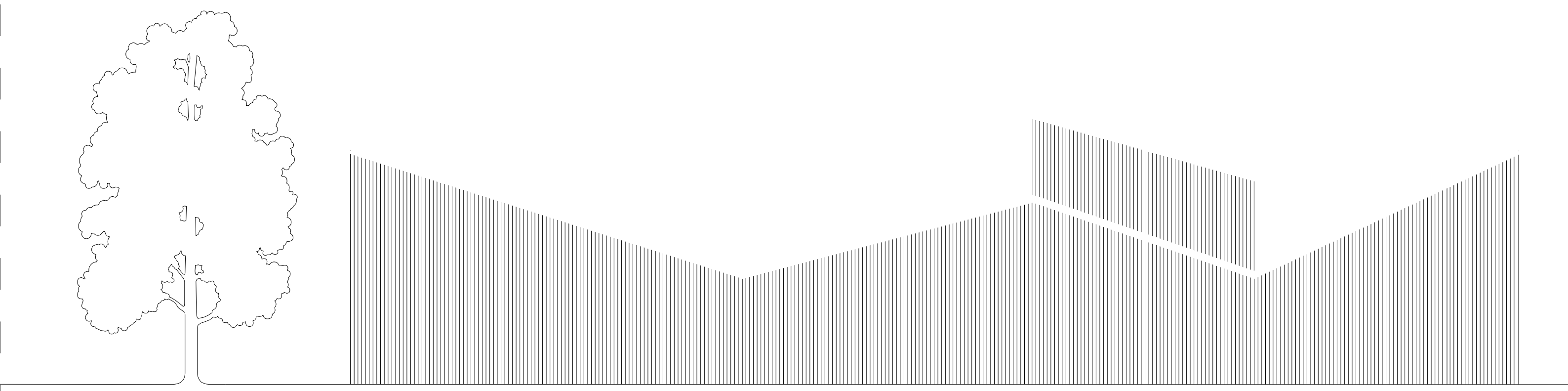
Kindergarten Karolinelunden

A Sustainable Kindergarten



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ABSTRACT

This thesis concerns the designing of a new sustainable kindergarten in relation to the renewal of Karolinelunden in Aalborg. The aims of the project are to design a kindergarten with focus on the children as well as the pedagogues of the kindergarten, while it also should leave a sustainable footprint in the green surroundings of Karolinelunden. The kindergarten is for 99 children with an area of 850 m^2 netto.
The kindergarten is designed with the italian pedagogical philosophy from Reggio Emilia in mind, making it a great playful and creative learning environment. In the meantime the kindergarten is well integrated in Karolinelunden with the green footprint and the playground mimicking its historic paths.
The kindergarten is designed as a sustainable building, reaching net zero energy condition with coverage of the energy requirements from the building regulation of 2020. However it is not only covering the energy requirements, and with DGNB as a guideline the building reaches for a sustainable solution in every aspect, especially in the topic of social sustainability and indoor climate. Not only do the indoor climate reach the requirements, but it is of such a level, that it will improve working and learning environment as well as wellbeing for the children and staff.

READERS GUIDE

This report shows the work with designing a new kindergarten in Karolinelunden from analysis to the final design.
The analysis is divided into four chapters; Research, Sustainability, Site analysis and Case studies. Each chapter ends with a sub-conclusion to give an overview of the most important parameters that will have an influence on the design of the kindergarten.
After the analysis the final design will be presented, followed by the design process that have led up to final design ending with a conclusion and a reflection on the project.
An appendix can be found on the last pages of the report is showing calculations, simulations and other aspects of the project not shown in the main report.
The literature used during the project will be referenced according to the Harvard reference method and will be found in an bibliography section.

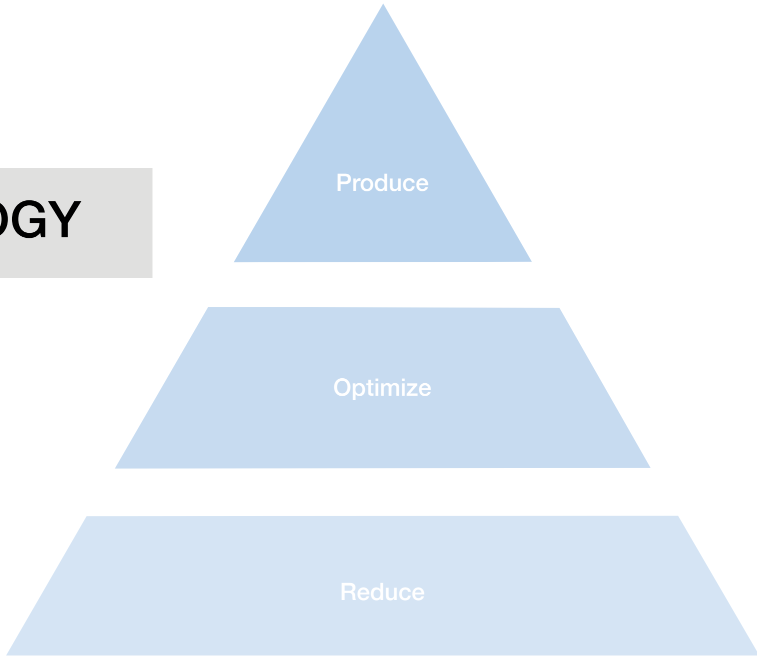
CONTENTS

INTRODUCTION

It is a well known fact that children have a steeper learning curve than adults, therefore it is also natural to have a focus in the building industry on educational architecture for kids. In the early years of education the pedagogical approach to architecture is the main factor. The idea is to make the kids ready and prepared for the following school years. It is a way to combine the learning environment with play, because kids learn best through play. In Denmark it is the educational sector that handles the kids for most of their growing years, starting from kindergarten all the way through public school and further education choices. Therefore the educational architecture have a huge impact on the kids, as it is providing the frames for their growth and their future.

Another well known fact is that the modern society are polluting the environment we are all sharing. In the fight of decreasing the pollution the building sector have for the last 10-20 years been working more and more in sustainable ways. The sustainable approach to architecture are not only securing the environment but is also improving the way of living for the people affected by it. The sustainable approach to architecture will keep growing and become the only common way to do it.

METHODOLOGY

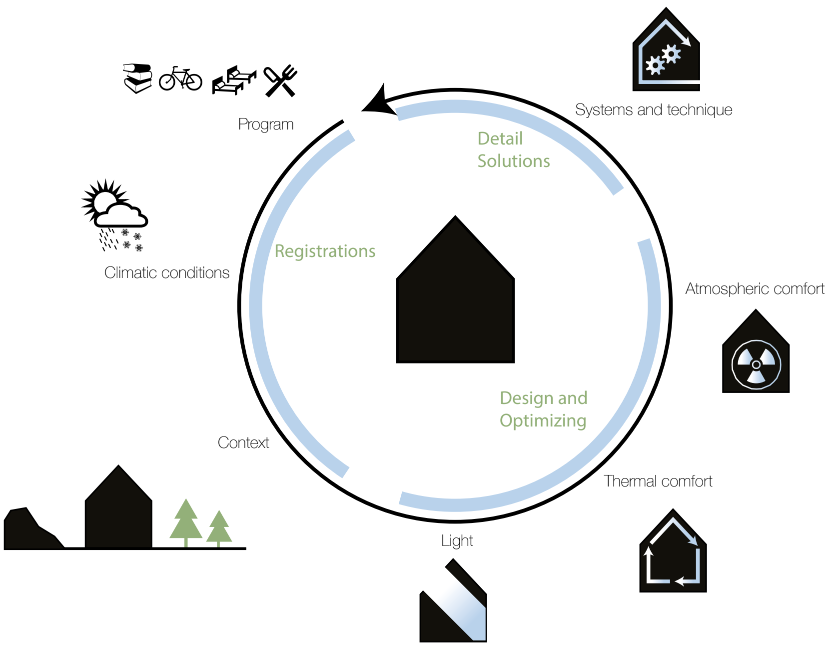


ill. 01: DWK

Design with knowledge

Design with knowledge (referred to as DWK) is the design approach used and developed through research projects and Ph.d. studies in the sustainable department of Henning Larsen Architects. DWK is focusing on energy in the building while also the human, environmental and economic aspects are considered. The research behind DWK showed that the design solutions used at the time was not approaching energy design correctly and in some cases 40-50% of the energy consumption was locked into the building design. The idea of DWK is to change the common way where low energy building is solved by adding expensive technologies, to a way where the solution is in the building design.
The way of designing with DWK is by reaching after certain goals in different ways, the goals is put up in a pyramid (ill. 01) showing the importance and impact of each stage. The first step is to reduce the energy use of the building through good design, second step is to optimize the building through technical solutions and if necessary the last step is to produce energy via renewable energy sources.
The first step is incorporated already from the first sketch in the project, as the energy reduction already starts with the simple things as among other, height, width and orientation of the building. If the ideas and sketches behind the building are thought through there is optimal conditions for implementing passive strategies to the indoor climate, heating, cooling, ventilation, daylight etc. and thereby reduce the energy demands. The passive strategies are the most important way to reduce the energy consumption as it is a part of the building in its whole life time. The second step with optimizing through technical solutions comes with a higher cost, but the modern solutions are low on energy consumption, CO_2 emission and have a high performance. The last step with integrating renewable energy sources is where the solution is working positively on the energy balance, but are also the most costly and have a shorter life time.
To secure a satisfying result for the building it is an idea to set some sustainability goals to reach in the design process - goals that will be possible to measure. The measurable goals will be a guidance towards the final result and a tool to make corrections based on.
In DWK as mentioned above, the technical solutions have to be thought in from first sketch, but to reach the best result it is important to have the process work in the right order: Program, climatic conditions, context, light, thermal comfort, atmospheric comfort and systems and technique (ill. 02). As this process have to relate back all the time to make sure it fit the registrations, the process is not linear but more of an iterative process like the Integrated Design Process.

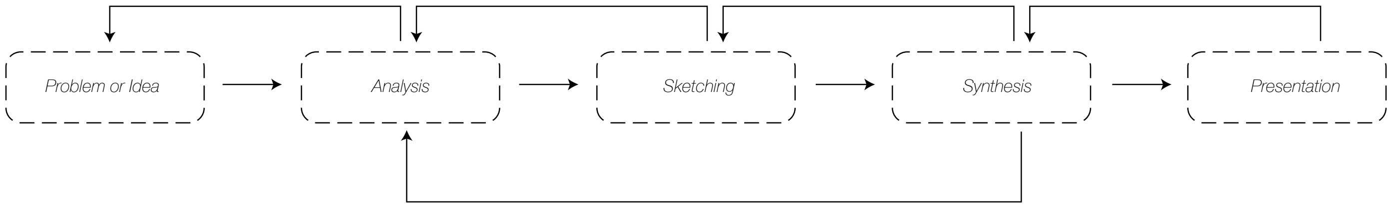
DWK also gives a view on five aspects with high importance of the design and sustainability; geometric, comfort, program distribution, daylight and materials.
The geometric is where the architectural and spatial qualities are formed and the buildings character is defined. It is also here the possibilities and qualities of passive strategies are defined and is therefore of high importance. The research behind DWK shows that one of the more common thoughts behind sustainable geometric with compact round buildings with a smaller envelope area is not as important as first thought. The research shows that with the level of insulation in new buildings other aspects are more important like the balance of openings in the facade, room heights and depths to spread the daylight, and it is also important in matter of social sus-



ill. 02: DWK

tainability as well.
People experience, reacts to and senses the comfort of a building. The comfort is often the key factor to how people organize their everyday life and uses the physical surroundings. The indoor climate is of outmost importance for the user experience but also for reducing the energy needs. To reach a high degree of satisfaction with the indoor climate, the users have to be involved instead of just looking at numbers. The possibility to open windows or control the sun shading will make the users more open to quality changes because they are in control and only have themselves to blame. By working in the design with three of the indoor climate factors as; thermal, atmospheric and visual comfort, it will be possible to find more ways to reduce the energy use.
Program distributions is the most important assignment for the architects. If the program is divided into some thought through units divided with the right functions combined it will secure the value of the building and can help in an energy efficient design. With a well defined distribution of the functions it gives an advantages in energy design. An efficient strategy is zoning where the units are organized with synergy in mind and make the building work both in zones and in a whole. By using these function units and distribute them correctly there will be a decrease in waste space as the units are more functionable and if there is aimed for a flexible unit as well it will expand the functionality and lifetime of the building.
Daylight is an everyday need for people and therefore very important for a building design. Daylight have a huge impact on people's health and wellbeing but also on the energy consumptions of a building. Sunlight and daylight are in an architectural context very different matters, where sunlight is the heating potential, the sun can also blind you and make a shadow play on the walls and the daylight is a measurable factor from an overcast sky. Daylight consists of three different factors: direct sun, sky illumination and reflected sun from surrounding surfaces and the ground. Daylight holds a great potential as it, as mentioned, provides to health and wellbeing, but a good daylight can also have an energy reduction effect as the daylight can fulfill the needs and reduce the use of artificial light and the energy for this. A good daylight can also extend the useable area of a building if it is distributed sufficient.
The choice of materials is a way of defining the indoor climate and comfort of the building. The materials will have an impact on social, economic and environmental considering the material lifetime. The material choice of a building sends a clear message from the building owner about his view on sustainability and the right materials will provide healthier buildings and healthier users. By choosing the right materials it can have an impact on every aspect of the indoor climate as it can affect air quality, acoustics and fire safety.

So when designing with DWK it is important to consider the process. Consider how to reduce the energy use from the first drawings and find simple ways to optimize the building and add both passive and active strategies. A way to approach DWK if there is a little hold up could be to consider the five important aspects: geometric, comfort, program distribution, daylight and materials. These five inputs could always be a focus to make a project focus upon (Kongebro, S. 2012).



ill. 03: IDP

The integrated design process

Throughout this project the approach followed is the integrated design process (IDP) by Mary-Ann Knudstrup. This is an analytical approach of design where every aspect is evaluated and redone if the outcome is not sufficient. This process is designed to combine architectural and engineering qualities and by that get the best result in both design and technical solutions.
IDP goes through five phases (ill. 03) which are all connected in some way to secure the most optimal outcome and show that design is not a linear process but more an iterative process. The first phase of IDP is the problem or idea definition, where the base and the goal of the given project is defined.
When the problem or idea is defined the next phase is the analysis. In the analysis phase every given knowledge and information relevant for the project is collected and analysed to give a program where both architectural and engineering aspects are covered.
There are several ways to make these analysis whether it is to analyse literature, videos, etc., to gather new information and knowledge or it is to do site analyses to get a better understanding of the site and the following context through different mappings and other visual analyses. Other analyses may just be simple diagrams showing some data or other easy communicated information in a graphical way.
All information from the analyses gathered in the program together with demands, vision and design parameters leads the design into its next phase; sketching.
Sketching is where all the knowledge from the program is incorporated into designs and whenever new knowledge is obtained the design is adjusted.
The sketching is done in various ways with different qualities to investigate as much as possible. Sketching is done as hand sketches, but also as 3D sketches or physical models. Alongside the producing of different designs some of them is tested in different softwares to test energy use, daylight qualities or other technical aspects.
After sketching the next phase is the synthesis phase. The synthesis phase is where all goals, aims and requirements from both the architectural and the engineering aspects should meet in a final product.
When the final design is done the last phase is the presentation where the final presentation material is produced and made ready for presentation. This includes everything from finishing the report to doing the last visualizations and the physical model (Knudstrup & Hansen 2005). Therefore the IDP is followed all the way to the very end and culminating at the end to the examination.

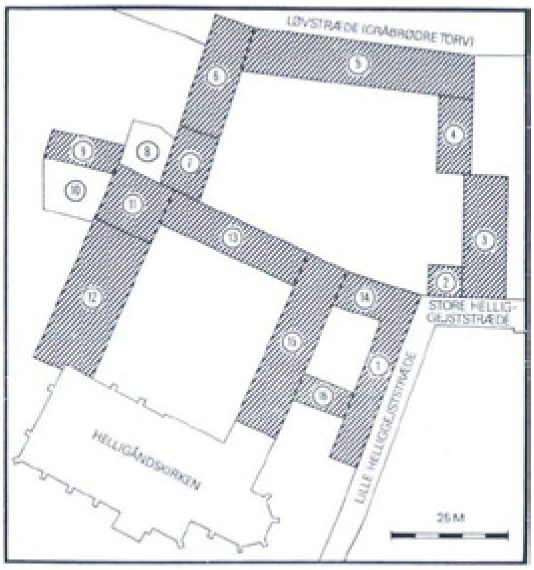
RESEARCH

Danish kindergarten timeline

1605

Christian IV's child house:
- Beggars and their kids
- Forced to work for the king
- First public child house

Christian IV's child house 1605



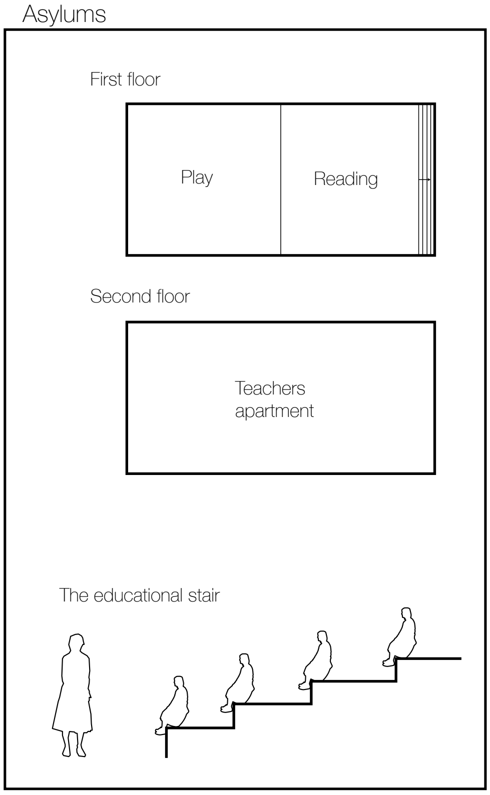
1700

1800

1828

First asylum:
- Public care and upbringing
- Strict pedagogy
- Education - mostly biblical

Asylums



1871

Fröbel kindergarten:
- Based on a educational theory
- Upbringing through play
- "Preschool for life"

1885

First education:
- Based on Fröbel's ideas
- Education for kindergarten teachers

1900

1901

School kids asylum:
- School kids
- Homework
- Predecessor for SFO

1919

Finance law:
- Day care institution becomes a part of the finance law
- 250.000 DKK a year

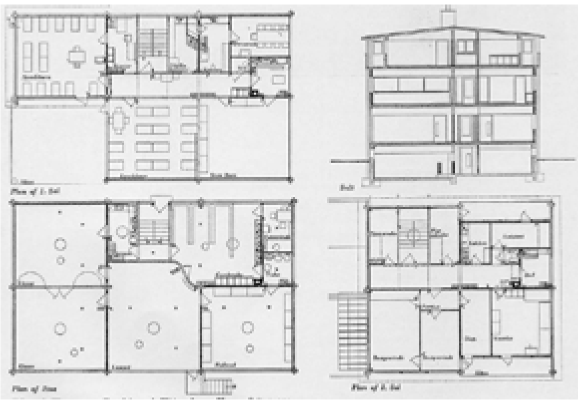
1920

1928

Montessori education:
- Altenative to the existing Fröbel's education
- Anti-authoritarian basic beliefs

1930

Utterslev daghjem 1936



1933

Social reform

1936

Daycare in new residential areas 20's-30's
Utterslev daghjem in 1936

1940

The fourties:
- Workshop activities
- Staffing standards
- Freedom of expression and children's creative work

1944

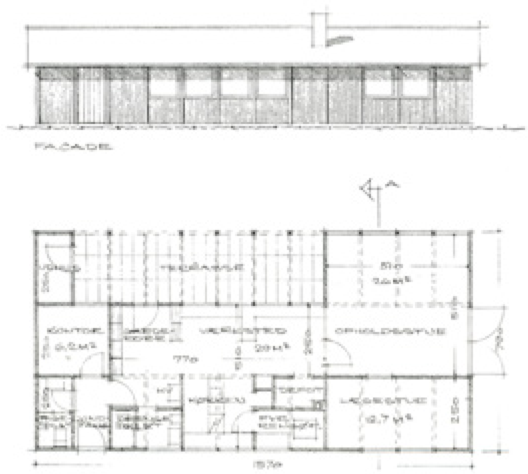
Ungdomsgården Husum:
- The first integrated institution
- nursery, kindergarten, SFO, and youth club

1950

1951

Financing of the kindergarten:
- The Municipality gets duty to be involved
- State-approved institutions

Kindergarten template from 1962



1960

The sixties:
- Anti-authoritarian pedagogy
- Kids could play and speak their oppinon - to some extent
- Piagets cognitive development theory

1970

The seventies:
- "Laissez-faire" wave in pedagogy
- Parents influence in the day care institutions

1976

Assistance act:
- Municipality gets the full responsibility
- Municipal or private institution

1980

The eighties:
- Common that very young kids gets in day care

YourHouse kindergarten concept BR10

1990

The nineties:
- Concepts: "Kids are competent" and "A whole in kids life"
- The transistion between kindergarten and school
- Reggio Emilia philosophy arrives in Denmark

2000

The millennium:
- Pedagogues ability to be present
- Curriculums is introduced in the kindergarten

ill. 04: Kindergarten timeline

Kindergarten of the future

In a collaboration between assistant professor Marie Martinussen, Rebild municipality and Arkitektfirmaet Hovaldt the report "Fremtidens børnehave - bæredygtighed i børnehøjde" was produced and published by Arkitektfirmaet Hovaldt. This report is meant to be a guide of how to design a sustainable kindergarten and gives some thoughts on how to combine the pedagogical approach, architecture and DGNB (see page 25).

Analysis by Marie Martinussen from "Bondegårdsbørnehaven" (refered to as BBH) shows that one of the most important aspects for the kids is the outdoor areas. These areas invite the kids to physical activities and provides fresh air and are often included in the children's favorite places to be. To ease this for the pedagogues, BBH uses transparent facades which, together with open doors, also gives a more free flow between the inside and the outside of the kindergarten and gives more freedom to the children. The glass in the facade often reflects sun on the outside and this makes the children feel more sheltered from the pedagogues and they will be more themselves.

At BBH the inside rooms also provides multiple opportunities as rooms meeting each other can often flow together and give flexibility to the rooms and the functions of the rooms. This flexibility is also a focus point from Marie Martinussen as the children enjoy the possibility to make changes to rooms and functions themselves. Some children enjoy closed rooms and to be themselves, other enjoy room-in-room where they can be a little sheltered but still enjoy the safety of the pedagogues and the other children. The main common room is still the most social room where the pedagogues are based and where most children are active simultaneously.

The approach to DGNB in the report is more of a new thinking as the DGNB is designed for offices and not for kindergartens or other institution (but under construction). DGNB for kindergartens should include an additional focus point named "physical framework" which should take the conditions of both children and pedagogues into consideration (Arkitektfirmaet Hovaldt 2014).

The conclusion of the work is the seventh focus of the DGNB: "Physical framework" which is shown on ill. 05.

PHYSICAL FRAMEWORK

TRANSPARENCY	View across the rooms Physical and visual contact between inside and outside Windows in child height
LEARNING ENVIRONMENT	Varity of room and spatiality Corners and niches for contemplation and silence Visibility of the building's ecosystem and energy consumption Possibility to change the arrangement of the rooms Undefined space that can be consumed, interpreted and arranged by the children
HEALTH	Healthy, sustainable of organic materials Materials that provide sensory experiences Spaces that encourage activity and movement Challenging and educational environments that inspire the development and innovation
AESTHETICS	Materials and decor to speak to all the senses: Sight, smell, touch, hearing and taste Focus on different moods, colors, light source and compartment composition Varying ceiling height Clarity of what the various rooms is used for Easy cleanup options
COMMUNICATION	The framework must be supported and enhance pedagogy and the pedagogical work Possibility of documentation and exhibition of children's work The acoustics must support a good dialogue Access to both traditional and digital media (books, games, education, etc.)
SOCIALLY	Gatherings in large and small groups Socializing with and without adults The opportunity to be alone
LOGISTICS	Reasonable location of spaces and functions in relation to: Noise/silence, stocking feet/wet shoes etc. Reasonable placement of staff facilities
CLOSE OUTDOOR AREAS	Varying areas with different activities and qualities Green areas and sunny places of residence Use of roof and wall surfaces Focus on planting and materials Integration of technical installations, so they do not maculate the area

ill. 05: Physical framework

Kids and space

The Danish Building Regulation sets some demands on how much free floor space there is the minimum for institutions, such as kindergartens. The minimum is 2 m^2 pr. child in kindergartens (Bygningsreglementet 2016). This demand has been the same since the 1920's which also have been to debate about if it should be raised (Kirkeby, Gammelby & Elle 2013). Even though the demand is the same there have been a change in the building regulation in 2008 where three quality levels were introduced: A, B and C

- C: The demand from the building regulation - 2 m^2 pr. child
- B: Free floor space of minimum 3.5 m^2
- A: Free floor space of minimum 3.5 m^2 + activity rooms

The minimum demand reflects a time where the educational vision was different than today. The educational vision from the 20's kindergarten was more similar to a school where almost every kid was occupied with the same activity at the same time (Kirkeby, Gammelby & Elle 2013). This of course means that the amount of square meters that was necessary was different than today.

Throughout the years there have been different research in the field of how much space there should be for the kids in kindergartens and what it does for the kids if the space is large or small. The research done in the field is typically about illness or behavior in the kindergarten and typically ends out in some kind of recommendation about how much space there should be for the kids. One study shows that for each square meter pr. child the sick days would fall with 10%, whereas other studies shows that more space and more resources gives a more constructive behavior and that more well defined spaces gives more social interaction and more explorative behavior (Kirkeby, Gammelby & Elle 2013).
A lot of these studies shows that more space for the kids gives less conflicts, less noise and easier planning of the day (Kirkeby, Gammelby & Elle 2013). This result is substantiated by interviews with 12 danish pedagogues done by Inge Mette Kirkeby in the SBi "Plads til trivsel og udvikling". Even though the 12 pedagogues don't know each other they have more or less the same observations from practical experience. They especially talks about how to plan the day so the kids gets more space in the kindergarten, an example could be to take half the kids on a trip or to the playground while the other half is in the kindergarten. But that might also be a problem due to lack of staff (Kirkeby, Gammelby & Elle 2013).
A small amount of square meters pr. child usually also means that some activities is either not possible to do or are being left out. It is usually bigger activities that takes up the space such as dance or other physical activity, but it could also be some kind of project that takes time and therefore needs the space to work on it and to store it (Kirkeby, Gammelby & Elle 2013).
The interviews also give an insight in the architectural according to rooms and interior design. In this matter the pedagogues mentions that in their opinion it is better with multiple small rooms and rooms in rooms, but it should also be possible to gather the kids in a bigger room to common activities. A small room could just be small confined places in a bigger room (Kirkeby, Gammelby & Elle 2013).

The research and interviews presented in "Plads til trivsel og udvikling" both raises some questions and gives some answers about building a kindergarten. One question is of course why the minimum demand still is only 2 m^2 pr. child when it repeatedly is shown that bigger space gives better environment. Of course the interior design can make the room feel bigger than it really is, and you can make a small space really effective if just the interior is done properly. But in a small space there will always be some limit to what is possible to make of activities. At the same time a bigger space is easier to reorganise and to make small confined spaces in which gives less conflicts between the kids.

Reggio Emilia

The kindergarten architecture is often driven by rules and regulations, which usually divides the kindergarten into different zones. This strategy is also often because of the way the children is divided in groups according to their age. The groups then have their own zone in the kindergarten, which is also divided into smaller zones, such as quietzone, wardrobe and wet zone (painting and stuff). This can sometimes have the effect that the architecture decides what is possible and what is not, and therefore reduce the possibilities for learning and curiosity instead of invite for learning. The reason for this is the parents and pedagogues needs for safety and security (Dudek 2008).

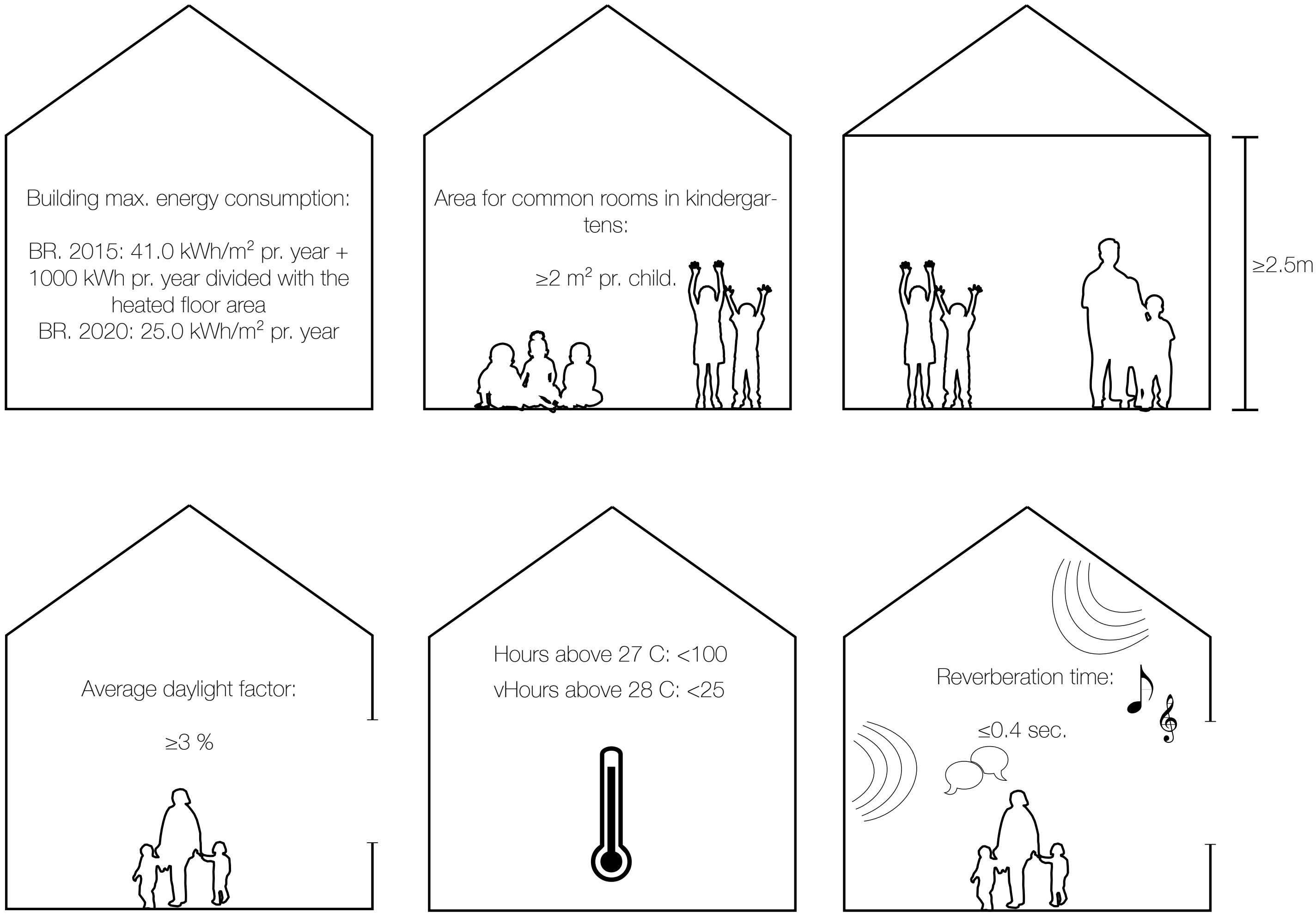
In the later years there have been a focus on learning environments for children, which also have resulted in different approaches to work and organize a kindergarten, one of them is the Reggio Emilia approach.

