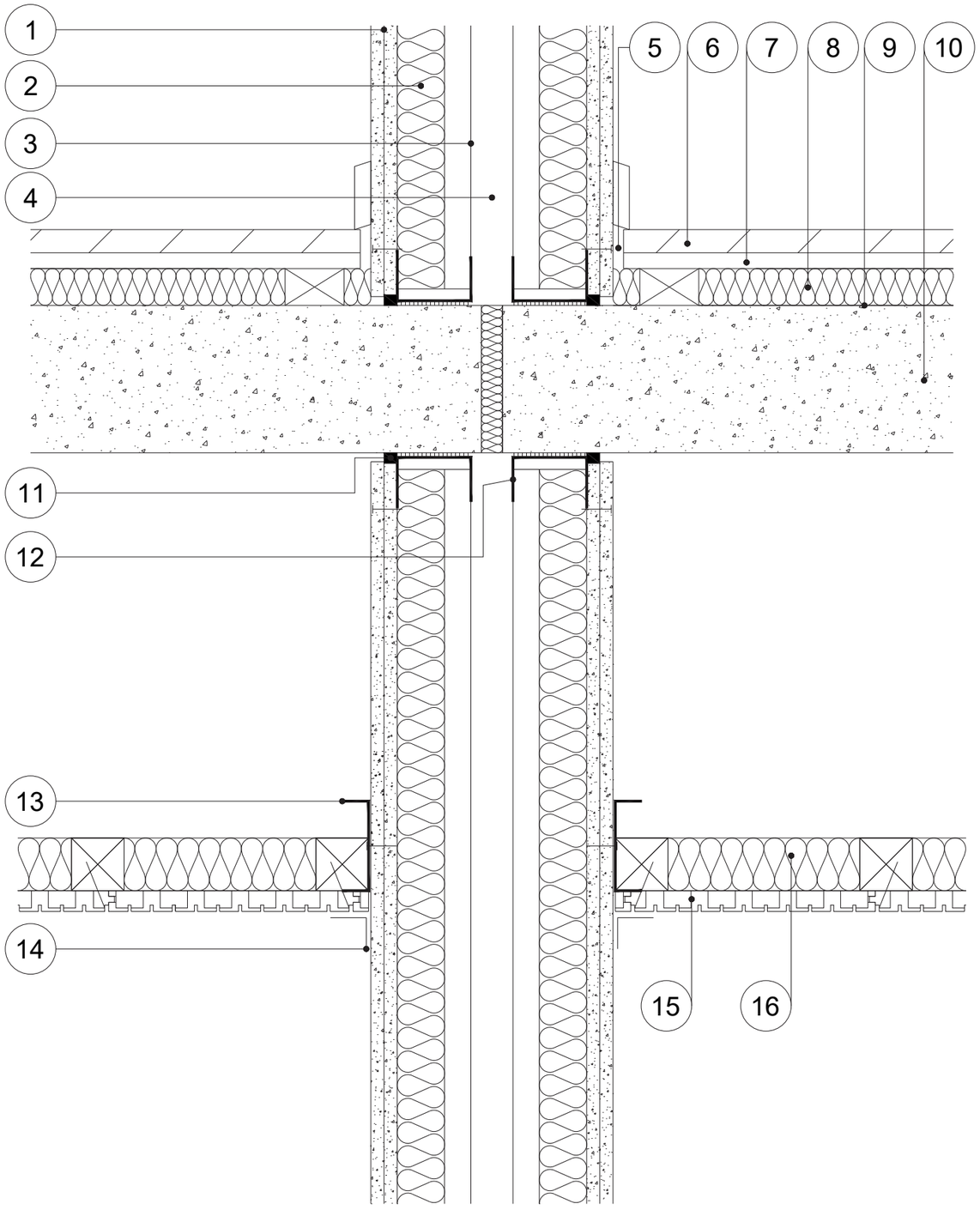
AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:5
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A501
	Drawing: Foundation		

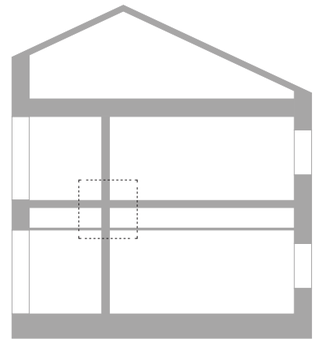




1. Laminated floor 22mm
2. Sound insulation plate 15mm
3. Joist 35x56 mm / Insulation
4. Moisture barrier
5. Reinforced concrete 140 mm
6. Suspended ceiling 615 mm
7. Ventilation Duct with fireproofing insulation 70 mm
8. Batten 50x50 mm / Insulation
9. Linear panel 20 mm

