THE FUTURE SCHOOL OF NYE

MASTER THESIS, MSC04 2021

TITLE PAGE

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ABSTRACT

This report represents a design proposal for the Future school of NYE. The project takes a point of departure in a self-developed method evolving around Sustainable Development Goals to ensure integration of architectural quality and sustainable solutions. Furthermore, users and site relations have created a base for the project. By considering subjects as alternative learning, play and movements, indoor environment, and wayfinding simultaneously with energy solutions, water diversion, and materials, a beneficial setting for education is designed. In addition, to being a school, the building becomes a gathering point for the local community, whose requirements and wishes are considered in the design.

The final project fits within the landscape, and it respects the scale of the surroundings, while it stands out with its large volume to become a landmark. Internal the classroom is replaced with bases and project surfaces to embrace an alternative way of learning where outdoor spaces, movement, and play are an active part of teaching. In addition, social sustainability is incorporated in the school by evolving the design around the need and wishes of users, while the building has natural and sustainable material to be environmentally sustainable. This results in the school being a gathering point for the local community. The New School of NYE is an educational gathering point for teaching, learning, and sustainability.

READER'S GUIDE

This project consists of three reports where the 'Program' and 'Design Process' is the first report, the appendix is the second report, and the Presentation is the third report. The purpose of the 'Program' is to present the problem area, studies, and analysis, resulting in design criteria and UN-Goals that form the basis of the project and 'Design process'.

The studies and analyses in the 'Program' are structured as following:

- An introductory paragraph describing the purpose and methodology of the study.
- A paragraph analyzing the study.
- A concluding paragraph resulting in design criteria.
- A final paragraph on the implementation of the UN-Goals.

The 'Design Process' uses the presented criteria and UN-Goals from the 'Program' to control and clarify the design decisions.

The 'Design Process' is structured as follows:

- A selection of steps represents different steps of the design process.
- An elaborating appendix for the different design decisions.

If the reader wishes to print this report it fits an A4 portrait style.

1

TABLE OF CONTENT

LIST OF CONTENT

12. PROGRAM

13. DESIGN PROCESS

2

PROGRAM PROLOGUE

INTRODUCTION

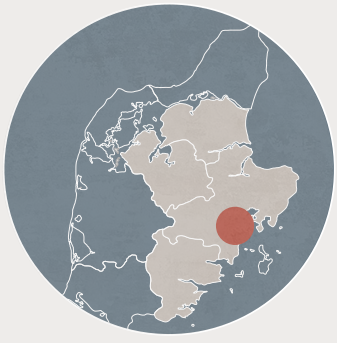
"The city of NYE will be sustainable in an environmental, economic, and social sense alongside challenging the existing norms for sustainable buildings, and technology in the area. NYE will be a sustainable setting for the future individuals living and working in the city (Vaerdierne, 2020)."

10 kilometres north of Aarhus is a sustainable city project rising from the naked field with the vision of sustainability and community. The new sustainable city is named NYE, and when the project is completed, the number of inhabitants is expected to reach 25.000. NYE is a developing city, and as it grows and when families inhabit the area communities, are established, which creates a need for a new school. (Historikken, 2020).

Within the last 10 years a break with the traditional schooling has arisen. In 2014 a new school reform was developed, which concerned longer and various school days with more qualified teaching and learning. Furthermore, exercise and movement should be implemented in schooling a minimum of 45 minutes a day (Folkeskolereformen, 2017). The new school reform was intended to obtain prosperity by developing skilled pupils and increase their well-being in school. Opposite the expectations an evaluation report published in 2018 showed that the schools have not improved because of lacking facilities(Bjerril, 2018). Therefore, the design of NYE school must accommodate the visions of the reform by challenging the traditional school structure and settings.

The following program is inspired by the tender documents and supported by additional analyses. A sustainable approach using the UN-Goals will be manifested as in the visions of 'The future school of NYE'. (Byggeprogram for lærings- og aktivitetsbyggeriet i NYE, 2020).

Ill:. 1 Denmark



Ill:. 2 Jutland

Ill:. 3 NYE, Aarhus

MOTIVATION AND PROBLEM

In our search for a master project, the users and sustainability were essential. When we discovered a competition, tender released by Aarhus municipality regarding a new school in the sustainable city NYE, we glimpsed the opportunity to work with the combination of user-oriented design and sustainability. This interest was the foundation for choosing 'The future school of NYE' as our thesis topic.

Children as users are special because they are driven by their own emotions, straightforwardness, and curiosity. Our mission is to design architecture on children's level. A building with which children can interact, a building being a setting beneficial to learning, and a building as a foundation for their individual development. A building being the future school for the children in NYE.

We have been introduced to the problematics regarding the UN-Goals in architecture, in our internships. There is a need for a new sustainable method, incorporating sustainability in architecture without neglecting either. By choosing a school as our project, it is possible to utilize the UN-Goals to create sustainable architecture and designing the setting for educating pupils. Additionally, the pupils obtain a natural awareness of sustainability, which enlightens the pupils about a greener future.

This leads to our problem statement, which connects sustainable architecture with a learning setting to create the future school of NYE.

"How to design the future school of NYE with the vision from Aarhus municipality as the point of departure and how can sustainable architecture generate a beneficial setting for the learning, development and well-being of children?"

LIMITATIONS

The project is based on a previous architectural competition, including multiple tender documents(Aarhus kommune, 2020). The competition includes a design of general learning facilities for 0th – 9th grade in three tracks, with integrated SFO and FU club. Furthermore, outdoor spaces, sports facilities, and room for association life are incorporated in the layout of the school.

To limit the extent of the tender documents, specific areas have been omitted. The requests and requirements from the tender documents have been considered and selected according to our analysis and vision. This project will focus on the school alone. The SFO, FU club, outdoor spaces, sports facilities, and room for association life will be considered conceptually. Furthermore, future development of the school extending the tracks with, yet another year will happen. This will be considered in the design, but not be a design parameter.

The economy will be disregarded in this proposal because of limiting knowledge in the areas and additionally, to prevent design limiting compromises.

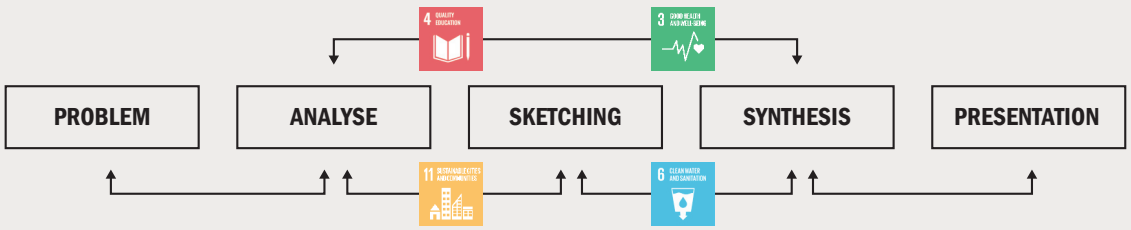
The limitations are chosen to focus on the best possible learning environment and well-being of the users as well as integrating a sustainable approaches.

THE INTEGRATED DESIGN PROCESS

The main method used in this project is the Integrated Design Process (IDP) with a complimentary of the UN-Goals. IDP is a holistic design approach that, along with the UN-Goals, is utilized to integrate sustainability in architecture and vice versa. This method implements analyses and studies during the design process, rather than gathering information and knowledge (Knudstrup, 2004).

IDP consists of five phases including problem, analysis, sketching, synthesis, and presentation. The IDP method uses iterations where new knowledge affects choices made in the various stages of the process (Ibid).

When incorporating UN-Goals in the IDP multiple aspects of a sustainable design are considered, including sustainability and architectural quality to the users.



Ill:. 4 Simplified model of the integrated design process and the integration of UN-Goals.

3

SITE SPECIFICS

SITE SPECIFICS

PROJECT SITE

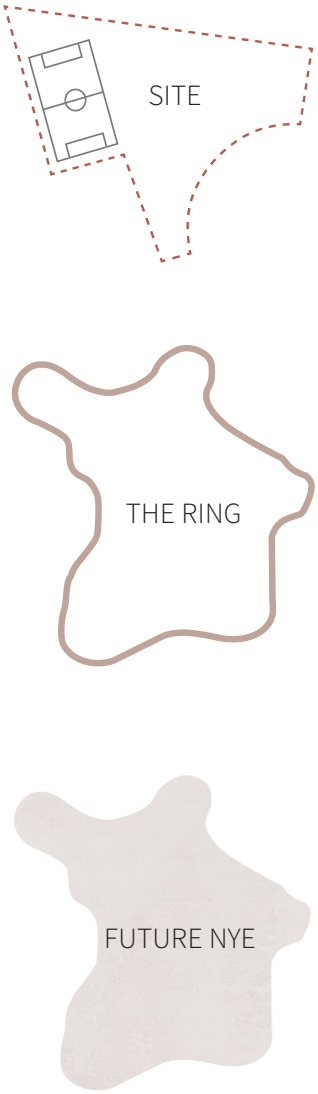
The future school of NYE will be located on the edge of two urban structures, and the cities NYE and Elev. The site is located by the southern boundary of Elev in an area characterised by fields. The school will be a part of the future development of NYE with a project site of **56.966 m^2**. The site is marked by a red outline and in the western part of the site, a playing field appears (Appendix 1).

'THE RING'

The Ring is a central part of the future road network in NYE. The intention is to create well-defined connections between the different quarters of the future NYE (BP 1, p. 28). The Ring facilitates car arrival at the school which makes the road an important factor of the future school design.

'FUTURE NYE'

NYE is a city in development. The vision is to expand the number of inhabitants to around 25.000 when the 2. phase of the development is fulfilled. The future development will consist of a variety of building types, that meet people in a different stages of life. A combination of family houses, cluster houses, terraced houses, and apartments will promote the attraction of NYE.



Ill:. 5 Site Specifics

SURROUNDINGS

The context of the site is analysed by mapping, photo registration (Appendix 2), and a phenomenological method. The purpose of these analyses are to integrate the elements of the surrounding nature in the design of 'the future school of NYE'. The following section includes investigations of the surrounding nature, wind conditions, and the topography of the site (Appendix 3-4).

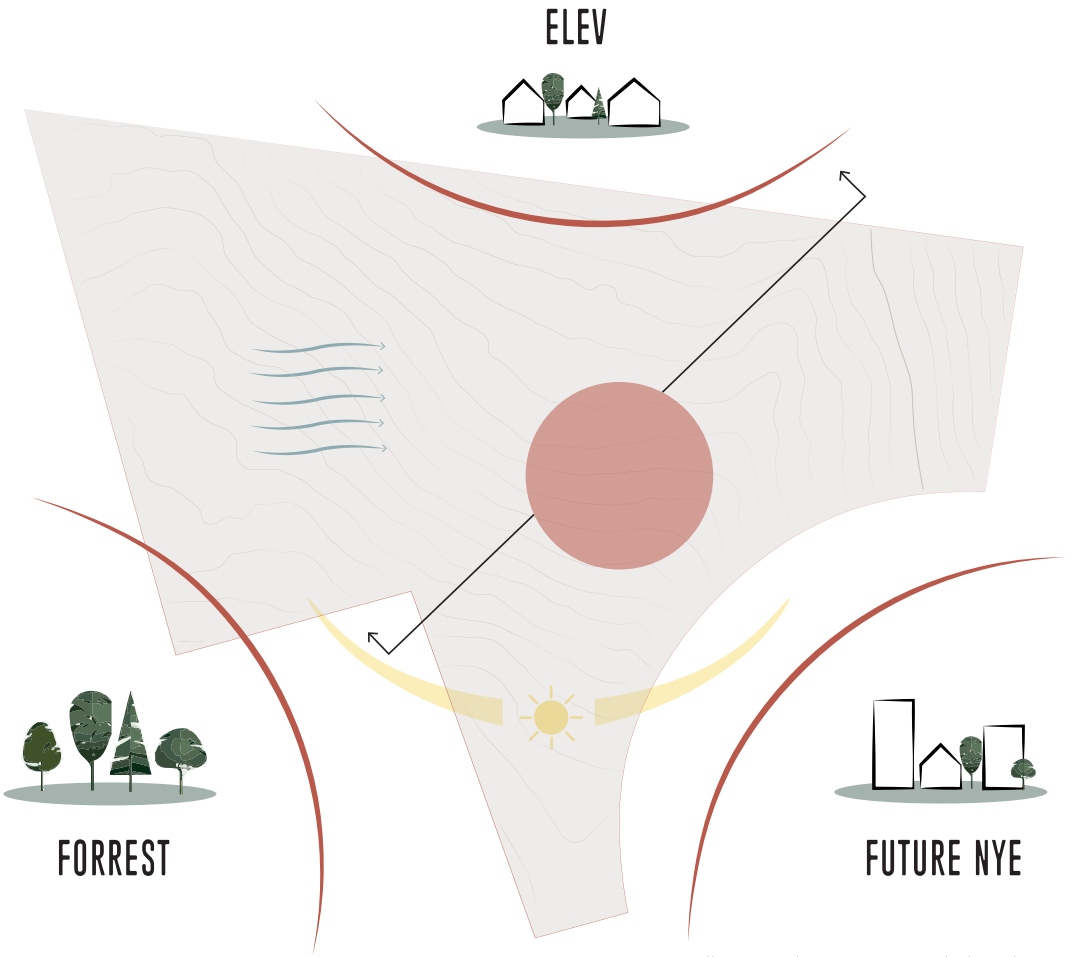
"Nature offers a variety of expressions which makes impression!"
(Aarhus Kommune, 2020)

The project site is located in scenic surroundings characterised by hills whichs slope downhill to the south. On a clear day it is possible to see Aarhus in the horizon, the nearest metropolis. The landscape is marked by fields, farms, and the neighbourhood, Elev, characterised by child-friendly family houses.

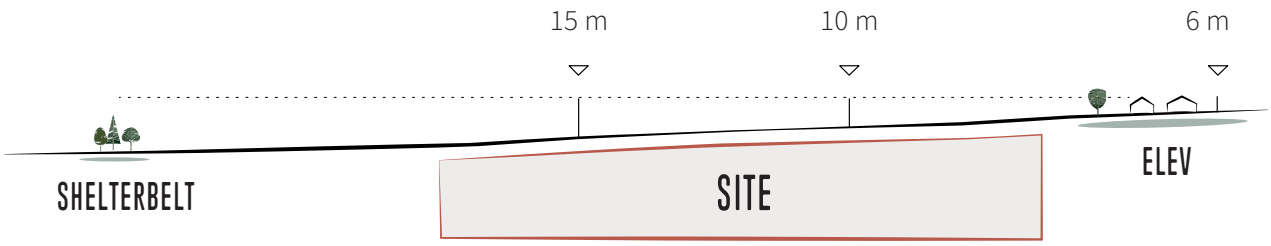
Additionally the surrounding nature offers a forest with diversity in trees and greenery with marshes and waterholes. Nature elements which advantageously can be integrated into the education by allowing the pupils to explore and investigate.

Ill:. 6 Nature map Scale 1: 10.000

SITE CHARACTERISTICS



Ill:. 7 Site characteristics, including climate



Ill:. 8 Site inclination

4

USERS

USER INVESTIGATION

A human-centered approach is used to create a user perspective while designing the future school of NYE. Research-based knowledge are gathered from existing investigations in addition to the information from the tender documents. The qualitative method of a semi-structured interview for teachers creates insight into daily life. Furthermore, a quantitative questionnaire for the children enlightens additional design elements.

The results of the different investigations will reveal the teachers' and children's needs, wish for placement of facility, and additional requirements for the school. This information will be gathered in different representative user groups. The tender documents present results from their user investigation which has been made through workshops.

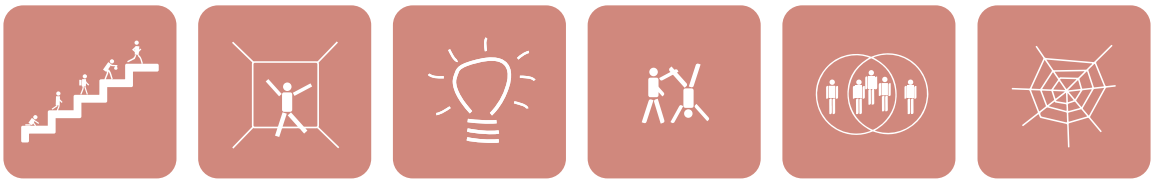
In Aarhus Municipality it is a requirement to implement RULL, rooms for play and learning, which is a design approach according to school development. Therefore, RULL is a part of wishes and requirements from the tender documents. RULL secures exciting and future-proof learning spaces that inspires children and young people to activate senses through active play. The use of the body and activation of senses ensure a higher quality of learning. (Ricken, n.d.)

The intention with RULL is to create an interaction between teaching and architecture ensuring pedagogical development and a structural upgrade. The result of RULL should lead to innovative learning spaces with multiple and different learning activities.

By integrating RULL in a schooling project all children are included. Therefore, the following analysis in this program will contain investigation according to the focus areas from RULL.

- Stage of development
- Commitment to inspirational rooms
- Innovation and interdisciplinary
- Activity and corporeality
- Social communities based on recognition of individuality
- Integration of informal technology

These strategies from RULL will be integrated into our projects without mentioning the approach directly. This will be achieved by analysing and investigating the activation of senses, use of alternative learning, integration of play and movement.



Ill:. 9 RULL

USER INVESTIGATION

The tender documents state multiple design criteria from their user investigation, which will be considered in our design. In contrast, when reading the material critically, some missing results have been discovered. Therefore, additional user investigation will be made.

The existing user investigations of children create a guideline of their needs and wishes, but the materials from the user workshops have been processed an unknown number of times. The tender documents are unclear about the actual presence of children during the workshop. Therefore, the workshop results are questioned, because the results might be adults' assumptions about children's wishes and needs. Furthermore, these user investigations are insufficient according to the time spend between lessons, especially for the older children (BØRNE- OG UNGEBYGGERIET I NYE, 2020).

The tender documents wish for physical activities targeted older girls, which implies that additionally mentioned physical activities are for boys. The tender documents suggest, that girls dance to Youtube videos (Aarhus Kommune, 2020 p. 19). We respond to this statement critically. Therefore, in addition to the tender documents user investigation and wishes gained from the results, we will collect and create further investigations.

Our investigation will enlighten how children spend their recesses and other spare time in the school settings. The question which needs answering is:

"What interests children when they are too old to play?"

When designing a school all users should be included. The tender documents state multiple wishes and requirements regarding the children as users but have limited requirements for the teachers and staff members.

The teachers spend more hours at the school than children and therefore, their well-being and needs are important as well. Based on these statements an investigation of the teachers' routine at the school will be made concerning their wishes and requirement for preparations rooms, staff rooms and additional areas.

Instead of asking the same questions to all the teachers the approach to this investigation will be unstructured interviews and conversations. The teachers might have different experiences according to schools, meaning that follow-up questions have to be different from each other. The question that needs answering according to the teacher is:

"What kind of rooms do the teachers need to ease their school day, and how should the rooms relate to each other?"

To summarize, we will be making two investigations.

- An investigation according to the children and their spare time.
- An investigation according to the teachers and their needs and wishes.

The results from the two investigations will be analyzed and diverted into personas on the following pages. Furthermore, user groups of both children and teachers are created to integrate the user perspective through the project.

ADDITIONALLY INVESTIGATION OF TEACHERS

A qualitative interview with the teachers are conducted. The tender documents are limited in the amount of information about the teachers wishes and demands for the future school of NYE. Therefore, it was necessary to investigate what kind of activities, wishes and demands the teachers utilize and need during their time at the school.

A qualitative interview was made to gain knowledge about a teacher's day and their preferred settings. The result from the questionnaire expands our knowledge and will be used as an addition to the tender documents to create useful teacher settings.

The interview was focused on clarifications of the teacher's day and their useful room settings. The complete answers can be read in the Appendix 5.

After reviewing the results, it became clear that the respondents had similar answers to the different questions. These answers are also similar to the tender documents, but with some relevant differences. The teachers find it important with a shared teacher's room, instead of the small break rooms belonging to each cluster of students. Furthermore, the questionnaire also clarified the flow of a teacher's day. It became clear that the teaching ways at the Danish public schools have changed during the past decades. A major change happened after the "arbejdstidsreform" in 2014, where teachers from that point on had to be present at the school when preparing for lessons. This reform requires preparation rooms on the school.

The answers from respondents are all from relatively small schools, where the functions vary from at large school. Therefore, the wish of one shared break room, will be disregarded due to the need for quiet and relaxation when having a break.

KIRSTEN, 52 YEARS, TEACHER

"I am a language teacher in 6th grade. I love teaching and challenge the pupils to become better versions of themselves, both regarding their personas and knowledge. I use a lot of my school day preparing lessons, reviewing assignments, and discussing the development of the students. In recess, I go for a walk or talk with my colleagues, often about pupils even though it is break time. "

Ill:. 10 Persona, teacher

ADDITIONALLY INVESTIGATION OF CHILDREN

The tender document determine which activities the elder children want at the future school of NYE through workshops. Based on the tender documents it seems that the workshops are mainly attended by adults. The statement of the tender documents according to activities seems influenced by the opinions of adults and teachers. It is necessary to investigate what kind of activities the older children utilize and lack in their recesses.

A quantitative questionnaire was made to clarify which activities the children utilize in their recesses. The results from the questionnaire indicate a missing factor when investigating activities for older pupils. The children did not consider facilities besides the ones offered at their schools. Therefore, further investigations were made by literature reviews, case studies, and researched-based knowledge to determine activities not mentioned by the pupils.

The following question was asked to children from third grade to ninth grade The full answers can be read in the Appendix 6.

1. What kinds of activities do you miss in your recesses?
2. What did you do in your last recess?
3. If you should do anything active in your recess, what should it be?

Some of the answers was consistent with the tender documents statements.

"The majority of us just want to play soccer."
Sebastian 8. Grade, Ringkøbing school.

On the other hand none of the girls stated that they wanted to danced to Youtube, but instead they either talked with each other while sitting inside or outside, was going for a walk or played soccer with the boys.

"I talk with my friends, otherwise I play soccer with the boys."
Marie 8. Grade, Aarhus

After receiving the results, it became clear that another factor needed to be considered. The fact that multiple schools lack activities for older children and therefore, the children did not imagine alternative activities. The results indicated that the tender documents partly cover the need for outdoor activities.

Further studies of increasing physical activities among older students had to be made. Two research projects were used to investigate how to increase the activity level for children in fourth to ninth grade (Appendix 7).

The investigation indicated that facilities and design matters when creating a schoolyard supporting physical activities. Functionality, placements, variation, and focus on different target groups must be considered while designing a schoolyard. A way to ensure a functional schoolyard is to divide it into separate spaces with different facilities and activities. Additional different elements in the schoolyard, such as colors, slopes, curves, and lines, can divided areas and create boundaries.

Based on these results the focus of this project is to create a divided and functional schoolyard that can accommodate multiple activities, rather than outline specific activities for the children. The starting of activities are out of our hands as architects but we can create the best possible settings. From these investigation following design criteria and user groups can be made.

- Create a functional schoolyard divided into multiple areas.
- Create variations in the schoolyard with colors, slopes, curves, and lines.
- Place the activities close to the pupils who use them.

USERS GROUP FOR THE FUTURE SCHOOL: PUPILS

Ill:. 11 Persona, User group 1

ENROLMENT CLASSES 0. - 3. grade

"My name is Ida, and I am 7 years old. I have just started in first grade. I do not like to play with the boys because they like to build caves or dig traps. I think the boys are loud and annoying. Expect from Karl. Sometimes I play with Karl. Mostly I play with Anna and Flora because they like to play family and fantasy games. I also like to play games with the teachers and other children in the big recess."

MIDDLE CLASSES 4. - 6. grade

"I am Anton, and I like basketball. My friends and I like to play basketball and sometimes soccer in our recesses. If the teachers arrange rounders or other ball games I like to attend. Sometimes it is only for us and the other fifth graders, but I like when it is for everyone. The girls have just started dancing to TikTok, I think that is silly, but at least they do not dance where we play ball games."

Ill:. 12 Persona, User group 2

Ill:. 13 Persona, User group 3

SCHOOL-LEAVING CLASSES 7. - 9. grade

"I am a 9th grader, and I just turned 15. In my recess, I spend time with my friends. Often, we go for a walk while we talk. If the weather allows it, we play small ball games outside with the boys. Otherwise, we like to use indoor facilities such as table tennis, table football or enlarged board games. Even though the teachers urge us to be active in our recess, sometimes my friends and I like to relax and talk to recharge for the next lesson."

SUSTAINABLE DEVELOPMENT GOALS

The Sustainable Development Goals are 17 goals composed in cooperation between the nations to promote sustainable development across the world.

"Sustainable development has been defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
(The Sustainable Development Agenda, 2021)

Therefore, sustainable development aims to improve lives, protect the planet, reduce inequalities, etc. Each country is expected to implement the UN-Goals in its policies and plans to archive national success (Ibid).

The new initiative regarding the UN-Goals is to implement a sustainable mentality while designing buildings. Sustainability can be hard to define, why it is necessary to understand that it consists of a tripartition of Social, Economic, and Environmental which the UN-Goals take into consideration as well (Mossin et al., 2020).

"For sustainable development to be achieved, it is crucial to harmonize three core elements: economic growth, social inclusion, and environmental protection. These elements are interconnected, and all are crucial for the well-being of individuals and societies."
(The Sustainable Development Agenda, 2021)

Each of the 17 UN-Goals contains Sub-Goals and a description which have been written in terms of politic and can therefore be hard to adapt in different industries. Despite the difficulties, multiple companies are trying to implement the UN-Goals in their strategies to become more sustainable.

Ill:. 14 UN - Goals

THE SUSTAINABLE DEVELOPMENT GOALS AS A METHOD

The following section describes how The Sustainable Development Goals (UN-Goals) are developed as a method to consider sustainable architecture throughout the design process. The purpose of our redeveloped UN-Goals is to integrate the sustainability while designing, without neglecting the quality of architecture.

The UN-Goals chosen in our method originates from the tender proposal and the vision of NYE. These Goals are then redeveloped as a starting point to implement the UN-Goals when designing sustainable in the building sector. Our sub-goals are specific redeveloped for designing a sustainable school considering the importance of learning spaces. At the end of a project, it should be possible to evaluate the final design according to the UN-Goals and our Sub-Goals by discussing the decisions made according to sustainability and architecture.

A limited number of UN-Goals are selected to bound this specific project, but ideally, all Goals should be considered. Every Sub-Goal will be elaborated in its chapter.

Architecture evokes feelings released by one's subjective opinion, resulting in being a subject for conversation, argumentation, and discussion. Therefore, architecture cannot be measured because it is a complex expression of the creators. Staging architecture in combination with sustainability creates many challenges but results in a holistic design.

Other applicative evaluation systems, such as DGNB, are invented to measure sustainability. For instance, DGNB can be used to evaluate every kind of building by scoring it in terms of the DGNB Sub-Goals and thereby certify the building if it meets the requirements. Different is our method of designing with the redeveloped UN-Goals and Sub-Goals which are created to discuss architecture and sustainability instead of measuring it.

The process of designing is revolving around the UN-Goals and not towards a certificate in the end. Concluding that the main goal by creating this new way of implementing and evaluating sustainable architecture is about a sustainable process as well as the result and thereby embracing the creation of rewarding sustainable architecture.

Ill:. 15 Chosen UN-Goals

OUR CHOSEN UN-GOALS

3. Good Health and Well-being
"Ensure healthy lives and promote well-being for all at all ages."

4. Quality Education
"Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all."

6. Clean Water and Sanitation
"Ensure availability and sustainable management of water and sanitation for all."

11. Sustainable Cities and Communities
"Make cities and human settlements inclusive, safe, resilient and sustainable."

Ill:. 16 Chosen UN-Goals

APPLIANCE OF THE UN-GOALS

When developing a method, the criteria and goals must be accurate for others to apply them. Furthermore, the method results shall be readable and relatable. Our design method ensures phenomenological and attitudinal analyses are considered equal to calculations and measurements. Our results will be presented through diagrams and overviews.

The appliance of UN-Goals is significantly different according to nations. Underdeveloped nations concentrate their resources to vitals and continuing development while developed countries already have obtained the crucial. All nations should contribute to the development of a sustainable world. In developed nations the UN-Goals can be implemented in the different industries sector to contribute to the sustainable world.