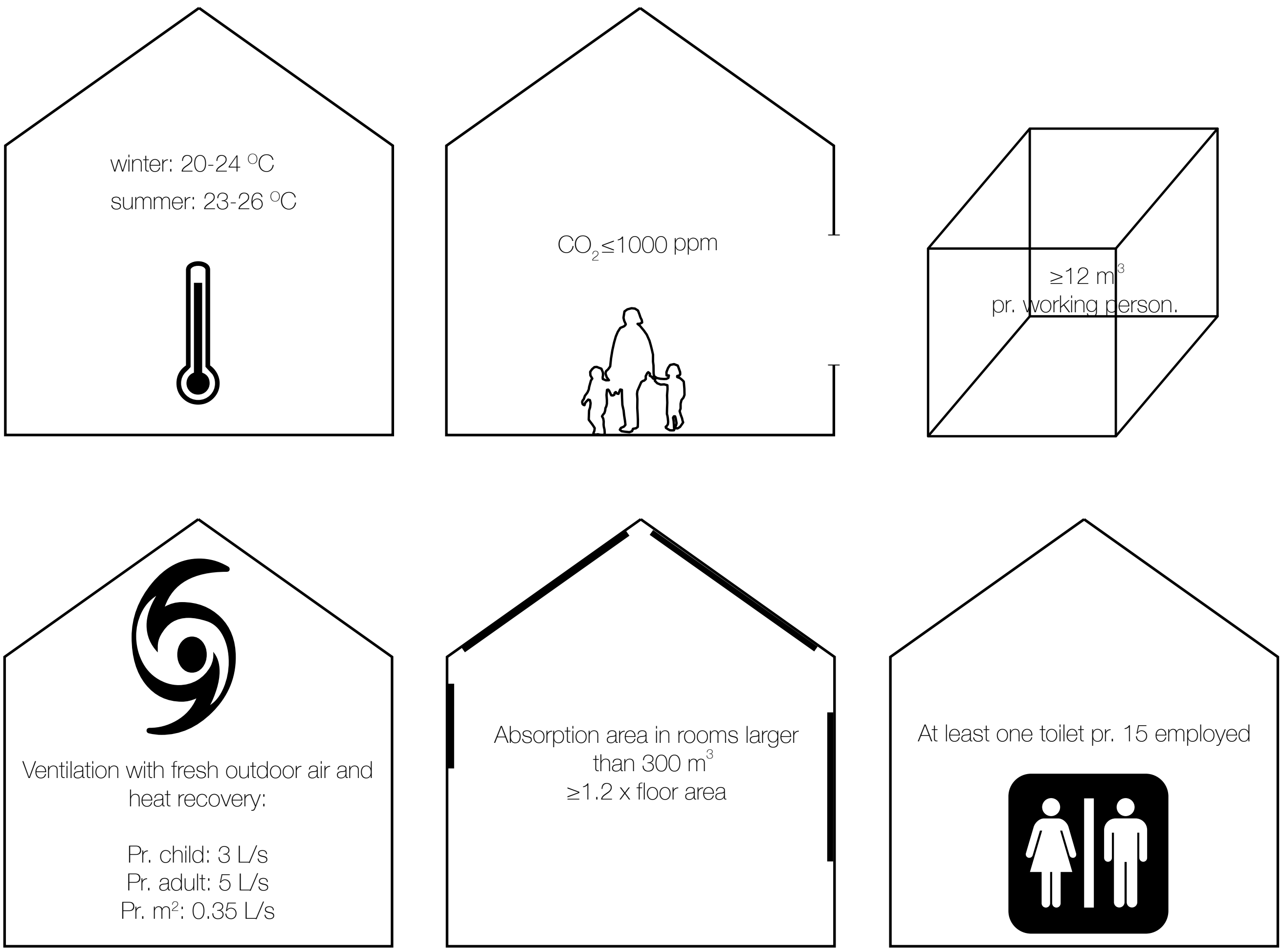
The Reggio Emilia approach originates from the northern Italian municipality Reggio Emilia, which are famous for their public kindergartens. It is the Italian philosopher Loris Malaguzzi that has described the approach, and he uses three main concepts to describe the approach: The competent child, the hundred languages and the environment as the extra pedagogue. It is with these three concepts that the pedagogues has to do their job and help the kids understand the world (Mehlsen 2010). These concepts is based on that there in the children's nature is a natural curiosity to learn and that it is important to support this curiosity. That is why the environment should invite the children to contemplation alone and together. The pedagogues is not the one to provide the answers but to encourage the child to find the answer and to listen and discuss it with the children (Lange 2014). That is why the spaces play a fundamental part in the Reggio Emilia philosophy (Dudek 2008).

The environment in the kindergarten is build up around creative expression, because of the big influence the art and pictures has in the daily life through newspapers and television. That is also why usually the kindergarten has an atelier (Mehlsen 2010) of some kind where the kids can use their creative senses. Another aspect they use in the kindergarten is small "corners" or niches for specific activities. Besides that the materials, such as color pencils and games are not placed higher than the kids can reach it themselves (Børnehuset Skovshoved n.d). The philosophy also tries to make every area of the kindergarten open to the children, a non-hierarchical space, because every corner and room could be a potential space for learning (Dudek 2008). Even though small spaces is important for the children to delve, there should also be the room for a bigger space - a piazza - where everybody can meet in social interaction and give the children an assumption of a public identity (Dudek 2008).

It is of course important to remember that it is an italian approach and that it is not possible to transfer the method directly from one culture to another. You can find inspiration but you can not copy (Børnehuset Skovshoved n.d).

Laws and regulations





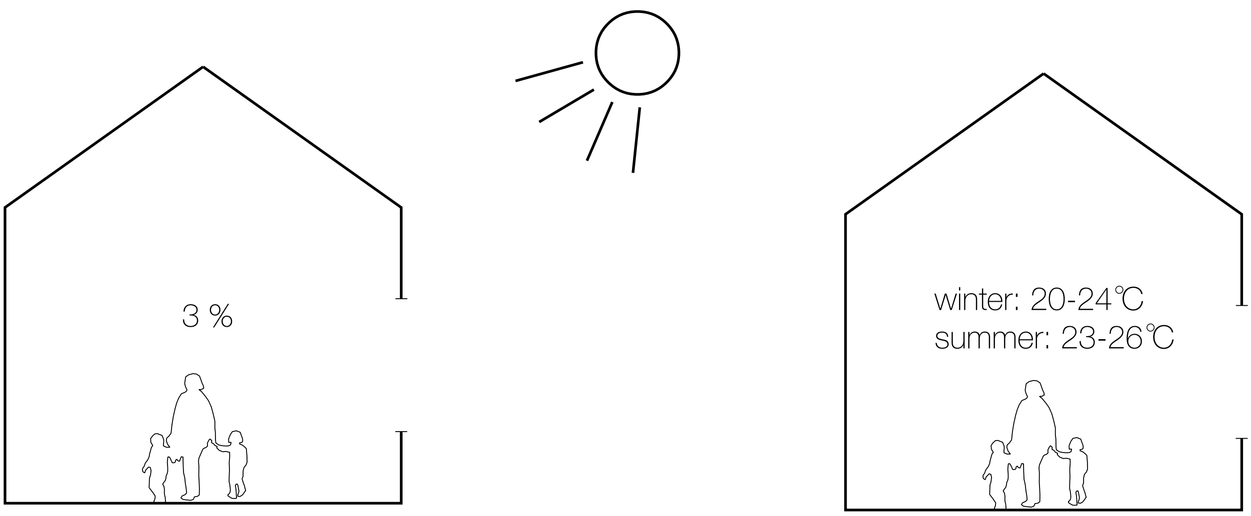
ill. 06: Laws and regulations,
bygningsreglementet

Subconclusion

The research done shows very well that some children will search for places to be alone and private and that these places very well could be outside. An open and transparent facade can help with a close connection to the outside and encourage the children to more outdoor activities. The research also shows that an open and flexible plan solution can encourage the children to play and design the interior themselves. This will also have a positive effect on the children's curiosity and invite them to learn through play. This plan solution should consist of small rooms with specific activity in mind but also undefined rooms where the children can define the activity themselves, these small undefined rooms can be a simple room-in-room designed by the children themselves in a larger common room which have the possibility to gather all children at once. The rooms with specified activities could for example be an atelier where the children's creativity could be grown. To improve the conditions for creativity and to work with the children as individuals it is also important to have furniture that match their size and always give them the possibility to express themselves through play, art, etc. To increase the wellbeing of both children and pedagogues a larger floor area pr. child will be preferable as it will help decreasing the amount of sicks days, the noise and the conflicts between the children. A floor area of 2 m^2 is what The Danish Building Regulation demands but an even larger area will be preferable, to reach category B or A it should be 3.5 m^2 pr. child and in category A it should be with activity rooms as well. The more room is also an important part of the Reggio Emillia where the extra space will help improve and develop the little individuals that are the children.

Design parameters:
- The kindergarten should have an open and transparent facade to make the plan solution and the outdoor flow together.
- It should have a flexible floor plan with possibilities to change rooms for certain activities and the possibility to make room-in-room solutions in the large common room.
- As much floor are pr. child as possible to improve the development of the children and improve the environment of the kindergarten.

SUSTAINABILITY

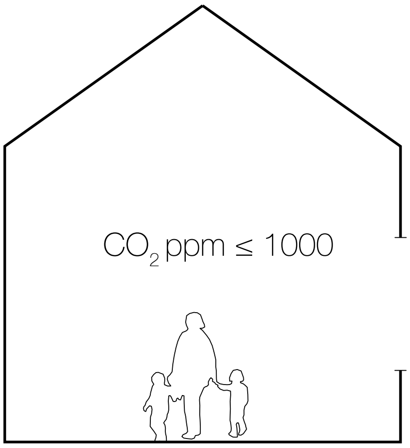


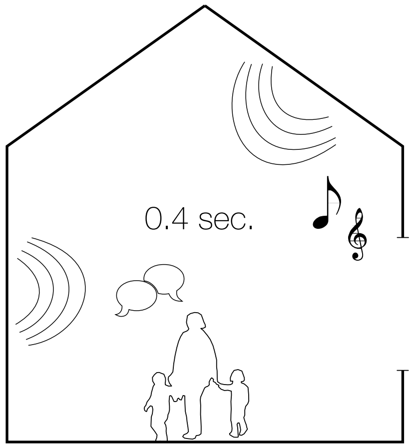
Indoor climate

A good indoor climate is very important to a kindergarten as it have a huge impact on both users and the environment. A good indoor climate can for the users give a more calm environment and bring down the days of sickness for both children and pedagogues (Indeklimaportalen 2 2015). For the environment a good indoor climate with the help of passive strategies will result in less use of energy and therefore also less CO_2 emission. The indoor climate consists of: Daylight, temperature, air quality and acoustics.

Daylight have huge importance in the indoor climate. In the Danish Building Regulation it is said that with a window ratio of 10% compared to floor area you should be able to reach the demands, which is a daylight factor of 2% in half the room or on the working surface (Bygningsreglementet 1 2015). In the future building regulation BR20 it is expected that the window to floor area ratio will increase to at least 15% and the daylight factor to 3% (Bygningsreglementet 2 2015). In schools and daycares the daylight factor calculations are done for representative rooms which is one of the main rooms in the building (Dansk standard 2011). The criteria from the Danish building regulation are minimums and are not warrenties for good quality. In the Danish Standard, DS 3033, there is made some different categories from C to A++ and by following them you can achieve the desired indoor climate. On the daylight matter the A++ category needs a daylight factor in the representative rooms of at least 5%. It is not only the daylight factor DS 3033 needs answers on, to reach A++ it also have to be guaranteed that there is an adjustable shading which can block for direct sun with both automatic and manual control and can be moved completely from the glass area. In the matter of artificial lightning the A++ category have to guarantee no flickering lights and individual control of adjustments (Dansk Standard 2011).
Other than the technical specifications for a good daylight, daylight have a great importance for the development of children. 70-80% of all senses are influenced by sight where light plays a huge role. It have a lot to do with the learning about wellbeing, focus, concentration and perception. The quality of light is not only about how it is in a moment, but more about the possibility of variation of light compared to the activities and how the light can support it. As the most important area for children's play is the floor, it is very important to light this the right way both considering daylight and artificial light. Small windows and windows in children heights could be a way of doing this, it could also be to install artificial light suitable for the zone and type of activity it upholds, some activities might also need the light dimmed it is therefore important that every light can be controlled individually. The individual controls will also bring more flexibility in use (Kirkeby 2011).

Temperature are in architecture measured by reaching for thermal comfort. The conditions for thermal comfort are very individual as it is affected by clothing (measured in clo) and the degree of activity (measured in met) of every individual. The temperature influences comes from three different factors; the temperature of the surrounding air, the radiation from surface temperatures and air movement. As thermal comfort is an individual state of mind it can not as such be measured, but are calculated by doing a PMV (Predicted Mean Vote) which goes from -3 cold to +3 hot, and by PPD which calculates the Predicted Percent of Dissatisfied in the PMV. In the Danish Standards to reach a PPD below 10% the temperatures in the occupied zone during winter should be 20-24 °C with a clo of 1 and a met of 1.2. In the summer the temperature should be 23-26 °C with a clo of 0.5 and a met of 1.2 (Jensen 2014). According to the Danish Working Environment Authority the temperature limits for light work in a daycare, schools or offices should be good about 20-22 °C, if the temperature goes above 23 °C the amount of complaints will raise. The temperature at seated work may not exceed 25 °C and during a day



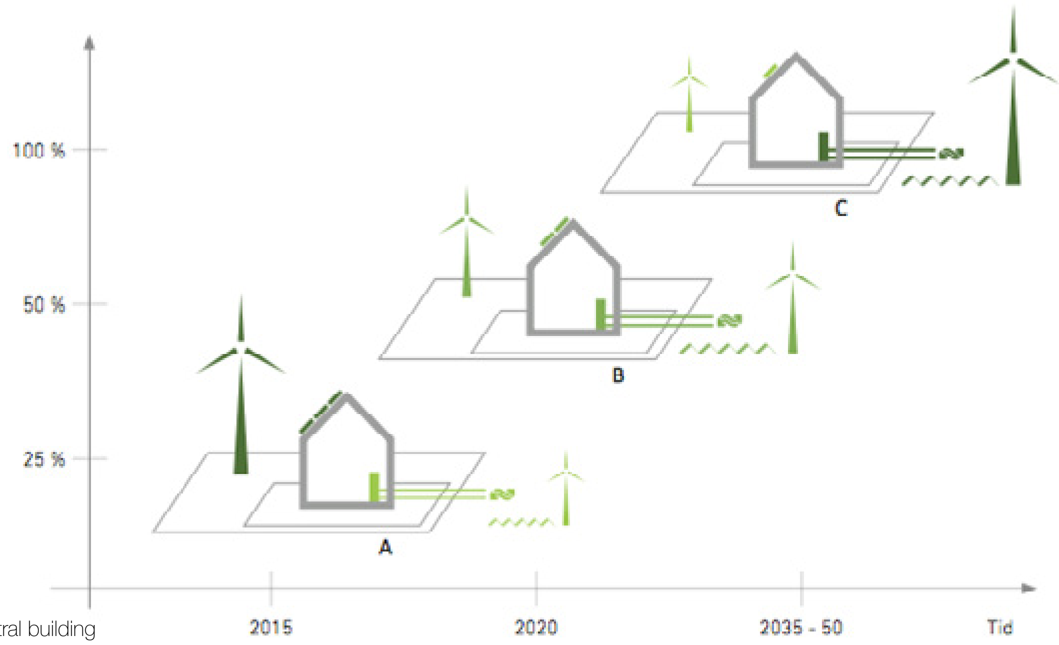


ill. 07: Indoor climate

the temperature change should not vary more than 4 °C, unless there are extreme weather conditions such as a heat wave (Arbejdstilsynet 2008).
Temperature have a huge impact on learning for children. The optimal temperature for a classroom or other learning rooms is between 21-22 °C, here the children will feel most comfortable in wellbeing and learning. If the temperature is too high the children will feel tired, headache, uncomfortable and fail in concentration. If the temperature is too low it will make the children feel tense and stiff (EMU n.d.).

Working with air quality can be done with both CO_2 and Olf. CO_2 is the most simple way to work with air quality as it is possible to do measurements on the amount of CO_2 in the air and it is also possible to do simulations of it. Met is a censored and experienced air quality that can only be detected by people and not measured or simulated, but it is possible to make some calculations on the estimated amount of clothing and activity of every individual. As Olf cannot be measure there are no restrictions regarding this, but there is for CO_2. CO_2 is measured in ppm (parts per million), in outdoor air the typical concentration is about 380 ppm (Indeklimaportalen 3 2015). In the Danish building regulation it is said that in kindergartens it is required to ventilate with heat recovery and at least 3 L/s pr. child and 5 L/s pr. adult and 0.35 L/s pr. m^2. While these requirements shall be met it is also required to keep the air CO_2 pollution under 0.1% or 1000 ppm for the most of the day (Bygningsreglementet 3 2015), but these are just the minimum requirements and the DS 3033 category A++ requires 2 L/s m^2 and demand control. In the matter of CO_2 concentration the DS 3033 A++ category requires an indoor concentration with a maximum of 800 ppm (Dansk standard 2011).
The indoor air quality have a huge impact on children's learning and health. A study made at DTU about indoor climate and learning for young school children (10-12 years old) shows the massive impact an improved indoor climate have. The study shows that when the ventilation is doubled the children improve their test results with more than a 10% average. The study suggests that schools should have at least the same requirements for indoor climate as there is in offices (Indeklimaportalen 1 2016).

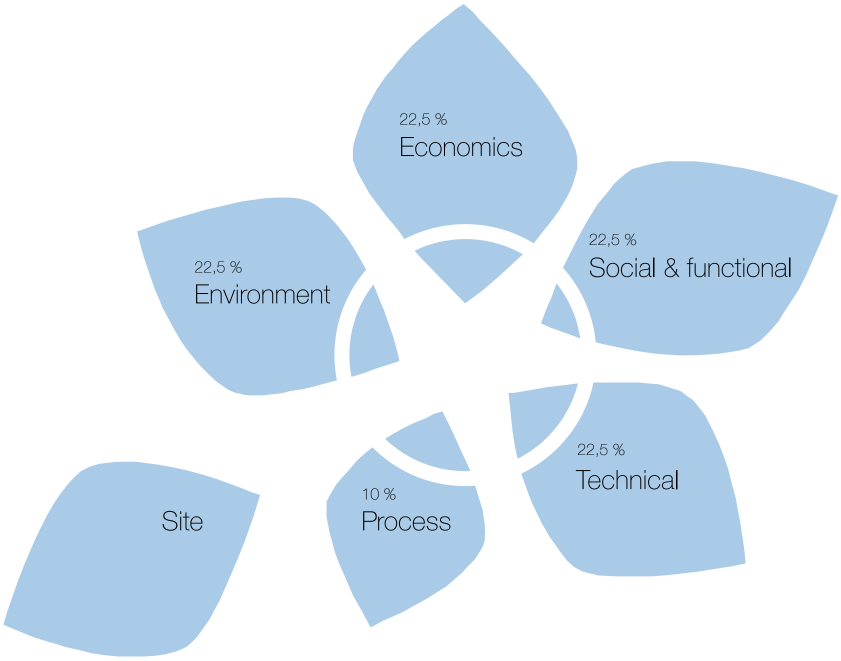
Acoustics is the last focus in the indoor climate concerns. Acoustics can be considered and measured in two ways: In decibel (dB) and reverberation time. In the Danish Building Regulation the demands for kindergartens changes according to rooms and what they are used to but it is suggested that if the reverberation time and the sound absorbing area are sufficient the requirements should be covered. The reverberation time are the same for all everyday room and should be below 0.4 s and the sound absorbing area should in rooms with more than 4 meters to the ceiling and a room volume larger than 300 m^3 be below or equal to 1.2 times the floor area (Bygningsreglementet 4 2015). Since sound is a special character, special rules applies to it, it is therefore possible to have up to 20 % higher reverberation time in the 125 Hz octave band as it is also possible to have less absorption area if the problem is only with that octave band (Hoffmeyer 2008).
A bad acoustic indoor climate will like the other parameters mentioned above have a negative influence of the children affected. The effect of the low reverberation time requirements comes from earlier experiences and shows that children understand speech better. It also have an effect on pedagogues as the lower reverberation time makes every individual talk in a lower voice and the headaches and concentration issues are lowered. A lower reverberation time also have the effect on children that they can concentrate more on what they are learning instead of the many sounds around them and they will therefore also remember better (Indeklimaportalen 2 2016).



ill. 08: Energy neutral building

Zero energy building

The Danish government stated in the 2013 climate plan that Denmark should be free of energy coming from fossil fuels after 2050. As the building sector is the highest consumer of energy in Denmark with 40% it has been the place to begin with. To complete these goals set by the government a concept of zero energy building have been developed. A zero energy building (ZEB) is a building designed with a low energy use and with the energy use covered by non fossil renewable energy sources from either a renewable energy utility grid or by a local renewable energy system on site. In modern ZEB building the solution is often to make the case where the energy is produced on site because the energy system grid is not ready for ZEB yet. This also means that the needs of on-site energy sources will decrease over time which of course will influence the building design (ill. 08). The ZEB is, besides being energy neutral, often characterized by a good indoor climate, a thoughtful and high quality architecture with the users and the user behavior in mind (Bejder et al. 2014). In Denmark the most common energy neutral building types are the net zero energy building (NZEB). The NZEB are very much like the ZEB, but is connected to the utility grid. In this connection to the grid the NZEB is provided with energy doing the time of the year where for example the solar panels can not provide the building with a sufficient amount of energy, the energy provided from the utility grid may not be from a renewable energy source even though that would be prefered. If the energy source is not renewable the energy balance will be in negative and the building will not be a ZEB, but when the building is on the utility grid it have an opportunity to "pay back" energy. So when a NZEB is in a period of time where it overproduces energy, this energy will be send back to the utility grid and the energy balance will be back to zero and make the building a NZEB. The changing weather in Denmark is what makes the NZEB the most common and preferred building (Statens forskningscenter for energineutralt byggeri 2014).



ill. 09: DGNB

DGNB

DGNB is the sustainability certification for buildings used in Denmark. It was first in 2012 the Danish DGNB certification was introduced by the Danish Green Building Council. Because it was a german certification it had to be adjusted to the Danish Building Regulation and Standards before it could be used. Since 2012 the certification has been developed so different types of buildings has its own DGNB manual (dk-gbc 1 n.d.). DGNB is based on the Brundtland report from 1987, where three words was used to describe how to reach sustainability. These three words was in the Rio Declaration elaborated (DGNB manual 2015).
Basicly the DGNB manual consists of six categories, where each category have some criteria's (Indeklimaportalen 3 2016):

- Environment
  consist of parameters concerning the environment, such as materials influence on the environment, energy consumption and lifecycle of the building.
- Economics
  consist of parameters concerning the economics, such as maintenance and operation of the building
- Social
  consist of parameters concerning the social environment, such as indoor climate, accessibility and user involvement
- Process
  consist of parameters about the development process
- Technic
  consist of parameters concerning the technical aspects about the physical frames of the building
- Site (side category)
  consist of parameters concerning the site environment, such as public transportation and climate conditions on site

Each category have a weighting, where the three categories stated in the Rio Declaration have the same weighting. The way DGNB is structured it is not only about a high score in each category, but also about creating a balance between the categories. Social sustainability might not be the sustainable solution according to economics or environment, and therefore it is about making a balance to secure the most sustainable way in every category (dk-gbc 2 n.d). The building can be certified with silver, gold or platinum. The site category is not a part of the calculation, when certifying a building, and therefore does not affect the result, but it is a separate calculation that has to be done to get the certification (DGNB manual 2015).

The focus of this project will be on the social category of the DGNB.
The social category consist of twelve criterias, where the indoor climate is a huge part. This is to make sure the building have a sufficient indoor climate for the users while giving the users the possibility to also manually control the climate themselves. Besides the indoor climate the social category also have criterias to cover safety, outdoor areas, bikes, architectonic quality and accessibility both in the building and for the public. In some of the criterias there is some minimum demands that has to be met, otherwise it will not be possible to get the building certified, even though it has a high enough score (DGNB manual 2015). Other aspects of the DGNB, such as the criteria under the technic category, will of course also be considered due to energy consumption calculations.

Subconclusion

One of the main impacts on the environment today is the CO_2 emission from houses. By having a focus on decreasing the energy consumption the CO_2 emission will also decrease, that is why the (Net) Zero Energy Building concept (NZEB) is smart. To help towards the NZEB an indoor climate helped by passive strategies is crucial as it will decrease the energy needs for cooling, heating, lights and ventilation massively. The indoor climate consists of temperature, light, air quality and acoustics. For the indoor climate the building regulations gives some minimum demands, these demands however are only minimums and the indoor climate should be improved even further. The sun plays a huge role in the indoor climate as it is the source of daylight which have to deliver a daylight factor of at least 3%, while it also is the source for passive heating. As this project ends out with a kindergarten the acoustics is of course very important, here the demands states a reverberation time of no more than 0.4 seconds. By doing a kindergarten and reaching for a good indoor climate it is also natural that the social sustainability is the main focus of the DGNB as the indoor climate is the main part of it. While the social sustainability is the main focus in this project, some aspects of the other DGNB categories will also be considered

Design parameters:

- Passive and active strategies should be considered to improve the indoor climate and reduce the energy consumption
- As a minimum make a building that meets the requirements from the BR20 and if possible make a ZEB building
- Consider the DGNB for social sustainability in both aesthetic and technical aspects of the design

SITE ANALYSIS

ill. 10: Location

Location

The site for the Kindergarten is located in the northern part of Denmark, more precisely in northern Jutland in the municipality of Aalborg.
Aalborg is the 4th biggest city in Denmark, and is a city with a lot of student activity because of Aalborg University. Aalborg is an old harbor city, located down to Limfjorden, where there earlier have been a lot of industry near the water to benefit of the use of water transportation. Today the harbor front is undergoing a change in function to a more recreational area.
The kindergarten is being placed in the center of Aalborg in an area called Karolinelunden, which is also under a change in function. The kindergarten is the first step in this change.

Municipality plan and future development

In a collaboration between the municipality of Aalborg and COBE there is developed an idea for the future of Karolinelunden. COBE have done a conceptual masterplan alongside a couple of ideas for designs, which the municipality of Aalborg have used to make a district plan concerning Karolinelunden and describing the future (Aalborg Kommune 2016).

Karolinelunden opened back in 1824 as a park for the officers of the Danish army, in 1847 it opened as a public park and in 1947 Tivoli Karolinelunden was opened. The tivoli had some bad years after the millennium, and in 2007 the tivoli was handed over to the municipality to take care of, but closed in 2010. When all of the rides were moved the park was again opened for the public in 2011 (COBE 2015). After the opening in 2011 the park have been a gathering place for lots of different uses, in various ages and with different interests in the park. This broad user group is important for the municipality to keep and therefore the district plan states that it is important to keep the park's character and the green profile as it is a part of "Østeråkilen". "Østeråkilen" is a green track through Aalborg going all the way to the surburb Svenstrup. To make it even more clear and keep the track, Karolinelunden will open the stream Østerå which is right now hidden under ground. Besides opening for the stream they also wants to keep as many of the old trees in Karolinelunden as possible.

To expand the broad user group even more one of the ideas in the future development of Karolinelunden is to make a kindergarten for approximately 100 children and with a size of 700-850 m^2. According to the district plan the kindergarten is planned to be placed in the south of Karolinelunden in a hilly landscape made as a sound barrier from Karolinelundsvej. The kindergarten will be able to benefit a lot on its placement in the park, but in the district plan it is suggested that the kindergarten gives back as well and maybe make some of the kindergarten's playground available for the park in the closing hours. The district plan states that the architectural quality is important for the park and that it have to be modern and experimental architecture and have to be integrated in the suggested hilly landscape. The kindergarten have an max height of 8.5 meters and two floors.

To keep the tempo and people in a mellow state of mind the paths in Karolinelunden are only for soft traffic as pedestrians and slow bikes. To keep the park nice there will be thought about lots of bike parkings and small pavilions for this.

To the east of Karolinelunden is the TULIP factory, and due to their ammonia storage they are categorized as a risk company and therefore in parts of Karolinelunden it will not be possible to build new accommodations, but the suggested site for the kindergarten is out of the risk zone.

