# FOREST HOUSE

## - A SUSTAINABLE INSTITUTION OF THE FUTURE

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Aalborg University

# COLOPHON

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# ABSTRACT


This thesis project revolves around a design of an integrated institution placed in Dyrhaven in Skanderborg, which is a recreational area containing large areas of forest and lakes.

The greatest and fastest learning we experience in childhood, therefore, this period is a great starting point for the rest of our lives.
This is why it's important to put a big focus on the surroundings and relationships that children are expose to already from the beginning of their lives.

A large part of today's institutions are older buildings whose main purposes have not been childcare, and the outdated conditions can have a negative impact on children's development.
Therefore, it is important to make an effort to create the best possible framework for children's development in the institution

In addition, energy and sustainability are also an important issue during this time, it is important to think about the planet that we must pass on to the future generations; therefore this project strives to create a new institution for today's and future children.
Where there is focus on development, energy and sustainability.

The institution will form the framework for 140 children with in the area of around 1700 m2.

Through the Integrated Design process, the project takes shape and integrates various topics such as early childhood development, the approach of Reggio Emilia and sustainability in relation to energy.

The integrated institution aims for an energy frame of BR20 (low-energy), in addition, the project has a great focus on ensuring good indoor climate conditions in relation to daylight, acoustics and thermal and atmospheric indoor climate. The project also works with integrating and using materials with one a low CO2 imprint on the environment.

# READERS GUIDE

In this report, an understanding of the design of this sustainable integrated institution which is located in beautiful forest surroundings in Skanderborg. The development of this report is structured in such a way that it contains 6 chapters, each focusing on different areas of the project.
This report must provide the reader with an understanding of the finished project and the path to it.

Chapter 01: PROLOGUE
This chapter creates an insight into the overall approach of project and it creates a solid foundation for the further development of project.

Chapter 02: PROGRAM
This chapter contains the program for the design - this is where the information and data are gathered through various analyzes that were necessary to create an understanding of both the area in which the design is located, but also other important information that can help control the project's progress. In this phase investigations about the site, the micro climate, the research in the field of children in institutions, but also topics in relation to the great energy demands the future holds.

Chapter 03: PRESENTATION
In this chapter, the final design will be presented through various illustrations.
These are diagrams, plans, sections, elevations, details and various measurements and results of energy and indoor climate conditions. In addition, there will be different visualizations that create a spatial understanding of different places in the building but also gives an idea of the atmosphere that is exactly in that place in the building.

Chapter 04: DESIGN PROCESS
This chapter contains a section of the long process that underlies the final design. Since the design process is a long iterative process, where it is going back and forth to different phases and topics throughout the design phase. It is difficult to describe without appearing chronologically, however, this is not the case. Therefore, this chapter is structured in such a way that the order in which the process is read must give an over-assured insight into how the process has been.

Chapter 05: EPILOGUE
In this chapter, the rounding of the entire project is described through a conclusion and a reflection of the project. In addition, this chapter also contains a list of the literature and all the illustrations in the report.

Chapter 06: APPENDIX
This chapter contains various appendixes that can create a greater understanding of different areas and processes that are not included in the report.

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# INTRODUCTION AND MOTIVATION

## Introduction

This master thesis project revolved around a design proposal for a new intergraded institution located in Skanderborg, Denmark.

Skanderborg is a smaller town approx. 30 km from Aarhus, with around 61.150 inhabitants.

The site is located in the vicinity of the area Sølund.
It is in the southern part of Skanderborg, in close connection with forest, green areas and Skanderborg Lake. In the forest close to the site, the famous Skanderborg festival is held every summer.

Today the area is a green recreational area located in the beautiful natural areas Dyrhaven in the southern part of Skanderborg. Here the area is characterized by lots of nature and lake areas.

In the municipality of Skanderborg there has been a large influx of people and there is a high birth rate, which results in a greater need for more childcare facilities. In 2017 Skanderborg was one of the municipalities with the highest fertility on 2, 39 live-born children per. woman and that result in a greater need for childcare facilities. (Dst.dk, 2017)

In the municipality of Skanderborg, a new integrated institution is being planned, which forms the basis for choosing a site and general information about size, number of children, etc.
In addition, the site is located in the middle of the beautiful nature in Skanderborg, which forms a good base for an institution in close connection with nature.

## Motivation

The reason for choosing this topic is based on personal interest in the future childhood education. The reason is also that there is a considerable need for buildings in the educational and childcare sector.
A great number of schools are currently being built, but there is also a need for preschools, kindergartens and daycare facilities.

Every day, most parents hand over their children to care for in another place while they are at work. Therefore, it makes sense for me to have a great focus on the hours and the environments you cannot be with your child.

The environment has a great influence on children and since today's children are the adults of the future, it is extremely important to maintain or establish the best conditions for today's but also the future children. In this way it creates the best conditions for the future society.

Today, a lot of institutions are public, where the economy creates the foundation for the building. Therefore, many of the important areas such as indoor climate acoustics and the materials, is set to a minimum so that it comply with the requirements of the building regulations but do not focus on health and development in the institution.
Therefore the project is focusing on the children's development, what affects their development in positive but also negative way so that it is possible to make the initiatives in all the areas where the institutions can predict a negative development for the children.

In addition, we all have a responsibility in relation to our planet and if we, as both individuals but also as a society, start to lift together, we can create some good framework for the children of the future. Therefore, this project is also characterized by sustainability with a focus on energy and $CO_2$ imprints.

Ill. 1 Location on country map
(Own illustration)

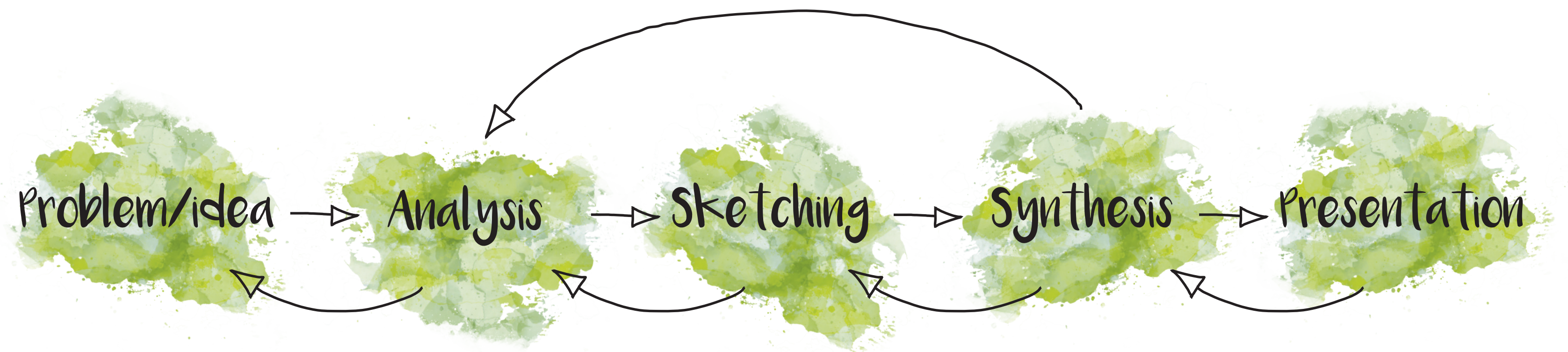
# METHODOLOGY

Today, there is a greater need to use integrated design.
In order to secure a construction in the future, great demands are made. The focus is on energy and use of renewable energy solutions, various passive and active strategies there must be incorporated to achieve the requirements and regulations the future holds.

The methodology forms the base of a project and it is an important tool. The methodology can be an overall approach to designing the project, but during the project several different methods can also be used and integrated, which helps to manage and investigate various topics in the project.
Methods are not established and it is therefore important to consider which methods are relevant to the individual project.

The methodology that makes the foundation for this master thesis project is the Integrated Design Process (IDP). The method has a hermeneutic approach and IDP is the new interpretation and further development of the more known method Problem Based Learning. (PBL) The IDP is defined by Mary-Ann Knudstrup Aalborg University in 2005. [Knudstrup, 2005]

The focus of the method is to integrate and combine knowledge's form architecture with the engineering so an interdisciplinary between the two areas is created. By integrating knowledge from the two different areas, it is possible to solve the difficulty of creating a building design that today must comply with many energy- and sustainable requirements.
Throughout the process there must be a balance between implementing and solving different problems, thus collecting new knowledge that can be used in the design phases. . [Knudstrup, 2005]




*Ill. 2 Intergraded Design Process [Knudstrup 2005] (Own illustration)*

The method contains 5 phases see Ill. 2 that are processed through an iterative process, thus different results and solutions are reconsidered as new knowledge or insight is collected throughout the process. Therefore, the project ends up being reconsidered and modified countless times to achieve the most integrated and accomplished design.
The following review will describe the 5 phases and which areas and studies will be reviewed through the design process of the Sustainable integrated institution, how they are approached and why they are used.

The methods first phase is **The Problem**: here a formulation is made which describes the contents of the project.

**The Analysis phase:**
Creates the foundation for research and analyzes where the projects overall framework is defined but also various analyzes about relevant topics are made.
The projects overall framework is documented through literary studies of Reggio Emilia Philosophy, research from Harvard related to early childhoods development and finally Sustainability with the main focus on energy.
Analysis of the selected site is examined through, data based on the sites micro climate but also phenomenological studies that are documented by visiting the site area. Analysis inspired by different methods are included as Gordon Cullen's "Serial Vision" (Cullen, 1961) and Norberg Schulz's"Genius Loci". (Norberg-Schulz, 1996)
In addition, the analysis phase also contains literature studies of the recent years' research within institutions and also various Case Studies that can compare the relationships between theory and practices and provide insight into context and the daily life in an institution.
This phase ends in design criteria and a vision for the project.

**The Sketching phase:**
In this process, the focus is to sketch various proposals that integrate knowledge from the analysis phase. In this phase, the iterative process is very active as it is often needed to return and search out new areas and compare design proposals based on the design criteria's and analyzes.
Here are the primary tool hand sketches, diagrams and various computer simulations, energy calculations, indoor climate simulations and 3D programs. All tools together help to create a technical, spatial, functional and aesthetic understanding of the design.

**The Synthesis phase:**
Here, the design reviews the last adjustments and a larger detailing of the project is achieved.
During this phase, it must be ensured that the design criteria and requirements for the design are fulfilled. In this phase, tools are used such as e.g. are BE18, EIS / BSIM, Adobe programs etc.

**The Presentation phase:**
It is in this phase the project must be presented through various media such as the report, drawing folder, models and posters.
Here, all the qualities of all the projects must be highlighted and made visible through e.g. plan drawings, facades, sections, diagrams and visualizations.

# 01

# PROLOGUE

REGGIO EMILIA -PHILOSOPHY

CHILDHOOD DEVELOPMENT

SUSTAINABILITY

SUSTAINABILITY AND ENERGY CONSUMPTION

Ill. 3 Picture of a cut down trunk on the site (Own photo)

# REGGIO EMILIA - PHILOSOPHY

The approach of Reggio Emilia is an educational philosophy where the focus is children in the preschool age.

The creation of the philosophy starts around the Second World War, in the city Reggio Emilia which is located in the northern part of Italy. Here some locals with the support from Loris Malaguzzi started to develop preschool institutions and that was the start of the approach. [Arseven.A. 2014]

It started in Italy but today it has inspired the rest of the world as one of the top pedagogical approach in early childhood education.

The founder Loris Malaguzzi's background was education in psychology and pedagogy; He had a special image and perception of children and breaks with the traditional image of them being egocentric and with great focus only on cognitive development. He saw children as small individuals who were curious about life and who from birth has certain intelligence. In addition, he argued that all children have potential and must have the rights to expand and realize them. [Valentine, M. 2006]

The Reggio Emilia approach contains various topics about the child and how to use the method as a basis for early childhood education. To create an overall understanding of philosophy, there are some basic principles:

- The perception of children
- The way children can express themselves
- The child in the center
- Cooperation and relationship between school and parents
- The environmental aspects
- Development and training of pedagogues
- Social ability through relationships

It is fundamental and very important that the child interacts socially as part of the learning, being able to cooperate, work and play with others and be able to communicate with other children.

The physical environment is creating the framework to unfold the children's potential, here the architecture must contribute.

*Ill. 4 Children's early development (Own illustration)*

A design with large rooms and open areas that creates the possibilities for children to interacting with others and thereby being open to each other but also exposed to the values that lie in openness. Being able to learn about diversity, culture, religion, language, gender, adults and children.

The child have unlimited potential and all children develops differently and have different ways of expressing themselves.

Malaguizzi stated that children have 100 different languages:

- 100 languages to discover
- 100 languages to invent
- 100 languages to imagine

[. . . ] [Arseven.A. 2014 pp. 167]

This means that children have different ways of finding and expressing themselves if the right framework is created. The pedagogue must also help the children in the right direction, through support and guiding them in the choices they make. Children can express themselves for example by drawing and painting, construction with block, making sculptures, but also through playing. [Valentine, M. 2006]

*Ill. 5 Let creativity flourish - (Beautiful Minds Therapy, n.d.)*

# CHILDHOOD DEVELOPMENT

In addition to the Reggio Emilia approach, research about early childhood development will be investigated. An understanding of a child's developing abilities will secure that the institution can create the framework the child needs to develop. The Rauch Foundation found out that 85% of the brain is developed before the age of 5. [Rauchfoundation.org, n.d.]

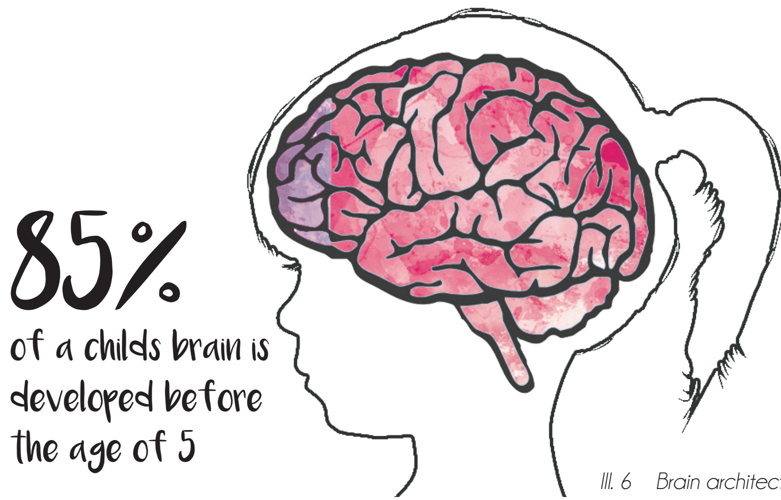
**Brain architecture**

The basic architecture of the brain is created through long process, that startes before the child is born and goes into the adulthood. The brain is formed through a process that can be compared to the way you build a house, first the foundation is made, and then you plan the space distribution and then finally connect electrical components to get light in the building.

Genes form the basis of a brain, but experiences contribute to the process in the development of the brain and thereby form a strong or weak basis for all learning, behaviors or health. Therefore, the first time is so important for a child's further development in life, because it is here that the basic elements are created. It works in such a way that the brain develops by the fact that billions of brain cells send electronic signals to each other to communicate, these signals from different circuits are those that form the basis of brain development. Our experiences and surroundings determine which circuits and signals are used the most and these become stronger and more permanent. The connections that aren't used disappear slowly. These important circuits develop slowly and create more connections in the brain, thus developing different competencies such as visual, emotions, motor skills, behavioral control, language and memory. [National Scientific Council on the Developing Child, 2007]

**Serve and return**

The serve and return means the back and forth interactions between a child and an adult, which is very important for development and further learning for a child. Since the brain is created so that you develop by adding and combining already acquired knowledge. It is important for parents but also educators/pedagogues in institutions to interact with the child, respond to feelings or actions they show. It may be, just to have eye contact with the child, respond with words or affection or by physical confirmation. If the child does not get the positive stimulation, the body will begin to stress, thereby sending harmful stress hormones to the developing brain, which may damage the brain. Thus, these caring relationships between child and adult are an important part of the development of a child. [Center on the Developing Child at Harvard University, n.d.]



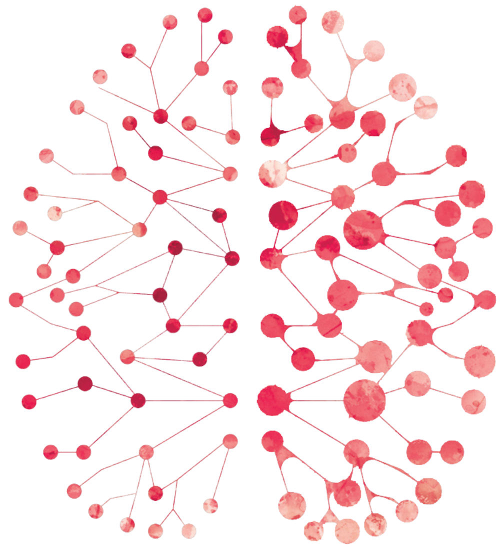

*Ill. 6 Brain architecture (Own illustration)*

**Toxic substances**
To build a healthy and durable brain at an early age, a natural biochemist process occurs. This biochemical process can be disturbed by various chemicals containing heavy metals. These chemicals are found in many different places, it can be in foods (mercury in fish), synthetic materials, such as paint, dust and soil. It is therefore common that they are present in many places and because they are slowly being decomposed, toxins are released which children then can inhale, eat or obtain through the skin.

This release of these chemicals is called degassing of chemical substances which are released into the environment. [Center on the developing child, Harvard University, 2006]

**Daylight**
It is proven that daylight gives people a positive feeling, but it can also contribute to psychological benefits for children. In France in 2012, a survey of over 2000 children was made across Europe. This study dealt with whether the amount of daylight in the classroom could have an impact on the children's performance. The experiment showed that up to 15% of students improved their results in mathematics and logic. The productivity of the children was increased and the mood was improved, by combining south-facing windows and effective sun shading as well. This indicates that daylight has a great influence on children. When you spend approx. 90% of the time indoors and 2/3 of that time is spent at home and 1/3 out of the home. It is important to do something both in the institutions but also in the home. [Velux.com, n.d.]

Daylight is also important to make sure that the "inner clock" is functioning so that you have a circadian rhythm. Having a natural understanding of light and darkness creates a connection between night and day. This is very important for all people but especial for children. Different studies show that children have difficulty falling asleep when it is bedtime because they don't get enough daylight during the day and too much artificial light during the evening. This is the result of the chemistry of the brain is not synchronized and therefore cannot distinguish between day and night. [Parentingscience.com, 2018]



*Ill. 7 Circuits and electrical signals - (RED. shutterstock.com, n.d.)*

# SUSTAINABILITY

The concept of sustainability is difficult to define, as it can be interpreted and divided into many different areas. The concept is complex and therefore it is important to delimit and define how sustainability is used in the project. In order to work with the concept as a design parameter, when creating a building the focus often is energy. Here sustainability can help to produce or optimize energy in a building. Another thing is to reduce the energy in the design as a sustainable initiative.

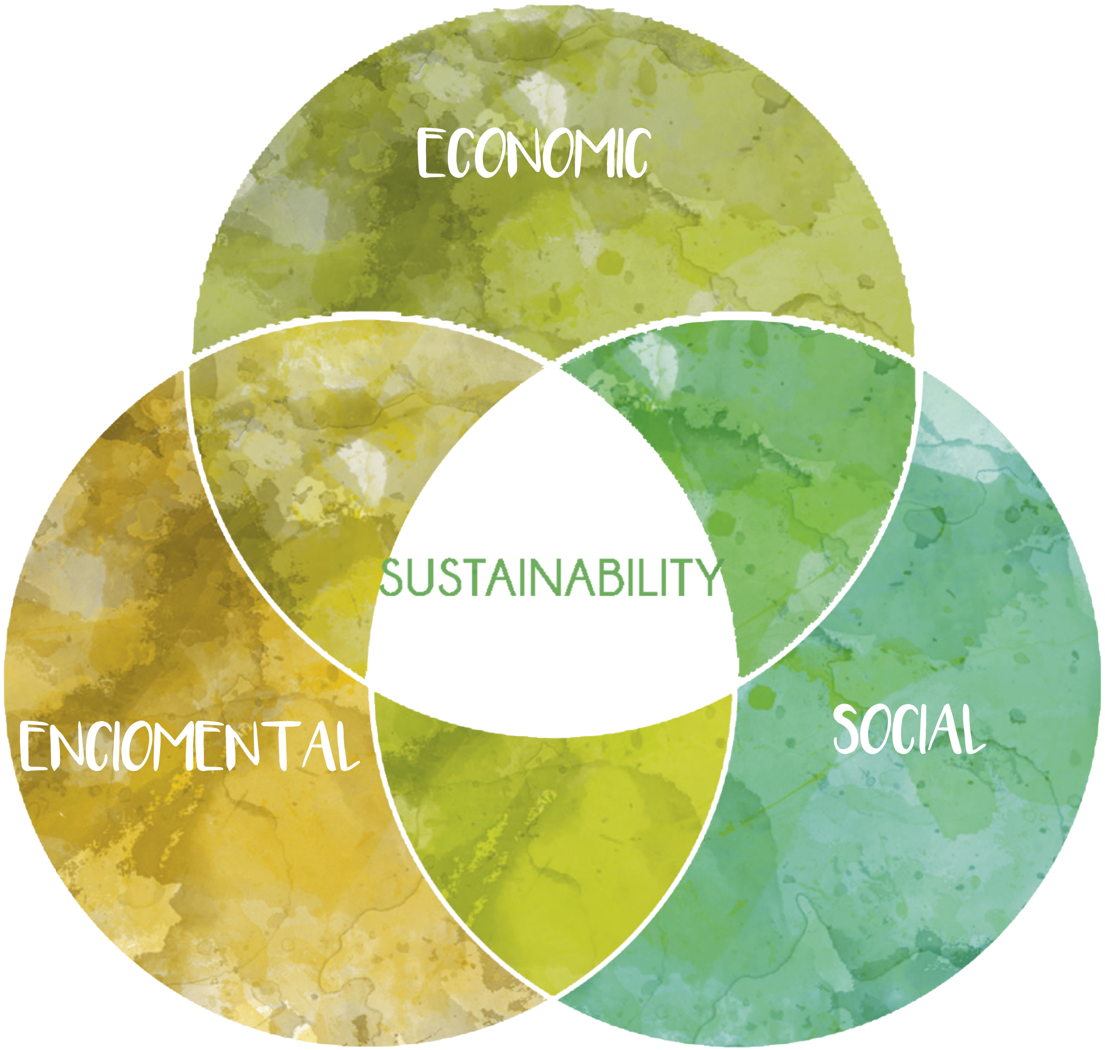
The most common approach to sustainability is focusing on 3 different areas, social, economy and the environment. [Kongebro.S. (2012]

**Social Sustainability**
The social sustainability is about creating the best framework for the people in and around the building area, here there is a focus on health, comfort and the indoor climate. In addition, it is also about a safe and secure place to stay. In order to create optimal indoor climate, work must be done in terms of, temperature level, air quality, daylight conditions and acoustics.

**Economical sustainability**
The economic sustainability is about creating a balance between the overall economy and its overall quality throughout the lifetime of the building. Good utilization of the buildings area with a focus on flexibility, so the building has good opportunities throughout its lifetime.

**Environmental Sustainability**
The environmental sustainability focuses on nature and the climate. In the construction industry it means reducing emissions and the use of problematic substances that can cause damage to the environment and affects the health by staying in the building.
In addition, a building design must have a preference for resource utilization, preservation and utilization of the site.
Eco-friendly materials are also preferable when referring to environmental sustainability.
When talking about exposure, it is common to mention the LCA-analysis, which is a life-cycle assessment, which gives an insight into the buildings environmental impact.
LCA looks at the lifetime of the building, the individual materials, which resources are used to produce and procure them. [Energistyrelsen, (2015)]

Today, there are also certification that can measure how sustainable a construction is. This certification is referred to as DGNB and, depending on how sustainable it is, the buildings are divided into classes, bronze, silver, gold and the best platinum.




*Ill. 8 Areas in Sustainability (Own Illustration)*

# SUSTAINABILITY AND ENERGY CONSUMPTION

In the construction industry, there are a lot of ways to incorporate sustainability into a building and it is therefore important to define which elements to focus on in order to measure and document it later on.

Since much of the building's energy is locked in the way the building is designed, it will be obvious to start by focusing on the energy consumption.

The Integrated Design Process by Marry Ann Knudstrup is a good opportunity to create and to integrate knowledge from the architecture and the engineer subject area, which can then help create a sustainable design with a focus on aesthetic and technical solutions.

From the start it is important to analyze all the areas that have influence on energy consumption, it is easier to integrate it from the start.

It is possible to future-proof the building if it is made with an energy-reduced design from the start, as it is always possible to optimize the building with simple actions.[Kongebro, 2012]

EU and the Danish Building Regulations have set requirements for buildings energy consumption and this will only be tightened in the coming years. In 2020 the target is to reduce the energy framework for all new construction by 75% which is measured in relation to the level that was set in 2006 and that is a significant difference compared to the low-energy strategy in the BR10. Here it was only reduced by 25% so the requirements for the buildings will only be greater in the future, which makes it more important to focus on it. [Marsh, 2011]

When talking about IED or Integrated Energy Design, the key element of a sustainable design is to:

- REDUCE
- OPTIMIZE
- PRODUCE


*Ill. 9 Key elements in IED (RED. - Kongebro, 2012)*

Ill. 9 shows a diagram of how to perceive sustainability in relation to reducing the energy consumption through a well-designed building. Here the foundation of the triangle is the reduction of energy through suitable strategies that will function throughout the lifetime of the building as they help to form building physically.

The next step in the triangle is to optimize the energy requirements through technical solutions, such as ventilation, daylight etc.
The price for integrating the technical solutions can be high, but taking the long lifetime into account it isn't that expensive.
That's because of the low operating costs and focus on minimal $CO^2$ emission.

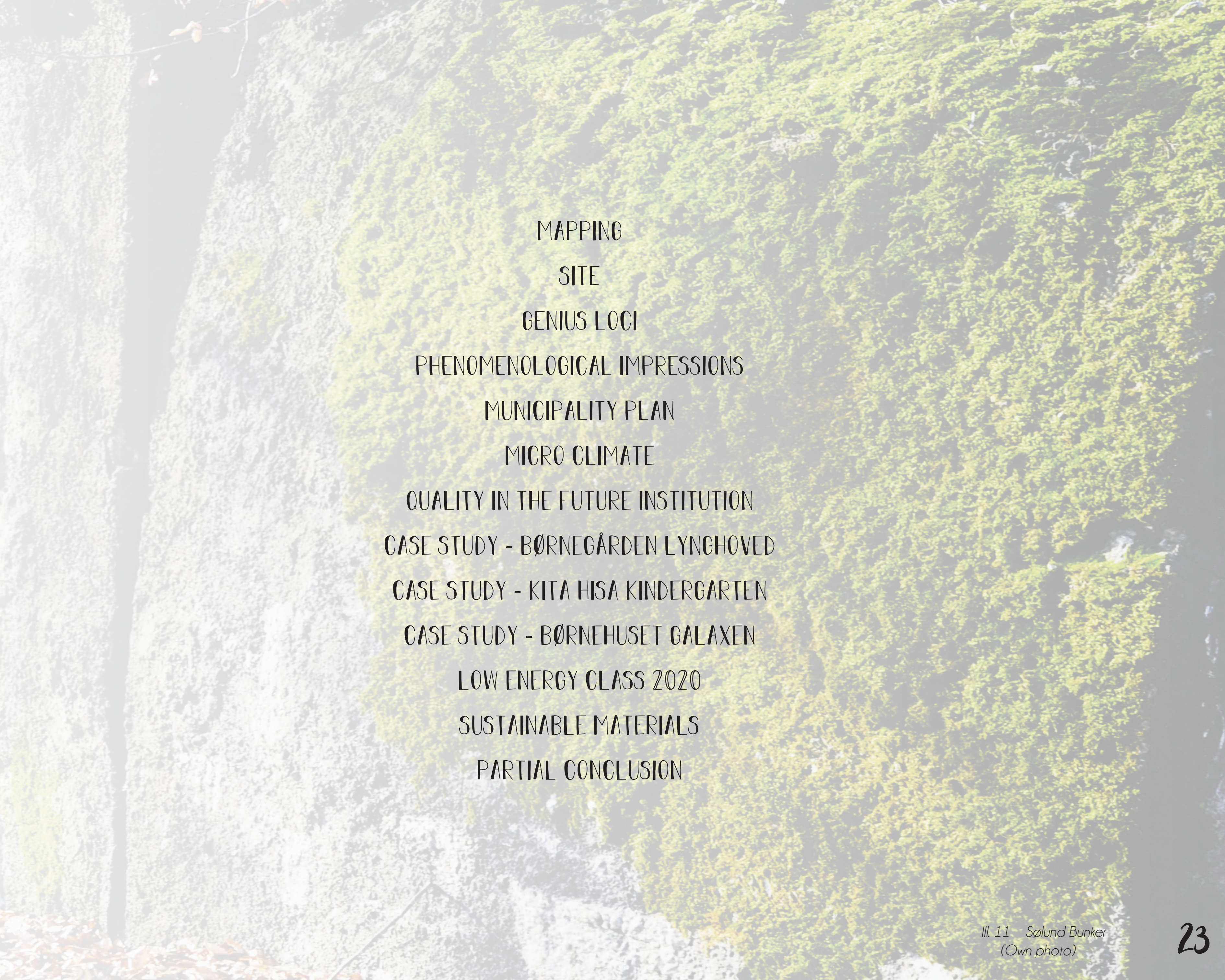
The top of the triangle is to produce energy using renewable energy sources that are integrated into the design. This step is where there is a positive effect in the buildings energy balance; the active strategy here could be solar cells, solar collectors or heat pumps. They are an expensive investment for the building but are a necessity in the future to meet the new stricter rules and requirements.
These elements create a positive result for the building's energy, but don't add an extra value to building when looked at the utility value.


*Ill. 10 Collecting information (RED. Kongebro 2012)*

*To create a good design process and end up with a good design, it is important to have control over the order the different information there is needed in the current construction. This process can be seen on Ill. 10. where the program is the first step of a design.*

# 02

# PROGRAM



MAPPING

SITE

GENIUS LOCI

PHENOMENOLOGICAL IMPRESSIONS

MUNICIPALITY PLAN

MICRO CLIMATE

QUALITY IN THE FUTURE INSTITUTION

CASE STUDY - BØRNEGÅRDEN LYNGHOVED

CASE STUDY - KITA HISA KINDERGARTEN

CASE STUDY - BØRNEHUSET GALAXEN

LOW ENERGY CLASS 2020

SUSTAINABLE MATERIALS

PARTIAL CONCLUSION

*Ill. 11 Sølund Bunker (Own photo)*

# MAPPING

**Intro**

Skanderborg city has a population on 18.849 inhabitants, whereas Skanderborg municipality has 61.160 inhabitants in 2018. The municipality has a total area of 462.5 $km^2$ [Skanderborg.dk, 2018] Skandeborg town contains beautiful scenery, with large areas of forest and lake. The beautiful forest has a particular significance for the city, as it each year provide the framework for Skanderborg Festival and here is 55.000 guests visiting the festival daily, this results in many visitors in the city [Smukfest.dk, 2018]

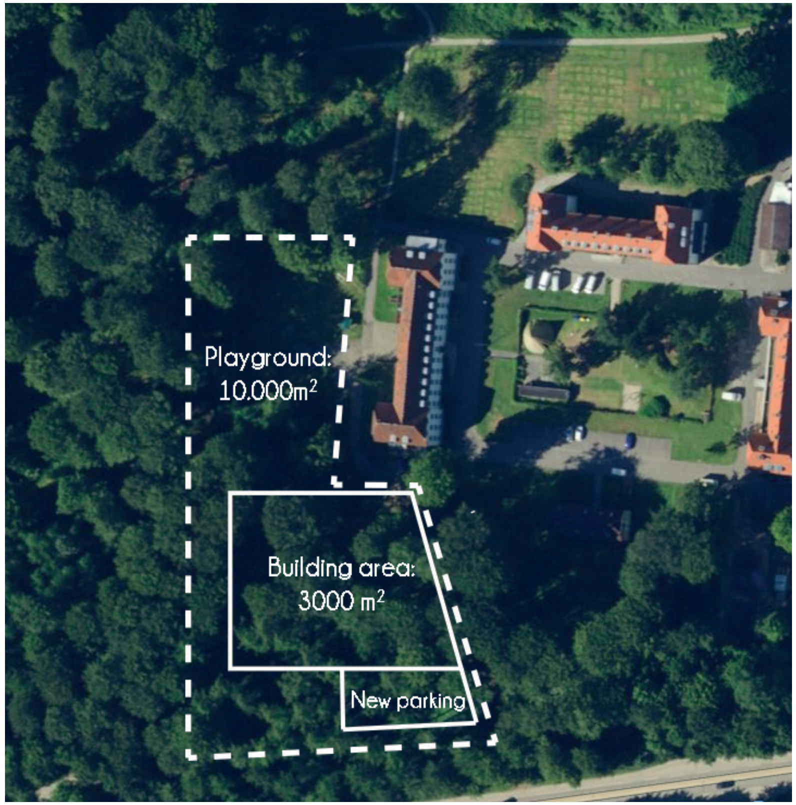
**Surroundings**

The site is located in an area with many different environments, as illustrated on Ill. 13.
The site is central location and other marketed circles tells a little about the area, near the site.
A large part of the area to the south and west is forest with close connection to the lake.
In addition north of the site is a residents' area for people with significant and permanently reduced mental and physical functional level, which has a close connection to the site area called Sølund village.

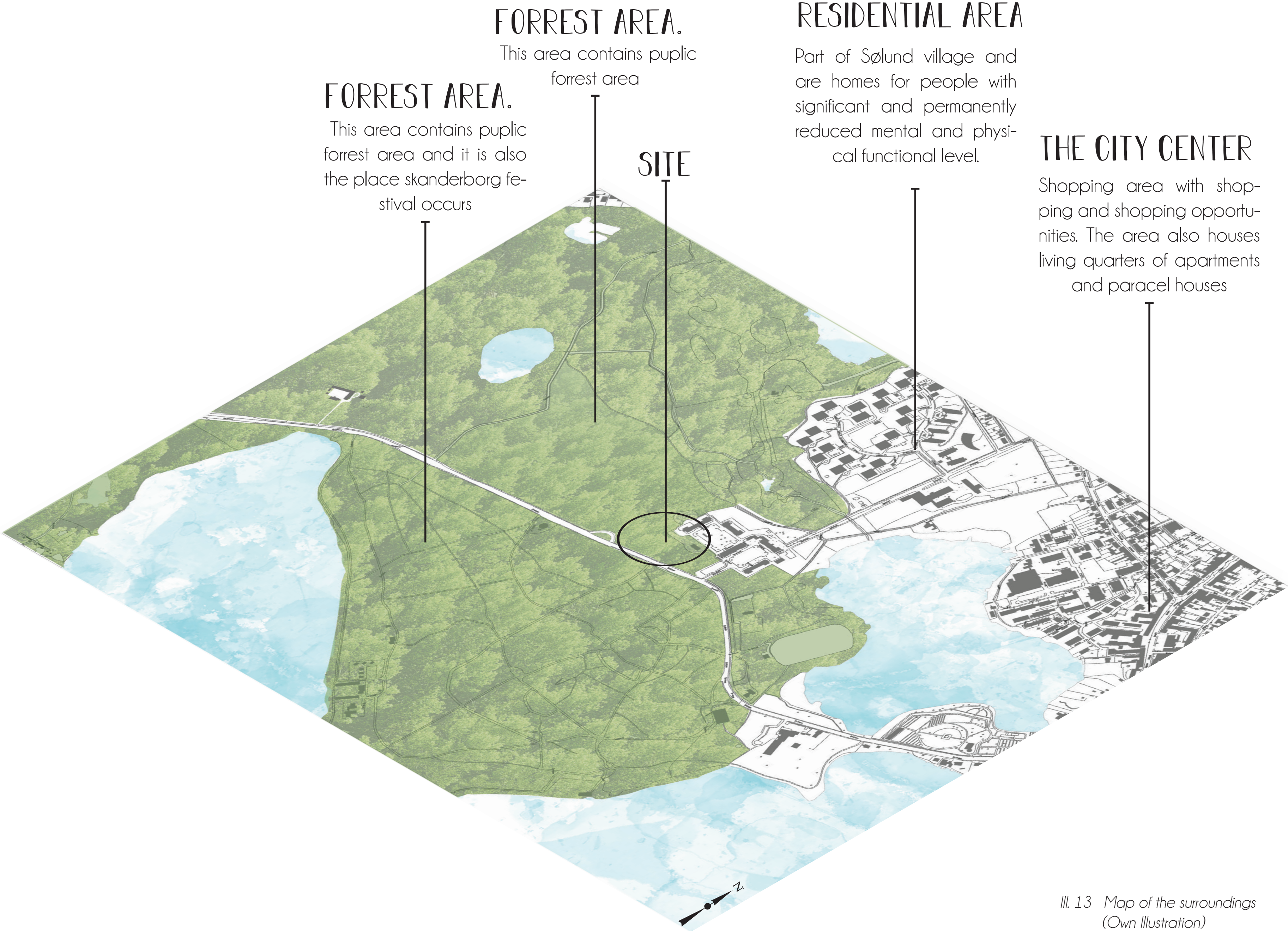
To the east is the city center, here is the central street Adelgade which contains a large part of the shops and general shopping posibilities. In the area there are also dwellings in the form of town houses and apartments.

**Information about the site**

The site functions today are as green recreational areas in close connection with the buildings around Sølund.
On Ill. 1w is the project's building site and the otherwise planned areas are illustrated. Those in predetermined areas from the Municipality Skanderborg.




*Ill. 12 Map of the buidling site (RED - Skanderborg.dk, n.d.)*




*Ill. 13 Map of the surroundings (Own Illustration)*

# SITE


Ill. 14   Section AA 1:200  (Own Illustration)

# GENIUS LOCI

Genius loci is an analysis method that can help describe the qualities of a place and which can be translated to "the place's spirit."

This analysis is done on observations that are registered in the area a sunny spring day in February (15.02.2019).

The site is located in the southern part of Skanderborg, where the area is characterized by forest. Here, it is primarily deciduous and coniferous that forms the basis of the forest. Big old beech- and oak trees are to be found in the forest, which stands as monuments from another time. This gives the place identity and creates insight into the history that the area contains.

The old trees tell a story about the area from the 1580's animal park created by Frederik the 2nd, to the German occupation of the area and to today's great festival and many recreational areas which the forest now creates the framework for.

The forest is in close connection with several lake areas, which create other qualities for the area both with wildlife but also with other sense impressions the water provides. The sound of the water moving quietly and the sight of the sun's rays reflecting on the surface of the water and throwing light back into the surroundings.

The atmosphere in the area is characterized by the beautiful nature but also the history the area contains.

Close to the site's location, the Sølund bunker gives an insight into a time when the area was seized by the Germans.

In the otherwise idyllic view, the four bunkers located in the area , creates a constrict that reminds one of a time of war and invention.

The bunker appears in raw concrete, which bear the imprint off the years that have passed with a contrast in the light green moss that is slowly beginning to take over this time pocket.

Underneath all the bare wooden crowns, the long logs testify to the lack of light, where for many years they have fought for the sun's rays, and therefore stand alone and as mastodon's that strive towards the sky.

The sun shines through the bare crowns and awakens life in the otherwise desolate forest floor, at this time of the year, the forest floor is covered with brown shades, where small pockets of spring appears with snowdrops and crocus flowers that testify to lighter times and a new year's beginning.

The distinctive line the asphalt road creates through the forest, is perceived as a clear boundary when moving in the forest, but the experience is perceived differently when driving through the forest, where it is nature that catches the eye's attention and no delimitations are insulted.