As previously mentioned, the purpose of our method using redeveloped UN-Goals is to consider architectural quality equal to sustainable measurements. In our method the process of designing matters as much as the result. Sustainable considerations should be integrated from the beginning of a design proposal to the end of the project.

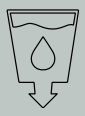
Ideally, every UN-Goal and Sub-Goal should be considered, when integrating the method in a design. Applying our method makes it possible to chose the fitting goals and implement them in a project. It is essential to underline the objective of our UN-Goal method. The target of our method is to apply sustainability in the process of designing. Not to result in a building with a sustainable certification. However, when applying UN-Goals during the design phases, the final result is a more sustainable building.

Sustainability is the future. With this method, the results are placed in the process itself, where concerns about sustainability and architectural quality are made. This will increase the value of the final buildings. The building will not only meet the requirements because the architectural quality will also be considered as well. The method can become a tool for drawings offices to integrate sustainability in their design.

3. Good Health and Well-being "Ensure healthy lives and promote well-being for all at all ages." 	3.1 Indoor climate *"Ensuring a good indoor environment according to the building regulation while integrating the solutions in the design."*
	3.2 Light *"Ensure quality of light in both indoor and outdoor spaces, which meets the requirements."*
	3.3 Play and movement *"Ensure the school facilities encourage pupils of all ages to be active and/or play."*
	3.4 Way-finding. *"Ensure easy way-finding as an integrated part of the school according to navigation and architecture."*

APPLIANCE OF THE UN-GOALS

4. Quality Education "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all." 	4.1 Alternative ways of learning: Classroom: *"Design bases and subject bases that accommodate the learning styles and the present school reform."*
	4.2 Alternative way of learning: Learning through play *"Design learning facilities that accommodate learning through play and the present school reform."*
	4.3 Activation of senses *"The environment of the school shall activate senses in both indoor and outdoor spaces."*
	4.4 Outdoor schooling "Creating nature elements and spaces that promotes outdoor schooling"

6. Clean Water and Sanitation. "Ensure availability and sustainable management of water and sanitation for all." 	6.1 Water as a resource *"The use of rainwater collection shall be considered in the design of a school."*
	6.2 Local Diversion of Rainwater *"Create diversion of rainwater considering the natural water movement and add LAR solutions."*
	6.3 Water and learning *"Ensure the possibility for children to utilise the movement and qualities of water for learning and playing."*

11. Sustainable Cities and Communities. "Make cities and human settlements inclusive, safe, resilient and sustainable." 	11.1 The local community *"Creating facilities at the school where the locoal community can meet and promote there interaction."*
	11.2 Amenities *"Consider the need and wishes of the users to strengthen the local community."*
	11.3 Energy consumption *"Reduce the building´s energy consumption considering passive solutions, energy efficient installations and renewable energy. In that order."*
	Sub-goal 11.4 Local materials "*Consider materials and their relation to the surroundings. Furthermore, consider material life cycle and maintenance."*

5

3. GOOD HEALTH AND WELL-BEING

Ill:. 17 UN - Goal 3

3.1 INDOOR CLIMATE

The building regulation has requirements regarding the indoor environment in classrooms which are listed at page 27.

A well-known problem in existing schools is the poor indoor environment. The main contributor to the poor indoor climate in schools is lack of ventilation. The issues occur from too high expectations for teachers and pupils to correctly use natural ventilation and the new school reform with longer school days. The problems with natural ventilation are described in the vicious indoor climate circle (ill 18) (Folkeskolereformen, 2017).

A poor indoor climate leads to:

- Fatigue
- Poor concentration
- Headache

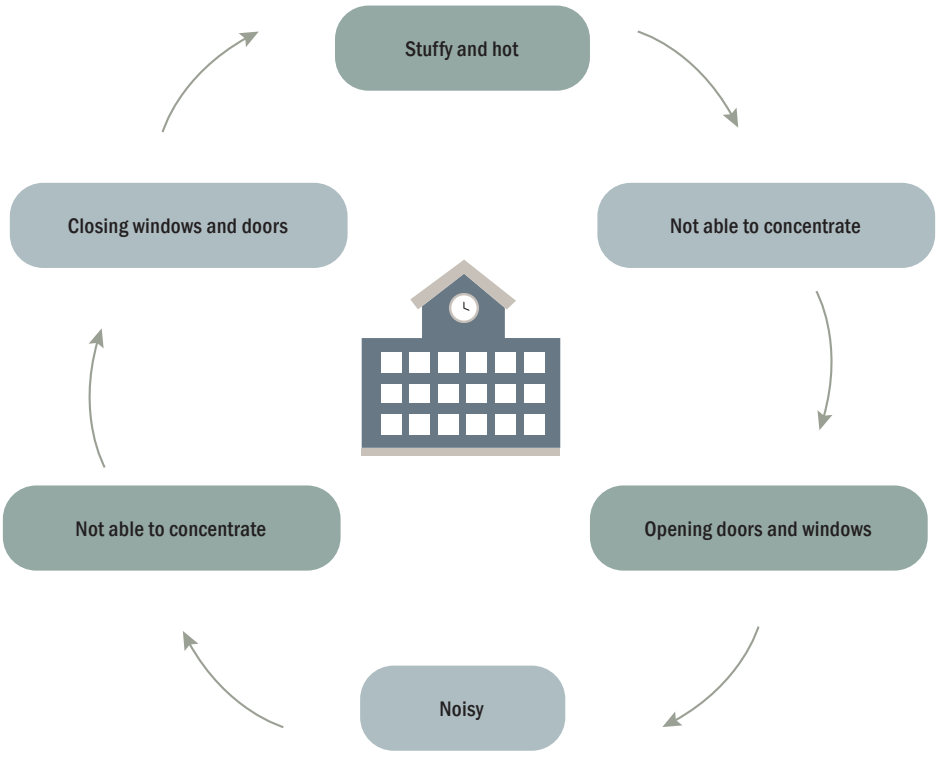
The new school reform challenges the indoor climate due to longer and more active days at school resulting in CO_2 levels to increase more than previously. The short breaks are not sufficient in bringing down the CO_2 concentration (Alexandre Instituttet, 2017).

To ensure sufficient ventilation in the new school in NYE following recommendations will be implemented in the design:

- The possibility for lessons to be in other locations than the classroom.
- Higher ceiling height in classrooms, resulting in increased volume.
- Mechanical ventilation in classrooms.

The previous design criteria will be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

Ensuring a good indoor environment according to the building regulation while integrating the solutions in the design.



Ill:. 18 The vicious indoor climate circle

3.1 INDOOR CLIMATE

BUILDING REGULATION REQUIREMENTS

THERMAL COMFORT

Max hours above 26^0	100
Max hours above 27^0	25

DAYLIGHT

Window/floor area ratio	10% with the factor of correction
Lux demand 50% of day	300 lux on 50% of floor area in 50% of daylight hours

RECOMMENDED REVERBERATION TIMES

Classrooms	0.6 s
Common areas with group work	0.4 s
Common areas without group work	0.9 s
Sports Center	1.8 s

ATMOSPHERIC COMFORT

Ventilation rate pr. child	3.0 l/s
Ventilation rate pr. adult	5.0 l/s
Ventilation rate pr. m^2	0.35 l/s
Max CO_2 concentration	1000 ppm

Ill:. 19 BR18, 2018)

3.2 DAYLIGHT

Investigating daylight according to requirements can be done in different ways regarding the Danish Building Regulation. Common to the regulations is the consideration of skylight as the main light source, meaning sunlight and reflected light are not a considerable factor. The building regulations dictate two ways of determining if there is enough daylight present:

- A minimum of 300 lux on minimum half of the floor in more than 50 % of the daylight hours (BR18, 2018).
- Calculating the 10 % rule (Ibid).

Either way, measuring and calculating the daylight does not consider the quality of the light. The method to determine the quality of light is a phenomenological approach because it depends on experience and additional factors. The impact of light in different settings can be supplemented by experience-based knowledge to define the experience.

Light is complex and difficult to utilise but an important element in architecture. Great architects such as Le Corbusier, Peter Zumtour, and Jørn Utzon, succeed in creating interesting experiences and atmospheres using the qualities of light.

The utilisation of light in architecture is a holistic approach where multiple factors are considered simultaneously to create memorable architecture. Whether it is the white-tills covered shells of Sydney Opera reflecting the sun, the experience of shadows as a contrast to channelling light leading the way in the Main Bath Therme Vals, or the big opening of Monastery Sainte Marie de la Tourette is spreading the light in contrast to the small openings focusing the light to create art, the light is utilised to create exciting spaces in impressive ways.

Light has a significant impact on the mental health and well-being of humans. Furthermore, light increases the learning ability which is important to consider when designing a school. Light plays a considerable part in the indoor environment which likewise is important to create the best possible surroundings and conditions for learning and teaching (Barrett, et al., 2015)

The first rule which states a minimum of 300 lux (BR18, 2018) can be determine by proving the amount of light in a room is satisfying, by ensuring the room has 2,1 % of daylight in 50 % of the room in 50 % of the lightning hours (DS/EN 17037, 2018). In our project light will be investigated according to this approach.

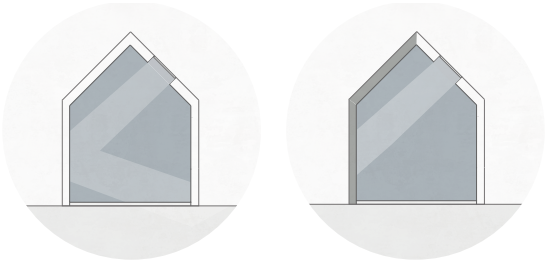
THE LANGUAGES OF LIGHT

"The key is light
And light illuminates shapes
And shapes have an emotional power.

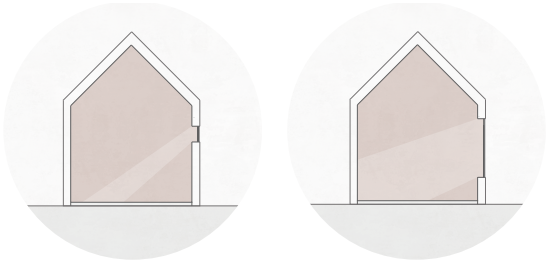
By the plays of proportions,
By the play of relationships,
Unexpected, amazing.

But also by the intellectual play
Of purpose:
Their authentic origin,
Their capacity of endure,
Structure,
Astuteness, boldness, even temerity, the play of those vital abstraction which are the essential qualities of the components of architecture"
-Le Corbusier (Steane, 2011)

3.2 DAYLIGHT



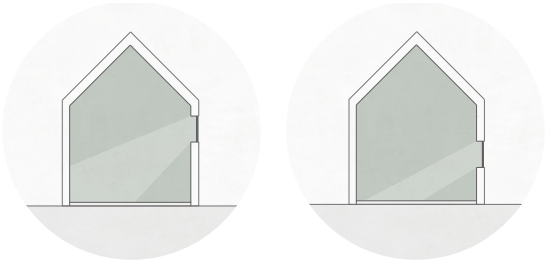
Ill:. 20 Reflected light on materials' surface



Ill:. 21 Window size dictates amount of light

MATERIALS

Reflected light comes from light bouncing of materials' surfaces leading it further into a space. Therefore, the reflective qualities and colours of materials are important to consider. Furthermore, the materials and their ways of reflecting or absorbing light are components in creating an atmosphere. Both the textures and compositions of materials contribute to the travel of light simultaneously with contributing to the activation of other senses (Rasmussen, 2000).



Ill:. 22 Placement and orientation affects the experience of light

PLACEMENTS AND ORIENTATION

The placement of windows affects the experience of light. A high position window allows the daylight far into a space, while a low place window will focus the light creating shadows.

The orientation of windows allows a person to follow the time of day through the travel of the sun, which eastern, western, and southern windows allow. The quality of the light from the corners of the world also differs where northern light is diffuse and cold perfect and southern light is direct and warm. (Johnson and Christoffersen, 2008)

AMOUNT OF LIGHT

Window sizes matter considering the amount of light entering a room. Small windows create contrast as shadow and brightness which can strengthen an experience. A bigger window creates a slight transition between interior and exterior erasing the line between indoor and outdoor. The view to nature is proven to improve the well-being of a person and especially a view to nature produce environmental stimulation (Ulrich, 1984).

HOLISTIC LIGHT DESIGN

It is necessary to consider all the different factors simultaneously while working with light. Light is part of creating an atmosphere and the interaction between space and people. (Boyce, 2014)

Light is an important part of the architecture and learning environment at 'The future school of NYE'. This leads to following design criteria:

- Choose materials with reflective qualities and colours to create experiences.
- Create the best possible light by working holistic with placement, orientation, sizes, and view of windows.

The previous design criteria would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

Ensure quality of light in both indoor and outdoor spaces which meets the requirements.

3.3 PLAY AND MOVEMENT

Case studies and the tender proposal are used as inspiration to determine activities alongside field trips that will be used to interview children to gain knowledge from their perception of existing schools and their different activities.

There is a lack of documentation on how the extended and prolonged use of computer and tablets can affect children. The outcome of such investigation is expected to influence the children negatively, which is why future schools require the development of motor skills and promote physical activity (Rådet for Børns Læring, 2020).

The tender documents, Frederiksbjeg school in Århus, Skørping school, and Mosedeskolen in Greve have been used as inspiration for different activities for different age-groups (Appendix 8).

When children reach school age, they are not done developing their motor skills. This happens during play, evolving senses and their interaction with their surroundings. The enrolment classes (0.-3. Grade) will benefit greatly from facilities that can be climbed upon, trough, under, over, and around alongside a motor skills room with free floor space and mounted facilities. A big concern is that in both the middle classes and the school-leaving classes the children's natural desire to move disappears. Therefore, the implementation of different age-appropriate activities is necessary to secure and improve children's health (Aarhus Kommune, 2020).

Childrens motoric skills are most developed when the children reaches the middle classes(4.-6. Grade). They need facilities that allow them to evolve their strength and endurance. This can be through climbing, crawling, jumping, or swinging (Ibid.).

For the school-leaving classes (7.-9. Grade) physical activities become challenging because of social norms. This requires creative, socially inclusive facilities that promote physical activities. The tender proposal suggests an obstacle course, skill-enhancing facilities, an activity loop, and activities specifically aimed at girls (Ibid.).

The need for activities vary between the different age groups, but it is important that the activity spaces are located in varius distances from the learning environments.

Enrolment classes:
- Facilities that can be climbed upon, trough, under, over, and around
- Motor skills room with free floor space and mounted facilities.

Middle classes:
- Facilities that can be climbed, crawled under, jumped upon and swinging.

School-leaving classes:
- Obstacle course and/or activity loop
- Skill-enhancing facilities.

The previous design criteria would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

Ensure the school facilities encourage pupils of all ages to be active and/or play.

Ill:. 23 Frederiksbjerg school, multi purpose room

3.4 WAY-FINDING

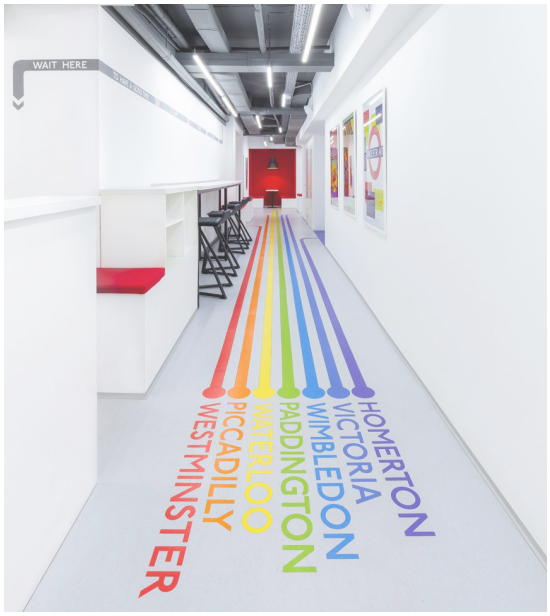
The way-finding methods are gathered through researched-based knowledge by reading papers to determine design principles. Furthermore, inspiration to the design after these principles are found through case-studies. The Danish Building Regulation states rules and dimensional requirements according to fire safety which must be followed (BR18, 2018).

The need for way-finding occurs from the individual's inclination of reaching places along with the knowledge about where to go and how to get there. Furthermore, accidents and delays should be avoided while moving towards the destination. The efficiency of way-finding relies on several factors and multiple skills (Montello, et al. 2006).

"In order to navigate effectively, we apply our psychological skills of perception, cognition, and motor behaviour, within the contexts of physical and social environments, and with the assistance of technologies of information and transportation."
(Montello, et al. 2006)

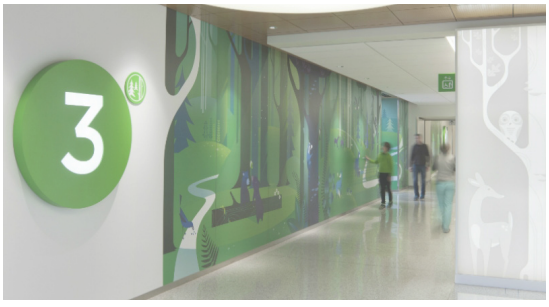
When designing a building the technology of information and transportation are different from other navigations technologies (Ibid). Depending on the size of the building a GPS might be too complex and unnecessary, which makes simpler navigation systems more effective. Easy navigation is essential according to fire safety (Appendix 9). In case of a fire, it must be easy to determine the nearest exit without having to return to a faraway, well-known exit. The dimensional requirements must be followed too (Bernardini, et al., 2016).

The tender documents state the wishes for an open school (Aarhus Kommune, 2020). Therefore, easy way-finding is important for the local community and guests to feel safe and unconcerned while moving around the school. The information provided to the users should be accurate and up-to-date. Additionally, the user should be aware of their location compared to their destination to determine the following direction (Montello, et al. 2006). The following factors should be considered when designing easy way-finding.



Ill:. 26 Underhub - Ukrainian language school.

Ill:. 25 Masa Depan Cerah School - Wayfinding



Ill:. 24 Seattle Children's Hospital

3.4 WAY-FINDING

DIFFERENTIATION

The environment with a difference in colors, shapes, ceiling height, and sizes creates distinct and memorable spaces that support way-finding because it is easier to separate homogeneous environments. Additionally, landmarks or other remarkable art establish a point of recognition(Montello, et al. 2006).

VISUAL ACCESS

Easy overview from starting point to memorable spaces or/and the destination makes easy orientation. Limiting the number of hidden corners and the creation of greater visual access cause easy way-finding (Ibid).

LAYOUT COMPLEXITY

It is hard to define a complex layout and why the layout might be hard to navigate within. Articulated spaces and oblique turns can be parts of a complex layout where the patterns of paths should be compared to the building shape and lines to determine their complexity(Ibid).

PLACEMENT OF SIGNS.

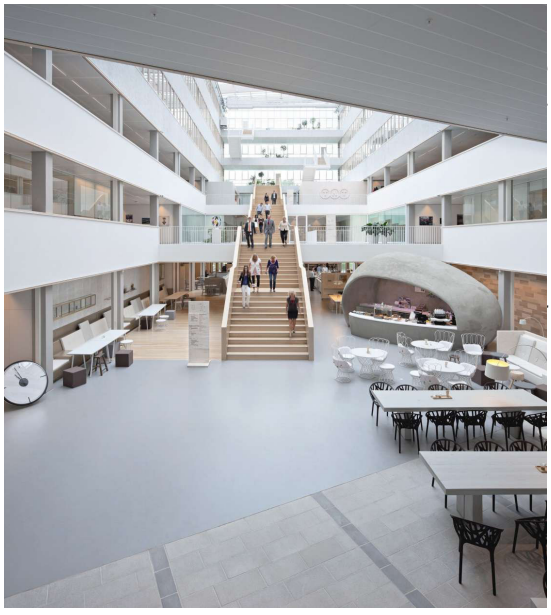
Signs can ease the way-finding, but the placement and content must be precise and well-considered. Unclear content can cause more confusion than clarity (Ibid).

To promote easy way-finding at 'The future school of NYE', following design criteria will be considered.

- Design distinct and memorable spaces.
- Create overview by visual access.
- Design the building layout to be simple.
- Consider the use of signs and their placement and contents.

The previous design criteria would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

Ensure easy way-finding as an integrated part of the school according to navigation and architecture.

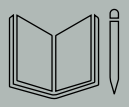


Ill:. 28 Studio Dumbar

Ill:. 27 New Vancouver Community Library

6

4. QUALITY EDUCATION



4.1 ALTERNATIVE WAYS OF LEARNING, CLASSROOM

The new school reform states that children must be treated differently based on their individual needs (Århus Kommune, 2016). To accommodate this, a learning style where the children dictate the new classrooms is necessary (Schmidt, Unknown). Literature studies, case studies, and tender documents are used to understand and design the children's optimal learning settings.

According to the tender documents, the vision of the future school of NYE states a transition from the traditional subject-divided lessons to project-oriented and interdisciplinary teaching and learning courses. The project-oriented teaching method reflects the division of the classroom: A presentation area, an immersion area, and the project surface area with group rooms (Aarhus Kommune, 2020).

The tender documents and multiple projects, such as Søndervangskolen, Frederiksbjerg Skole and Hillerød Lilleskole, differentiate the room requirements amongst the enrolment classes, middle classes, and school leaving classes based on the pupil's ability to focus, need for security and their individuality (Ibid.). This is apparent in the design of the new classrooms. The enrolment classes have 'bases' as classrooms, where most of their teaching happens. When reaching middle class and school leaving classes the bases are now subject divided, 'subject bases'. This enhances the possibilities to differentiate the classroom based on the subject and accommodate the pupils. The projects also express the importance of multiple zones/niches located throughout the school and the option to expand/decrease the room size.

SMAK architects and Søndervangskolen have published a document containing the background for the modernisation of the school. An apparent finding during the user involvement was "rooms with a specific purpose increases the motivation and learning" (SMAK Architects, 2019).

The tender document and SMAK architects document both state that dissemination areas benefit from direct view to the teacher and the blackboard. The learning environment enhances the learning by differentiating the furniture and inventory based on specific learning purposes.

Svend Erik Schmidt has published a booklet containing ideas for inventory and furniture that accommodate the different learning styles (Schmidt, Unknown). This idea of creating different interior designs, which consider the pupil's different learning styles, relates to the statement from the school reform mentioned previously.

When designing spaces that accommodate the different learning styles and the new school reform it is important to acknowledge the different needs amongst the pupils and the room's impact on the pupil motivation to learn.

- Design rooms with specific purposes, distances, and sizes differentiated between enrolment classes, middle classes, and school-leaving classes.
- Design rooms with specific purposes based on subjects and learning abilities.
- Use furniture and inventory that enhances learning abilities.

The previous design criteria would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

Design bases and subject bases that accommodate the learning styles and the present school reform.

4.2 ALTERNATIVE WAYS OF LEARNING, LEARNING THROUGH PLAY

Studies made by LEGO-Fonden and KORA showcase that learning through play is beneficial for children's learning. Literature studies and the tender documents are used to understand and design optimal facilities that encourage learning through play.

"Learning through play is beneficial when it evokes joy, is meaningful, requires active participation, consists of repetitions, and involves social interaction"
(Parker and Thomsen, 2019).

The LEGO-foundation has defined eight approaches that defines learning through play (Parker and Thomsen, 2019), but only the ones affecting the design of the learning environment will be mentioned:

- Active learning:
  Pupils are actively participating in the lectures, by involving the pupils in choices or the assignment.
- Cooperative and collaborative learning:
  A teaching strategy where pupils work in groups to solve assignments.
- Experiential learning:
  Learning through experience e.g., learning about fractions by cutting an apple.
- Problem-based learning:
  To discover and reflect on problems in small groups with supervision from the teacher.
- Project-based learning:
  Learning through a project which culminates into a presentation/product or event.

The learning through play approaches indicates that the school must contain facilities that engage the pupils in different learning activities and additionally accommodate multiple learning activities in the same space, including facilities that stimulate the different senses.

The tender documents state that the outdoor areas must contribute to the learning through play and engage the pupils through active learning. Additionally, the tender documents and the bases pinpoint multiple relevant indoor visions that correspond with the learning through play approaches (Aarhus Kommune, 2020).

The success of learning through play is primarily defined by the educator's engagement, but architects can provide the optimal settings for the alternative learning.

To ensure facilities and the optimal setting for learning through play, the following is necessary:

- Interactive facilities that can be used during lectures.
- Group rooms for assignment solving.
- Zones that enable the pupils experiential learning and ability to produce.
- Nature is an extended part of the learning environment.

The previous design criteria would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

Design learning facilities to accommodate learning through play and the present school reform.

4.3 STIMULATION OF SENSES

The awareness of active senses is attached to change which stimulates the sense of sight, smell, taste, touch, and hearing or several of them combined. The method to analyze the stimulation of the five senses is an experience-based approach. Investigating according to this approach must be objective, and consider when and how the senses are stimulated, not the experiences caused by the stimulation.

The senses are constantly activated but can be stimulated differently. The stimulation of senses is alike among humans, but the experiences caused by the stimulation are different. The method of analyzing this experience is phenomenological because it is subjective and depends on memory, experiences, and personality.

The stimulation of senses in buildings should be considered holistic while design architecture because architecture is a product of a multi-sensory experience (Rittelmeyer, 1992).

An additional reason to consider the senses is the importance of experiences in a learning environment. Growing up children needs to stimulate their senses to develop and learn (Schilhab, 2017). The stimulation of sense have an impact on initial learning. Senses work in relation to each other to create a holistic picture and store knowledge in the brain. (Jarvis and Watts, 2012)

The interaction between the body, brain, and environment activates pupils' cognition and develops learning situations. When creating a learning environment, the dynamic interaction between senses should be challenged because surroundings are experienced through senses. While urging to learn from the stimulation of senses, it is important not to overstimulate the senses over a longer period of time. Considering the content of learning and how learning develops knowledge ensures that stimulation of senses leads to learning (van der Schaaf, 2019).

"Our bodies themselves are active participants in all our knowledge"
- Burwood (Jarvis and Watts, 2012 p. 13)

The senses contribute to experiential learning creating an understanding of information. Primarily the visual and auditory senses are activated in learning, but combining them or additional senses in a teaching situation increase the amount of knowledge disseminated. Therefore the learning environment at the future school of NYE should create multi-sensory experiences. (Jarvis and Watts, 2012)

Our senses are always activated, but they can be stimulated differently. Over-stimulation of senses over a short period is preferable. Therefore, to increase learning, the spaces within and outside the building should stimulate the senses by creating changes and different experiences in the design of rooms . The following design criteria will be considered (C. Spyhalski, 2019).

- Stimulate the sight through changes in colour, light, texture, and movement.
- Stimulate the hearing through changes in noise level, sound, and pressure.
- Stimulate touch through changes in surface, temperature, and body pressure.
- Stimulate smell through changes in air quality, activity, setting, and material.
- Stimulate taste through changes in food.

The previous design criteria would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

The environment of the school shall stimulate different senses in different areas of indoor and outdoor spaces.

4.4 OUTDOOR SCHOOLING

Outdoor schooling is based on the visions of the tender documents concerning the importance of nature as an active element in schooling. The benefits of outdoor schooling, as an educational element, are investigated through research-based knowledge (Aarhus Kommune, 2020).

" Nature must be considered as an object for investigation and puzzlement and must act as exercise space for the development of the natural scientific competencies. Nature must give the pupils opportunity for authentic experiences with different natural scientific problems"
(Aarhus Kommune, 2020).

The School reform emphasizes well-being and the educational environment as important factors in the danish public schools (Ejbye-Ernst, et al., 2016). Multiple investigations states that outdoor schooling can promote both well-being among pupils and support their academic and social development (Ejbye-Ernst et al., 2018, p.13).

Quantitative, qualitative, and neurological investigations concerning the effect of learning- health and well-being-promoting elements in outdoor schooling have been made by Ejbye-Ernst. The result showed positive effects of the following four parameters (Ibid, p.78).

1. PROMOTING MOVEMENT

Nature and green areas promote physical and mental development. Investigations Indicate that children, who participate in outdoor schooling, are more likely to be physical active (Ibid, p.78).

2. CREATING A GREAT SOCIAL ENVIRONMENT

Learning activities in outdoor schooling results in diversity of group formation supporting a positive social environment. A great social environment can promote the power of concentration and immersion and be a great foundation for pupil's interaction and problem-solving (Ibid).