The district plan seeks to open the park even more for the public and make even more accessible by making four new entrances and do some squares to make it even more welcoming. The district plan also seek to develop even more recreational activities in the park and try to make a synergy between the activities as children on playgrounds, sports, skating, parkour, dirt bikers, graffiti artists, etc (Aalborg Kommune 2016).

ill. 11: Plan for Karolinelunden

Karolinelunden


ill. 12: Mill in Karolinelunden


ill. 13: Petanque Karolinelunden


ill. 14: Beach volley


ill. 15: Garden plots


ill. 16: Pavilion


ill. 17: Parking


ill. 18: Walk path

ill. 19: Football

ill. 20: Old entrance

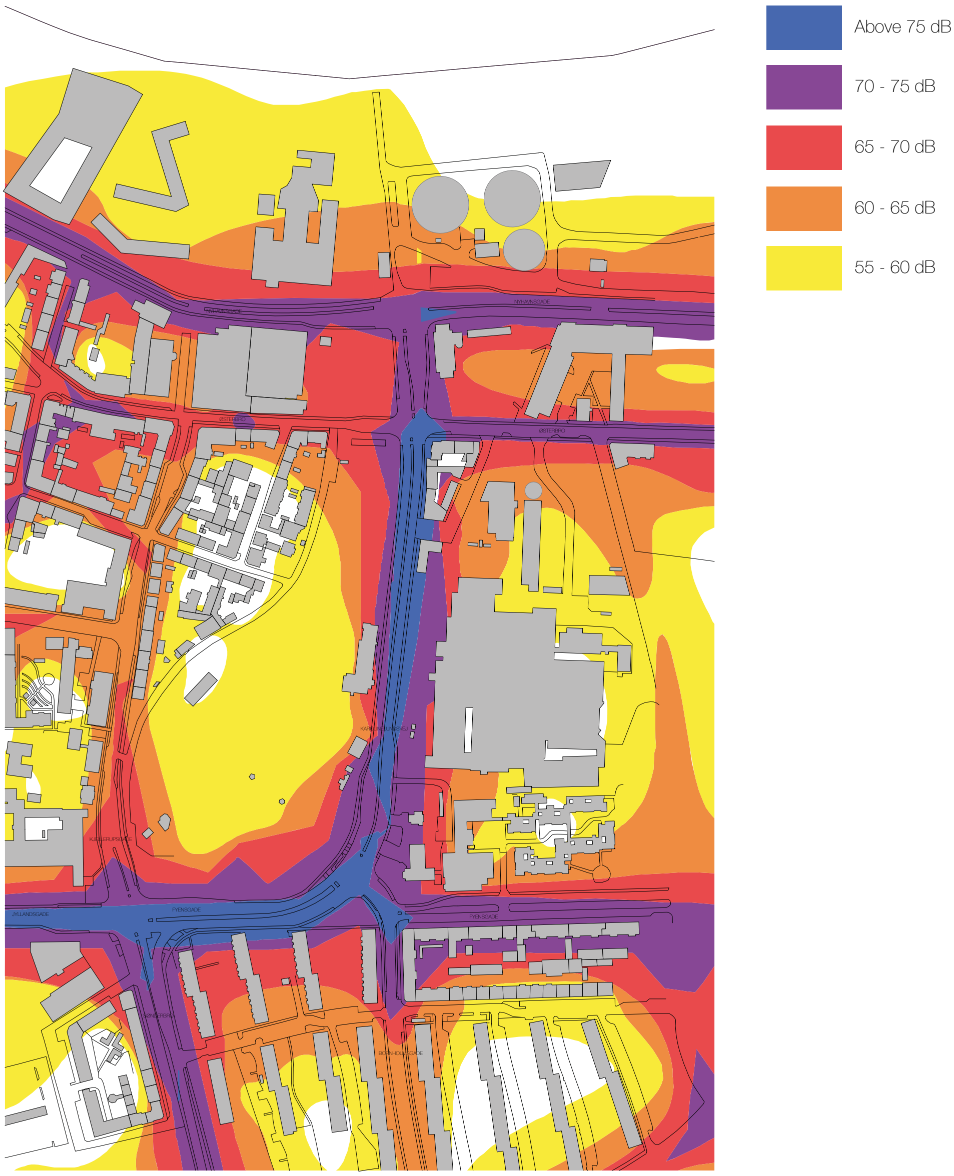
ill. 21: Platform 4

ill. 22: Outdoor stage

ill. 23: Skate area

ill. 24: North entrance

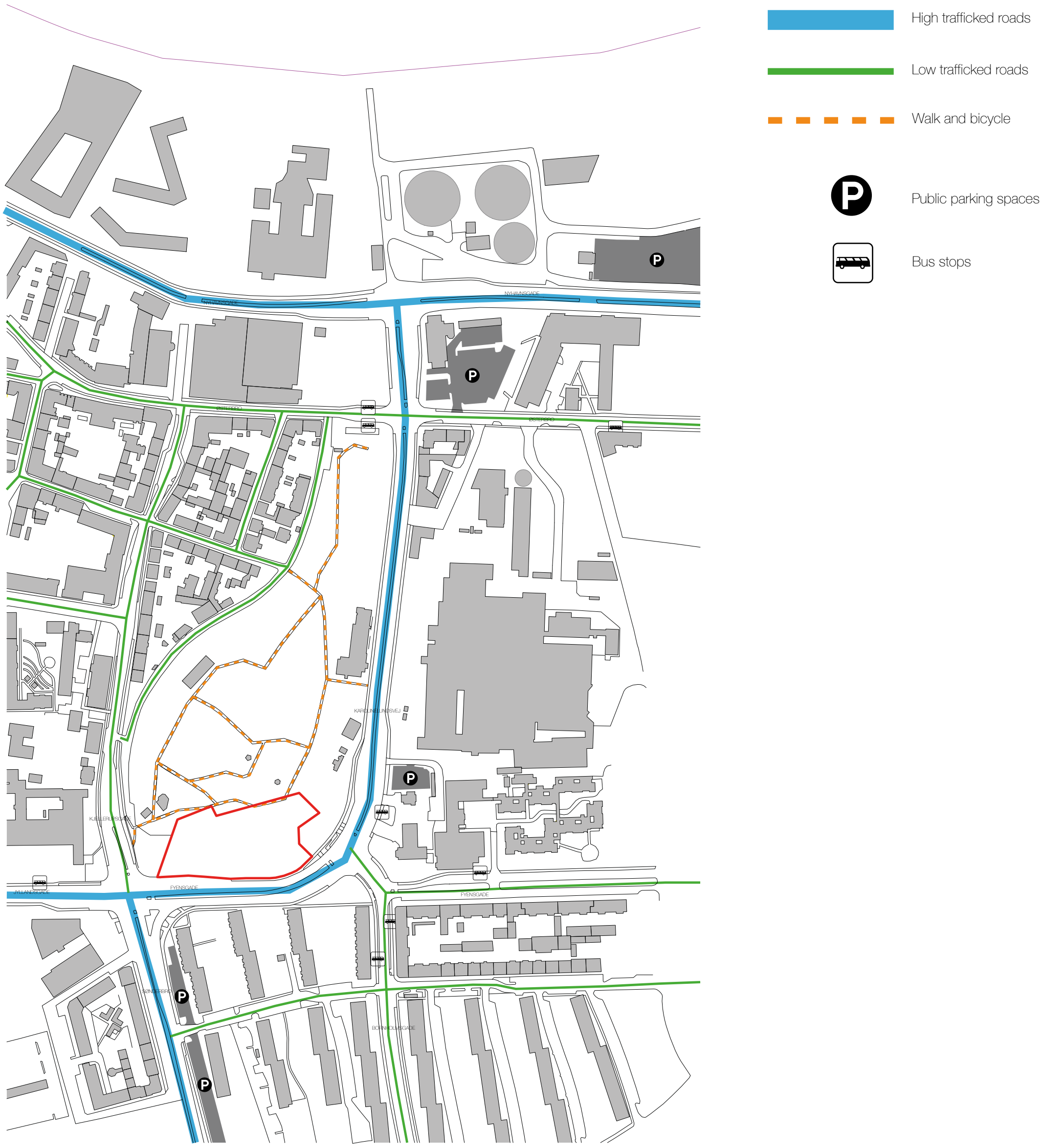
ill. 25: Playground



ill. 26: Noise levels

Noise

From the noise diagram it is shown that Karolinelunden is quite exposed to the surrounding traffic noise. This is due to the location up against two highly trafficked roads on the south and east side of Karolinelunden.
One of the most exposed places is the southern site of Karolinelunden where the kindergartens location is going to be. According to Bygningsreglementet there is a limit of 58 dB in outdoor spaces and a limit of 33 dB in indoor spaces with closed windows (Bygningsreglementet 2010). This means that it is necessary to make some kind of sound barrier to minimize the noise in the kindergarten from the surroundings (Aalborg kommune 2016).

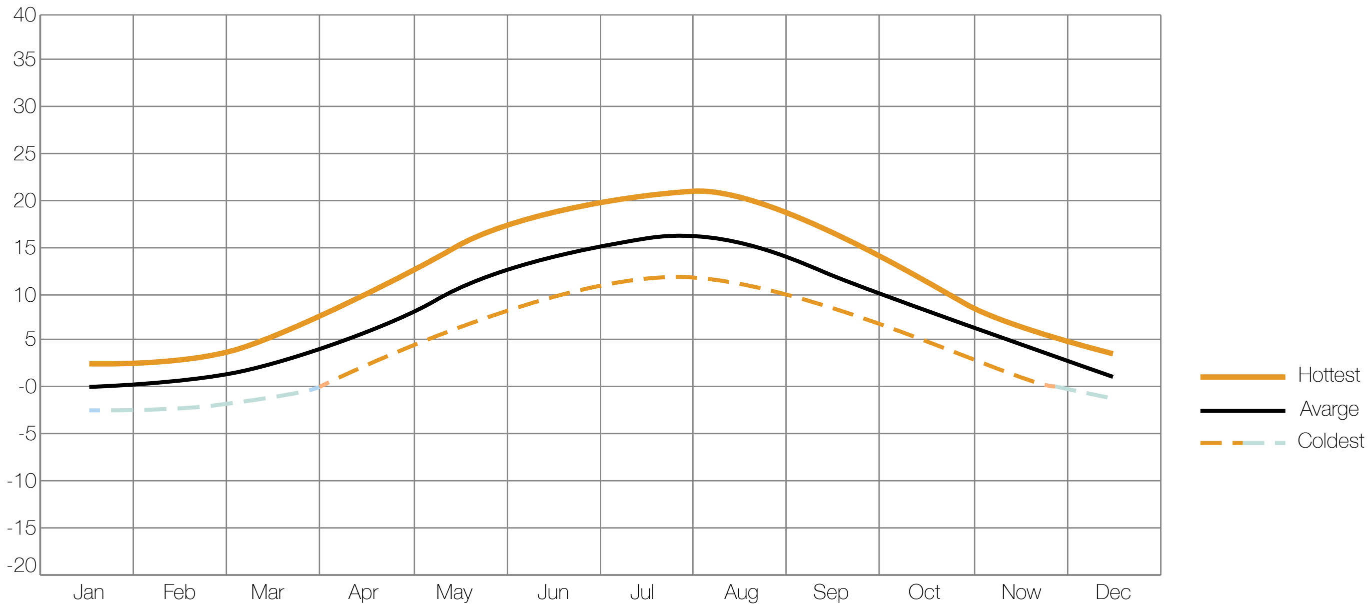


ill. 27: Accessibility and paths

Accessibility

The site for the Karolinelunden Kindergarten is located in the southern end of the park, just next to the big road Fyensgade. Even though it is placed next to a big road and therefore easy to access by car, there is not many public parking spaces in the area, and therefore it might not be that easy to find a place to park, while taking the child to the kindergarten. The two bigger parking lots is placed north of Karolinelunden and therefore there is quite a distance to the kindergarten. However, it is planned to build a parking lot along Kjellerupsgade for the users to the kindergarten (Aalborg Kommune 2016).

It is also possible to arrive at the site by public transportation. The train station is located nearby and close to the site there is several bus stops. According to the district plan 1-1-124 there is also planned to establish a solution called Bus Rapid Traffic (BRT), which is an articulated bus, going from Aalborg Vestby to the university hospital in east. This bus is planned to have stops on Bornholmsgade and Jyllandsgade near Karolinelunden.
It is of course also possible to arrive to the site by foot or bike and Karolinelunden itself is mainly meant to be for this kind of soft trafic.



ill. 28: Temperature

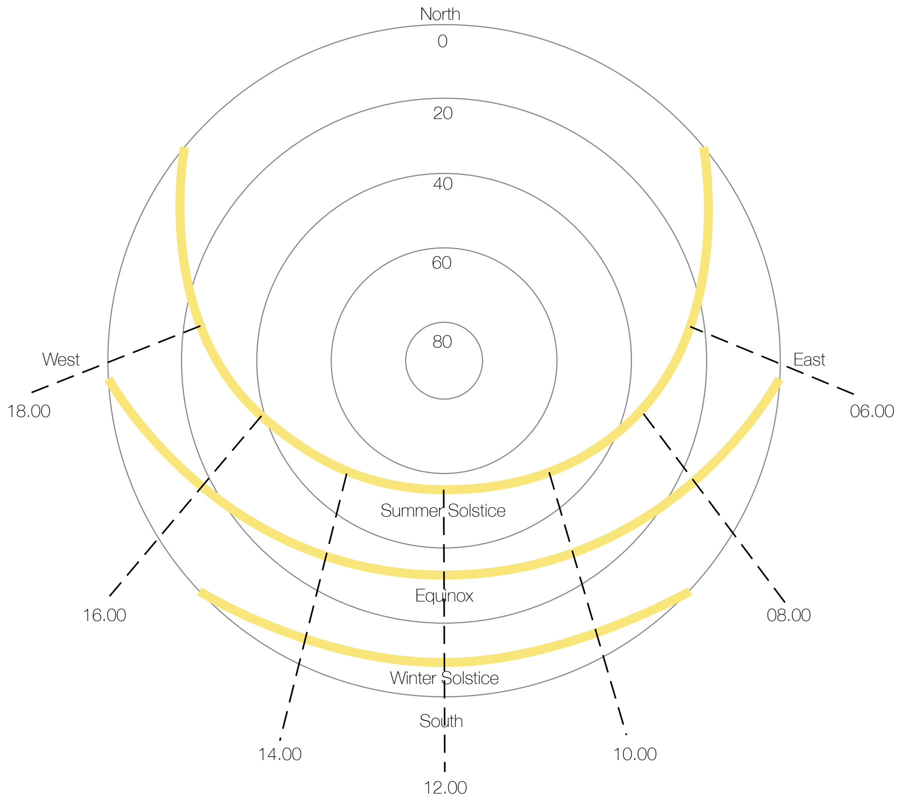
Climate

Doing a sustainable building the climate plays a huge role, as it have a massive influence of which passive strategies can be implemented and bring down the energy consumption and it also have an influence on which active strategies should be implemented. The most important climatic factors will be sun, wind and temperature.

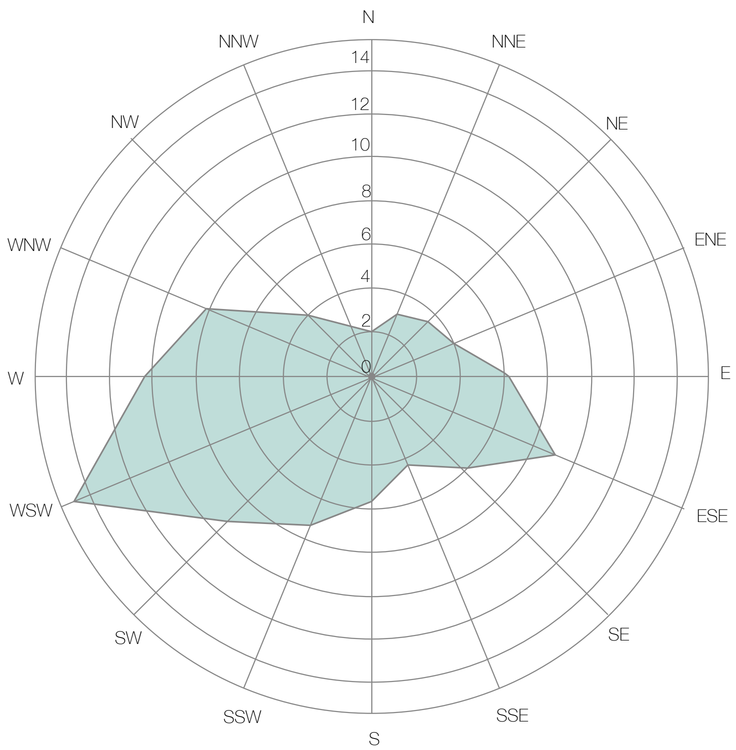
As the site is located in Aalborg in the northern part of Denmark it is in the northern hemisphere where the climate is known for cold winters and mild summers. This means that the temperature in Denmark is quite moderate and do not vary much, as shown on ill. 28, the temperature is only occasionally receding due to extreme weathers. The maximum daily mean temperatures varies doing a year from approx. 2-21 ºC and the minimum temperatures approx. -2-12 ºC (Yr 2007).

The temperature is naturally affected by the sun and hours of sun available. In Denmark the hours of sun in the winter time is only few, and because of the low angle of the sun, from raise to set, it will cast long shadows and effect the urban areas a lot. At the winter solstice there will be less than seven hours of daylight during the day (ill. 29). In the summer the sun is set in a much higher angle and therefore the sun rises early and sets late, giving the days of summer more daylight hours and the summer solstice is approximately eighteen hours a day (ill. 29) (Sunearthtools 2009).

As the wind is also an important factor the analysis of the windrose (ill. 30) from the airport have to be done with that in mind that the airport is placed in a huge open field and not in a urban area as the site (Bjerg 2012). The urban area will have to come into considerations when calculating on wind.



ill. 29: Sun hours



ill. 30: Wind

Subconclusion

Karolinelunden is undergoing a bigger change in the coming years, which started with some visions and plans from the municipality. The changes in Karolinelunden should make the park a more welcoming place for a lot of different people with a variety of recreational activities, but still keep the green touch in the city. First step is a new kindergarten. The kindergarten is a part of expanding the user group for Karolinelunden, even though the user group is quite diverse as it is now.

Karolinelundens placement in the city, does that in some areas of the park there is a quite high traffic noise, especially in the area of the new kindergarten. This of course gives some challenges in reducing the noise, to make the kindergarten and the park in general a nice and undisturbed place. The placement also makes it easy to access the park, especially for people arriving by bike or foot. When arriving by car it is a bit more difficult, because there is not that many public parking spaces in the area. The plan is though to build a parking lot for the users of the kindergarten.

According to the climate, there is of course some issues that have to be considered when building. Aalborg is placed close to Limfjorden which does that it is quite windy, this of course have to be considered when designing the kindergarten. Another aspect of the climate is the amount of sun hours available, and because of the northern placement it means that there is few hours of sun in the winter time and therefore not that big potential for using the sun as an energy source.

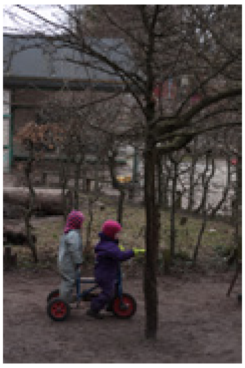
Design parameters:

- Outdoor spaces should be shaped to function, both as a playground and a noise barrier from the traffic
- Consider placement and orientation of the building to allow as much daylight as possible to enter the building
- The kindergarten should keep the green touch and be an integrated part of the recreational Karolindelunden

CASE STUDIES


ill. 31: Playground


ill. 32: Playground


ill. 33: Playground


ill. 34: Playground

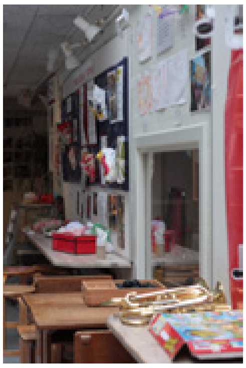
Børnehuset Tiziana

Architect:	Aage Skou
Engineer:	-
Built:	1994
Location:	Hasseris, Aalborg
Size:	app. 1000 m^2

This case studie is based on a visit to the kindergarten.
Børnehuset Tiziana is an integrated public institution where they are rated to have 16 day care kids and 50 kindergarten kids (Børnehuset Tiziana n.d). At the moment they have approximately 80 kids.
The kindergarten was built in 1994 as a test and development institution, where the work should be based on the Reggio Emilia philosophy from Italy. It was a small group of promoters that made it possible to built Tiziana. One of the things from Reggio Emilia they uses is the way to work with projects in smaller projects groups. This is because it gives, both the kids and the staff, the possibilities to have presence with each other and it gives a sense of community in a learning environment. According to Helle Jørgensen, head of Tiziana, the projects they are working with are usually chosen on a background on what the kids have talked about and shown an interested in at that time. At the same time it is a good way to support another aspect they are working with: Contemplation
Contemplation is a term they uses in their daily practice, in the projects with the kids but also according to the interior design.
The architecture of the building support the way of thinking and the project-oriented philosophy, by having a common workshop and workshops facilities for each of the three groups there is in the kindergarten. Because they work with different projects it is possible to change or rearrange the interior to fit just exactly the needs. In addition to this they keep all the walls white to emphasize the kids productions and drawings.
In almost every room there is worked with a visual connection to other rooms. In some places it is done to make the work of the pedagogues easier, and in some places

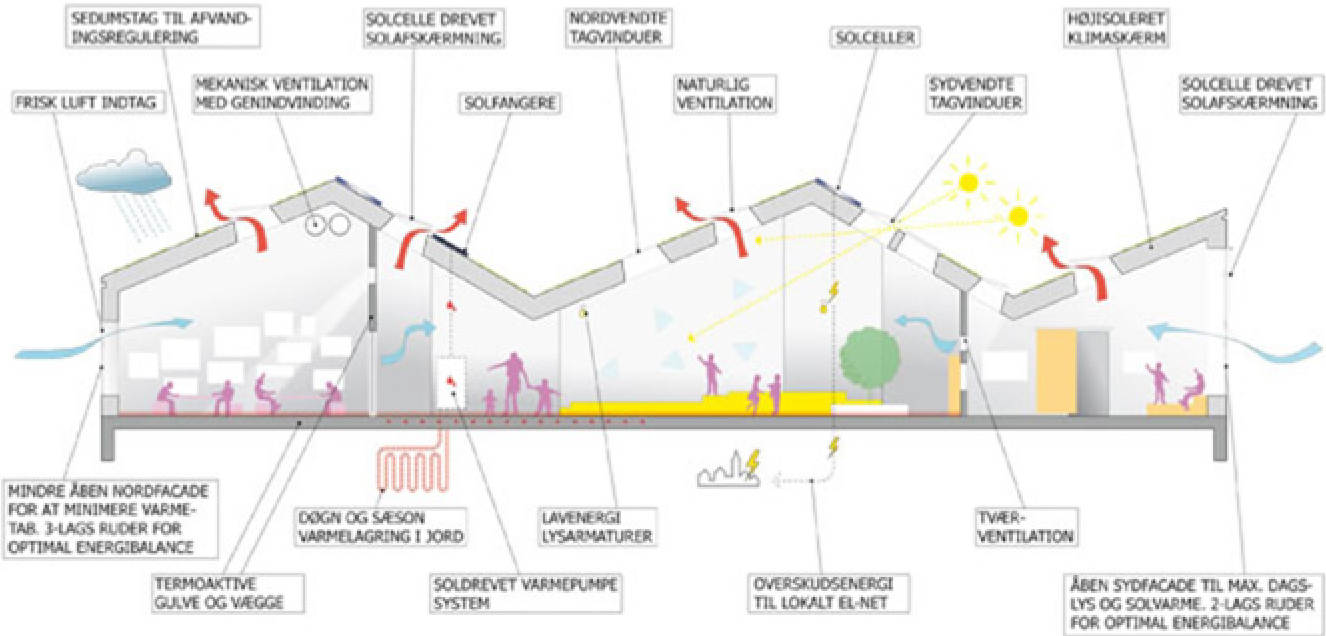

ill. 35: Common room


ill. 36: Common room


ill. 37: Common room


ill. 38: Common room

it is done in kids height and for the kids sake to give them the possibility to see what others are doing. The transparency in Tiziana is done by making interior windows between rooms. The windows in the house is an important factor, not only to get sufficient daylight, but also to get the transparency, both between the outdoor and the indoor and between the different rooms. The windows to the outside is placed in a height where it is possible for the kids to look out to the playground without having to stand on their toes or being lifted of the floor by an adult. The main focus in the interior design is to accommodate the children's development and learning through play (Børnehuset Tiziana n.d).
Because the Reggio Emilia philosophy is a project-based environment it also means that Tiziana have more square meters than a regular Danish kindergarten. This sometimes means that they have more kids in the kindergarten than it was actually was build for.
The building is originally made with an open loft in the big common room, but as kids has a natural curiosity, they drop things from the railing just to see what happen or they will by accident drop something when playing. They also experienced that the noise level in the common room would raise when the kids was playing at the loft, and at the same time they would always need to have a pedagogue up there to look after the kids. According to Helle Jørgensen, this is the reason why Tiziana have chosen to close the loft for the children and use it as some kind of combined storage and meeting room instead. If the staff had the possibility to make changes to Tiziana, they would get rid of the loft and wish for other rooms to be made. A toilet that is accessible from the outside, so the kids do not have to go inside to access the toilet, a quiet room or a place sheltered from noise, where the kids can go to have some time for themselves and a more defined staff area are some of the functions they would add to the building.

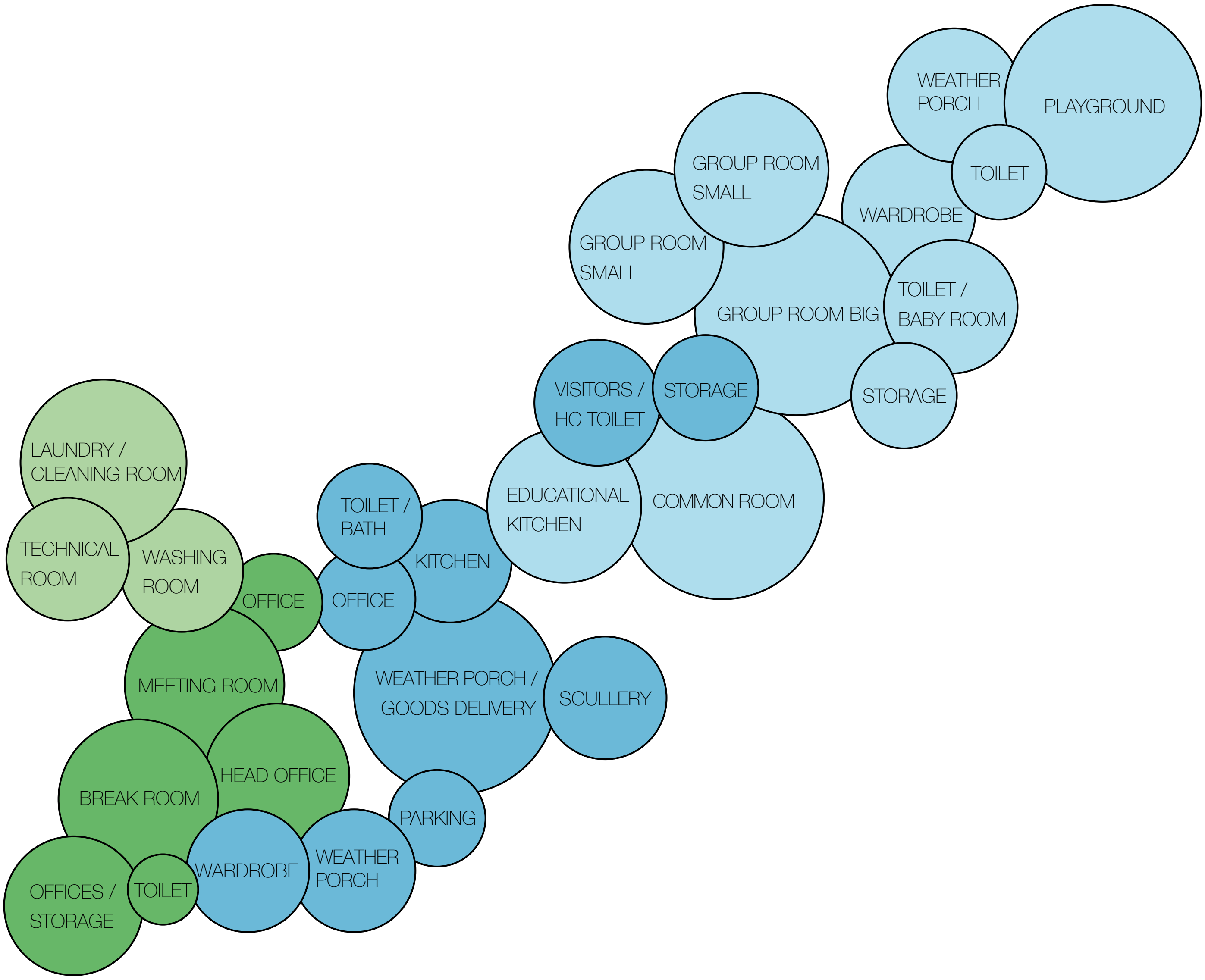


ill. 39: Sustainability principles in Solhuset

Solhuset

Architect: Christensen & Co (referred to as CCO)
Engineer: Rambøll
Built: 2011
Location: Hørsholm
Size: 1300 m^2

Solhuset in Hørsholm is the most climate friendly and sustainable kindergarten in Denmark, and is build like an active house, which means that the house is producing more energy than it uses (DAC 2014).
Solhuset translated to English is “The sun house” and the sun is the main focus point in the project. The kindergarten has no less than 80 windows and skylights to illuminate the building and always keep the daylight factor at a high level. The day light from the sun gives a positive and play-full atmosphere and there is never a problem with dark corners in the kindergarten (Indeklimaportalen 2015). The many windows and skylights together with the sun provides lots of passive heating for the kindergarten, but an intelligent system with sensors in the rooms and on the roof will blind the windows, ventilate and turn off the lights in a way that the needs are held. The window blinds will also prevent the heat to escape doing the nights and keep a stabile temperature, reduce heating needs and prevent overheating in the summer.
As an active house Solhuset also produces energy itself. Solhuset uses solar cells to produce electricity; the solar cells are placed in a way to optimize energy production on the roof and produce electricity both summer and winter. Solhuset produces 8 kWh/m^2/year with 250 m^2 solar cells and energy for heating and hot water with 50 m^2 solar collectors. When all the sun energy is combined with the heat pumps and the energy saving passive methods Solhuset is self-sufficient in energy for heating, electricity, ventilation and lightning (DAC 2014).
CCO have not just had the energy concerns in mind designing Solhuset, but also the users of the kindergarten. Every material in the building has got a sort of certificate indicating its sustainability in every way. But CCO have also thought about the issues with loud noises and sounds in a kindergarten and optimized on the acoustics (Indeklimaportalen 2015).
In the illustration (ill. 39) above all of the energy concepts are shown.



ill. 40: Function diagram

ROOM PROGRAM

CATEGORY	FUNCTION	AREA m^2	NO.	AREA SUM m^2
Kids functions	1.1 Grouproom small	12,5	8	100
	1.2 Grouproom big	40	4	160
	1.3 Wardrobe	35	2	70
	1.4 Weather porch	8	2	16
	1.5 Toilet	4	2	8
	1.6 Toilet / baby room	23	2	46
	1.7 Educational kitchen	10	1	10
	1.8 Common room	30	1	30
Staff functions	2.1 Weather porch	3	1	3
	2.2 Head office	12	1	12
	2.3 Offices / storage	10	1	10
	2.4 Break room	15	1	15
	2.5 Meeting room	12	1	12
	2.6 Wardrobe	8	1	8
	2.7 Toilet	3	1	3
Kitchen facilities	3.1 Kitchen	15	1	15
	3.2 Scullery	6	1	6
	3.3 Toilet / bath	5	1	5
	3.4 Office	5	1	5
	3.5 Storage	4	1	4
	3.6 Washing room	10	1	10
	3.7 Weather porch / goods delivery	3	1	3
Secundary functions	4.1 Storage	6,5	3	20
	4.2 Technical room	15	1	15
	4.3 Laundry / cleaning room	10	1	10
	4.4 Visitors toilet / HC	4	1	4
	4.5 Shed - playground equipment		1	
	4.6 Outdoor workshop		1	
	4.7 Shed - bike parking		1	

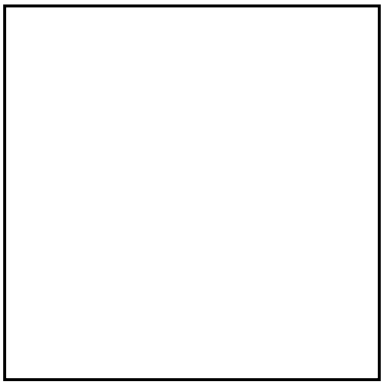
PPM LEVEL	AIR CHANGE RATE	DAYLIGHT
900		X
900		X
	4 h^{-1}	
	0,5 h^{-1}	
900		
900	2-4 h^{-1}	
900		X
900		X
	0,5 h^{-1}	
900		X
900		X
900		X
900		X
	0,5 h^{-1}	
900		
	2 h^{-1}	X
	2 h^{-1}	X
900		
900		X
	1 h^{-1}	
	2 h^{-1}	X
	0,5 h^{-1}	
900	0,5 h^{-1}	
	0,5 h^{-1}	
900		
900		

VISION

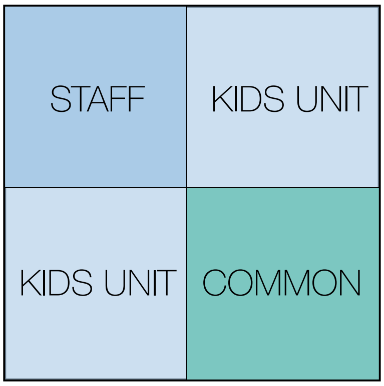
The danish kids are in these modern times often based in older buildings designed for another use and therefore not suited for children, but over recent years there have been a change of mind and kindergartens are now developing with and for the children. This development is putting the kids in focus with greater framework for learning, development and wellbeing. As the kindergarten architecture is developing so is the sustainable architecture, and for this project these two ends will meet up and form a sustainable kindergarten with the kids in focus, both while attending but also for their future.