Ill. 15 Path from the main road - Own photo)

Ill. 16 Sølund Bunker - Own photo)

Ill. 17 Snowdrops break out in the forest floor - Own photo)

Ill. 18 A lake in the nearby area - Own photo)

Ill. 19 Deciduous trees without leaves- Own photo)

Ill. 20 Crocus spring flower - Own photo)

# PHENOMENOLOGICAL IMPRESSIONS

1

When arriving to the area, you enter the road into the Sølund area. With the notable white buildings in the background.

2

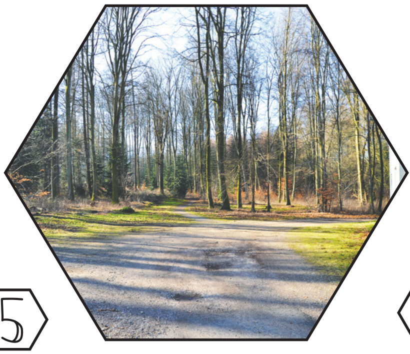
Short after arriving you past by the parking lot and looks towards the site.

3

Looking down at the site and see the various white buildings and the forest.

4

At the end of the road is the last wing of the buildings and to the left of it is the site located.



5

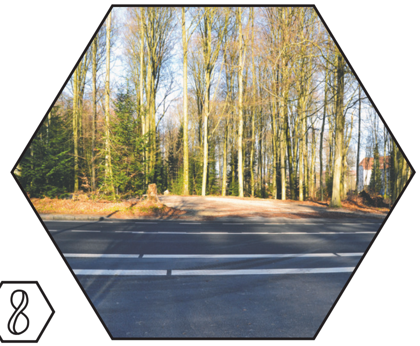
How the site looks. There are trees and forest vegetation in the area today.

6

When you follow the small path you end at the main road that goes through the forest.

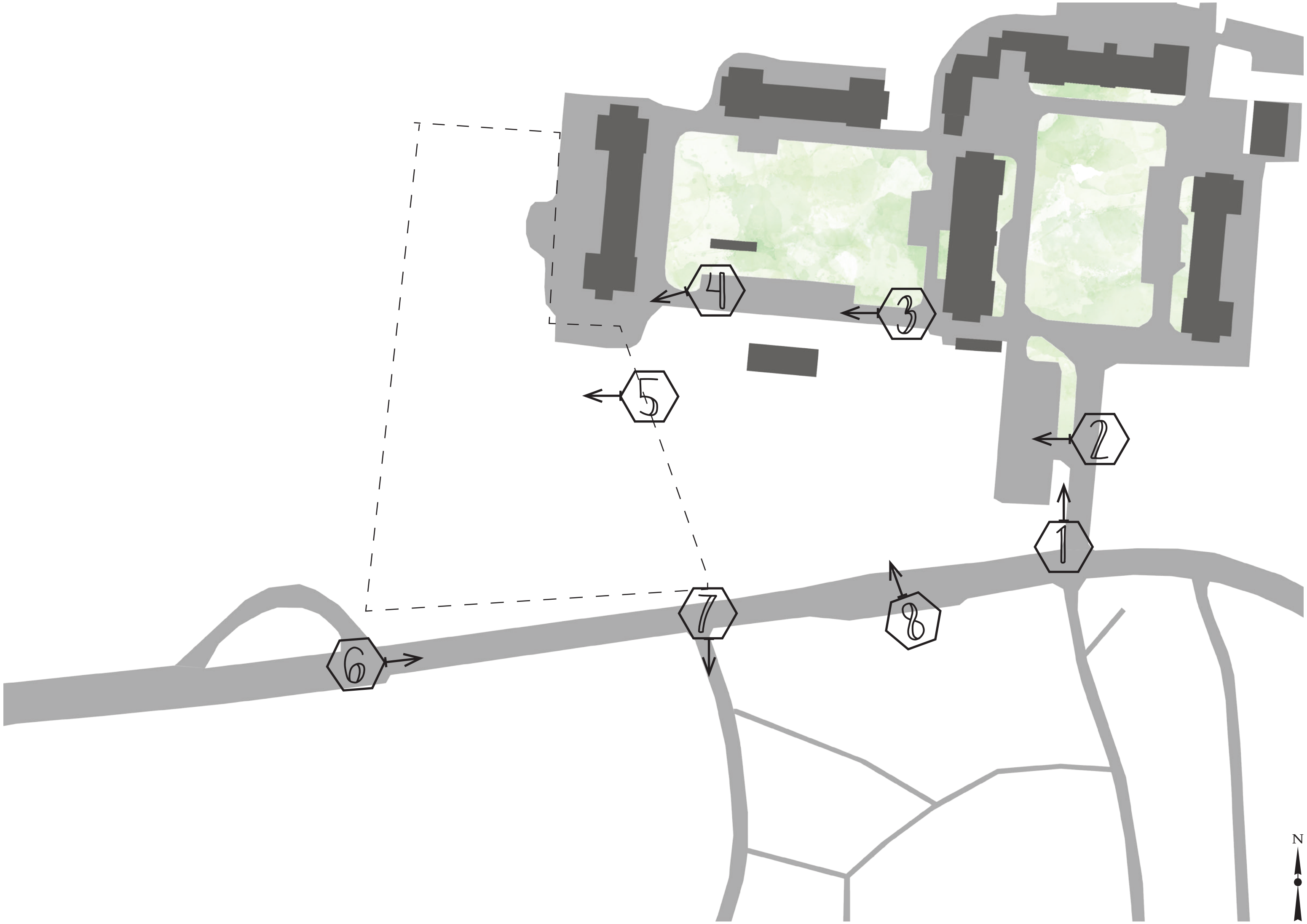
7

Look up the forest on the opposite side of the road. Great outdoor areas enclosed in the woods.



8

Look from the main road down to the site, the forest vloses off towards the road and stores the site a little away from the road.




Ill. 21   Map of the site
(Own Illustration

# MUNICIPALITY PLAN

This is a sample of various relevant topics from the municipal plan from 2011.

Skanderborg must have different offers that can attract and be used by the entire municipality and one of the areas mentioned is Dyrhaven in the forest south west of Skanderborg.

The municipality is experiencing a large influx of people and the population has growth. Several people have begun to find beautiful location attractive with the forest, lake and with good infrastructure and close location to the highway.

There is a desire to create different residential areas with green recreational areas, as the cities must be able to accommodate the increased growth and still have to focus on efficiency and sustainability.

With a focus on sustainability, the municipality has made a project called "sustainability in children's height" that is to create awareness and knowledge of it at an early age and hopefully influence the society forward-looking.

The municipality has great ambitions to be $co^2$ neutral with electricity and heat in 2020, so the city is also moving towards more initiatives that can help the ambitions on the way. This is done among other things by creating space for wind turbines in the municipality, settlements in low-energy; establish charging stations for electric cars.

Climate-wise, the focus is on the changed conditions with more cloud bursts and how to reducing the damage when it occurs. Here the solution is among other things, to use the water as an active resource by collecting the rainwater so that it can be recycled.

The municipal plan framework for the area called 10.R.03 states that the area is to be used as park- and forest area with leisure activities.

In relation to buildings, it is mentioned that smaller buildings are allowed in the forest if they support recreational functions such as forest kindergarten or scout cabins.

There are preservation-worthy buildings in the area that must be taken into account and the forest, nature of the area, the lakes and cultural-historical values must be preserved. [Kommuneplan16.skanderborg.dk, 2016]


Ill. 22 Municipality of Skanderborg
(Own Illustration)

# MICRO CLIMATE

The microclimate is analyzed to get information about the site. It can be helpful to decide placement of the buildings, outdoor areas and to get a better connection with the surrounding area.

Further in the design process it can be helpful to incorporate technical aspects to the building, such as natural ventilation, shadings and to ensure good daylight conditions inside the building.

Because the site is place inside the forest, there are a lot of trees at different heights that can affect the wind and sun conditions on the site. These considerations must be included in the analysis of the micro climate, as it can determine how much light and wind are actually on the site. The type of trees also helps determine light conditions according to season.

**Sun**

The sun path diagram on Ill. 24 shows the suns path on different time of the year. It shows the different angles of the sun and when the sun rises and goes down again.

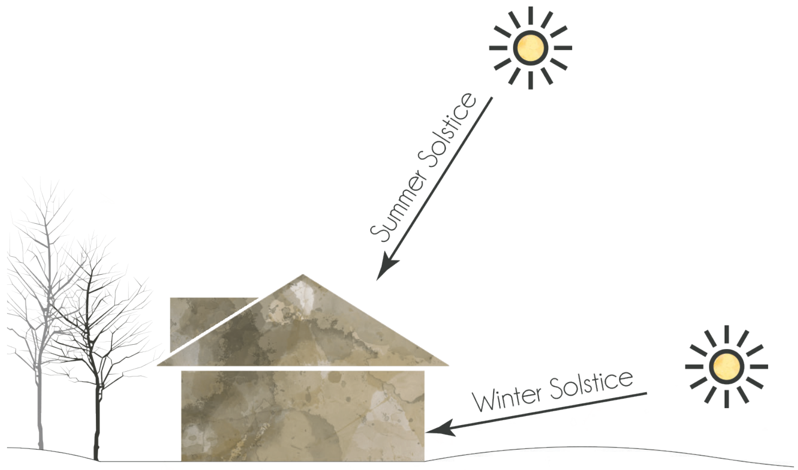
In the summer time the sun rises around 03.30 am and then goes down again around 21.00 pm. The angle of the sun is high in the summer time around 57.

Spring and autumn are almost the same but there are small differences, here an average of the two seasons is taken. Here the sun rises around 06.00 am and then goes down again around 18.30 pm. The angle of the sun is around 30 degrees.

In the winter time there are only a few hours of daylight a day, here the sun rises around 09.00 am and then goes down again around 16.00 pm. The angle of the sun is around 10 degrees.

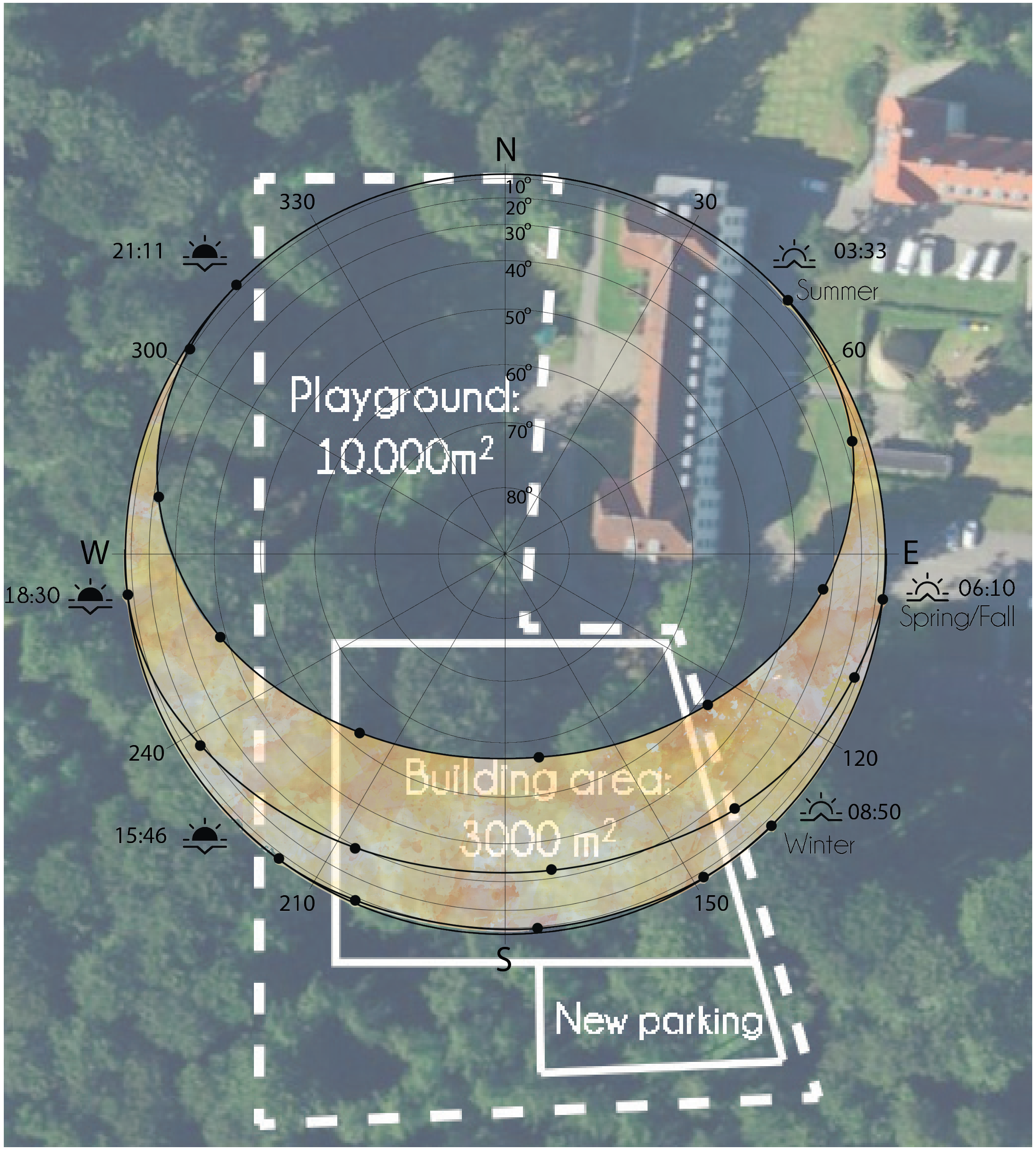
Due to the many deciduous trees on the site, it can be difficult to achieve optimal daylight during the summer period. Since all the trees have leaves on and therefore minimal light comes through to the site. This can also be an advantage because the solar heating in the summer can be minimized.

Because the site is planted with trees today, the sun conditions on the site must be taken into account when the optimum number of trees have been felled on the building field. So it would be advisable to do some new daylight studies later in the design process.




*Ill. 23 Diagram of the sun's angles (Own Illustration)*

The diagram on Ill. 23 shows the different angels of the sun summer- and withers time. Here it is clear how large the difference between the angles is and how the direct sun is entering a building. This is useful information in terms of including sun protection and overhangs on the building.




Ill. 24 Sun path diagram on the site
(Own Illustration)

## Wind

The wind analyses are based on data from the wind station in Skanderborg.

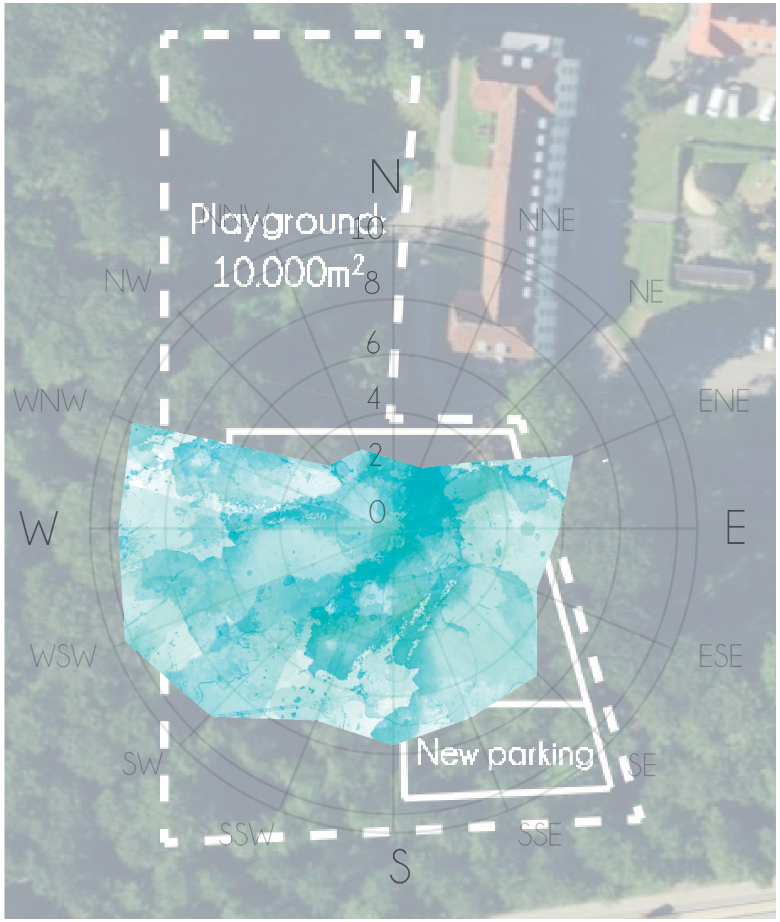
Analysis of the wind is important to know in relation to the location of the building and outdoor areas on the site.

Looking at Ill. 25 you can see the average of the wind over the year. Here it is clearly that the wind is strongest to the west.
The western part of the site is and that there is also comming some wind from the eastern part of the site.

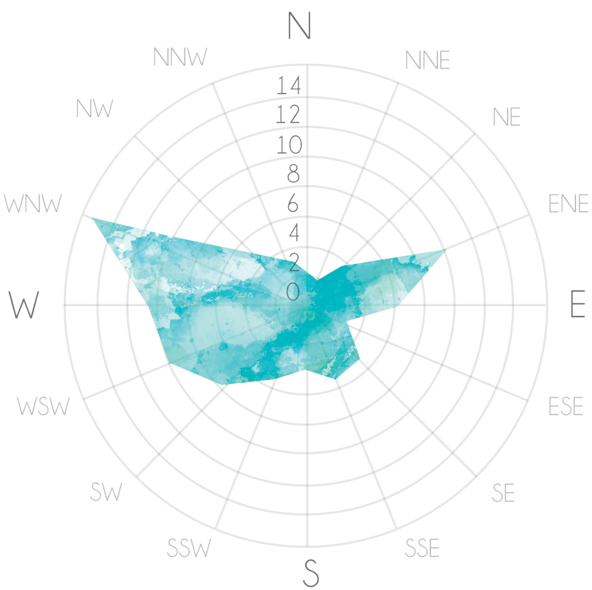
These are the general weather conditions for Skanderborg city, but since the site is in the forest it is very limited how much wind there is on the site and from phenomenological studies on the site it can be found that there is minimal wind on the site.

The wind from the east could be present on the site at some times of the year, since the site is opening up towards ENE.

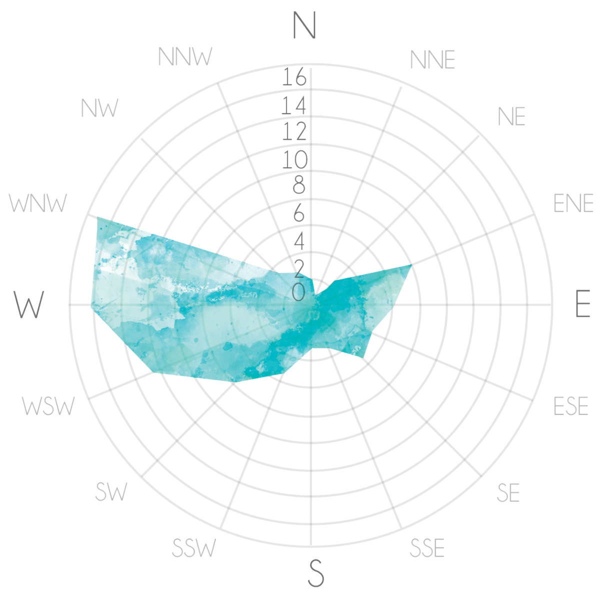
The conclusion of the wind conditions is, that it have a minimal impact on the design and outdoor areas. There may, however, be problems with intergrating natural ventilation due to the lack of wind on the site area.



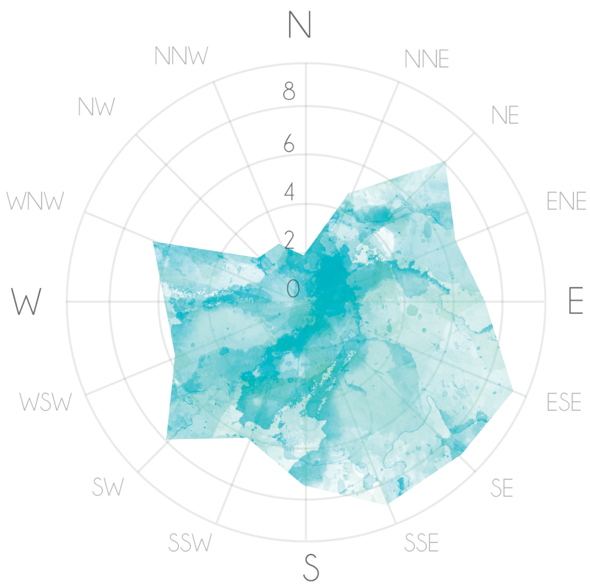

*Ill. 25 Wind rose for a year - direction distribution in % (RED. windfinder.com, n.d.)*



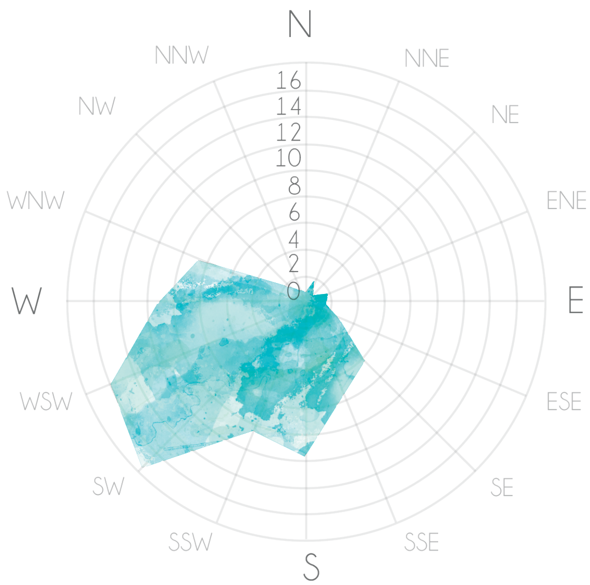

Ill. 26 Wind rose - Spring - Direction distribution in % (RED. windfinder.com, n.d.)




Ill. 27 Wind rose - Summer - Direction distribution in % (RED. windfinder.com, n.d.)




Ill. 28 Wind rose - Fall - Direction distribution in % (RED. windfinder.com, n.d.)




Ill. 29 Wind rose - Winter - Direction distribution in % (RED. windfinder.com, n.d.)

All of the data collected in the chart is based on the last 30 years of temperature and precipitation measurements.

## Precipitation

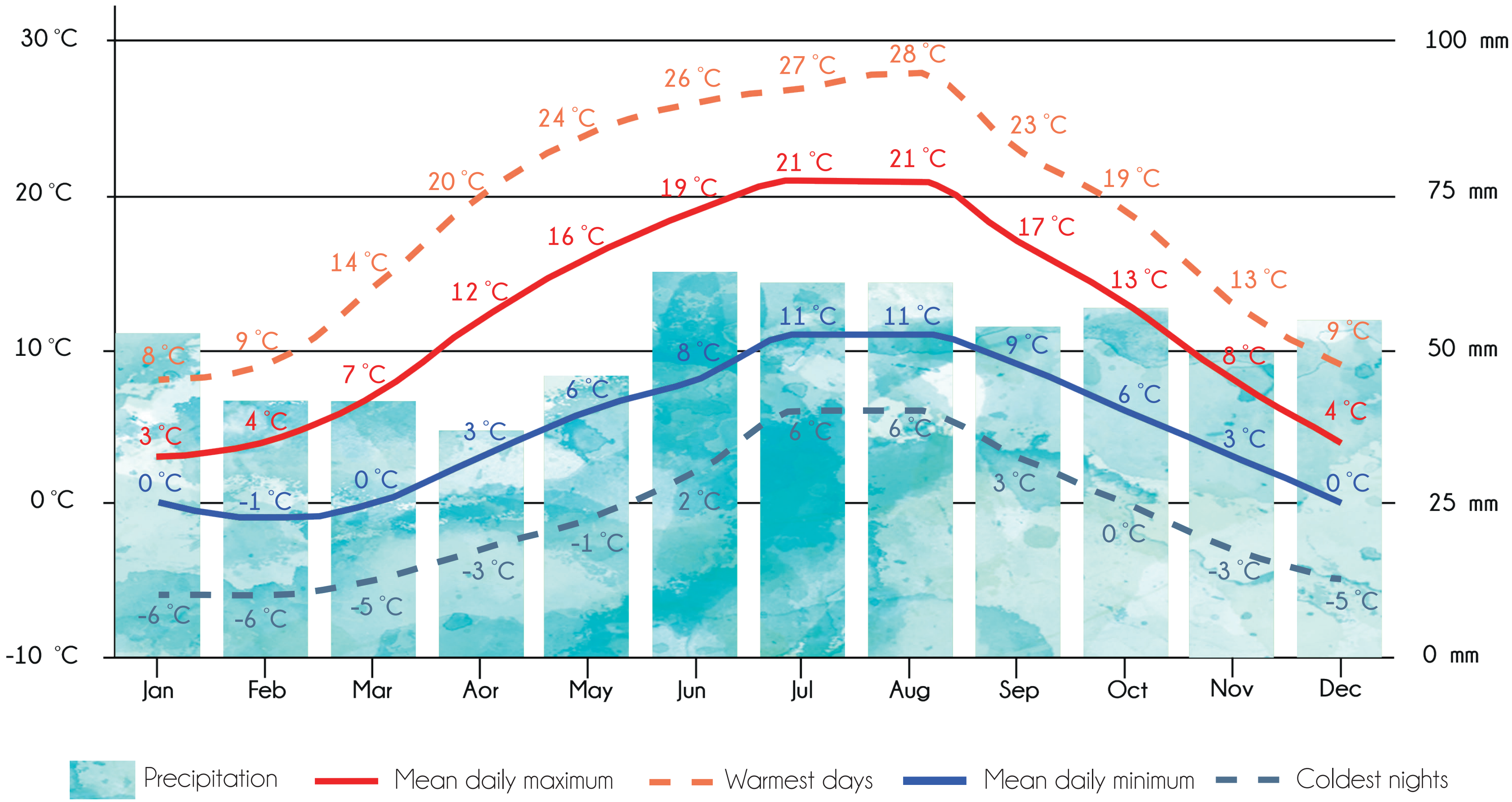
The diagram on Ill. 30 shows how the precipitation is for a year in Skanderborg.
The information on the chart shows that the precipitation dosen't vary much during the year.
The months most exposed to precipitation are the summer period from June to August, where there is around 60 millimeters of rain. May is the month with the minimum amount of precipitation on about 35 minllimeters. [meteoblue.com, n.d.]
Every moth there is a certan amount of rain, and therefore it is optimally to consider collecting the rain for recycling.
This can be done through rainwater collector, here the water can be used to water flowers or outdoor areas or lead the water away, so no floods are created during rainy periods.
Otherwise the water can also be colleced in a gabion that creates opportunities to save energy and protect the environment.
Here the rainwater can be reused as, for example, to flush out the toilet [Frederiksen, Clasen and Boding, 2017]

## Temperature

The diagram on Ill. 30 gives an insight into how the temperature is distributed in Skanderborg over the year.
The red and blue lines show average minimum and maximum temperature for each month. Where the dashed red line shows the mean of the hottest day every month and the dashed blue line shows the mean of the coldest night, through the period the data has been collected in.

At Ill . 30 it is seen that the warmest temperature is measured to 28 degrees in August and that the coldest night is in January and February measured at minus 6 degrees.
The average temperature during the year ranges from -1 degrees to 21 degrees, which shows that there are large temperature differences throughout the year. [meteoblue.com, n.d.]

The different seasons are of great importance for the temperature and this must be taken into account in the design. How to incoporate which passive and active strategies that can be used to optimize or minimize the temperature differences.
In the summer times there is focus on the heat of the sun, so no heat problems occur and in that way spend too much energy on cooling the building down.
During the winter period, it must be investigated how to get as much heat from the sun and make sure to get the most daylight as possible in period.




*Ill. 30* *Average temperatures and precipitation (RED mitrejseveje.dk, n.d.)*

# QUALITY IN INSTITUTION

Our children are the future of society and to ensure they grow in a safe and quality-rich environment it is necessary to look at research within the area and try to deal with the framework we have today.
In this way, the institutions of the future can secure the best possible conditions for the children who are to live and create the society in the future.

Based on the previous 8 years of research in Denmark and abroad, it will appear which parameters can be regulated in order for the children to be able to develop as best as possible cognitively, socially, emotionally on both short- and longer terms. It is primarily children in the aged of 3-5 years that the research is based on but also applies to children at the aged of 1-2 years.

Research shows that the quality of the institution can have a great influence on the children's development. The children who are in an exposed group are more cautious and insecure and also the children who experience the greatest impact of a poor quality in the institutions.

The children at the exposed group were very careful in their contact search, if they also were placed in the poor quality institutions with a lack of presence and contact.
It resulted in the children eventually giving up on the contact or reacting with impotence. Wherever the children outside of the exposed group ruled with willpower and self-confidence and initiated contact.[Albæk Nielsen and Nygaard Christoffersen, 2009]

The standards in institutions when talking about children per. adult also has a great influence on the children, today the focus is about savings and not so much about assuring quality.

The difference in how many children per. adult is proven in the experimental groups. Group number 1 with 4 children per. adult and better trained pedagogues and group number 2 with 7 children per. adult and less trained pedagogues. Experimental group 1 showed that the child was clearly influenced by the increased contact and education. In comparison, the children in group number 1 were less aggressive, got a larger vocabulary, were better at collaborating and in general they got more knowledge than the children in group number 2. [Albæk Nielsen and Nygaard Christoffersen, 2009]

In addition, there is also research that proves that children are stressed by a low staff level and that the stress hormones the brain develops have a long-lasting effect and also affects the parts of the brain that develops memory and learning.

In relation to stress, research also indicates that children there are exposed for noise in a long period of time, can be stressed. This can result in a negative influence on cognitive development.

Noise can occur from lack of space or too many children and adults in a room. Studies show that over half of the institutions in the test group, had an average sound level above the permitted level of 80 dB.

The high sound level can thus have a negative cognitive effect on children's development. [Albæk Nielsen and Nygaard Christoffersen, 2009]

An increased area per. child can contribute to a lower noise level but can also reduce the risk of infection.

Children at the age of 1-2 years have a very high risk of diseases in institutions, but also children at the age of 3-5 years are at risk. However it is not to the same extent as the 1-2 year olds. The most common diseases are infectious diseases, which are reduced by an optimal and great focus on hygiene.

Other experiments show a positive effect of a larger area per. child since children in overcrowded institutions were easier to become aggressive, hyperactive or withdraw themselves from the fellowship.

Otherwise, it must be possible for the children to have smaller places where the children who have a need to withdraw can get the silence and immersion they need.

An experiment with increased area per. children in group rooms showed in the first part of the test-period that the number of days with sickness was decreased by 10% and in the second part of the test-period the number of days with sickness was decreased by 11%.
Therefore, the positive effect of increased area per. children can be demonstrated. [Albæk Nielsen and Nygaard Christoffersen, 2009]

*Ill. 31 Kids of the future (Own Illustration)*

# CASE STUDY - BØRNEGÅRDEN LYNGHOVED

Name of institution: Børnegården Lynghoved
Pedagogical approach: Reggio Emilia
The institution's capacity: 93 kids
Kindergarten: 65 kids
Nursery: 28 kids
Placement: Ry - east Jutland

The institution Børnegården Lynghoved has 93 kids in the age of 0-6 years, and it is a combined nursery and kindergarten i two different buildings. The pedagogical approach is inspired by Reggio Emilia, which is incorporated in the interior design and approaches of the child.

**Reggio Emilia influences**

In the institution they see the room as" the third educator," this makes great demands to the surroundings. The children must be surrounded by opportunities and the surroundings may inspire the children to play and learn, because every child has the right to be curious.

The institution is divided by age, as the age has a great influence on children's development opportunities. The age says something about developmental place, challenges and perception of phenomena and eventually also the way children reflects on things, therefore the children are divided so that they are about the same level.

However, it is up to the child to decide who they are playing with and therefore the house is arranged, so that the children meet each other regardless of age and can play both up and down in age.

*Ill. 32 Drawing of Børnegården i lynghoved - (Lynghoved.dk, 2011)*

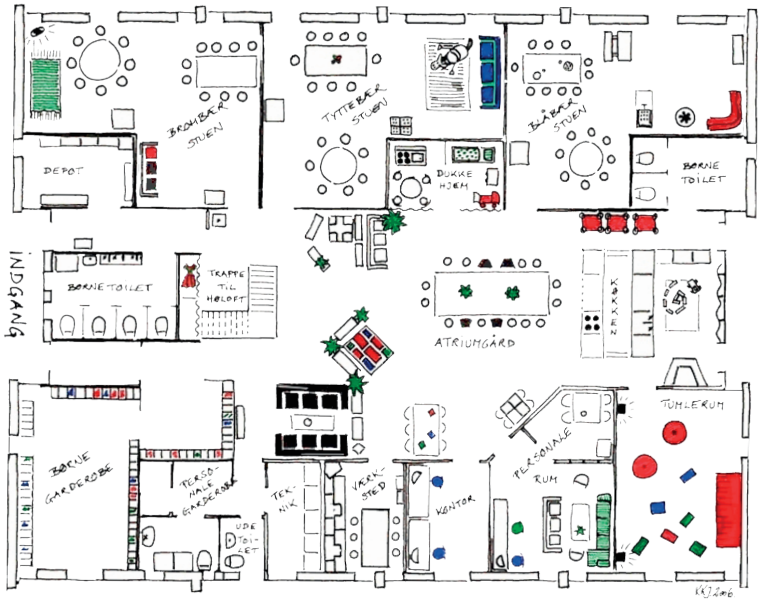
**Interior design**

The facilities are also based on Reggio Emilia's approach, several of the furniture can be used to build with and in the rooms there is focus on different exploration possibilities.

The wooden blocks lead up to construct and they are sorted in various forms and other construction areas with drawing and recycling materials to be creative in.

A corner with windows and binoculars, so there is the opportunity to study birds and then examine whether they are in the bird book. In that way there are spaces for an learning environments where you can challenge and immerse yourself

They are focusing on that all children must be able to reach toys and materials, so there are arranged in children's height, thus the




Ill. 33 Drawing of interior design - (Lynghoved.dk, 2011)

child can independently start playing and discover when they want. In the middle of the house there is an atrium area there is furnished with a variety of play possibilities, but also a large dining table that forms the framework for a good and quiet delivery and pick up place of children, here is the opportunity for a talk and a cup of coffee as parents

The house is also arranged so that there is the possibility of physical activities both inside and out, to ensure the children are challenged both mentally and physically. A large playground forms the framework for the outdoor area, where there is also an area with animals. Here are both chickens and goats, which the children help to feed and care for.

## General information

In order to create a safe framework for the child and create coherence between family, home and the institution, family pictures are made that hang in the institution. From the age of 3, the child gets a permanent pedagogue who follows them through their years in the institution, which can create security for family and children.

There is a focus on the children themselves being involved in developing, so let them take initiative and let them do the things they can, get water in the cup when they are thirsty, etc.

The children must learn to set personal limits; here the pedagogues support them in making choices, speak out and encouraging the children to resolve conflicts through dialogue. They must listen to each other and take each other into account.

Emphasis is also placed on helping children with special language challenges with dialogic reading. [Lynghoved.dk, 2011]

Ill. 35 Goats in the playground area - (Lynghoved.dk, 2011)

# CASE STUDY - KITA HISA KINDERGARTEN

Name of institution: Kita Hisa
Size of the institution: 420m2
The institution's capacity: 65 kids
Placement: Berlin, Germany

The kindergarten in Berlin, named Kita Hisa, is a former retail store, which was rebuilt to create a kindergarten. It is designed by Baukind, who focuses on intelligent design where children are inspired to play and develop. The kindergarten is for children in the age 1-6 years and there is room for 65 children.

The kindergarten is made with different zones, created through interior designs and colors and It is a priority that there is created a visual connection between the room in the entire building. Therefor it is built up so that mobile glass walls form the spaces and that also means that it can be transformed if there is another need for the building in the long terms.

The furniture used in the kindergarten has several different functions so they have a multifunctional purpose and thus saves space but also money. [Architecture Lab, 2014]

The colors are used in the whole building to create different zones and those makes it easy for the children to relate and recognize the rooms. The colors are also used as an active element to create different atmospheres in the different zones. [baukind Architekten, n.d]

*Ill. 36 Plan solution of Kita Hisa - [Baukind Architekten, n.d]*

Ill. 37 Interior design of play area - (Architecture Lab, 2014)

Ill. 38 Toilet and bathroom - (Architecture Lab, 2014)

Ill. 39 Multifunctional furniture- (Architecture Lab, 2014)

Ill. 40 Mobile glass walls- (Architecture Lab, 2014)

# CASE STUDY - BØRNEHUSET GALAXEN

Name of institution: Børnehuset Galaxen
Size of the institution: 1.300m2
The institution's capacity: 180 kids
Placement: Jyderup - Western part of Zealand

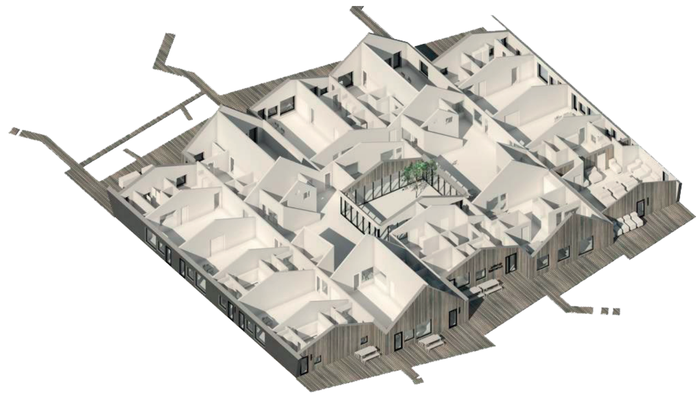
The house was built in 2015/2016 and it is a replacement for two institutions which are then merged into this new institution.

The Institution is built by Kullegaard, who won the turnkey project in a competition with his design on a institution of the future. [Kullegaard.dk, n.d.]

**Interior design**

The building is made as a large house with many independent rooms which lead out to a large common area and a centrally placed staff area. The independent rooms that are group rooms for the children are placed along the facade, so the common room is formed by the middle of the building. Centrally located in the house there is an atrium courtyard which ensures good daylight conditions for the large common room. The large common room creates the framework for how to move around in the house and ensure that the staffs have a visual contact with the children. [Byggeplads.dk, 2016]

The institution is divided into a nursery department which also have room for daycare facilities. The kindergarten part is divided into children at the age of 3-4 years and then to children at the age of 5-6 years. [Dagtilbudskovvejen.holbaek.dk, n.d.] Each group has its own entrance to the wardrobes and group rooms to make it clear to children and parents. This means that the children themselves can choose whether, it will be in the safe frame of their own group room or if it is ready to expand their horizons and move around the house and play with other children. This creates the opportunity for the child itself, when to be or not to be a part of the community. [Dagtilbudskovvejen.holbaek.dk]



Ill. 41 Interior design - (Kullegaard.dk, n.d.)

**Outdoor areas**

The outdoor areas contain a large playground which is divided into 2 - toddler playground for children aged 0-2 and a playground suitable for children aged 3-6 years

In addition, there is also the outdoor sensory zone with the scout hut and the rainwater lake - where the water from the roof is led down into the lake, as a sustainable initiative. [Byggeplads.dk, 2016]

## General information

The pedagogical approach focuses on a recognized and relationship-oriented learning and development. A good relationship between adults and children is important for the children's development such as motoric development. Then the children can make their experiences and translate experiences through play.

All children eat morning meals together if they are in at the time. Then children and siblings can eat together and learn to pay attention to each other big as small.