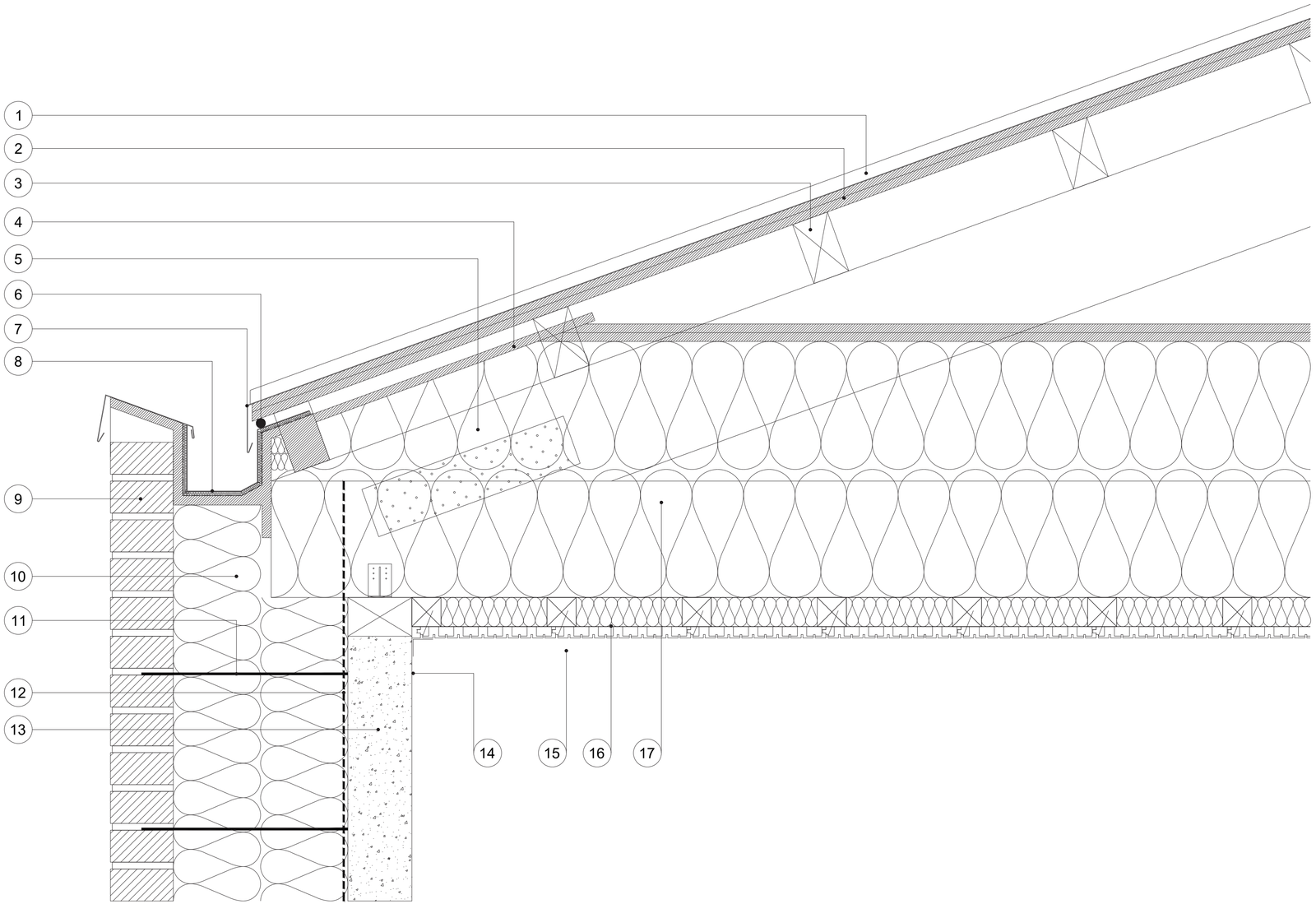
AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus	Scale: 1:5
	Drawn by: MSc04 ARC Group 23 / Date: 25/5-2016	Drawing. nr: A502
	Drawing: Floor slab	

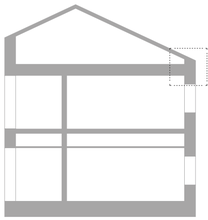




1 Plasterboard 2 x 12,5 mm
2 Insulation 45 mm
3 Stud pr. 450 mm
4 Empty cavity 40 mm
5 Joint min. 10 mm
6 Laminated floor 22mm
7 Sound insulation plate 15mm
8 Joist 35x56 mm / Insulation
9 Moisture barrier
10 Reinforced concrete 140 mm
11 Rubber joint
12 Top and bottom rail
13 Wall rail
14 Filler tape
15 Batten 50x50 mm / Insulation
16 Linear panel 20 mm