PRESENTATION

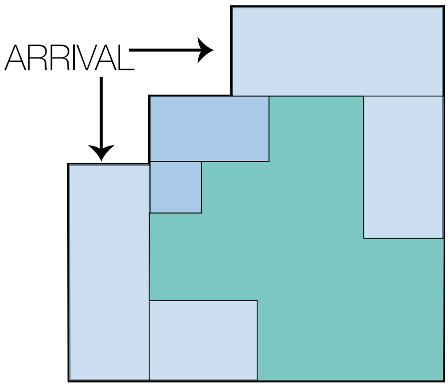
Concept



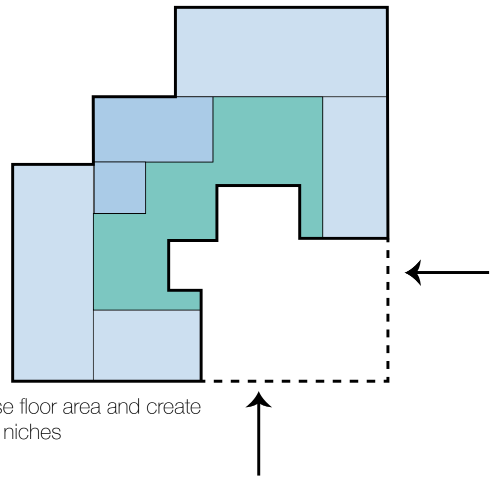
The area; maximum 850 m^2 netto



The volume; divided into four units

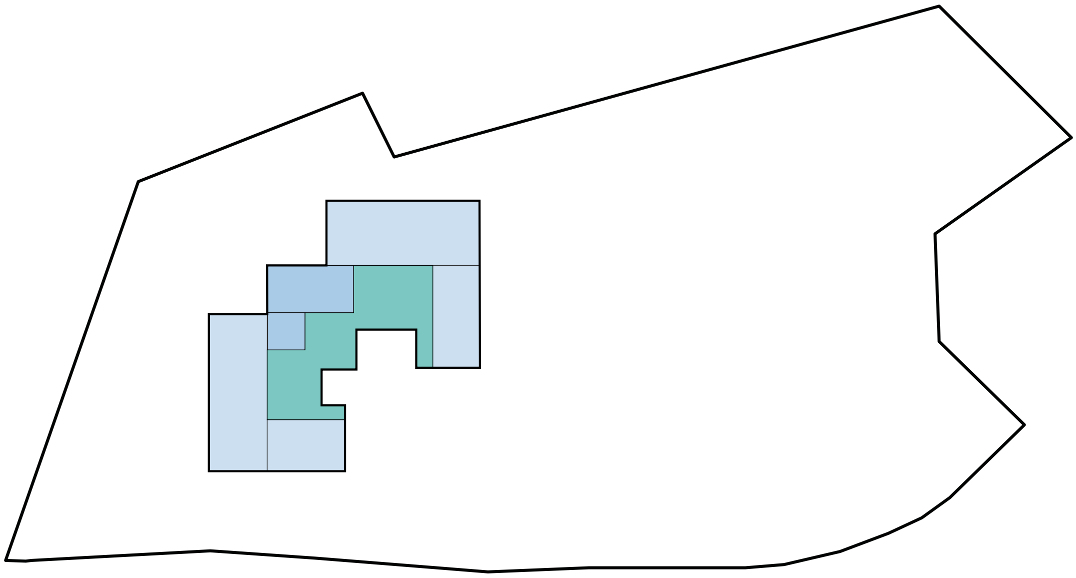


Rearrange the units and make room for arrival and entrances

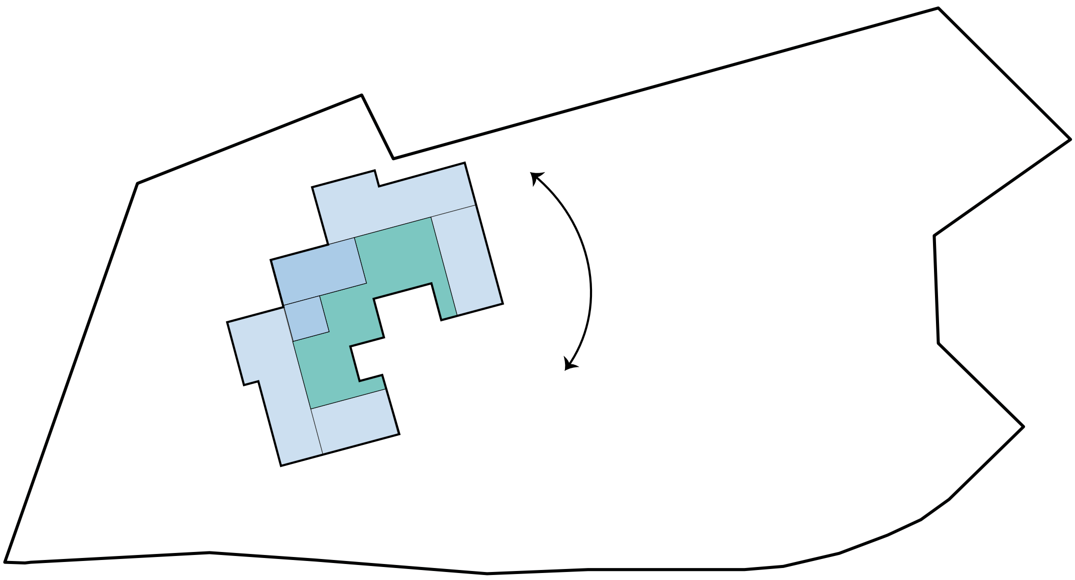


Decrease floor area and create outdoor niches

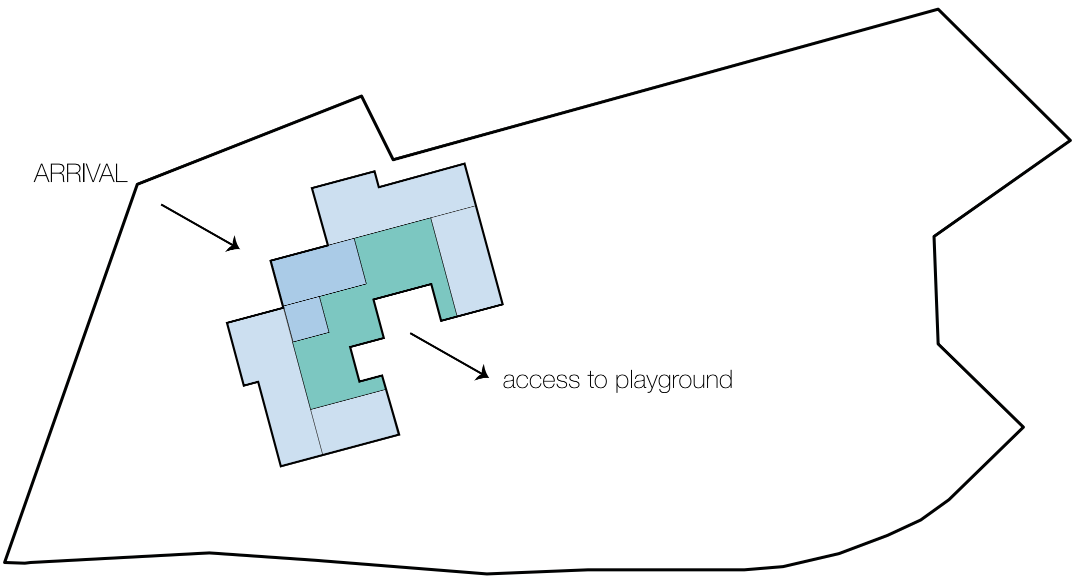
ill. 41: Concept diagram I



Placement on site



Rotate to align with site boundary



Rotate to make entrances visible from parking and have a visible connection to the playground from the common room

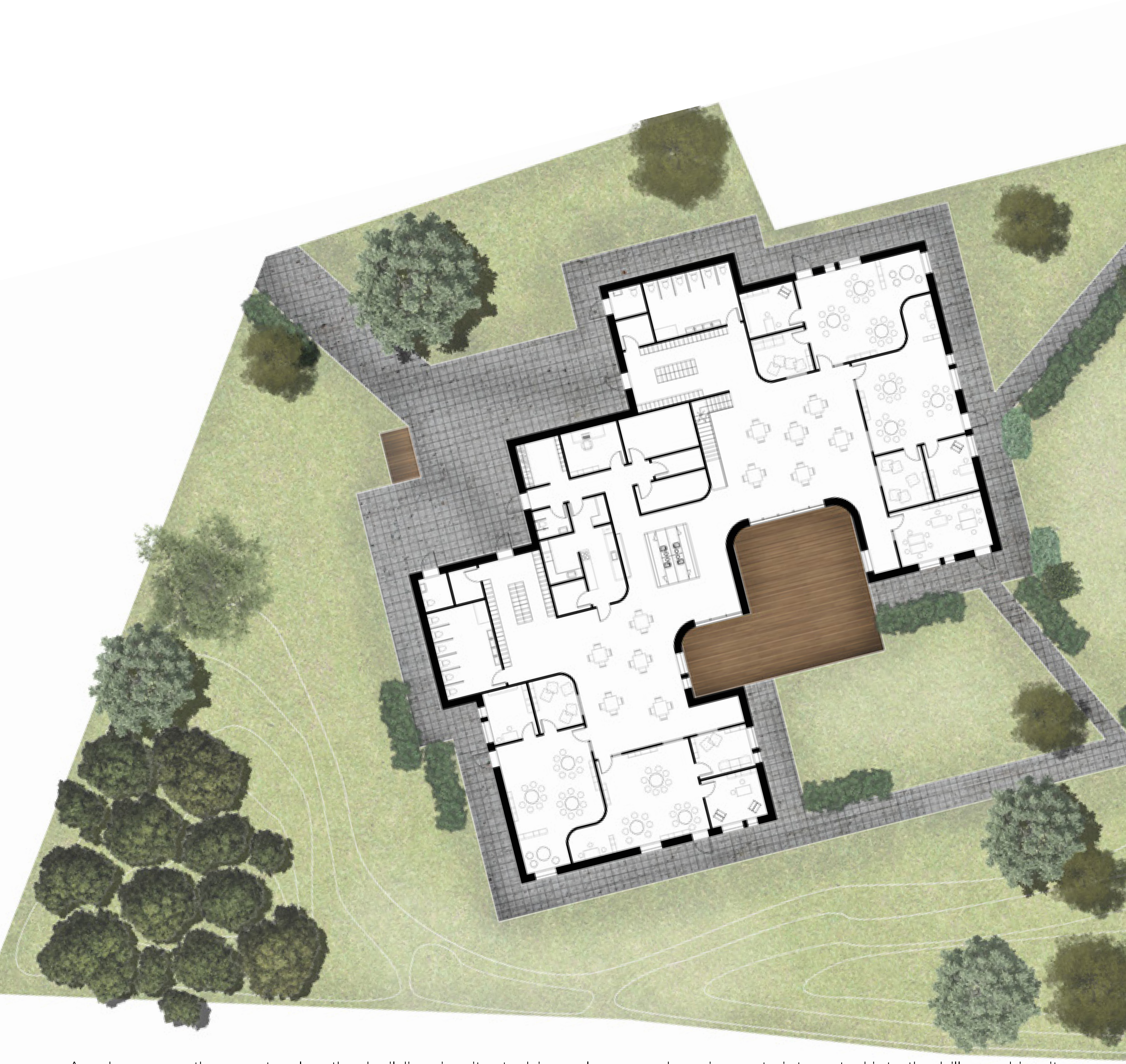
ill. 42: Concept diagram II

ill. 43: The kindergarten

The new kindergarten in Karolinelunden is a building where sustainability, learning and play is the main focuses of the design.
For the sustainability in the building there is worked with social sustainability in the DGNB certification. The social sustainability focus on the wellbeing of the users of the building, which means that a good indoor climate has been the main focus.
To ensure a playful and creative learning environment for the children, the approach of Reggio Emilia has been utilized. One of the main elements in Reggio Emilia is also one that is present in the new kindergarten; the atelier. The atelier gives the possibility to be creative and in that way learn about different subjects. In the building there is placed a common atelier where projects between the different kindergarten groups can take place or if a group is working with a bigger subject. Each group also have their own smaller atelier, where the kids always can go and be creative. The smaller ateliers are placed towards the common room where windows will create a transparency between the rooms. Transparency is an element that is used throughout the whole building to make it possible for the children to see what other children are doing and in that way create an interaction. The windows to the outside of course makes a transparency to the landscape and playground outside, but to make sure it also was a transparency the children could enjoy some of the windows is placed close to the floor, and in that way also allows the children to look at the outside.
The common room is the central area of the building, where big gatherings can occur. It is a place that is inspired by the central 'piazza' as used in Reggio Emilia, but instead of having one big room, that easily can seem overwhelming it is "divided" into three areas, whereas the middle one is where the educational kitchen is. The two other areas are addressed to the children's group rooms.
Besides the Reggio Emilia approach, the design of the kindergarten also applies to new ideas about the kindergarten of the future (see page 14), where some of the points are in line with the Reggio Emilia approach. The design has also used some of the other ideas behind "kindergarten of the future", such as a varying ceiling heights, which comes from the roof shape and niches which is a part of the windows, where the windowsills can be used as a little place for engagement in a small game, or just to get some time for yourself.

ill. 44: Educational kitchen

Masterplan



As shown on the masterplan the building is situated in the northwest corner of the site. It is done so to make the transition from the parking lot to the kindergarten easy for the parents, while making lots of space to the playground. On the playground the paths are mimicking the historical path system of Karolinelunden, making the kindergarten seam more like a part of the park. To the south of the playground there is a hilly area with lots of vegetation to keep out the noise from the roads with heavy traffic. To the east of this hill landscape is the shed for playground equipments integrated into the hills, making it a part of the landscape, like the shed for farming equipments just north of it. The shed for farming equipments are placed to be in a close relation to the kindergartens farming area, where the children will help the pedagogues grow vegetables for the kitchen and thereby learn the children about farm-to-table. By having fruit trees to the playground the farm-to-table concept is enhanced even more, and will also give the children something from the nature to play with.

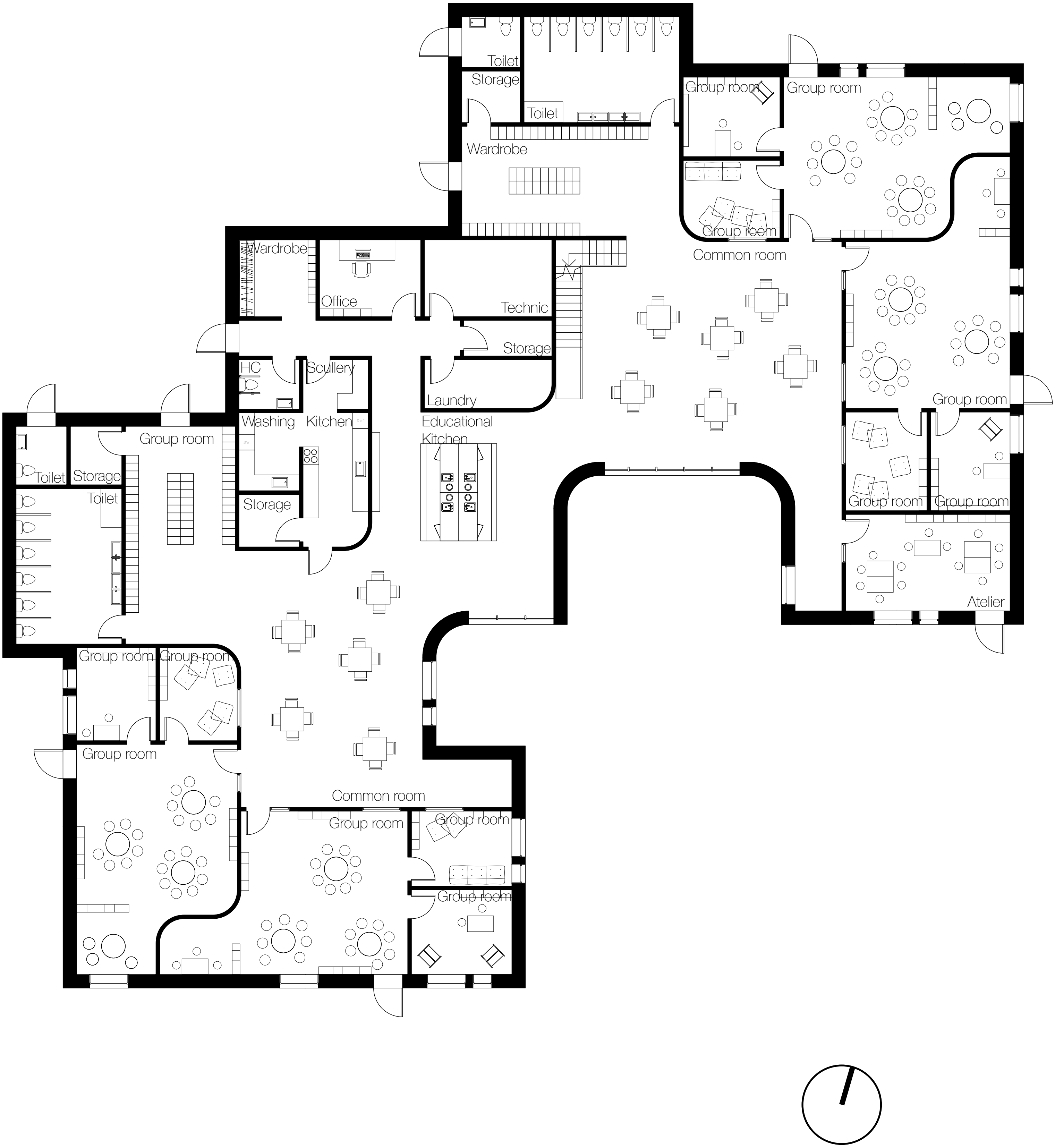
ill. 45: Master plan

Final room program

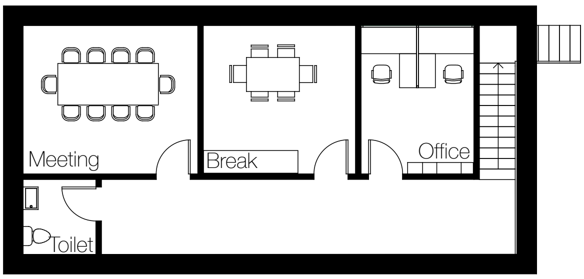
CATEGORY	FUNCTION	AREA m²	NO.	AREA SUM m²
Kids functions	1.1 Grouproom small	12.5	8	100
	1.2 Grouproom big	50.75	4	203
	1.3 Wardrobe	35.5	2	71
	1.4 Toilet	5.5	2	11
	1.5 Toilet / baby room	26.5	2	53
	1.6 Educational kitchen	10	1	10
	1.7 Common room	228	1	228
	1.8 Atelier	26	1	26
Staff functions	2.1 Head office	12	1	12
	2.2 Offices / storage	13	1	13
	2.3 Break room	17	1	17
	2.4 Meeting room	20	1	20
	2.5 Wardrobe	10	1	10
	2.6 Toilet	5	1	5
Kitchen facilities	3.1 Kitchen	14	1	14
	3.2 Scullery	5	1	5
	3.3 Storage	5	1	5
	3.4 Washing room	8	1	8
Secundary functions	4.1 Storage	5	1	5
	4.2 Technical room	15	1	15
	4.3 Laundry / cleaning room	10	1	10
	4.4 Visitors toilet / HC	5	1	5
	4.5 Shed - playground equipment		1	
	4.6 Outdoor workshop		1	
	4.7 Shed - bike parking		1	

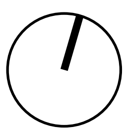
PPM LEVEL	AIR CHANGE RATE L/s/m^2	DAYLIGHT
900	2.3	X
900	2.3	X
	2.9	X
900	1.6	X
900	1.6	X
900	2.8	
900	2.8	X
900	2.6	X
900	1.1	X
900	1.1	X
900	2.9	X
900	2.9	X
	1.7	X
900	1.4	X
	1.1	
	1.1	
	1	
	1.1	
900	1	
	0.9	
900	1	
900	1.4	

Plans

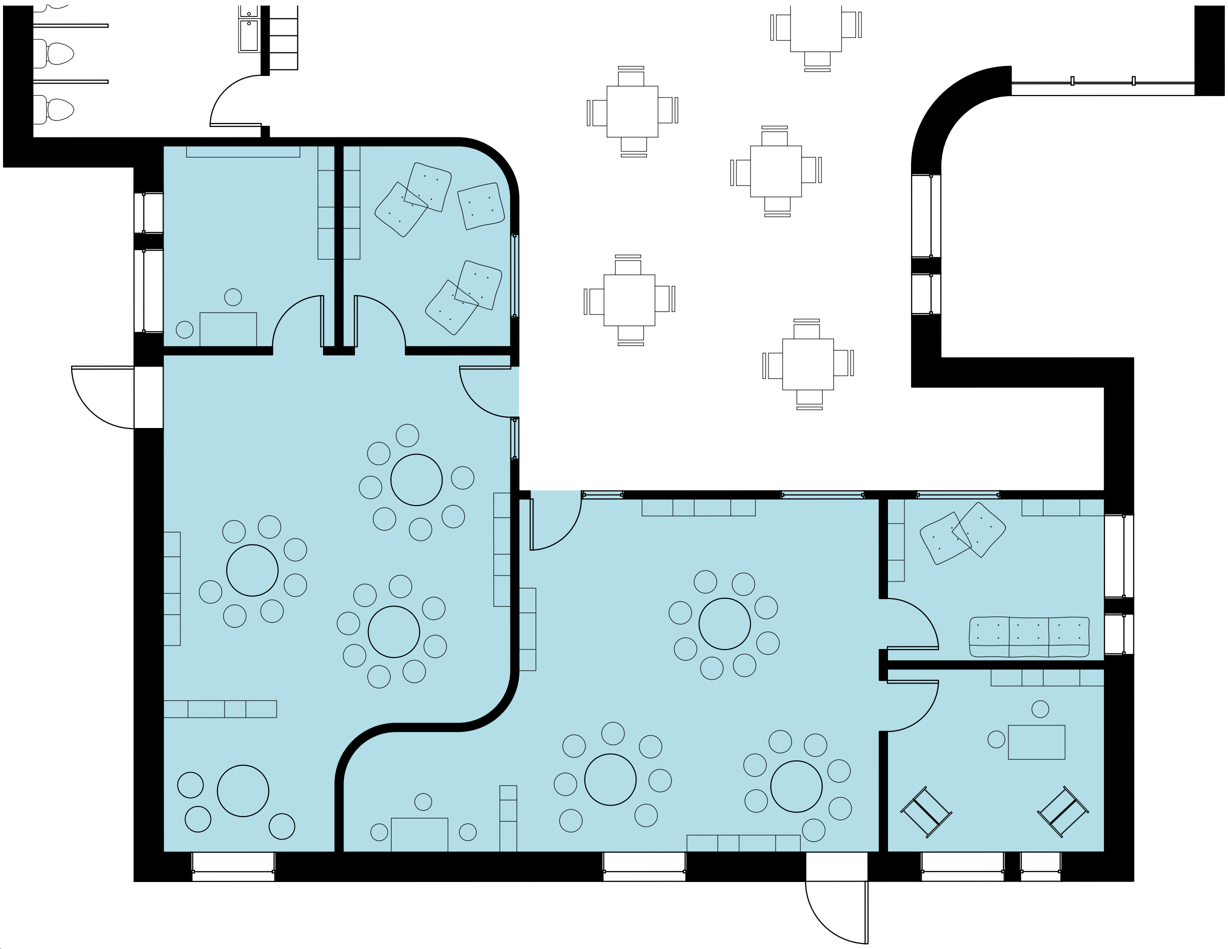


ill. 46: First floor 1:200





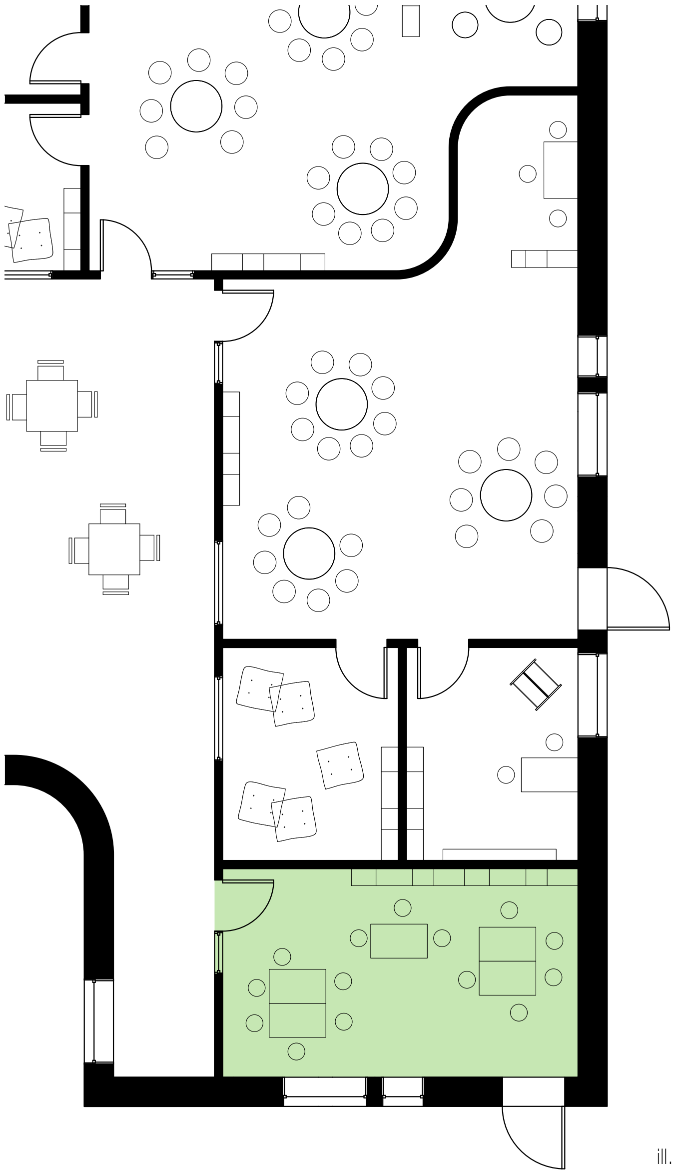
ill. 47: Second floor 1:200



ill. 48: Group room

Group rooms

The kindergarten houses 99 children divided into four groups. Each group have its own group room with two smaller group rooms belonging. The group room has a shape where it is possible to organize it in smaller niches or just as one big room. The flexibility to organize as it fits the groups individually is a way to involve the children in how they want the room and if it needs changes it can be reorganized. From the group room there is a door leading out to the playground to give the possibility to use the outdoor in a creative process.
One of the small group rooms is intended to be a small atelier for the kids, a small place for creativity. The other small group room is for the kindergarten and the individual group to decide what kind of activity or function the room should held, such as a pillow or reading room.
It has been important that every group room has a direct access to the common room.
The four different kindergarten groups, is given a colour. This colour will be shown on the doors into the different group rooms, and the furniture in the group rooms, such as the chairs, will also be given this colour (ill. 48). By doing this the children will have a colour to relate to.