Sleeping options are arranged so that children under 2 years are sleeping in cribs and they have their own crib. Children over the age of 2 are sleeping in bedrooms in bunk beds - additional appointments can also be made in case the child has special needs. [Dagtilbudskovvejen.holbaek.dk, n.d.]

*Ill. 42 Outdoor area - (Kullegaard.dk, n.d.)*

*Ill. 43 The institution from the outside- (Kullegaard.dk, n.d.)*

## Energy and sustainability

The house is built with a focus on sustainability and energy. A well-insulated climate screen that ensures a minimal heat loss, windows with high insulation capacity and external sun protection which contribute to less need for cooling. The windows in the roof also contribute to natural ventilation, which can limit the need for mechanical ventilation and at the same time contributed to an optimal daylight in the rooms. On the roof there are solar cells that contributes to the energy balance.

The cantilevered roof creates spaces with good ceiling heights, where Troldtekt is used in the ceiling to ensure good acoustics in the rooms. [Byggeplads.dk, 2016]

# LOW ENERGY STRATEGY

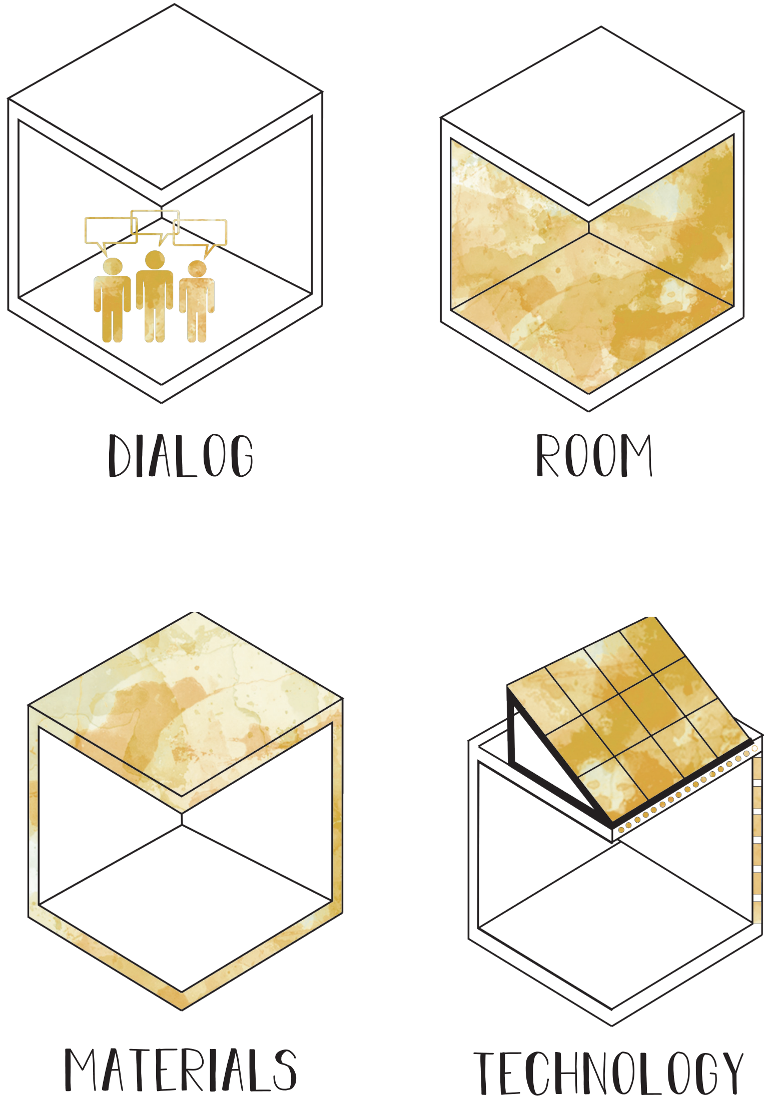
A focus on the energy class can contribute to future-proofing a building and thus secure a building  has been energy optimized for several years.

The first element in the energy class is the energy frame, which can be explained as the amount of energy that is supplied to the construction per. m$^2$.  The energy is domestic hot water, heating, ventilation and cooling.

Today there are several energy frames and in the low energy class there are 5 different frames- BR10 - BR15 - BR18 and BR20 and then there is one called passive. The passive strategy comes from Germany and therefore it can not be compared with rules and requirements from the Danish building regulation.

Due to the fact that the technology and the construction industry are not completely ready for the BR2020. The Danish building regulations have instead chosen to create a low-energy class which is an adjusted version of BR2020. The BR18 is the one to be used from July 1, 2018. [Bygningsreglementet.dk, n.d.]

In order to ensure that the building can achieve the 2020 energy class it is important to make a strategy, thus achieving the energy objective. This strategy has 4 different phases that ensure a good strategy for achieving a low energy construction.
The 4 different areas described here is based on Rob Marsh's book about architecture and energy towards a 2020 low-energy strategy. [Marsh,R, 2011]




Ill. 44  Low energy strategy        (Own Illustration)

The first point is DIALOG, which means that a good dialogue and understanding of the client's wishes and the users of the building. The different requirements for building are specific early, with a focus on functions, context and the economy. In connection with the requirements, it is also important to determine indoor climate and energy frame. Indoor climate and energy requirements can also be determined based on the users of buildings, so that the users of buildings have a central role in relation to the building design.
It is a good idea to take a closer look at the type of building and focus on the dominant area in the energy frame, then there is focus on the greatest saving in relation to the energy frame. The dominant area can thereby become part of the design process to reduce this critical area in the energy frame.

Second point is the ROOM. Here it is about utilizing the space, both its functionality but also the passive properties the room has. The geometry and orientation of the building is considered, to get the optimal starting point. The users and their workflow in relation to the orientation of the individual rooms are also important to take into account.
In relation to the interior spaces in buildings, there must be a focus on utilizing daylight in that way it can reduce the electricity consumption for lighting. Another important area is the solar heating in relation to minimize the need for cooling.
The strategy in the room is to focus on the design of the rooms so that they do not become to deep and a with a good ceiling heights, so that optimum daylight conditions can be achieved and the height allows the natural ventilation to work.

The third point is the MATERIALS. Here is the focus on choosing the right materials and the right building method i relation to minimize the energy consumption with the use of passive strategies.
The envelopes thickness in relation to gross and net area, where the thick construction reduces the net area of the building and can also influence the functionality of the design. Robustness and the life time of the materials - today's shift to more lightweight constructions with cladding can be less resilient to the Danish climate. The materials' use of resources for manufacturing can also be included in this process - where there is a focus on energy and $CO_2$ emission in connection with the reuse or production of the different materials.

The last point is the TECHNOLOGY which focuses on energy sources that contributed actively to the construction and use of renewable energy sources.
In this area the focus should be on minimizing the need for the active technical solutions and the solutions used must then focus on energy-saving technologies such as ventilation with heat recovery. There must be easy access to the installations so it is easy to maintain or optimize them.
In order to keep the energy costs down on for example electricity, LED lighting can be used and daylight control can be incorporated so that the electric lighting is minimized.
It is also possible to divide the building into smaller zones so the electricity use is based on the acute user needs. [Marsh,R, 2011]

# PARTIAL CONCLUSION

This partial conclusion is made to summarize and synthesize the knowledge that is allocated in the prologue and the program. Here it will be made visible which parameters there can help determine the design criteria.

It is important that the architecture creates a good framework for the children, so that they have the best possible conditions for developing their potentials. The architecture must inspire to play and challenge the children's motile.

The identity of the area is characterized by the nature and therefore nature must play a major role in the design - it is important to incorporate nature into the design and take into account the present nature. The design must create a synergy between nature and architeture.

Sustainability must be a key element of the project in several different ways. Sustainability must characterize the energy of buildings, in the relation to reducing the need for energy, optimizing the energy by using various elements focusing on daylight, ventilation and a healthy and good construction.

Sustainability also affects the building design in relation to the materials, a low environmental impact is the focus with a a low CO2 footprint and a wish to minimize or if it is possible, completely exclude dangerous toxins in relation to degassing.

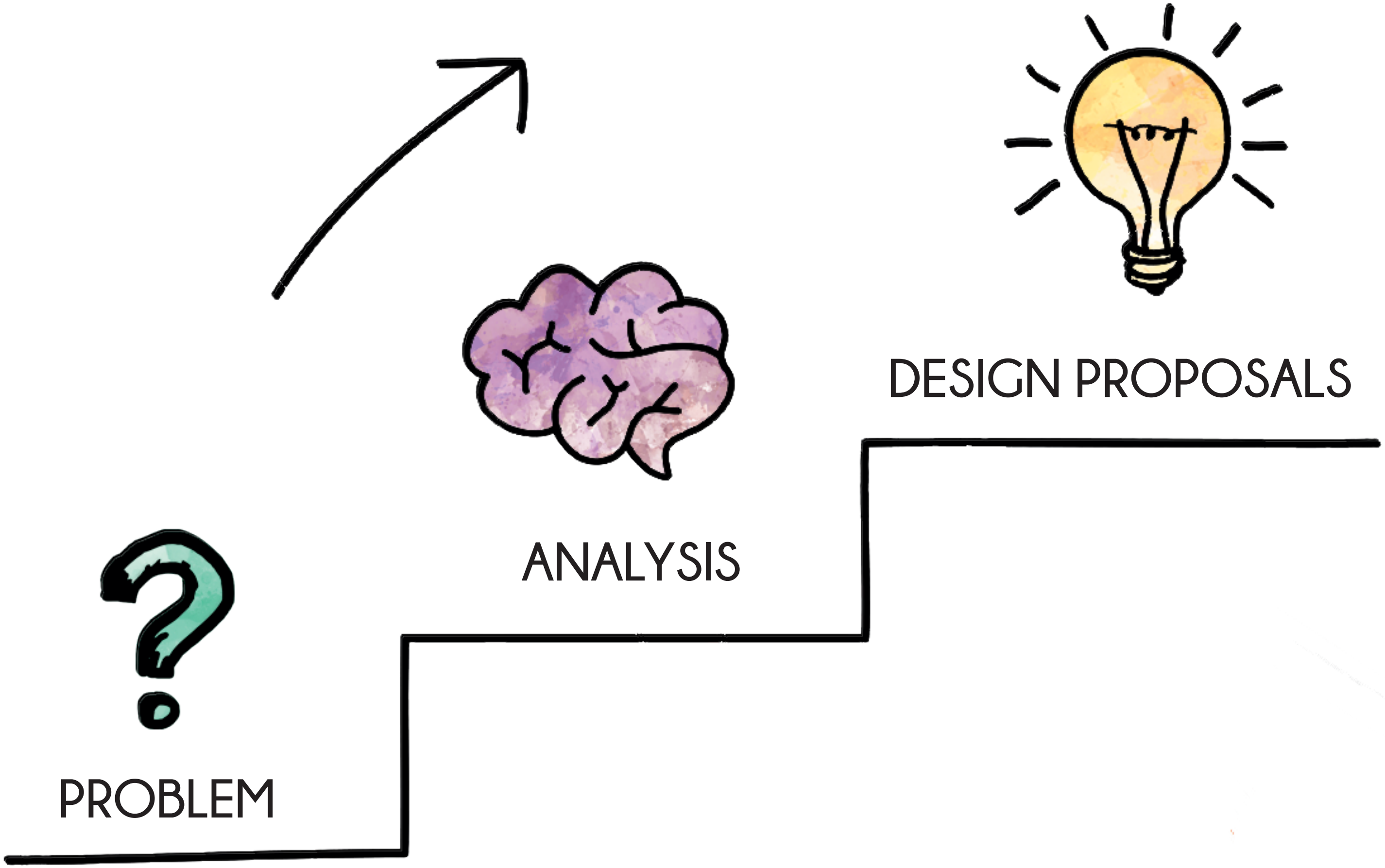
Social sustainable initiatives are a great focus on the indoor climate to create a healthy and good learning environment for the children and in addition the indoor climate must ensure good comfort and health in the building. In relation to indoor climate it can be considered to go for the best conditions instead of going for minimum requirements.

In relation to economic sustainability, the focus is on flexibility so that the building's area is utilized to the best possible extent and that the functions can adapt with time

The design must ensure optimal acoustics to avoid too much noise in the building, which can lead to stress and damage the development of children.

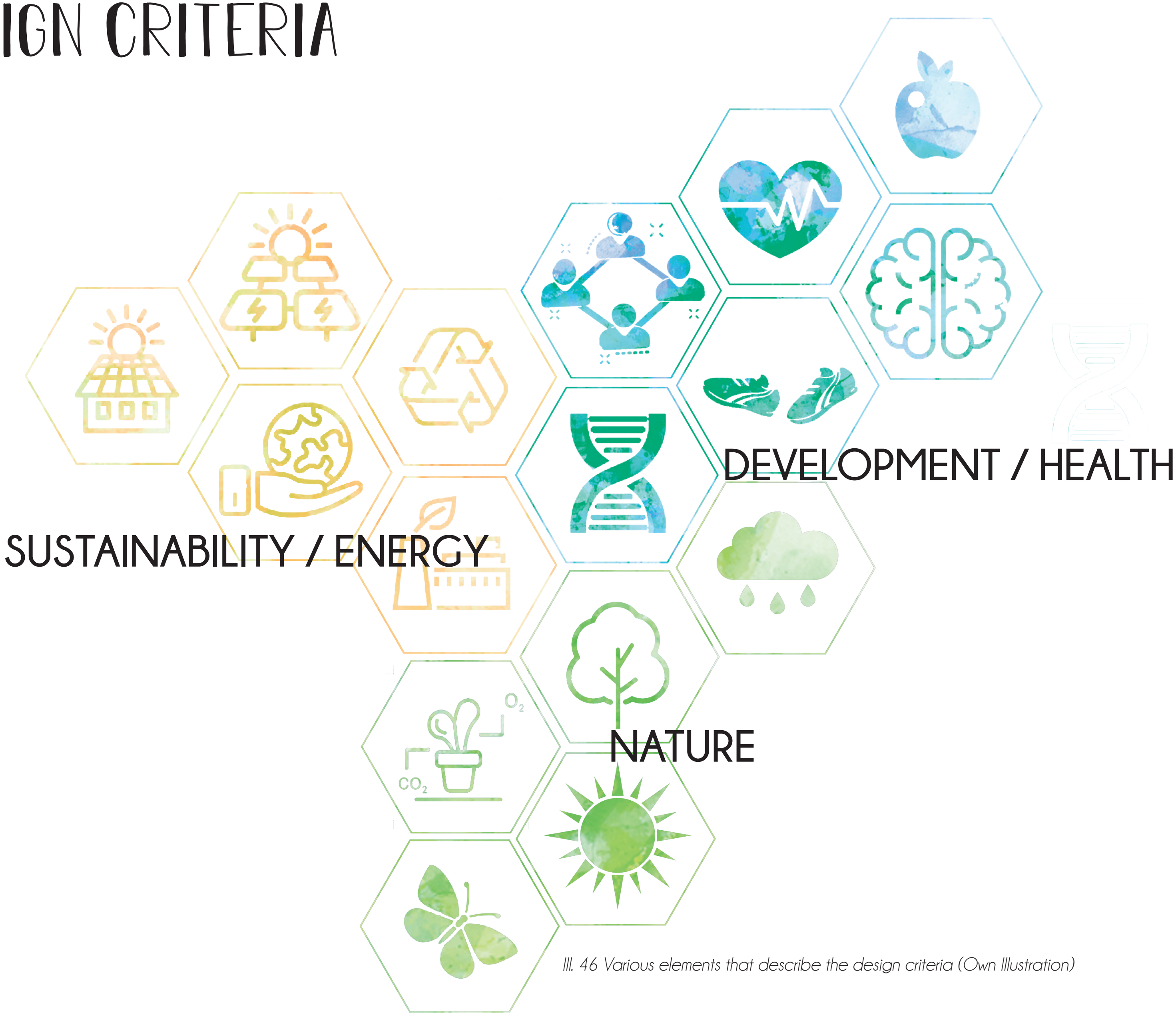
Daylight and focus on the nature / forest must play a leading role in the design. Here, a natural connection to the forest must be created using a visual contact and taking into account the present vegetation. The daylight must be worked on to draw in the design in several different ways and in the end it must be ensured that the children receive a sufficient amount of daylight.
There should be incorporated windows in children's height so the children can observe and experience nature and other children from within.

The building must comply with the energy frame for the BR20 and focus on passive solutions that minimize the energy consumption and one or more active energy sources must be incorporated so the building can produce energy itself.




*Ill. 45  Step by step process ( Own Illustration)*

# DESIGN CRITERIA




*Ill. 46 Various elements that describe the design criteria (Own Illustration)*

## SUSTAINABILITY / ENERGY

***Sustainable materials*** that have a low co² imprint and focus on minimal degassing and still have a great focus on aesthetic qualities.

**BR20 requirements** - The energy frame must not exceed 33 kWh / m² per unit. year.
Focus on the energy - by making a house that can meet the demands of the future.
Many of the actions a building requires to meet BR20 can be linked to sustainability.

## NATURE

***Adapt to the nature*** and create a visual contact to nature outside.
The design should create a synergy between nature and architeture.
Focus on preserving the present nature as it is the identity of the area.

## DEVELOPMENT / HEALTH

***Optimum daylight*** conditions - Focus on light from various directions and various ways to get the light into the building. During the summer period the deciduous trees have leaves on it can be difficult to draw daylight down to the site.
Daylight improves the development of learning and supports the brain's inner clock to know the difference between day and night.

***Indoor climate*** - Focus on thermal and atmospheric comfort designing for children and therefore strives for category 1 in DS / EN 15251 se room program s. 58
Ensure the best environment for the children in relation to the indoor climate

***Design for children*** - Easy visibility for children - windows in the level of the children and use colors and shapes to create zones and spaces that children easily can relate to.

## SECONDARY WISHES

***Focus on acoustics to reduce noise*** - Comply with the recommendations on a reverberation on ≤ 0,4 sec. in SBI 218 - Based on interior materials.
Minimize the chances of stress based on too much noise - which can have a negative impact on cognitive development.

***Flexibility*** - Interior walls with flexibility inspired by the Kita Hisa kindergarden with the mobile glass walls. To insure the building can cope more load and also adapting to future development in child care.

***Outdoor areas*** - children of all ages use the forest actively in the playground, to create different zones.
Wooden cabins, areas with animal children can help to fit and perhaps a zone of rainwater collection for play.

***Rainwater collection*** - Recycling water for flushing the toillet or other purposes such as water for animals or plants in the outdoor areas.

***Actively use the architecture*** - use the thick construction as seating area or make seating/play areas in the wall.

# FUNCTION DIAGRAM

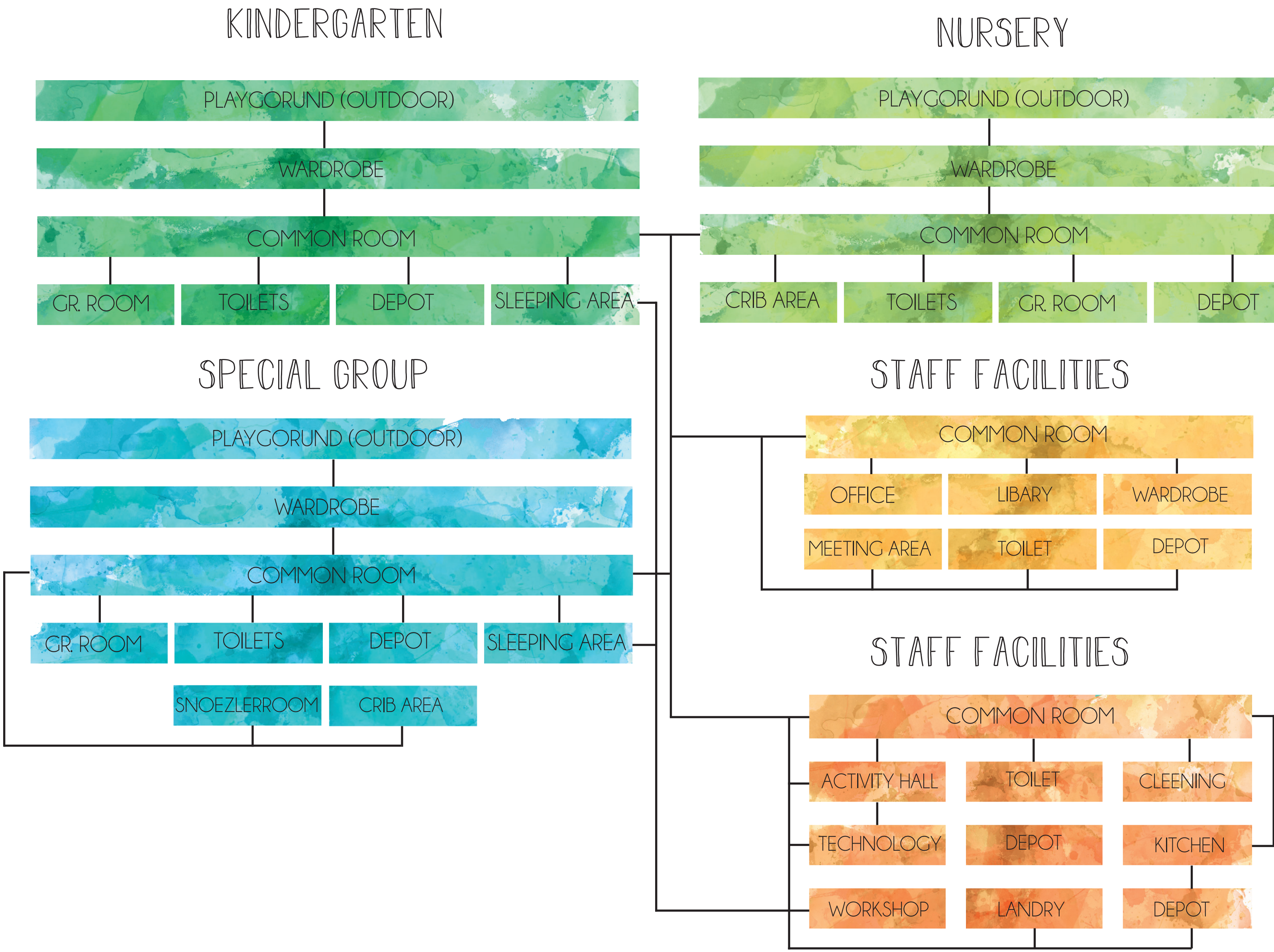
The function diagram gives an understanding of the connections between the different rooms in the building. How they are connected to each other and what functions should be in close connection.
The function diagram should provide an over-view of institution's various functions and how they are related to each other.

The various functions that are located in the design have been defined on the basis of descriptions from the new institutions of Skanderborg, and are therefore determined in advance.
The function diagram gives only a visual overview of buildings and it is in the room program that, a more detailed overview of the building is. In the room program the number of rooms, areas and other criteria is given, see  roomprogram page 56.

The diagram 47 shows that it is divided into functions linked to the child and the staff.  The different colors shows the differnt  kind of groups and what they need to be in contact with.

The lines that combinds the boxes together , illustrates which rooms need to have a direct connect to each other.

The functions diagram is made as an overall overview of the functions of the institution and their connection to each other.




*Ill. 47 Functional diagram - (Own Illustration)*

# ROOM PROGRAM

| ROOMS | NO. | ORENTATION | MIN. HEIGH | AREA | AIR FLOW RATE | | DAYLIGHT | THERMALE CONDITIONS (WINTER) | THERMAL CONDITIONS (SUMMER) | CO2 LEVEL |
|---|---|---|---|---|---|---|---|---|---|---|
| | Amount | | BR20 | Assumption | BR20 | | BR20 | DS EN 15251 2007 | DS EN 15251 2007 | BR20 |
| | | | | | | | | Category 1 | Category 1 | |
| Measures | | (N,S,E,W) | (m) | (m2) | l/s per. m2 | l/s per. Person | % | (C°) | (C°) | PPM |
| **Children with special needs : 12 children** | | | | | | | | | | |
| Group Room | 1 | - | 2,5 | 26 | 0,35 | ** | 10% glass area* | 19-21 | 22,5-24,5 | 1000 |
| Toilet facilities adults | 1 | - | 2,5 | 7 | 15 l/s pr. room | | - | 19-22 | 22,5-24,5 | 1000 |
| Snoezleroom/ Gr. | 1 | - | 2,5 | 38 | 0,35 | ** | 10% glass area* | 19-22 | 22,5-24,5 | 1000 |
| **Institution - 39 kids(nursery) + 88 kids (kindergarten)** | | | | | | | | | | |
| Group Room kindergarten | 4 | - | 2,5 | 50 | 0,35 | ** | 10% glass area* | 19-22 | 22,5-24,5 | 1000 |
| Group Room small | 2 | - | 2,5 | 15 | 0,35 | ** | 10% glass area* | 19-22 | 22,5-24,5 | 1000 |
| Toilet and changing room | 2 | - | 2,5 | 12 | 0,35 | ** | - | 19-22 | 22,5-24,5 | 1000 |
| Wardrobe | 1 | - | 2,5 | 73 | 0,35 | ** | - | 19-22 | 22,5-24,5 | 1000 |
| Group Room nursery | 3 | - | 2,5 | 50 | 0,35 | ** | 10% glass area* | 19-22 | 22,5-24,5 | 1000 |
| Group Room small | 1 | - | 2,5 | 15 | 0,35 | ** | 10% glass area* | 19-22 | 22,5-24,5 | 1000 |
| Toilet and changing room | 1 | - | 2,5 | 12 | 15 l/s pr. room | | - | 19-22 | 22,5-24,5 | 1000 |
| Wardrobe | 1 | - | 2,5 | 72 | 0,35 | ** | - | 19-22 | 22,5-24,5 | 1000 |
| **Common areas** | | | | | | | | | | |
| Kitchen - Industry | 1 | - | 2,5 | 57 | 20 l/s pr. room | | 10% glass area* | 19-22 | 22,5-24,5 | 1000 |
| Depot kitchen | 1 | - | 2,5 | 12 | 0,35 | - | - | - | - | - |
| Depot room | 1 | - | 2,5 | 33 | 0,35 | - | - | - | - | - |
| Workshop area /Sleep area / Small Gr. | 2 | - | 2,5 | 30 | 0,35 | ** | 10% glass area* | 19-22 | 22,5-24,5 | 1000 |
| Activity Hall | 1 | - | 2,5 | 212 | 0,35 | ** | 10% glass area* | 19-22 | 22,5-24,5 | 1000 |
| Technology | 1 | - | 2,5 | 30 | - | - | - | - | - | - |
| Common areas | 1 | - | 2,5 | 400 | 0,35 | ** | 10% glass area* | 19-22 | 22,5-24,5 | 1000 |
| **Staff Facilities** | | | | | | | | | | |
| Libary | 1 | - | 2,5 | 11 | 0,35 | ** | 10% glass area* | 19-22 | 22,5-24,5 | 1000 |
| Wardrobe Staff | 1 | - | 2,5 | 26 | 0,35 | ** | - | 19-22 | 22,5-24,5 | 1000 |
| Meeting facilities | 1 | - | 2,5 | 14 | 0,35 | ** | 10% glass area* | 19-22 | 22,5-24,5 | 1000 |
| Office area | 1 | - | 2,5 | 25 | 0,35 | ** | 10% glass area* | 19-22 | 22,5-24,5 | 1000 |
| Cleaning / Landry | 1 | | 2,5 | 14 | | ** | | | | |
| Toilets - HC + bath | 3 | - | 2,5 | 10 | 15 l/s pr. room | | - | 19-22 | 22,5-24,5 | 1000 |
| **Outdoor areas - Not heated** | | | | | | | | | | |
| Crib area | 1 | - | 2,5 | 80 | | | | | | |
| Crib Storage | 1 | - | - | 20 | | | | | | |
| **Total area of the institution** | | | | 1571 | | | | | | |

* 3 l/s per. kids + 5 l/s per. adult
*10% glass area in relation to the relevant floor area
BR20 - 100 hours over 26 degrees - 25 hours over 27 degrees

# VISION

*The vision for this project is to create the best possible framework for todays and the futures children.*
*The institution must form the basis for the child being able to develop, play and learn, but also create space for immersion and silence.*
*Based on research in the field over the past years, there must be a focus on which elements can change the "standards" for today's institution. This is with a focus on children's development, which elements the architecture can help to change within the area.*
*The institution must adapt to the area and focus on preserving and taking care of the surrounding nature and the building must create a visual connection to the nature.*
*The institution must be characterized by sustainability, both in the choice of materials but also in relation to energy.*
*The energy should be in focus and must form a basis for the sustainable institution of the future.*

# 03

# PRESENTATION

CONCEPT

MASTER PLAN

PLAYGROUND /OUTDOOR AREAS

FLOORPLAN

ELEVATIONS

SECTIONS

CONSTRUCTION

DETAILING

INDOOR ENVIOMENT - THERMAL AND ATMOSPHERIC

VENTILATION

DAYLIGHT

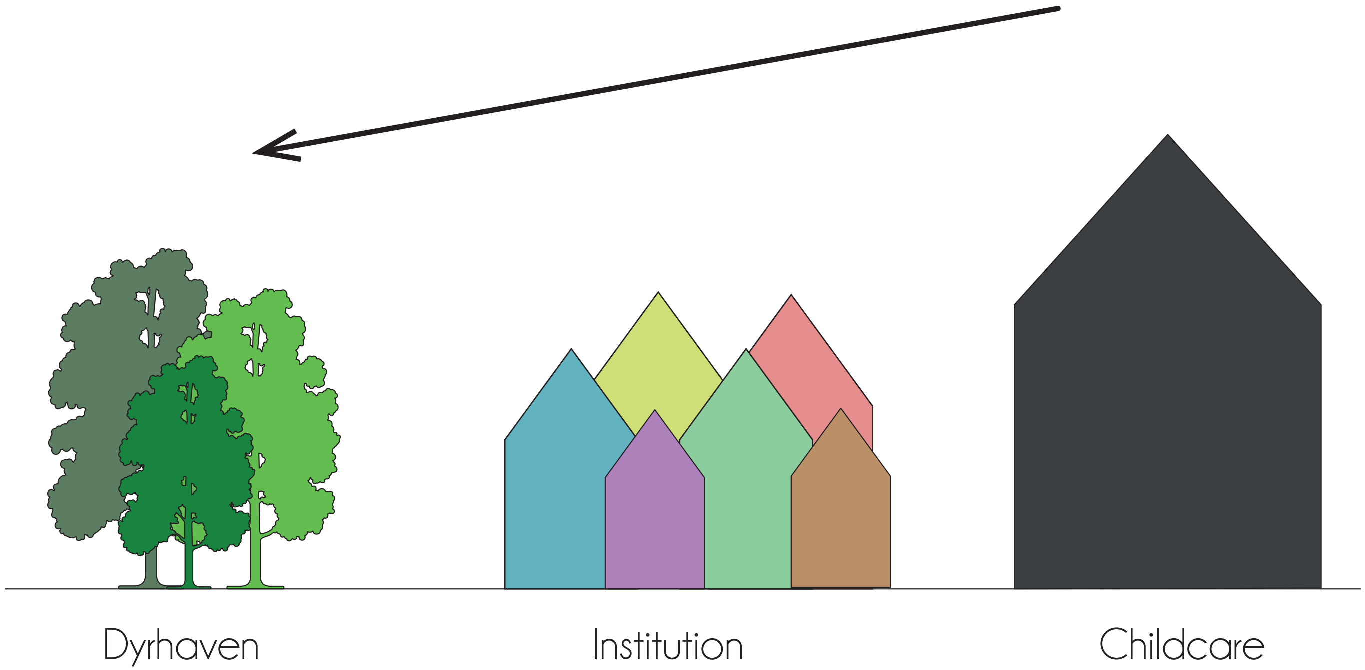
ENERGY FRAME

ACOUSTICS

FIRE STRATEGY

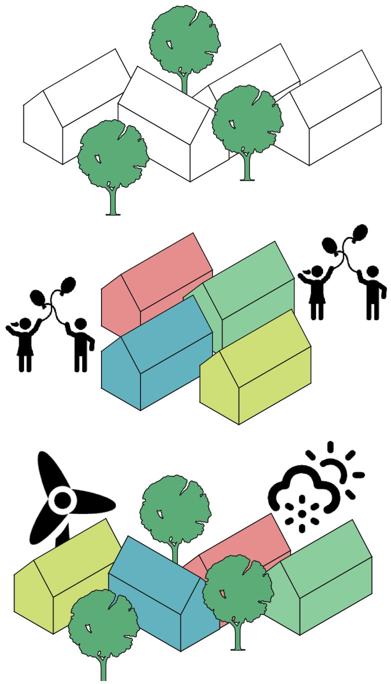
Ill. 48 Picture of forest floor
(Own photo)

# CONCEPT




Ill. 49 Concept diagram
(Own Illustration)

The overall concept is to break the scale of the large institutions with a justification to make them more manageable and usable from a child's perspective. Thus breaking the trends and traditions that don't has the child in focus.
There by creating a new institution with a fusion between the values of the site and the future of childcare..



Adapt to nature

Focus on development and health

Integrated sustainable and energy related initiatives

*Ill. 50 Concept diagram 3 steps (Own Illustration)*

The first step is to adapt the building to the sites values and challenges, in order to be able to integrate and preserve the nature in the best possible way.

After that, there is a focus on optimizing the building to create the best framework in relation to well-being, health and development.

To end up with a building that focuses on energy and sustainability, without setting aside the needs of nature and the target group.


Ill. 51  Visualization of the building from outside    (Own Illustration)



The Forest house is a new institution that is located among the trees in Dyrhaven in Skanderborg. It is an integrated institution that focuses on creating a new goal for future development in the children care sector.

Here, a sustainable building forms the framework for around 140 children, where the main focus is development and play. The building is characterized by a Reggio Emilia approach where the children have many opportunities for being creative and expressing themself.

There is also great focus on children being able to meet and interact in the large open common area, as social community is an important value for the Forest House. The institution has several creative workshops and various outdoor activities.

Several of the group rooms have sliding doors that create a visual contact through the group room, but it also makes it possible to make multifunctional rooms which can be made larger and smaller.

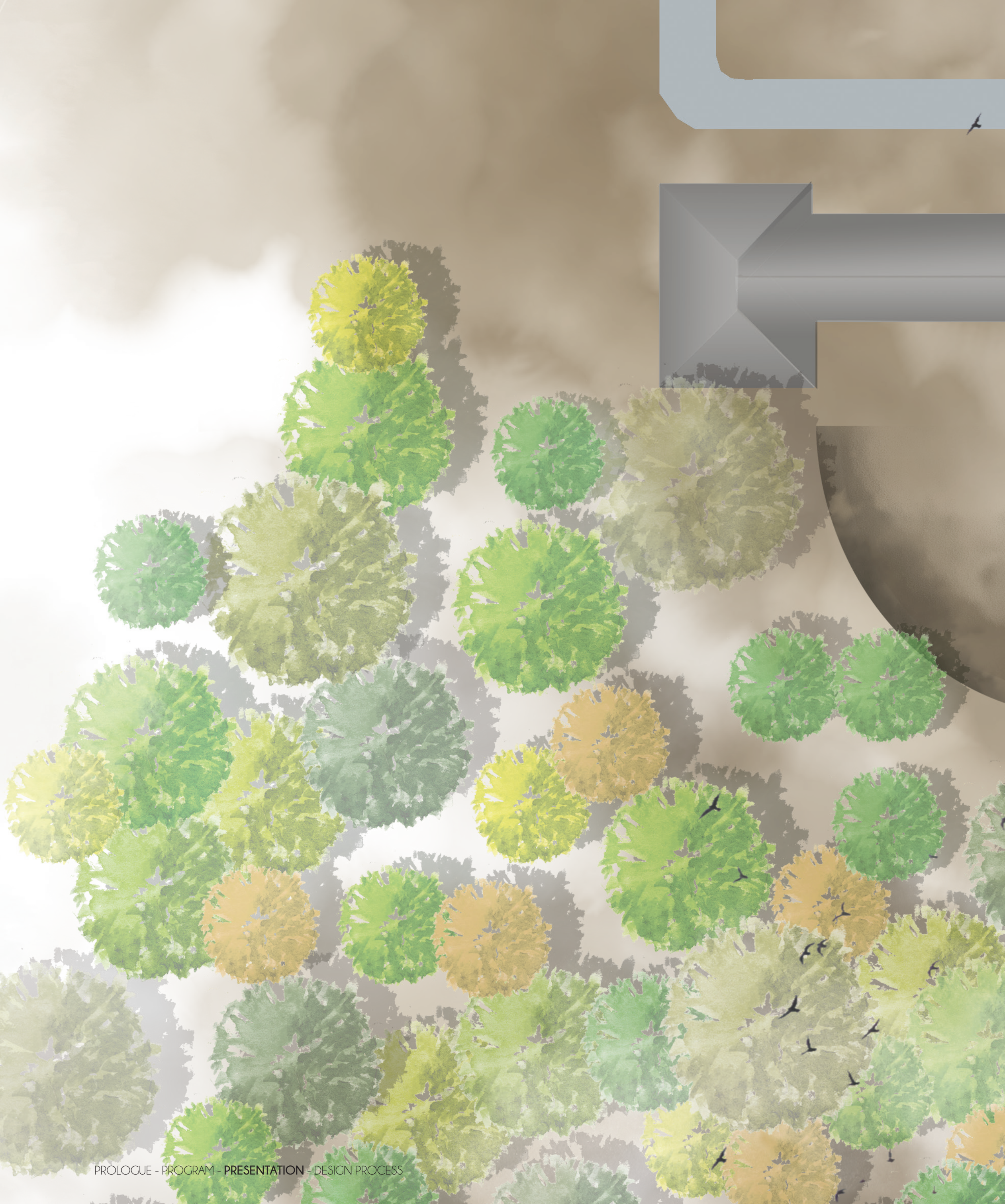
# MASTER PLAN

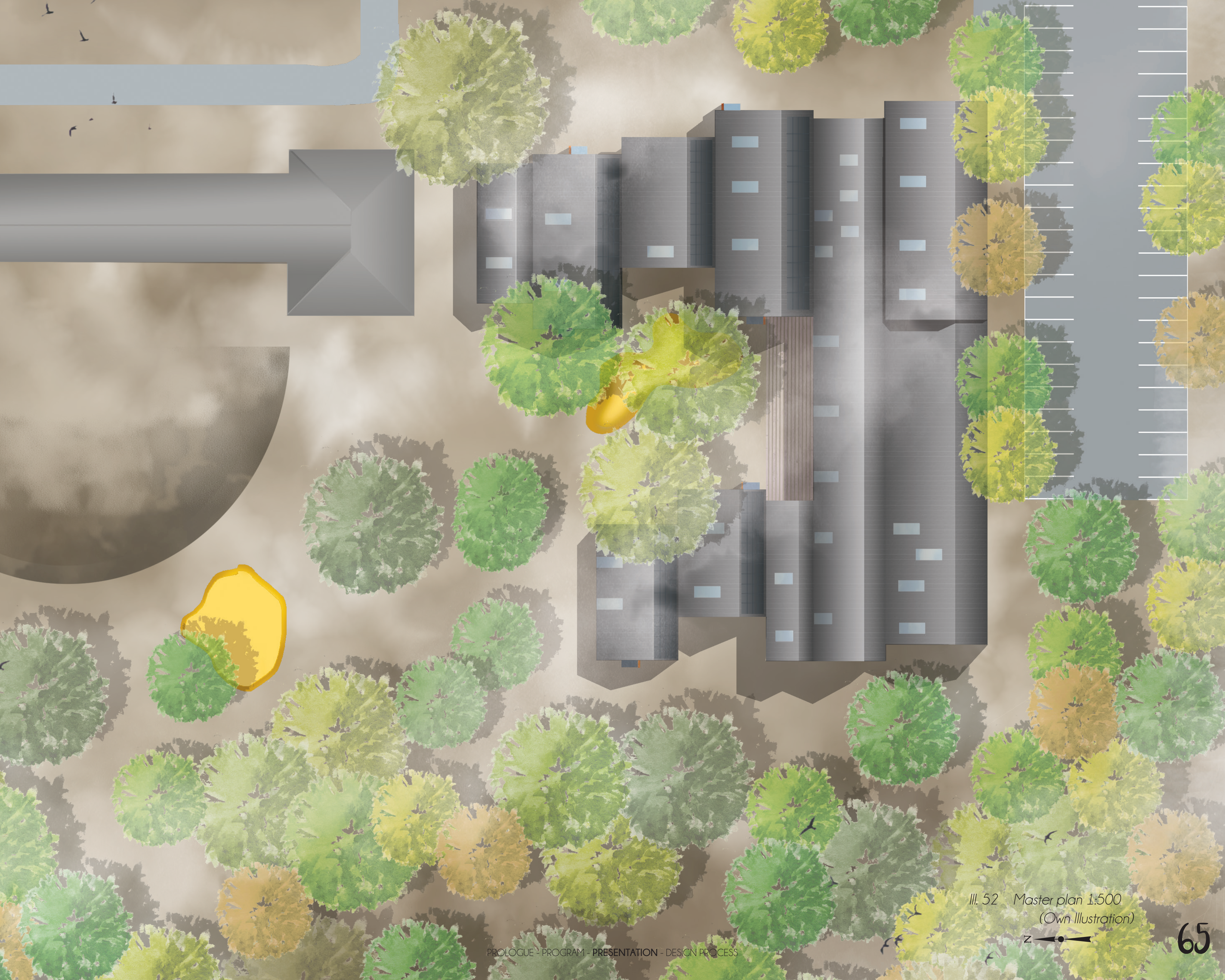
The master plan shows how buildings close off towards the road and the park ring area in the south of the site.
This is to create a safe and secure environment in the larger outdoor areas that is located north of the building.