3. GENERATING WELL-BEING

Quantitative questionnaire surveys are used to investigate the well-being of pupils who participate in respectively traditional schooling and outdoor schooling. The results indicated a significant increase in well-being among pupils who participated in outdoor schooling (Ibid, p.79).

4. IMPROVING PROFESSIONAL LEARNING PROCESSES

Outdoor schooling improves professional learning processes when pupils interact with their senses and use their engagement, curiosity, and exploring elements in nature (Ibid).

When implementing outdoor schooling as a part of the education the teachers must be engaged and motivated. It is challenging to change the traditional classroom teaching to outdoor classes (Ibid, p.67).

Therefore, 'The future school of NYE' must offer profitable settings for outdoor schooling by designing and implementing spaces and elements that promote learning in nature.

- Ensure close connection between workshop bases and outdoor spaces.
- Establish beehives, bonfires, herb gardens, water circulations and flowerbeds with plants as a nature learning environment.
- Create outdoors spaces that are characterised by natural materials e.g. boulders, tree trunks, wild plantation.
- Create outdoor workshop spaces that are characterised by lee and shelter.
- The outdoor spaces and nature elements can be connected by pathways.

4.4 OUTDOOR SCHOOLING

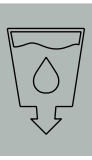
The previous design criteria would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

Create nature elements and outdoor spaces that promotes outdoor schooling.

Ill:. 29 Outdoor schooling diagram

7

6. CLEAN WATER AND SANITATION



6.1 WATER AS A RESOURCE

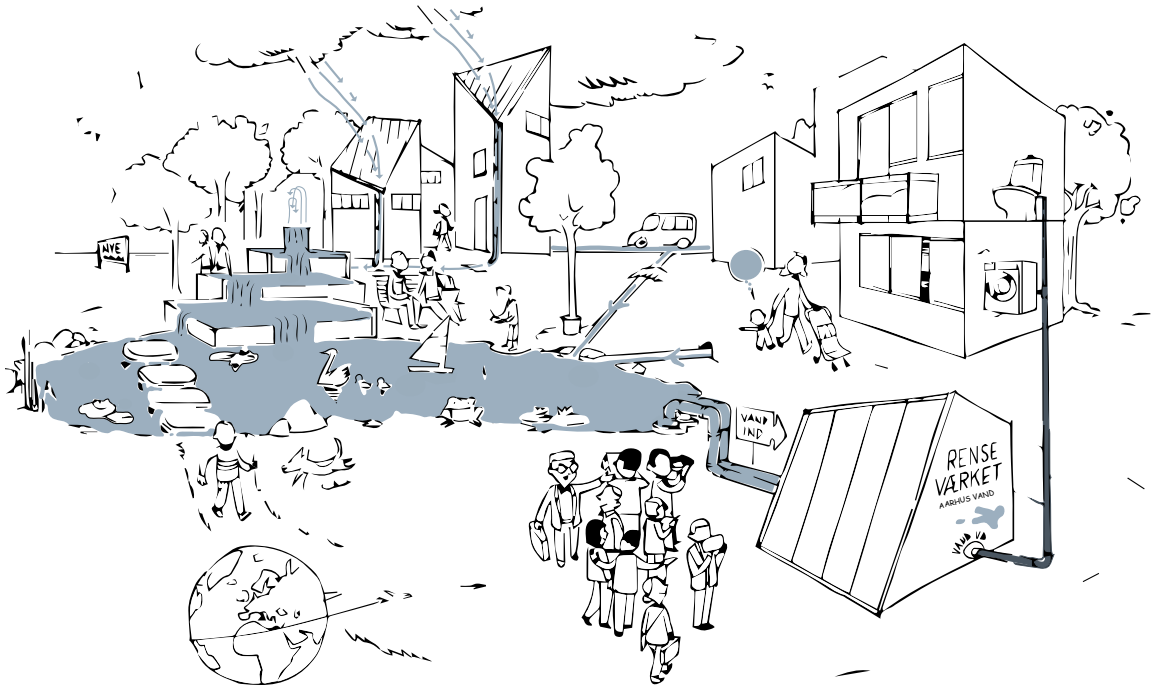
The tender documents describe a wish for rainwater diversion and collection. Therefore, it is necessary to understand the handling of water as a resource in NYE. The method to gather knowledge has been through visits, videos, and articles of NYE. This results in following case-study of water handling in NYE.

CASE-STUDY - HANDLING OF RAINWATER IN NYE

In NYE water is seen as a resource. The city has already established a wastewater treatment plant where the collected rainwater from roofs roads and green areas gets cleansed and used for flushing the toilet and washing machines. The flow of surface water leads the water to a sea of rainwater. From the pond of rainwater, the water is directed to the wastewater treatment plants where it is cleaned. After the cleaning, the water is led through a separate water distribution system and into the homes (Miljø, 2020).

NYE is designed to handle a centennial incident of extreme rain. Before Tækker Group even started the project and considered the placement of buildings, the handling of water was determined. In case of drought drainage water are used a secondary source to rainwater. The whole city is designed to diversify and collect rainwater for further use. These considerations will ensure high biodiversity in the area, where the wildlife thrives in the wild nature(Ibid). The rainwater solution is calculated to save 40 % of portable water in NYE (Bech, et. al., 2020)

The rainwater solution is a part of the sustainable lifestyle of NYE which the residents can enjoy without further responsibility, inconveniences, and costs. The recreational elements are an integrated part of NYE and support the vision of the city (Aarhus Vand, n.d.).



Ill:. 30 Diagram to illustrate the diversion and collection of rainwater in NYE

6.1 WATER AS A RESOURCE

These pictures illustrate NYE´s solutions of diverting rainwater into the ponds of rainwater. Following design criteria, is based on these ways of handling rainwater.

- Integrate ponds and channels for rainwater to collect water for the wastewater treatment plant.

The previous design criteria would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

The use of rainwater collection shall be considered in the design of a school.

Ill:. 32 Greenery to collect and evaporate water.

Ill:. 33 Pond of rainwater

Ill:. 34 A part of the wastewater treatment plant.

Ill:. 31 Visible water channels along the building to direct water.

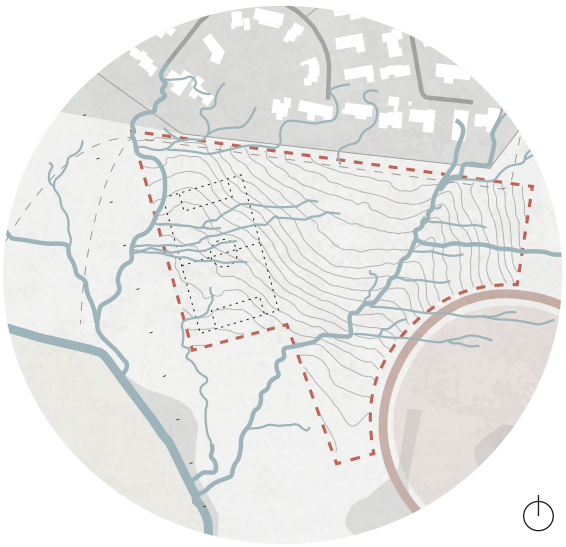
6.2 LOCAL DIVERSION OF RAINWATER

The diversion of rainwater are investigated through case-studies according to schools and existing solutions in NYE. Other methods to investigate the movement of rainwater can be made through simulations and calculations, which is too complex for this assignment. Therefore, knowledge of already existing systems are found and used as inspiration.

Local diversion of rainwater works as a part of collecting water as a resource. Channels is an elements to divert and relocated rainwater to pounds of rainwater, or to different LAR-elements as greenery and basins. In various areas of the world local diversion of rainwater is integrated in agriculture to divert rainwater from watery areas to dry areas. Even though local diversion of rainwater might seem like a new approach, to handle rainwater, it has been used for millenniums. Due to the present climate changes the purpose of diversion of rainwater has changed. Instead of watering dry areas, the over-flooded areas are drained.

The last decades the amount of cloud burst and storms has increased and these cause new areas to over-flood (Water Footprint, 2018). This is critical in areas where the soil cant absorb water or in areas where water collection haven't been implemented.

To determine LAR-solutions at our site an analysis of the soil types in the area has been made to determine how soil can absorb the water. According to our studies the percolation qualities in moraine clay can vary drastically over small areas. Additionally moraine clay is low permeable meaning the water sink slowly into the ground causing the creation of lake and water gathering. (Skov og landskab, 2015) Our investigation reveals that moraine clay is the dominating soil type in the area. Therefore, the implementation of water collection and LAR is essential (GEUS, 2018).



Ill:. 35 The map illustrates the natural flow paths of rainwater on terrain (Aarhus Kommune, 2020 p. 85) - Out of scale.

The analysis of the natural movement of water relating to the topography has been illustrating no creation of natural rainwater pound on the site (Appendix 10). Therefore different placements of the pound of rainwater can be determined and suited to the building. Collecting these results from the analyses illustrates the necessity of implementing LAR-solution and results in the following design criteria (Appendix 11).

- Design ponds and greenery to avoid uncontrolled flooding
- Integrate visible channels to lead water towards the pond of rainwater.
- Integrate sedum roof where it is possible.

The previous design criteria would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

Create diversion of rainwater considering the natural water movement and add LAR solutions.

6.3 WATER AND LEARNING

'Water and learning' is a continuation of the previous section 'Local diversion of rainwater' (LAR). A similar method is used to analyse how to integrate LAR in water and learning. Research-based papers is used to gain knowledge that will be backed up by a case-study to outline ideas.

The increased amount of rainwater and climate change is an relevant issue and is significant to the future. Additionally learning and interacting with water can motivate children to play outdoor and experience the movement of water (Laridanmark, n.d.). The integration of nature, learning, and water in the teaching at 'The future school of NYE' has a high priority (Aarhus Kommune, 2020). The following case studies outline the LAR-elements which can be a part of learning and playing.

CASESTUDIE: LINDEBJERGSKOLEN

Lindebjergskole involves the pupils in the handling of rainwater. The LAR project has been designed to generate attention to the sustainable approach of handling rainwater through play and teaching. When children interact with the diversion and collection of rainwater they learn through play. The LAR project consists of a variety of water channels, rain beds with different plants, and a paddling pool which is a small model of Roskilde fiord. These elements are placed with a connection and thereby indicate, that it is necessary to have different LAR-elements to handle ordinary rain, dimension-affected rain, and cloudburst.

In 2015 the project was expanded with a percolation system, where the rainwater from the roofs ensures connected to an additional rainwater handling system.

The design criteria gain from this section:

- Design LAR element, with which children can interact to learn and play.

The previous design criteria would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

Ensure the possibility for children to utilise the movement and qualities of water for learning and playing.

Ill:. 36 Kids play in the pond of rainwater.

Ill:. 37 Waterpumps to engage children in the movement of water.

8

11. SUSTAINABLE CITIES AND COMMUNITIES

11.1 THE LOCAL COMMUNITY, AMENITIES

Knowledge is gathered by first-hand observations and research of NYE's website where the visions of the local community are presented. Amenities and facilities are investigated by mapping to clarify the possibilities in NYE and the surroundings. The subsequent sections will consist a random walking investigation and a phenomenological atmosphere analysis.

"A green city, with an active urban life"
(Byliv, 2020.)

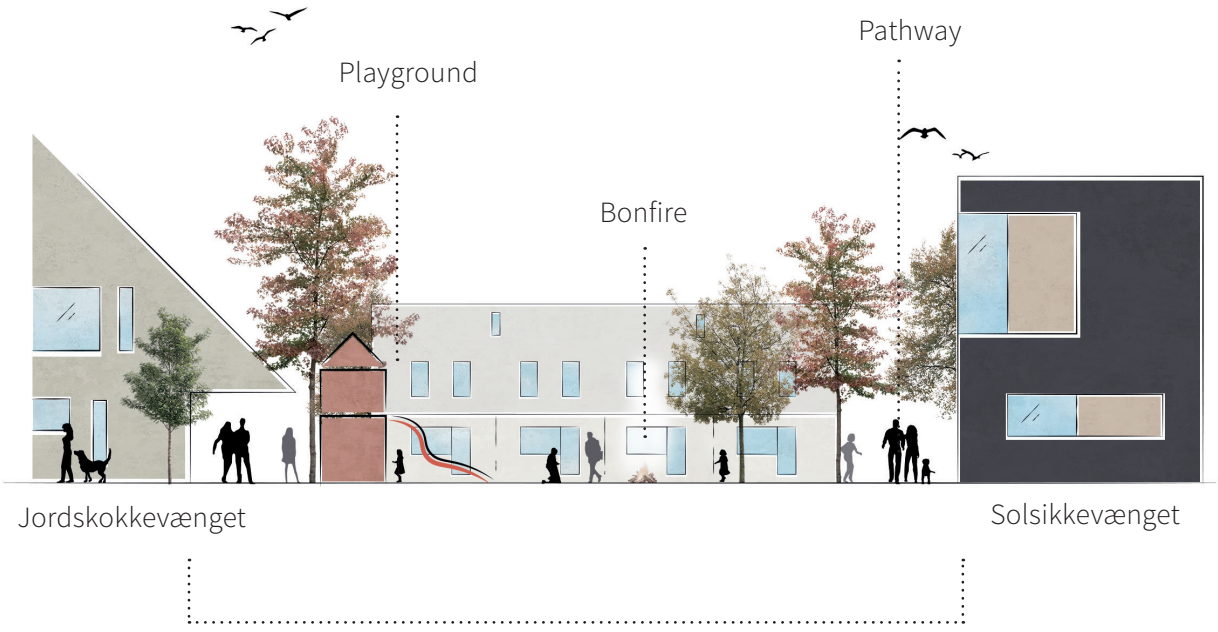
The city should be a safe place to live for everyone. The established buildings are most suitable for young families, but in the future NYE will offer building types for diversity (Ibid).

NYE consists of small quarters which are connected by pathways. In the middle of each small quarter, a common area is placed where the inhabitants meet and interact in green surroundings. The nearby buildings do not have gardens which reinforce the use of the common areas. By own observations in NYE, it was clear that areas are well-attended in all kinds of weather.

"We strive to develop a place, where people can meet and where communities arise naturally"
(Naturen, 2020.)

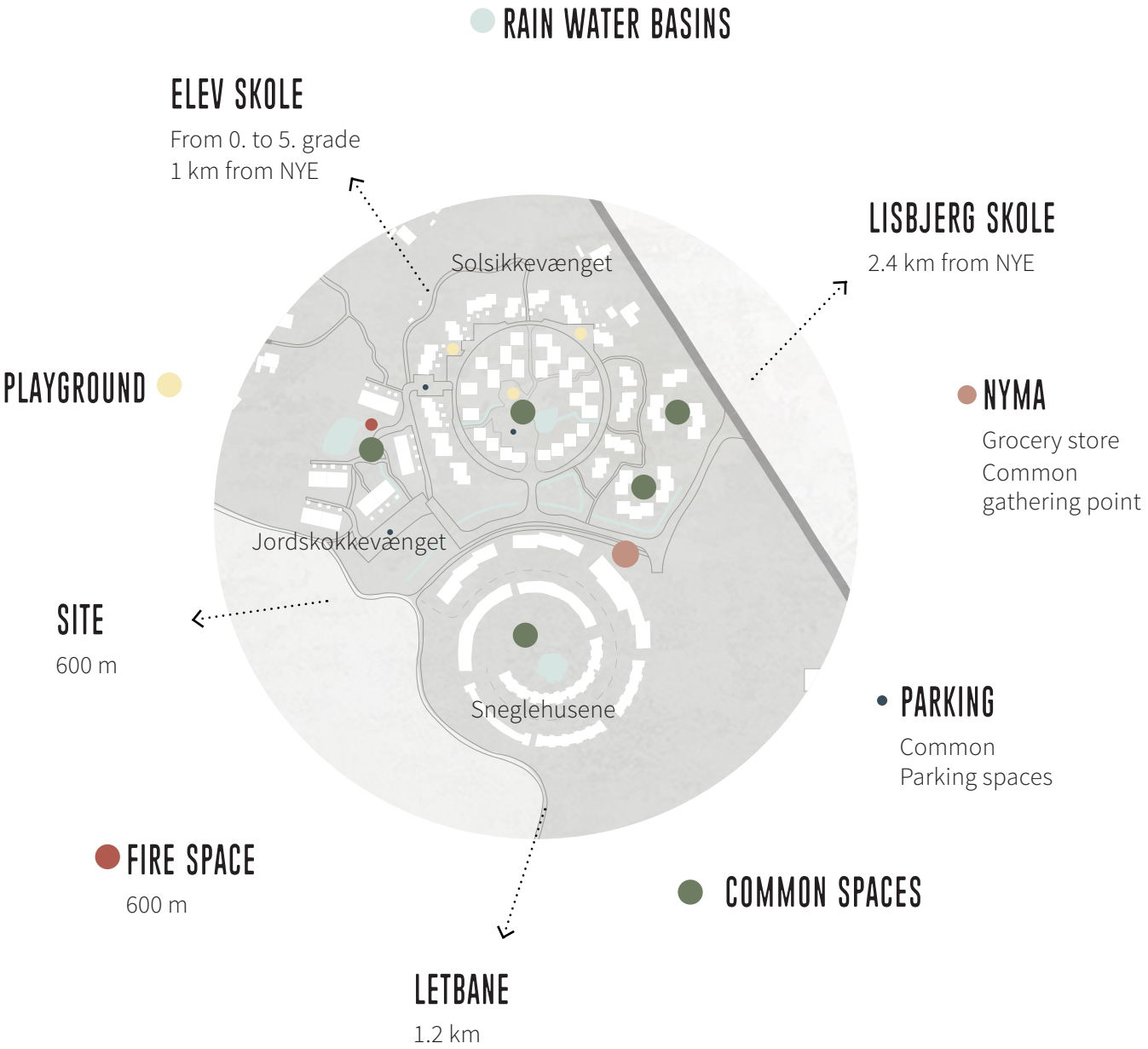
Based on the strong local community in NYE it is the ambition of the project to implement facilities in the design of the school that improves the community.

Creating facilities at the school where the locoal community can meet and promote there interaction.



Ill:. 38 Local Community

11.1 THE LOCAL COMMUNITY, AMENITIES



Ill:. 39 Amenities - scale 1:5000

11. THE LOCAL COMMUNITY, ATMOSPHERE

Standing on a field with a view
A view to forest, a view to community
A man with his dog passing by
He is smiling and beckoning
The sky is grey but human and animals showing their faces
The area is huge but safe
The silence is relaxing
Interrupt by laughing children
Their happiness is contagious

Ill:. 40 Atmosphere

11.2 THE LOCAL COMMUNITY, USER

The following study of the local community is based on a random walking interview. The knowledge gathered from this study are categorized as qualitative research because it is based on the individual experience of the users of NYE (Brinkmann, 2014). The approach to gather knowledge is user-oriented.

A prepared interview with predetermined questions can seem formal. The results of such an interview can be prejudiced and thereby not equal to the users' thoughts and feelings. Therefore, the interview is unstructured and people are approached on their terms and in their environment. The people then decide what to tell and the length of the conversation. The information gathered from the interviews depends on the given answers and subject opinions of the users, which is important to acknowledge applying this method. Analysing the result of these interviews create a more accurate understanding of NYE and the users.

Before carrying out the interview, purpose and expected result are determined:

The purpose of the interview:

- Characterize the area and users.
- The users' interaction with the spaces
- The user's relation to the area.

The visits to NYE have been done mostly in weekends to interact with as many users as possible. Furthermore, the observation of NYE and people's activities and movements indicates the number of visitors in the village and the popular activities. The people and the atmosphere in NYE have been investigated to understand the local community. After talking to several people, three interviews has been chosen to cover the prevalent knowledge gained from the different conversations.

USER 1 AND 2 - AT THE PLAYGROUND

To women and their children play on the playground. They live in the neighbouring town, Elev, but visit NYE, its playground, and outdoor areas to entertain their children. Additionally, they visit NYMA to get a cup of coffee or a few groceries. Despite them having children they had not considered the new schools but looked forward to getting more activities and facilities nearby. The women were examples of people moving to Elev to enjoy nature and small village life.

USER 3 - IN FRONT OF NYMA

The third user was a sixteen-year-old boy who lived in Elev too. As a recent graduate, he understands the need for a closer and bigger school. An increase in activities would be interesting to him and his friends because Elev lacks facilities and entertainment. The establishment of NYE is a breath of fresh air and a possibility to create settings for more than beautiful nature in the area.

USER 4 - INSIDE NYMA

The owner of the local grocery store NYMA started the store in partnership with Tækker Group. He takes his time talking to us and explains the future of NYE. He reports many visitors, which at the time mainly are families and elderlies. In the future when NYE is established he hopes that the intended diversity of the residence constellation will be fulfilled. He lives in Aarhus, but is considering to move to NYE in the future. The local community is a big draw. This is obvious looking in front NYMA where people are enjoying conversation, the sun, and the surroundings.

Already before conversing with the visitors of NYE, the community feeling are present. People greet while crossing them on the paths of NYE, and in the distance the smell of a bonfire scatters. Young and old in the area moves, on foot, on bikes, or with prams.

11.2 THE LOCAL COMMUNITY, USER

The analysis indicates a healthy community with an interest in the city and each other. The users have chosen the village life with nature nearby and enjoy the possibility NYE has to offer. The wish for more activities, especially for older children is high and, therefore, the prospect of a new school spreads excitement. An additional wish is to create gatherings points such as NYMA, where people meet and spend time together. At the moment the area has a limited number of gathering points which is reachable by foot and with the population increasing the need for more increases as well. The design of 'The future school of NYE' should consider the community's wish for more facilities but still maintain the spirit and nature.

The design criteria gain from the unstructured random walking interview:

- Create activities and facilities available to the community after schools opening hours.
- Create outdoor areas easy accessible to the community.

The previous design criteria would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

Consider the need and wishes of the users to strengthen the local community.

FACILITIES FOR THE LOCAL COMMUNITY

Several schools and society houses connected to villages have been investigated to obtain knowledge about facilities, that could be interesting for people living in the local community of NYE. Additionally, a few people of different ages, have been interviewed, to support the knowledge gained from the research of schools and society houses (Appendix 12).

The following diagram illustrates facilities addressed to respectively children and adults. Several facilities can be visited across ages and in groups of families.,

CHILDREN

- Playground
- Gymnastics
- Music-school
- Baking courses
- Sports
- Library
- Homework club
- Creative workshops

ADULTS

- Sports
- Book-club
- Yoga and pilates
- Choir
- Café
- Dinner club
- Communal eating
- Presentations
- Creative workshops

Ill:. 41 Children and adults

11.3 ENERGY CONSUMPTION

The following section covers the strategies to reduce energy consumption. The strategies are created to reach the energy demands from the building regulation(BR18, 2018) and tender documents (Aarhus kommune, 2020).

An environmental focus in the project is to create a building with low energy consumption - A low energy building.

According to the tender documents the voluntary class of sustainability, BR20 should be implicated in the design of 'The future school of NYE' (Aarhus kommune (BP5), 2020. P. 15). The voluntary class of sustainability BR20 consists of seven points about accessibility, energy consumption, indoor environments, life circle, and safety. In our project, the requirements of BR18 will be followed with the use of BR20 as inspiration to create a more sustainable building. BR20 will create a more sustainable project than just following the legal building requirements (BR18, 2018).

The tender documents propose three areas which would be followed according to environmental sustainability and be focus areas in our project (Ibid. P. 8).

1. Climate and CO_2 reduction concerning the building's life circle both according to materials and energy consumption(Ibid).
2. Improved indoor and learning environments to create spaces for better learning(Ibid).
3. Include the sustainable development goals(Ibid).

Points 2 and 3 have been covered in previous sections. Therefore, this section and the following section will be cover point 1. Early investigations and analysis have been made to reduce the energy consumption in the building design. The strategy presented in the tender documents regarding the appliance of passive and active solutions is an effective strategy towards saving energy. (IBID. P. 11) Therefore, this strategy will be implemented in the design of the building. The strategies under each step will be outlined in appendix 13 (Kang et al. 2015).

The clarification of handling the energy consumption in this projects lead to the following design criteria:

- Design a low-energy building.
- Integrate passive strategies, energy-efficient mechanical installations, and renewable energy.

The previous design criteria would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

Reduce the building's energy consumption considering passive solutions, energy efficient installations and renewable energy, In that order.

11.4 LOCALLY USED MATERIALS - NYE

When designing a new school in NYE, the sustainable expression of the local community must be taken into consideration. The sustainable profile of NYE is clearly visible when visiting the village. A registration analysis is used to explore the effects of the sustainable expression of NYE. The analysis is supported by observations and photo recording (Appendix 14).

When arriving at NYE, the buildings characteristics differentiate from the common building materials such as bricks and concrete which is widely used in new build. Instead, the buildings have a more natural expression that fits the surroundings dominated by fields and forest. The building façades of NYE are characterised by wood in different expressions where nuances, compositions, and patina varies.

Wood is one of the more sustainable building materials because of the ability to store CO_2 . Furthermore, wood is a heat energy source, when it incinerates after end-of-use (Lassen, 2020).

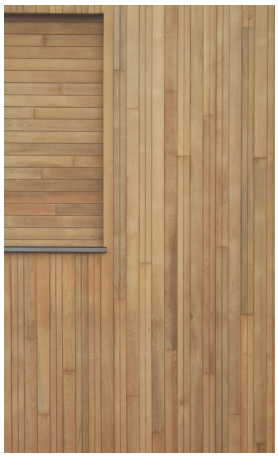
To support the sustainable character of wood, it is important to use local sawmills to minimize the pollution caused by material transportation.

Life cycle analyses will be further developed during the design process, to ensure the sustainability of the used materials. There can be a big difference in the environmental impact of various wood species, their lifetime and maintenance. Therefore, it is important to choose materials that relates to the micro-climate of the site.

The analysis of locally used materials in NYE leads to the following design criteria:

- **Wood must be implemented, in the expression of 'The future school of NYE', to ensure sustainable and architectural relation to the local community of NYE.**

Ill:. 42 Patinated wood



Ill:. 43 Oiled wood

Ill:. 44 Stained and olied wood

11.4 LOCALLY USED MATERIALS - ELEV

NYE is a part of the local community connected to 'The future school of NYE' but actually, Elev is located even closer to the site. Therefore, it is interesting to investigate the expression of the area. Registration and observation methods are used to explore the expression of Elev.

Elev is a suburb of Aarhus, that has existed for hundreds of years. Today the suburb has about 1.700 inhabitants (Elev sogn, 2019).

The part of Elev that is adjacent to the site is characterised by single-family houses built in two ages. The western part of Elev, closely connected to NYE, is established in the 70th and the Eastern part of Elev is quite newer and built in the early year of the 20th century (Lokalområdet før og nu, 2004).

Two similarities of the areas, are the materials and morphology. The materials of the houses are mainly characterised by bricks in different nuances, treated wood as smaller parts of the façades, and roofs of tile. The average building is one floor with a saddle roof.

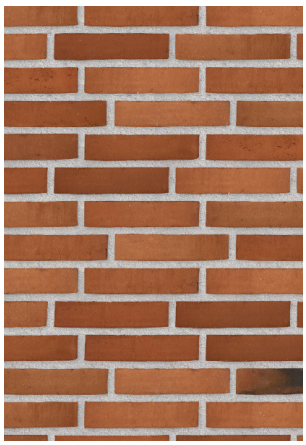
The overall expression of Elev can be compared to a classic detached house neighbourhood which contrasts with the newly developed sustainable village, NYE.

The analysis of locally used materials in Elev leads to the following design criteria:

- **The materials and morphology of Elev must be considered according to the expression of the future school of NYE.**
- **Bricks as facade materials must be redeveloped in a more sustainable way.**

The previous design criteria concerning both materials in NYE and Elev would be used to implement the following UN-Goal in the project and at the end evaluate accordingly.

Consider materials and their relation to the surroundings. Furthermore, consider material life cycle and maintenance.