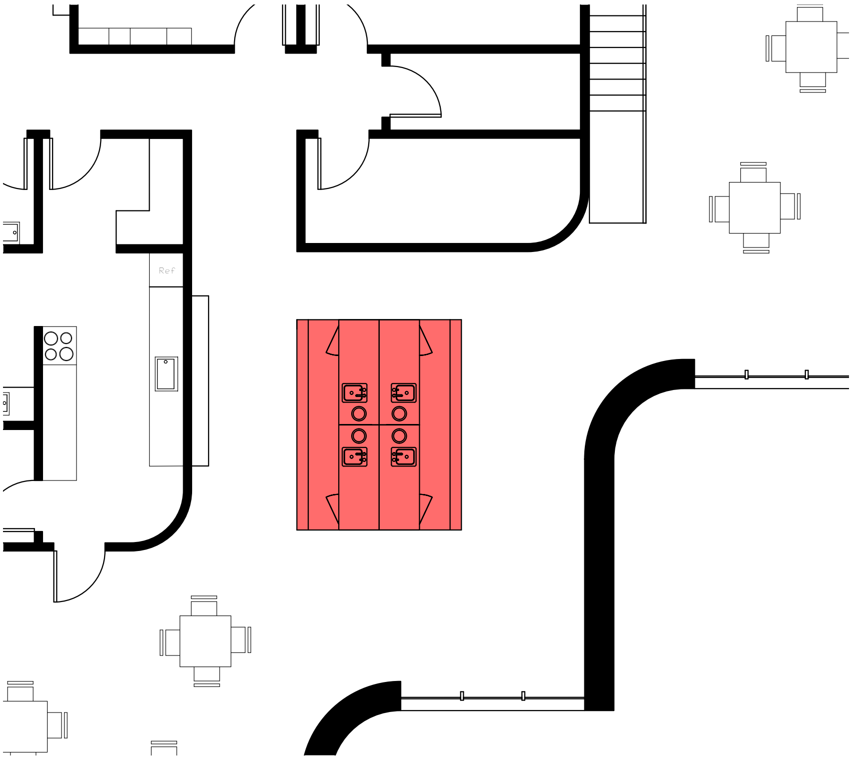


ill. 49: Atelier

Atelier

The kindergarten has a big atelier for use in bigger groups and for projects that needs more space. It is a place where the children do not have to remove their creations when done for the day or because other activities are going to take place. The atelier is a main element in the Reggio Emilia philosophy.
The placement of the atelier is due to the closeness to the playground, so the children have direct access to the outdoor areas and in that way can use the outdoors to find materials for their work in the atelier.

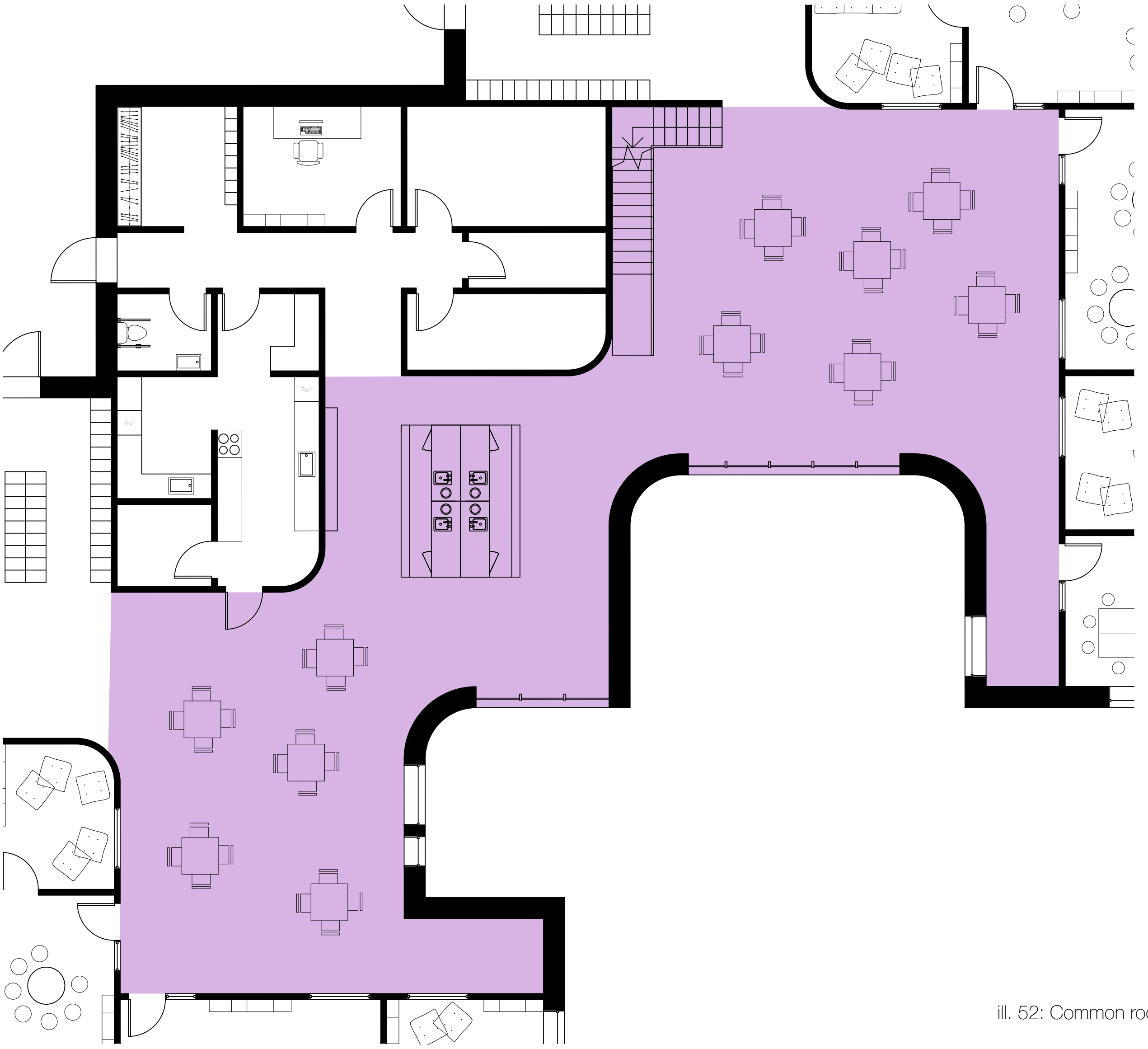
ill. 50: Group room



ill. 51: Educational kitchen

Educational Kitchen

The educational kitchen has a central place in the common room, where it also helps divide the common room in smaller areas.
The educational kitchen is a place where the children can help preparing food for lunch, bake a cake etc. It is also a place for learning about food and groceries. Even though the educational kitchen is a free standing area in the common room, it has a close connection to the kitchen, which is opened with a hole in the wall and a small step so the children has the possibility to see what is going on in the kitchen. The reason for the educational kitchen and the kitchen is not one unit, is because of safety for the children.

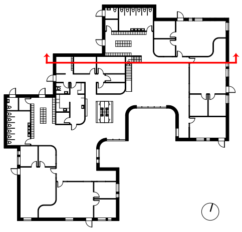


ill. 52: Common room

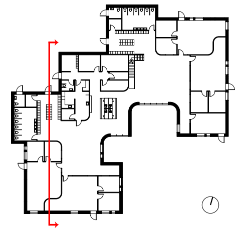
Common room

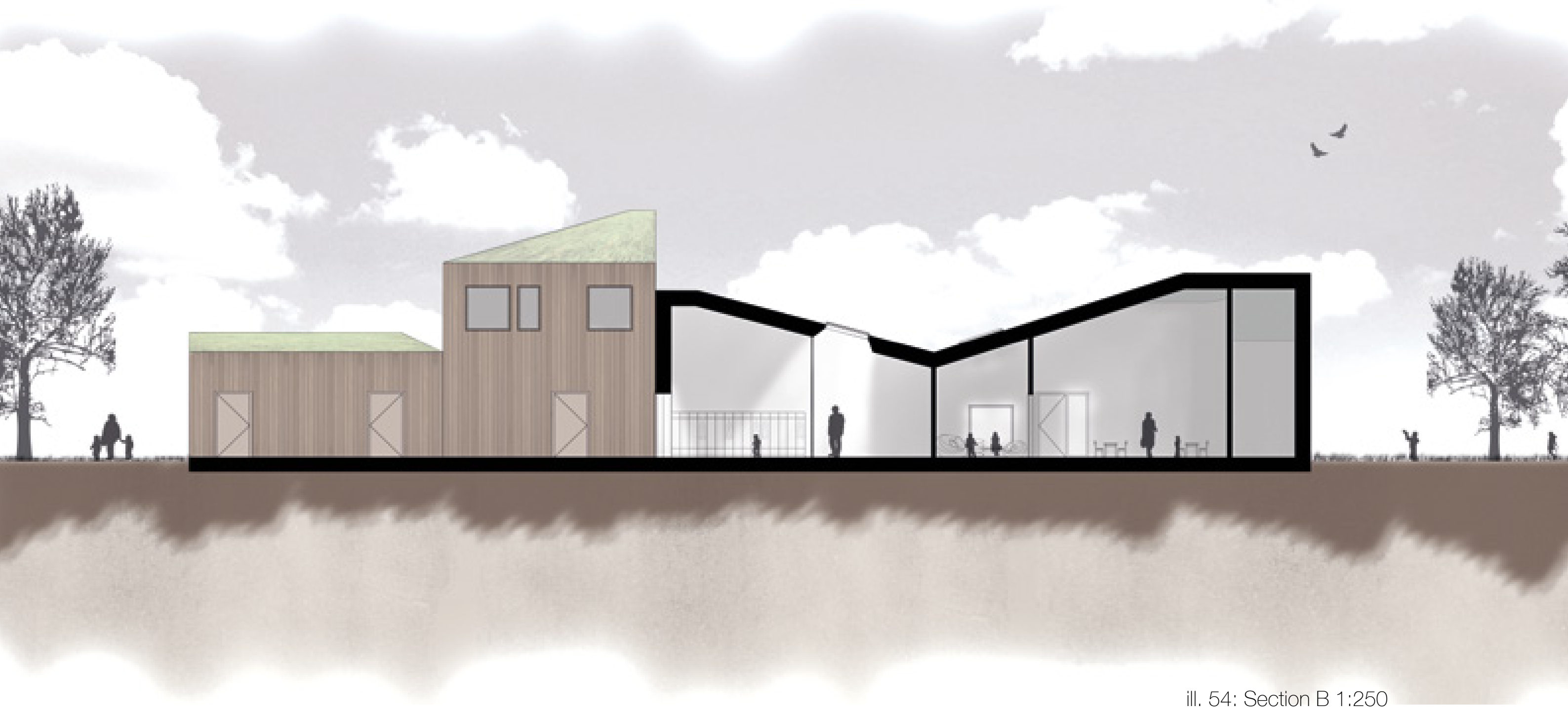
The common room is the central area in the building. It is here big gatherings will occur. It is also the place where the children will eat and interact with the children from other groups than their own.
The common room is one big room, but where the educational kitchen and the shape of the building will divide it into smaller areas. From the common room there is access to a big covered terrace, and the playground.
The common room is in open access to the two wardrobes, which gives an transparency between the rooms and in that way is easier to overview for the pedagogues. It also gives the children the possibility to use the wardrobe in games and play.
The rounded corners are to make the interior seems more child friendly.

Sections



ill. 53: Section A 1:250





ill. 54: Section B 1:250

Elevations

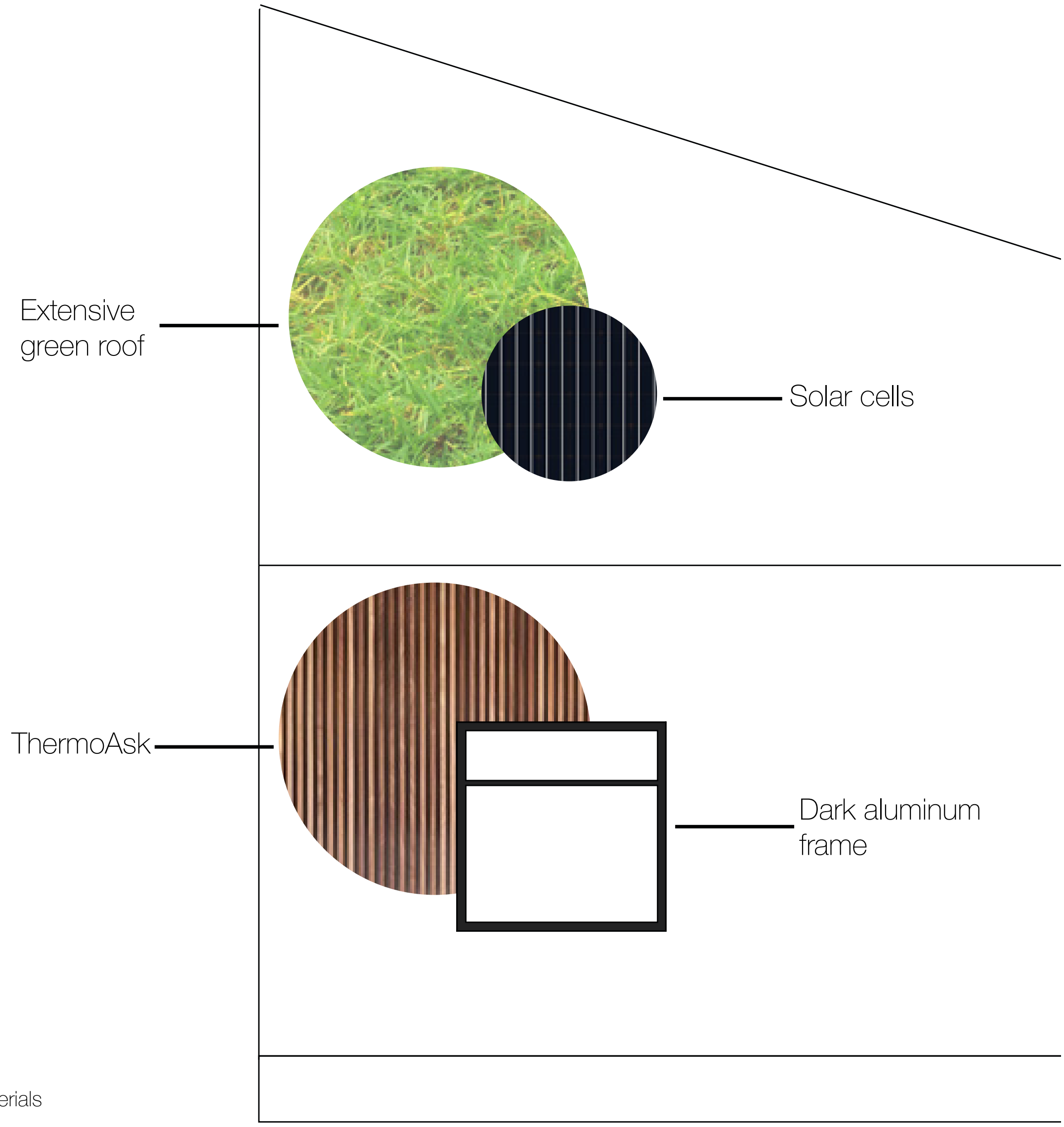
ill. 55: Elevation towards
north 1:250

ill. 56: Elevation towards west 1:250

ill. 57: Elevation towards
east 1:250

ill. 58: Elevation towards
south 1:250

ill. 59: Entrance



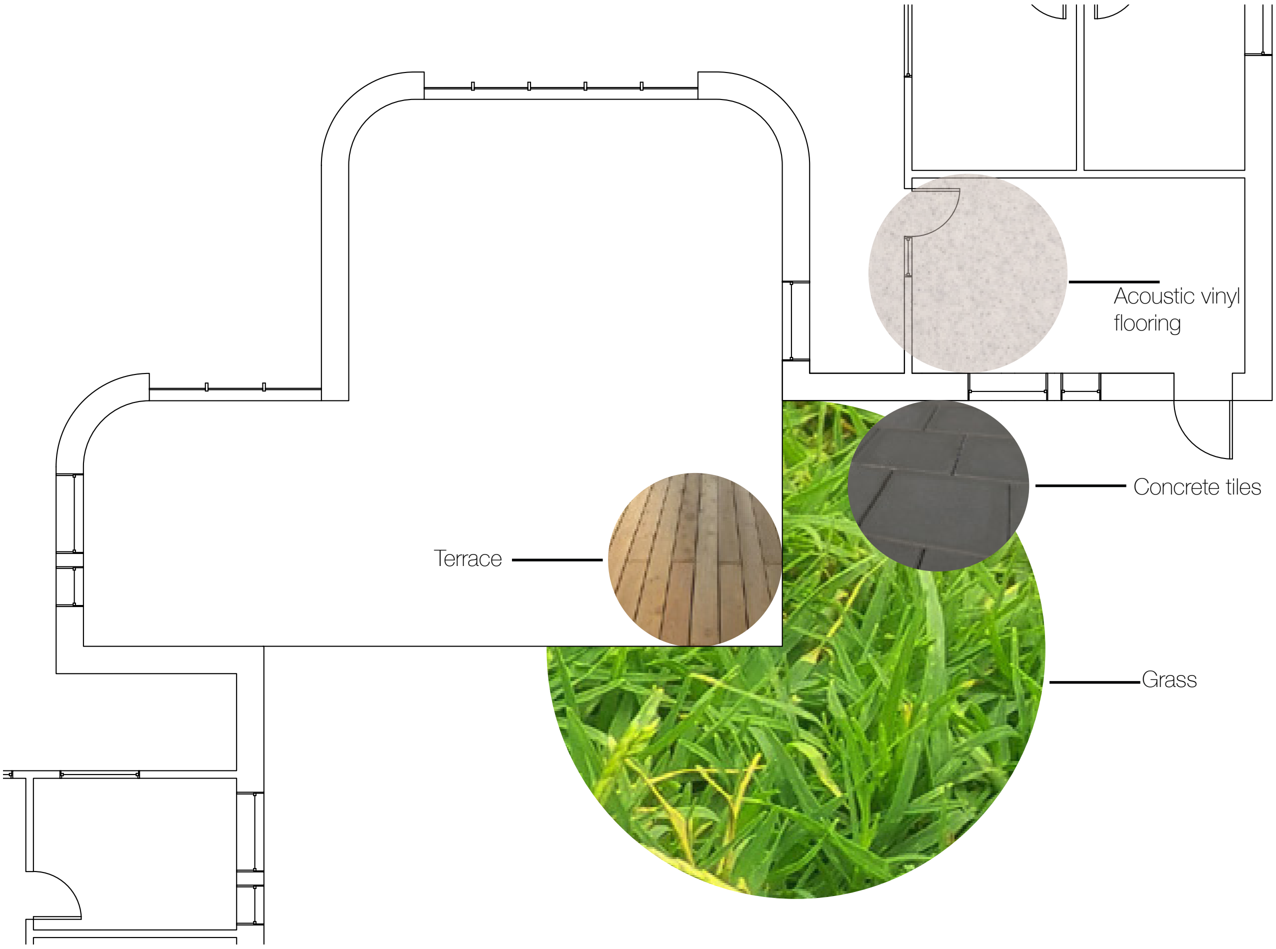
ill. 60: Exterior materials

Materials

Exterior

The facade cladding is of a product called ThermoAsk because of its good sustainable properties. It is a wood cladding that is treated after a 100 % sustainable method, which means that there in the treatment of the wood is not used any form of chemicals. The thermal treatment gives the wood a resistant to mold and fungus, and therefore do not need any surface treatment to secure a long life time.
The cladding will be made in a small profil and placed with only a little space between each other.

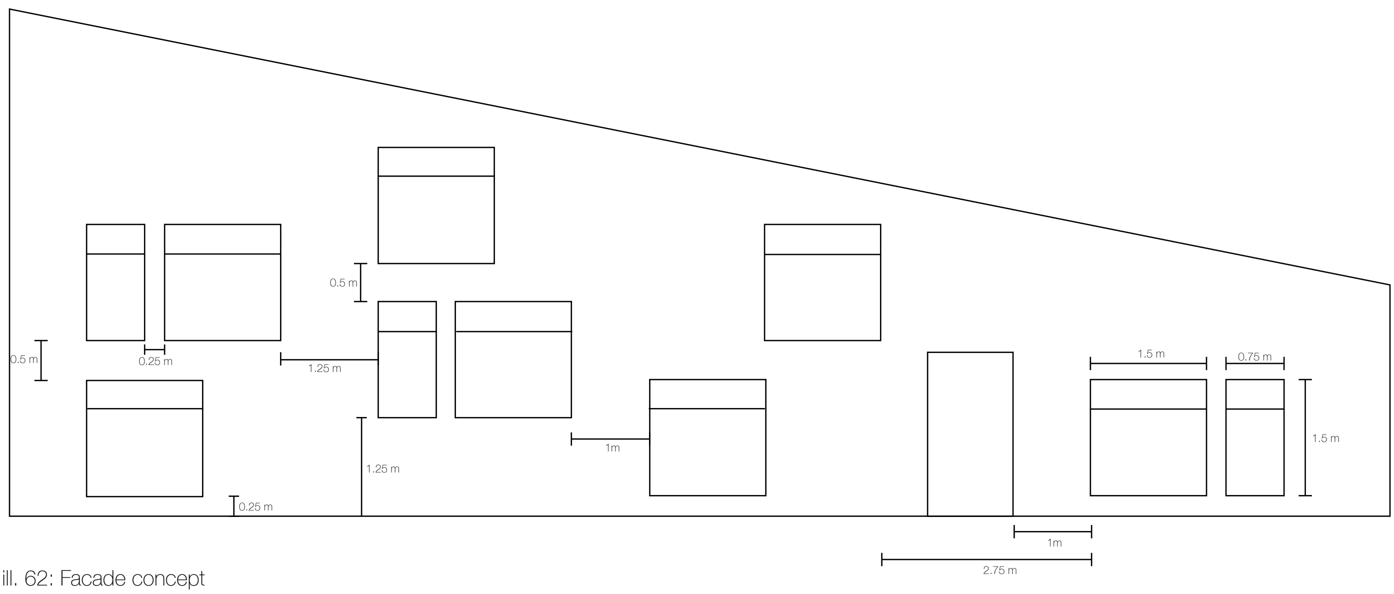
An extensive green roof is chosen because of its benefits to the environment. A green roof has the possibilities to storage rainwater and reuse it for the green roof, otherwise it will slow the rainwaters trip to the sewers and by that help the sewer system in times with heavy rain. It also have an improving property to biodiversity and to the polluted air because of the photosynthesis. Besides that it can be a help to save energy in the building because it gives a natural insulation to the roof (Green roof 2016).



ill. 61: Ground materials

Interior and pavings

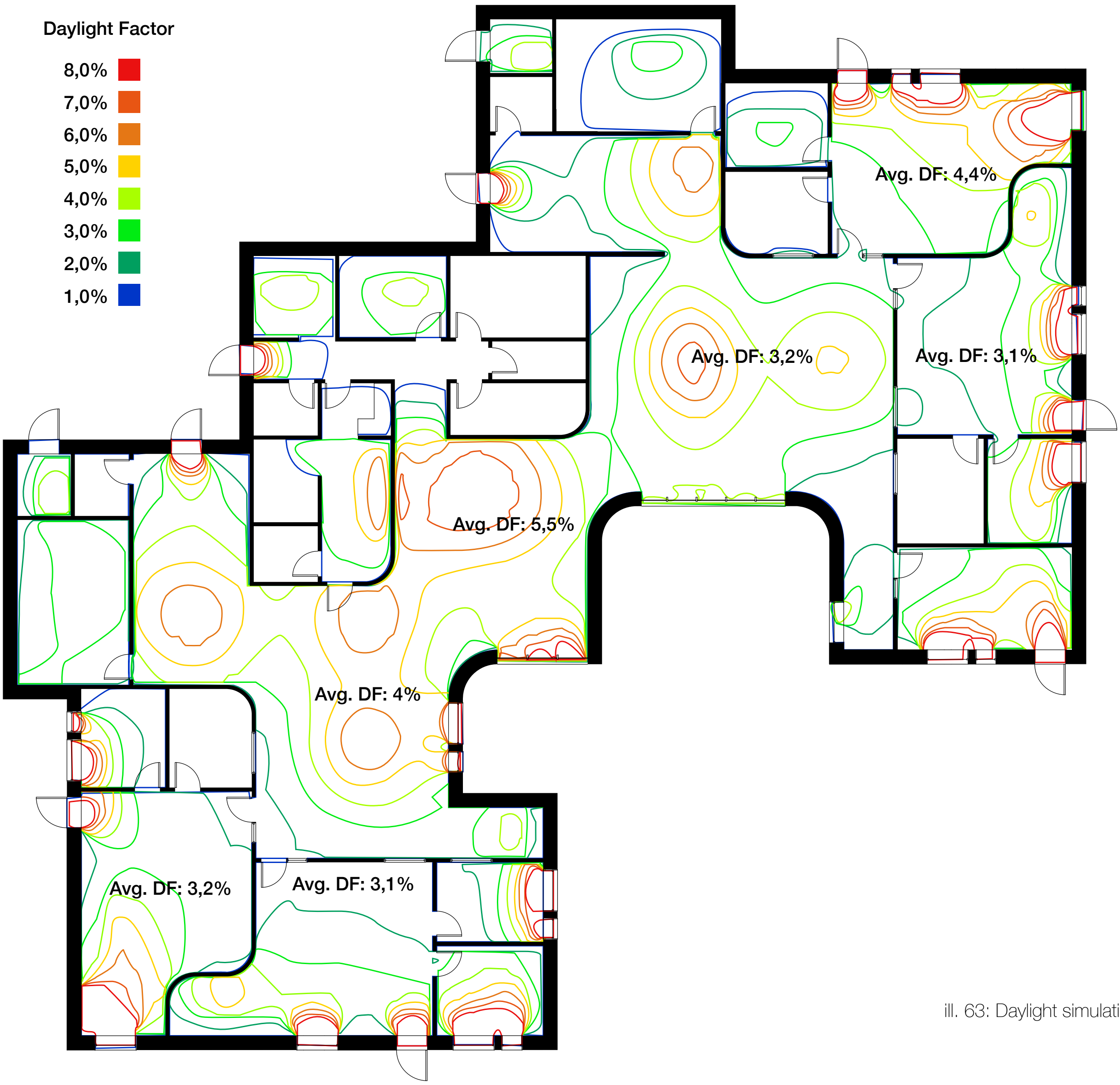
On the interior of the kindergarten the flooring is a vinyl acoustic flooring, made to absorb sounds and decrease both volume and reverberation time. This flooring not only have a good effect on the indoor climate but will also have a positive effect in the DGNB, as it is an easy material to clean and maintain. On the kindergarten terrace the material is like on the facade a thermal treated wood material, a material which is resistant to mold and fungus and will not absorb moisture like regular wood will. The main material of the kindergarten playground is grass. The grass is chosen to relate the kindergarten to the rest of Karolinelunden and to provide the kindergarten with nature. In the meantime the grass will also invite the children to different paces as it can be used as a soft material for seating and playing near the surface, but it can also be seen as a fall surface and invite to more active play as it can dampen hits and falls. In between the grass of the playground, around the kindergarten and to the main entrance, the paving is made with concrete tiles. This paving will invite to even more speed, and as it is a very solid material, it will also be where the children will use all of their play vehicles.



ill. 62: Facade concept

Windows

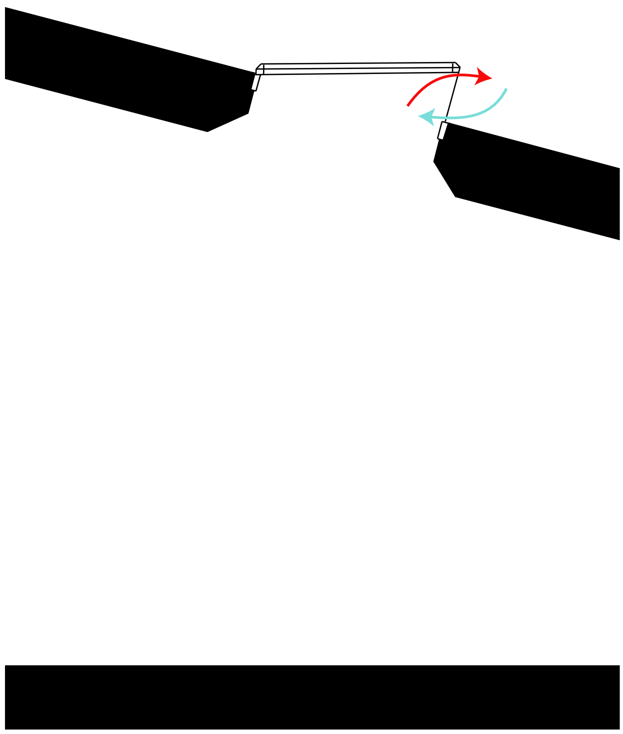
The windows of the kindergarten is designed to have a playing feel to it, but most of all it is designed to create the best possible settings in a learning environment for the children. This is helped on its way by designing with the needs of natural light which will not only help on the learning, but also on health and wellbeing. Therefore the glazing area of the building is in general high, and the windows individually are quite large. When the facade provides the amount of light as it does it also decreases the needs of artificial lighting and therefore the needs of electricity. To make the playing facade and still have a logical system, windows in two different sizes are used while they are jumping in the facade in intervals of 25 cm. The kindergarten is designed in a way that have all rooms reach a fulfilling amount of daylight through the facade, except for the deep rooms like the wardrobes and the shared common rooms. These rooms are therefore solved in other ways when it comes to needs of natural daylight. The shared common rooms are at some areas covered with the same system of windows as the remaining of the build, while it towards the covered terrace and playground is opened with curtain walls, both to provide more daylight, but also to have more connection to the outdoors. Since this have proven to not be enough to reach an average daylight factor of 3% the shared common rooms are helped with skylights (see page 93). The skylights is also the solution for the wardrobes since it have a small facade area to the depth of the room.
With the skylights installed every common room and educational room is reaching an average daylight factor of at least 3% as seen on the following page.