The forest house is located in the woods and therefore the large outdoor area is also characterized by green wooden crowns in the summer and a red / brown forest floor in the autumn where all the leaves are falling of the trees, which also draws the light in between the trees.

The many windows inside the building are designed to create a visual contact to the forest, both inside and outside.
This creates the opportunity for children to see the seasons change and follow the different plants and animals that the seasons contain.

On the southern side of the buildings, a new parking lot is integrated, but there is also a larger parking space near the site which can be used if needed.






Ill. 52 Master plan 1:500
(Own Illustration)

# PLAYGROUND/OUTDOOR AREAS

To create different outdoor areas, the diagram on Ill. 53 can make an impression of the different activates and where they are located.
There has been a focus on creating different opportunities for the children, so that children of different ages are stimulated.

The forest house's location in the scenic surroundings - creates the perfect setting for the children to have many good hours in the outdoor areas.

Ill. 53 Shows the forest house many areas and zones which will be described here.

Zone 1: Here, the focus is on the children being able to help cultivate different plants and take care of them. Water for the plants can be found in Zone 6 - where rainwater is collected and used for play.
In addition, there are tepees that can be set up for games and themes in periods.

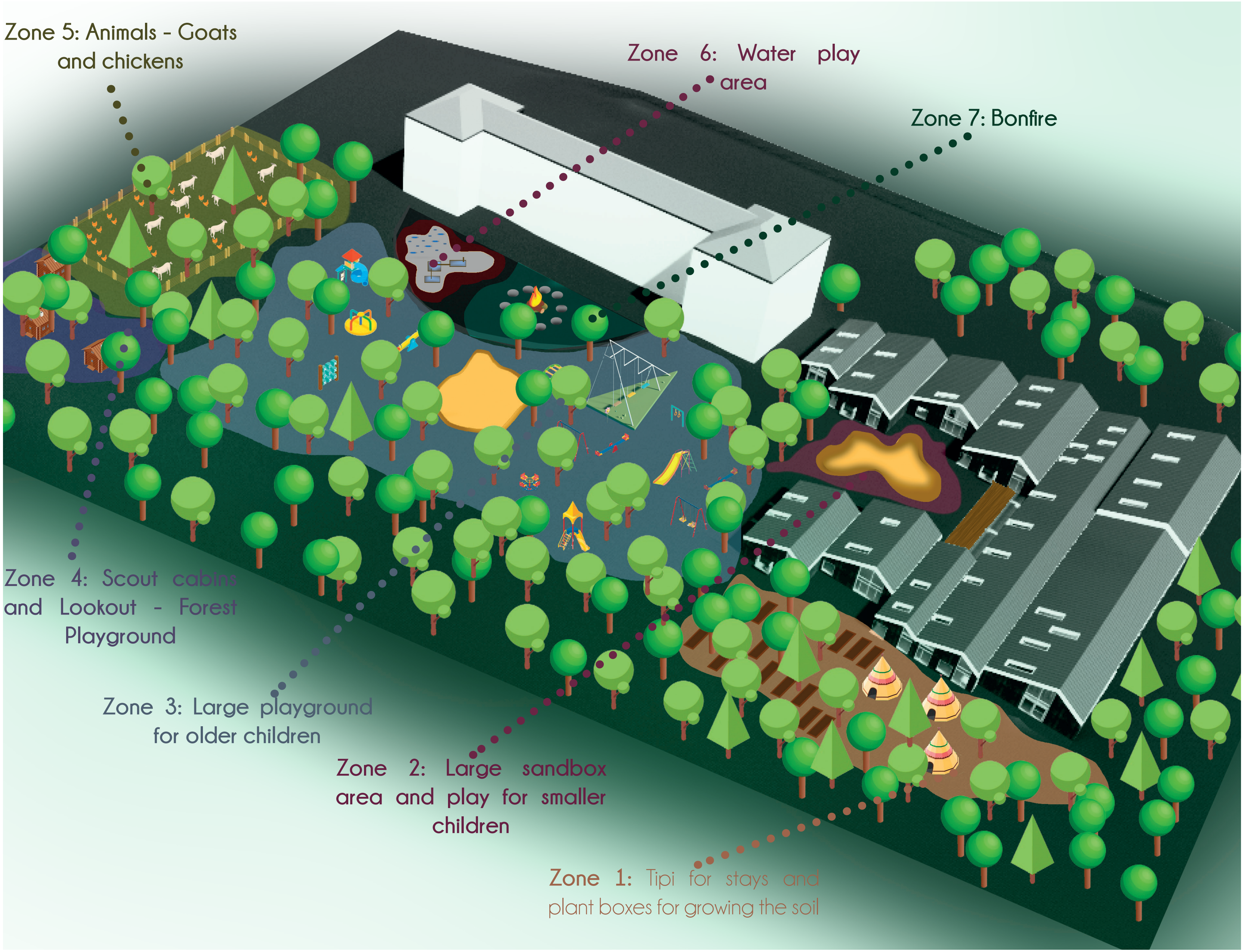
Zone 2 contains a large sandbox and other small play areas that caters to the children in the nursery

Zone 3 contains a large playground with all different playground equipment primarily aimed at the children in the kindergarten. Here, there are, among other things, roller coasters, sandbox, swings, scraper frame, carousel, etc.

Zone 4 contains a special forest area furthest from the buildings - Here there are small scout cabins and viewpoints and several forest playground elements.
Zone 5 contains an area of different animals, animals such as chickens and goats. This area is to teach the children responsibility and how to care and care for animals.

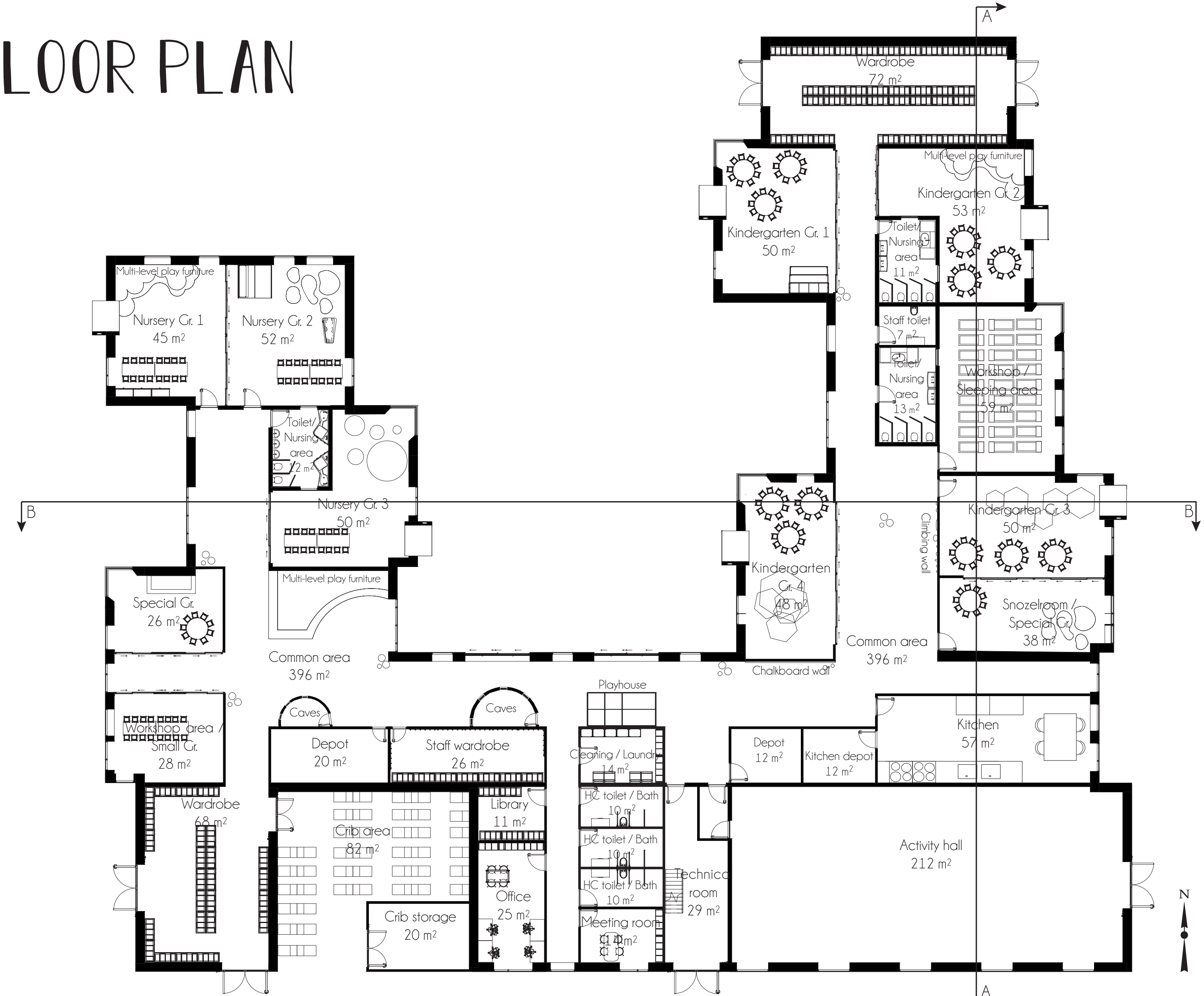
Zone 6 contains an area where water play is in focus - here rainwater is collected which then can re-water for play and also water for the plants grown area 1

Zone 7 is an area there is room for a big bonfire so the child can make twist bread, popcorn or other activities around the fire.




Ill. 53 Outdoor areas with colors for the different zones
( Own Illustration)

# FLOOR PLAN




Ill. 54 Plan drawing 1:300
(Own Illustration)

The forest house's plan shows the distribution of rooms and areas in the institution. The two wardrobes have helped to shape the building and affected the interior design of building. This is because it was important that these two areas were contacted to both sides of buildings, both the parking areas but also the playground.
In addition, the wardrobe should not be a passage area, since everyone then would get dirty feet and drag dirt around the whole institution.

In the western side of the building, the nursery is located and in the east side the kindergarten is located.
In addition, the workshop area and special group rooms are spread out on both areas.

In the southern part of the building, the staff area is located with offices, toilets and wardrobes.
In addition, a large activity hall has been integrated to the south, which creates the framework for various activities and sports.

In the eastern part of the building is an industrial kitchen that ensures that the institution can cook healthy and good food for the children.

The large common area connects the whole building and creates an opportunity for the children to interact across ages differences.

In the common area there are different zones and activities such as, climbing wall, chalkboard, multifunctional furniture for play and small caves to hide inside. Thus, small niches are also integrated around inside the building this is in the window areas where seating areas are created, where the thick construction is used. Here it is possible to read a book or look out and follow the life that goes on outside. It is also an opportunity to immerse in animal species or plants using binoculars.

Several of the rooms have a multifunctional purpose for optimizing spaces and creating more space for common areas. Thereby there are no unused spaces around the building.

I the majority of the group rooms there are integrated sliding doors in the wall, so that both the light can flow through but also to create an opportunity to use the rooms for other purposes or not be limited by space sizes to different activities.
In addition, it is also an advantage in relation to robustness, since the building, therefore, does not have many bearing inner walls and can therefore be used for other purposes if it should become applicable in the future.

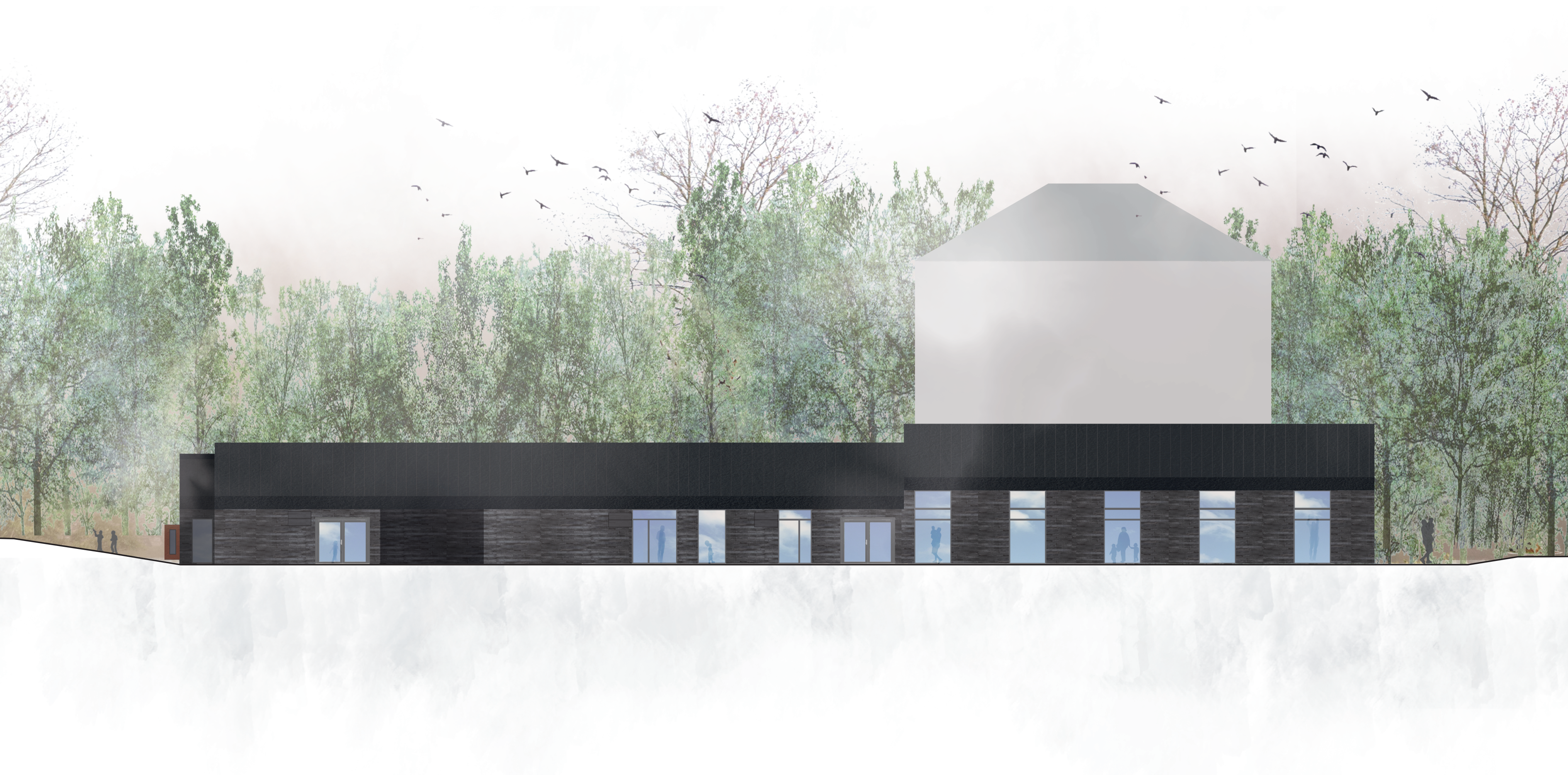
As the building is primarily ventilated by Microvent, there is no need for a lot of technology space, but there is still integrated a technology room in the southern part of the building where several rooms have suspended ceilings, so the 1st floor can also be used for technology.

Ill. 55 Visualization of the common area
(Own Illustration)

# ELEVATIONS

Ill. 56 Elevation East 1:300
(Own illustration)

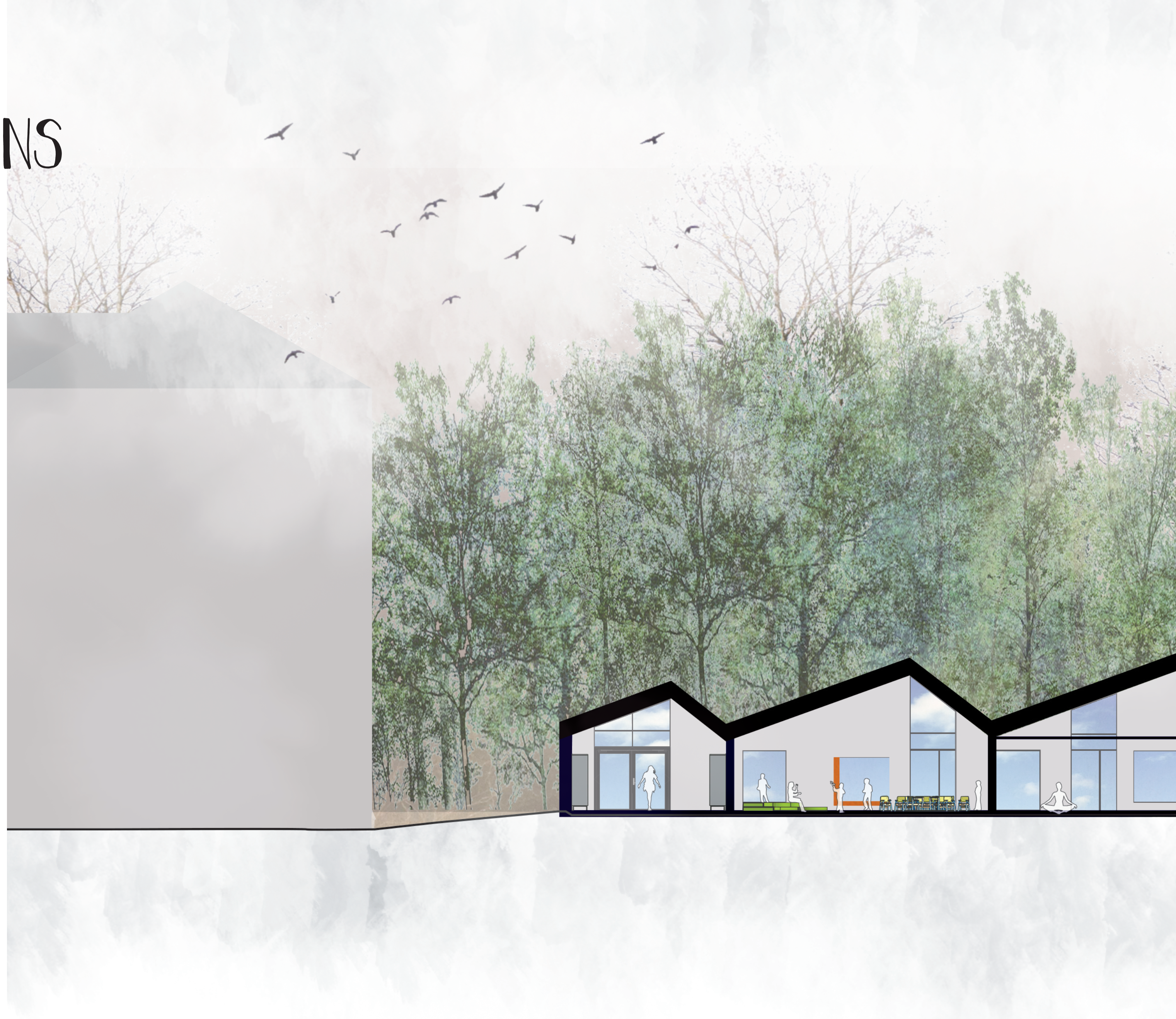
Ill. 57 Elevation West 1:300
(Own Illustration)



Ill. 58 Elevation South 1:300
(Own illustration)

Ill. 59 Elevation North1:300
(Own illustration)

# SECTIONS



Ill. 60 Section AA 1:200
(Own illustration)

Ill. 61 Section BB 1:200
(Own illustration)

The windows form the floor to the ceiling creates the opportunity for the children to lie on the floor and look up In the tree tops and thereby give a special mood and feel to the rooms, in addition there are window boxes that protrude out form the facade, here the children have the possibility of being pulled out of the building, directly into nature.

The many different zones in the room are not bounded by walls but by colors, heights or other markings and that helps to create smaller and more manageable areas for the children so that they do not have to relate to the whole room at once.
In addition, the different zones also create different games and expressions.

All the facades are covered with burnt wood which creates diversity and tactile in the surface of the building; in most exterior walls, MircoVent boxes are installed to ventilate the building.
The roof is covered with sustainable zinc from Rheinzink, which has a dark gray color that plays well with the dark wood on the facade.

*Ill. 62 Visualization of nursery group room 1 (Own illustration)*

# CONSTRUCTION

The building's constructive principle is illustrated in illustration 63.

Here, the diagram shows 4 steps where in each image the different constituent parts are highlighted.

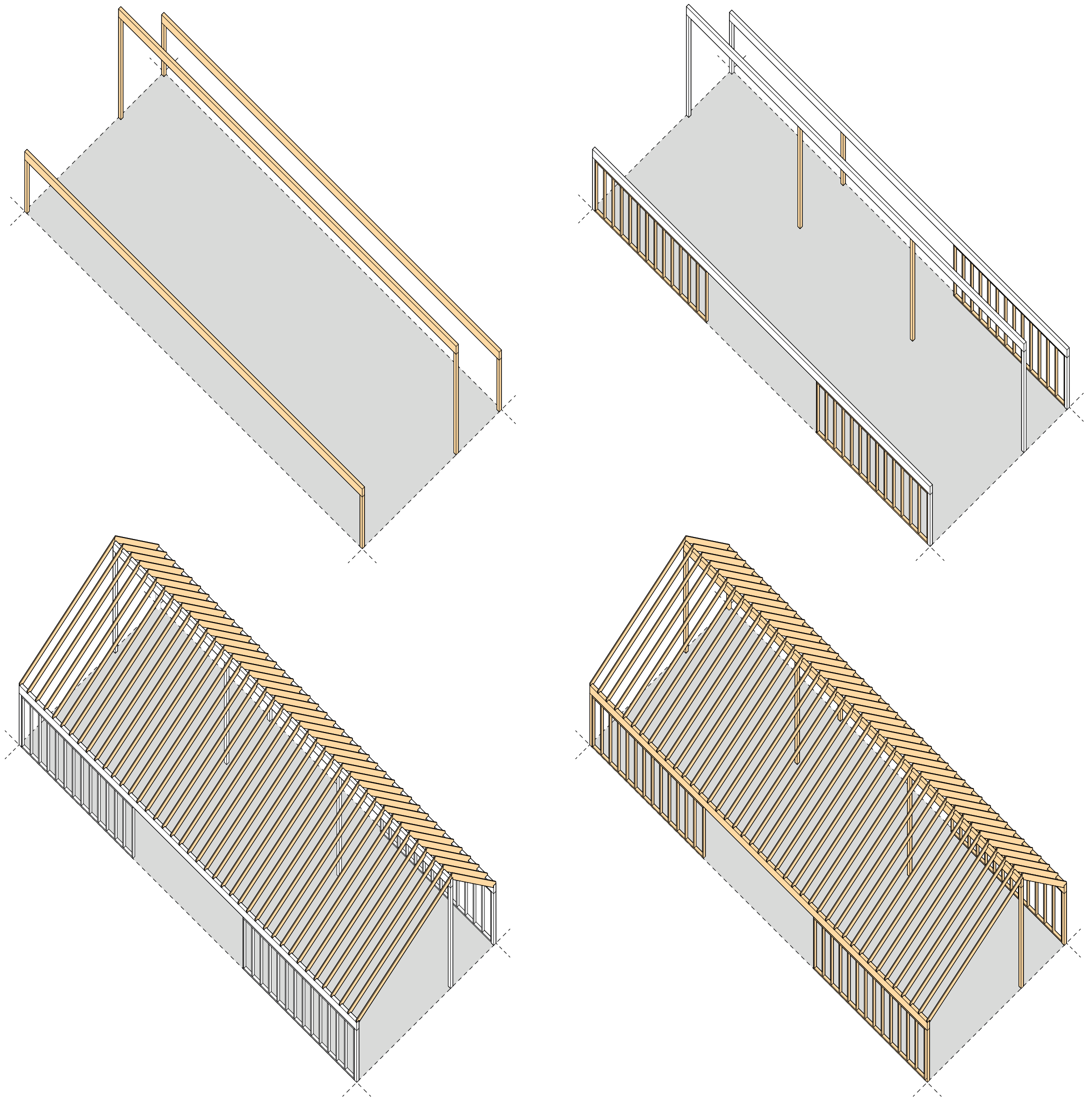
The first step shows the glulam beams

Step 2 shows the support of glulam, in the form of either columns, or load-bearing walls or a mixture of columns and load-bearing walls.

Step 3 shows the rafters

And the final step shows the assembled construction.

The diagram illustrates how one of the "houses" is constructed and the individual units are put together to form the structure for the whole building.

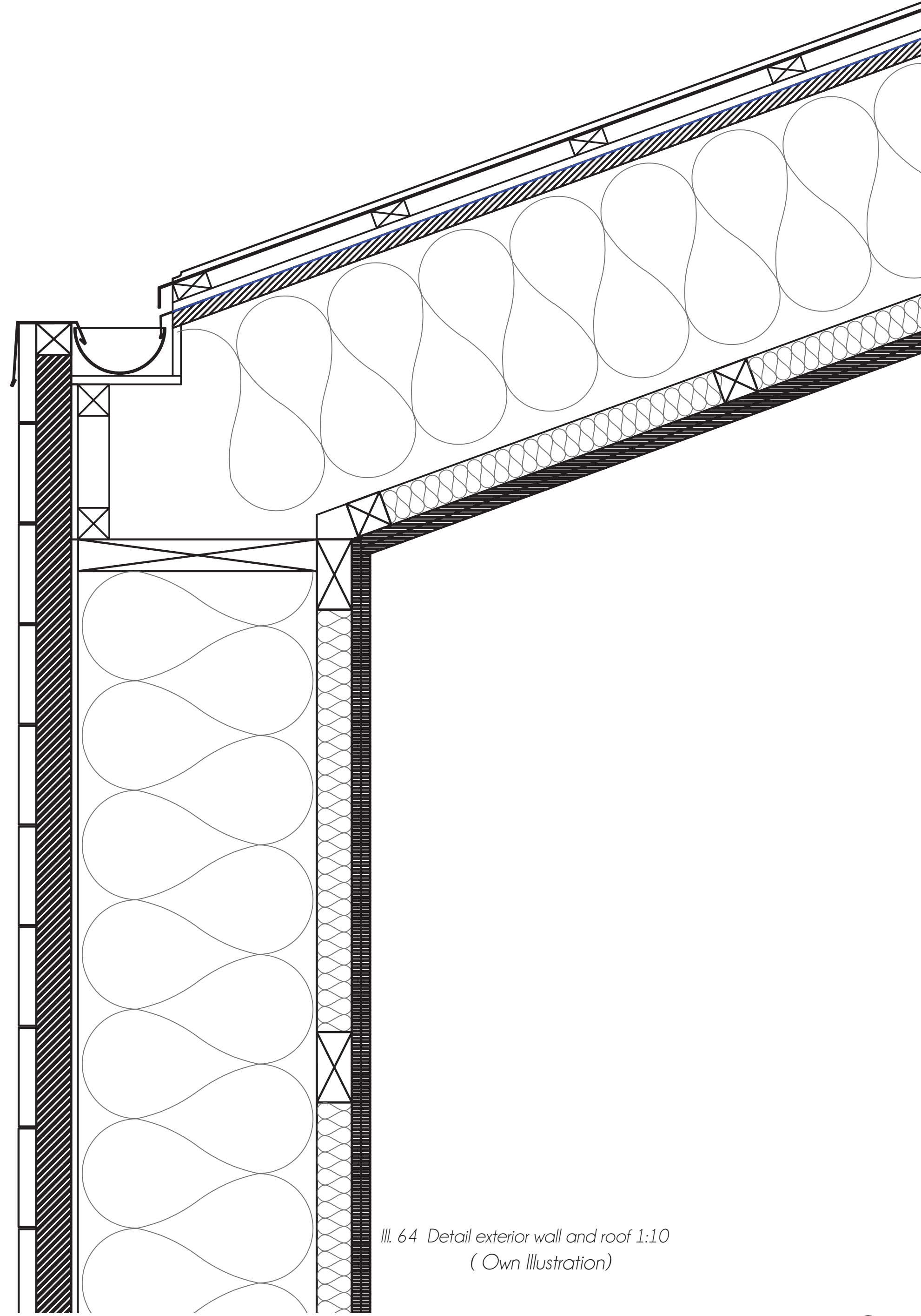


*Ill. 63 Constructive principles divided into 4 phases ( Own Illustration)*

# DETAILING

**Roof structure**
Rheinzink roof with standing seam (solid color)
25x50 mmWooden moldings
12 mm impr. Battens
Diffusion Open Roof (blue line)
22 mm plywood plate
45x295 mm structural timber (T1) cc 600
320 mm Insulation
0,2 mm vapor barrier
45x45 mm Wooden moldings cc 600
45 mm Insulation
20x90 mm Formwork cc 300
13 mm Troldtekt

**Outerwall : U-value: 0,115**
25x140 mm Burnt Wood - Cladding
50 x 50 mm Battens with air gap
09 mm Cembrit windstopper extreeme
90 x 145 mm Isover plus stolper
45 x 195 mm Structural timber (T1)- cc 600
340 mm Seaweed insulation
0,2 mm Dampspærre
45x100 mm Wooden moldings
45 mm Kingsspan insulation
2 x 13 mm Plaster



*Ill. 64 Detail exterior wall and roof 1:10*
*( Own Illustration)*

# INDOOR ENVIRONMENT - THERMAL AND ATMOSPHERIC

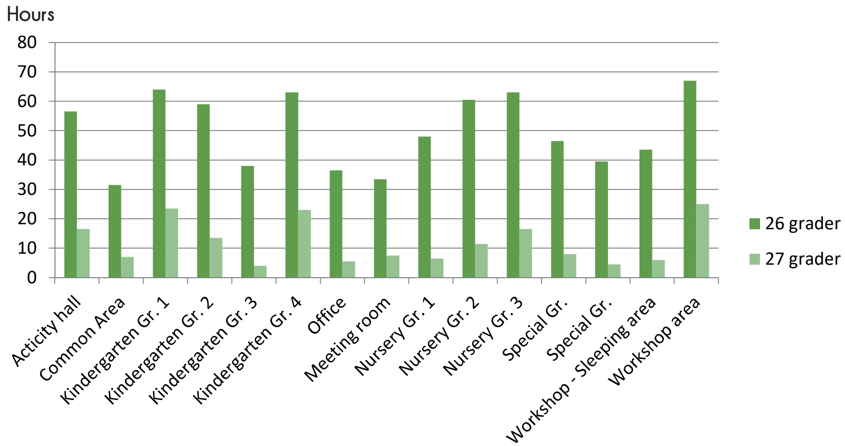
To calculate the indoor climate the program IES-VE has been used to ensure that the building's design can meet requirements and wishes for both the thermal and atmospheric indoor climate. The process for achieving an optimal indoor climate is seen in the desing process on pages 109-112.

The entire building is calculated in the program as the indoor climate occupies a large part in relation to the design criteria and to maintain a focus on giving the children the best conditions.

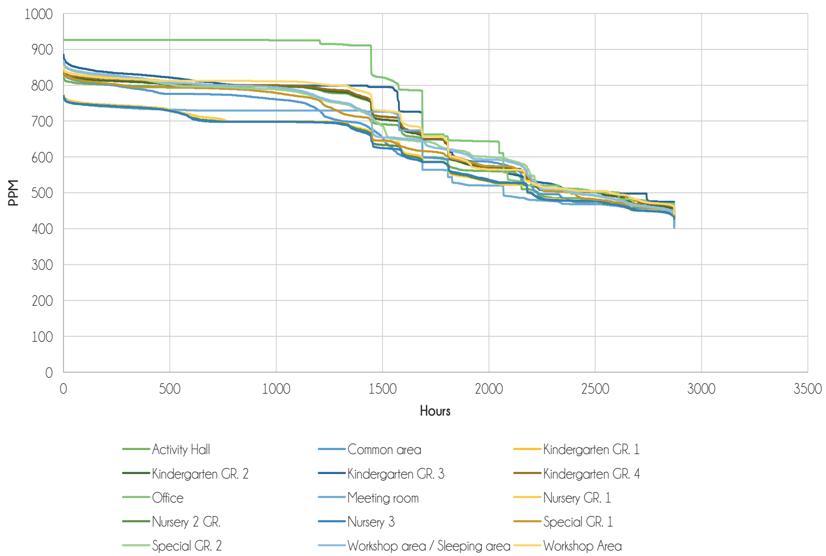
Therefore, all rooms in the institution comply with the requirements of the building regulations regarding that max must be 100 hours over 26 degrees and 25 hours above 27 degrees. on Ill. 64 shows all the room of all buildings and that all rooms stay within the desired conditions.

Ill. 65 showes how the atmospheric indoor climate is, here it is seen that all the room stays below the wished CO2 co-concentration where the indoor concentration stays below the 1000 ppm that BR18 sets as a requirement for institutions.
This ensures that there is sufficient fresh air and that there are no problems with excessive concentrations of CO2 that can cause problems with headache, concentration and fatigue.

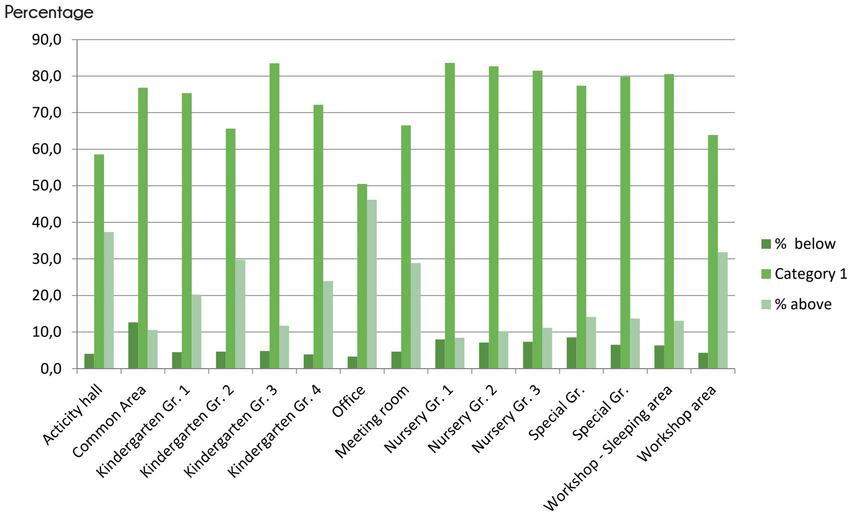
All the tables are based on results that can be found on appendix 03 page 130.



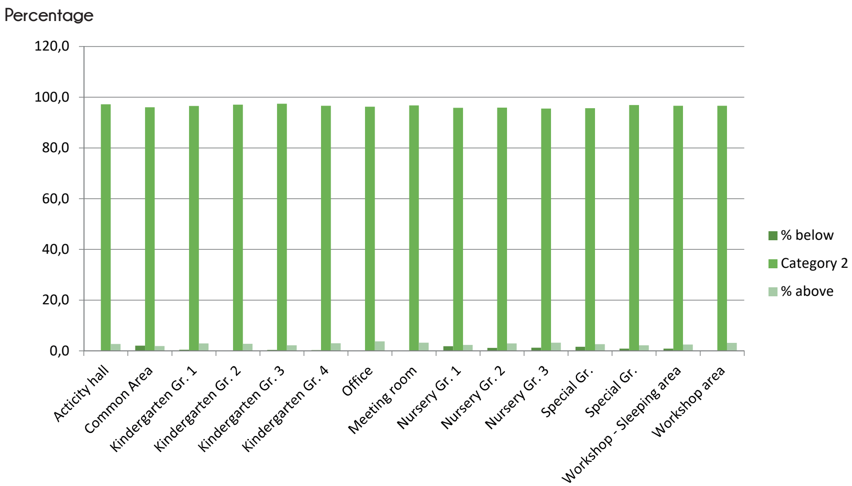

Ill. 64 Hours above 26°c og 27°c ( Own Illustration)




Ill. 65 $CO_2$ concentration for the different rooms ( Own Illustration)




*Ill. 66 Category 1 - Hole year ( Own Illustration)*




*Ill. 67 Category 2 - Hole year ( Own Illustration)*

In addition, it was a requirement to keep the largest part of the time the building is used in the area of category 1 in DS / EN 15351 that is relatede to the temperature in the building.

Category 1 in a kindergarten is:
Summer: 22.5 - 24.5 degrees
Winter: 19-21 degrees.

Category 2:
Summer: 21.5-25.5 degrees
Winter: 17.5-22.5 degrees

On Ill. 66 it is showen that most used time complies with the requirement for category 1 both in winter and summer.
Ill. 66 shows in percentage how much of the time that stays within category A and how many% are over and under cate- gory A. All data is based on a whole year.

On Ill. 67 sees the same values only for category 2 - here it can be seen that approximate 100% of time remains within category 2.

The forest house can therby ensuring a good indoor enviorment that contributes to both well-being but also benefits children and adults in relation to health. It is important that the children can sit and immerse without building regulated problems influences them. A healthy and good indoor climate contributes to creating the optimal framework that is needed in future institutions.

# VENTILATION

The building is constructed in such a way that all rooms are facing a façade so that it is possible to use MicroVent to ventilate the building -

Information and calculations is referred to page 109 and Appendix 02 page 120 and appendix 06 page 134.

In order to maintain both a good thermal and atmospheric indoor climate, it was necessary to add a larger air change in a few rooms, which shows Ill. 69. The final calculation of airflows in the rooms.

MicroVent is installed in the outer wall, thereby avoiding piping inside. However, it is necessary to use traditional mechanical ventialtion in the rooms that do not have an outer wall such as toilets and change rooms. In addition, it has been chosen to run traditional mechanical ventilation in the kitchen as point extraction must already be installed.

It was also optimum to use traditional mechanical ventialtion in the activity hall as it has a large people load, this was no problem as it was placed in connection with the technical room.

Ill 68 it is shown which rooms that do not use Micro vent and how the pipe guide is.