Ill:. 45 Red bricks

Ill:. 46 Yellow bricks

Ill:. 47 Gable of painted wood

9

PROGRAM

ROOM PROGRAM, MIDDLE CLASSES

LEARNING ENVIRONMENT

Room	Amount	Area m²	Total area m²	Height m	People AMT	General comments
Toilet	16	2-5	75	2.5		
Storage	2	16	32	2.5		
Wardrobe	1	80	80	2.5	90	
Subject bases	9	65	585	3	30	Must include: Dissemination, immersion and project solving.
Shared Project Surface	1			3		Including hallway, lounge area, group rooms and smaller project surfaces for interdisciplinary lectures.
Group room	7	10-20	100	2.5	4-8	For group or individual work in a concentration area
After - School Centre	2	65	130	3	20	Including pedagogical kitchen

STAFF AREA

Room	Amount	Area m²	Total area m²	Height m	People AMT	General comments
Toilet	7	2-5	20	2.5		
Team room	2	20	40	2.5	12	
Wardrobe	1	30	30	2.5		
Immersion room	2	10	20	2.5	2-4	
Copy/Storage	1	12	12	2.5		
Break room	1	30	30	2.5	10	Including kitchenette

ROOM PROGRAM, ENROLLMENT CLASSES

LEARNING ENVIRONMENT

Room	Amount	Area m²	Total area m²	Height m	People AMT	General comments
Toilet	16	2-5	75	2.5		
Storage	2	16	32	2.5		
Wardrobe	1	80	80	2.5	112	
Bases	12	65	780	3	30	Must include: Dissemination, immersion and project solving.
Group Room	10	10-20	120	2.5	4-8	Used for play. LEGO, drawing or games.
Shared Project Surface	1			3		Including hallway, lounge area, group rooms and smaller project surfaces for interdisciplinary lectures.
After-School Centre	1	65	65	3	20	Including pedagogical kitchen.

STAFF AREA

Room	Amount	Area m²	Total area m²	Height m	People AMT	General comments
Toilet	7	2-5	20	2.5		
Team room	2	20	40	2.5	25	
Wardrobe	1	30	30	2.5		
Immersion room	2	10	20	2.5	2-4	
Copy/Storage	1	12	12	2.5		
Break room	1	30	30	2.5	15	Including kitchenette

ROOM PROGRAM, SCHOOL LEAVING CLASSES

LEARNING ENVIRONMENT

Room	Amount	Area m²	Total area m²	Height m	People AMT	General comments
Toilet	16	2-5	75	2.5		
Storage	2	16	32	2.5		
Wardrobe	1	80	80	2.5	90	
Bases	8	65	520	3	30	Must include: Dissemination, immersion and project solving.
Group Room	10	10-20	120	2.5	4-8	For group or individual work in a concentration area
Shared Project Surface	1			3		Including hallway, lounge area, group rooms and smaller project surfaces for interdisciplinary lectures.
After-School Centre	1	65	65	3	20	Including pedagogical kitchen.

STAFF AREA

Room	Amount	Area m²	Total area m²	Height m	People AMT	General comments
Toilet	7	2-5	20	2.5		
Team room	2	20	40	2.5	15	
Wardrobe	1	30	30	2.5		
Immersion room	2	10	20	2.5	2-4	
Copy/Storage	1	12	12	2.5		
Break room	1	30	30	2.5	10	Including kitchenette

ROOM PROGRAM, WORKSHOP AREA

WORKSHOP

Room	Amount	Area m²	Total area m²	Height m	People AMT	General comments
Home Economics	1	90	90	3	30	Close connection to nature and green-house.
Depot, Home Economics	2	15	15	3		
Music / Rhythmic	1	60	60	3	30	
Depot, Music / Rhythmic	1	15	15			
Music	1	60	60	3	30	
Music, Rehearsal room	1	15	15	3	5	
Science	1	85	85	3	30	Close connection to nature and outdoor base.
Science, Experimentarium	1	70	70	3	30	For projects and experiments.
Science, Laboratory	1	85	85	3	30	Scientific experiments.
Visual art, Dry	1	60	60	3	15	Theoretical lectures and presentations.
Visual art, Wet	1	30	30	3	15	For painting, graffiti and sculpture.
Depot, Visual art	1	20	20			
Craft & Design, Dry	1	60	60	3	20	Theoretical lectures and presentations.
Craft & Design, Wet	1	40	40	3	20	Messy activities.
Craft & Design, Coarse	1	60	60	3	30	For woodworking
Craft & Design, Machine	1	25	25	3	2	
Depot, Craft & Design	1	20	20			
Craft & Design, Exhibition	1	90	90	3	30	
Makerspace	1	60	60	3	30	
Depot, Makerspace	1	16	16			
Techincal Workshop + Office	1	40	40	2,5	7	
It-Office	1	12	12	2,5		

SPORTS FACILITY

SPORTS FACILITY

Room	Amount	Area m²	Total area m²	Height m	People AMT	Comments
Sports Centre	1	1200	1200	10	60	
Storage	1	30	30	4		
Changing Room	8	38-42	310	3	20	
Teacher Changing Room	2	20	40	3	3	
Storage	3	10-30	70	3		
Multi Hall	1	120	120	7	30	
Dance Hall	1	140	140	4	30	
Association Room	1	120	120	3	90	
Toilet	12	2-5	75			
Association, Meeting	1	30	30		10	
Association, Office	1	30	30		10	

ROOM PROGRAM, COMMON SPACE

ADMINISTRATION:

Room	Amount	Area m²	Total area m²	Height m	People AMT	Comments
Open - Plan Office	2	50-80	80	3	12	1: Including wait- and arrival area.
Archive + Copy	1	20	20	2.5		
Break Room	1	12	12	2.5	5	
Meeting Room	1	30	30	2.5	10	
Toilet	2	2	4	2.5		

KITCHEN:

Room	Amount	Area m²	Total area m²	Height m	People AMT	Comments
Food Sale	1	35	35	3		
Canteen, Kitchen	1	80	80	2.5		
Changing Room, Kitchen	2	5	10	2.5		
Toilet, Kitchen	2	3	6	2.5		
Office, Kitchen	1	7	7	2.5	2	
Fridge, Kitchen	1	10	10	2.5		
Dishwashing	1	15	15	2.5		
Storage, Kitchen	1	20	20	2.5		

COMMON SPACE:

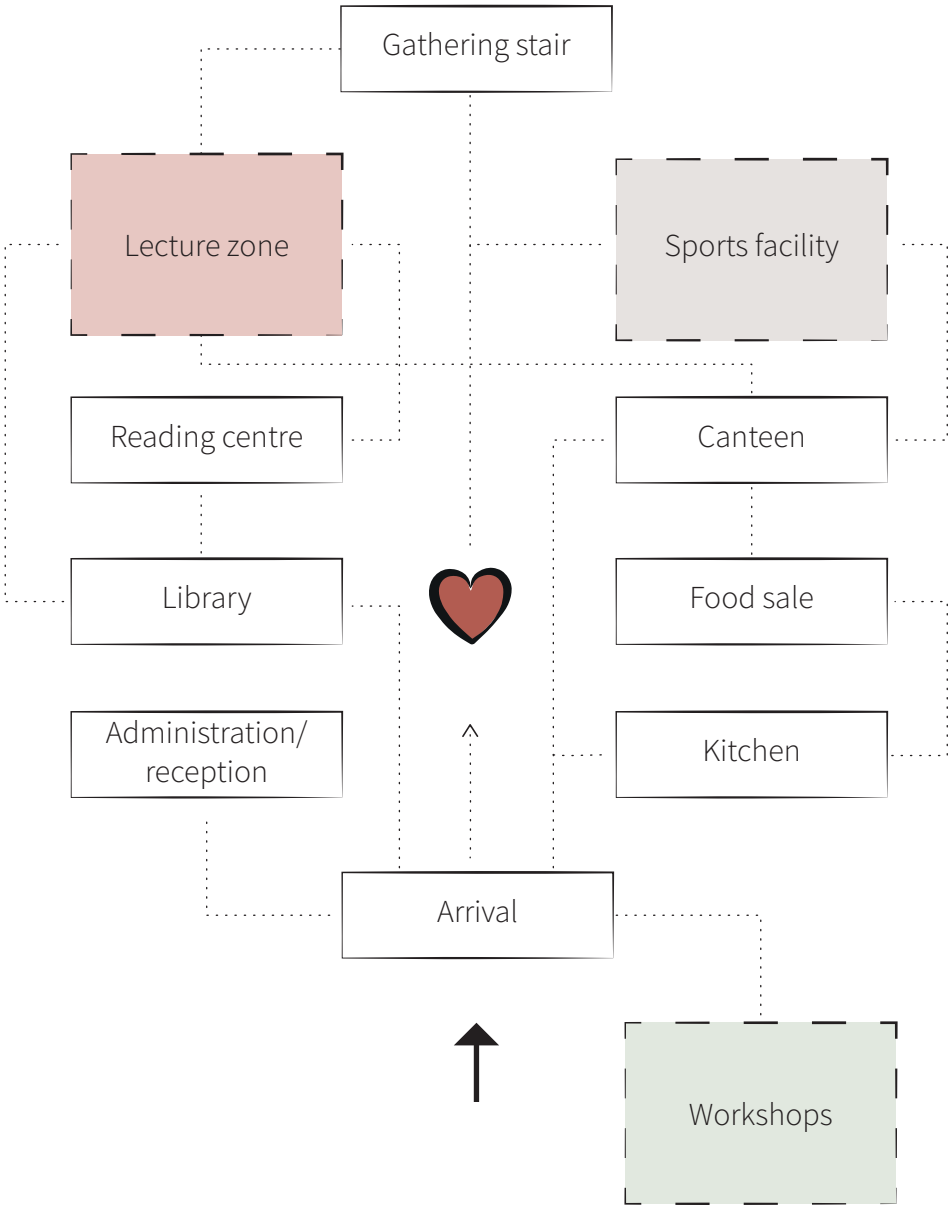
Room	Amount	Area m²	Total area m²	Height m	People AMT	Comments
Canteen	2	110-290	400	3	200	
Depot, Furniture	1	40	40			
Gathering Staircase	1	200	200		200	
Toilet	14	2-5	75			

LIBRARY FACILITIES:

Room	Amount	Area m²	Total area m²	Height m	People AMT	Comments
Library	1	400	400	3	60	
Reading Center	2	20	40	3	4-10	
Librarian Office	1	12	12	2.5	5	

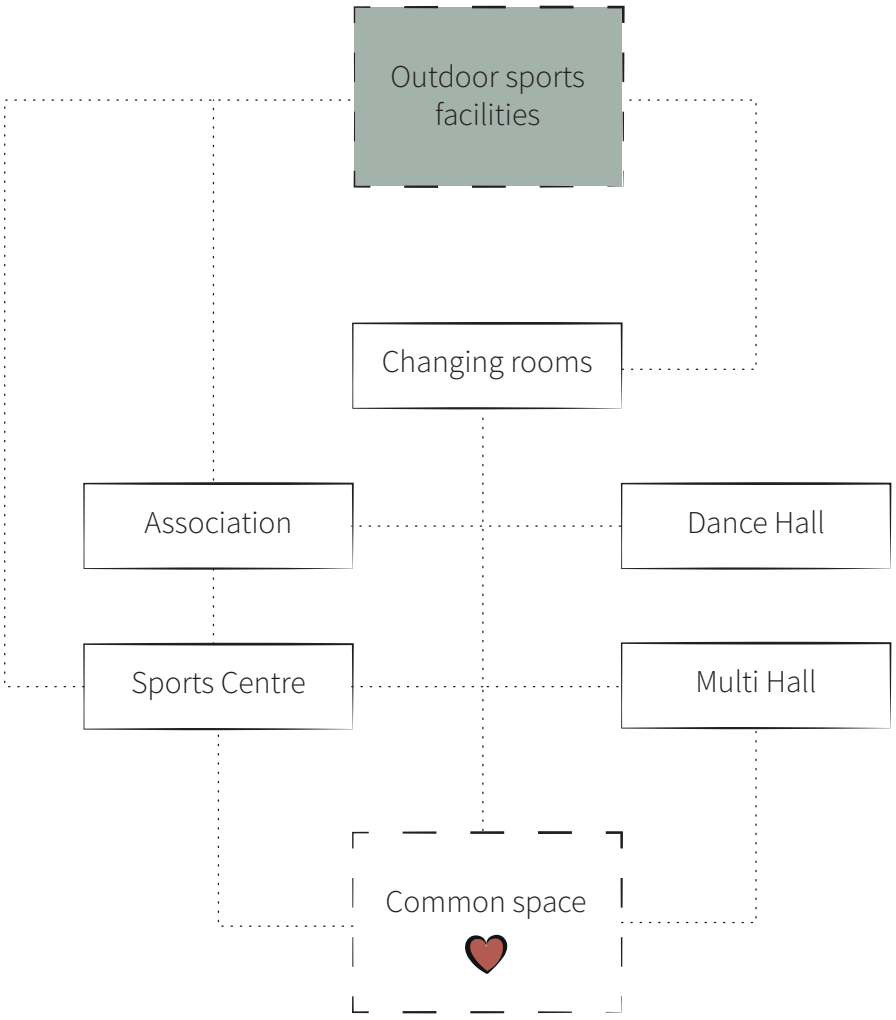
FUNCTION DIAGRAM - COMMON SPACE

The following function diagrams are developed to highlight the important connections and relations between rooms in the different zones. The function diagrams are designed in a simple structure and must be used parallel with the room program. Thereby it is possible to change between simple and detailed information depending on the phase of the design process.



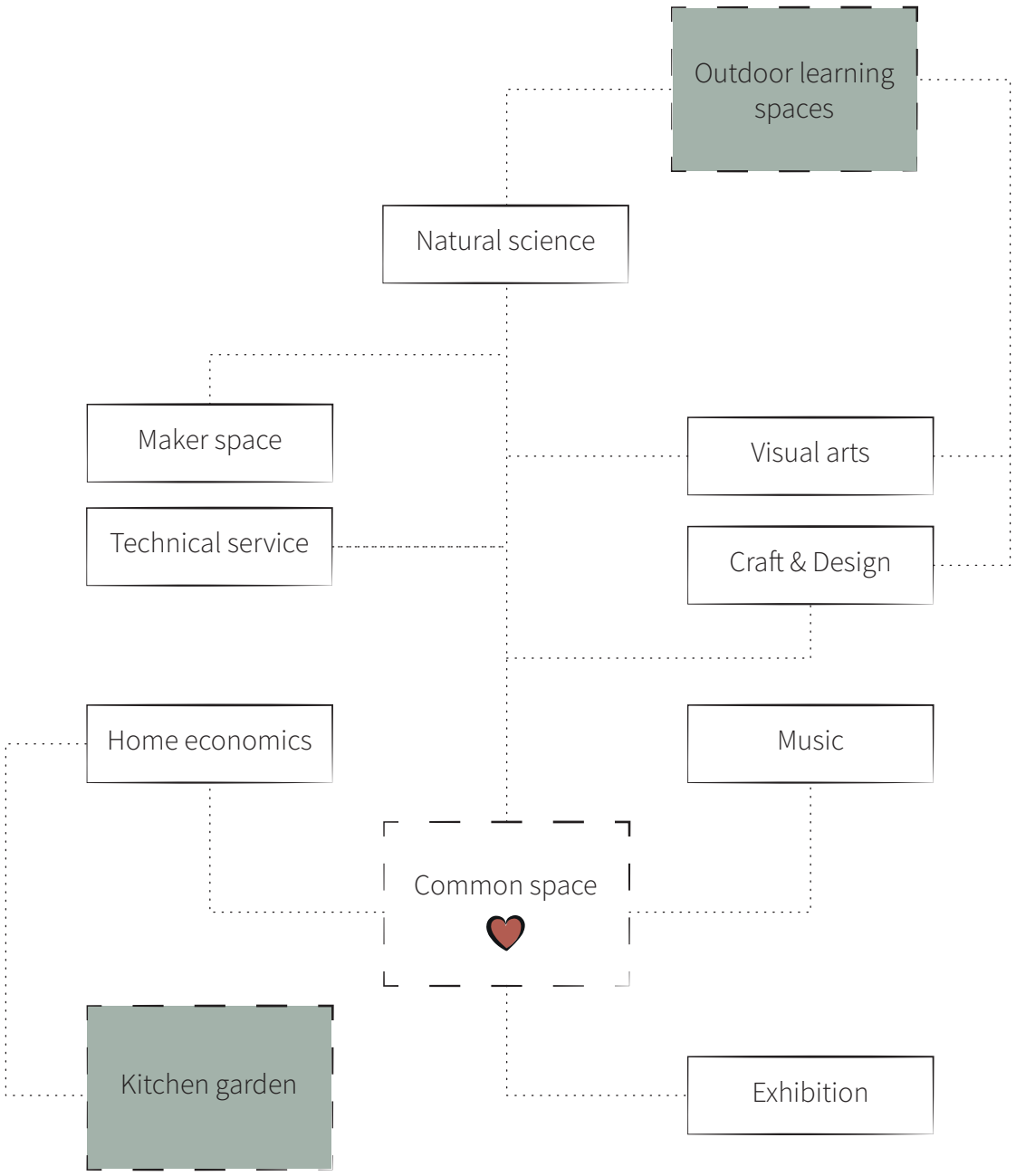
Ill:. 48 Functionsdiagram, Common Space

FUNCTION DIAGRAM - SPORTS FACILITY



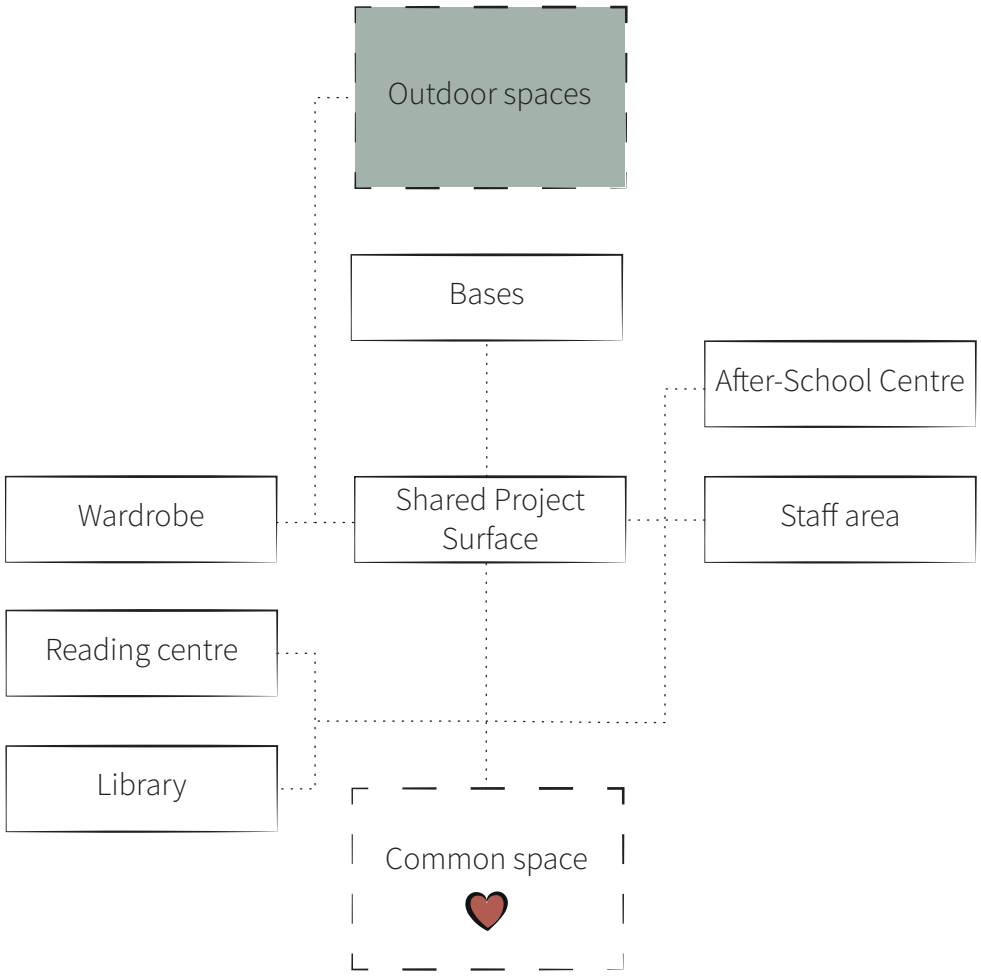
Ill:. 49 Functionsdiagram, Sports facility

FUNCTION DIAGRAM - WORKSHOP AREA



Ill:. 50 Functionsdiagram, Workshop area

FUNCTION DIAGRAM - LECTURE ZONE



Ill:. 51 Functionsdiagram, Lecture zone

VISION

The vision of the future school of NYE is to design a building that respects the unique location surrounded by nature. A building relating to the local community both architecturally and socially. The future school of NYE must be a local gathering point where people of all ages can meet, be entertained, learn, and develop healthy relations. Furthermore, it is the vision to develop a school that educates individuals in sustainable behaviour, by integrating visible initiatives, promoting the sustainable expression of the school. The UN-Goals will be used as a benchmark to ensure the development of a school with a high level of sustainability. The vision is to invite nature into the school and utilise the local surroundings.

The vision is to design a school expressing sustainability
- A sustainable and educational gathering point.

10

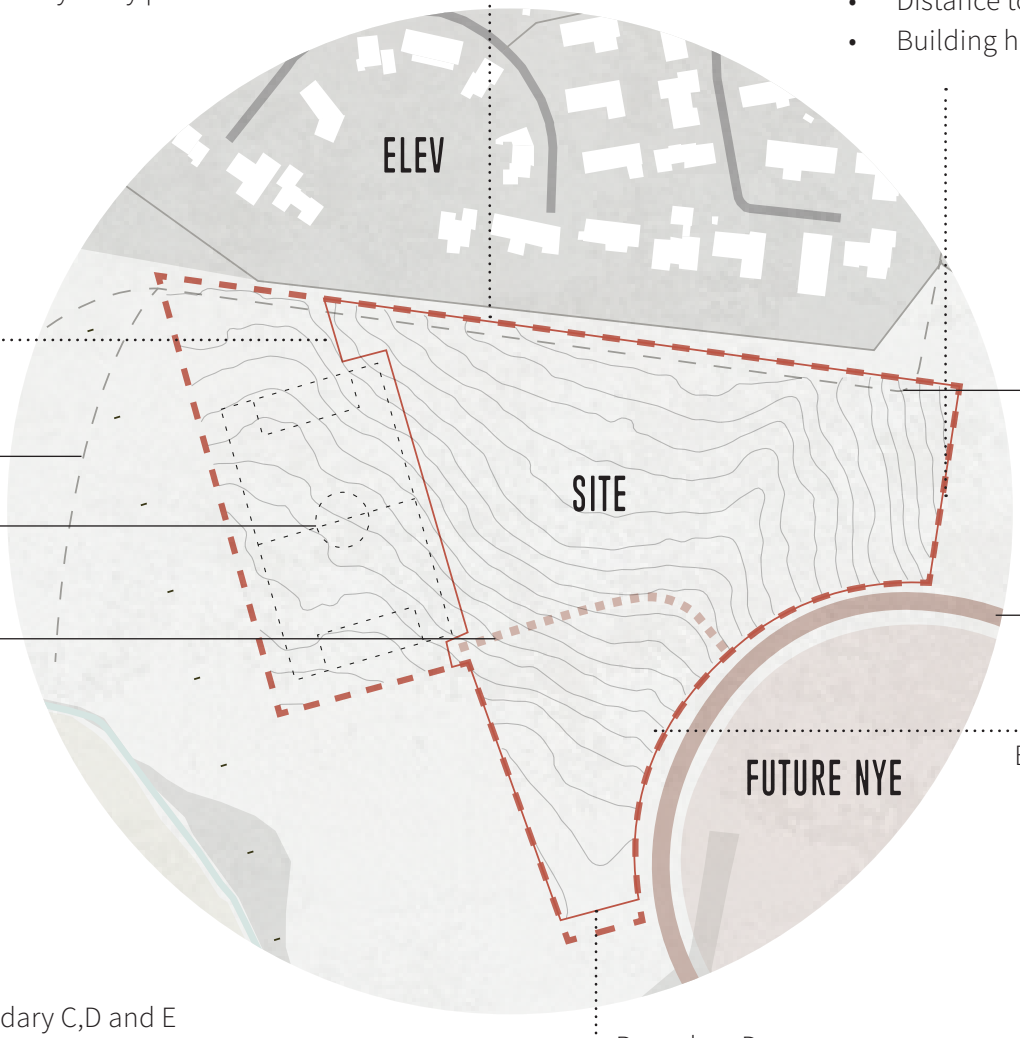
DESIGN PROCESS

SITE CONDITIONS

Boundary A
- Distance to boundary = 10 m
- Building height = 0.5 x distance

Bike-Parking
- 75 bike PL. pr. 100 pupils
- Divided between main entrance, play fields, arrival roads and secondary entry points.

Boundary B
- Distance to boundary = 10 m
- Building height = 1.4 x distance



Boundary E

Pathway

Play field

Service road

Pathway

The Ring

Boundary C

Boundary C,D and E
- Allow maximum building height to boundary

Boundary D

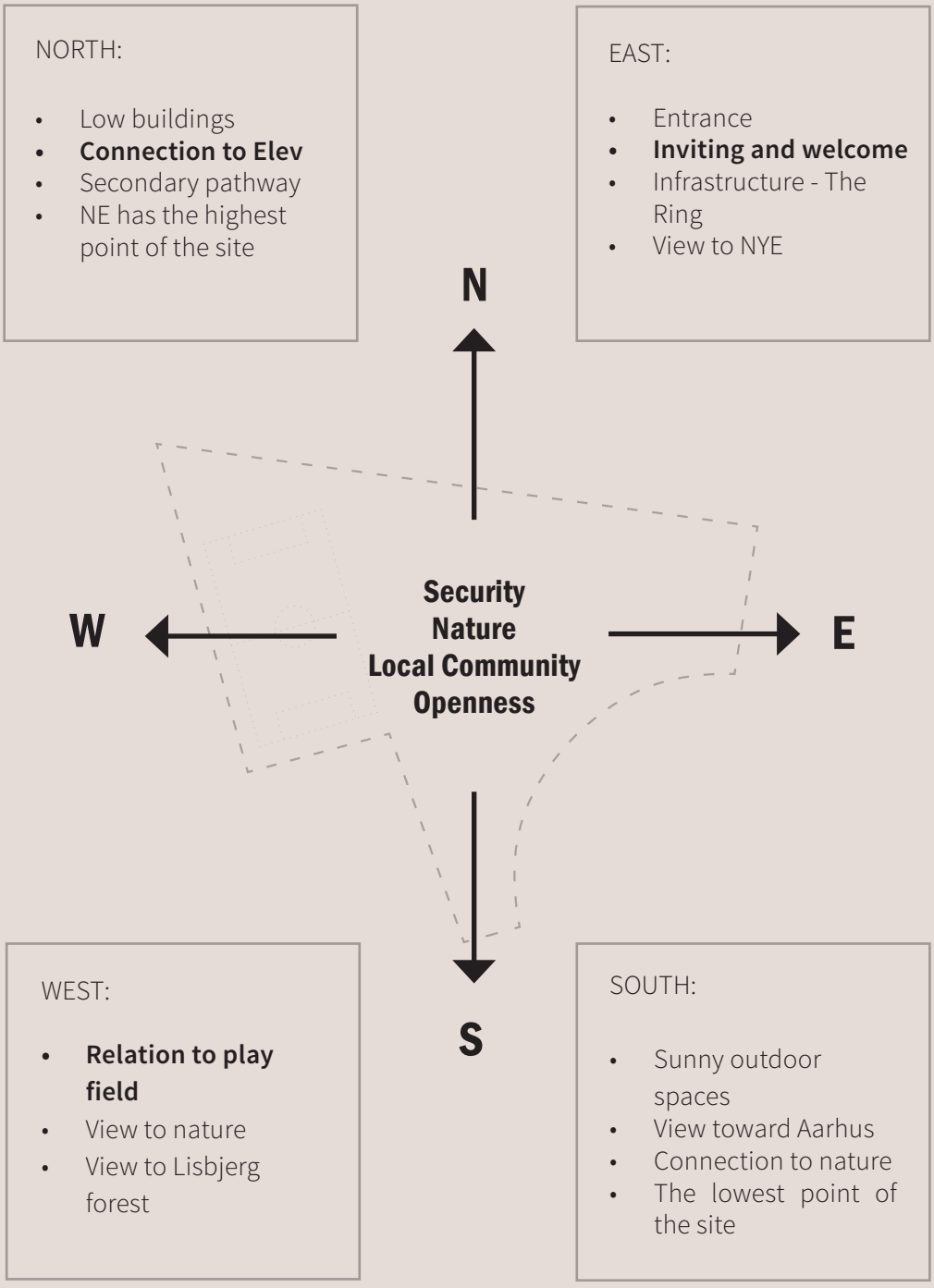
Car- Parking
- 1 PL. pr. 100 m^2 building work

Maximum building height at site = Datum 72.0 m

Ill:. 52 Site

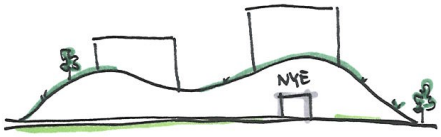
Scale 1: 3.000

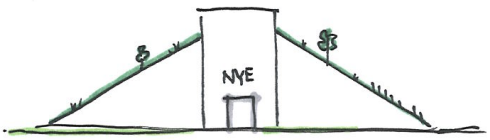
SITE QUALITIES AND LIMITATIONS

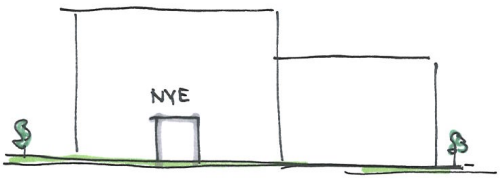


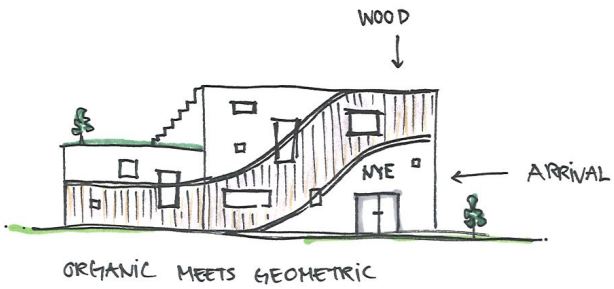
Ill:. 53 Site qualities

INITIAL IDEAS







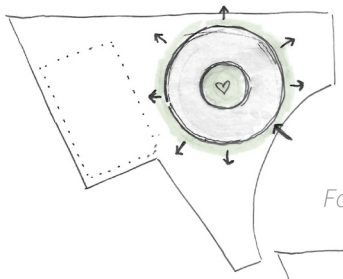


"How to let the building interact with the curving fields winding through the landscape greeting each other"

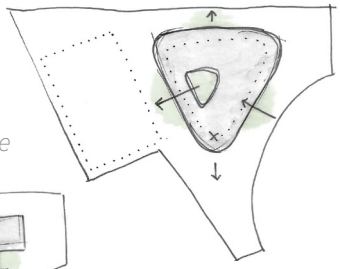
The initial ideas were created through brainstorming, inspirational pictures and sketching (appendix 15). Thereby word as a gathering point, landscape, and relation was connected as synonyms for our vision for the design of the building.