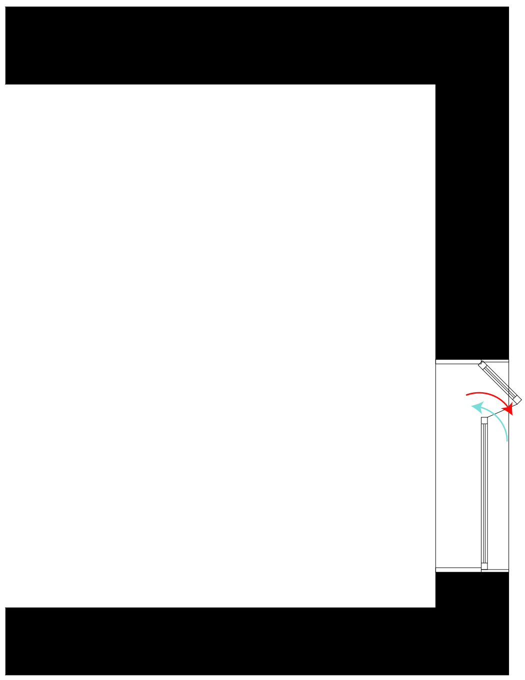
ill. 63: Daylight simulation

ill. 64: Use of the windowsill
as niches

To exploit the thick walls and the window openings even more the lowest placed windows are placed only 25 cm above the floor. Doing this makes the windowsills an extra area for the children to sit and read, relax or play. It will also help to make a stronger connection between the inside and the outside for the children.
The windows used in the kindergarten are of the



ill. 65: Skylight



ill. 66: Window opening

type VELFAC 200 ENERGY. These windows are designed specifically to improve sustainability in the building sector. The windows are therefore developed with a Uw value on only 0.8 W/m^{2}K and a slim profile to improve the intake of daylight. Other than that all the tree in the VELFAC 200 ENERGY windows are FSC certified while approximately 50% of the aluminium is recycled.
Furthermore the windows come with a mechanical system which opens the top of the window automatically. This helps both as a security system as mechanical smoke ventilation in case of fire, but also helps as it can increase the use of natural ventilation and therefore increase both thermal and atmospheric comfort in the kindergarten (Velfac 2 n.d.). In the common rooms the skylights will also open automatically to be used both as smoke ventilation and natural ventilation. With the windows placed that high the natural ventilation will work with the concept of thermal buoyancy.

ill. 67: The terrace

DGNB

DGNB have been used as a guide tool in the designing of the kindergarten where especially the social sustainability have been important as it covers subjects like indoor climate and exterior qualities which are very important for the people using the kindergarten. But as the social sustainability have been the most important, the environment sustainability comes a close second. The environmental sustainability are covering the building environmental impact. While these parameters have been following the design close, the other subjects have been under consideration as well with technical and economical aspects. Only the process quality have not been a part of this project as it is not decided in the designing but before and under construction of the kindergarten.

The kindergarten are covering some of the most important parameters in the following ways:

SOC 1.1 Thermal comfort:
The thermal comfort are secured in the kindergarten as it keeps a temperature around 22-23 °C year around and there are only few hours of overheating, and almost non outside of the holiday periods (see page 87).

SOC 1.2 Indoor air quality:
The indoor quality of the kindergarten is secured with a relatively high ventilation rate calculated on the base of the sensory experience, the calculations can be seen in appendix 01.

SOC 1.4 Visual comfort:
In the kindergarten design, one of the main focuses have been openings in the facade and therefore the kindergarten are covering every aspect of this subject with a high level of daylight (see page 77), visual contact to the outdoors and modern artificial lighting equipment to reach a high level of colour reproduction.

SOC 1.5 User control of the indoor climate:
The indoor climate will be controllable in the matter of visual, thermal and atmospheric comfort as it is possible to turn on and off the light if necessary and to manually open the windows in the two lowest heights.

SOC 2.1 Availability:
To increase availability for the kindergarten the building is in one plan, except for three office rooms on the second floor. To compensate for these offices, there is an office in the first floor as well if there should be disabled people working in the kindergarten. Between first floor rooms the doors is accessible by wheelchair and there is made a toilet suitable for disabled persons.

SOC 3.3 Space disposal:
With light frame construction applied to the partition walls the space of the kindergarten are very flexible as it is easy the remove a wall, or to put up another. The large common rooms in the center of the building together with the large playground is also counting up in this account like the visual connection to the surroundings through the large glazing area.

ENV 1.3 Environmental impact in invention of materials:
By using FSC certified wood in the kindergarten this subject is covered since FSC wood have even higher standards than DGNB.

ENV 2.3 Efficient land use:
As the building plot is on a former build site the efficiency of the land use is high. And with the introduction of the green roof and green playground the environmental footprint will be improved as well.

TEC 1.2 Acoustics and sound insulation:
As confirmed on page 88 the acoustic comfort of the building is high and have been in focus when choosing materials for floors as well as for roofs. At the same time the partition walls have been insulated just to improve the acoustic relations.

TEC 1.3 Envelope quality:
The building envelope is fulfilling the building regulation of 2020 and is therefore of highest standards. The envelope is reaching a high U-value and only the best windows are used. For more details about the envelope appendix 04.

TEC 1.6 Fitness for removal and recycling:
The kindergarten are mainly constructed of wood materials which have a high recycling value and is easy to disassemble.

ECO 2.1 Flexibility and adaptation:
As the kindergarten are built by light wood frames it is very flexible as it is easy to remove walls or add new. This will make the building able to adapt new functions and therefore economic as it is not necessary to demolish the building if the current function have to be changed.

Zero Energy Building

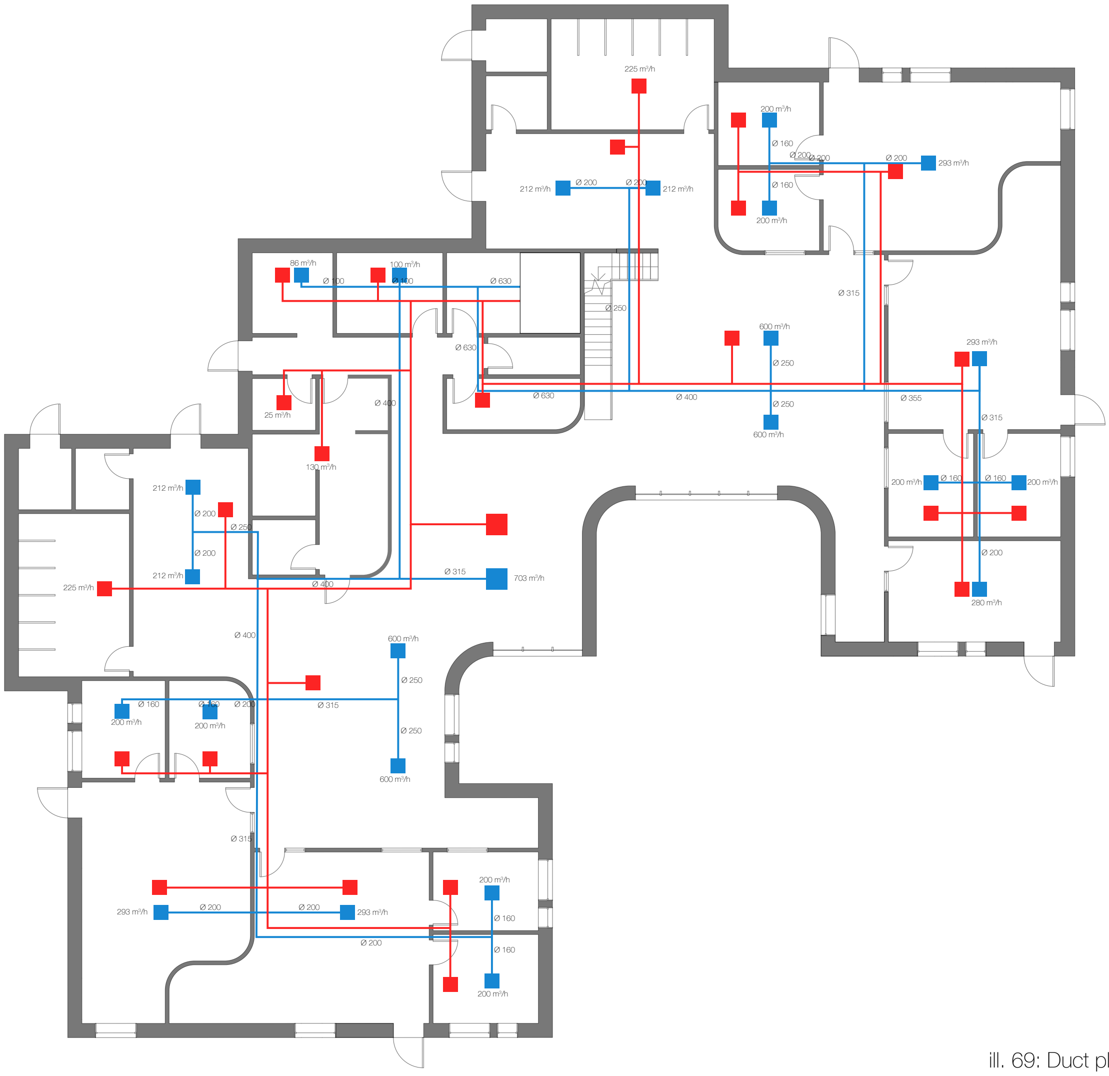
For the kindergarten to reach for a Net Zero Energy Building (NZEB) it is build with a low energy use and completing the energy goals for a BR2020 building by only using 24.9 kWh/m^2 year, for further elaboration of this see page 86.
One of many ways to keep down the energy needs are by ensuring the building is well insulated and in the case of the kindergarten the building is well insulated with outer wall reaching as low an U-value as 0.07 W/m^{2}K, the roof is reaching a U-value of 0.06 W/m^{2}K and the slab is as the outer wall reaching a U-value of 0.07 W/m^{2}K (to see the specifications see appendix 04).
Other than keeping a high level in the insulation to keep down the costs of energy use for heating, other methods like passive strategies are used as well. Passive strategies like natural ventilation which will help lower the energy use for ventilation (see page 79) and passive solar heating where the many windows in the facade will help heating the rooms.

With the kindergarten using 24.9 kWh/m^2 year, which have to be covered with some sort of renewable energy, and in the case of the kindergarten it is solved using solar cells. By calculating in Be15 the kindergarten should be able to reach the level of zero energy by using 79 m^2 of polycrystalline cells, placed on the most tilted part of the roof reaching a 25 degree angle. This also means that the kindergarten not only can reach and become a net zero energy building, it can also become a plus energy building by integrating more solar cells to the remaining parts of the roof.

ill. 68: Construction principle

Construction

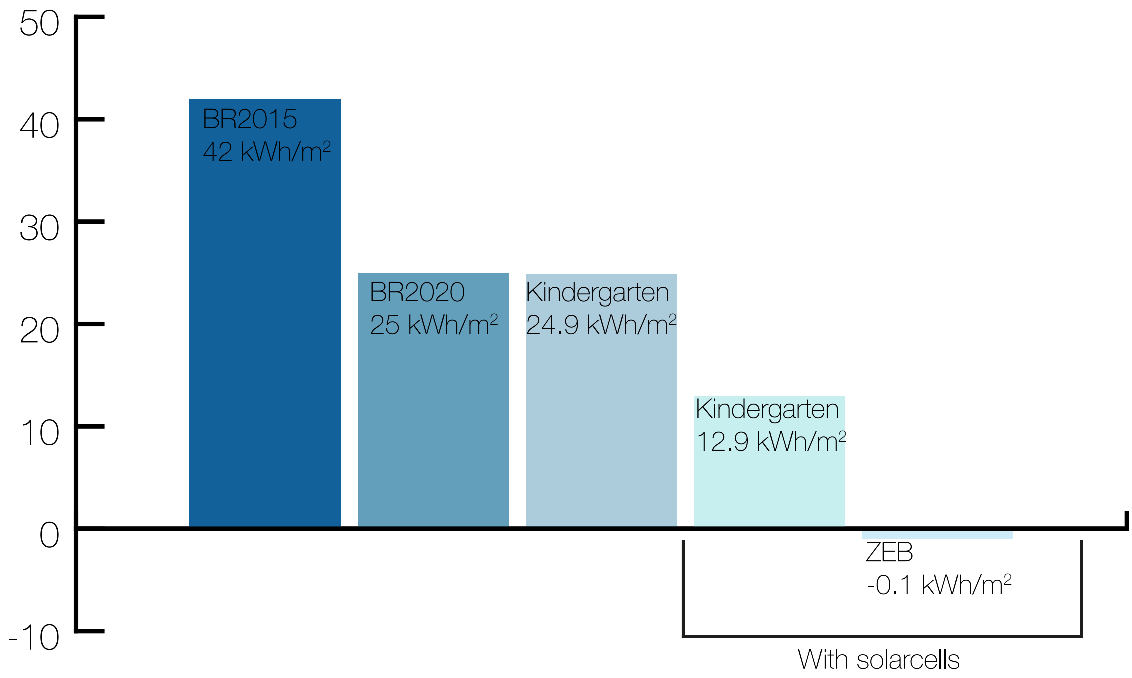
The construction concept of the kindergarten is considered done with the outer walls made up of a lightweight timber frame construction inspired from the balloon frame principle. This construction will force the vertical loads through the columns of construction timber to the concrete foundation. In the cases where the columns meets a window the load forces are transferred to the two nearby columns by a horizontal beam over and under the window. These timber frame walls will be supporting and hold the roof, but they cannot do it by themselves, they will be supported by steel columns hidden in partition walls which are also made in a light construction. The placement of the steel columns are shown conceptually in a plan drawing (appendix 04).



ill. 69: Duct plan

Ventilation

The ventilation system in the building is a VAV (variable air volume), which is a system that regulate the airflow according to the actual need. The reason for choosing a VAV system is that it is more energy efficient than a CAV (constant air volume) (Hvenegaard 2002), and when designing kindergarten where the aim is to reach the 2020 energy frame it make sense to chose the more energy efficient system. Besides that there will be different amount of activities in each room during the day where it makes sense to have a ventilation system that can regulate to fit the pollution in the air. To find out the maximum air flow for each room the air change rate [L/s/m^2] was calculated.
The ventilation rate can be calculated in different ways, according to which source would need the highest rate of airflow (appendix 01). In this building it is the sensory pollution (Olf) that is the source for the ventilation rate. This calculation was used for calculating the size of the ventilation ducts, for the be15 energy calculation and for the Bsim simulation of the indoor climate.
There is different ventilation principles, which have an effect on how the duct plan (ill. 69) would look like. The princip used for the kindergarten is the mixed ventilation principle, which is where fresh air is added to the room in a way where it will mix with the polluted air (indeklimaportalen 2016). Usually, when using this principle both the insufflation and the extraction will be placed in the ceiling, which means that all pipes will be attached to the ceiling. The duct plan, as seen above, shows the inlet and outlet and how the ducts are connected to each other, it also shows the amount of fresh air needed for each inlet and the duct sizes. The ventilation aggregate needs a total capacity of 8359.2 m^3/h to be able to supply the whole kindergarten with fresh air.
The ducts will be hidden by a suspended ceiling.

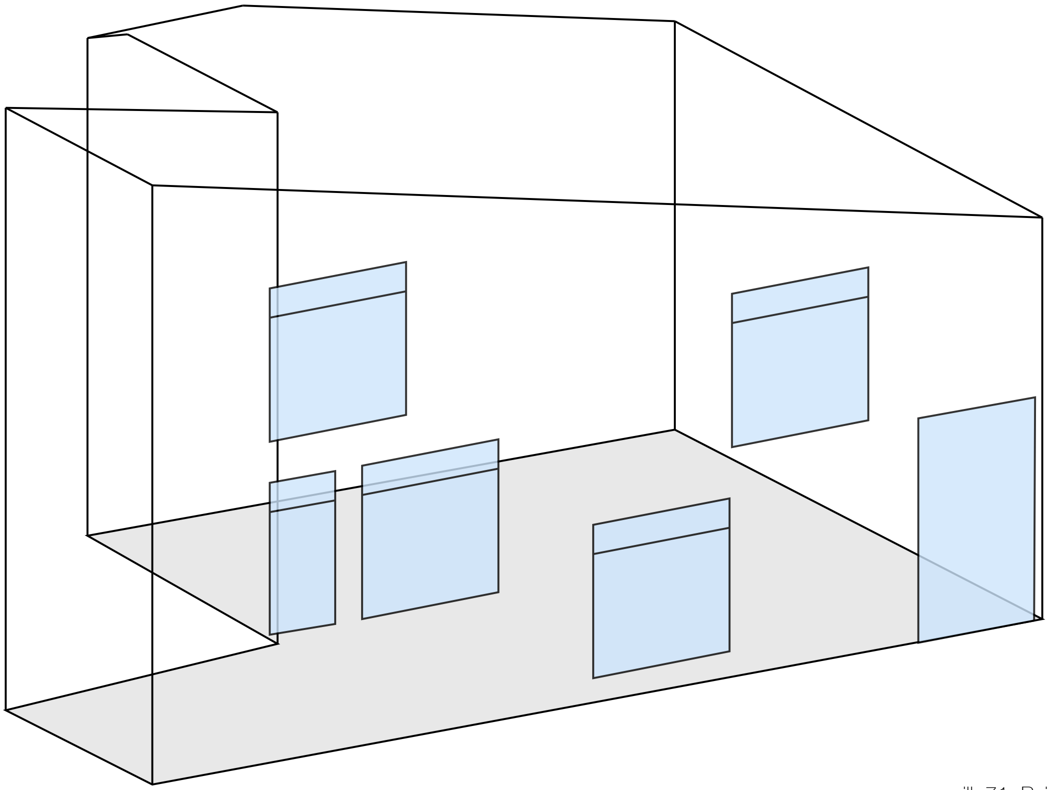


ill. 70: Energy use

Energy use

The building aims to fulfill the energy frame for BR2020, which states that a non-residential building cannot exceed 25 kWh/m^2 year. For calculating the energy use in the building there is used the Be15 software.
Without solar cells the building just reach the energy requirements with a energy use of 24.9 kWh/m^2 year (appendix 05).
Applying 38 m^2 of solar cells on the south facing rooftops will lower the energy use to 12.9 kWh/m^2 year. At the same time it also means that the electricity for operating the building will be zero. To reach a zero energy building the amount of solar cells will have to be increased to 79 m^2 and the building will have to be connected to a grid where it is possible to sell excess energy produced by the solar cells and to get energy in periods with no sun and therefore not enough produced energy.
Another solution would be to have some batteries where it would be possible to store the excess energy to use for a later time.

U-value roof: 0.06 W/m²K	U-value windows: 0.08 W/m²K	Air change rate: 0.9 - 2.9 l/s m²
U-value wall: 0.07 W/m²K	g-value windows: 0.5	Heat recovery: 86%
U-value floor: 0.07 W/m²K	Solar cells: Peak power: 0.17 Rp: 85%	SEL: 0.6 kJ/m³
Line loss: 0.01 W/mK		



ill. 71: Bsim simulation model

Indoor climate

To analyze the indoor climate a critical room was selected. The room selected was the large group room facing south with adjacent rooms to both sides and plenty of windows. The heat gains from the sun and people makes it necessary to keep the room well ventilated while it is also ventilated to keep sensoric discomfort down. This means the room is ventilated more than what is the demand of the Danish building regulation. The calculation is based of a full group room with 25 children and two pedagogues in the period from 8-12 where they are supposed to be in the room. From 12 to the kindergarten closes there is a varied people load as the room will be free for use, but so will the rest of the kindergarten. The kindergarten is on summer holiday in the period of weeks 26-35, and the overheating hours from this period is subtracted. In the summer period where there is no holiday the room is provided with natural ventilation through an automatically opening part of the windows while it is also possible to open the windows manually all year around.

The calculations for the indoor climate are made in the software Bsim and this group room fulfills every requirement for both temperature and atmospheric comfort.

Hours above 26 ^{o}C/year:

25 h

Hours above 27 ^{o}C/year:

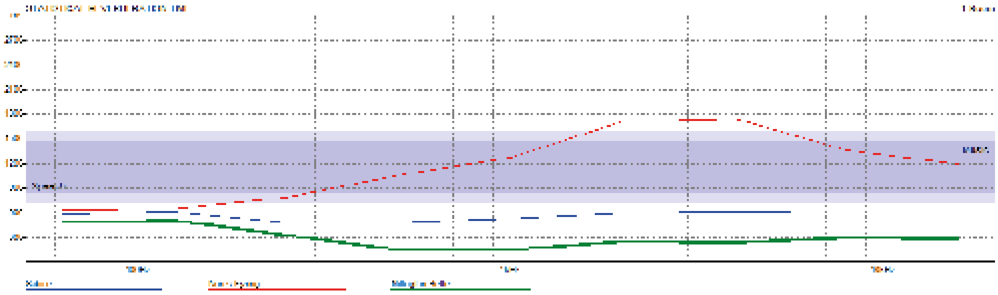
0 h

Hours above 28 ^{o}C/year:

0 h

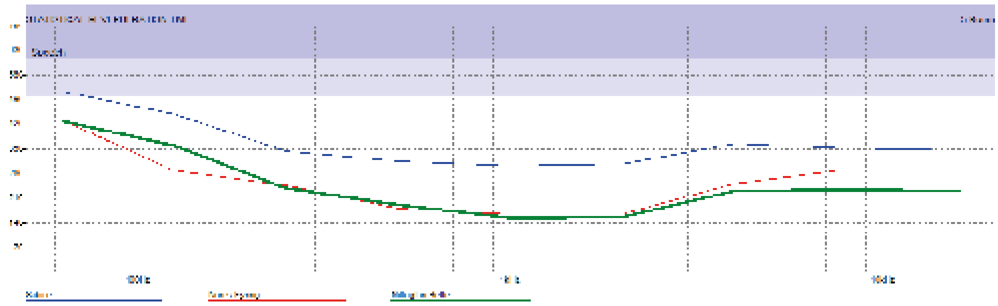
Max CO_2 level:

889.6 ppm



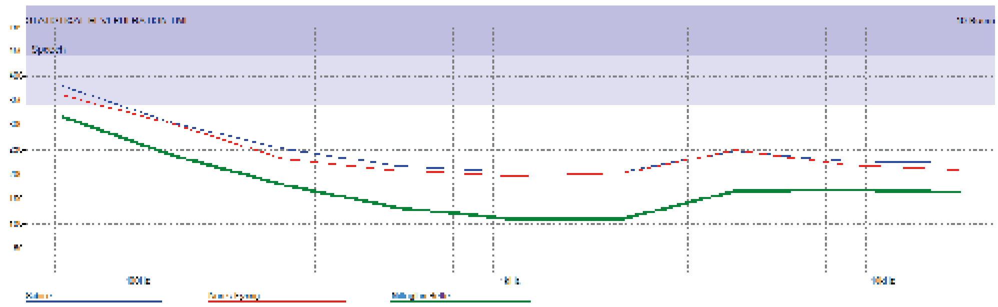
ill. 72: Sound spectrum
common room

63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	16000 Hz
0.49 s	0.51 s	0.33 s	0.15 s	0.16 s	0.25 s	0.24 s	0.19 s	0.29 s



ill. 73: Sound spectrum
group room big

63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	16000 Hz
0.43 s	0.36 s	0.24 s	0.19 s	0.16 s	0.16 s	0.23 s	0.24 s	0.23 s



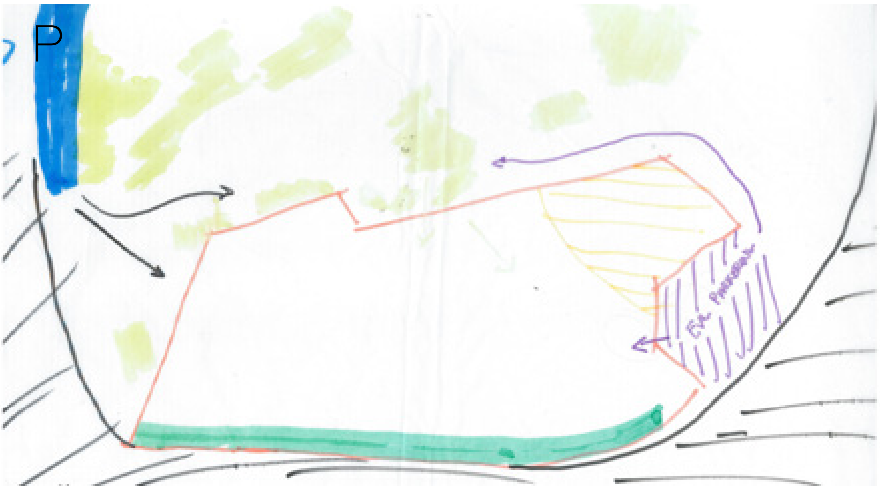
ill. 74: Sound spectrum
group room small

63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	16000 Hz
0.32 s	0.24 s	0.18 s	0.13 s	0.11 s	0.11 s	0.17 s	0.17 s	0.17 s

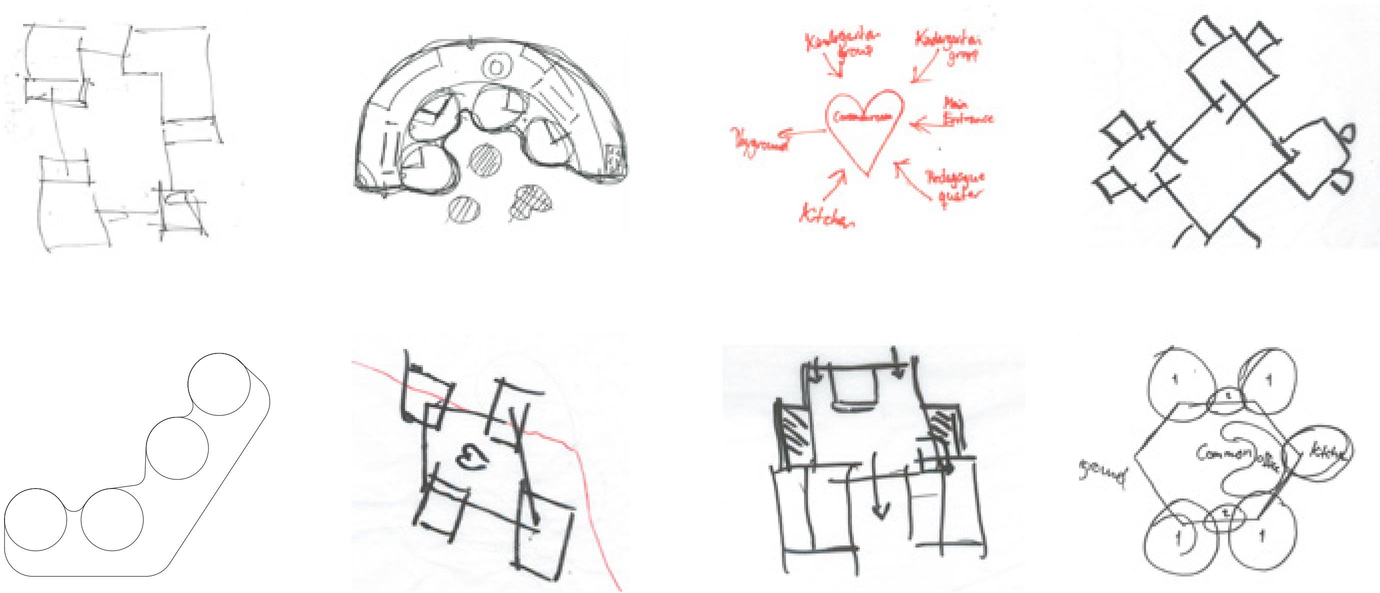
Acoustics

The acoustics in the building is solved by having an acoustic ceiling and an acoustic vinyl floor. The acoustic ceiling is chosen to cover the entire ceiling, because of the requirement of a reverberation time lower than 0.4 seconds from the building regulation and it gives a more calm look to the ceiling. The vinyl floor is not only chosen because of the acoustic effect it has, but also because of easy cleaning and a slightly resilient surface for better walking conditions. These two acoustic approaches does that the reverberation time gets under the required 0.4 seconds (as seen above), which also means that it won't be necessary to have acoustic panels on the walls, and therefore the walls are free space to display the kids drawings and other creations.
Even though the reverberation time is below the requirements, it does not always help the issue of a high noise level in kindergartens. The noise level is measured in decibel and is therefore first possible to measure after the building is built and has been taken into use.