*Ill. 68 Principle of traditional mechanical ventilation ( Own Illustration)*

| The rooms | Area | Air flow supply l/s - Comfort | Air flow supply pr. m2 | Air change rate h-1 |
|---|---|---|---|---|
| Groop room Kindergarten ( x 4) | 52 | **261,2** | **5,07** | 7,30 |
| Group room Nursery (x3) | 51 | **240,0** | **4,74** | 6,82 |
| Group Room Special needs(x2) | 28 | **104,2** | **3,79** | 5,46 |
| Snozleroom / Workshop | 33 | **164,1** | **4,92** | 7,09 |
| Toilet (4) | 10 | **15,0** | **1,58** | 2,27 |
| Toilet + Changing room (x3) | 15 | **15,0** | **0,98** | 1,41 |
| Wardrobe (x2) | 73 | **194,6** | **2,67** | 3,84 |
| Common area - Zone 1 | 137 | **243,8** | **1,78** | 2,56 |
| Common area - Zone 2 | 131 | **239,2** | **1,83** | 2,63 |
| Common area - Zone 3 | 128 | **236,9** | **1,85** | 2,67 |
| Kitchen | 60 | **20,0** | **0,33** | 0,48 |
| Activity Hall | 212 | **1178,5** | **5,56** | 8,00 |
| Office | 25 | **70,0** | **2,80** | 4,03 |
| Meeting room | 14 | **76,0** | **5,43** | 7,82 |

*Ill. 69 Calculation of air flows ( Own Illustration)*

# DAYLIGHT

The daylight has played a major role in desing the building this is due to the many good values and effects an optimal daylight creates for the well-being. The daylight helps to keep the "inner clock" going and thereby create an understanding of when it is night and day. A large part of the day is spend inside inside and therfor it is important to secure a good daylight conditions. Daylight calculations is seen on Ill. 70 and it is made from the building regulations requirements to 10% of the floor area and in this calculation the many corrections that are necessary to count on daylight are also included.
The full daylight calculation can be found on appendix 05 page 133, here the various correction factors can also be found.
In addition, appendix 05 page 133 also contains a diagran that is showing the different rooms average daylight factor.

The daylight has also been an important element in the design because it has a great influence on the calculation of the energy frame, since lighting is included in this calculation, by a good daylight could reduce the need for artificial lighting and thereby save energy in the energy frame.

The importance of daylight has, as mentioned, characterized the design a lot, but also a desire for a visual contact to the beautiful nature outside has been a great design criterion, it should be possible for the children to experience nature from within as well as from outside.

| Rooms | Total glass area | BR18 requirements |
|---|---|---|
| Kindergarten Gr. 1 | 7,1 | 5,0 |
| Kindergarten Gr. 2 | 5,9 | 5,4 |
| Kindergarten Gr. 3 | 7,6 | 5,0 |
| Kindergarten Gr. 4 | 5,4 | 4,8 |
| Nursery Gr. 1 | 6,1 | 4,5 |
| Nursery Gr. 2 | 7,3 | 5,3 |
| Nursery Gr. 3 | 6,6 | 5,0 |
| WorkShop/ Sleeping area | 7,3 | 5,9 |
| Workshop /Small Gr. | 3,4 | 2,8 |
| Special Gr. | 5,5 | 2,6 |
| Snozleroom/Special Gr. | 2,5 | 3,8 |
| Kitchen | 6,6 | 5,7 |
| Wardobe Kindergarten | 10,0 | 7,2 |
| Wardrobe Nusery | 10,5 | 6,8 |
| Office | 3,0 | 2,5 |
| Meetingroom | 3,1 | 1,4 |
| Activity Hall | 26,2 | 21,2 |
| Commonroom + hallways | 35,8 | 13,7 |

*Ill. 70 BR18 calculation of daylight - 10% of the floor area ( Own Illustration)*

The only room that does not meet the requirements for daylight in relation to BE18 is Snozleroom, but since this room is primarily used for sensory play and often is in use without light due to various forms of artificial lighting, it is not considered to be a problem in relation to to daylight.

# ENERGY FRAME - LOW ENERGY CLASS

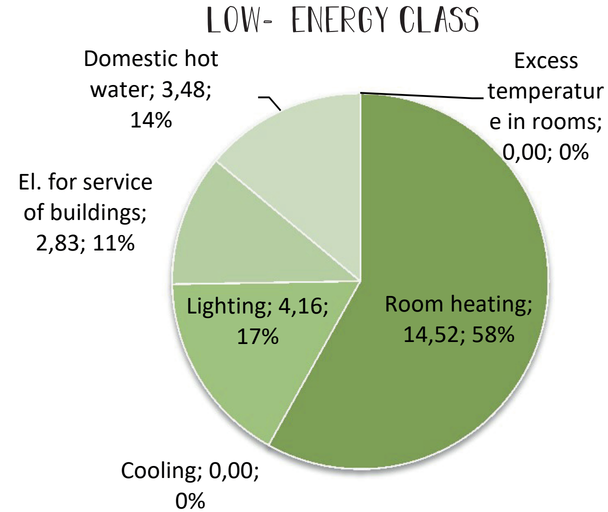
One of the main design criteirea was ot forfill the energy demands for low energy frame (2020), with an energy consumption of 33, kWh / m2 per year.

In order to maintain the energy frame and document the energy framework data, the calculation program BE18 has been used to calculate the energy in the construction. BE18 has also been used throughout the design process to optimize and develop a design with a focus on energy.

The energy frame has a close connection to the indoor climate and therefore the energy considertations is linked to the data collected in relation to the indoor climate calculators.

This energy frameis an estimated calculation that can contain several variable error margins, this is due to the location of the site in the forest area, where shadows and location of trees, cannot be determined precisely in a reproduction of the area and this must be taken into account.
In the calculation, shadows and the trees' location are assumed in relation to underlying investigations of the area.

This energy frame is a mean value of a two different energy frames that is basset on a summer and winter situation, since in the winter there are not so many shadows as there are in the summer, because the trees are deciduous trees that lose their leaves in the fall. Therefore, an energy frame only bassed on fully shade area as the summer situation will give an over estimated heat consumption, as there will not be much contribution in the form of passive solar




*Ill. 71 Distribution of energy in percentage after primary energy factors ( Own Illustration)*

energy.
A mean value is therefore what gives a realistic picture of the building's energy frame and a more real answer to the building heat demands.

When the energy frame is calculated, BE18 is using different primary energy factors, which are assigned to different areas of consumption.

The different factors are multiplied with 1.8 for electricity and 0.60 for district heating. These factors are also seen in Ill. 75 where an overview of the energy consumption is also seen.

It is important to minimize electricity in the energy framework to meet the requirements.

Since this building belongs to the category " other buildings", which is not residential buildings, lighting must be included in the energy frame and therefore this is a big cost in the energy frame, since electricity calculation must be multiplied by 1.8. Ill. 71 shows the distribution of energy in percent after the primary factor is multiplied.

Therefore, it has been important to maintain a good daylight in urban design so it was possible to minimize the electricity consumption for lighting.
The Veltialtion system is often also a large coast in a big construction when talking about the energy frame, but MircoVent has a very low SEL value which also helps to reduce the need for electricity.
Since Microvent does not have a huge cost, it would not be optimal to use natural potential also, since in this case a system had to be installed to automatically open and close the windows and thereby, electricity should be used for this. Automatic opening and closing of the windows would also result in a great extra cost if viewed from an economic point of view.
However, it is envisaged in the design that it is possible to add or use natural ventilation if it should be necessary in terms of securing buildings in the future, in relation to more load, change in weather conditions or other conditions that may affect an increased need for ventilation. This is conceived as a form of robustness so that design is secured against unaware changes.

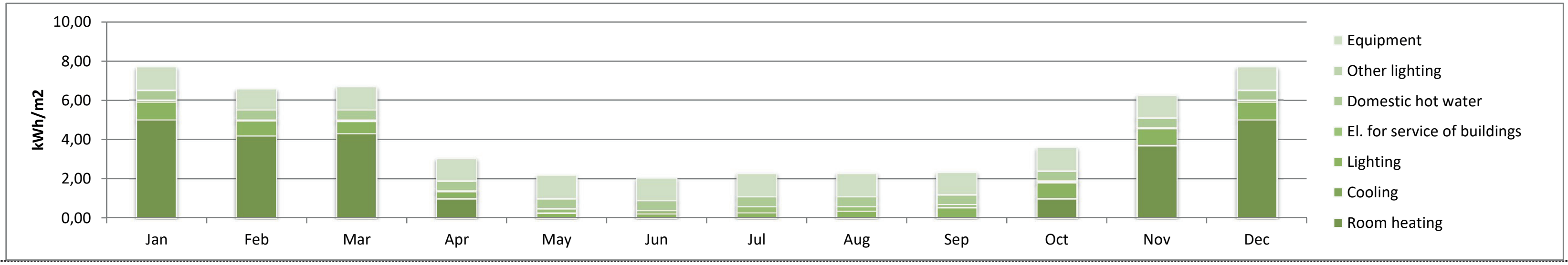
When looking at the figures, a clear picture of Denmark's changing weather condtions is seen, with higher temperatures in thesummer and lower in winter. On Ill. 74 El production vs. Electricity consumption it is showen that more kWh is consumed in the winter period, where it is especially the extra need for lighting that increases energy consumption. Meanwhile, it is seen that in the summer more electricity is produced, as the solar cells are most effective in the summer period.

When looking at Ill. 73 - Heating demand vs. Heating supply it is clearly evident that there is a greater need for heating of the buildings in autumn and winter period, while during the summer period it is seen that a greater supplement is obtained from the sun.
The orange lines show the utilization factor of heat consumption where it is stated that the utilization it is high in autumn and winter and low in the spring and summer period where there is not so great a need for heating and where the building also achieves a larger passive supplement from the sun.

The forest house' energy comply with the requirements in the building regulations' related to the low-energy class has been complied within the 33, kWh / m2 pr. year.

This also contributes to an view for the future, where energy solutions both passive and active contributes.
The forest house has integrated more passive solutions such as a well-insulated climate screen, a building that is not oriented to the south, so few windows in the south facade, good daylight conditions that minimize the need for electric lighting, and in addition windows with a lower g-value which reduce the heat from the sun but still have a good LT- light transmittance which ensures a good daylight as well.

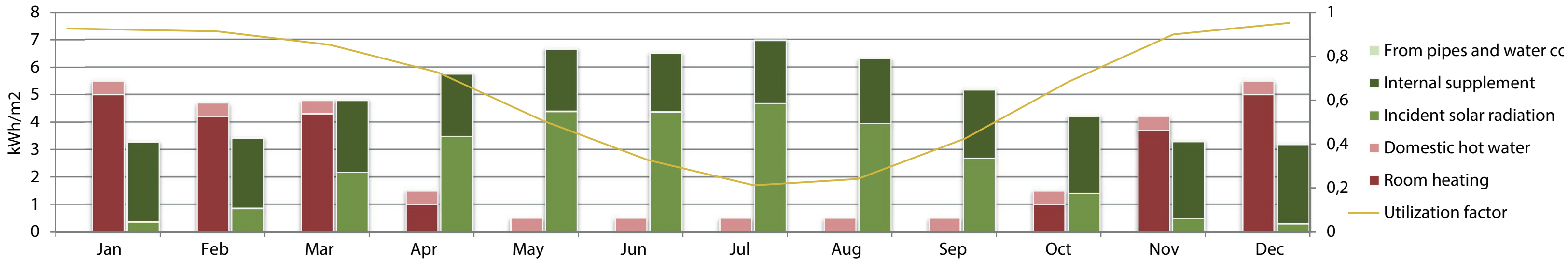
## ENERGY CONSUMPTION




| kWh/m² | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Excess temperature in rooms | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Room heating | 5,00 | 4,20 | 4,30 | 1,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 1,00 | 3,70 | 5,00 | 24,20 |
| Cooling | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Lighting | 0,90 | 0,76 | 0,64 | 0,36 | 0,27 | 0,22 | 0,29 | 0,37 | 0,55 | 0,81 | 0,87 | 0,90 | 6,93 |
| El. for service of buildings | 0,10 | 0,04 | 0,06 | 0,04 | 0,23 | 0,18 | 0,31 | 0,23 | 0,15 | 0,09 | 0,03 | 0,10 | 1,57 |
| Domestic hot water | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 5,80 |
| Other lighting | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |

*Ill. 72 Energy consumption ( Own Illustration)*

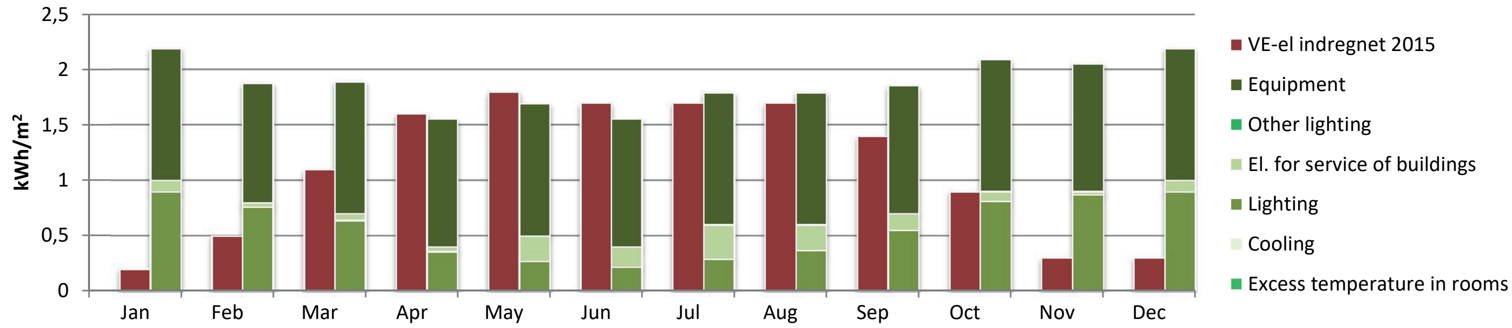
## HEATING DEMAND VS. HEATING SUPPLY




| kWh/i² | Jar | Feb | Mai | Api | May | Jui | Ju | Auc | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Room heating | 5,00 | 4,20 | 4,30 | 1,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 1,00 | 3,70 | 5,00 |
| Domestic hot water | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 |
| Incident solar radiation | 0,37 | 0,86 | 2,17 | 3,47 | 4,39 | 4,36 | 4,68 | 3,94 | 2,69 | 1,41 | 0,49 | 0,30 |
| Internal supplement | 2,89 | 2,55 | 2,63 | 2,28 | 2,26 | 2,14 | 2,28 | 2,35 | 2,48 | 2,80 | 2,79 | 2,8 |
| From pipes and water cont | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 |
| Utilization factor | 0,94 | 0,93 | 0,89 | 0,69 | 0,5 | 0,37 | 0,18 | 0,19 | 0,43 | 0,74 | 0,92 | 0,95 |

*Ill. 73 Heating demand Vs. Heating ( Own Illustration)*

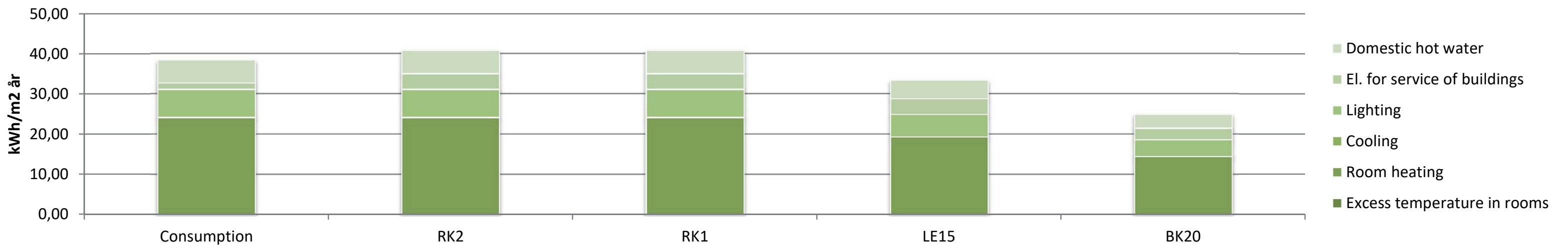
## EL PRODUCTION VS. EL CONSUMPTION




| kWh/m² | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Excess temp | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Cooling | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Lighting | 0,90 | 0,76 | 0,64 | 0,36 | 0,27 | 0,22 | 0,29 | 0,37 | 0,55 | 0,81 | 0,87 | 0,90 | 6,93 |
| El. for service | 0,10 | 0,04 | 0,06 | 0,04 | 0,23 | 0,18 | 0,31 | 0,23 | 0,15 | 0,09 | 0,03 | 0,10 | 1,57 |
| Other lightin | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Equipment | 1,19 | 1,08 | 1,19 | 1,16 | 1,19 | 1,16 | 1,19 | 1,19 | 1,16 | 1,19 | 1,16 | 1,19 | 14,05 |
| VE-el indreg | 0,20 | 0,50 | 1,10 | 1,60 | 1,80 | 1,70 | 1,70 | 1,70 | 1,40 | 0,90 | 0,30 | 0,30 | 13,20 |

*Ill. 74 El production vs. El consumption ( Own Illustration)*

## ENERGYFRAME : ENERGY CONSUMPTION




**Energy consumption**

| kWh/m2 year | Consumption | RK2 | RK1 | LE15 | BK20 |
|---|---|---|---|---|---|
| Excess temperature in rooms | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Room heating | 24,20 | 24,20 | 24,20 | 19,36 | 14,52 |
| Cooling | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Lighting | 6,93 | 6,93 | 6,93 | 5,54 | 4,16 |
| El. for service of buildings | 1,57 | 3,94 | 3,94 | 3,94 | 2,83 |
| Domestic hot water | 5,80 | 5,80 | 5,80 | 4,64 | 3,48 |

**Energy production**

| kWh/m2 year | Consumption | RK2 | RK1 | LE15 | BK20 |
|---|---|---|---|---|---|
| PV panels | 14,70 | 36,75 | 36,75 | 36,75 | 26,46 |

**Energy factors**

| | RK2 | RK1 | LE15 | BK20 |
|---|---|---|---|---|
| Heating | 1 | 1 | 0,8 | 0,6 |
| El | 2,5 | 2,5 | 2,5 | 1,8 |

**Energiramme**

| kWh/m2 year | Consumption | RK2 | RK1 | LE15 | BK20 |
|---|---|---|---|---|---|
| Sum | 23,80 | 4,11 | 4,11 | -3,27 | -1,47 |

*Ill. 75 Energyframe : Energy consumption ( Own Illustration)*

# ACOUSTICS

In order to make sure that the acoustics in the institution there is in the design process the work to optimize the room acoustics in the institution.
In relation to building regulations, the requirement for a kindergarten is a reverberation time that is less than or equal to 0.4 seconds.

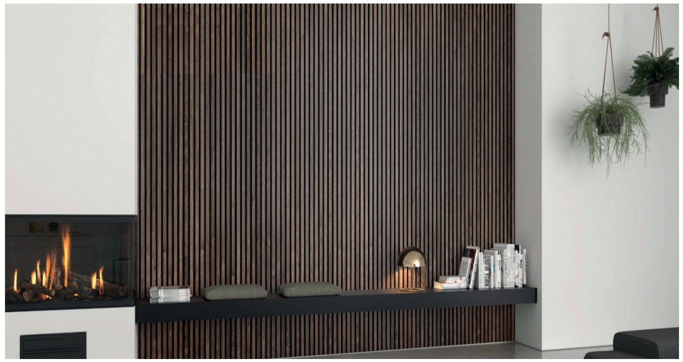
A good acoustics ensure that children and adults are not adversely affected by noise, as noise for longer periods can lead to stress that sends different substances into the brain and this can have a negative influence on cognitive development. Therefore, it is emphasized that the acoustics of the institution have been studied so that one can set up the best possible framework for the children.

The result is described in Ill. 78 where it is seen 3 different rooms that are calculated and because the Nursery Gr. 1 are very similar in relation to materials and areas with the other group rooms, only the reverberation time in this room is calculated.

The materials used are:
Loft: Troldtekt
Walls: Gypsum - as this also has good fire properties. and acoustic plaster in Activity hall.
Flooring: Forbo marmoleum floors
Acoustic clothing: Town pannels and Alpha Nordic wood slats.

Detailed calculations for the reverberation time is showed on Appendix 04 page 134.


Ill. 76 *Town Pannels* (Lyddæmpende billeder og akustikløsninger | Earmark Akustik, n.d.)

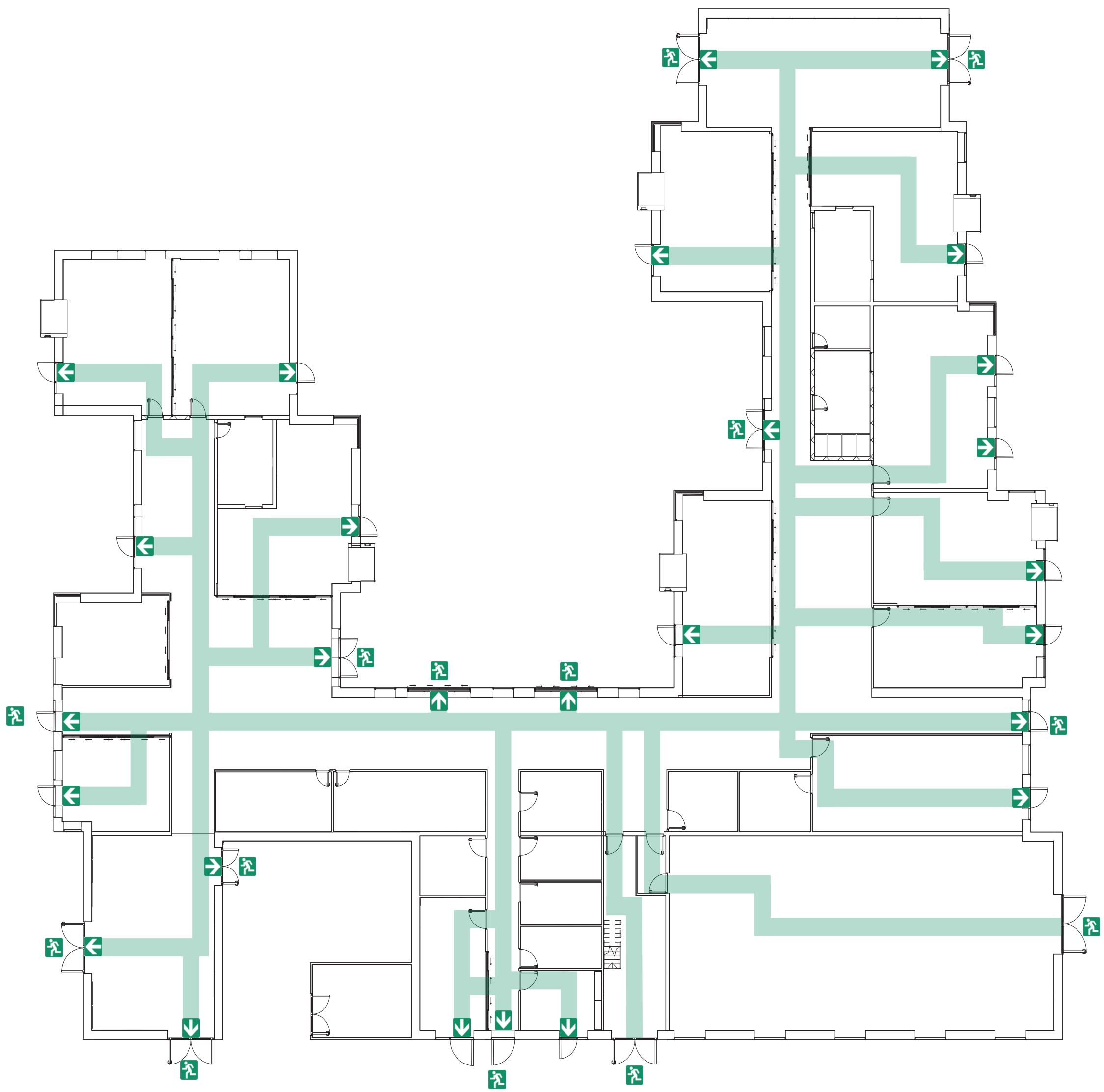


Ill. 77 *Alpha nordic wall* (Alpha-akustik.dk, n.d.)

| | 125 | 250 | 500 | 1000 | 2000 | 4000 | Avg. |
|---|---|---|---|---|---|---|---|
| Nursery Gr. 1 | 0,67 | 0,45 | 0,26 | 0,29 | 0,30 | 0,27 | 0,38 |
| Common area | 0,48 | 0,38 | 0,23 | 0,26 | 0,27 | 0,23 | 0,31 |
| Activity Hall | 0,91 | 0,39 | 0,26 | 0,26 | 0,28 | 0,27 | 0,39 |

*Ill. 78 Calculation of reverberation time for different rooms ( Own Illustration)*

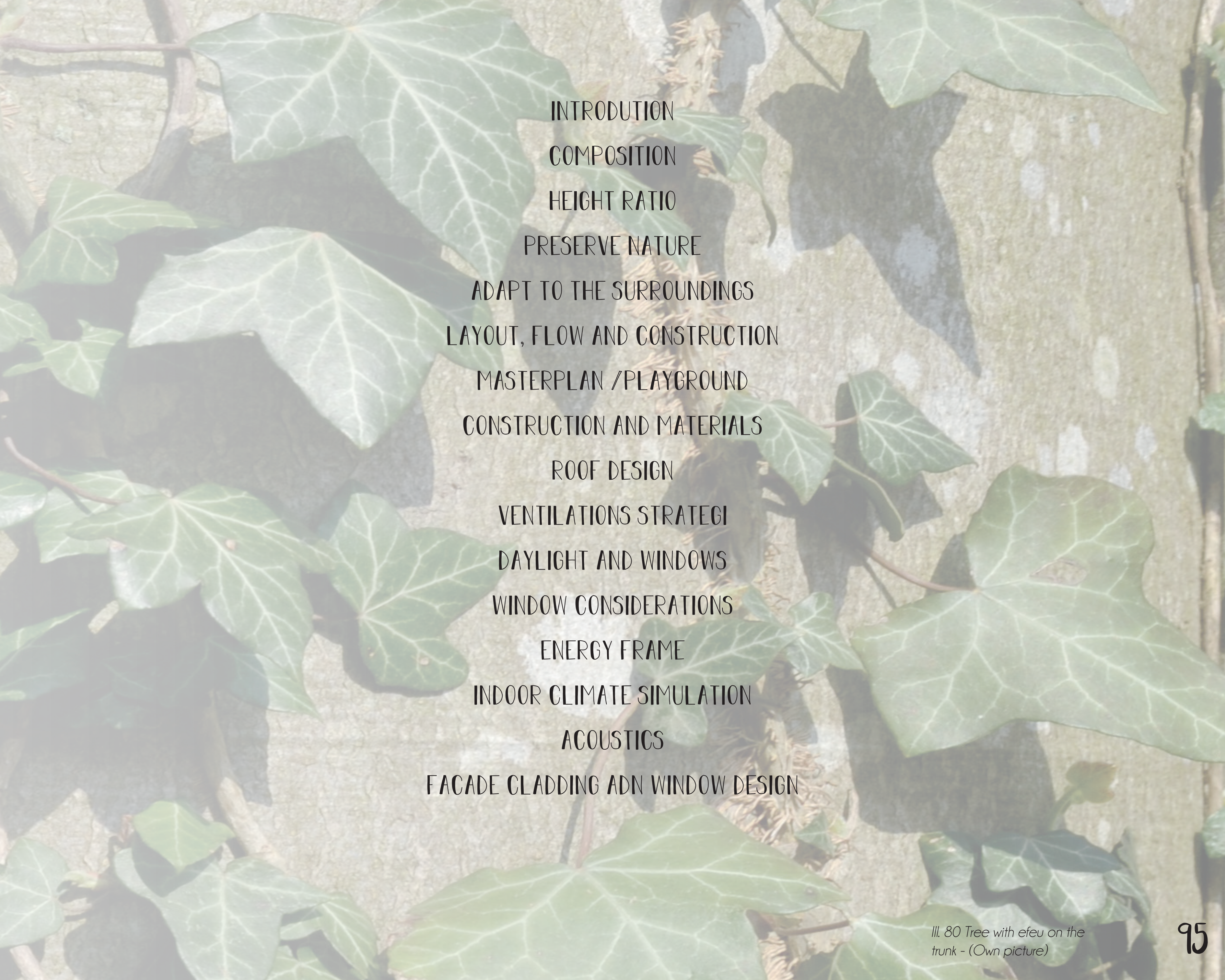
# FIRE STRATEGY - ESCAPE ROUTES



Ill. 79 Fire - Escape routes ( Own Illustration)

# 04

# DESIGN PROCESS





*Ill. 80 Tree with efeu on the trunk - (Own picture)*

# INTRODUCTION

This chapter is a description of the process which has created the shape and the final design.

The overall process is the Integrated Design Process which goes through various phases through an iterative process.

The design process may appear as a linear process but has gone through an iterative process. Where many loops have been made to integrate and achieve a better design based on requirements and the design criteria's.

The process includes both large-scale designs as the master plan and outdoor areas, but also smaller details such as windows materials, etc.

In this chapter various phases and important processes have been selected and shown, which have had a great influence on the final design.
There are, however, a lot of other studies and iterations that are not shown in this report but still have been part of the final design process.

The focus points in the design process are based on the design criterions which are described in the problem chapter at page 52-53.
The design criteria set the overall subjects that are dealt with in this process.


*Ill. 8.1 All sketches through the design process - (Own picture)*

# COMPOSITION

Intitial volume studies.

During this phase, various volumes are being tested on the site in order to find out how the different volumes look at the site.

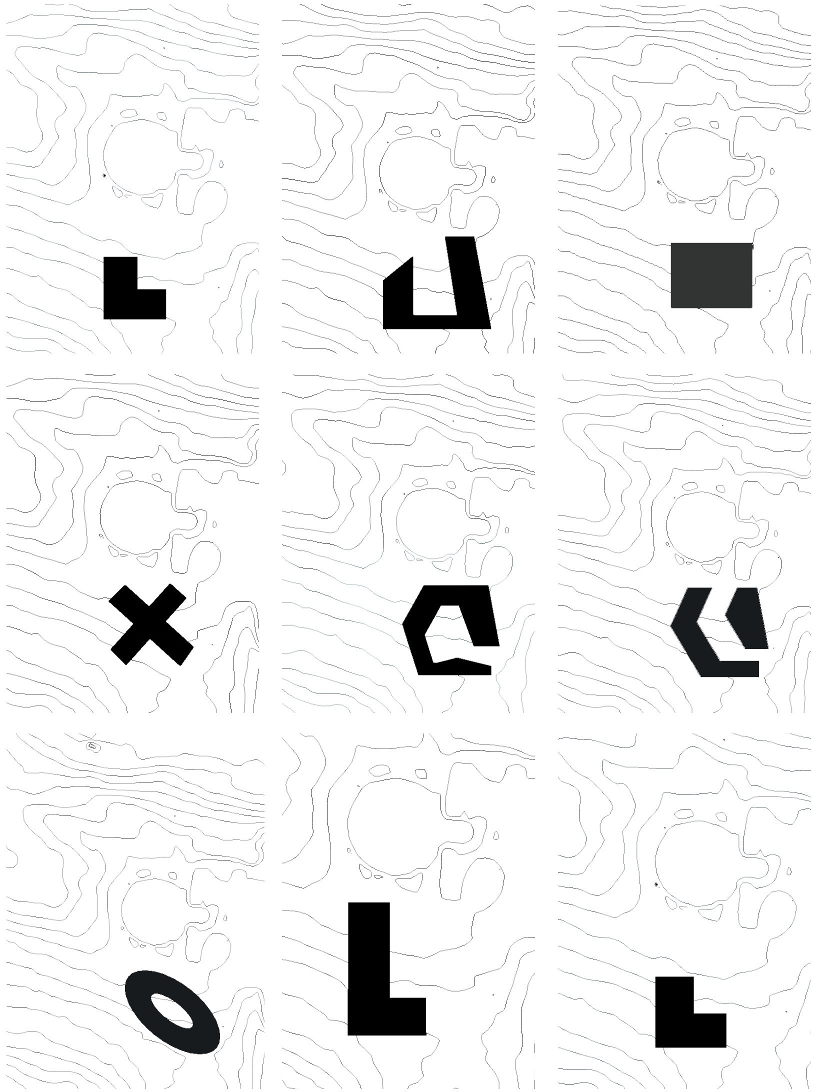
All the volumes are made to adapt the building field, see Ill. 12 page. 24. to see the site area marked on the map. In addition, all volumes are 1700 m2, which is spread over 1 - 1½ and 2 floors.

All volumes are based on a "slim" design so the shape does not create a too wide building and thereby have problems with daylight in the building. This is based on knowledge from Low energy strategy on pp. 48-49.

The daylight is important for the building design as an cost-heavy item in the energy frame is electricity, which can be minimized by including daylight and minimizing the need for artificial lighting.

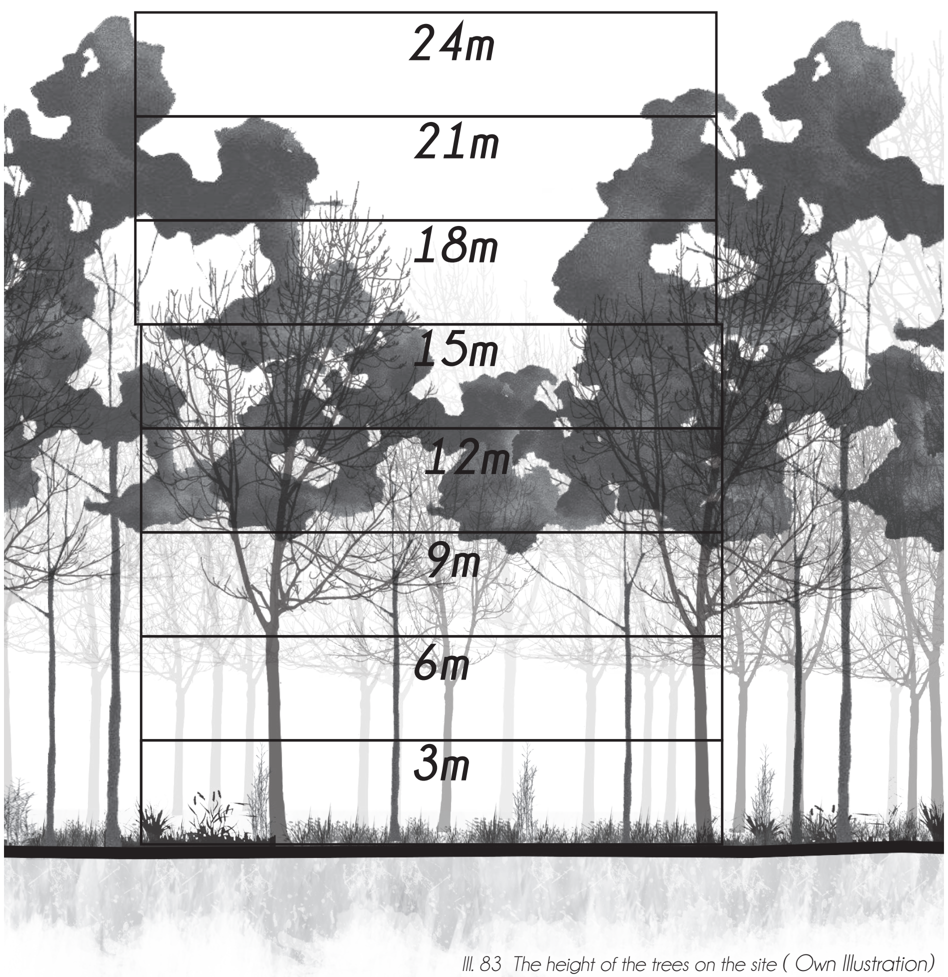
There are also made solar studies over the sitearea - which did not give the design extra knowledge because currently the hole site is covered with trees, with means the hole site is shaded.

The sleek building design will create the best daylight conditions for the building but at the same time prevents the building from becoming compact. And thus, daylight is a larger design criterion than working with compactness and transmission loss



*Ill. 82 Volume studies on the site ( Own Illustration)*

# HEIGHT RATIO




Ill. 83  The height of the trees on the site ( Own Illustration)

The forest is an important characteristic of the areas, therfor it is important to include it in the design.  The aim is to preserv the nature of the site but also adaot to the current nature.

The primary trees in the area are beech trees and belong to the deciduous family.
The trees looses their leaves in the autumn/winter periode and receive new green leaves - in the early summer period.
Beech trees will be between 25-40 meters and since they grow in a densely planted area they have long logs where the crown sits high up. (Træ.dk, 2016)

The sites trees are estimated to be between 15-25 meters and therefore as shown on Ill. 83 it would be an advantage that the buidling design stays below 9 m to save as much of the trees as possible if you look vertically on the trees. But it is preferable only to build in around 6 meters to stay out of all the cowns.

When taking the target group into account it will be optimal to work in one plane to avoid stairs in the institution.

In addition, there will be better condition for disabled people, both in terms of kids but also adults will have access to the whole building if built in one plane.

The building will also be closer to nature if buidling in one plane and it will seem more intimate and adapt better to the present nature which is a key element for the project.

Therefore, it was decided to continue working on a building design in one plane.

# PRESERVE NATURE

At this stage, the focus is on maintaining the present nature on the site. After several trials and deliberations on how to take, the nature into account. It was desiced to select some unique trees on the site which should be preserved no matter what, in the design.

After visiting the site several times and at different times of the day and the year, it was decided which trees were to be integrated into the design and which had to be preserved on the site. on Ill. 85 to 91 ther are some pictures from the site of the various trees that should be preserved.
In addition, Ill. 84 where the different trees are.
The other illustrations show pictures of the trees taken on the site.

These trees play a major role in designing buildings.
Here, a form must be included which makes it possible to preserve the trees.


*Ill. 84 Marking the trees to be preserved (Own Illustration)*

*Ill. 85 Largest and oldest tree on the site (Own Photo)*

Ill. 86 Tree trunk (Own Photo)

Ill. 87 Trees to be preserved (Own Photo)

Ill. 88 Trees with efeu grow on the trunk (Own Photo)

Ill. 89 Moss on the tree trunk (Own Photo)

Ill. 90 Wood crowns without leaves (Own Photo)

Ill. 91 trees from the site (Own Photo)

# ADAPTATION TO THE SURROUNDINGS

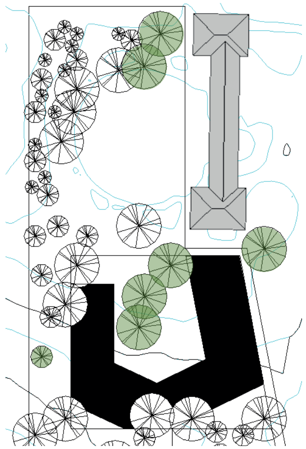
In this phase, the focus is on building the design for the selected timber and the current building on the site. It is still a focus to keep the building narrow for daylight in relation to the energy frame.

On Ill. 92 to 94 see the forms that made most sense in relation to target group, site and design.

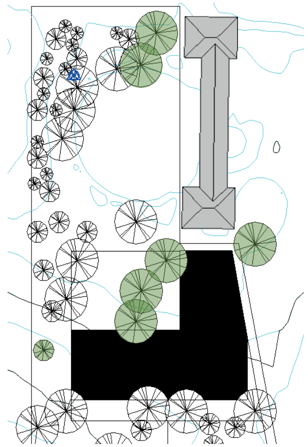
There is also a need to create a back cover for the current building close to the site.
This building is 4 storeys high and has a sloping roof and is considered to be around 15 meters high - so it works much like a wall when you enter the forest and come out to it.

Since the building is a kindergarten, they will hang around the entire area and therefore create a natural boundary to the surroundings, but the design can also work with shutting off the high building instead of opening up towards it.