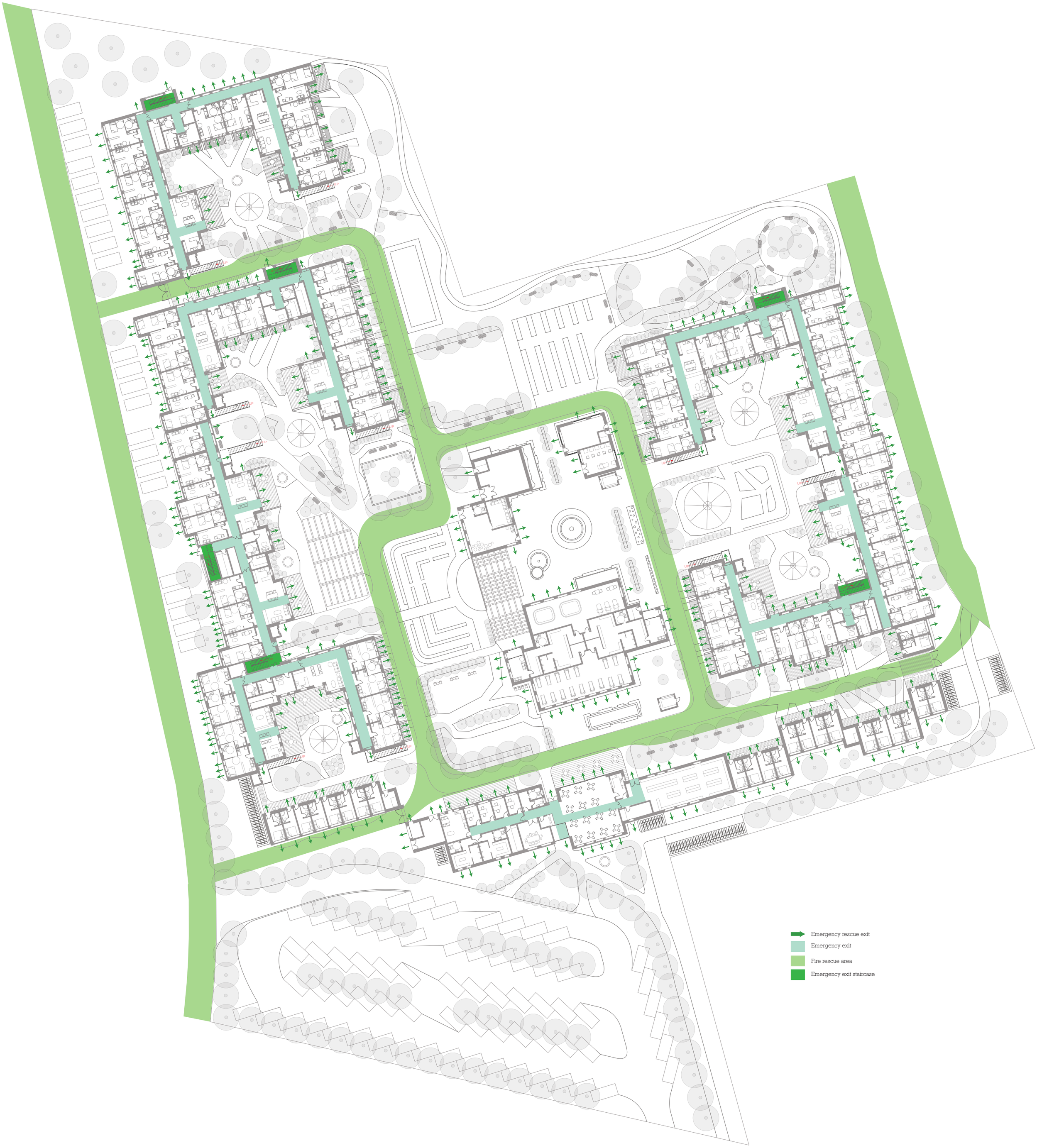
AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:5
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A503
	Drawing: Partition wall		





1. Roof felt with triangular profiles
2. Plywood 2 x 15
3. Tile battens 60 x 100
4. Wind board
5. Rafter 45 x 220
6. Snow stopper
7. Eaves drip
8. Gutter
9. Brick 108 x 54 mm
10. Insulation 2 x 150 mm
11. Brick tie
12. Roof anchor
13. Concrete 110 mm
14. Filler tape
15. Linear panel 20 mm
16. Batten 50x50 mm / Insulation
17. Insulation 2 x 220

AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:5
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A504
	Drawing: Roof		



AALBORG UNIVERSITY DENMARK	Project name: Dementia & Brain Center, Aarhus		Scale: 1:500
	Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A601
	Drawing: Fire plan ground floor		

Emergency rescue exit
Emergency exit
Fire rescue area
Emergency exit staircase

AALBORG UNIVERSITY DENMARK

Project name: Dementia & Brain Center, Aarhus		Scale: 1:500
Drawn by: MSc04 ARC Group 23	Date: 25/5-2016	Drawing. nr: A602
Drawing: Fire plan first floor		