DESIGN PROCESS



ill. 75: Site, arrival

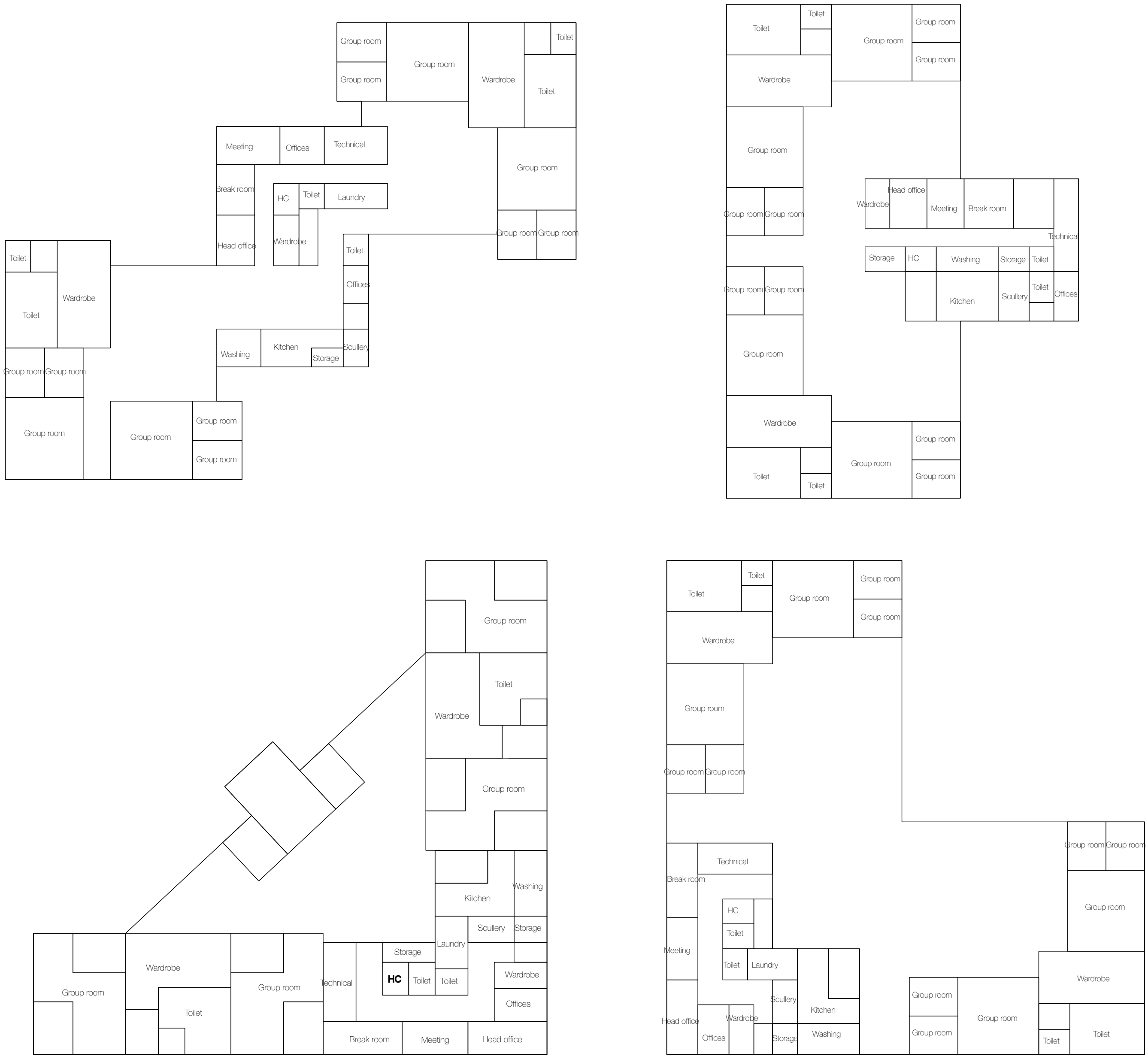


ill. 76: Sketching proposals

Start-up

In the beginning of the design process, it was important to understand the design brief and the analysis. This would make it easier to see if a sketch or idea would be something to work further with.
From the analysis it could be seen that there was a limit to how big the building could be, even though the site is quite big. At the same time there is a boundary to where the kindergarten can be placed on the site, because of the Tulip factory next to Karolinelunden. These two factors had a big impact on how the design process would develop.
It was important to come up with some different ideas on how the layout of the building could be, both to have some ideas to work further with but also to see if there was some elements that would come up multiple times.
One thing that was a criteria for the design, was a central place where the children could gather for eating or other common activities. From this place there should be access to the group rooms, the kitchen and the offices. This idea about a common space is something that is inspired from the Reggio Emilia philosophy where they work with a 'piazza' in the building like in the outside world. This idea is easy to see from the drawings above, the difference between them is how this common space is arranged and how the other functions is connected to it.

With a variety of sketches and idea it was important to try them out with a plan solution and it was important to find out how many units should be attached to the common space. From the design brief it was stated that there would be four kids groups and two groups would share a wardrobe. The next step would therefore be to find out how the kids group rooms should be attached to the common space and how they should be arranged according to each other.

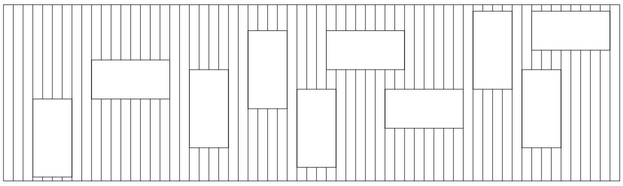


ill. 77: Plan sketching

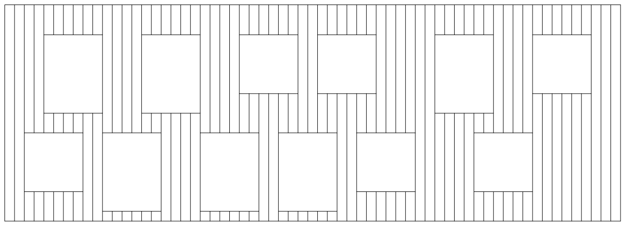
Plans

The internal flow in a kindergarten has a huge impact on the daily work for the pedagogues. The internal flow also plays a role for the children, as the kindergarten is the place where they spent most of their waking hours. The plan solution should therefore create an environment that for the children is a place for play and learning, but at the same time is a solution that for the pedagogues is manageable and easy to navigate in. A manageable plan solution will also help the parents way through a space they do not spent many hours in. One of the most important factors for the parents is where they should deliver and pick up their children. Therefore the entrances and the wardrobe for the children should be easy to access both from the outside and the inside.
The wardrobe is also the access point to the playground, and should therefore be placed so it give access to the playground so the children do not bring dirty shoes and clothes through the common spaces in the kindergarten, which also got pointed out from the visit to Tiziana.
Another idea from the visit to Tiziana was to have doors to the outside from nearly every room, which makes it easy to access the outdoor and was something they used a lot during the summer time. The doors would not only provide an access to the outdoor, but also encourage to use the outdoor when the weather would allow it. Besides that they would also function as an emergency exit in case of fire.

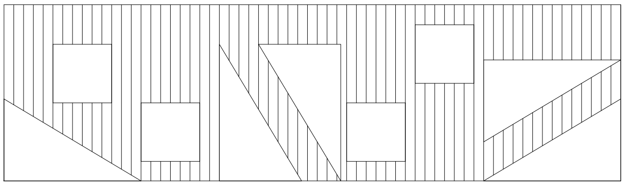
Because the internal flow between outdoor/indoor and between different functions in the building means that much, it was the first aspect that needed to settled. This made the design of the building in the end would be a process of designing from the inside and out.



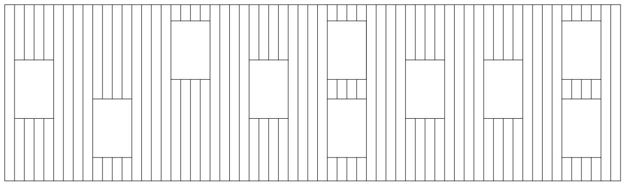
ill. 78: Facade 1



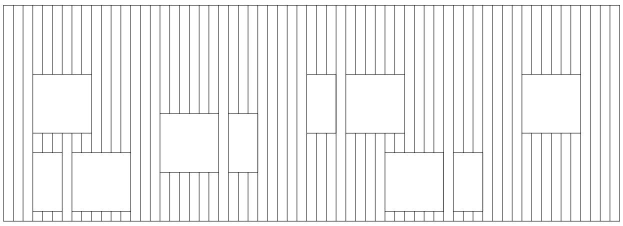
ill. 79: Facade 2



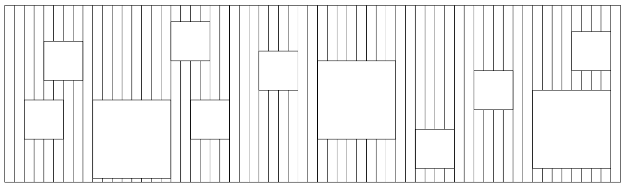
ill. 80: Facade 3



ill. 81: Facade 4



ill. 82: Facade 5

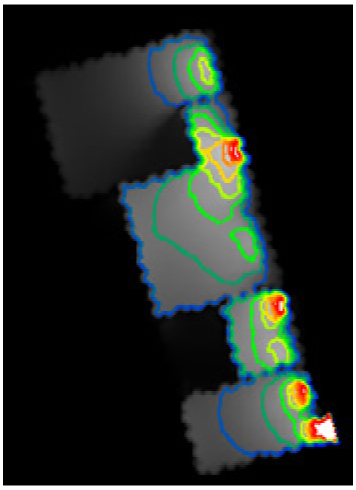


ill. 83: Facade 6

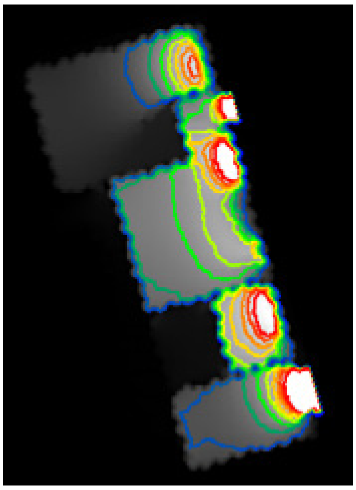
Facades

In the designing of the facades different window opening was investigated. In the process the most important factor was the daylight coming through the windows. To ensure the daylight is sufficient and every large group room and common room reach a daylight factor of at least 3%, every design was tested in one facade of the building in the software VELUX Daylight Visualizer 3. Whilst the daylight factor was important, so was the buildability and therefore it was important to make a system which made sense and made a rhythm which was buildable. Other than this it was found important to make windows in children's height as it is a kindergarten and the children are the main focus, but at the same time also keep in mind that a kindergarten is a workplace for the pedagogues. To make the windows even more exciting for the children, the windows are put far out in the wall to make a deep space for seating, relaxing and playing on the inside of the facade.

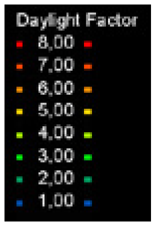
In the start lots of different designs were tried, some with only one size and form of windows, and some with two or more different windows. Some of the designs were made with a loose system to make the facade more playful and variated, others were made with a more strict system to increase the buildability and give the building a more steady and calm look.

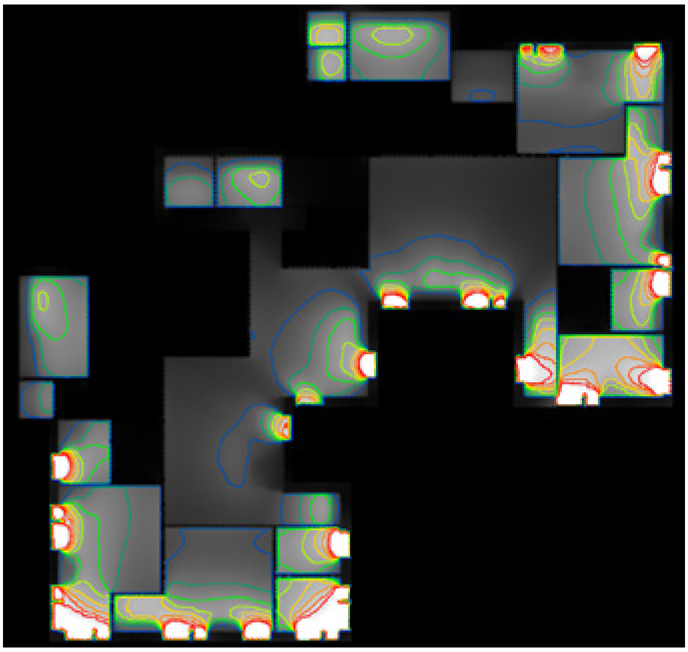


ill. 84: Daylight from facade 1

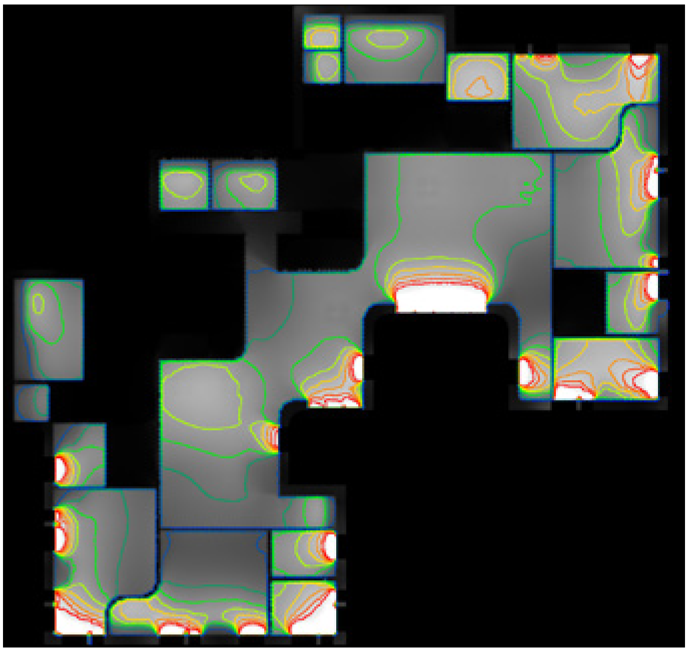


ill. 85: Daylight from facade 6





ill. 86: Daylight from facade 5

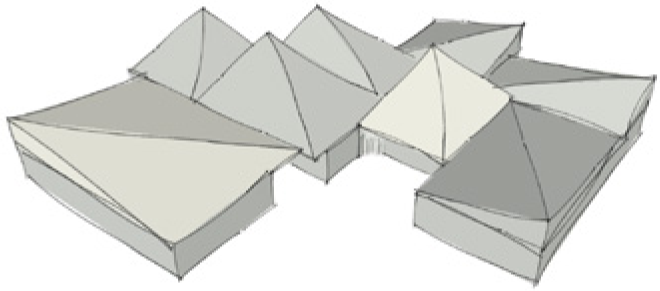


ill. 87: Daylight from facade 5 with curtain walls and skylights

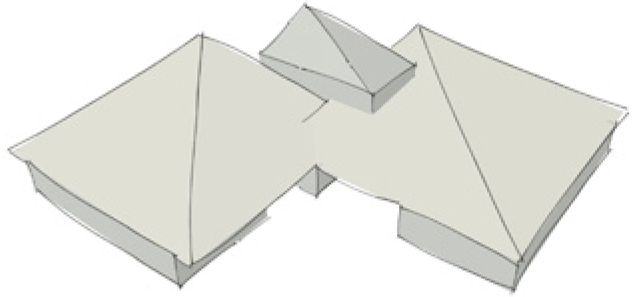
Daylight

The daylight tests done in VELUX Daylight Visualizer 3 made it very clear that to get a sufficient daylight factor in the rooms, and all the way to the back of the rooms, the glazing area in the facade had to be high. The illustrations shows some daylight visualizations from tests made in just one facade and referring to the facade design on the page before (ill. 84-85).

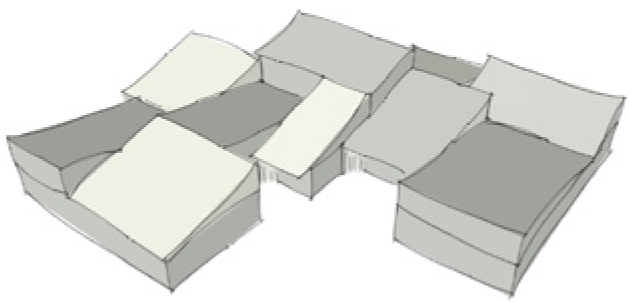
Through the visualizations it became clear that to get enough daylight all the way into the deep common rooms sky lights were necessary. It is also based on the daylight visualizations that the curtain walls to the "courtyard" are found necessary. The curtain wall system will also provide more transparency to the kindergarten and connect the inner common room with the outer common room, the playground.



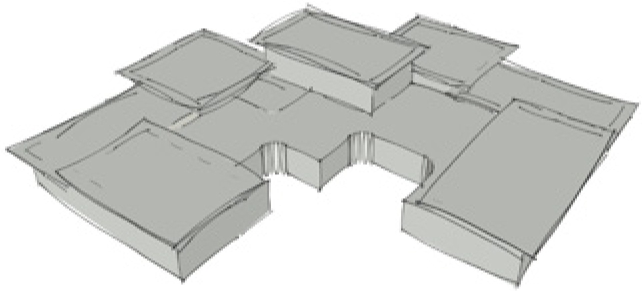
ill. 88: Roof 1



ill. 89: Roof 2



ill. 90: Roof 3



ill. 91: Roof 4

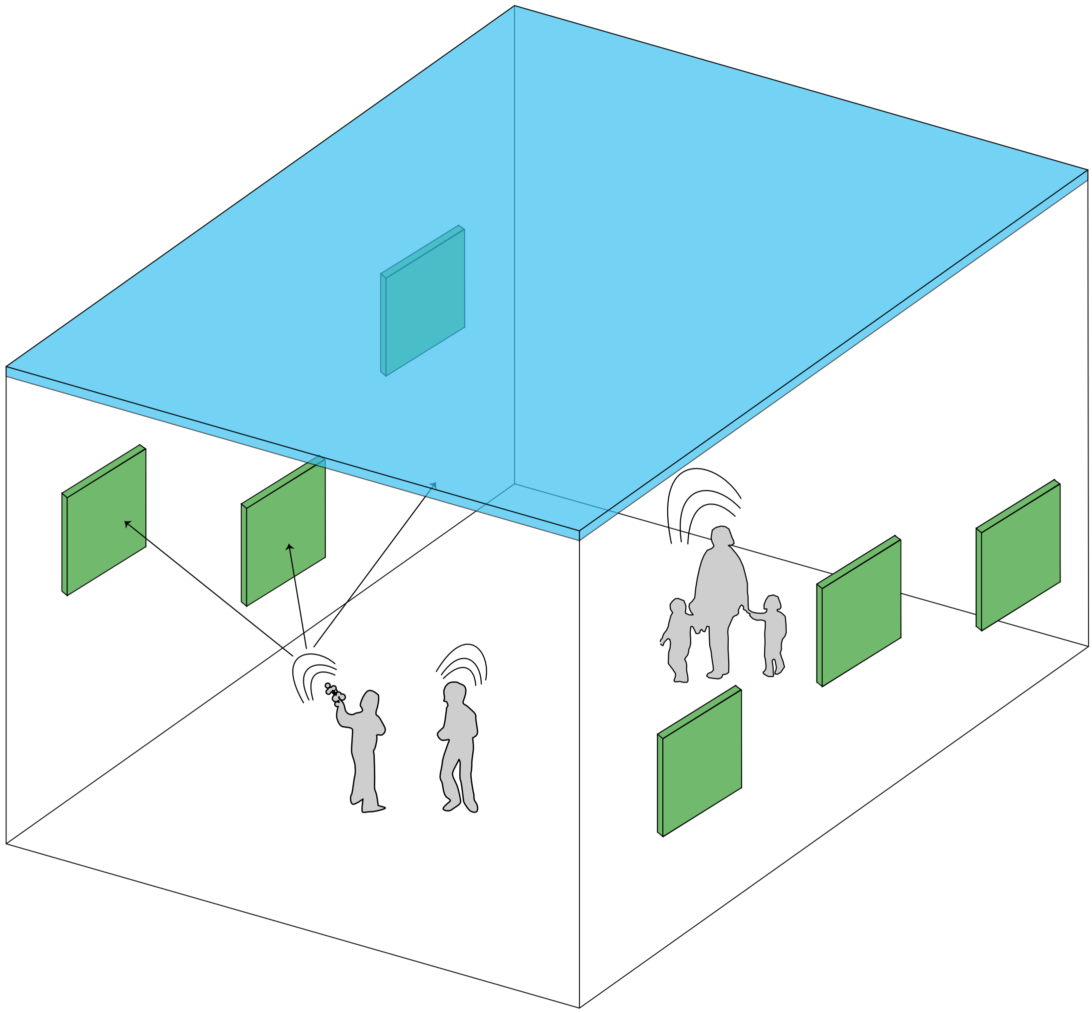
Roof

The roof is the building element that might be the least visible, because it is usually not placed in eye height. Even though it might be a bit out of sight it can still help giving the finishing touch to the building, and can even be seen as the fifth facade. That is also why it was important to have a roof that could be an integrated part of the building and help giving a unity to the overall expression.

In the design brief it is stated that the municipality want a building with varying heights, and from the district plan it was stated that the building could not be higher than 8.5 meters. And with a vision on integrate sustainable parameters, solar cells and a green roof, it made sense to have some kind of pitched roof, because it would make the varying heights and it would be possible to integrate the solar cells on the roof surface.

An optimal inclination for the solar cells would be 30 degrees facing south, but with a 30 degree inclination the building would in some places be higher than 8.5 meters and it would give some extremely high room heights which was not desirable.

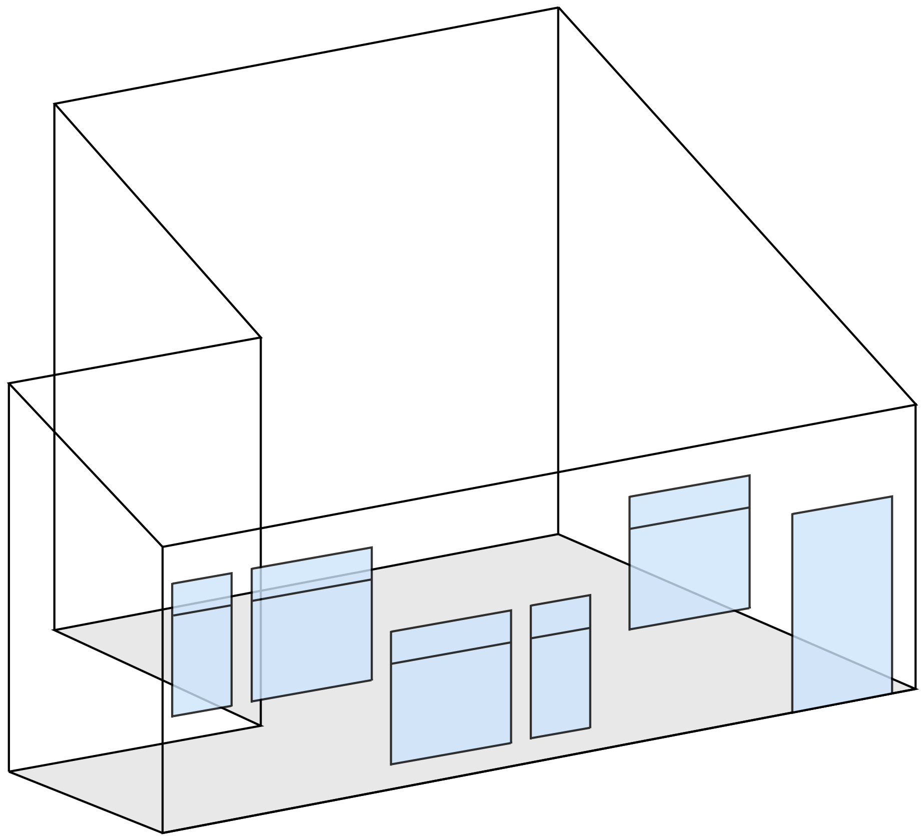
The inclination had to be a symbiosis between the aesthetic and sustainable aspects and still be an integrated part of the building.



ill. 92: Acoustics

Acoustics

The Danish building regulation states some acoustics properties that have to be fulfilled. It is both about noise level from the surrounding environment and the reverberation time in the kindergarten. The noise from the surrounding is solved by establish a sound barrier towards the high trafficked road on Jyllandsgade/Fyensgade.
The reverberation time is in the building regulation stated to be 0.4 seconds or lower. To simulate the reverberation time in the building, there is used Ecotect as a tool. To reach this requirement there is often needed large areas of sound absorbing materials, where an acoustic ceiling is one of the most used solutions. Another solution that is often used is acoustic panels mounted on the walls, but with this solution there will be less space to display of the children's creations. Another aspect is the furnitures and people, that also will have an effect on the reverberation time.
To get a better understanding of the building and what actions there had to be made to reach a sufficient reverberation time, there is as a start simulated on a building with standard hard materials on the surfaces. The results gave (appendix 02), as expected, some quite high reverberation times, which just confirmed that an acoustic ceiling would be necessary and that an acoustic ceiling would not be enough in itself.



ill. 93: Bsim simulation model

Hours above 26 ^{O}C/year:	Hours above 27 ^{O}C/year:	Hours above 28 ^{O}C/year:	Max CO_2 level:
106 h	5 h	0 h	874 ppm

Indoor climate

When the general shape and plan solution was found in the design process, a indoor climate analysis was conducted and calculated through the building simulation software Bsim. This Bsim model was made on basis on the first idea of what could have been the final result. The results of the Bsim model also shows that on the stage when the analysis was made the design was almost complete, and the general knowledge about and ideas of how to improve and make a good indoor climate have been more than sufficient.

The Bsim model is made with the same ventilation, venting, heating, people and equipment load as used in the be15 calculation.

To fulfil the building regulations the room can only have a certain amount of hours above 26 and 27 degree which should be determined by the builder, if it had been a house it would have been no more than 100 hours above 27 degrees and no more than 25 hours above 28 degrees (Bygningsreglementet 5 2015). With that in mind, it could be logical to choose the same amount of hours just with the higher temperatures. Another demand to fulfil is the sensoric demands, where it is said in the building regulation that the amount of CO_2 in the air should not be more than 1000 ppm in a longer period of time (Bygningsreglementet 3 2015).

ill. 94: Playground layouts

Playground

The playground in a kindergarten should have room for different activities. Activities that is stationary and activities in motion without interfering with each other.
Besides that it can be seen from the analysis that the site is placed just next to a trafficked road, which means that some of the site will have to be used as a sound barrier. This sound barrier is proposed in the masterplan for Karolinelunden to be a natural hill landscape that of course have been taking into consideration when working with the playground. First of all it was needed to find a shape and height for the hills, a balance between high enough to have an effect as an sound barrier and low enough to make as little shadow for the building as possible. An idea was also to use it as an integrated part of the playground, with functions such as a slide coming down from it. It was a matter of exploit and see the potentials of having a hill landscape on the site. Another way to use the hills was to implement the sheds for playground equipment in the hills, and by that do not take up space on the playground.
It was important to find balance between paved areas and areas with grass, and as it can be seen above different systems and divisions of the site was tried. From the municipality plan there was a wish of implementing the atmosphere from Karolinelunden and that the playground could be open for the public outside of opening hours of the kindergarten. Especially the topic of the playground being open for the public was an issue, because there needs to be some kind of boundary for the kids and that it should be possible for the kindergarten to have a place to store all of their outdoor belongings.
In the beginning there also was an idea about implementing shared garden plots between the kindergarten and the public using Karolinelunden.

CONCLUSION

Kindergarten Karolinelunden is a sustainable kindergarten integrated to the recreative area of Karolinelunden in the heart of Aalborg. The kindergarten is the the home of 99 children and a staff of 20 people who will together with the building design embrace the pedagogical principles from Reggio Emilia. These children and employees will enter the kindergarten site through the new Karolinelunden under development based on the plans from COBE.

The inside of the kindergarten flows together with the new Karolinelunden through the transparent facade with windows designed for the children, as well as for the adults. This feeling is enhanced even more from the common room with the open facade towards the playground area which mimics the history of Karolinelunden with the playful paths which the children will enjoy to ride on their different vehicles. The orientation of the building and the facade openings are enhancing the possibilities for daylight, and with the hill landscaping on the playground the kindergarten is secured from noise interference from the nearby trafficked roads.

The Reggio Emilia is embraced by optimizing spaces and let rooms flow together with either physical openings or visual openings. These large spaces together with the group rooms are flexible as it is possible with room dividers or other furnitures to make room-in-rooms and the small group rooms can easily change function according to the needs just like the atelier and other rooms can.

To embrace the 2020 building regulation the building are developed with passive and active strategies in mind, therefore the energy needs are decreased and the building are with the use of solar cells self powering in a yearly perspective and if it is added to a renewable energy grid it will be a NZEB. To secure the sustainability even more Kindergarten Karolinelunden are designed with DGNB as a tool to secure a high sustainable standard and the kindergarten have completed in such.

REFLECTION

Designing a kindergarten on only 850 m^2 when inspired of the Reggio Emilia philosophy turned out to be quite difficult due to the philosophy works with a big common 'piazza' and extra rooms for creative expression. That have made it very difficult to comply to the 850 m^2 stated in the district plan and to implement an atelier and a big common room without exceeding the limit. A solution to this problem could have been to work with another pedagogical approach, but as the Reggio Emilia philosophy fits quite well with building sustainably and with other research about space in kindergartens it seemed like the best solution.

A playground is an important part of a kindergarten, because it is the place for fresh air and play for the children. It is a different kind of play that can take place in the playground than inside the building of the kindergarten, which therefore makes it a huge part in the children's development. The playground for this kindergarten is partly made with a background on the development plan for the area designed by COBE but it has also been a development in how to use the atmosphere of Karolinelunden and the already existing activities. It has been a challenge to find out how to plan the big area that is left for the playground, and it is a part of the project that could have been much more developed and investigated, which means that the proposal showed in the report is on a conceptual stage.

Because this project focuses on sustainability and indoor climate, there have not been much time to consider the structural principles of the building design. If this aspect had been taken into consideration during the design process the building might have turned out differently. The only issue really addressed in the design process was that it would be a light construction (a wood construction) and therefore it would be a thicker wall because of the lack of thermal mass to hold on to the heat. But as it is primarily a one plan building the biggest issue is how to hold the roof from collapsing.

As the kindergarten is the first step in the renewal of Karolinelunden, there have not been much context to consider, besides the vision and ideas from the district plan and the master plan from COBE.

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APPENDIX

Appendix 01 - Ventilation

The air change rate is calculated for the minimum standards from the building regulation and for Olf, to see which one would be the most sufficent one to use in the building.

The building regulation states that for kindergartens and schools you have to ventilate with a minimum amount of fresh air, which is 3 L/s pr. child, 5 L/s pr. adult and 0.35 L/s pr. m^2.

There is not so much difference between the two calculations, but the one where the air change rate is highest is the one calculated for Olf.