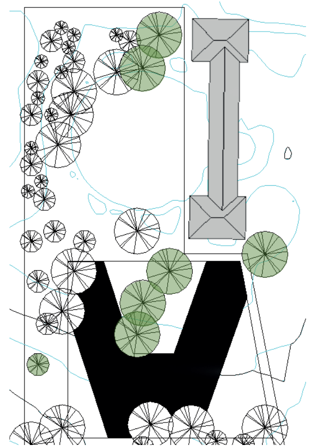
Based on this process, it is decided to proceed with U-Shape and L-Shape, as they creates the best opportunity to close off against the high building.



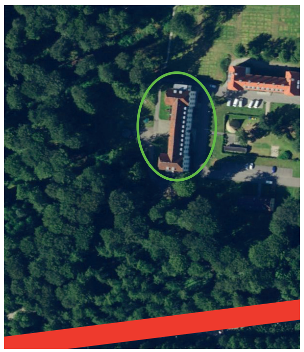
Ill. 92 U- Shape ( Own Illustration)



Ill. 93 L-Shape ( Own Illustration)



Ill. 94 V-Shape ( Own Illustration)

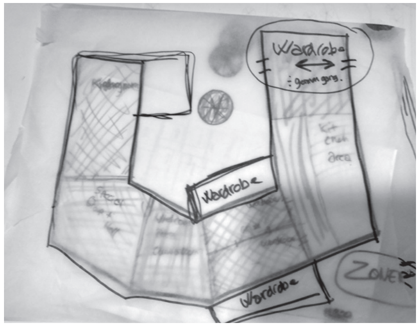


Ill. 95 Building and road marked (RED Google maps)

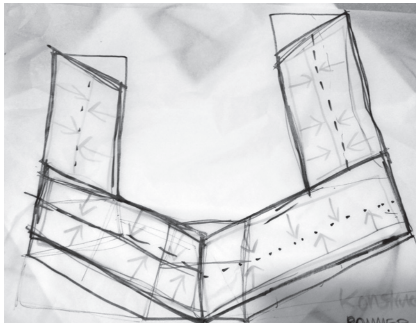
Ill. 96 Picture of the building close to the site ( Own picture)

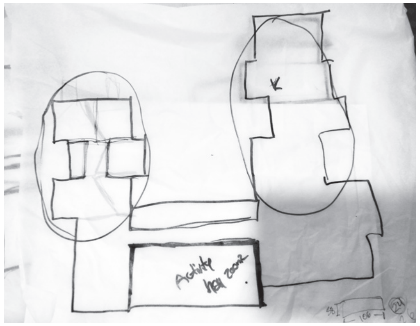
Ill. 97 Elevation new building 1-floor, compared with existing building ( Own Illustration)

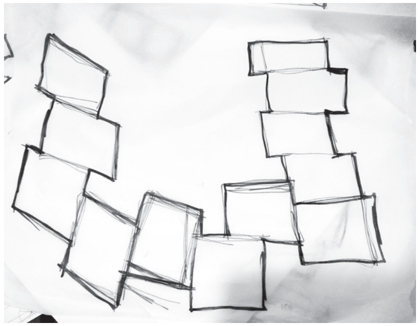
# LAYOUT, FLOW AND CONSTRUCTION

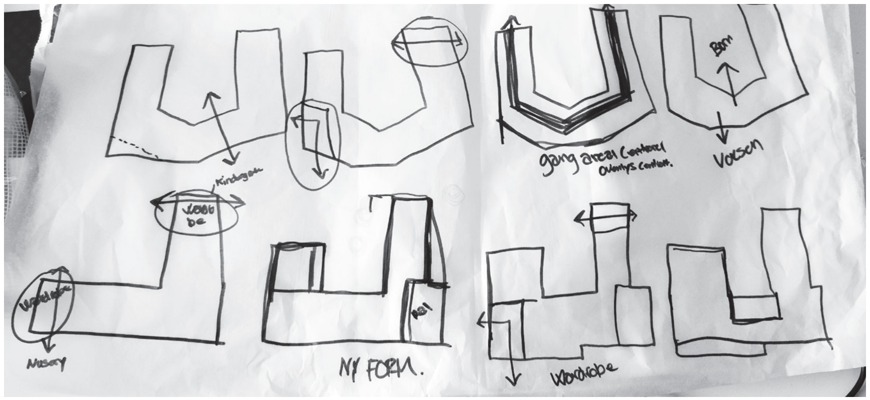


Ill. 98 Wardrobe studies ( Own Illustration)


Ill. 99 Roof studies ( Own Illustration)


Ill. 100 Zones and breaking up shape ( Own Illustration)


Ill. 101 Breaking up the scale ( Own Illustration)



Ill. 102 Sketches of the process ( Own Illustration)

In this phase the two shapes: L-shape and U-shape are being investigated.
Several aspects are investigated such as constructive principles of the building, interior design and the flow through the building.
After a long sketchting phase on both shapes it ended up with creating a fusion between the two shapes.

After working with different situations in the institution about flow and interior design it was clear that the wardrobe area should not be placed centrally to avoid it being a walk through area. Thereby, the wardrobe area was defined at each end of the building in order to create a connection between the parking lot / arrival and the playground on the other side of the building. Thus it is avoided that anyone has to get through the wardrobe area to pass on to other areas in the building.

A desire to incorporate the target group and reconsider the scale of the design leaded to futher work on breaking up the design into smaller sections that could break the scale of the building and create some depth and play in the facade.

Therefore, sketches and studies were made on how the building could be broken up into smaller parts and in the same time in connection with a constructive principle of having focus on small span widths, which later in the process would make several different types of construtions possible.
From an energy point of view, it would be most optimal to orient the roof so that solar cells could be integrated to the south and skylights to the north.

# MASTER PLAN / PLAYGROUND

During this phase, work has been done on outdoor areas. Here the focus is on different play areas and in differnt zones.

There has also been focused on creating zones for children in different age scales so that all children are challenged with motor skills and can use their imagination in the games inside as well as outside.

Ill. 103 to 104 shows various thoughts and distributions of the outdoor areas.

On Ill. 106 one of the last iterations of this phase is showen.
Here the different zones are divided over the playground area and there are plenty of outdoor areas there that are creating different sense impressions.

The zones that were chosen to participate in the final master plan are a water area, scout cabins, large playground area, sandbox play for smaller children.
A zone with plant boxes for growing plants in the soil, here the children can plant and care for different plants, if possible. vegetables that can be eaten in the institution when they are finished. At last there is a zone with animals where the children have the opportunity to learn about the animals and to care for the animals.

Inspiration for outdoor areas has been found through various re-scearch within outside areas and playgrounds.

Ill. 107 and Ill. 108 shows examples of different types of water playgrounds

Ill. 109 to 111 shows examples of areas of plant boxes where the child can plant and grow different types of vegetables and herbs.

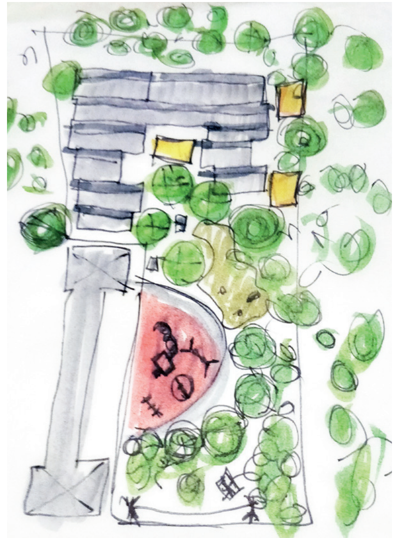
Ill. 112 shows examples of how areas with animals can be arranged so that the children can interact with the animals.

Ill 113. shows how a cabin in the forest can look for different purposes for both play and stay.

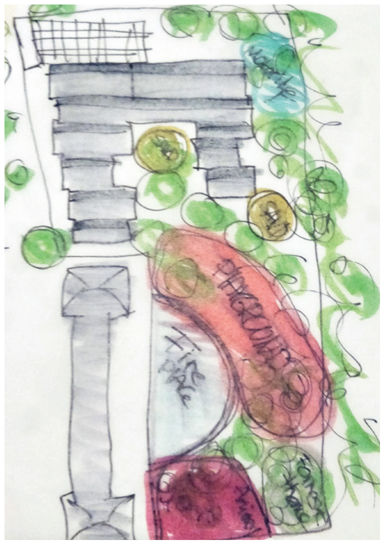
Ill. 114 to 115 shows examples of playground equipment.

These inspirations are taken further in the design of the master plan.

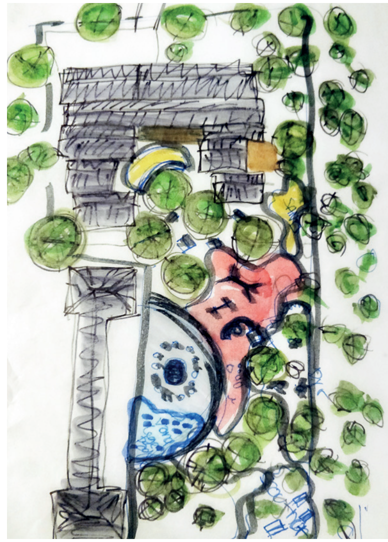
*Ill. 103 Outdoor areas ( Own Illustration)*



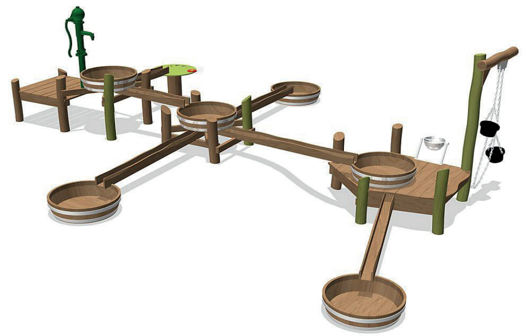
*Ill. 104 Outdoor areas ( Own Illustration)*



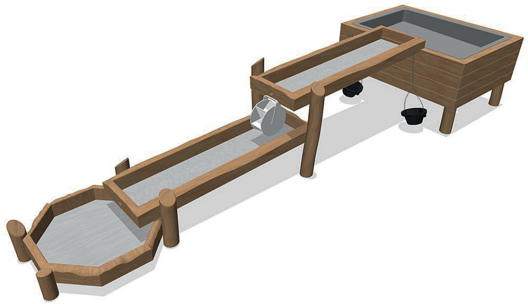
*Ill. 105 Outdoor Zones ( Own Illustration)*



*Ill. 106 Outdoor areas ( Own Illustration)*



Ill. 107  Play area for water (Legepladsspecialist.dk, n.d.)



Ill. 108  Water play different ages (Legepladsspecialist.dk, n.d.)

Ill. 109  Area with chickens (Gør Det Selv, 2010)

Ill. 110  Plant boxes for growing vegetables (Lekolar.dk, n.d.)

Ill. 111  Plant boxes  (Lekolar.dk, n.d.)

Ill. 112  Fencing with goats (assens.dk, n.d.)

Ill. 113  Cabins inside the woods to stay (Visitskanderborg, n.d.)

Ill. 114  Nature playground with various activities (Uniqa.dk, n.d.)

Ill. 115 Sandbox area (Brooklynbridgepark.org, n.d.)

# CONSTRUCTION AND MATERIALS

In this phase materials and constructions were investigated.
They were investeigated through the LCA program, which examines the environmental impact of materials.

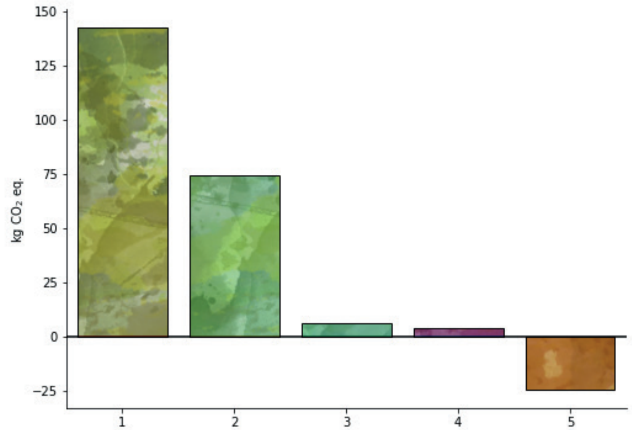
First, various insulation materials were examined and compared see ill. 116 and 117
After several considerations about the advantages and disadvantages of seaweed and paper wool, it ended on seaweed. The seaweed has a higher energy consumption but since it originates primarily from renewable energy, it was decided tat the seaweeds negative $Co_2$ imprint was more important, since it can absorb and store more $Co_2$ than it emits. The $Co_2$ imprint is one of the main design criteria and therefore it was weighed higher.

The next phase was to investigate seaweed insulation in connection with different types of construction. All constructions have an u value of 0.1 W / m2K. See Ill. 118- 119.

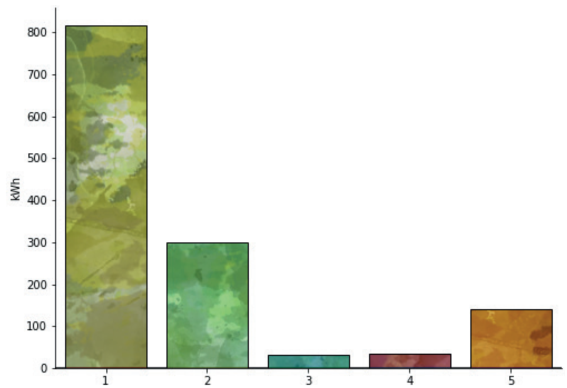
Here it was clear that a wooden construction with seaweed insulation was the best solution when looking at $CO_2$ emission and held against the energy consumption (PEtot), the difference is small between the concrete construction and the wood and therefore the wooden construction was chosen.

The last invistigation see Ill. 120-121 was the wooden construction with seaweed compared with a concrete construction with glass wool in. This was to create an insight into how big the difference was on the two constructions.

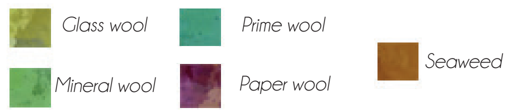
By comparing the impact of $Co_2$ on the wooden construction with seaweed and concrete construction with glass wool, this would correspond to the fact that throughout the building lifespan the wooden construtions would save the $Co_2$ imprint of what an airplane would emit by flying 43.9 times around the world or the amout of $Co_2$ 12 Peugeot 207 would emit when driving for 10 years.

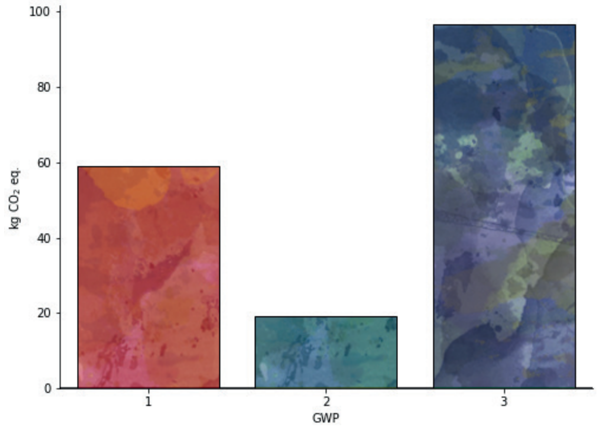



Ill. 116 Comparison of GWP insulation - ( Own Illustration)

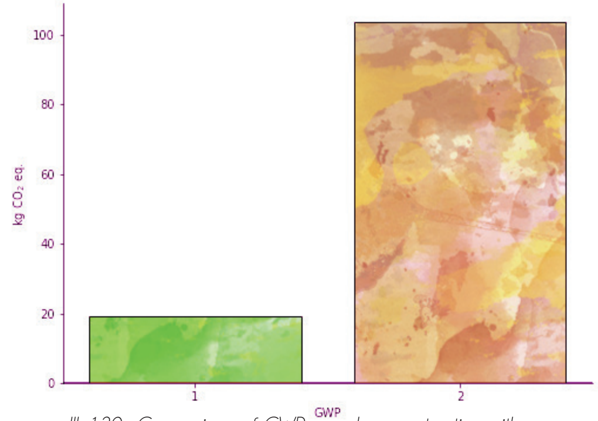



Ill. 117 Comparison of PEtot insulation - ( Own Illustration)

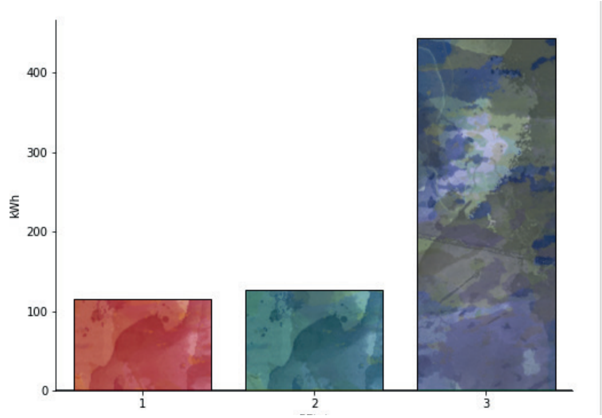




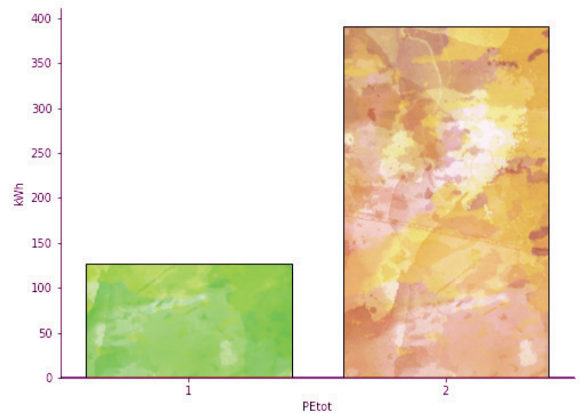

Ill. 118 Comparison of GWP 3 different constructions - ( Own Illustration)




Ill. 120 Comparison of GWP wooden construction with seaweed and concrete with glass wool - ( Own Illustration)




Ill. 119 Comparison of PEtot 3 different constructions - ( Own Illustration)




Ill. 121 Comparison of PEtot - wooden construction with seaweed and concrete with glass wool - ( Own Illustration)

Concrete/Seaweed

Wood/Seaweed

Brick/Seaweed

concrete/glass wool

Wood/seaweed

# ROOF DESIGN

In this phase, various roof shapes were tested in relation to the aesthetic expression of the building and also in relation to both the target group/recognition. But also in relation to energy in conjunction to integration of solar cells, where the optimum slope for solar cells is 38 degrees and alsothe possibility of integrating skylights which does not face south, bu preferably to the north.

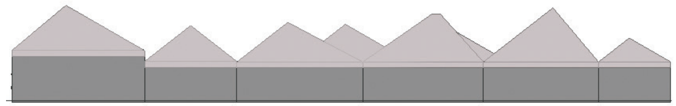
In addition, the wish was to create a room with ceiling to the roof, so that the building was easy to read from the outside as well as from the inside.
The ceiling to the roof put great demands on the ventilations, as later will be investergated see page108

First phase various roof slopes were tested.
Based on a desire to design for children and break the scale in close connection with the integration of solar cells and skylights the rectangular house shape was the optimal choice.

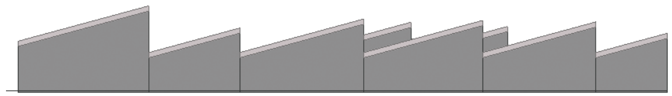
The well-known house shape that children always connect with a house, creates a visual contact to the building.
In addition, it was possible to break the scale of the building by dividing it into "small" houses and at the same time maintaining the requirement for solar cell angle and skylights to the north.

The pitched roof with 2 angles, created a new process, where different angles were examined. in Ill. 122- Ill. 128 parts of various studies are shown. This phase works with different angles on pitched roof in relation to aesthetics appearance and how the room is experienced.

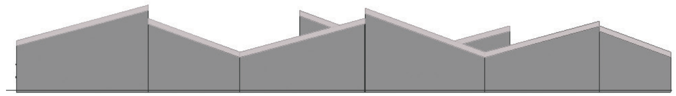
The solution on Ill. 128 with 38 and 20 degrees was chosen as it created the desired conditions and at the same time achieved a good ceiling height without being too high inside.



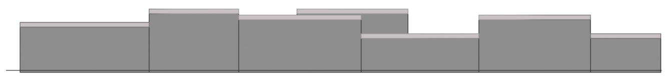
*Ill. 122 Pitched roof with 4 slopes - ( Own Illustration)*



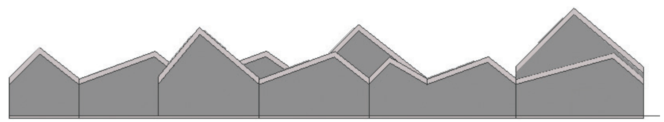
*Ill. 123 Pitched roof with 1 slopes - ( Own Illustration)*



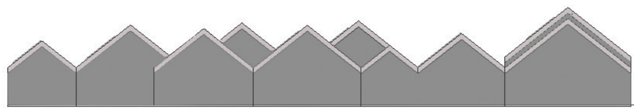
*Ill. 124 Pitched roof with different directions - ( Own Illustration)*



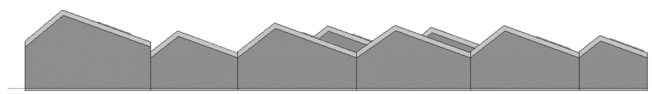
*Ill. 125 Flat roof - ( Own Illustration)*



*Ill. 126 Pitched roof - different angles to south and north - ( Own Illustration)*



*Ill. 127 Pitched roof - same angle 38 degrees - ( Own Illustration)*

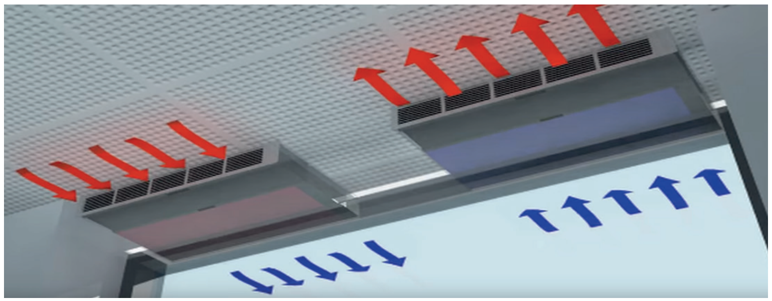


*Ill. 128 Pitched roof - 38 degrees to south, 20 degrees to north - ( Own Illustration)*

# VENTILATION STRATEGY

| The rooms | Air flow supply l/s - komfort | Air flow supply l/s - BR18 | Air flow supply pr. $m^2$ | Air flow supply pr. $m^2$ BR18 |
|---|---|---|---|---|
| Groop room Kindergarten ( x 4) | 261,2 | 94,0 | 5,07 | 1,83 |
| Group room Nusery (x3) | 186,7 | 71,7 | 3,68 | 1,42 |
| Group Room Special needs(x2) | 104,2 | 42,6 | 3,79 | 1,55 |
| Snozleroom / Workshop | 164,1 | 62,7 | 4,92 | 1,88 |
| Toilet (4) | 15,0 | 8,3 | 1,58 | 0,88 |
| Toilet + Changing room (x3) | 15,0 | 24,4 | 0,98 | 1,59 |
| Wardrobe (x2) | 194,6 | 80,6 | 2,67 | 1,10 |
| Common area - Zone 1 | 243,8 | 97,0 | 1,78 | 0,71 |
| Common area - Zone 2 | 239,2 | 94,9 | 1,83 | 0,72 |
| Common area - Zone 3 | 236,9 | 93,8 | 1,85 | 0,73 |
| Kitchen | 20,0 | 51,0 | 0,33 | 0,85 |
| Activity Hall | 1178,5 | 424,2 | 5,56 | 2,00 |
| Office | 56,2 | 28,8 | 2,25 | 1,15 |
| Meeting room | 47,7 | 24,9 | 3,41 | 1,78 |

*Ill. 129 Section of ventilation calculation - ( Own Illustration)*



*Ill. 130 MicroVent Princip - (Inventilate.dk, n.d.)*

*Ill. 131 MicroVent Panel - (Inventilate.dk, n.d.)*

*Ill. 132 Structure - (Inventilate.dk, n.d.)*

During this phase, it was investigated whether it was possible to use the ventialtion system MicroVent, which is an integrated system that can be installed in the facade thus avoiding piping through the entire building and thereby having high ceilings which are not characterized by pipes and nozzles .

In addition, MicroVent also has good energy properties, because it is possible to avoid piping throughout the building, you can minimize the electricity consumption, the system has a high heat recovery and it is posible to minimize the area for the ventilation system - where traditional ventilation needed large technical rooms

Basic requirements for using MicroVent is that all rooms in need of ventilation must have access to 1-2 outer walls, which places great demands on the layout of the building. In addition, it is not possible to cool with MicroVent, which puts heavy demands on loads, space disturbances, orientation, sun protection etc.

First step was to look if it was possible to comply with the requirements for ventilation in relation to the building regulations' minimum requirements, but also in terms of comfort. See full calculations appendix 02 page 129.

The calculations compared to the specifications for MicroVent panels, demonstrated that it was possible to use the system in this building. The panels can be assembled to fit the amount of air required in the individual rooms-
Thereby, 4 panels with 2x8 tabs, an air change of 160 l / s can be achieved and at 4 panels with 3x8 tabs, 240 l / s. (Inventilate.dk, n.d.)

There are, however, some rooms that are initially thought to be traditional mechanical ventilation with piping and extraction as the toilets and the kitchen are. The kitchen must have point extraction and therefore it will be optimal to utilize the plant and make mechanical ventilation here.
After this phase it was necessary to go back and work with the plan and layout again.

# DAYLIGHT AND WINDOW

The daylight has a great influence in the design process of the building as lighting is a heavy cost in the energy frame, so a good daylight could minimize the need for artificial lighting. Therefore the BE18 has been a parallel process together with the windows. See Be18 phase on page 113
In relation to the sites location in the forest, not much light comes down through the tree crowns in periods of the year and there is also a lot of shadows, which is also an important factor for the building design.

In addition, it was clear in the program that daylight is an important element in a learning environment since the effect of daylight conditions can have a positive and negative influence on children's learning ability and well-being.

Last but not least, the building is placed in a unique environment inside the forest. The surroundings is an important element for design to create a close contact with nature outside.
Therefore, a lot of daylight simulations and studies of the site have been made to create an understanding of the environment's influence on daylight. At appendix 01 on page 128, it is seen how sites are experienced during the year in relation to shadows and light.

On page 111 there are a selection of the many studies that underlie the window process.

Ill. 136 shows the difference in how the sill height affects the dayligt. A window with the same dimensions but different sill heights have a great influence on the daylight factor in the room.

It is clear that 1000 sill height has a much better illuminated space compared to a sill height of 0.

After several investigations in relation to daylight, it was clear that windows to the floor did not give anything extra in relation to the daylight, however, they have nevertheless been chosen work on with. Thats because of the target group and keeping it possible for the children to always have contact with the nature outside. Thus it is posible to experience the different seasons' both from the outside as well as from the inside of the building.

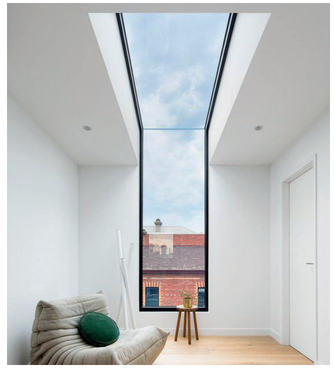
Ill. 137 shows the relationship between daylight and the width of the window - since most of the windows in the building have to go up from the floor, studies are made on the width of the window. Here it is seen that the width of the window influences how far into the room the light gets.

Ill 138 shows the relationship between the number of windows and how they are placed in the facade - here the study shows that 1 window strip from floor to ceiling is more effective than 2 windows placed in a sill height of 900mm.
That's why it is choosen to work with window ribbons in the facade expression.

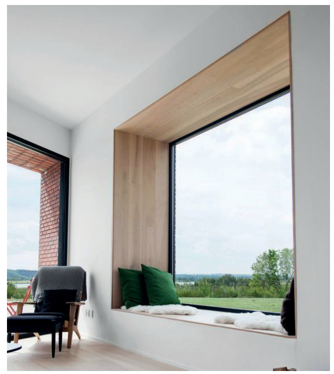
Ill. 133 - 135 shows some different considerations about different purposes in relation to the windows and utilization of construction thickness.

Ill. 134 is integrated to allow the children to see the whole tree from head to toe and thereby lie down and look straight up into the wooden crowns.

*Ill 133 - Create stays in the windows (Contemporary Modern Architecture Furniture Lighting Interior Design, 2009)*

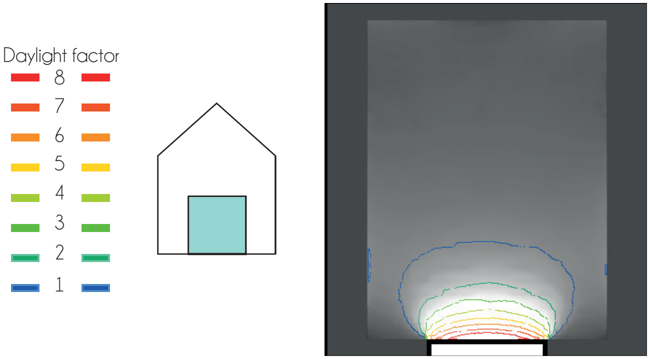


*Ill. 134 - Window with combination between roof and wall (Emily Bartlett Photography, n.d.)*

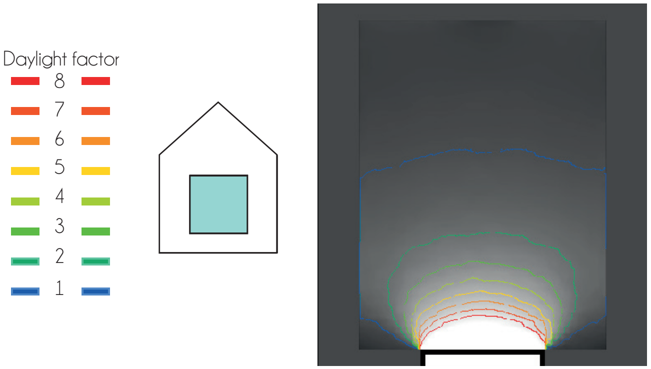


*Ill 135 - Utilize the structure thickness to stay (Archello, n.d.)*

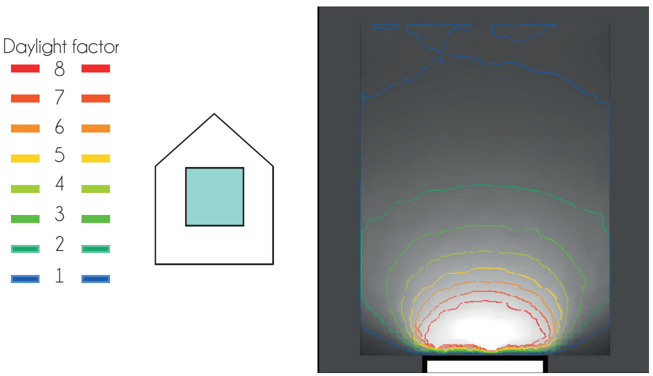
Ill. 136 - The placement of the window vertical / silll height - ( Own Illustrations)




1500 X 1500 mm. - Sill height 0 mm.

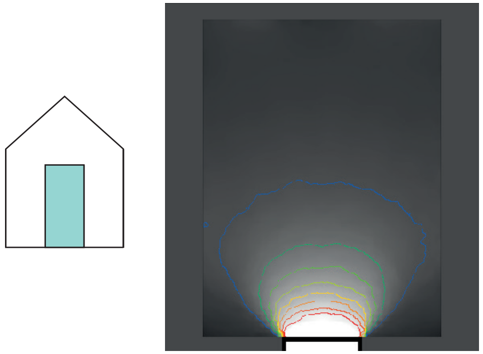



1500 X 1500 mm. - Sill height 500 mm

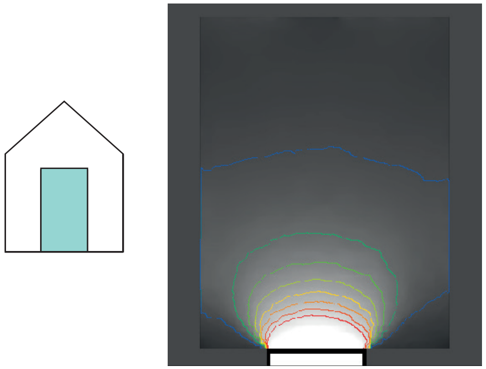



1500 X 1500 mm.- Sill height 1000 mm

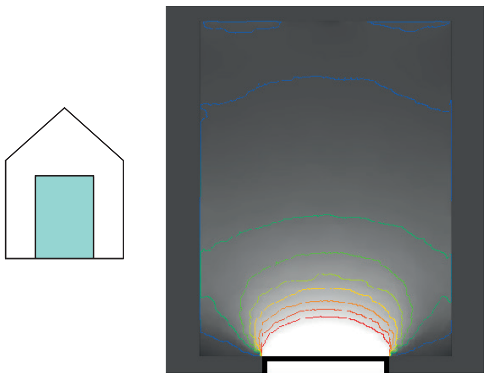
Ill. 137 - Ratio in relation to optimal daylight - ( Own Illustrations)



1000 X 2100mm. - Sill height 0 mm.

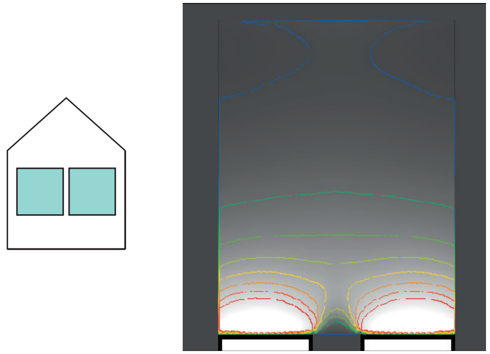


1200 x 2100 mm.- Sill height 0 mm.

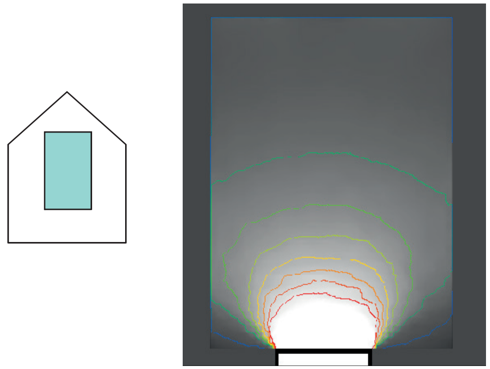


1500 x 2100 mm.- Sill height 0 mm.

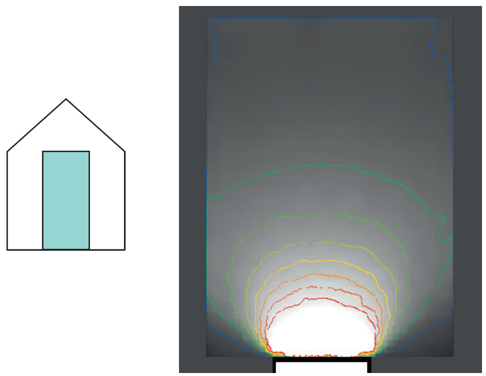
Ill. 138 - The difference in number and location - ( Own Illustration)



2x 1200 x 1200 mm. - Sill height 900 mm.



1200 x 2000 mm. - Sill height 900 mm.



1200 x 2500 mm. - Sil height 0 mm.

# WINDOW CONSIDERATIONS

This process has been about creating visibility and utilize the daylight.

The placement of the window is an important element in connection with the view and daylight in a building and is therefore an important element to consider and integrate.

In this building, there is a visual contact with life outside the institution and therefore there is a focus on seeing and experiencing as much out of the windows as possible.

It is chosen to put the window close to the surface of the outer wall, see the first diagram in Ill. 139. This is to achieve a better view and at the same time, it also creates an opportunity to use the thick construction to stay and thereby utilize the thickness for play and stay.

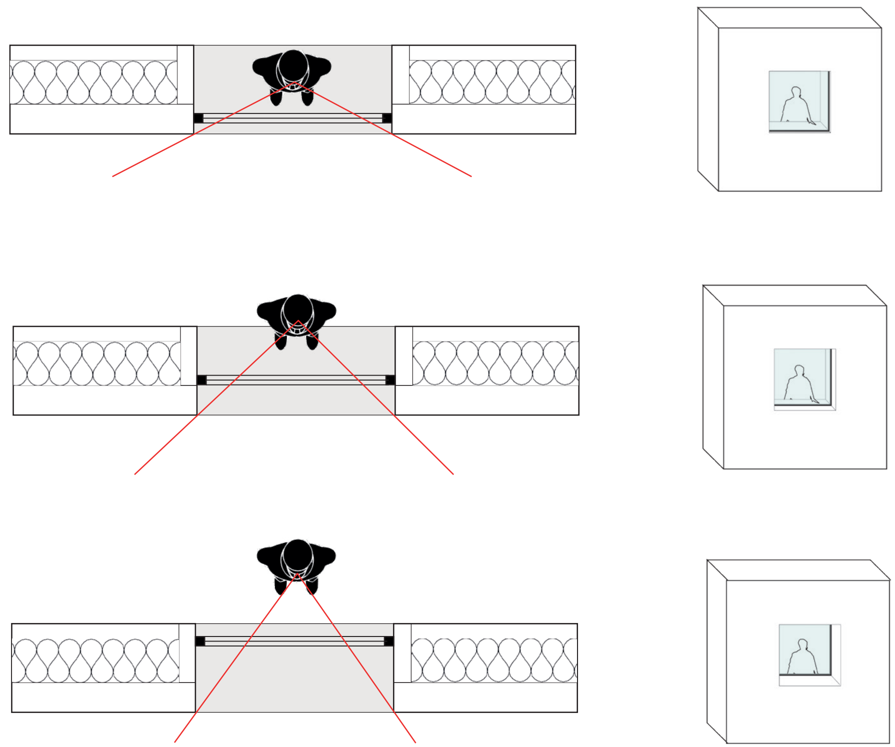
The last diagram on Ill. 139, creates the best opportunities for sun protection when the window is retracted, but unfortunately it also takes out much of the visibility and destroys the possibility of utilizing the construction's thickness for stay in it.

On Ill. 140 shows different ways of working with the rabbet in the window.

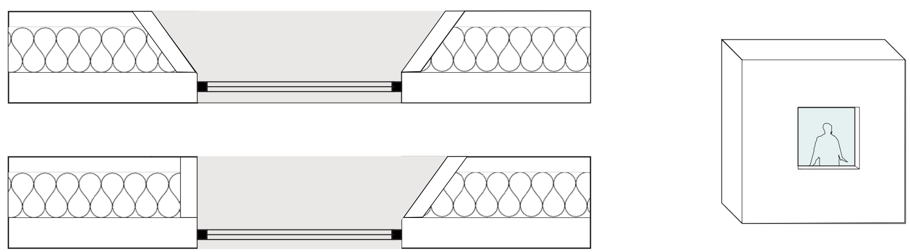
The oblique rabbet creates the possibility that the light can better reflect into the room and therefore puts better possibilities of getting the daylight futher into the building. In addition, it also opens the window more and invites to stay or look outs.

There is worked with making a oblique rabbet few places in the building to create a different expression but also to draw daylight further into the building. The project has worked mostly with the type where the rabbet is oblique on both sides of the window.

The oblique rabbet is breaking the hard and large outer wall and invites to stay indside it.



*Ill. 139 - Location of window in the wall - (Own illustration)*



*Ill. 140 - Oblique glare to bring in more daylight - (Own illustration)*

# ENERGY FRAME

This phase is parallel to the design of the windows and the indoor climate analyziz.
BE18 was used as a tool that put the energy frame in focus.