The alternative learning, play and movement, and nature investigations from our analyses generated the idea of the school being open toward the surroundings instead of closing around the pupils (appendix 16).

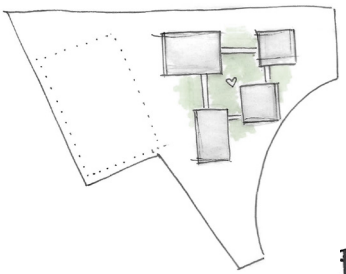
Forms fitting to the site

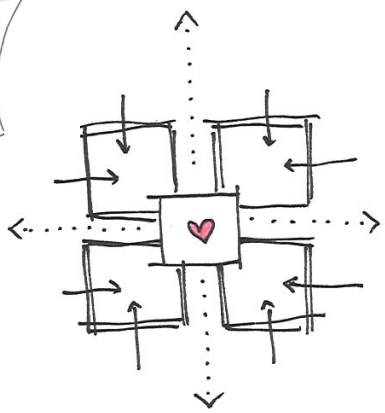


Forms fitting to the site



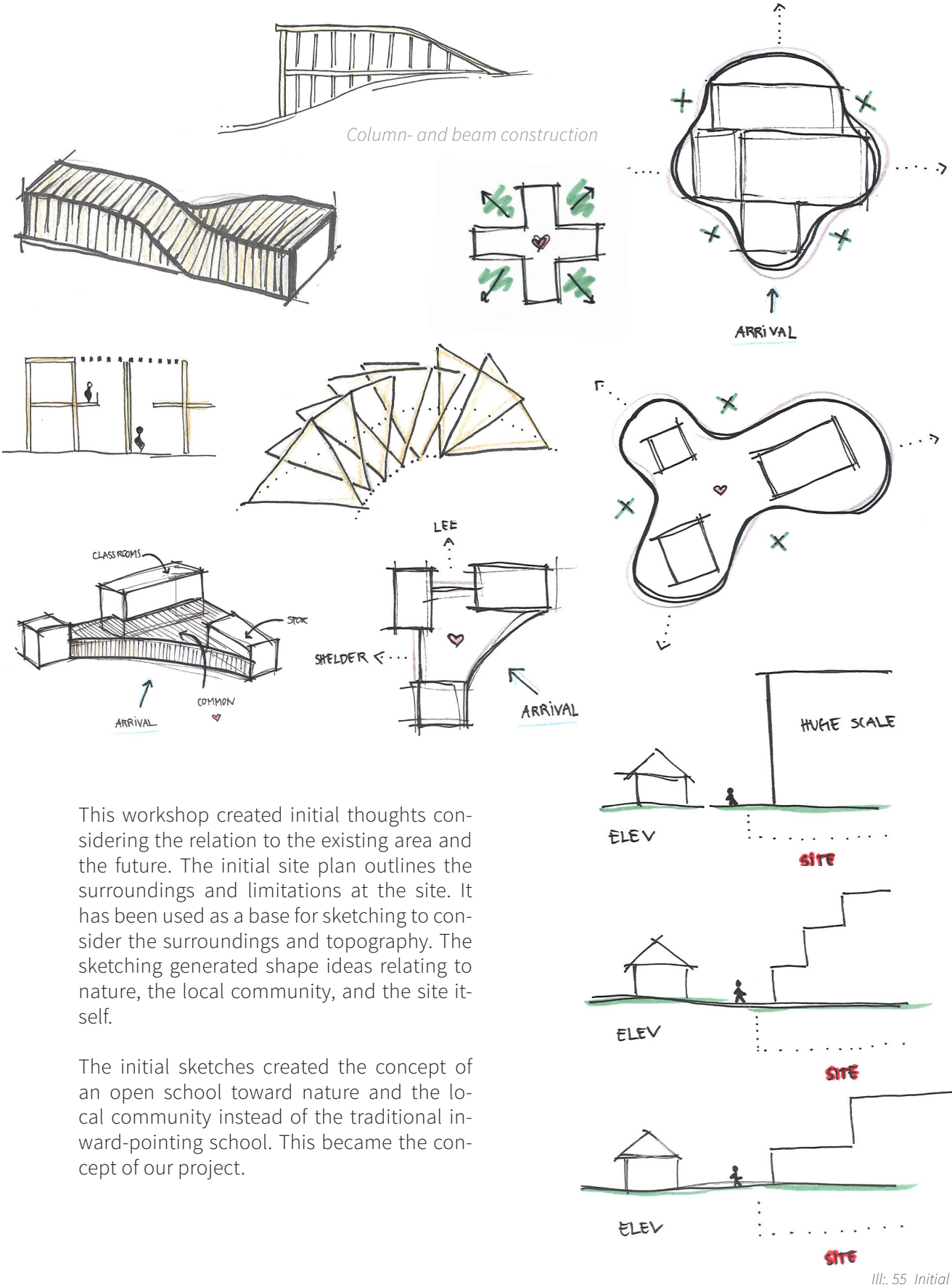
Forms fitting to the site





Ill:. 54 Initial ideas

INITIAL IDEAS



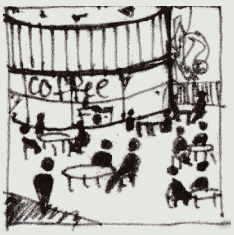
This workshop created initial thoughts considering the relation to the existing area and the future. The initial site plan outlines the surroundings and limitations at the site. It has been used as a base for sketching to consider the surroundings and topography. The sketching generated shape ideas relating to nature, the local community, and the site itself.

The initial sketches created the concept of an open school toward nature and the local community instead of the traditional inward-pointing school. This became the concept of our project.

Ill:. 55 Initial ideas

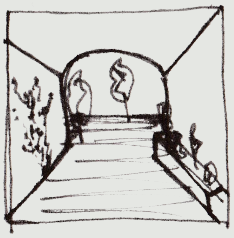
INITIAL WORKSHOPS

The following section consists of four initial workshops with specific focuses. They are made to consider different aspects we want to integrate into the buildings design. When finding inspirations in reference projects and working with brainstorms, it is possible to revert to the workshops and used them as a basis for further and more in-depth investigations.



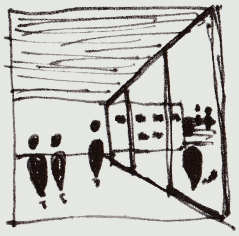
Ill:. 57 Create gathering spaces to bring people together

Ill:. 56 Maintain the vegetation



Ill:. 58 Greenery both indoor and outdoor to create a nature feeling everywhere

Ill:. 62 View to the surrounding landscape and greenery which enhance activities.



Ill:. 59 View to nature and outdoor activities to incite people to go outside

RELATION TO NATURE

The initial investigations of the relation to nature highligt the possibility to bring the countryside into the buildings and opposite facilities out in nature.

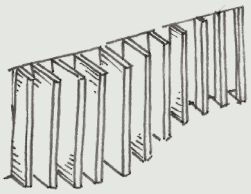
One of the focus points has been to create gradual transitions from interior to exterior. This can be done with transparent façades and views to the landscape. Additional design of activities that can be utilized outside has been studied in appendix 17.

FACADE

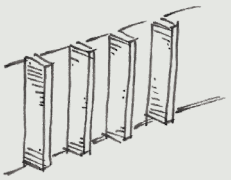
This initial facade workshop (appendix 18) is based on wood as façade materials, because our investigation indicated that wood is the main material in NYE. These early investigation indicates how wood can be used to divide the facade both horizontal and vertical.

The vertical wood studies indicates that wood can be used to divide a large facade into smaller sections. At the same time the wood planks can work as sun shading depending on their width.

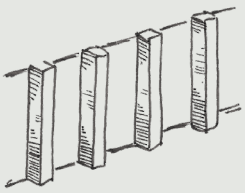
The horizontal wood studies indicates that by using different kind of wood or materials, higher façades of the building can be brought into human scale.



Ill:. 63 Varying depth of wood façade

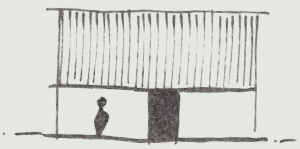


Ill:. 60 Slim wood panels on façade



Ill:. 64 Wide wood panels on façade

Ill:. 65 Consistent material on façade



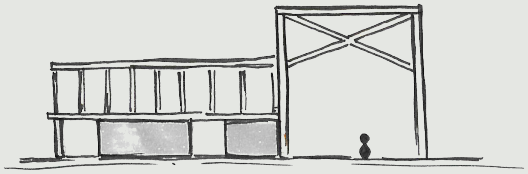
Ill:. 61 Façade in human scale

INITIAL WORKSHOPS

STRUCTURE

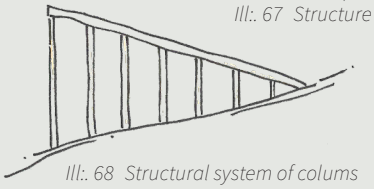
When looking at the structure in an early stage of the design process, the output is suggestions. The intention is to cover solutions that can meet different concepts (appendix 19). Wood is a general inspiration source, but the workshop supports the combination of different structural strategies.

The result illustrates, that by combining both wooden and concrete structures the construction can be adapted into the building shape. Structural principles such as beam and column construction in combination with the load-bearing concrete wall, can create a diverse building with open spaces as well as closed focus rooms. Thereby, the structure can be exposed to create architectural quality and or otherwise hidden.

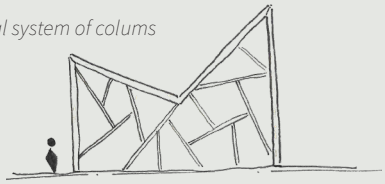


Ill:. 66 Combination of structural strategies

Ill:. 67 Structure meeting curving surfaces



Ill:. 68 Structural system of colums

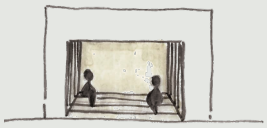


Ill:. 69 Structural system becoming an exhibition

INTERIOR MATERIALS

Interior materials are not just elements to cover floors, walls, and roofs. Interior material must meet the functions of the building, promote the interaction, and support the intention of generating well-being among the users.

This investigation (appendix 20) outlines ideas how materials can be integrated and used functional to create experiences. Materials can be used to highlight different spaces in the building as well as the purpose of the space itself. Additionally change in materials can help way finding and recognisability. Furthermore considerations about robustness and maintenance have to be considered.

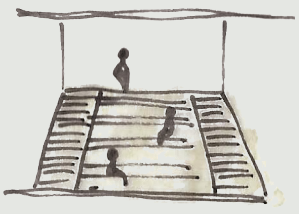


Ill:. 70 Highlighting specific functions

Ill:. 71 Materials fitting atmospheres

Ill:. 73 Highlighting nature

Ill:. 74 Highlighting zones



Ill:. 72 Materials that highlights way-finding

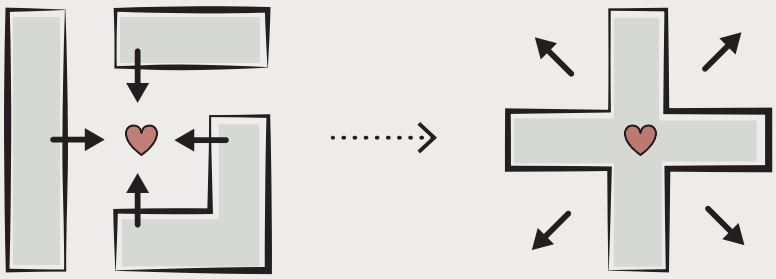
CONCEPT

During the initial part of the design process, the importance of the site topography became apparent. The unique site placement must be supported by a concept relating to the surrounding qualities such as open landscape and nature.

The site location differs from many of the modern school sites which are often placed in dense cities bounded by the surrounding buildings and crowded roads. At these locations, the schools are responsible for the safety of the pupils by protecting them from traffic. Therefore, the school yards are often placed in calm and safe conditions encircled by the building or fences.

This protecting concept is suitable for schools in dense cities. In NYE, the concept creates a clear connection to the local community and nature by opening towards the surroundings.

The new school of Nye must be open, unfold and apply to the surroundings.



"Open towards the local community and nature instead of enclosing the pupils."

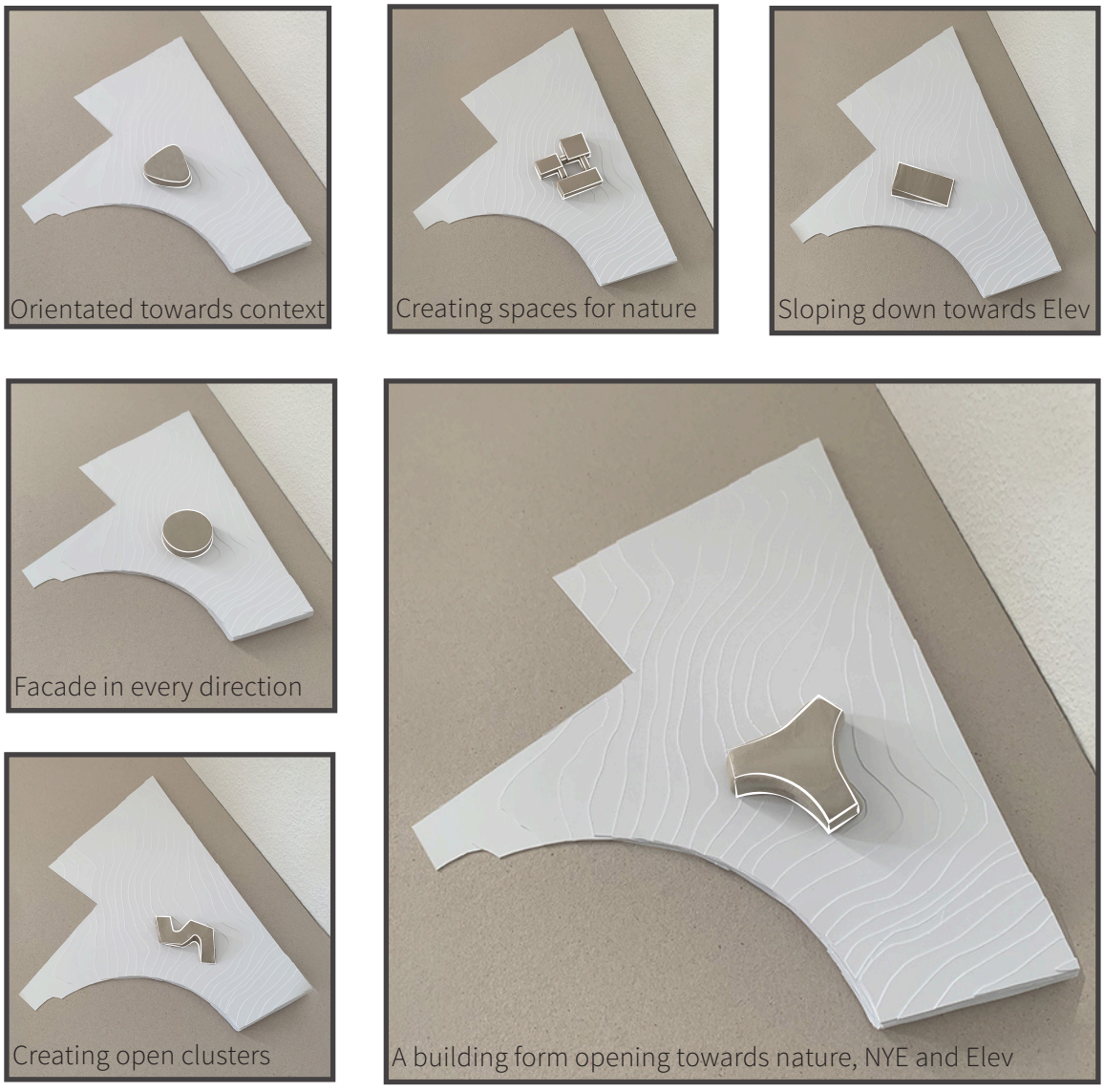
Ill:. 75 Initial concept

FORM WORKSHOP

In this form workshop clay was used as working material in combination with a site model in 1:500 with contours (appendix 21).

The purpose of working with clay models, was to generate a row of different forms, suitable to the specific site. The initial thoughts was unleashed and the clay was formed with inspiration, based on the program analysis, the vision of the project, and the initial workshops. Clay is an appropriate material to create fast models driven by fast thoughts and thereby easily adapts to the contoured site surrounded by nature.

The results was multiple models where the main thoughts behind each form are written on the following pictures. The workshop gathered our thoughts from early workshops to specific forms. The outlined pictures indicate the forms with interesting parts that contribute to our initial form concept.



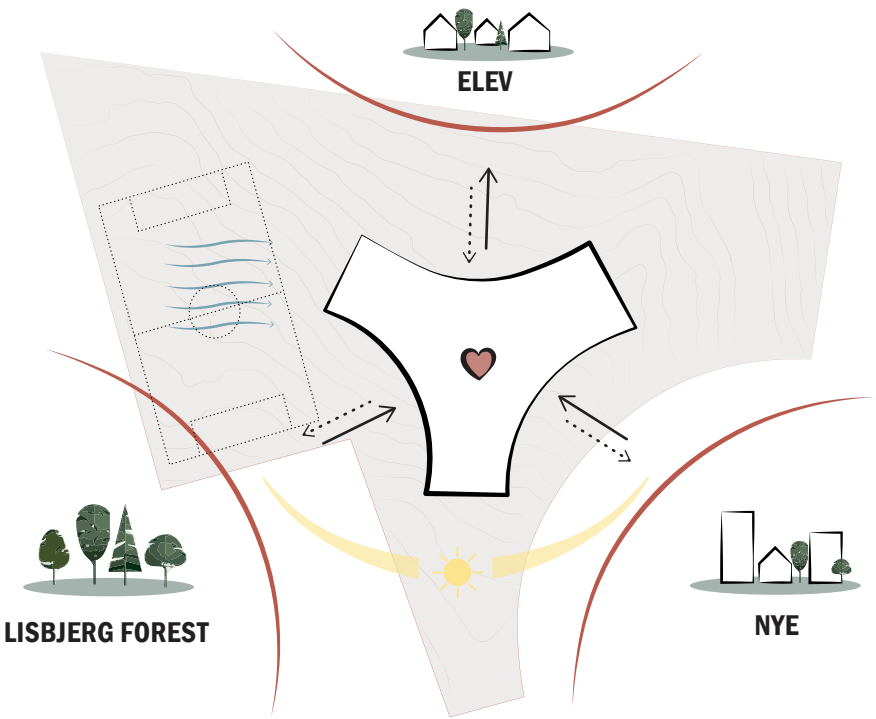
Ill:. 76 Form workshop, clay workshop

INITIAL FORM CONCEPT

Our initial form concept are developed by collecting the strengths from the clay workshop and evaluation of the form concept studies (appendix 22). The initial form concept supports the community feeling by having a natural centre that functions as a gathering point for the locals and pupils. The form consists of three wings where zones with different functions can be placed according to room requirements. Additionally, the form invites the users into the building when arriving from pathways and The Ring because of the curving contour. The curving contour are repeated towards the three parted surroundings: Elev, Nye and nature to ensure relation to the close context.

The form is not fixed and have the potential of being raised, lowered, staggered, extended, or reduced to develop the best possible school design. The future steps are to ensure the interaction and relation to the surrounding nature and adapt the building to the sloping landscape of the site. The intent is to create a landmark connecting the local community while still respecting the scale of Elev and Nye.

The next part of the design process is to evolve the design and how to meet the UN-Goals.



Ill:. 77 Initial form concept

PLACEMENT OF ZONES

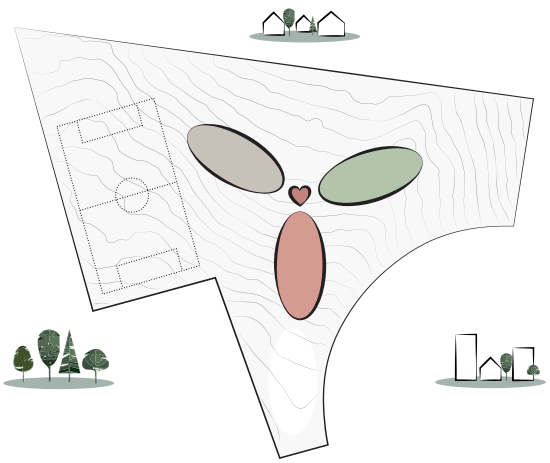
To create an overview of the placement of different rooms they have been divided into three zones: lecture zone, workshop zone and sportsfacilities based on their requirements and connection with the site.

WORKSHOPS

The workshop area is in a separate zone because of the noise pollution from equipment. The northerly placement of the workshop zone is based on the activity level and equipment in the rooms. To ensure a healthy indoor environment it is necessary to place the workshop rooms with the highest equipment load and activity levels with north-facing windows. Furthermore, the visibility of the workshop area is necessary when wishing to engage with the local community.

SPORTS FACILITIES

The sports facilities is located with close connection to the westerly placed outdoor sports facilities. This connection is important to clearly distinguish the sports centre and facilities for the locals and visitors. Furthermore, it ensures easy access to changing rooms from both indoor and outdoor sport activities. The sports centre can be placed into the ground because there is no daylight requirements.

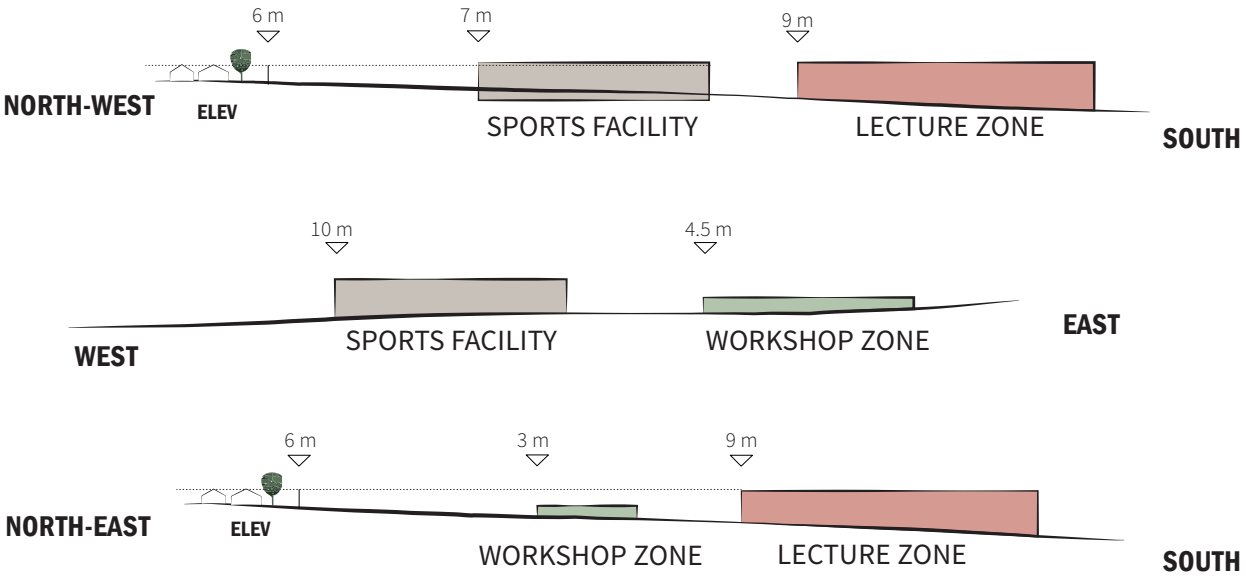


Ill:. 78 Placement of zones

LECTURE ZONE

The placement of the lecture zone is orientated towards south where the landscape slopes down and away from Elev to ensure the building height respects the scale of Elev.

The focus is a vertical connection between the lecture floors, joined through a gathering-staircase. The vertical lecture zone must be separated from the other functions, to ensure private belongings are safe in the bases. Placing the bases in one zone also enhances the way-finding of the school for the pupils and visitors.



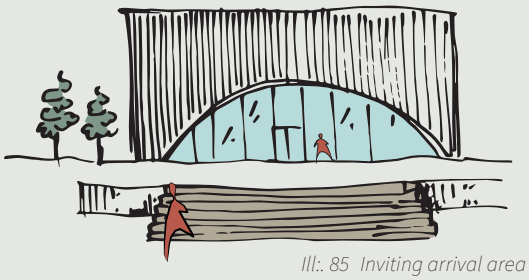
Ill:. 79 Sections of zone placement

EARLY INVESTIGATIONS

INVITING

This investigation (appendix 23) was made in connection with initial plan layouts. The purpose was to ensure inviting elements throughout the building for the users.

The results of this investigation were that transparent materials towards the entryway highlights the entrance and in combination with a clearly divided platform can help ensure users of the main entrance. Furthermore, a lower ceiling in the entrance area provides a more secure feeling when entering a new place. Together with atriums or higher ceiling height in the common space the users will be drawn towards the open and lighter areas. This contrast element from darker areas towards lighter areas will also be used in around the bases and naturally guide the pupils towards these specific zones.



Ill:. 85 Inviting arrival area

Ill:. 86 Gathering staircase

BRINGING NATURE “INTO” THE BUILDING

This investigation (appendix 24) was made in connection with deciding a form. The purpose was to outline how the countryside can be integrated with the form of the building instead of only surrounding the building.

The results of this investigation were that the surfaces of the form needed to be split up to create hubs for nature. The benefits of plants and trees will be integrated further into the design process. These are considered both in outdoor and indoor spaces. Further investigations can illustrate how nature can be brought into the building by materials, transparency, and interior plants.

Ill:. 80 Bringing the nature into the building by multiple views and outdoor hubs.