Room	Area	people load	Ci	C	Pollution	Airflow supply	Air change rate
	m^2		Olf	Olf	Olf	L/s	L/s/m^2
	A				People+(A*ci)	(Ci+10*pollution)/C	Airflow/A
Kids group room	327,87	75	0,1	1,4	107,7	769,97	2,34
Kids wardrobe	80,09	25	0,1	1,4	33,0	235,85	2,94
Kids toilet	74,28	10	0,1	1,4	17,4	124,55	1,67
Atelier	29,32	8	0,1	1,4	10,9	78,15	2,66
Common room	307,15	90	0,1	1,4	120,7	862,32	2,80
Offices	29,6	2	0,1	1,4	4,9	35,5	1,19
Meeting/break room	32,18	10	0,1	1,4	13,2	94,48	2,93
Adult wardrobe	13,68	2	0,1	1,4	3,8	24,12	1,76
Adult toilet	9,66	1	0,1	1,4	1,9	14,11	1,46
Kitchen facility	29,91	2	0,1	1,4	4,9	35,72	1,19
Tech	27,77	1	0,1	1,4	3,7	27,05	0,97
Storage	19,79	1	0,1	1,4	2,9	21,35	1,07

Room	Area	Adults	Kids	Airflow supply	Air change rate
	m^2			L/s	L/s/m^2
	A	B	C	(C*3)+(B*5)+(A*0,35)	Airflow/A
Kids group room	327,87	20	100	514,7	1,56
Kids wardrobe	80,09	4	50	198,0	2,47
Kids toilet	74,28	1	10	60,9	0,82
Atelier	29,32	2	15	65,2	2,22
Common room	307,15	20	100	507,5	1,65
Offices	29,6	2	0	20,3	0,68
Meeting/break room	32,18	12	0	71,2	2,21
Adult wardrobe	13,68	2	0	14,7	1,08
Adult toilet	9,66	1	0	8,3	0,86
Kitchen facility	29,91	2	0	20,4	0,68
Tech	27,77	1	0	14,7	0,53
Storage	19,79	1	0	11,9	0,60

Duct size

When having a pipe that has to support 200 m³/h it has to be changed into m³/s to be able to calculate the duct size.

$$\frac{200m^3/h}{3600sek} = 0.055m^3/h$$

The area of the duct can be calculated as:

$$\left(\frac{\pi}{4}\right) \cdot d^2$$

But as it is the diameter we need to find it will be:

$$\left(\frac{\pi}{4}\right) \cdot d^2 \cdot 3m/s = 0.055m^3/s$$

⇓

$$d^2 \cdot 3m/s = \frac{0.055m^3/s}{\left(\frac{\pi}{4}\right)}$$

⇓

$$d^2 \cdot 3m/s = 0.07m^3/s$$

⇓

$$d = \sqrt{\frac{0.07m^3/s}{3m/s}}$$

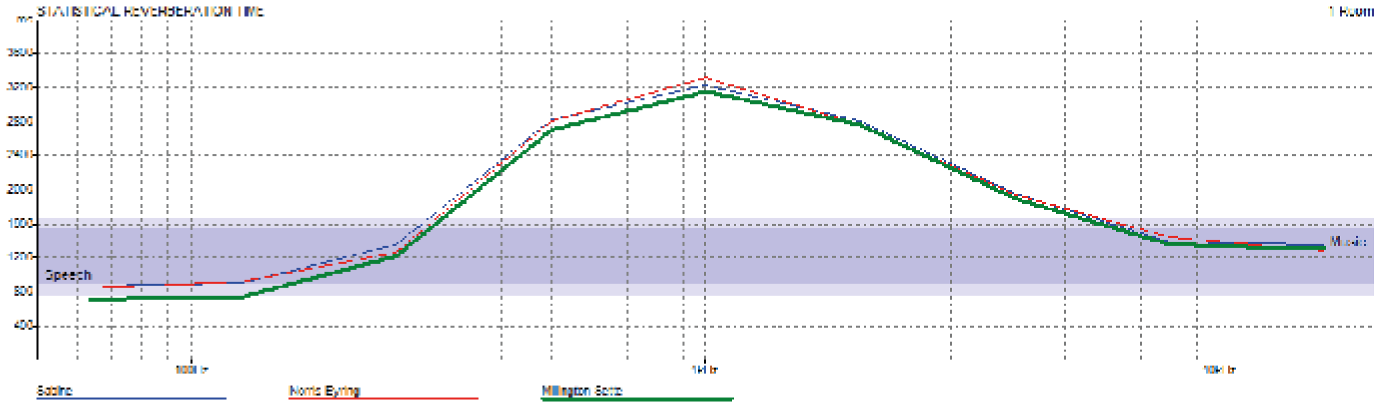
⇓

$$d = 0.152m \quad \approx \quad \underline{\underline{160mm}}$$

Because there do not exist a duct size of 152 mm it will be a duct size of 160 mm.

Appendix 02 - Acoustics

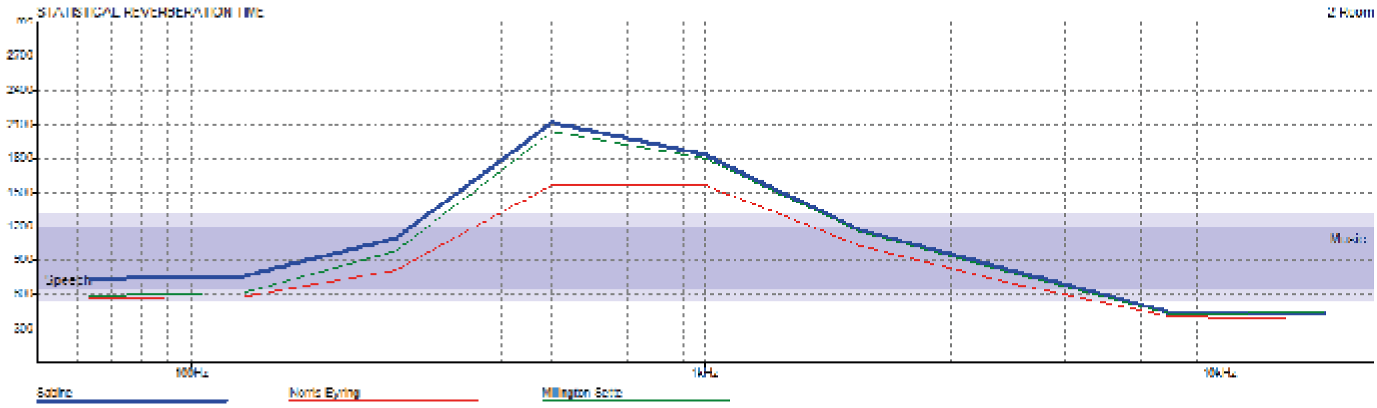
Common room



ill. 95

63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	16000 Hz
0.71 s	0.74 s	1.22 s	2.71 s	3.15 s	2.76 s	1.89 s	1.35 s	1.31 s

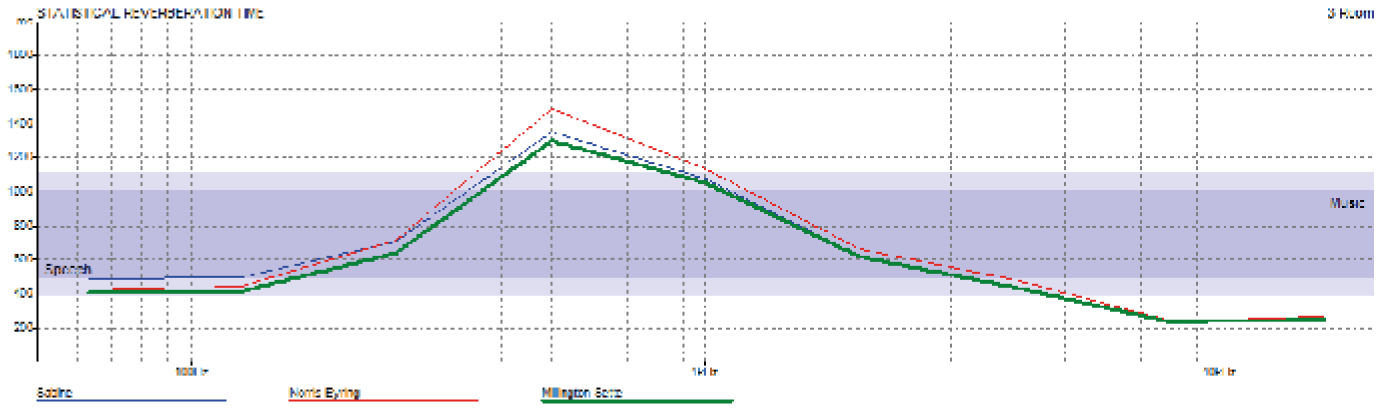
Big group room



ill. 96:

63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	16000 Hz
0.6 s	0.61 s	0.99 s	2.03 s	1.81 s	1.15 s	0.79 s	0.44 s	0.44 s

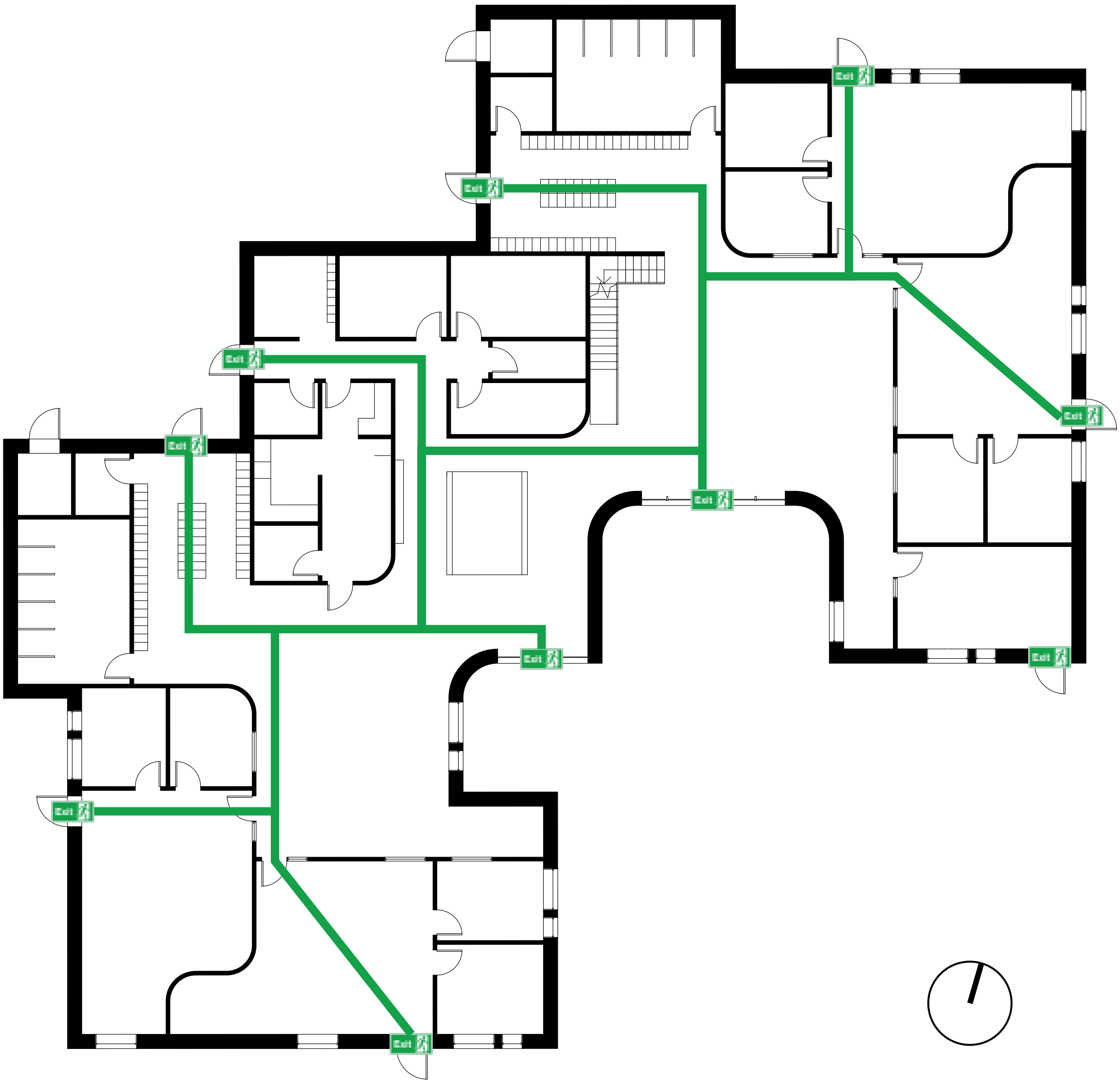
Small group room



ill. 97:

63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	16000 Hz
0.41 s	0.42 s	0.64 s	1.3 s	1.05 s	0.62 s	0.43 s	0.23 s	0.25 s

Appendix 03 - Fire safety

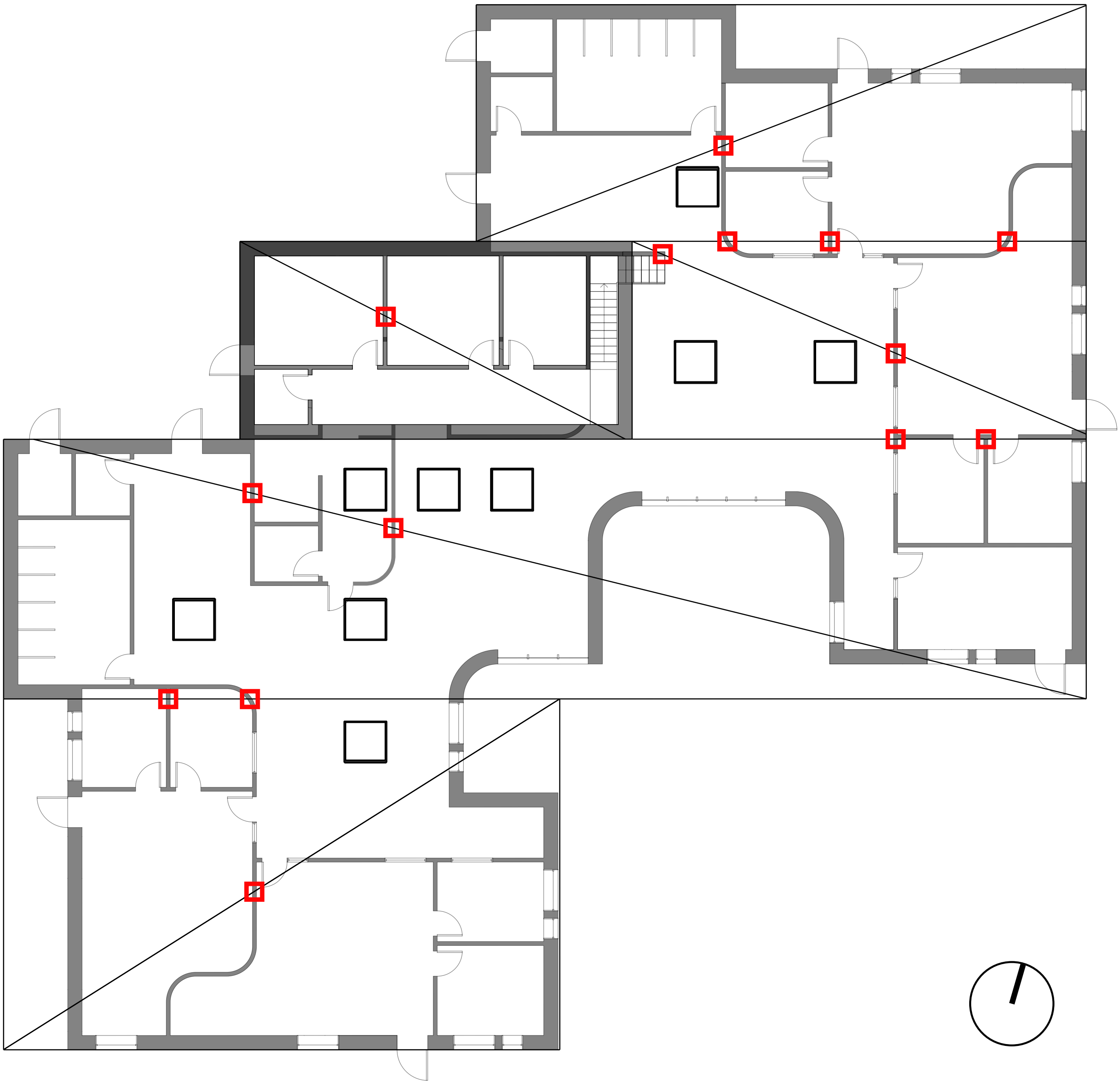


ill. 98: Fire plan

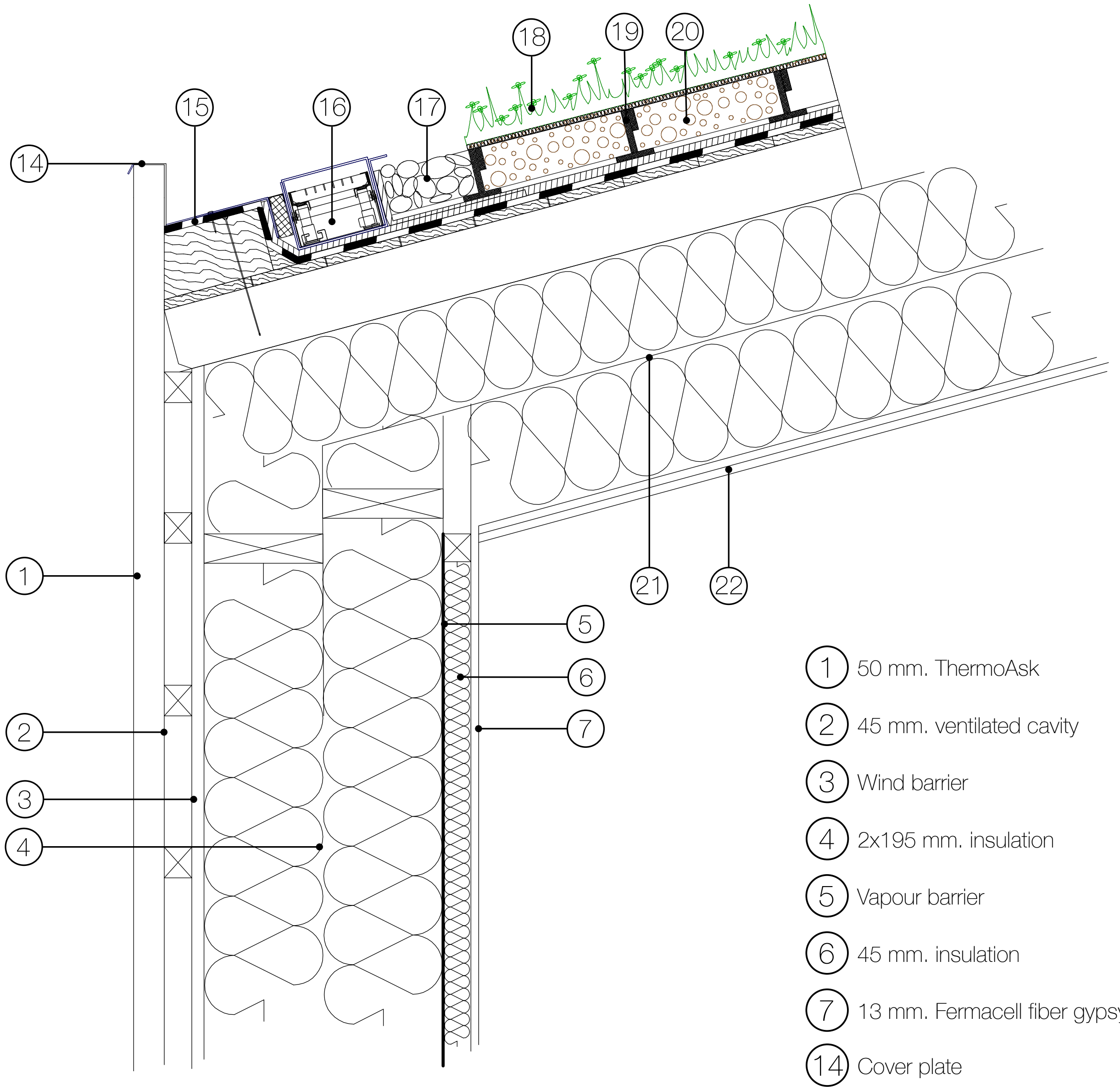
There is six different categories when dealing with fire. This building will belong to category 6, which states that the building is for use in the day times, and where the users of the building will not be able to bring themselves to safety (Bygningsreglementet 2017).
The Danish building regulation and SBi 230 states that there can not be more than 25 meters to an exit and that an exit should lead to the outside or another fire cell. The escape route to the exit should have a width of minimum 1.8 meters when the building is in category 6. Because large parts of the building is an open floor plan there is not more than 25 meters to the nearest exit.

Besides having doors that leads to the open, it will also be possible to use some of the windows as a rescue opening. It is stated in the building regulation that for a window to be a rescue opening it has to have a free height and width that together have a minimum of 1.5 meters where the height minimum should be 0.6 meters and a width of minimum 0.5 meters.
There should be at least one rescue opening pr. 10 persons in the room.
The rescue opening would primarily be used on the second floor because it only have the staircase as an escape route.

Appendix 04 - Construction



ill. 99: Construction plan



1 50 mm. ThermoAsk

2 45 mm. ventilated cavity

3 Wind barrier

4 2x195 mm. insulation

5 Vapour barrier

6 45 mm. insulation

7 13 mm. Fermacell fiber gypsym

14 Cover plate

15 Waterproofing membran

16 Drainage gutter

17 Structured storage fleece

18 Vegetation

19 Safety net for pitched roof

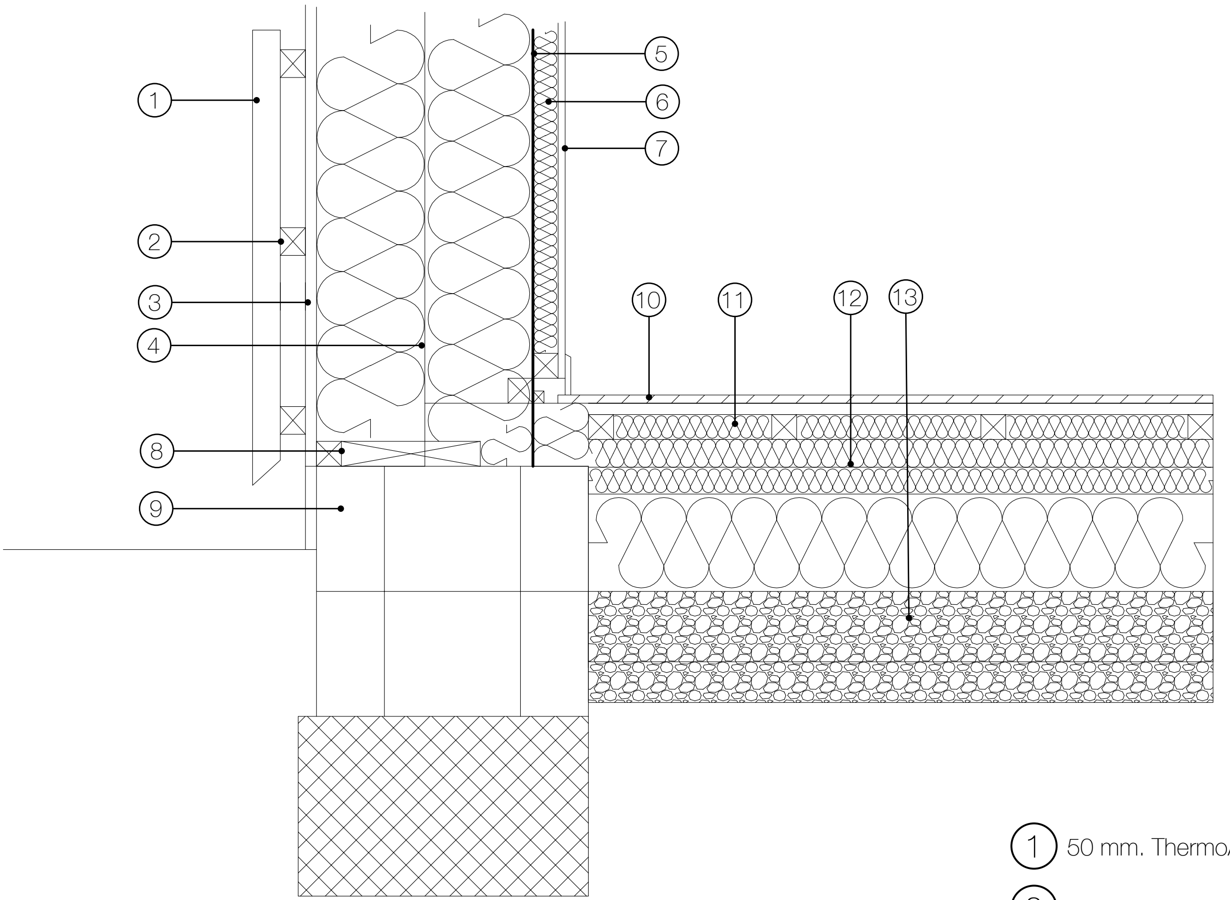
20 80 mm. growing media/substrate

21 2x195 mm. insulation

22 13 mm. acoustic ceiling

U-value wall: 0.07 W/m^{2}K
U-value roof: 0.06 W/m^{2}K

ill. 100: Roof/wall detail



1 50 mm. ThermoAsk

2 45 mm. ventilated cavity

3 Wind barrier

4 2x195 mm. insulation

5 Vapour barrier

6 45 mm. insulation

7 13 mm. Fermacell fiber gypsym

8 Fodlægte og fodrem

9 2x Leca block

10 Acoustic vinyl flooring

11 45 mm. insulation

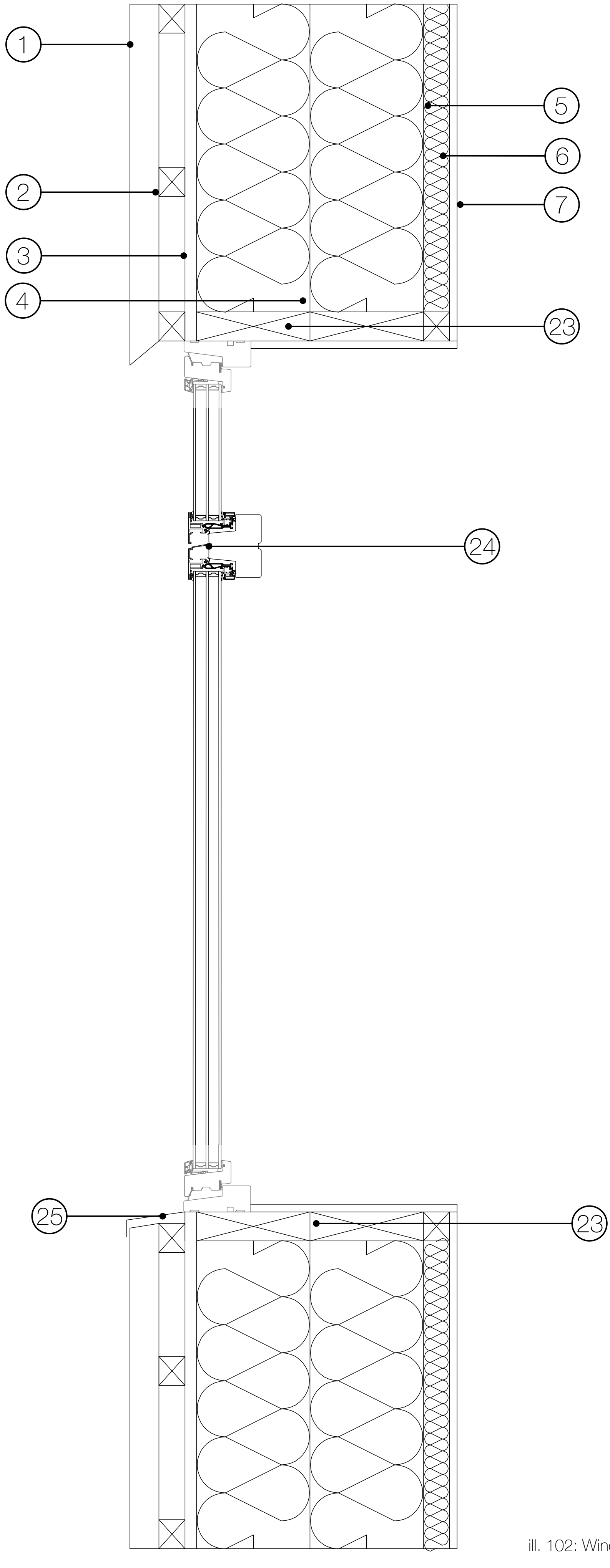
12 270 mm. insulation

13 Capillary layer

U-value wall: 0.07 W/m²K
U-value floor: 0.07 W/m²K

ill. 101: Wall/deck detail

U-value wall: 0.07 W/m²K
U-value window: 0.8 W/m²K



1. 50 mm. ThermoAsk
2. 45 mm. ventilated cavity
3. Wind barrier
4. 2x195 mm. insulation
5. Vapour barrier
6. 45 mm. insulation
7. 13 mm. Fermacell fiber gypsym
23. Cross bar
24. Glazing bar
25. Sill

ill. 102: Window detail

Appendix 05 - Be15 calculation

Without solar cells

Nøgletal, kWh/m² år

Renoveringsklasse 2		
Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
138,3	0,0	138,3
Samlet energibehov		38,2

Renoveringsklasse 1		
Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
73,0	0,0	73,0
Samlet energibehov		38,2

Energiramme BR 2015		
Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
42,0	0,0	42,0
Samlet energibehov		33,9

Energiramme Byggeri 2020		
Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
25,0	0,0	25,0
Samlet energibehov		24,9

Bidrag til energibehovet		Netto behov	
Varme	21,5	Rumopvarmning	16,0
El til bygningsdrift	6,7	Varmt brugsvand	5,4
Overtemp. i rum	0,0	Køling	0,0

Udvalgte elbehov		Varmetab fra installationer	
Belysning	3,3	Rumopvarmning	0,0
Opvarmning af rum	0,0	Varmt brugsvand	0,2
Opvarmning af vbv	0,0	**Ydelse fra særlige kilder**	
Varmepumpe	0,0	Solvarme	0,0
Ventilatorer	3,3	Varmepumpe	0,0
Pumper	0,0	Solceller	0,0
Køling	0,0	Vindmøller	0,0
Totalt elforbrug	11,1		

ill. 103: Be15 without solar cells

With solar cells

Nøgletal, kWh/m² år

Renoveringsklasse 2		
Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
138,3	0,0	138,3
Samlet energibehov		13,2

Renoveringsklasse 1		
Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
73,0	0,0	73,0
Samlet energibehov		13,2

Energiramme BR 2015		
Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
42,0	0,0	42,0
Samlet energibehov		8,9

Energiramme Byggeri 2020		
Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
25,0	0,0	25,0
Samlet energibehov		-0,1

Bidrag til energibehovet		Netto behov	
Varme	21,5	Rumopvarmning	16,0
El til bygningsdrift	-3,3	Varmt brugsvand	5,4
Overtemp. i rum	0,0	Køling	0,0

Udvalgte elbehov		Varmetab fra installationer	
Belysning	3,3	Rumopvarmning	0,0
Opvarmning af rum	0,0	Varmt brugsvand	0,2
Opvarmning af vbv	0,0	**Ydelse fra særlige kilder**	
Varmepumpe	0,0	Solvarme	0,0
Ventilatorer	3,3	Varmepumpe	0,0
Pumper	0,0	Solceller	14,0
Køling	0,0	Vindmøller	0,0
Totalt elforbrug	11,1		

ill. 104: Be15 with solar cells