Since the construction is in the category "other" in the energy frame, the lightning counts in the calculation and this has a great influence on the energy framework. Therefore it was important to always have an iterative process between the Energyframe and the daylight phase.

Other things that have influenced the energyframe is the orientation of windows - Few windows to the south, and all windows on the roof sould be orientated to the north.

The construction of the climatescreen in relation to cold bridges and u-values has also been a part of this process.

Another area in the energy frame has been heating demand in relation to heatloss and overheating.
As the buildings lie inside the forest, sun / shade changes during the year.

In the summer there are a lot of shadows as all the trees have leaves on and in winter time it is only the trunks and the branches that are casting shadows on the building.
This can result in buildings having an overdimensioned heat consumption. Therefore, the shadows were worked with in relation to the seasons and the influence on the energy frame.

The energyframe was fulfill after putting the solarcells on the building it was 100 m$^2$ of solarcelles that was added on the roof.

To make another iteration it was decided to remove all the shadows and make an energyframe for the winter period where the leaves are of the trees. Here it was clear that the heating amount was slightly reduced.

It was still unrealistic without any shadows so the optimal solution for this building will be a mixture of the phase called solarcells and reduce shadows winter to get a realistic insight into the heating demands of the building.

In the last iteration, 40m$^2$ more solar cells were also added.
The result in Ill. 141 shows that it is a mean value of the two previous processes when looking at heat and room heating.

| | Starting point | Reduce windows -EIS indoor Climate calc. | U-values | G-value windows | DF% EIS calc. | Ventilation EIS Calc. | Shadows | Solarcells | Without shadows winter | Avrage value reduces shadows |
|---|---|---|---|---|---|---|---|---|---|---|
| Energy demand | 69,9 | 65,3 | 64,1 | 55,7 | 45,2 | 44,7 | 41,1 | 22,9 | 21,5 | 16,6 |
| Heat | 27,6 | 27 | 23,3 | 25,4 | 26 | 26 | 33,2 | 32,9 | 27,6 | 30 |
| Room Heating | 21,8 | 21,2 | 17,5 | 19,4 | 20,1 | 20,1 | 27,4 | 27,1 | 21,7 | 24,2 |
| Excessive in rooms | 24,6 | 20,6 | 22,6 | 12,3 | 9,8 | 9,2 | 0 | 0 | 2,3 | 0 |
| Electricity for building operation | 11,4 | 11,4 | 11,5 | 11,4 | 7,1 | 7,1 | 6,9 | -2,7 | -2,2 | -4,7 |

*Ill. 141 - Design results from be18- (Own illustration)*

# INDOOR CLIMATE SIMULATION

The indoor envioment has ben investergarted over serveral of interation and other calculations as ventialtions was need to make simulations on the indoor climate.

The model was built up and the first indoor climate simulations were made in the EIS program.
The goal of this phase was to control thermal and atmospheric comfort without using cooling in the ventilation system.

The calculated amount of air flow in relation to comfort (See Apendix 02 page 134 and 06 page 134). The building's windows and construction were defined - after the first simulation it was clear that the building had problems with over temperature see Ill. 142.
Therefore, the first iteration was to calculate daylight from BR18 requirements to see if an optimal daylight ratio was achieved or if it were posible to reduce some of the window areas.

Daylight calculations on appendix 05 - page135

showed that in the majority of the rooms was more than enought window area and therefore it was possible to start by reducing the windows to get rid of the overtemperature. see calculation with reduced windows on Ill. 143

After this iteration, there were still problems with temperature in the building, but it was reduced now.

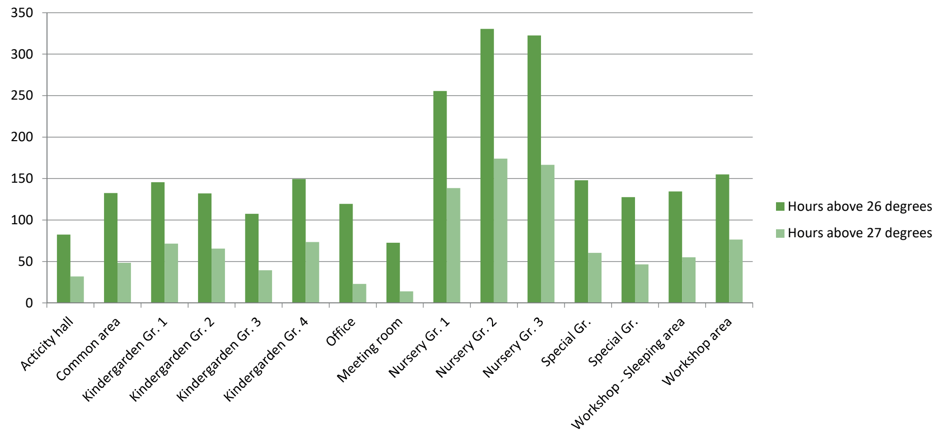
Then it was decided to reduce in the load on all the children's group rooms as it would almost never happen that all the children are gathered, some will play outside or in the common areas.
Therefore, the load in the group rooms is reduced by 80% and then there was added holiday in July wher the load was reduced with a 50% as it would be summer holidays during this period and there will be not be max load on the institution during this period.

After these small changes in the model, the results were closer to the goals about complying with the largest part of the use time in the building between the 22.5 - 24.5 degrees in the summer period and during the winter period 19-21 degrees which is category 1. In addition, the co$^2$ level must remain within the 1000 ppm and the building regulations must be fulfilled with 100 hours above 26 degrees and 25 above 27 degrees.

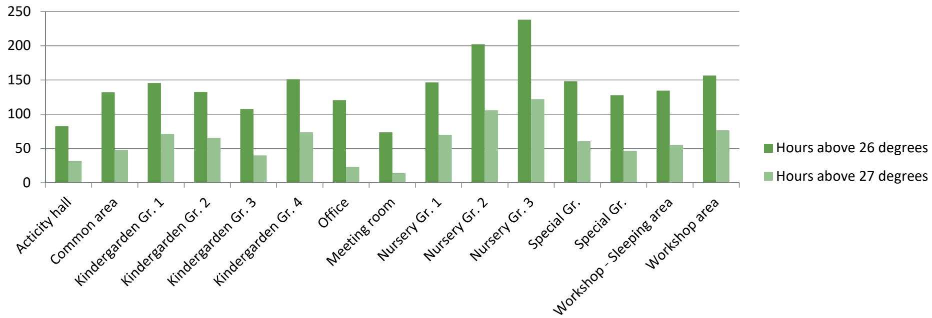
In order to fully meet the temperature level inside the building and adhere to the stringent requirements it was checked whether it was possible to reduce the g-value in relation to the daylight calculation.
The calculation of the daylight showed it was possible therefore, a g-value of 0.35 was used instead of the 0.51.
on Ill. 144 it its shown that the thermal envioment is very close to fulfill the requierments about the 100 hours above 26 degrees and 25 hours over 27 degree.

There were still few hours that were over the allowed 25 hours over 27 degrees therefore the last iteration was to try to increase the air volume in the rooms that were problematic, this was office, meeting room and nursery gr.

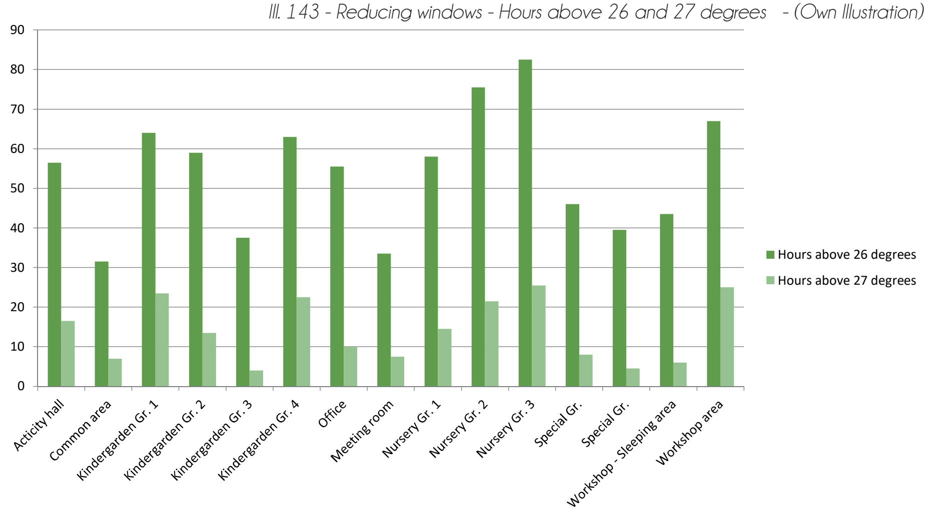
After this iteration the indoor climate turned out to be within the required limits and it was therefore possible to solve the indoor climate in the building without the use of cooling.




Ill. 142 - Starting results - Hours above 26 and 27 degrees - ( Own Illustration)




Ill. 143 - Reducing windows - Hours above 26 and 27 degrees - (Own Illustration)




Ill. 144 - New g-value - Hours above 26 and 27 degrees - - (Own Illustration)

# ACOUSTICS

In this phase, work has been done with different materials to achieve a fusion between good acoustics and aesthetics in relation to the interior design of the institution.

It has been important to incorporate the acoustics in the design since, in the analysis phase, it became clear that poor acoustics can lead to stress and thereby have a negative impact on the cognetive development.

In addition, BR18 also has a requirement for a reverberation time of 0.4 seconds or less and that in larger rooms bigger than 300m$^2$ there must be an absorption area which is larger than or equal to 1.2 x the floor area. (Bygningsreglementet.dk, n.d.)

Different materials have ben investergated in realation to acoustic properties but at the same time there is a focus on sustainability and degassing of the materials.

There have been wooden floors of different kinds tested including bamboo and so various acoustic floors and marmoleum floors from Forbo see information in Appendix 08 page 137.

For the walls ordinary plaster was considered due to fire characteristics, various axial walls with wooden slats, patterns of holes and other ascoustic wall boards.

In the ceiling, Troldtekt, acoustic plaster and other perforated acoustic ceilings have been tried out in the process.

Various materials have been tested to investigate the room's reverberation time.

Ill. 145 shows differnt mateirals reverberation times and Ill. 146 shows some test in the Nusery Gr. 1.
Here, different materials were tested together in the room to get an optimum reverberation time that meets the building regulations requirements for the 0.4 seconds.

| Wall | | | | | | |
|---|---|---|---|---|---|---|
| Frequency | 125 | 250 | 500 | 1000 | 2000 | 4000 |
| Wonder wall | 0,025 | 0,025 | 0,08 | 0,05 | 0,42 | 0,71 |
| TOWN panels | 0,15 | 0,5 | 0,95 | 1 | 1 | 1 |
| Mos panels | 0,08 | 0,2 | 0,38 | 0,78 | 0,9 | 0,8 |
| Offecct sound wave | 0,05 | 0,25 | 0,6 | 0,7 | 0,85 | 0,7 |
| Alpha puzzle | 0,05 | 0,35 | 0,75 | 0,95 | 1 | 1 |
| Gypsum | 0,29 | 0,1 | 0,05 | 0,04 | 0,07 | 0,09 |

| Celing | | | | | | |
|---|---|---|---|---|---|---|
| Frequency | 125 | 250 | 500 | 1000 | 2000 | 4000 |
| Acoustic plaster | 0,3 | 0,75 | 1 | 0,8 | 0,7 | 0,6 |
| Alpha direct 40 mm | 0,25 | 0,8 | 0,95 | 0,95 | 1 | 1 |
| Troldtekt | 0,2 | 0,5 | 1 | 0,85 | 0,8 | 0,95 |

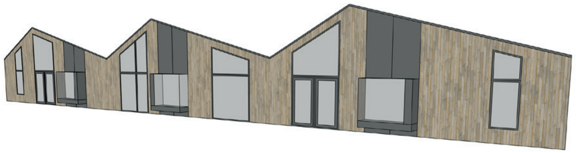
| Flooring | | | | | | |
|---|---|---|---|---|---|---|
| Frequency | 125 | 250 | 500 | 1000 | 2000 | 4000 |
| Forbo floor marmoleum | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 |
| Forbo flotex | 0,1 | 0,1 | 0,1 | 0,1 | 0,1 | 0,1 |
| woodenfloor | 0,15 | 0,11 | 0,1 | 0,07 | 0,06 | 0,07 |

*Ill. 145 - Various reverberation values - (Own illustration)*

| Nusery 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 125 | 250 | 500 | 1000 | 2000 | 4000 | Avg. |
| Test 1 | 1,03 | 0,48 | 0,36 | 0,45 | 0,38 | 0,35 | 0,51 |
| Test 2 | 1,19 | 0,46 | 0,24 | 0,28 | 0,29 | 0,25 | 0,45 |
| Test 3 | 0,67 | 0,45 | 0,26 | 0,29 | 0,30 | 0,27 | 0,38 |

*Ill. 146 - Test of different materials in Nursery Gr. 1 - (Own illustration)*

# FACADE CLADDING AND WINDOW DESIGN

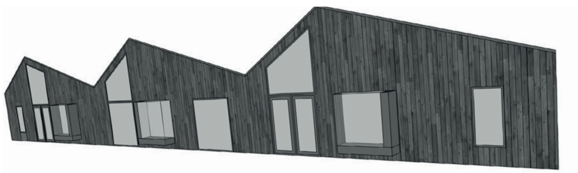


Ill. 147 - Facade light wood with slate- (Own illustration)

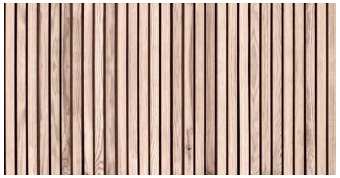
Ill. 148 - Facade burnt wood with panels of light wood (Own illustration)

Ill. 149 - Facade burnt wood with panels of slate (Own illustration)

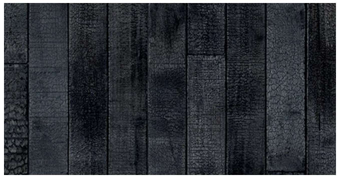
Ill. 150 - Facade light wood - (Own illustration)



Ill. 151 - Facade only burnt wood - (Own illustration)



Ill. 152 - Wooden slats - (Herningsky.dk, n.d.)



Ill. 153 - Burnt wood - (Do, n.d.)

Ill. 154 - Different types of burnt wood - (Burnt Wood, n.d.)

Ill. 155 - Zinc cladding - (Rheinzink.dk, n.d.)

Ill. 156 - Slate cladding - (Cupa Danmark, n.d.)

In this phase aspects such as window types and facade materials have ben investergated.

Ill. 147-151 shows a sample of the various proposals that have been worked on throughout the process.

After the studies in relation to the LCA analyzes, it was decided to use a wooden construction with wood cladding on the outside and gypsum inside. Therefore, various types of wooden facades have been studied.

Ill. 147 shows a façade with wooden slats, which gives both depth in the facade but the slates need to be treated to withstand wind and weather and therefore it will not be an optimal solution if chemicals are used on the wood.

After material Burnt Wood was considered and tested in the facade, it is an old technique that has been used both in Japan and in the north, the method is also known as "Shou sugi ban". More information about the technique and the tree can be found on Appendix 08.
The wood is not treated with different chemicals and therefore avoids degassing, which is very attractive to the target group, so that the child is not exposed to harmful substances.

After examining several different types of wood and evaluating them in relation to each other, Burntwood was chosen due to the good properties in relation to the target group. The durability is good and there are still iking building that stands today, therefore it is difficult to set an age on the lifetime
The long lifetime weighs up in relation to sustainability, where the burning method speaks against. In the production there is used gas. However, a minimum of gas is used in manufacturing and compared with other facade materials, it is estimated that the burnt wood is still at the low end of the $Co_2$ imprint and it also has other good properties.

In the facade various materials were tested together in different ways, these are materials such as zinc and slate. However, it has been decided to use only Burnt Wood because it consist of and the color changes when the sun hits the tree, where a silver glow appears.

# 05 EPILOGUE

CONCLUSION

REFLECTION

LITTERATURE LIST

ILLUSTRATION LIST

Ill. 157 Tree from the site area (Own photo)

# CONCLUSION

The design proposal has focused on creating the best framework for children's development so time in the institution creates a good foundation for their future learning.

Sustainability has an essential role in the design proposal, today's energy requirements set great goals for a new future and there is a greater focus on the world we leave behind for the coming generations.

The project integrates sustainability, where the main focus was to reduced, optimized and produced energy, and the choice of materials also reflects the desire to minimize CO2 impressions.

By using the integrated design process, it has been possible to integrate and optimize the building and where it becomes very interesting is when different approaches and solutions together are solving a problem. Example. using the windows to stay and play can be benefited from the thick construction positively and the value of the windows can be exploit in several ways, thus melting together, and creates a cohesion between the different approaches to children's development.

The Forest house solves to intergrate knowledge about children's development based on research, with a pedagogical point of departure that focuses on community and relationships and the needs and abilities of the individual with a sustainable approach to energy and at least the co2 impression.

To eleborated it the  common areas are creating frameworks for creating relationships across age and enabling all children to interact with each other, the common areas create neutral zones where everyone is on equal terms and many different activities inside and the opportunity for children as individual individuals can express themselves where daylight, acoustics, etc. creating optimal frameworks for children's development in close association with the many energy initiatives in the form of orientation of the building and windows, the various highly isolated construction parts and a lot of other initiatives.

As an architect / engineer, you have the opportunity to form new initiatives and push to the norms of today, you can put greater demands on future buildings, and you can influence a new trend.

# REFLECTION

It has been exciting to work with another target group one previously tested and there has been very interesting information and knowledge through this process. There is a great deal of knowledge about how we can optimize the relationship we have today in the institutions, what measures one can take and change in order to achieve a better development at the children. It is an incredible interassembly topic and very regular in time, the great riddle is how to transfer this knowledge you have today to new trends and initiatives in the construction industry.

Most parents today do not have the opportunity to go home and take care of their children and it is a total rigitg many hours they stay out of the home, therefore it is as an architect / initiator to look through this project what measures and ways you can go in order to optimize the development conditions for the children just through the actual structure, how great an effect a through optimized building could have.

In relation to the method and working with IDP, it is a really good tool that forces more optimizations and iterations into the various processes. Throughout this project, several intensive initiatives have emerged which have arisen through several different iterations and problems, sometimes two different problems can be the solution to each other and this is where it has become interesting to work with IDP.
For example, noise can contribute to affecting children negatively in relation to stress, using materials with good acoustic qualities you can solve the noise nuisance and when using materials - materials can focus on sustainability and a low carbon footprint and at different end different approaches and action to solve each other or solve a problem together.

The negative thoughts about IDP are that sometimes the aesthetic actions and iterations may well drink a bit in the integration of technical solutions and therefore this can well span more creatively based iterations and processes.

In addition, it can be really hard to overlook all the processes you have to go through when working alone, through this design process you have a way of focusing on the shape, indoor climate, energy, construction, materials, acoustics, etc. and derfo it is a little host to get structured so that one can keep a red thread and gather all the information together in the end, especially that working alone with so many subject areas has been a challenge and no matter how much you plan and make schedules it is almost too many tasks for a person, so therefore one might have chosen a few fewer starting points and then have the work concentrated on them in order to achieve a more efficient process.

It was also very ambitious to calculate indoor climate on the whole urban area, which has been an exciting but also difficult process, in the previous semesters there has been focus on few rooms and therefore it was some of the task to get the whole building solved so that the observed requirement and wishes for a good indoor climate. In this process, some rooms might have been selected for calculation instead of when this item has been one
time-consuming item in the project, which has meant that the time was short for presenting presentation material.

A project is never finished one can always work on it and go deep with several topics, but it is often time that ends up setting a deadline for a project, therefore there are other things that could have been exciting to work more with.

Although the project has been well-rounded, it could have been exciting to work with picking up rainwater for reclamation in toilets or else as another sustainable initiative and in addition.

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# 06

# APPENDIX

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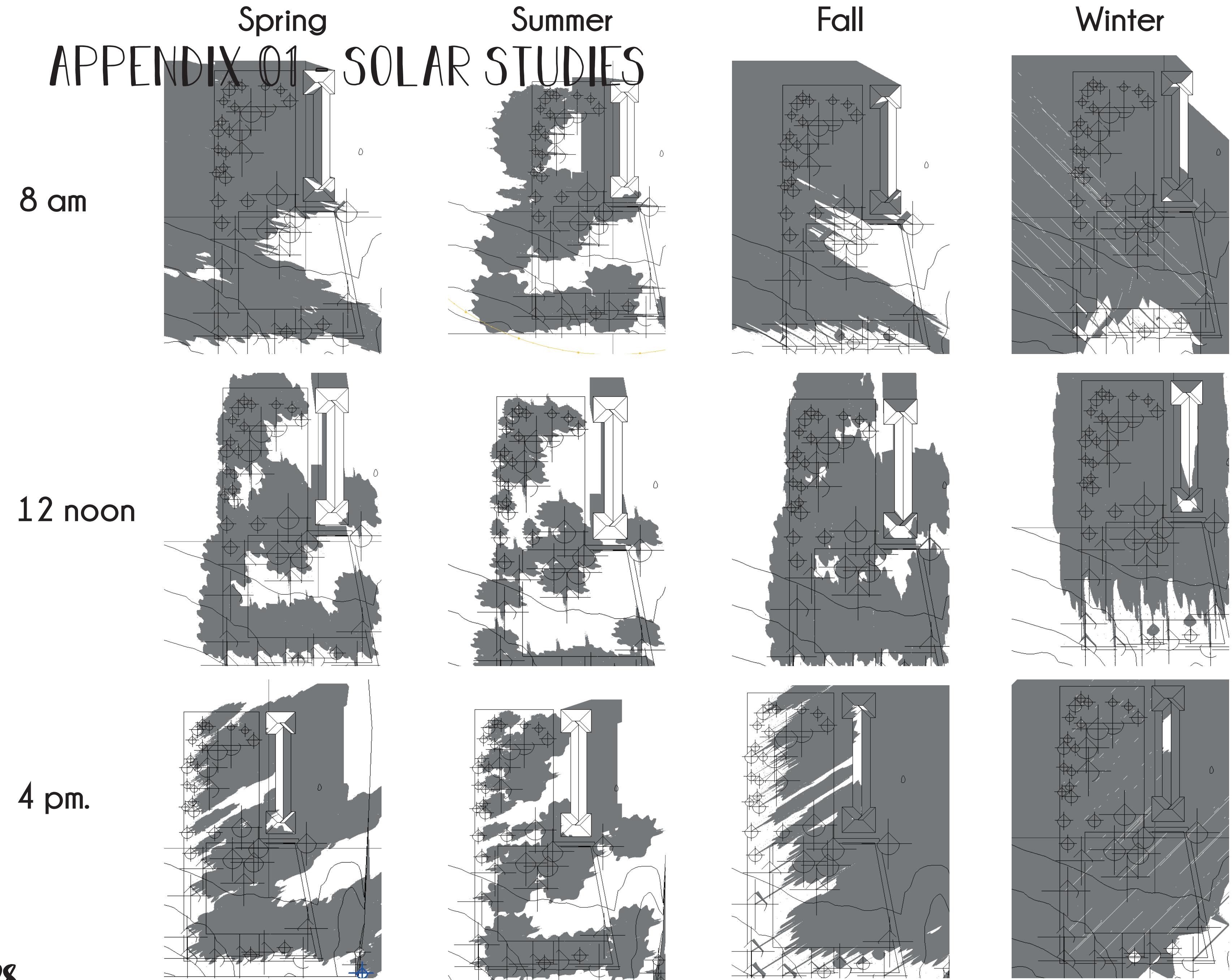
*Ill. 158 Flowers from the site (Own photo)*

# APPENDIX 01 - SOLAR STUDIES




*Ill. 159 Solar and shadow studies (Own Illustration)*

# APPENDIX 02 - VENT. CALCULATION

| The rooms | Area | Volume | PL - kids | PL - Adult | PL Total | Pollution load | Air flow supply l/s - komfort | Air flow supply l/s - BR18 | Air flow supply pr. $m^2$ | Air flow supply pr. $m^2$ BR18 | Air change rate $h^{-1}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Groop room Kindergarten ( x 4) | 52 | 129 | 22 | 2 | 24 | 33,95 | 261,2 | 94,0 | 5,07 | 1,83 | 7,30 |
| Group room Nursery (x3) | 51 | 127 | 13 | 3 | 16 | 24,27 | 186,7 | 71,7 | 3,68 | 1,42 | 5,31 |
| Group Room Special needs(x2) | 28 | 69 | 6 | 3 | 9 | 13,55 | 104,2 | 42,6 | 3,79 | 1,55 | 5,46 |
| Snozleroom / Workshop | 33 | 83 | 12 | 3 | 15 | 21,33 | 164,1 | 62,7 | 4,92 | 1,88 | 7,09 |
| Toilet (4) | 10 | 24 | 0 | 1 | 1 | 2,15 | 15,0 | 8,3 | 1,58 | 0,88 | 2,27 |
| Toilet + Changing room (x3) | 15 | 38 | 3 | 2 | 5 | 7,53 | 15,0 | 24,4 | 0,98 | 1,59 | 1,41 |
| Wardrobe (x2) | 73 | 183 | 10 | 5 | 15 | 25,30 | 194,6 | 80,6 | 2,67 | 1,10 | 3,84 |
| Common area - Zone 1 | 137 | 343 | 13 | 2 | 15 | 31,70 | 243,8 | 97,0 | 1,78 | 0,71 | 2,56 |
| Common area - Zone 2 | 131 | 328 | 13 | 2 | 15 | 31,10 | 239,2 | 94,9 | 1,83 | 0,72 | 2,63 |
| Common area - Zone 3 | 128 | 320 | 13 | 2 | 15 | 30,80 | 236,9 | 93,8 | 1,85 | 0,73 | 2,67 |
| Kitchen | 60 | 150 | 0 | 6 | 6 | 13,20 | 20,0 | 51,0 | 0,33 | 0,85 | 0,48 |
| Activity Hall | 212 | 530 | 100 | 10 | 110 | 153,20 | 1178,5 | 424,2 | 5,56 | 2,00 | 8,00 |
| Office | 25 | 63 | 0 | 4 | 4 | 7,30 | 56,2 | 28,8 | 2,25 | 1,15 | 3,23 |
| Meeting room | 14 | 35 | 0 | 4 | 4 | 6,20 | 47,7 | 24,9 | 3,41 | 1,78 | 4,91 |

| | | | | |
|---|---|---|---|---|
| **Person** | 1,2 olf/ person | **DS1752** | **s. 26** | |
| **Materials** | 0,1 olf / m2 | DS1752 | S. 27 | |
| **$C_{c,i}$ - Perceived indoor air quality** | 1,4 dp | DS1752 | s. 23 | = kategori A |
| **$C_{c,o}$ - Perceived air quality at air intake (outdoor)** | 0,1 dp | DS1752 | s. 27 | I byer - god luft kvalitet |

*Ill. 160 Calculation of ventilation (Own Illustration)*

Calculation - Office

$$\frac{10\ x\ (1{,}4\,\frac{olf}{person}*4) + (0{,}1\,\frac{olf}{m^2}*25)}{1{,}4\ dp - 0{,}1\ dp} * 1/1 = 56{,}2\ l/s$$

$$56{,}2\ l/s * 3600s\ /\ 1000l*(25m^2*2{,}5m) = 3{,}11\ h^{-1}$$

# APPENDIX 03 - IES RESULTS

| Category 1 | Summer (1. May - 31. Oct.) | | | Winter (1. Nov. - 30 April) | | | Hole year | | |
|---|---|---|---|---|---|---|---|---|---|
| | <= 22.50 | 22.50 to <=24.5 | > 24.50 | <= 19.00 | >19.00 to <=21.00 | > 21.00 | | | |
| Acticity hall | 8,1 | 79,7 | 12,1 | 0,0 | 37,6 | 62,4 | 4,1 | 58,6 | 37,4 |
| Common Area | 25,4 | 61,9 | 12,7 | 0,0 | 91,6 | 8,4 | 12,7 | 76,8 | 10,5 |
| Kindergarten Gr. 1 | 9,0 | 76,7 | 14,3 | 0,0 | 74,0 | 26,0 | 4,5 | 75,3 | 20,2 |
| Kindergarten Gr. 2 | 9,3 | 77,0 | 13,7 | 0,0 | 54,4 | 45,6 | 4,6 | 65,7 | 29,7 |
| Kindergarten Gr. 3 | 9,7 | 79,4 | 10,9 | 0,0 | 87,5 | 12,5 | 4,8 | 83,5 | 11,7 |
| Kindergarten Gr. 4 | 7,8 | 77,1 | 15,1 | 0,0 | 67,3 | 32,7 | 3,9 | 72,2 | 23,9 |
| Office | 6,6 | 75,9 | 17,6 | 0,0 | 25,4 | 74,6 | 3,3 | 50,5 | 46,2 |
| Meeting room | 9,3 | 77,8 | 12,9 | 0,0 | 55,3 | 44,7 | 4,6 | 66,5 | 28,9 |
| Nursery Gr. 1 | 16,0 | 74,0 | 10,0 | 0,0 | 93,2 | 6,8 | 8,0 | 83,6 | 8,4 |
| Nursery Gr. 2 | 14,2 | 73,3 | 12,5 | 0,0 | 92,1 | 7,9 | 7,1 | 82,7 | 10,2 |
| Nursery Gr. 3 | 14,8 | 70,9 | 14,3 | 0,0 | 92,0 | 8,0 | 7,3 | 81,5 | 11,1 |
| Special Gr. | 17,1 | 68,8 | 14,1 | 0,0 | 85,8 | 14,2 | 8,5 | 77,3 | 14,1 |
| Special Gr. | 13,1 | 74,3 | 12,7 | 0,0 | 85,3 | 14,7 | 6,5 | 79,8 | 13,7 |
| Workshop - Sleeping area | 12,7 | 74,1 | 13,2 | 0,0 | 87,0 | 13,0 | 6,3 | 80,6 | 13,1 |
| Workshop area | 8,6 | 75,2 | 16,2 | 0,0 | 52,6 | 47,4 | 4,3 | 63,9 | 31,8 |

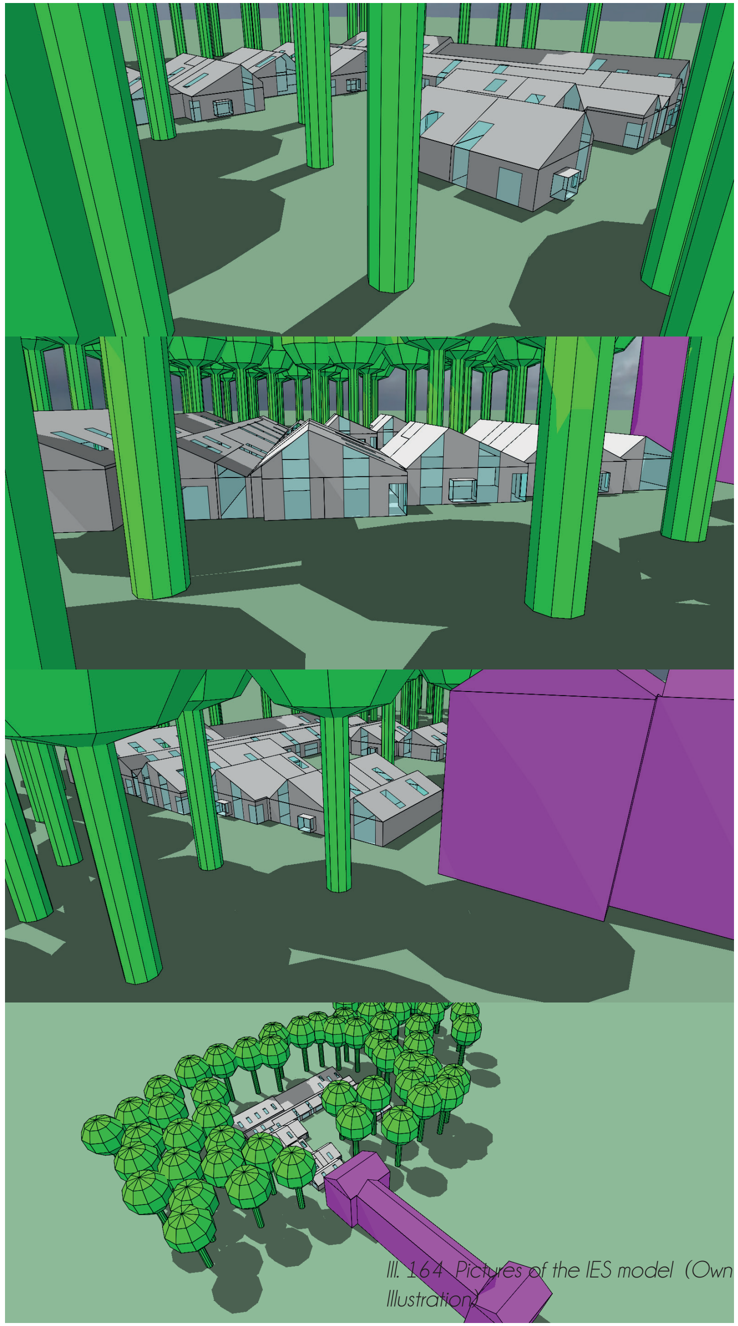
*Ill. 161 Temperature - Category 1( Own Illustration)*

| Category 2 | Sommer (1. maj - 31. okt.) | | | Vinter (1. nov. - 30 april) | | | Hole Year | | |
|---|---|---|---|---|---|---|---|---|---|
| | <= 21.50 | 21.50 to <=25.5 | > 25.50 | <= 17.50 | >17.50 to <=22.50 | > 22.50 | | | |
| Acticity hall | 0,0 | 94,5 | 5,5 | 0,0 | 99,9 | 0,1 | 0,0 | 97,2 | 2,8 |
| Common Area | 4,1 | 92,1 | 3,8 | 0,0 | 100,0 | 0,0 | 2,1 | 96,0 | 1,9 |
| Kindergarten Gr. 1 | 1,0 | 93,1 | 5,9 | 0,0 | 99,9 | 0,1 | 0,5 | 96,5 | 3,0 |
| Kindergarten Gr. 2 | 0,3 | 94,1 | 5,6 | 0,0 | 99,9 | 0,1 | 0,2 | 97,0 | 2,8 |
| Kindergarten Gr. 3 | 0,7 | 94,8 | 4,5 | 0,0 | 100,0 | 0,0 | 0,4 | 97,4 | 2,2 |
| Kindergarten Gr. 4 | 0,6 | 93,3 | 6,1 | 0,0 | 100,0 | 0,0 | 0,3 | 96,6 | 3,0 |
| Office | 0,0 | 94,7 | 5,3 | 0,0 | 97,8 | 2,2 | 0,0 | 96,3 | 3,7 |
| Meeting room | 0,0 | 95,3 | 4,6 | 0,0 | 98,1 | 1,9 | 0,0 | 96,7 | 3,2 |
| Nursery Gr. 1 | 3,7 | 91,5 | 4,8 | 0,0 | 100,0 | 0,0 | 1,8 | 95,8 | 2,4 |
| Nursery Gr. 2 | 2,4 | 91,7 | 5,9 | 0,0 | 100,0 | 0,0 | 1,2 | 95,9 | 2,9 |
| Nursery Gr. 3 | 2,6 | 90,9 | 6,5 | 0,0 | 100,0 | 0,0 | 1,3 | 95,5 | 3,2 |
| Special Gr. | 3,4 | 91,3 | 5,3 | 0,0 | 99,9 | 0,1 | 1,7 | 95,6 | 2,7 |
| Special Gr. | 1,8 | 93,8 | 4,4 | 0,0 | 100,0 | 0,0 | 0,9 | 96,9 | 2,2 |
| Workshop - Sleeping area | 1,7 | 93,3 | 5,0 | 0,0 | 100,0 | 0,0 | 0,9 | 96,6 | 2,5 |
| Workshop area | 0,3 | 93,3 | 6,3 | 0,0 | 99,9 | 0,1 | 0,2 | 96,6 | 3,2 |

*Ill. 162 Temperature - Category 2( Own Illustration)*

| | Hours above | |
| --- | --- | --- |
| | 26 degrees | 27 degrees |
| Acticity hall | 57 | 17 |
| Common Area | 32 | 7 |
| Kindergarten Gr. 1 | 64 | 24 |
| Kindergarten Gr. 2 | 59 | 14 |
| Kindergarten Gr. 3 | 38 | 4 |
| Kindergarten Gr. 4 | 63 | 23 |
| Office | 37 | 6 |
| Meeting room | 34 | 8 |
| Nursery Gr. 1 | 48 | 7 |
| Nursery Gr. 2 | 61 | 12 |
| Nursery Gr. 3 | 63 | 17 |
| Special Gr. | 47 | 8 |
| Special Gr. | 40 | 5 |
| Workshop - Sleeping area | 44 | 6 |
| Workshop area | 67 | 25 |

*Ill. 163 Hours above (Own Illustration)*



*Ill. 164 Pictures of the IES model (Own Illustration)*

# APPENDIX 04 - ACOUSTIC - REVERBERATIONTIME

## Nursery Gr. 1

| Surface type | Frequency / Absorption coefficient / Surface area [m2] | 125Hz a | 125Hz A[m2] | 250Hz a | 250Hz A[m2] | 500Hz a | 500Hz A[m2] | 1000Hz a | 1000Hz A[m2] | 2000Hz a | 2000Hz A[m2] | 4000Hz a | 4000Hz A[m2] | avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Celing | 54,94 | 0,20 | 10,99 | 0,50 | 27,47 | 1,00 | 54,94 | 0,85 | 46,70 | 0,80 | 43,95 | 0,95 | 52,19 | |
| Floor | 44,23 | 0,05 | 2,21 | 0,05 | 2,21 | 0,05 | 2,21 | 0,05 | 2,21 | 0,05 | 2,21 | 0,05 | 2,21 | |
| Wall | 39,00 | 0,29 | 11,31 | 0,10 | 3,90 | 0,05 | 1,95 | 0,04 | 1,56 | 0,07 | 2,73 | 0,09 | 3,51 | |
| Sound absorbing wall covering | 25,00 | 0,15 | 3,75 | 0,50 | 12,50 | 0,95 | 23,75 | 1,00 | 25,00 | 1,00 | 25,00 | 1,00 | 25,00 | |
| window and door area | 15,60 | 0,35 | 5,46 | 0,25 | 3,90 | 0,18 | 2,81 | 0,12 | 1,87 | 0,07 | 1,09 | 0,04 | 0,62 | |
| Room Volumen [m3] | 141,52 | | | | | | | | | | | | | |
| Total Absorption Area A [m2] | | | 33,72 | | 49,98 | | 85,66 | | 77,34 | | 74,99 | | 83,54 | |
| Reverberation time [Sec] | | | 0,67 | | 0,45 | | 0,26 | | 0,29 | | 0,30 | | 0,27 | 0,38 |