Ill:. 81 Heat rejecting

Ill:. 82 Air cleaning

Ill:. 83 Sound absorption

Ill:. 84 Nature view

EARLY INVESTIGATIONS

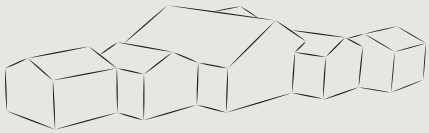
ROOF

The purpose of this early roof investigation was to consider the building as volumes along side create a plan layout. The studies illustrates how the building can relate to the surroundings and at the same time be a visible gathering point for the two cities: NYE and Elev. Additional investigation can be seen in appendix 25.

The roof investigation illustrated:

- The roof have different heights to relate to the surroundings and orientation, but also needs to have higher points to highlight different functions of the building.
- The need for utilising the roof is not necessary because of the amount of great nature surrounding the site.

Ill:. 87 Flat roof can be utilised as an additional outdoor space.



Ill:. 88 Pitched roof pointing in different directions creates a characteristic building shape.

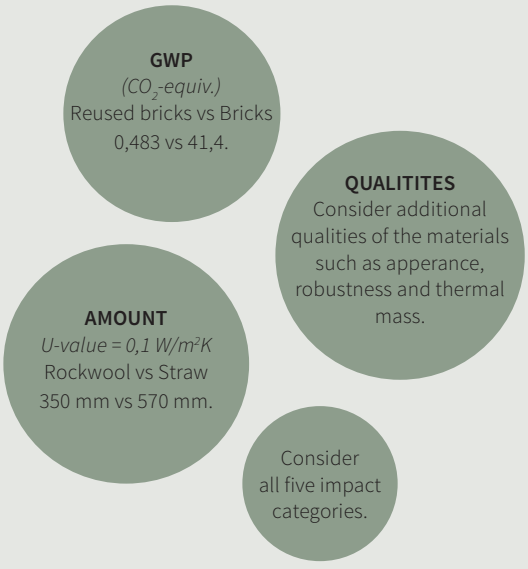
Ill:. 89 A roof sloping in different directions can create focus point and relations to the landscape.

LIFE CIRCLE ASSESSMENT OF MATERIALS

To investigate materials Life Circle assesment (LCA) are calculated regarding a lifespand on 100 years and the amount of each material. The materials are compared to each other according to 5 impact categories. Further studies are illustrated in appendix 26.

Based on the LCA analysis the following materials are chosen for further work, because of their performance and further qualities:

- External cladding: Reused bricks, concrete and wood.
- Internal: Reused bricks, concrete and wood, wet plaster.
- Insulation: Rockwool



5 IMPACT CATEGORIES

GREENHOUSE GASES (GWP)
Climate change, melting ice etc.

STRATOPHERIC OZON DEPLETION (ODP)
UV radiation increase, holes in the ozon layer.

TROPOSHERIC OZEN FORMATION (POCP)
Smog formation in cites, affecting humans.

ACIDIFICATION (AP)
Change PH value, impact flora and fauna.

EUTROFICATION(EP)
Increase of nutrients in marina and water.

EARLY INVESTIGATIONS

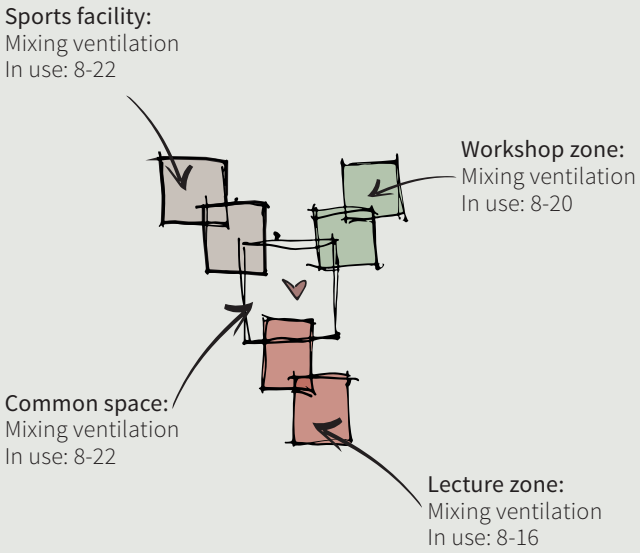
VENTILATION

The purpose of investigating ventilation solutions early in the process. Air currency, people load, and ventilation strategies can be seen in appendix 27. All the results of the investigations are done according to the requirements from BR18. At this point in the process, the calculation and numbers are roughly done.

The plan drawing on the right illustrates the determined ventilation strategies in the different zones of the building.

The result of this investigation is:

- Use hybrid ventilation in the main rooms of the building.
- Use displacement ventilation as the main mechanical ventilation strategi
- Natural ventilation solutions can be seen in the table:



Ill:. 91 Ventilations strategies in the different zones.

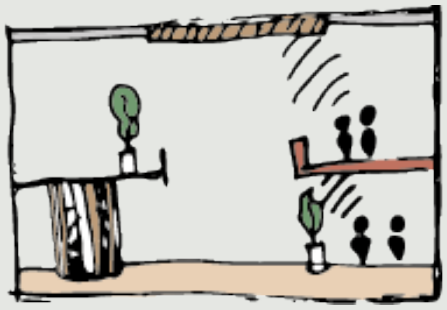
	Bases	Project surfaces	Common space	Sports facility
Natural Ventilation	Diffuse ceiling ventilation	Double sided ventilation	Stack ventilation	Stack ventilation/ double sided

ACOUSTICS

The purpose of investigating acoustics solutions this early in the process is to consider integrated solutions. At this point, there is a wish for at least one double-high space. Furthermore, there are specific requirements for reverberation time in classrooms (appendix 28).

The results illustrate that multiple solutions can be applied to a room.

- Create smaller separated rooms in large spaces.
- Place plants in the open spaces.
- If the above mentioned is not enough, use sound catchers.



Ill:. 90 Implementation of sound absorbing materials, plants, shelters spaces and sound catchers have a positive impact on traveling sounds

Materials	Plywood	Acoustic board	Wet plaster	Curtain
(α) (1000 Hz)	0.03	0.80	0.08	0.50

EARLY INVESTIGATIONS

ENERGY STRATEGIES

The purpose with the energy workshop (appendix 29) is to consider the passive and active solutions. While it is to early to calculated energy consumption following strategies can be integrated.

The workshop highlight the necessity of the following:

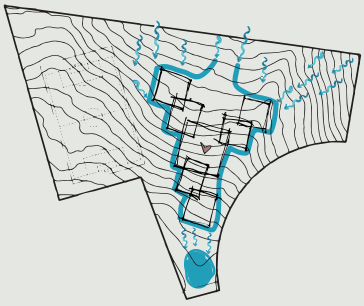
- Materials with a high thermal mass to create a stabilise temperature with limit cooling and heating.
- Determine a minimum U-value of the walls and roof - according from BR18.
- Determine ways of implementing solar cell early in the process to integrate them.

From the energy workshops we will work further with the following solutions:

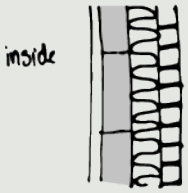
- Choosing concrete, tiles or wet plaster as additional materials for flooring, ceilings and wall. These will work in combination with wood and bricks.
- U-value of the exterior walls < 0,1 w/m^{2}K
- U-value of the Roof < 0,1 w/m^{2}K
- Solar cells are only considered if they can be integrate as roofing material or mimicked as skylights.

LOCAL DIVERSION OF RAINWATER

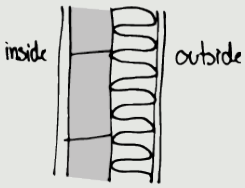
The purpose with this workshop is to redirect water around the building to prevent over-flooding (appendix 30). When redirecting the water, it is necessary to incorporate rainwater pounds to collect the water.



Ill:. 95 Water directed around the building



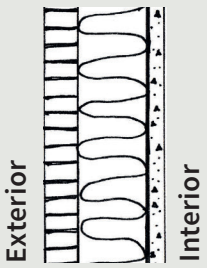
Ill:. 98 Wall detail concept 1



Ill:. 99 Wall detail concept 2

Material	Thermal Conductivity (W/mK)
Stone	1.8
Concrete	1.13
Brick	0.73
Wet plaster	1.16

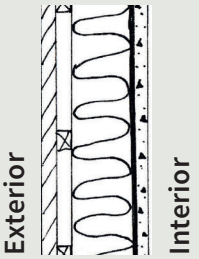
0,097 W/m^{2}K



Ill:. 96 Wall detail 1

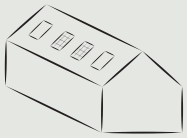
108 mm - Bricks.
350 mm - Insulation
50 mm - Concrete

0,098 W/m^{2}K



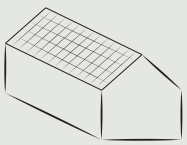
Ill:. 97 Wall detail 2

50 mm - Wood.
50 mm - Air gap
350 mm - Insulation
50 mm - Concrete



Ill:. 92 Solar cells mimics the skylight

Ill:. 93 Solar cells as cladding material



Ill:. 94 Solar cells as roofing material

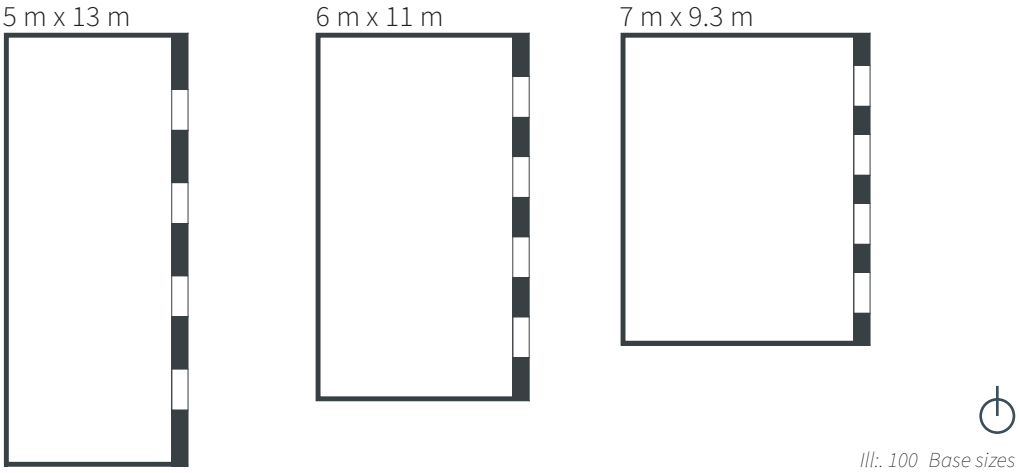
BASE SIZE

The bases in the enrolment classes are 65 m^2 and 60 m^2 in middle- and school leaving classes. To establish a form for the bases, the enrolment classes will be used as a baseline because they are the largest. Furthermore, the daylight calculations will be used as a guideline for the window area (appendix 31).

To ensure the bases meets the requirements stated in **UN-Goal 3.2**, a daylight analysis of the bases are made in Velux Visualizer.

The intent with the daylight analysis (appendix 32) is to determine the shortest exterior facade possible, while obtaining the daylight requirements. This is necessary to ensure the shortest possible distance between the bases and common space. The shortest possible exterior facade also ensures the shortest lecture zone.

The daylight factor (D_T) must be achieved across a 50% vertical fraction of the relevant floor area. The minimum daylight factor (D_{TM}) must be fulfilled across 95% of the area (Dansk Standard, 2018).



Ill:. 100 Base sizes

Room dimensions (mm)	5000 x 13000	6000 x 11000	7000 x 9300
Glass area (East)	7 m^2	7 m^2	7 m^2
D_{TM} > 0.7 %	1.87 %	1.74 %	1.60 %
D_T > 2.1 %	2.62 %	2.52 %	2.43 %

INTERIOR DESIGN OF BASES

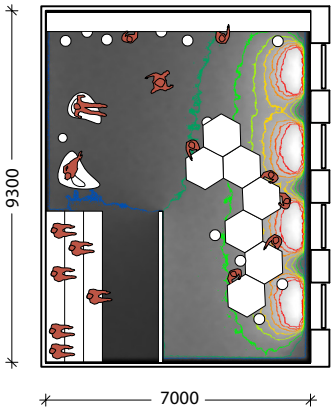
Investigations of the interior layout of the base is necessary to accommodate the new learning style. The base must include an area for dissemination and different settings for assignment solving. Additionally, optimal daylight settings are a requirement to ensure an optimal learning environment.

The functions of the bases differ between enrolment classes, middle classes and school leaving classes. The important part of the base design, is to ensure space for different learning environments.

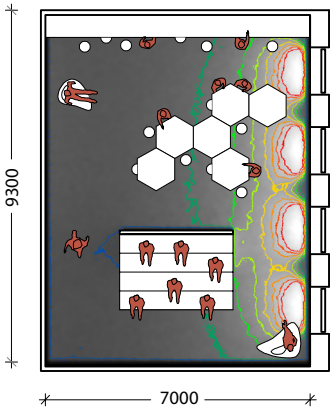
Three iterations of the interior design are investigated according to their impact on the learning environment, both in terms of the use of the learning environment and to ensure optimal daylight in the assignment solving area.

Iteration 2 and 3 both fulfil the daylight requirements, but iteration 3 are optimal regarding the plan layout due to no unused space. The optional placement of the assignment area close to the windows maximise the daylight in the work zone.

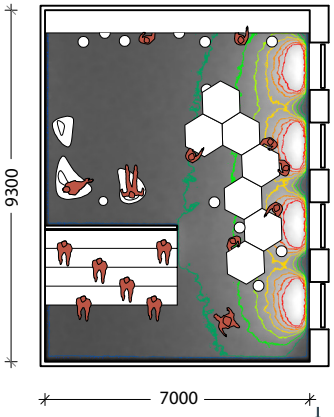
This fulfils the **UN-Goal 3.2** in regards to the indoor daylight and **UN-Goal 4.1** due to the plan layout are accommodation towards the learning style.



Ill:. 101 Iteration 1



Ill:. 102 Iteration 2



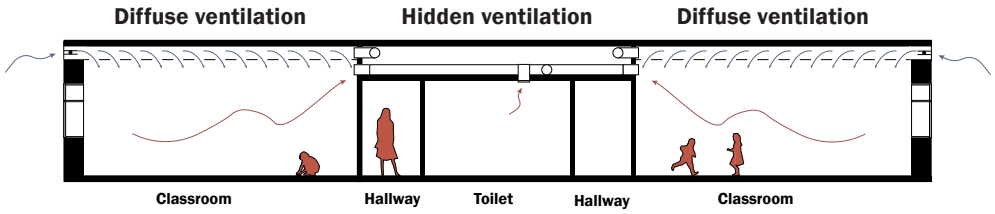
Ill:. 103 Iteration 3

	Iteration 1	Iteration 2	Iteration 3
Room dimensions (mm)	7000 x 9300	7000 x 9300	7000 x 9300
Glass area (East)	7 m^2	7 m^2	7 m^2
D_{TM} > 0.7 %	0.53 %	1.25 %	1.25 %
D_T > 2.1 %	2.81 %	2.71 %	2.71 %

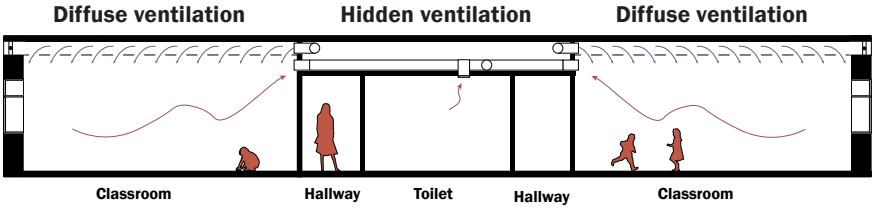
INDOOR CLIMATE IN BASE

To ensure no over temperature in the bases during the summertime, a indoor climate analysis is made. A mix between natural and mechanical ventilation is used in the summertime and mechanical ventilation is used in the wintertime. The result of the analysis is, the natural ventilation system during summertime requires a cooling surface to withstand the internal loads in the bases (appedix 33). The estimated systems can be seen in appendix 34 .

The intent with this analysis is to ensure a good indoor environment for learning as stated in UN-Goal 3.1.



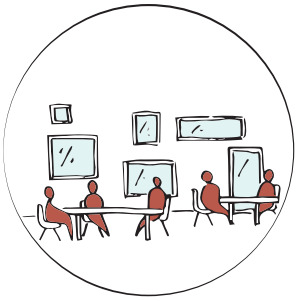
Ill:. 104 Hybrid ventilation, summertime



Ill:. 105 Mechanical ventilation, winter timer

	Without windows and cooling surface	Without cooling surface
Inlet area (natural)	x	1.75 m^2
Window glass (East)	x	7 m^2
Hours above 26	991	132
Hours above 27	703	80

BASE - WINDOW STUDY



Ill:. 106 Assignment solving

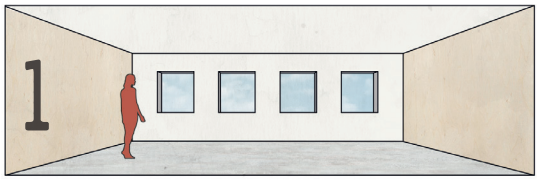
Ill:. 107 Dissemination area

Ill:. 108 Retraction area in window sill

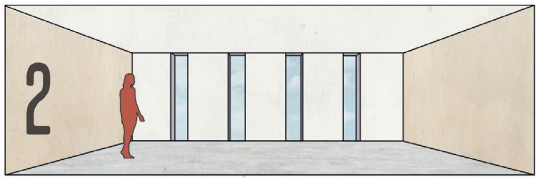
The placement of windows influences the interior experience of the base. Three variations of window design are investigated according to light and interior experience.

While different spaces of the base are suited to various functions, the light needed to be fitted to these functions. Therefore, playful windows in various dimensions are chosen as the suitable window design in the bases. With these windows, the different functions can also be given to the windows. Some of them can be used for staying, others with frames for storage, or simply to let light into the far corners of the room.

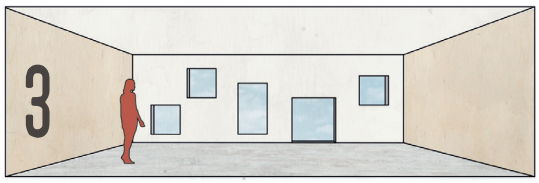
This windows solution supports the alternative learning in bases regarding **UN-Goal 4.1** and utilization of light according to **UN-Goal 3.2.**



Ill:. 109 Iteration 1



Ill:. 110 Iteration 2



Ill:. 111 Iteration 3

	Iteration 1	Iteration 2	Iteration 3
Window dimentions (mm)	1250 x 1400	530 x 3000	Variations
Glass area (East)	7 m^2	7 m^2	7 m^2
D_{TM} > 0.7 %	1.25 %	1.11 %	1.07%
D_T > 2.1 %	2.71 %	2.04 %	2.16 %

LECTURE ZONE

The lecture zone primarily consists of bases, group rooms and a shared project surface. Each floor in the lecture zone has different requirements based on their designated school level.

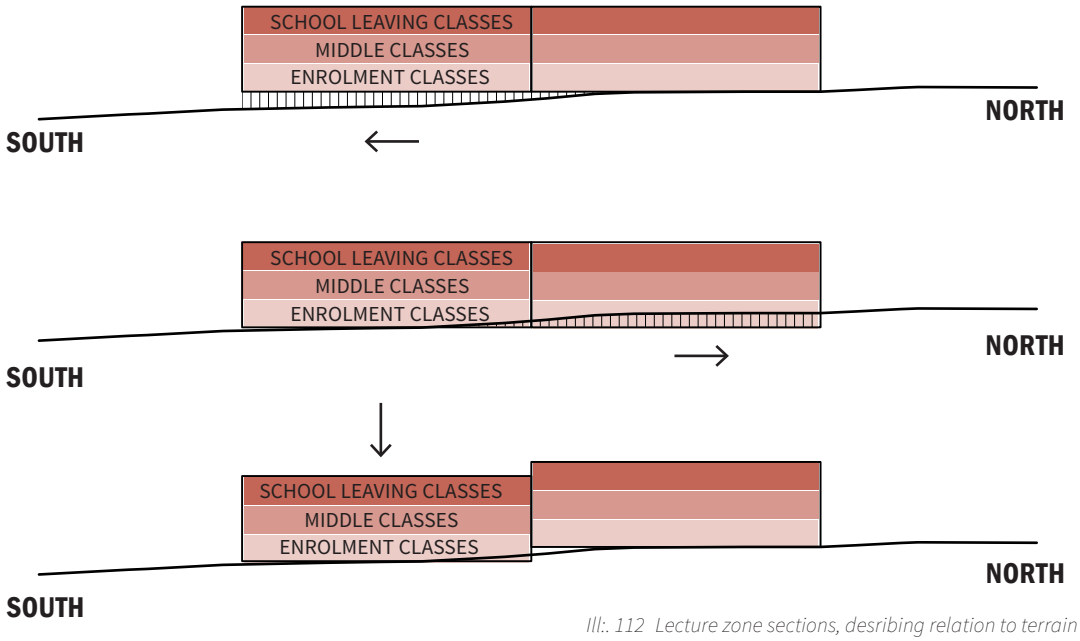
The enrolment class floor consists of 12 bases of 65 m^2 where most of their teaching will happen, additionally a shared project surface joins the bases.

The middle class floor consists of 9 subject bases of 60 m^2 where dissemination will happen before dividing into different group room areas located in both the subject bases and the shared project surface. The shared project surface joins the bases.

The school-leaving floor consists of 8 subject bases of 60 m^2 where dissemination will happen before dividing into different group room areas located in the subject bases, the shared project surface, and in the common space. The shared project surface joins the bases.

TERRAIN

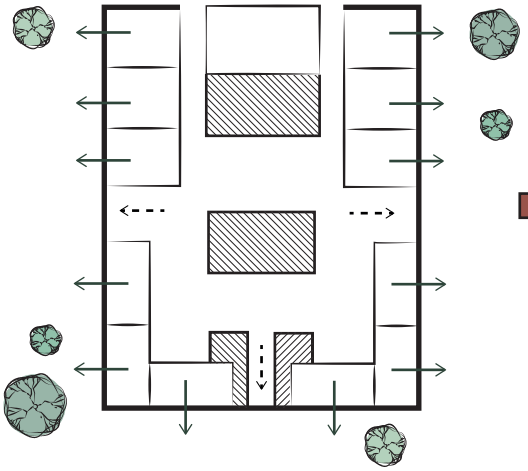
The terrain influences the placement of the lecture zone. To decide the terrain placement of the lecture zone an investigation of the vertical shifts in the building volume are made.
The determining factors of the vertical shifting in the lecture zone are the direct access to outside from the enrolment classes and the need for daylight in the bases, which eliminates the option of placement in the ground.



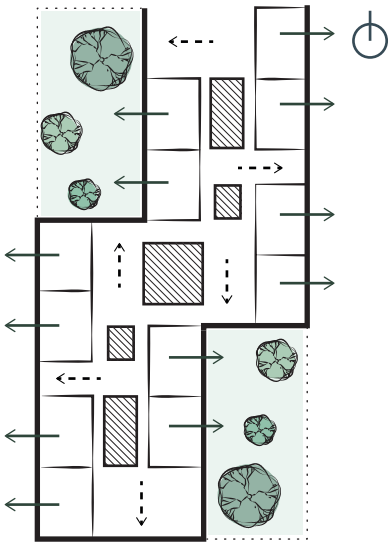
Ill:. 112 Lecture zone sections, desribing relation to terrain

LECTURE ZONE

PLAN LAYOUT



Ill:. 113 Restricted form based on initial form concept



Ill:. 114 Form adapting to nature

RESTRICTED FORM

Focus areas:

- Placing rooms inside initial concepts form (appendix 35).
- Creating view to nature form both shared project surface and the bases.

Problematics:

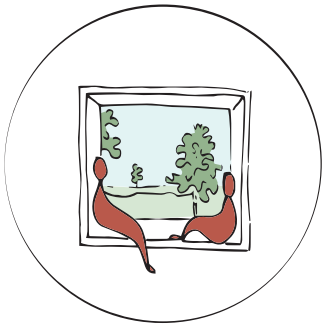
- Wide shared project surface, without optimal daylight for working in groups.
- Not relating to the surrounding nature.

FORM ADAPTING TO NATURE

Focus areas:

- Placing rooms with largest facade towards outside (appendix 35).
- Creating close connection to nature by incorporating the nature in the form concept.
- Daylight analysis dictating placement of cores (appendix 36).
- Optimal daylight settings in shared project surface.
- Creating views to outside in multiple directions.

Ill:. 115 Access to nature



Ill:. 116 Close connection to nature

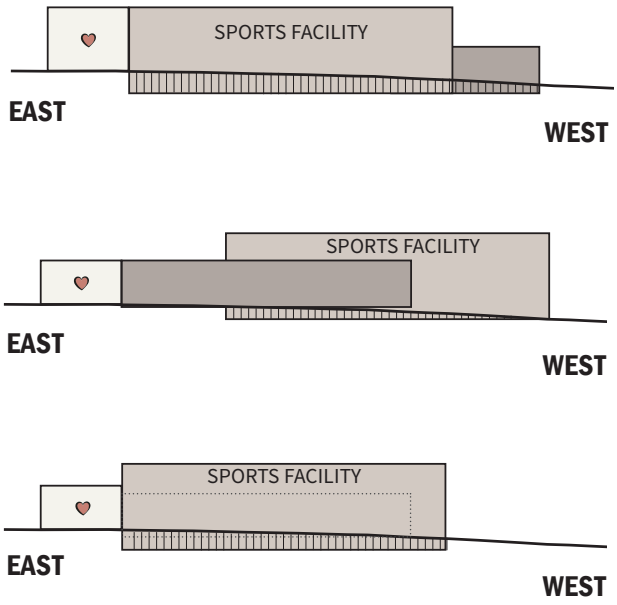
Ill:. 117 View to nature

SPORTS FACILITY ZONE

TERRAIN

In connection with creating a plan layout for the sports centre zone, the placements of the sports centre in elevation are investigated. The first focus in this investigation is the sports centre which should be immersed into the ground because of its height. Due to way-finding and recognisability, the resultant decision was that the sports centre should stand out with its volume.

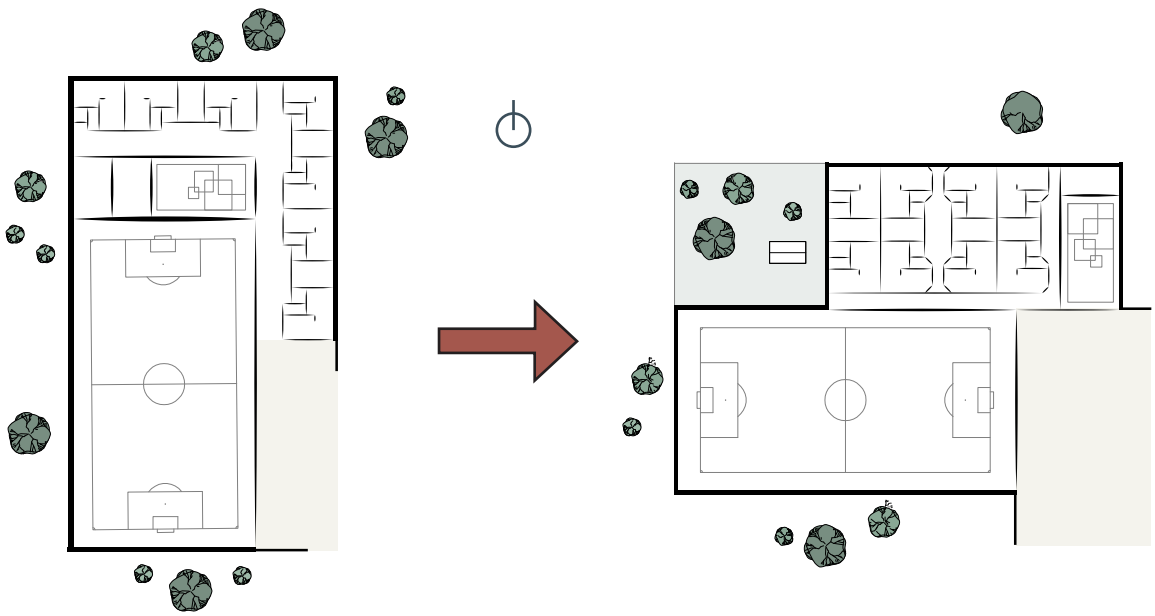
Secondly, visibility is essential to create a connection between the common space and the sports centre. This is done to consider UN-Goal 3.4 concerning way-finding to make the building welcoming for visitors. Additionally, the remaining facilities in this zone should be placed towards north because the volume respects the city of Elev. Therefore, the placement of the sports centre is as the middle illustration.