*Ill. 165 Calculation of reverberation time nursery gr. 1( Own Illustration)*

## Common area

| Surface type | Frequency / Absorption coefficient / Surface area [m2] | 125Hz a | 125Hz A[m2] | 250Hz a | 250Hz A[m2] | 500Hz a | 500Hz A[m2] | 1000Hz a | 1000Hz A[m2] | 2000Hz a | 2000Hz A[m2] | 4000Hz a | 4000Hz A[m2] | avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Celing | 843,70 | 0,20 | 168,74 | 0,50 | 421,85 | 1,00 | 843,70 | 0,85 | 717,15 | 0,80 | 674,96 | 0,95 | 801,52 | |
| Floor | 396,00 | 0,10 | 39,60 | 0,10 | 39,60 | 0,10 | 39,60 | 0,10 | 39,60 | 0,10 | 39,60 | 0,10 | 39,60 | |
| Wall | 758,70 | 0,29 | 220,02 | 0,10 | 75,87 | 0,05 | 37,94 | 0,04 | 30,35 | 0,07 | 53,11 | 0,09 | 68,28 | |
| Sound absorbing wall covering | 50,00 | 0,15 | 7,50 | 0,50 | 25,00 | 0,95 | 47,50 | 1,00 | 50,00 | 1,00 | 50,00 | 1,00 | 50,00 | |
| window and door area | 90,00 | 0,35 | 31,50 | 0,25 | 22,50 | 0,18 | 16,20 | 0,12 | 10,80 | 0,07 | 6,30 | 0,04 | 3,60 | |
| Room Volumen [m3] | 1392,30 | | | | | | | | | | | | | |
| Total Absorption Area A [m2] | | | 467,36 | | 584,82 | | 984,94 | | 847,89 | | 823,97 | | 963,00 | |
| Reverberation time [Sec] | | | 0,48 | | 0,38 | | 0,23 | | 0,26 | | 0,27 | | 0,23 | 0,31 |

*Ill. 166 Calculation of reverberation time Common area( Own Illustration)*

# APPENDIX 05 - DAYLIGHT CALCULATION

| | | | | Frame correction | | Correction for LT | | Correction for surroundings | | Correction for skylights | | Total glass area | BR18 requirements |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rooms | Area | Window Area | Skylights Area | Window Area | Skylights Area | Window Area | Skylights Area | Window Area | Skylights Area | Window Area | Skylights Area | | |
| Kindergarten Gr. 1 | 50 | 15,1 | 3,5 | 12,9 | 3,0 | 10,8 | 2,5 | 5,4 | 1,2 | 5,4 | 1,7 | 7,1 | 5,0 |
| Kindergarten Gr. 2 | 54 | 11,6 | 3,5 | 9,9 | 3,0 | 8,3 | 2,5 | 4,1 | 1,2 | 4,1 | 1,7 | 5,9 | 5,4 |
| Kindergarten Gr. 3 | 50 | 11,6 | 7,0 | 9,9 | 5,9 | 8,3 | 5,0 | 4,1 | 2,5 | 4,1 | 3,5 | 7,6 | 5,0 |
| Kindergarten Gr. 4 | 48 | 15,1 | 0,0 | 12,9 | 0,0 | 10,8 | 0,0 | 5,4 | 0,0 | 5,4 | 0,0 | 5,4 | 4,8 |
| Nursery Gr. 1 | 45 | 12,2 | 3,5 | 10,3 | 3,0 | 8,7 | 2,5 | 4,3 | 1,2 | 4,3 | 1,7 | 6,1 | 4,5 |
| Nursery Gr. 2 | 53 | 15,7 | 3,5 | 13,3 | 3,0 | 11,2 | 2,5 | 5,6 | 1,2 | 5,6 | 1,7 | 7,3 | 5,3 |
| Nursery Gr. 3 | 50 | 15,1 | 2,4 | 12,9 | 2,0 | 10,8 | 1,7 | 5,4 | 0,9 | 5,4 | 1,2 | 6,6 | 5,0 |
| WorkShop/ Sleeping area | 59 | 20,4 | 0,0 | 17,3 | 0,0 | 14,6 | 0,0 | 7,3 | 0,0 | 7,3 | 0,0 | 7,3 | 5,9 |
| Workshop /Small Gr. | 28 | 9,5 | 0,0 | 8,1 | 0,0 | 6,8 | 0,0 | 3,4 | 0,0 | 3,4 | 0,0 | 3,4 | 2,8 |
| Special Gr. | 26 | 12,0 | 2,4 | 10,2 | 2,0 | 8,5 | 1,7 | 4,3 | 0,9 | 4,3 | 1,2 | 5,5 | 2,6 |
| Snozleroom/Special Gr. | 38 | 7,1 | 0,0 | 6,0 | 0,0 | 5,1 | 0,0 | 2,5 | 0,0 | 2,5 | 0,0 | 2,5 | 3,8 |
| Kitchen | 57 | 8,4 | 7,2 | 7,2 | 6,1 | 6,0 | 5,1 | 3,0 | 2,6 | 3,0 | 3,6 | 6,6 | 5,7 |
| Wardobe Kindergarten | 72 | 18,4 | 7,0 | 15,6 | 5,9 | 13,1 | 5,0 | 6,6 | 2,5 | 6,6 | 3,5 | 10,0 | 7,2 |
| Wardrobe Nusery | 68 | 12,2 | 7,0 | 10,4 | 5,9 | 8,7 | 5,0 | 7,0 | 2,5 | 7,0 | 3,5 | 10,5 | 6,8 |
| Office | 25 | 5,3 | 0,0 | 4,5 | 0,0 | 3,8 | 0,0 | 3,0 | 0,0 | 3,0 | 0,0 | 3,0 | 2,5 |
| Meetingroom | 14 | 5,5 | 0,0 | 4,6 | 0,0 | 3,9 | 0,0 | 3,1 | 0,0 | 3,1 | 0,0 | 3,1 | 1,4 |
| Activity Hall | 212 | 29,2 | 11,9 | 24,9 | 10,1 | 20,9 | 8,5 | 16,7 | 6,8 | 16,7 | 9,5 | 26,2 | 21,2 |
| Commonroom + hallways | 137 | 81,7 | 8,3 | 69,5 | 7,0 | 58,4 | 5,9 | 29,2 | 4,7 | 29,2 | 6,6 | 35,8 | 13,7 |

| | | |
|---|---|---|
| Window area | 0,85 | |
| Light transmittance, LT | 0,63 | g-værdi 0,35 |
| Light transmittance, LT (BR18) | 0,75 | |
| Skylights factor BR18 | 1,4 | |
| Reduction for wall thickness | 1 | |
| Surroundings east and west | 0,5 | |
| Surroundings to the south | 0,8 | |

*Ill. 167 Full daylight calculation ( Own Illustration)*

**Dalylight factor**

| Rooms | Min | Ave. | Max |
|---|---|---|---|
| Office | 0,40% | 1,20% | 5,70% |
| Meeting room | 0,40% | 1,80% | 5,70% |
| Acvity hall | 1,20% | 4,30% | 11,70% |
| Kindergarten 1 | 0,70% | 3,40% | 12,50% |
| kindergarten 2 | 1% | 3,10% | 10,70% |
| Kindergarten 3 | 0,80% | 2,10% | 16,90% |
| Kindergarten 4 | 0,60% | 2,50% | 15,90% |
| Nursery 1 | 0,80% | 2,70% | 13,80% |
| Nursery 2 | 0,60% | 2,90% | 12,80% |
| Nursery 3 | 0,80% | 3,80% | 16,20% |
| Special Gr. | 0,60% | 1,40% | 9,30% |
| Workshop/Sleeping | 0,80% | 5,30% | 12,20% |
| Workshop area | 0,60% | 1,40% | 8,30% |
| Common area | 0,20% | 4,30% | 22,20% |

*Ill. 168 Daylight factor form IES ( Own Illustration)*

# APPENDIX 06 - AIR FLOW CALCULATION

| The rooms | | Area | Volume | PL - kids | PL - Adult | PL Total | Pollution load | **Air flow supply l/s - Comfort** | Air flow supply l/s - BR18 | **Air flow supply pr. m2** | Air flow supply pr. m2 BR18 | Air change rate h-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Groop room Kindergarten ( x 4) | 1,5 | 52 | 129 | 22 | 2 | 24 | 33,95 | **261,2** | 94,0 | **5,07** | 1,83 | 7,30 |
| Group room Nursery (x3) | 1,5 | 51 | 127 | 13 | 3 | 16 | 24,27 | **240,0** | 71,7 | **4,74** | 1,42 | 6,82 |
| Group Room Special needs(x2) | 0,8 | 28 | 69 | 6 | 3 | 9 | 13,55 | **104,2** | 42,6 | **3,79** | 1,55 | 5,46 |
| Snozleroom / Workshop | 1,0 | 33 | 83 | 12 | 3 | 15 | 21,33 | **164,1** | 62,7 | **4,92** | 1,88 | 7,09 |
| Toilet (4) | 0,3 | 10 | 24 | 0 | 1 | 1 | 2,15 | **15,0** | 8,3 | **1,58** | 0,88 | 2,27 |
| Toilet + Changing room (x3) | 0,5 | 15 | 38 | 3 | 2 | 5 | 7,53 | **15,0** | 24,4 | **0,98** | 1,59 | 1,41 |
| Wardrobe (x2) | 2,2 | 73 | 183 | 10 | 5 | 15 | 25,30 | **194,6** | 80,6 | **2,67** | 1,10 | 3,84 |
| Common area - Zone 1 | 4,1 | 137 | 343 | 13 | 2 | 15 | 31,70 | **243,8** | 97,0 | **1,78** | 0,71 | 2,56 |
| Common area - Zone 2 | 3,9 | 131 | 328 | 13 | 2 | 15 | 31,10 | **239,2** | 94,9 | **1,83** | 0,72 | 2,63 |
| Common area - Zone 3 | 3,8 | 128 | 320 | 13 | 2 | 15 | 30,80 | **236,9** | 93,8 | **1,85** | 0,73 | 2,67 |
| Kitchen | 1,8 | 60 | 150 | 0 | 6 | 6 | 13,20 | **20,0** | 51,0 | **0,33** | 0,85 | 0,48 |
| Activity Hall | 6,4 | 212 | 530 | 100 | 10 | 110 | 153,20 | **1178,5** | 424,2 | **5,56** | 2,00 | 8,00 |
| Office | 0,8 | 25 | 63 | 0 | 4 | 4 | 7,30 | **70,0** | 28,8 | **2,80** | 1,15 | 4,03 |
| Meeting room | 0,4 | 14 | 35 | 0 | 4 | 4 | 6,20 | **76,0** | 24,9 | **5,43** | 1,78 | 7,82 |

*Ill. 169 Final calculation for air flow bases on comfort ( Own Illustration)*

# APPENDIX 07-U-VALUE CALCULATION

| OUTERWALL | b | d | λ | b x λ | λ' | R | |
|---|---|---|---|---|---|---|---|
| Inside overgangsisolans | | | | | | 0,1 | |
| Plasterboards 2 x 13 mm | | 0,026 | 0,16 | | | 0,16 | |
| Insulation kingspan 50mm | 0,55 | 0,05 | 0,022 | 0,0121 | | | |
| Wooden moldings CC.600 mm - 50 x 100 mm | 0,05 | 0,05 | 0,3 | 0,015 | 0,0371 | 1,3477 | |
| Seaweed insulation 195 mm | 0,555 | 0,195 | 0,037 | 0,021 | 0,057 | 3,44 | |
| Structural timber (T1) - CC. 600 mm - 45 x 195 mm | 0,045 | 0,195 | 0,3 | 0,014 | | | |
| Seaweed insulation 145 mm | 0,555 | 0,145 | 0,037 | 0,021 | 0,072 | 2,02 | |
| Plus stolper Isover - 90 x 145 mm | 0,045 | 0,145 | 0,5 | 0,023 | | | |
| Cembrit windstopper extreem 9 mm | | 0,009 | 0,5 | | | 0,02 | |
| Air gap | 0,55 | 0,05 | 0,025 | 0,01375 | | | |
| Battens with air gap - CC 600 mm. 45 x50 mm | 0,05 | 0,05 | 0,3 | 0,015 | 0,025 | 2,00000 | |
| Burnt wood - Cladding - 25x 140 mm | | 0,025 | 0,3 | | | 0,08 | |
| Udv. overgangsisolans | | 0,5 | | | | 0,04 | |
| | | | | | | | |
| | | | | | R = | 9,2 | $m^2K/W$ |
| | | | | | U = | 0,11 | $W/m^2K$ |

*Ill. 170 Calculation of u-value outerwall ( Own Illustration)*

# APENDIX 08 - MATERIALS

The project's focus on sustainability and the future's great demands and wishes for a more sustainable world make it obvious to find out which new opportunities and initiatives are available within materials. In order to delimit sustainability, the focus within materials is on health in relation to degassing and a minimum co$^2$ footprint.

In addition, there must be a focus on aesthetics, maintenance and longevity.

**Marmoleum flooring - Forbo**

Floors made of marmoleum are made from 97% natural materials and contain 72% renewable materials. In the manufacturing of marmoleum, residual products are used from the paper industry, which means that it is upcycling since the residual products have been actively used. The product is non-toxic and therefore does not add any harmful elements to the indoor climate.
The product is co$^2$ neutral and therefore does not affect the environment or harm our climate.
Marmoleum is also available with noise-reducing properties, so it can contribute to better indoor acoustics.
In addition, the floor is hypoallergenic during the right cleaning and has received the "Seal of Approval" awarded by the British allergy foundation. [Forbo.com, n.d.]

Ill. 171 Forbo marmoleum floor - [forbo.com, n.d.]

**Bamboo floors - Holse and Wibroe**

Bamboo is the fastest growing plant in the world and therefore it takes only approx. 4-6 years to grow a reasonable size, so it can be used for various purposes.
Bamboo is a surprisingly hard material and can therefore be used for e.g. floors. By comparing bamboo with other types of wood, bamboo measures about 4.7 on the Brinell scale, where pine wood only measures 2.8.
Bamboo also has good properties in relative to CO$^2$, and oxygen. As it is a fast-growing plant and it releases more oxygen than other plants and 35% more oxygen compared to other wood types. The rapid growth of bamboo also makes it possible to absorb large amounts of CO$^2$ and, therefore is bamboo CO$^2$ neutral in relation to its lifetime.
Bamboo production also has a minimal waste; about 20% is reserved for harvesting and production. This waste is used for other purposes and can therefore be said to have a very minimal waste. [Wibroe, n.d]

Ill. 172 Bambus flooring - Holse&Wibroe - [holseogwibroe.dk, n.d]

### Seaweed insulation - Zostera

Insulation batts made of eelgrass, which are collected from coastal areas and dried. Since Denmark is surrounded by coast, there are good prerequisites for utilizing and cultivating the seaweed. Eelgrass has several advantages in relation to $CO^2$ and purification of the sea. Research suggests that seaweed has a positive effect on the $CO^2$ level, as the seaweed can absorb some $CO^2$ from the air and thereby transport the $CO^2$ down to the seabed, from which it loses its harmful properties [Politiken, 2016]

In addition, it can be avoided that seaweed flows up onto the beach and start rotting, after which it again separates the $CO^2$ and the nutrients it had absorbed in the sea water.

To utilize the good properties of seaweed, it is recycled to insulation by collecting it and afterwards dried it.

The product of eelgrass has an almost infinite durability and can be reused for the production of new batts.

The product in itself is flame retardant and it is free of harmful substances, therefore it contributes to a healthy indoor climate. [Zostera, n.d.]

*Ill. 173 Insulation batt made of eelgrass - [Zostera.dk, n.d.]*

### Facade - Burnt Wood

Burnt wood is an ancient technique to make the wood resistant and contains the properties from pressure impregnated wood. This is a technique that can be traced back to the Viking Age and later a distinct method in Japan called Shou Sugi Ban.

The top layer of the wood is burned, and therefore, it becomes charred and the sugars in the wood are eliminated. Therfore it's impossible for microorganisms to live inside in the wood.

It is thereby resistant to the weather and can be used as an facade element.

The wood has a long shelf life, with up to 80 years or more, as it is still possible to see burned poles from the Viking age.

The wood there is used to the product comes from local sawmills, creating a minimal $CO^2$ emissions for transportation. [Burnt Wood, n.d.]


*Ill. 174 Burnt Wood 3 diffent types - [burntwood.dk, n.d]*

List of drawings:

1. Master Plan

2: Floor plan

3: Elevation West

4: Elevation East

5: Elevation North

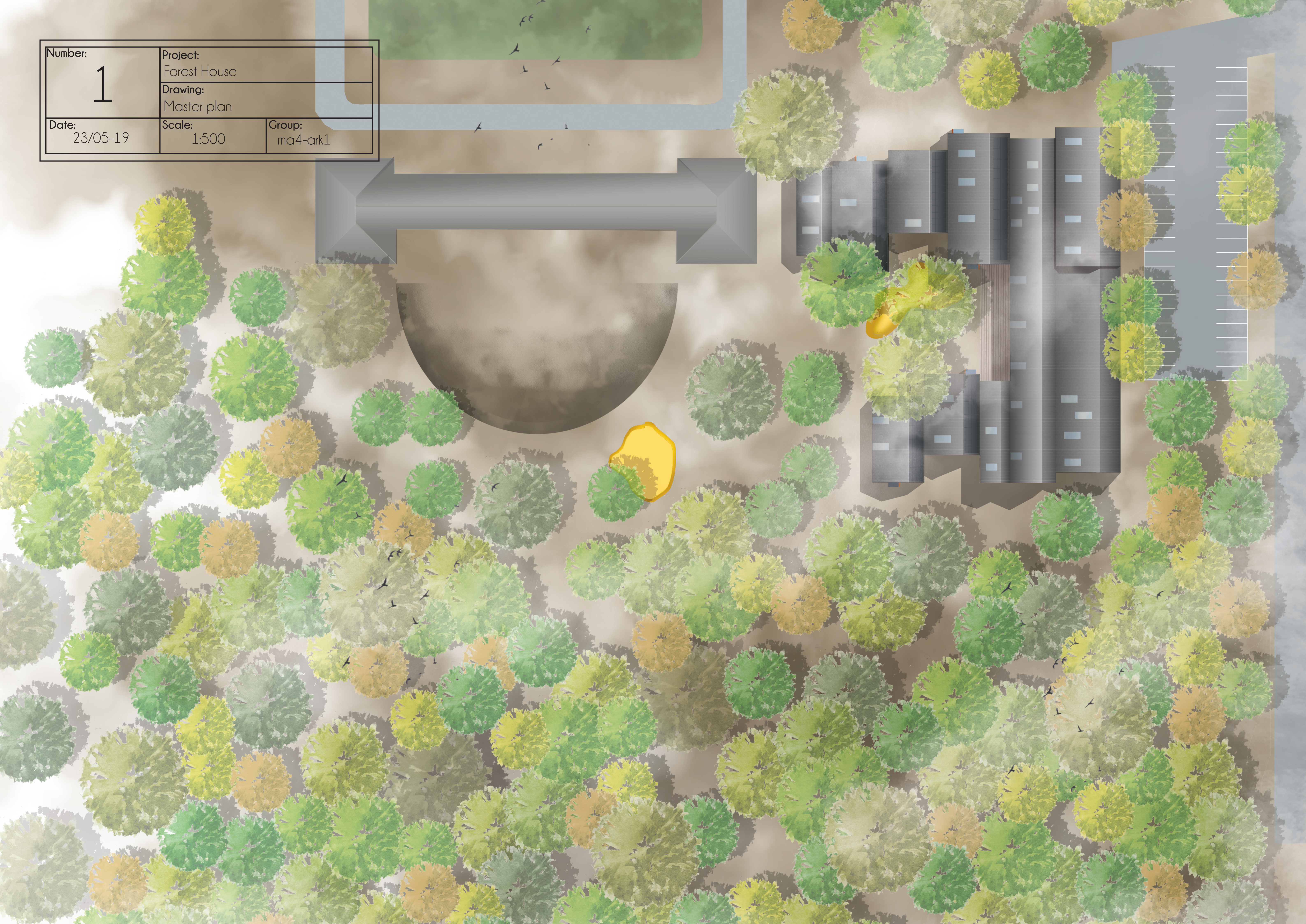
6: Elevation South

7: Section AA

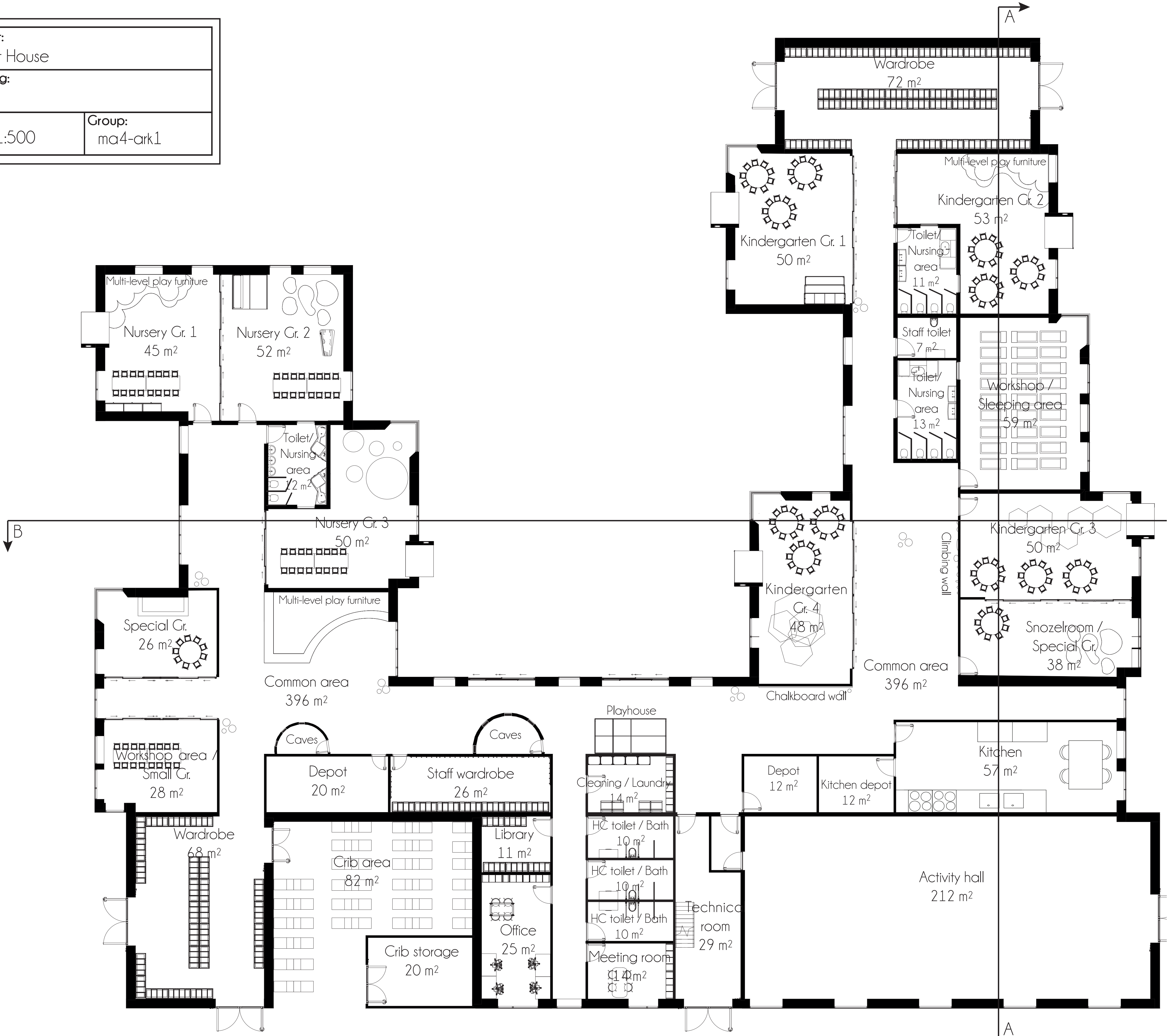
8: Section BB

9: Detail

| Number: | Project: | |
|---|---|---|
| 1 | Forest House | |
| | Drawing: Master plan | |
| Date: 23/05-19 | Scale: 1:500 | Group: ma4-ark1 |



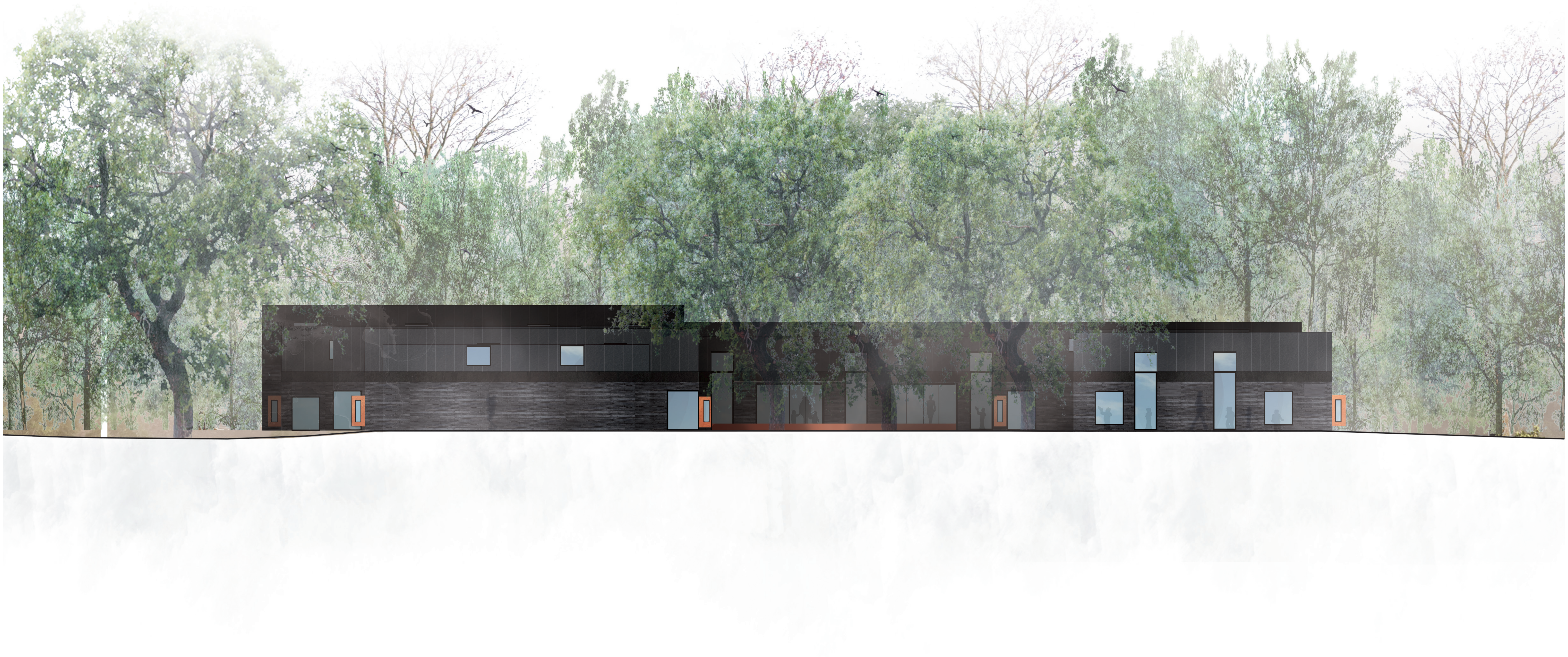
| Number: | Project: | |
|---|---|---|
| 2 | Forest House | |
| | Drawing: | |
| | Plan | |
| Date: | Scale: | Group: |
| 23/05-19 | 1:500 | ma4-ark1 |



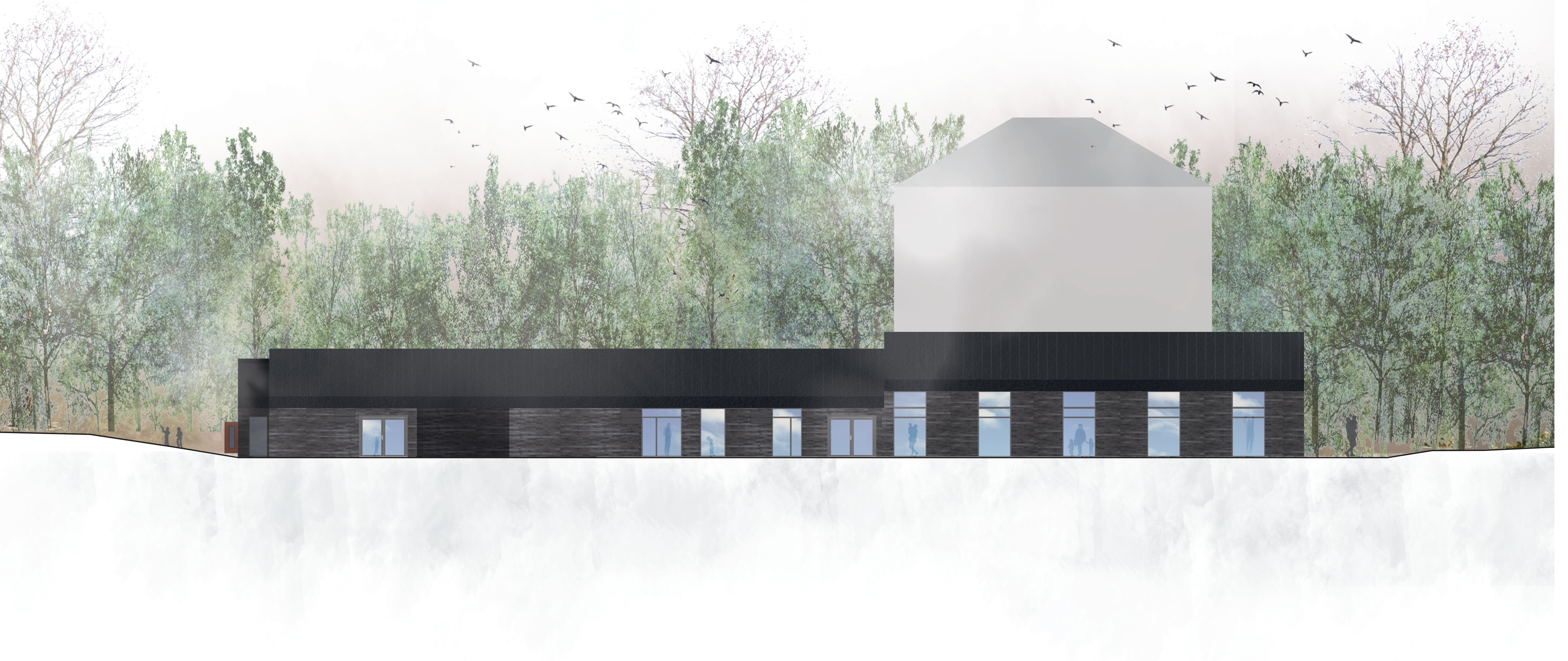
| Number: | Project: | |
|---|---|---|
| 3 | Forest House | |
| | Drawing: | |
| | Elevation West | |
| Date: | Scale: | Group: |
| 23/05-19 | 1:200 | ma4-ark1 |

| Number: | Project: | |
|---|---|---|
| 4 | Forest House | |
| | Drawing: | |
| | Elevation East | |
| Date: 23/05-19 | Scale: 1:200 | Group: ma4-ark1 |

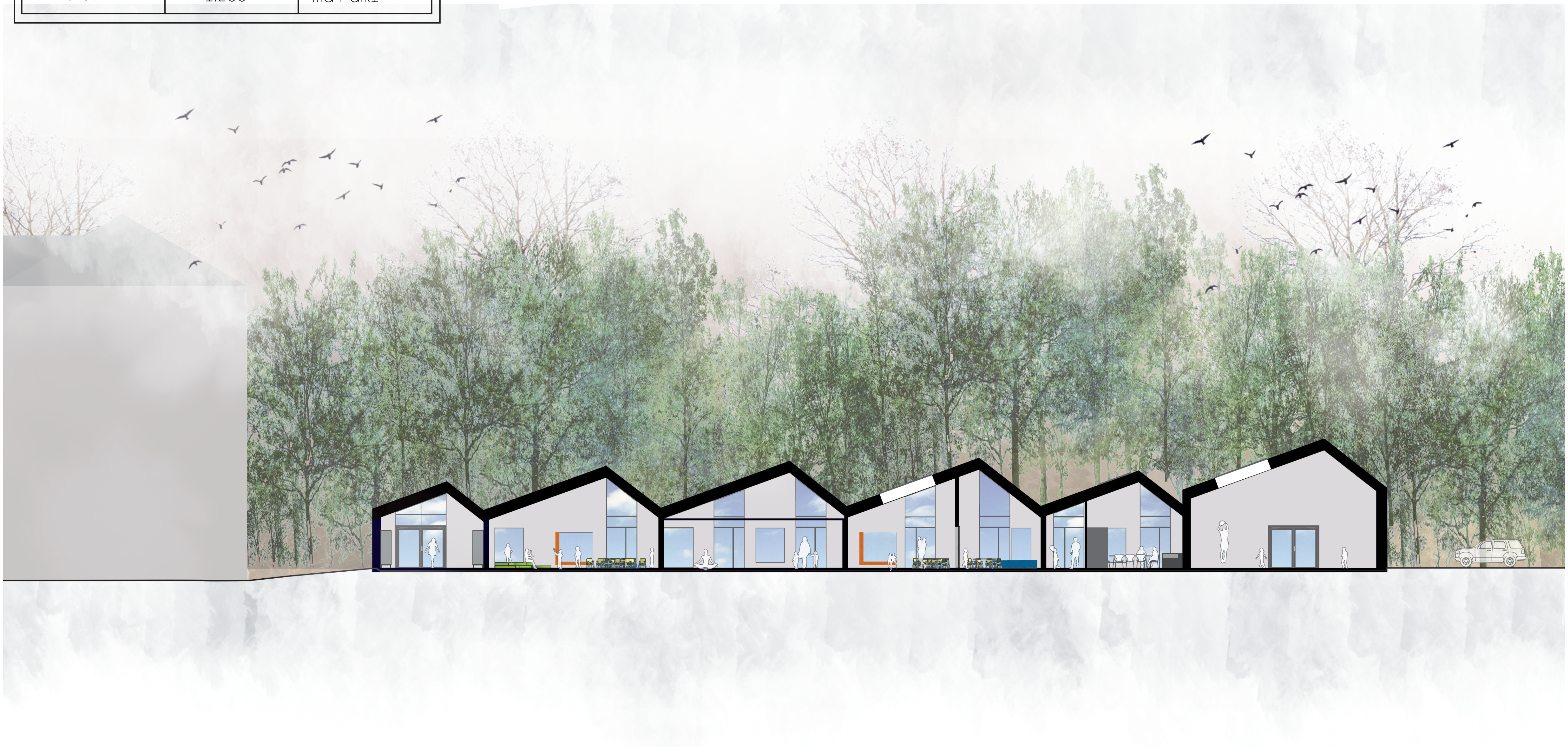
| | | |
|---|---|---|
| Number: 5 | Project: Forest House | |
| | Drawing: Elevation North | |
| Date: 23/05-19 | Scale: 1:200 | Group: ma4-ark1 |



| | | |
|---|---|---|
| Number: 6 | Project: Forest House | |
| | Drawing: Elevation South | |
| Date: 23/05-19 | Scale: 1:200 | Group: ma4-ark1 |

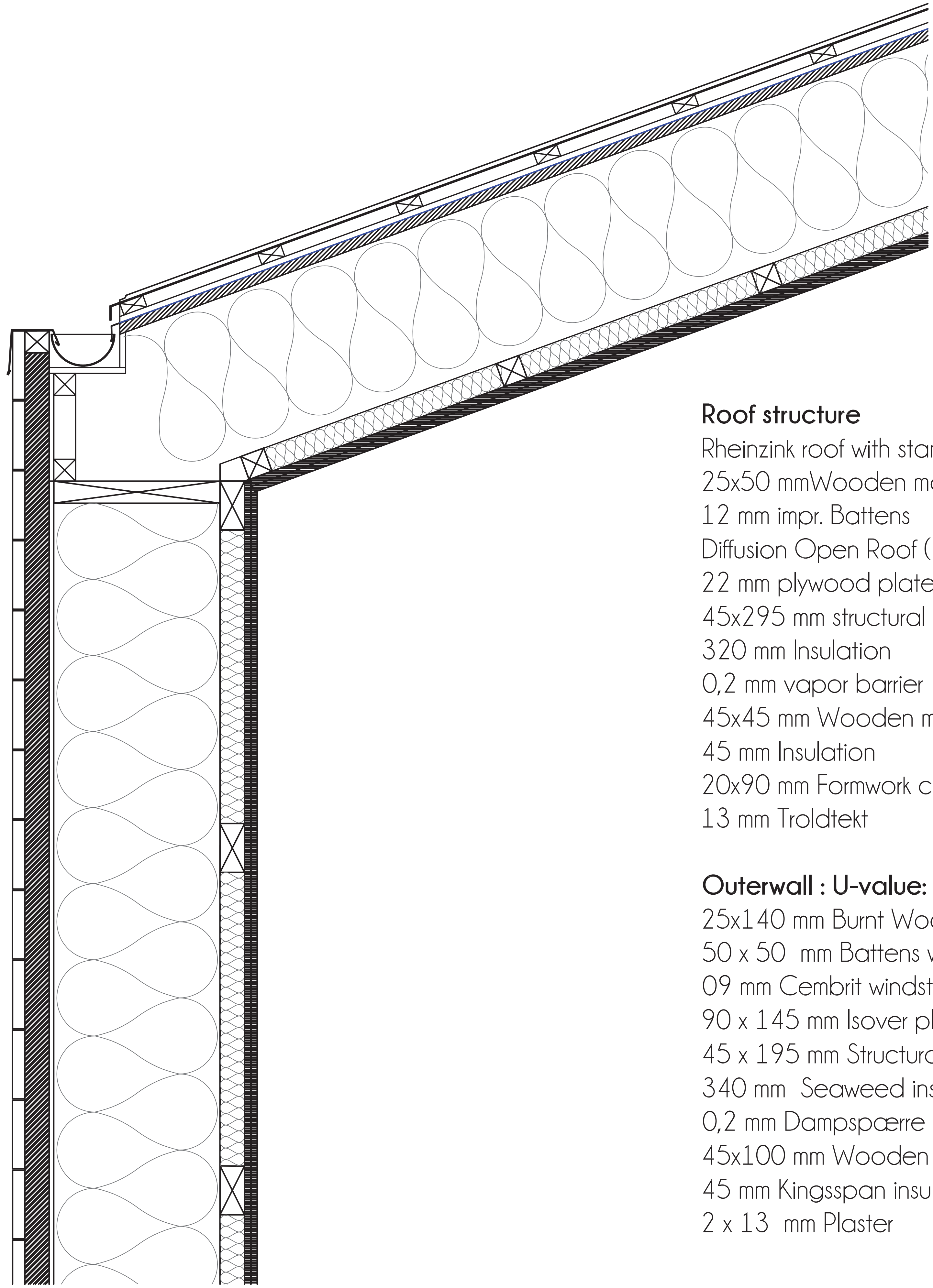


| | | |
|---|---|---|
| Number: 7 | Project: Forest House | |
| | Drawing: Section AA | |
| Date: 23/05-19 | Scale: 1:200 | Group: ma4-ark1 |



| Number: | Project: | |
|---|---|---|
| 8 | Forest House | |
| | Drawing: | |
| | Section BB | |
| Date: | Scale: | Group: |
| 23/05-19 | 1:200 | ma4-ark1 |

| Number: | Project: | |
|---|---|---|
| 9 | Forest House | |
| | Drawing: | |
| | Detail: Roof and outer wall | |
| Date: 23/05-19 | Scale: 1:10 | Group: ma4-ark1 |



**Roof structure**

Rheinzink roof with standing seam (solid color)
25x50 mmWooden moldings
12 mm impr. Battens
Diffusion Open Roof (blue line)
22 mm plywood plate
45x295 mm structural timber (T1) cc 600
320 mm Insulation
0,2 mm vapor barrier
45x45 mm Wooden moldings cc 600
45 mm Insulation
20x90 mm Formwork cc 300
13 mm Troldtekt

**Outerwall : U-value: 0,115**

25x140 mm Burnt Wood - Cladding
50 x 50 mm Battens with air gap
09 mm Cembrit windstopper extreeme
90 x 145 mm Isover plus stolper
45 x 195 mm Structural timber (T1)- cc 600
340 mm Seaweed insulation
0,2 mm Dampspærre
45x100 mm Wooden moldings
45 mm Kingsspan insulation
2 x 13 mm Plaster