Ill:. 118 Sports facility sections, desribing relation to terrain

PLAN LAYOUT

Multiple plan layouts has been investigated according to the placement of the Sports facility zone (appendix 37). The result illustrate the sports activity is placed in close connection with the common space to create a visible contact for users and visitors. Therefore, the sports centre and other functions have been shifted from each other to create a connection to the space inside, and outdoor space for activity.



Ill:. 120 Plan layout, one continuous facade

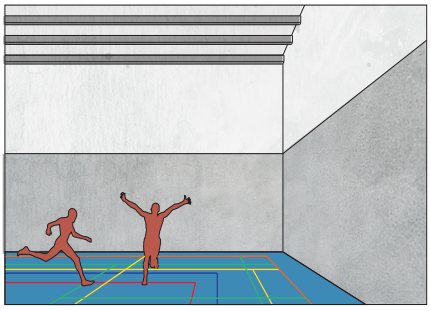
Ill:. 119 Plan layout, inviting nature in.

SPORTS CENTRE MATERIALITY

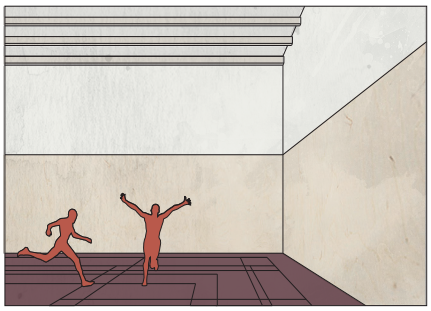
ATMOSPHERE AND MATERIALITY

The sports centre is a place for everyone and must accommodate both pupils and the community. Our intention is to create a calm and embracing environment with room for activity and movement. The sports centre shall differ from the traditional expression of sports centres, where powerful colours and cold materials dominate. This cold expression points to sporting seriously with a focus on function.

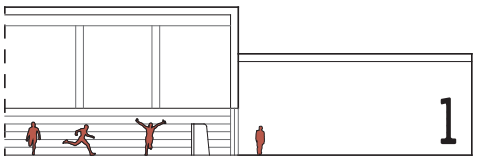
Opposite the traditional sports centre, the future sports centre in NYE is given a warm expression focusing on multiple functions in the space. Movement and play are still essential, but more users are invited into the area to embrace activities on multiple levels.



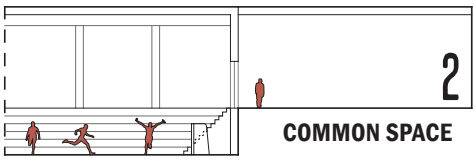
Ill:. 124 Traditional sports centre with powerful colours, strong materials and a cold expression.



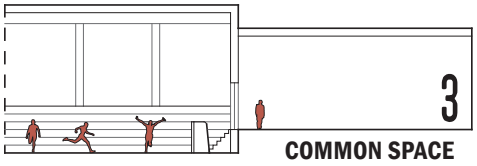
Ill:. 125 In the future sports centre warm colours and multiple functions invites a diverse user group in.



Ill:. 123 Iteration 1, connection to common space



Ill:. 121 Iteration 2, connection to common space



Ill:. 122 Iteration 3, connection to common space

VISUAL CONNECTION, ELEVATION

An investigation according to visible connection in elevations is studied.

1: The connection between the sports centre and the common space is strong when placed in the same plan. On the contrary, privacy is reduced, which can disturb sports activities.

2: By placing the sports centre a whole floor lower than the common space, there is a minimal visible connection between the two areas.

3: The visible connection and privacy are maintained by placing the sports centre a half-floor lower than the common space. Here the privacy is intact, the concentration according to activities is maintained. Therefore, option 3 is chosen for further work.

SPORTS CENTRE INTERIOR

CONNECTION BETWEEN SPACES

Ill:. 126 Iteration 1, non-visible connection to the sports centre.

Ill:. 127 Iteration 2, transparency scattered along interior wall.

Ill:. 128 Iteration 3, transparency in a panel along interior wall.

The traditional sports centre is visibly closed from the outside. Our intention is to create a clear and visible connection between the sports centre and the common space. Therefore, investigations are made on how to create this connection without disturbing the concentration necessary in the sports game. Three scenarios are evaluated according to their different degree of transparency created by a difference in the amount of glass, the ability to create a connection, without compromising privacy.

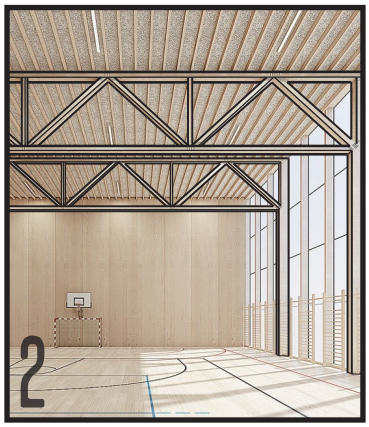
The result illustrate a solution where the amount of glass is scattered along the wall. This creates an area where activities inside can be seen and other areas where the privacy is intact. The pupils inside the sports centre are not staged, and it is still possible for the viewers to the movement and thereby create a connection.

STRUCTURAL SYSTEM

The study (appendix 38) of principles of the sports centres' structural system results in wooden frames. An LCA analysis of wood and steel beams illustrates that wood is the most sustainable (appendix 39). The final choice of structural systems is according to the final decision on the roof. Preferable 2 or 3 will be used or combined in the final project.

	GWP	ODP	POCP	AP	EP
CLT	0.28	4.6e-08	0.00029	0.0013	0.00028
STEEL	1.03	4.2e-11	0.00036	0.0029	0.00026

Ill:. 129 Iteration 1



Ill:. 130 Iteration 2

Ill:. 131 Iteration 3

SPORTS CENTRE INDOOR ENVIRONMENT

ACOUSTICS

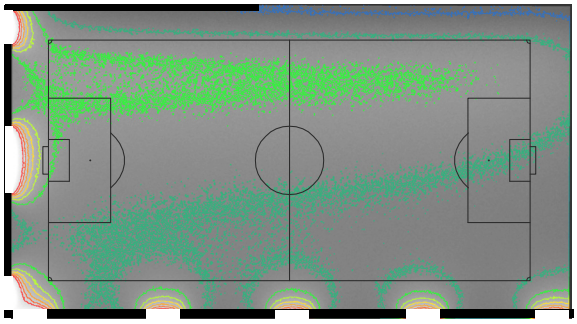
While materials are investigated according to the atmosphere they are also studied according to acoustic qualities (appendix 40). The sports centre has a high volume and therefore, a short reverberation time should be maintained. The chosen materials creates a warm and welcoming sports centre while still obtaining the required reverberation time.

	"Traditional" Sports centre	"Future" Sports centre
Absorption Area	1161.45	1656.45
Reverberation Time	2.65 s	0.97 s

DAYLIGHT

An initial daylight study of the sports centre is created to evaluate our ideas about windows and their placements. Requirements and background knowledge can be seen in appendix 41.

The daylight analysis reveals that our desire for big windows in the top of the facade toward the north is suitable to let light far into the building. Additionally, the window in the south and west façades are necessary to get light from multiple sides. The windows must be placed in a system according to the structure and visibility.



Ill:. 132 The amount of light is above the requirements of 300 lux.

UNDER TEMPERATURE INVESTIGATION

To ensure no under temperature in the sports centre during the wintertime, a indoor climate analysis is made. Natural ventilation is used in the summertime and mechanical ventilation is used in the wintertime.

The result of this analysis is that the sports centre requires a relatively large heating system to ensure optimal temperature in the wintertime. (appendix 42). The estimated systems can be seen in appendix 43.

The intent with this analysis is to ensure a good indoor environment for sports as stated in **UN-Goal 3.1.**

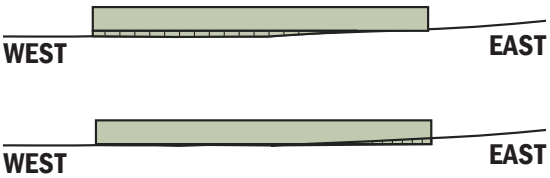
	Without heating	With heating
Hours below 16 (°C)	4146	0

WORKSHOP ZONE

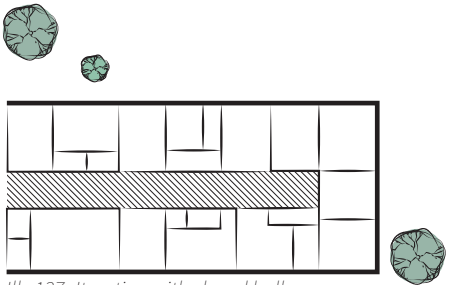
The workshop area is placed in the north-eastern part of the site in close connection to Elev, Nye and The Ring. The following section consists of a selection of elements, that influenced the workshop design.

To decide the terrain placement of the workshop zone an investigation of the vertical placement of the building volume is made (appendix 44). The two scenarios focus on either direct access from the common space, or a vertical shift of the workshop zone that differentiates the common space and workshop zone.

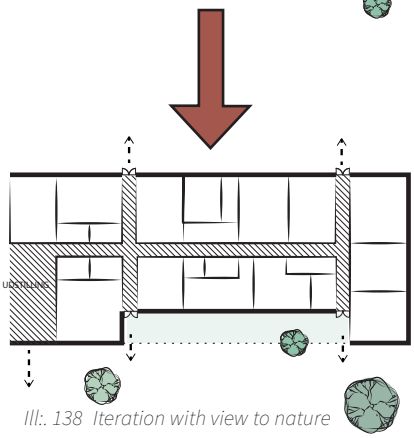
Iteration 2 is chosen to ensure direct access to the workshop area and a non-elevated workshop zone.



Ill:. 136 Workshop zone sections, describing relation to terrain



Ill:. 137 Iteration with closed hallway

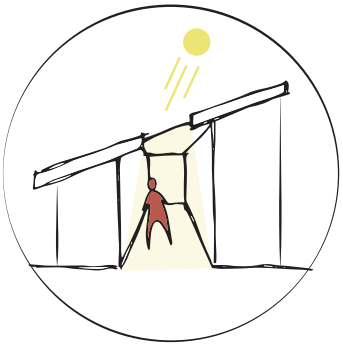


Ill:. 138 Iteration with view to nature

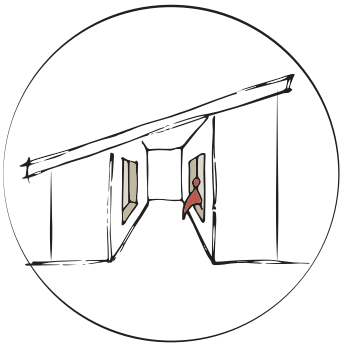
PLAN LAYOUT AND HALLWAY AREA

When designing the workshop layout, a focus was to ensure view to nature. The workshop area does not require a gathering space between the bases, resulting in hallways without function and views. The focus is to create a hallway area with an interesting space to move through.

The diagrams (ill. 133 to 135) illustrate activation elements that have been considered.



Ill:. 133 Integrate skylight to light op the hall way naturally.



Ill:. 134 Integrate functions in the wall of the hall way. Space to sit, storage or exhibition.

Ill:. 135 Integrate view and access to surroundings.

WORKSHOP ATMOSPHERE

CONNECTION TO NATURE

The implementation of the UN-Goal 4.4 outdoor schooling has been a focus. Outdoor schooling promotes the movement of pupils, creates a better social environment, generates well-being, and improves professional learning processes. The intention is to design a plan layout that promotes the learning environment, by implementing easy access to nature and outdoor areas close to the workshop bases.

The intention is to place elements in the landscape to urge the pupils to explore the surroundings.

Outdoor facilities already developed, considered, and discussed during the development of the workshop area, are illustrated in the following diagrams.

Ill:. 139 Greenhouses where pupils can observe photosynthesis of plants and grow organically for cooking in home economics.

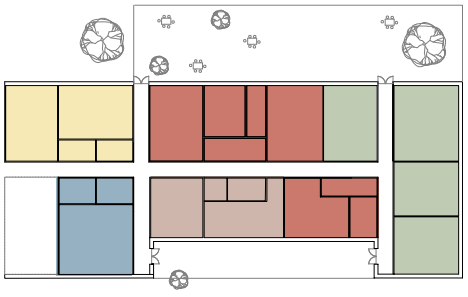
Ill:. 140 Fire place there can be used for experiments or outdoor cooking.

Ill:. 141 Sheltered working stations for assignment or study of field investigations.

ATMOSPHERE

The workshop area is a collection of learning facilities that differs from the bases. The idea of gathering the facilities is to promote the community feeling. The workshop area represents facilities used by the locals after school time.

The workshop area consists of home economics, music facilities, creative facilities, and science facilities, all with different functions. Therefore, we have investigated the expression of the different facilities by creating a mood board (ill. 143) that represents the different atmospheres.



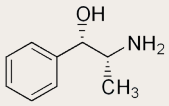
Ill:. 142 Workshop plan divided in zones

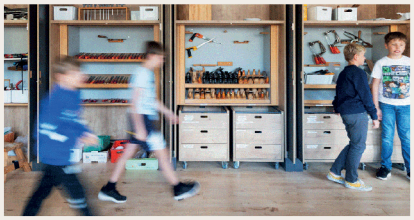
To enhance the way-finding and minimize noise pollution through rooms with different activity noise levels, it was necessary to place facilities with similar themes besides each other. Illustration 142 is an example of the zone division and appendix 44 contains additional iterations.

HOME ECONOMICS

MUSIC ROOM

NATURAL SCIENCE





WORKSHOPS AND CREATIVITY

Ill:. 143 Atmosphere mood-board

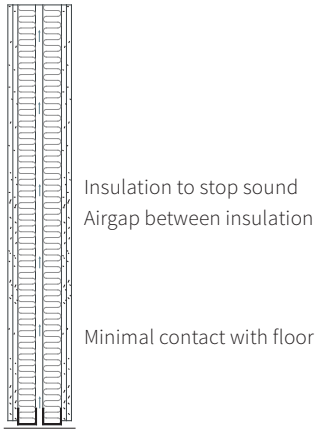
WORKSHOP, SOUND ABSORBTION AND DAYLIGHT

SOUND ABSORBING WALLS

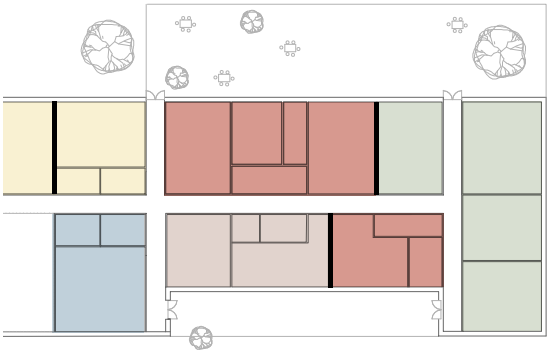
The creative and scientific subject bases are both located in the workshop zone. The scientific subjects require minimal noise pollution from the adjacent rooms, while the creative bases often create noise pollution due to machinery.

Preventing sound transmitting through walls can be done either by the construction of the wall or by reflecting the sound of the surface of the wall (appendix 45).

To prevent disturbance between the different workshop bases sound-absorbing wall constructions will be used.



Ill:. 144 Sound absorbing wall construction, example



Ill:. 145 Placement of sound absorbing walls

DAYLIGHT

The wishes and requirements for windows in the workshop area are various. Therefore, a daylight analysis is made from a principal basis. The daylight analysis is not created to determine the design of windows but to ensure that the deep rooms get enough daylight. The daylight analysis are in appendix 46.

The results of this analysis illustrates the need for skylight in the workshop area. Without the skylight, it is impossible to reach the 300 lux of daylight we wish for in a workspace. With skylight in the deep rooms, the following wishes can be implemented in the facade.

Home economics: Windows with parapet to allow the daylight to enter the countertops. Doors toward the outdoor for connection to the vegetable garden and greenery.

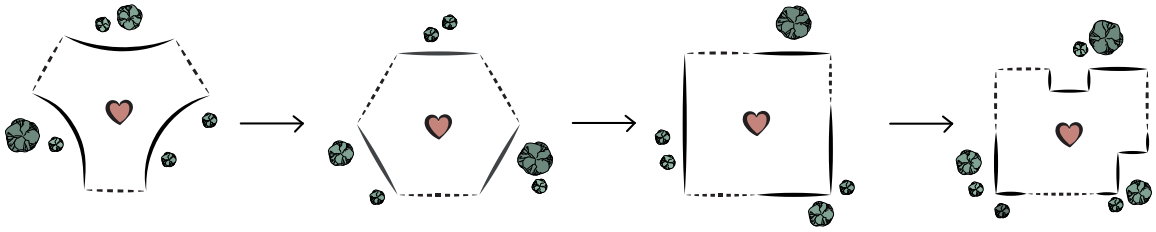
Craft workshop: Large windows toward the north for exhibitions and glimpse. Additional diffuse daylight for creation of art.

Musics: No specific requirements, but aim to create 300 lux from daylight.

Science: Windows with parapets to utilize the spaces against the wall for tables and experimental equipment.

COMMON SPACE

DEVELOPMENT OF THE OUTLINE



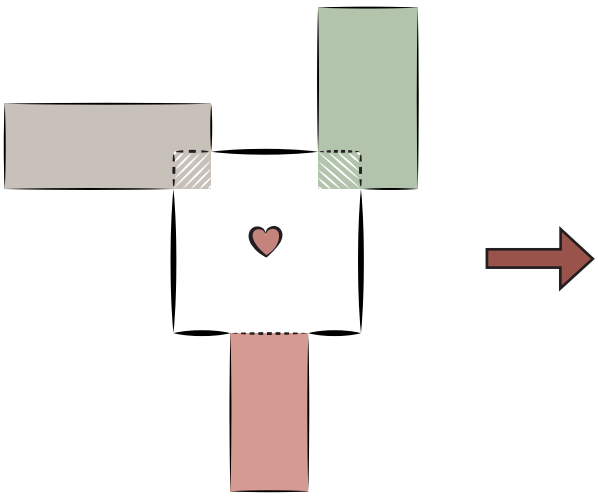
Ill:. 146 Common space, development

As the different zones came along, the common space was also designed. Even though we have been working with zones, the building is still considered as one united building. Therefore, the common space is formed based on the layout of the wings. Simultaneously the appearance of the wings is adjusted for the overall form.

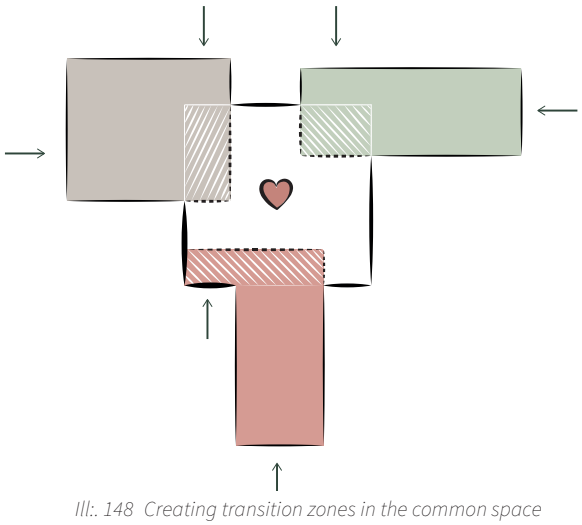
The early decision about placement of the zones according to function, experience, and topography involved the common space. The layout is formed by function and atmosphere. The large volume of the common space creates possibilities for designing spaces within the volume with a different atmosphere. This embraces the various needs of the children. Furthermore, the visibility throughout the common space is created to embrace and consider the UN-Goal 3.4 regarding way-finding. Way-finding is essential because the building is more than a school and will have many visitors. By considering them in connection with the local community and their wishes, it helps us fulfill UN-Goals 11.2: The local community.

The connections between the different zones have been a focus point as well. Instead of adding the wings to the common space they became integrated by making notable transition areas. Thereby, the building is merged into one with transitions between the different functions and the common space being the centre.

CONNECTION TO THE WINGS

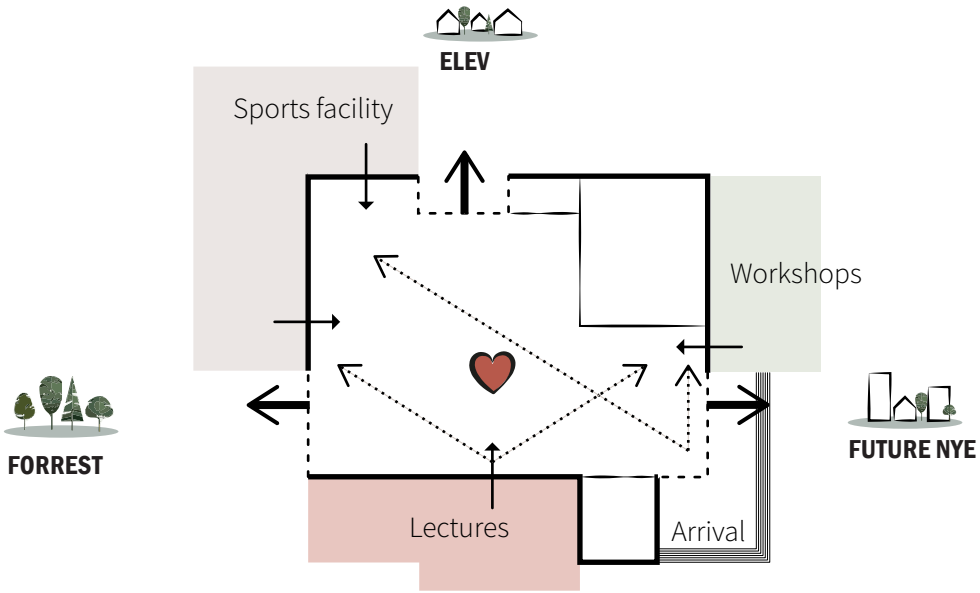


Ill:. 147 A clear division of functions in plan layout



Ill:. 148 Creating transition zones in the common space

COMMON SPACE



Ill:. 149 Visibility and connections in the common space

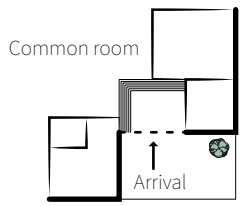
VISIBILITY AND CONNECTIONS

The school includes functions used by locals and visitors after school time. The common space is a gathering point for the school and is located in the centre of the three wings. The arrival zone is located in connection to the common space. Therefore, it is important, that the common space is easy to navigate and has a clear connection to the additional functions of the school. To promote easy navigation a line of sight is implemented in the plan layout. Furthermore, we have worked with visibility towards the surroundings and clear visibility of the common space from outside.

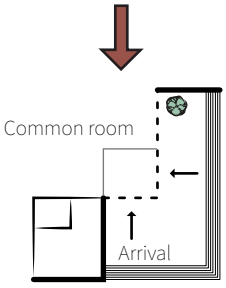
VISIBILITY AND ARRIVAL

The arrival at the school is essential because it is the first meeting with the building. Therefore, it has been a focus, in the development of the common space. During the process, multiple arrival layouts were investigated according to visibility from outside. Pupils and visitors arrive from different directions, on foot, by bike, or car. Therefore, it is decided, that the arrival area must be visible from more than one direction.

The diagram illustrates the development from a close arrival façade to a more open and visible arrival.



Ill:. 150 Iteration 1, sheltered arrival zone



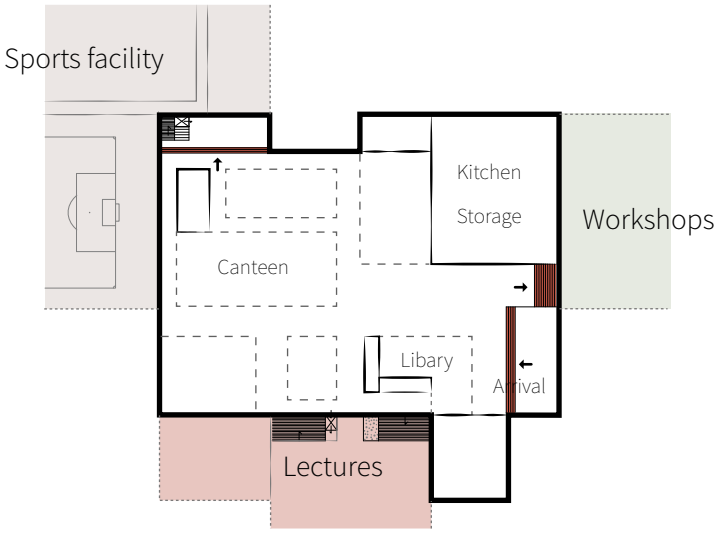
Ill:. 151 Iteration 2, visible arrival zone

COMMON SPACE

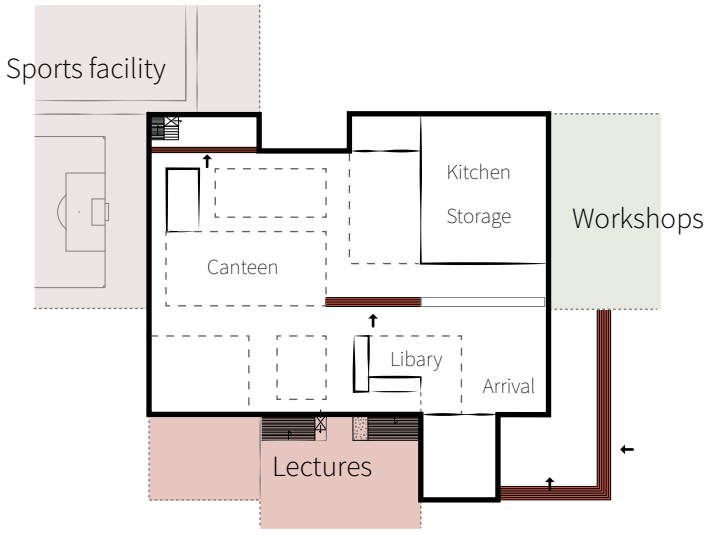
LEVEL DIVISION

The sloping landscape has resulted in the placement of the wings on different levels. Therefore, we have worked with different ways of dividing the floor of the common space to meet the levels of the workshop zone, the lecture zone, and the sports facility zone.

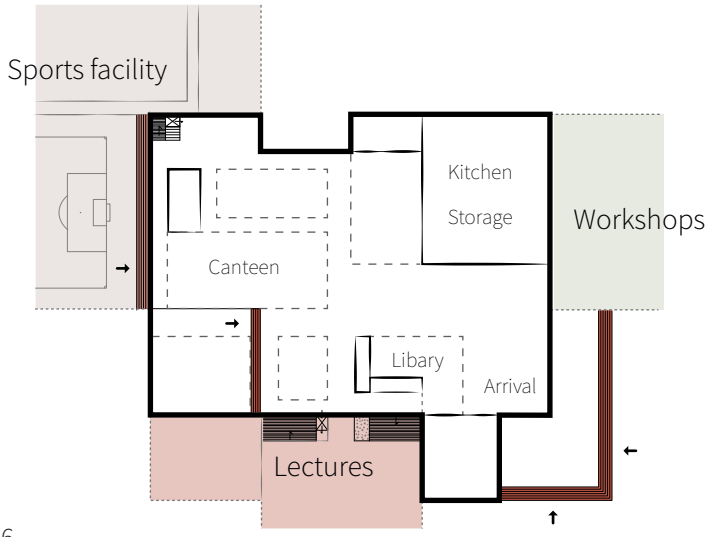
The following diagrams illustrate three examples of level division in the common space. The red areas illustrate level divisions where stairs are placed. Space is divided into whole and half floors.



Ill:. 152 Iteration 1



Ill:. 153 Iteration 2



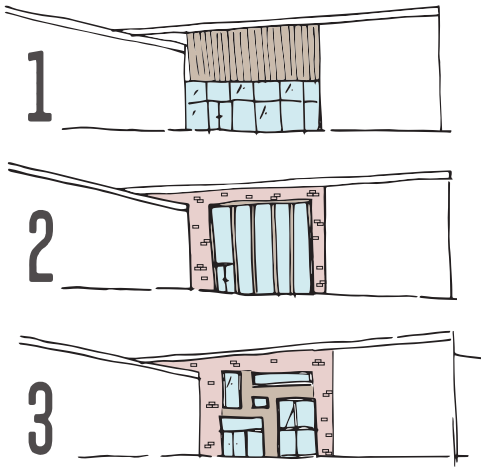
Ill:. 154 Iteration 3

COMMON SPACE

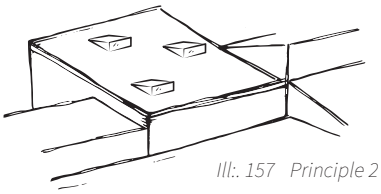
EXTERIOR WINDOW EXPRESSION

The future school of NYE shall be a place where people can meet, and the common space shall be the central gathering point. Therefore, the façade expression must indicate, that the common space is open for visitors.

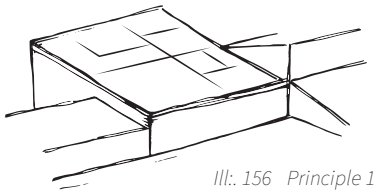
The following diagrams are a selection of investigated façade iterations, relating to the development of the common space. The result is to combine iterations 1 and 2 into a facade expression with high windows and exterior wood cladding.



Ill:. 155 Facade expressions, common space Looking from west towards east



Ill:. 157 Principle 2



Ill:. 156 Principle 1

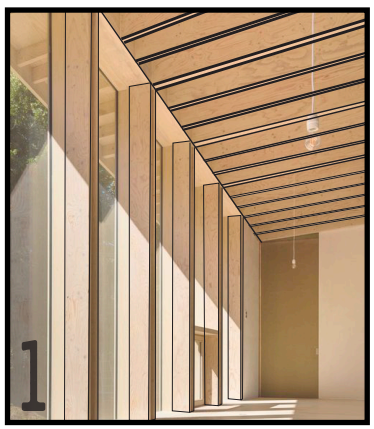
SKYLIGHTS

The common space is a large volume, which complicates the daylight requirements in the centre of the room. Therefore, it is decided to integrate skylights where two principles are investigated.

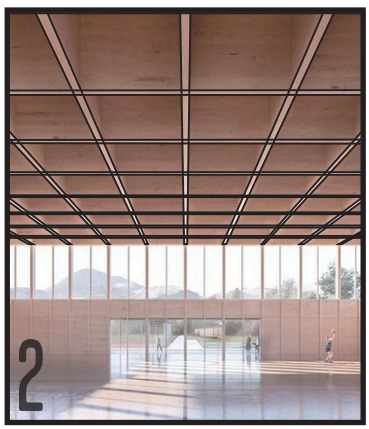
1. Skylights highlights functions inside, such as dining areas or other zones of stay
2. Skylights as a wedge to highlight the walking area.

STRUCTURAL SYSTEM

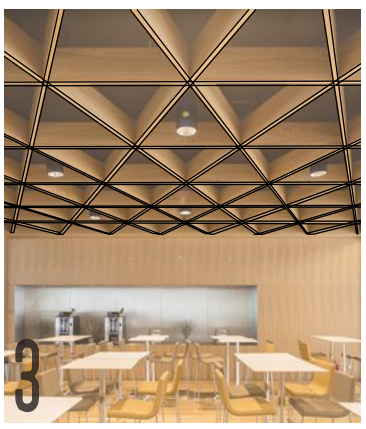
The previous LCA analysis of wood and steel illustrates that wood is the most sustainable material (appendix 39). This results in the common spaces structural system will consist of wooden frames. The final choice of the structural system will be determined by the structural system's ability to divide the room into smaller zones. Preferable inspirational pictures 1 or 2 will be used in the final project.



Ill:. 158 Iteration 1



Ill:. 159 Iteration 2



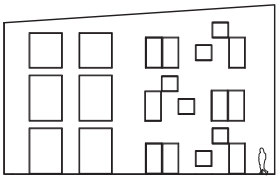
Ill:. 160 Iteration 3

FACADE EXPRESSION WINDOWS

The windows vary throughout the building due to different requirements for daylight and window function. This affects the overall expression of the façade. The various façade expressions are illustrated on this page to clearly summarize the different requirements for each façade element. Due to the different window expressions throughout the building, a need for structure in the general façade expression is required.

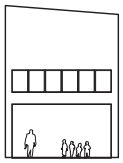
LECTURE ZONE

Playful windows in various dimensions are chosen as the suitable window design in the bases. With these windows, different functions are given to the windows e.g, To retract in, sit in, or simply to light up the room. The shared project surface has regular large window panels to bring in nature and light.



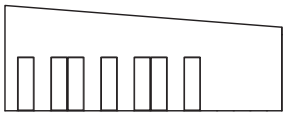
ARRIVAL AREA

The arrival area needs large window openings to create a sense of transparency. This invites the users and visitors of the school inside.



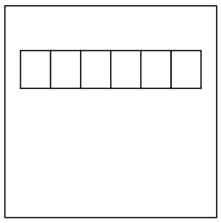
COMMON SPACE

Large window panels are placed towards the outside to connect with nature throughout the common space. Additionally, this functions as multiple exits and entrances to the common space.



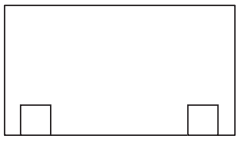
SPORTS CENTRE, NORTH

To minimize the need for electricity use in the sports centre, large window openings towards the north ensure a non-glazing light. Furthermore, the windows ensure natural ventilation setting in the summertime.



SPORTS CENTRE, SOUTH

The windows are scattered along the façade. This creates areas where activities can be seen and where privacy is intact.

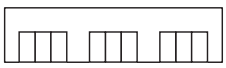


WORKSHOP, SOUTH

Windows with parapet allow the daylight to enter without overheating and addtional doors to enter the vegetable garden.

WORKSHOP, NORTH

Large windows toward the north for exhibitions and glimpse.

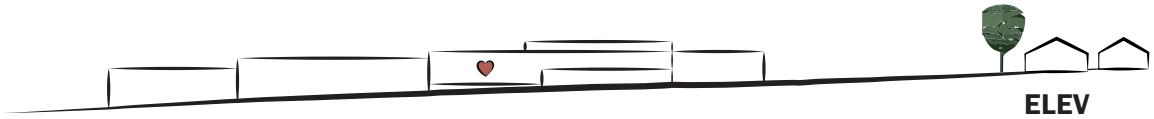


Ill:. 161 Window principles throughout the building.

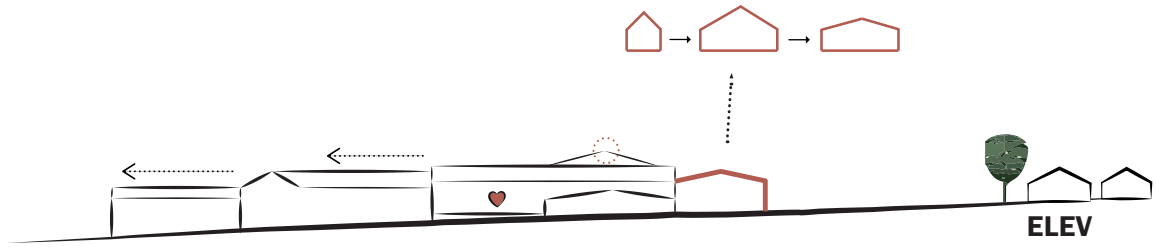
ROOF INVESTIGATIONS

The whole building is considered for further work with the roof. Volume studies were created to sense the buildings as one united building. Furthermore, 3D studies are made with topography to create a relation. The study can be seen in appendix 47.

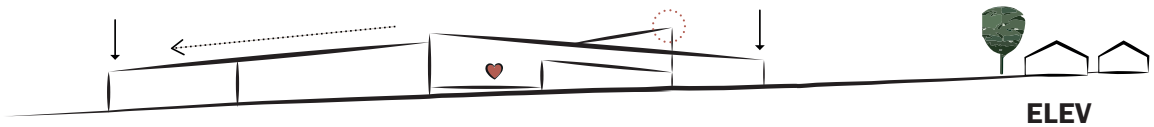
The result of the investigation can be seen in the following illustrations. Furthermore, the roof on illustration 164 is chosen based on the argumentations regarding respect of scale, relation to landscape, and the building as a landmark.



Ill:. 162 The building with a flat roof appears as individual boxes. The boxes are divided into different heights to relate and respect the surroundings, but the building will still create a hard transition to the landscape. Furthermore, to create a meaningful flat roof it should be given a function, otherwise, it brings no character to the building.



Ill:. 163 Inspired by the traditional houses of Elev, a pitched roof was chosen to give the building character. The building was given a pitched roof relating to the direction of the wings. This investigation illustrated that the building must have a low pitch not to create a waste of space. Therefore the buildings appear a bit industrial in the form of a warehouse. Furthermore, the transitions between zones became odd and divide the zone from each other instead of connecting them.



Ill:. 164 Based on the sloped landscape, a sloped roof was investigated. The connection among the individual zones and relation to the common space is essential. The roof is lowered toward Elev to respect the scale. Additionally, the common space is raised to create a clear indication of the building as a landmark. Furthermore, this indicates the entrance. The sports centre was raised to create recognisability for the visitors. At last, the roof of the lecture zone is lowered to mimic the slope of the landscape. The sloped roof is chosen for the school.

ROOF INVESTIGATIONS

SOLAR CELLS

When the roof points directly towards the South the efficiency of the solar cells is between 70 % - 100 %. Therefore, the roof angle is chosen according to aesthetics and other functions (appendix 48). We aim for the best possible angle, but with other factors as ceiling height, it seems realistic to reach around 15°. With approximately 15° the efficiency of the solar cells will be approximately 90 %.

BE18 is used to adjust to the buildings' regulations regarding low energy class. The calculation of the required amount of solar cells can be seen in appendix 49.

Additionally, the solar cells will be integrated into the roof of the sports centre to fulfil UN-Goal 11.3 regarding energy consumption. Furthermore, the purpose of the solar cells will be to educate the children about sustainability while producing energy.

ANGLE	South 0°
0°	82.3 %
15°	92.9%
30°	99.0 %
35°	100.0 %
45°	100.0 %
60°	95.8 %
90°	72.7 %

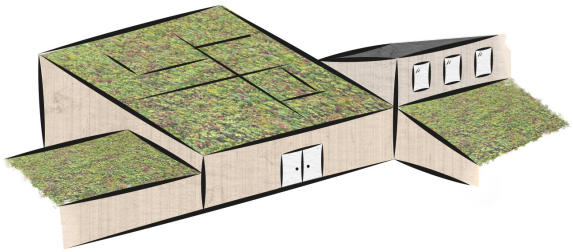
CONCLUSION ON THE SELECTED MATERIALS.

The school must appear sustainable from the outside. Therefore the chosen materials for the building parts have to radiate sustainability. The non-organic materials are deselected. The choice between sedum roof and wood is made according to their connection to the landscape. Therefore sedum roofs are chosen because they can blend in with the green nature.

Additionally sustainable qualities of the sedum roof are: Good water absorption, improvement of air quality, natural cooling of interior spaces and good for biodiversity.

Various materials for the roof were investigated in the early design phase. Preferably we will use reused sedum roof, because of its performance according to the LCA.

	Reused Sedum Roof	Sedum Roof
GWP	-291.0	57.2
ODP	-5.26e-08	4.77e-08
POCP	-4.31e-02	5.39e-03
AP	0.451	0.0116
EP	0.054	0.0021



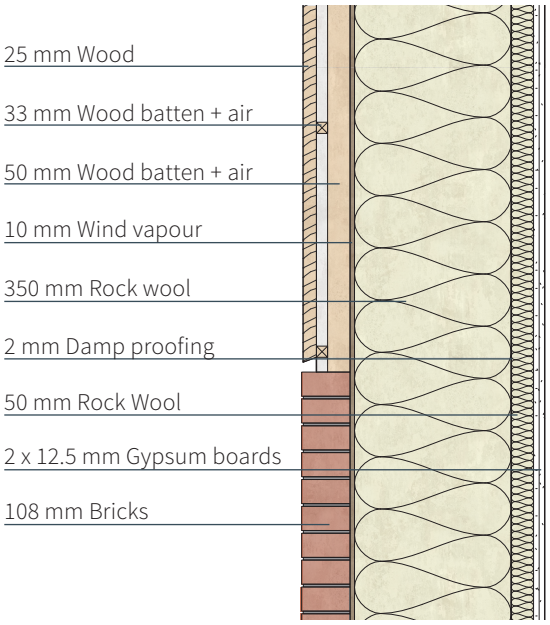
Ill:. 165 Roof expression, sedum roof

WALL CONSTRUCTION AND MATERIALS

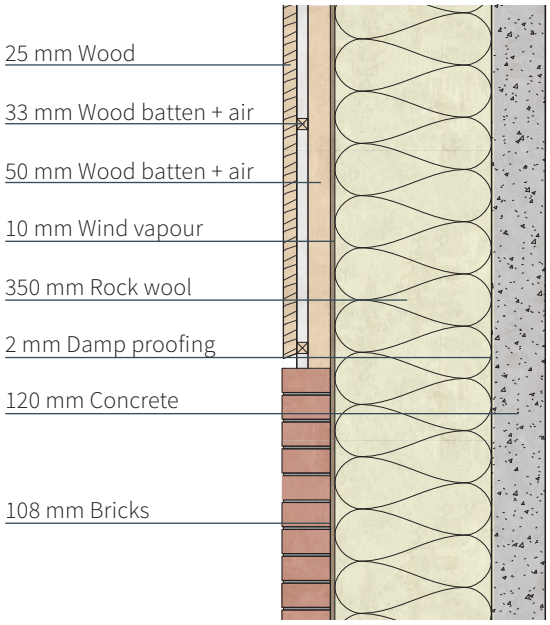
The choice of materials of the building's parts has been an ongoing discussion throughout the project. Due to the long lifespan of the building, organic materials must be displaced multiple times during the lifetime of the school. Furthermore, a school must consist of robust and durable materials to keep the maintenance low. Furthermore, the lack of evidence for the performance of sustainable materials cost us to selected alternative materials.

We discovered that some of the inorganic materials performed well when considering the life span and durability. According to the appearance of the buildings, additional investigations, and the composition of the materials in combination.

These investigations resulted in two wall solutions which we tested further according to LCA and U-value. Furthermore, initial combinations of the materials are made.



Ill:. 166 Wall 1 is inhomogeneous.
U-value = 0.86 W/m²K



Ill:. 167 Wall 2 is homogeneous.
U-value = 0.95 W/m²K

The two walls have been considered according to LCA. See the investigation in appendix 50. The gypsum boards might need to be replaced, which can be done by replacing them one at a time. Replacement of the concrete wall is more complex because the concrete wall works as a load-bearing structure. Additionally, concrete, used for the interior part of the wall, must have a porous finish which makes it vulnerable to damage.

Based on these results, Wall 1 has been chosen because of its performance. Furthermore, the wall will be load-bearing and work in connection with concretes cores. In rooms with large spans, a wooden construction will be added.

In connection with this investigation is the following page considering the architectural qualities of the materials.

MATERIALS

This investigation of exterior materials ensures the relation to the surroundings stated in UN-Goal 11.4. The surrounding building materials are primarily wood and bricks. The material investigation takes departure in the surrounding materials, although reused bricks will be used instead of new bricks because of the life cycle assessment.

The choice of interior materials must be based on contrast to experiences the qualities of the individual materials instead of blending them together. The change in materials activates the senses and changes atmospheres in the different parts of the school. An overview of materials and their qualities can be seen in appendix 51.

COMBINATION OF EXTERIOR MATERIALS

Ill:. 168 When combining wood, reused brick and steel, the wood will appear as the light material.

Ill:. 169 The combinations of bricks, wood and glass makes the glass the light material and brick the heavy.

Ill:. 170 Combining only wood and glass the glass became the light expression of the building.

COMBINATION OF INTERIOR MATERIALS

Ill:. 171 Combining wood in different aspects with concrete the wood becomes the softer material.

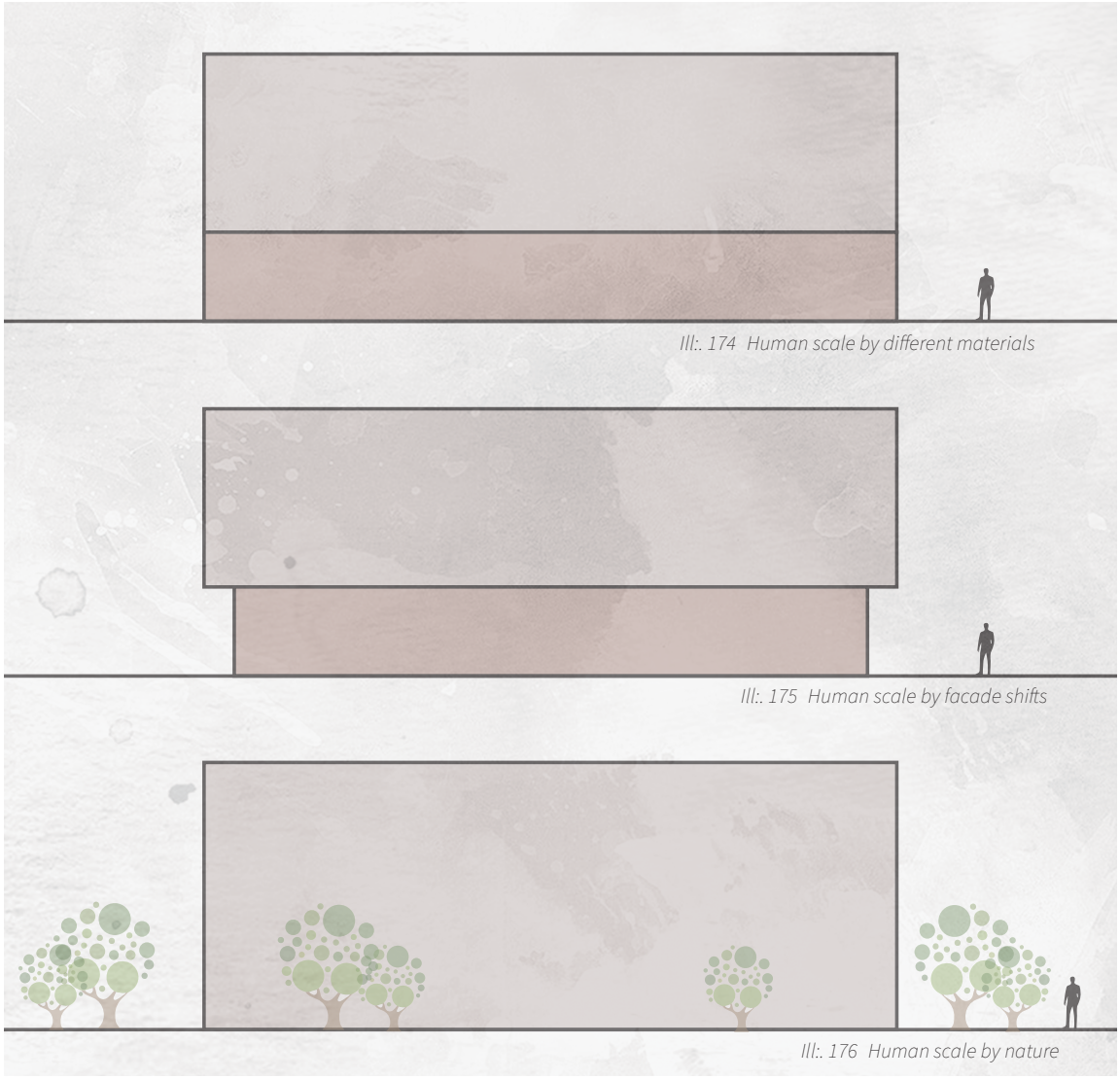
Ill:. 172 When combining concrete and bricks with wood, the appearance wood might disappear in the design.

Ill:. 173 Wood combined with gypsum and concrete requires a high amount of wood to soften the expression.

CONCLUSION ON THE SELECTED MATERIALS.

The materials chosen for the school are reused bricks, wood, and glass as exterior materials. The interior materials will be concrete, wood, and gypsum due to the contrast in the materials. Combining materials with different textures, weight, and warmth ensures a facade expression relating to nature and the human scale. Furthermore, the change in interior materials will create different experiences when moving through the building.

FACADE EXPRESSION HUMAN SCALE



Ill:. 174 Human scale by different materials

Ill:. 175 Human scale by facade shifts

Ill:. 176 Human scale by nature

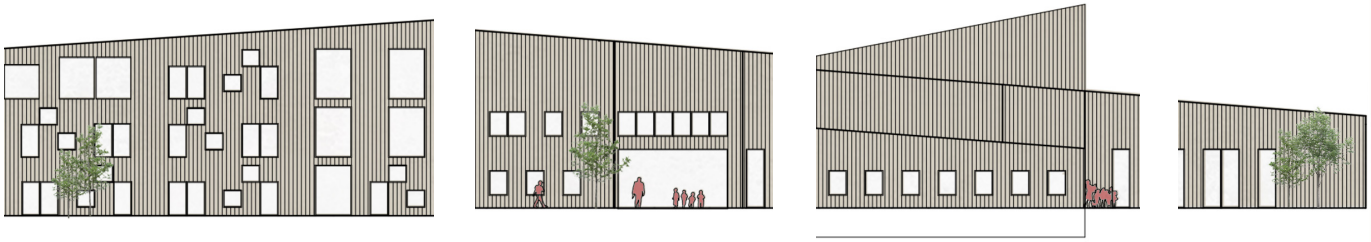
Human scale is the proportion of buildings/ urban spaces concerning humans. Human scale is essential when designing larger-scale buildings to relate to the users who utilize the building. In this project, the human scale is necessary to incorporate on the façade elements higher than two floors. The sports facilities zone and the lecture zone are taller than two floors, but the human scale will only be implemented in the lecture zone. The sports facilities wing is a distinct function compared to the rest of the school. Therefore it will appear as a dominating volume. Human scale is important when wishing to engage with the local community as stated in **UN-Goal 11.1.**

In this project, a combination of ill. 174 and ill. 176 will be used to ensure a relation to the users in human scale. Studies of how to implement these design elements can be seen in appendix 52.

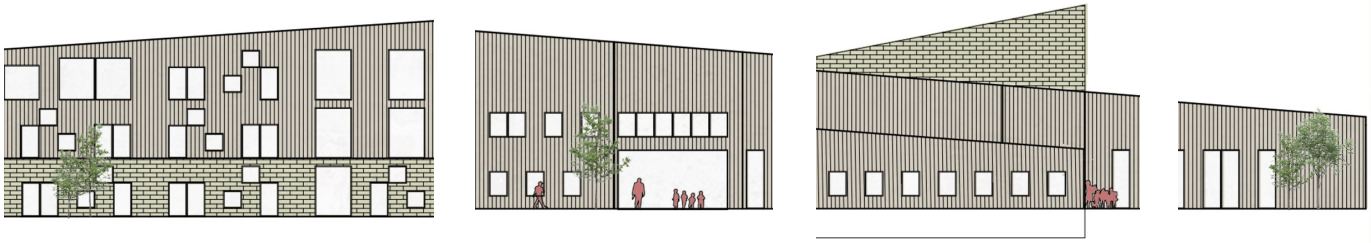
FACADE EXPRESSION

The building size results in a large amount of façade. Furthermore, a school requires various functions which entail differences in window areas, placement, and sun shading. Therefore, a general principle of the façade are made to create a complete expression. This can be made through repetition, correlation in materials and systems. The whole investigation can be seen in appendix 53.

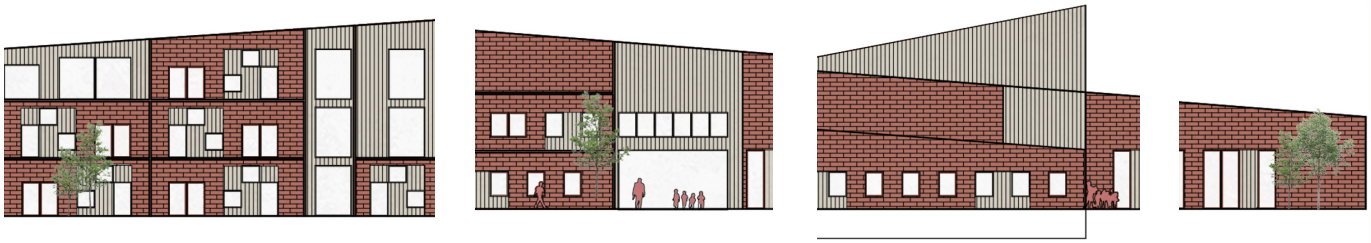
The investigation indicates that the facade design, presented in illustration 180, creates coherence in the facade. The wood panels and vertical pillars create a system in the design of the facade. Furthermore, the use of wood as the primary material strengthens the sustainable appearance of the school. Thereby the use of bricks are deselected even though the analysis illustrated it.



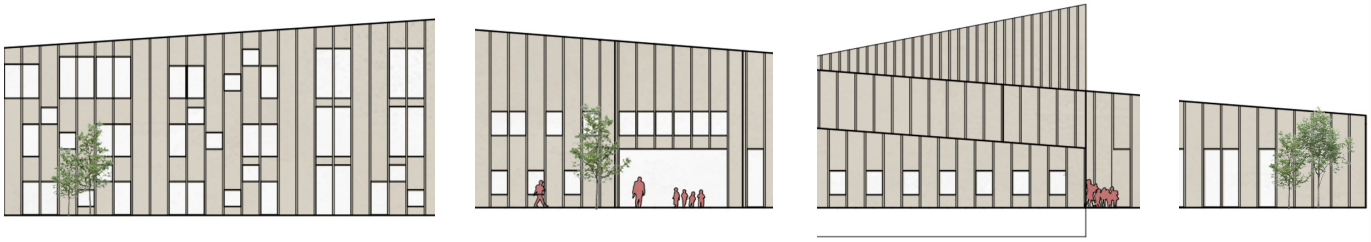
Ill:. 177 One general material can be monotonous and appear statically. When not creating a clear division of the façade, the façade becomes on long façade.



Ill:. 178 Horizontal band creates structure and coherence, but when we work with different elevations it is hard to create a structure or system.



Ill:. 179 This connection between bricks and wood creates a unclear expression. The wish is to create a coherent expression and by using more than one material, more elements were adapted into the facade, which made it even harder to create structure.



Ill:. 180 Vertical band in the facades can creates structure and coherence.

OUTDOOR SPACES

Ill:. 181 The abilities of Greenery

THE FUNCTION OF GREENERY

The intention with the surrounding area of The future school of NYE is to include nature, play, and learning. The building site is a naked field with a view of The Lisbjerg forest. To create a relation to the near forest and wild nature, greenery is establishing and given a function. Illustration 181 are examples of the use of greenery.

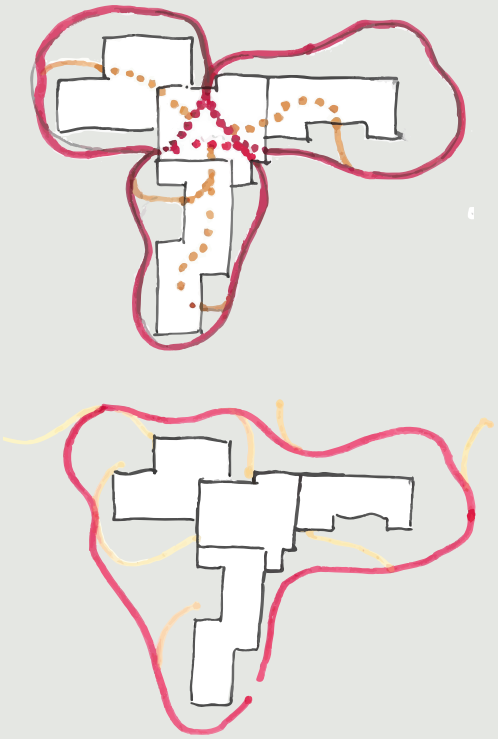
Ill:. 182 Placement of parking area

PARKING

When designing a school, there is a need for parking lots. The future school of NYE shall include 100 parking lots. We have worked with different placements of the parking area. In the beginning, we wanted to place the parking area close to Elev and NYE in the northern part of the site. Further investigations discovered the Northern part of the site must consist of learning facilities connected to the workshop area. The parking area is placed in the Southern part of the site, where it does not disturb the outdoor facilities.

LOOP OF MOVEMENT

The school setting must activate the pupils. Therefore, a 'Loop of Movement' is integrated into the design. By incorporating a Loop of Movement, the pupil can move between different facilities or activate themself with a fun run or walk through the site.



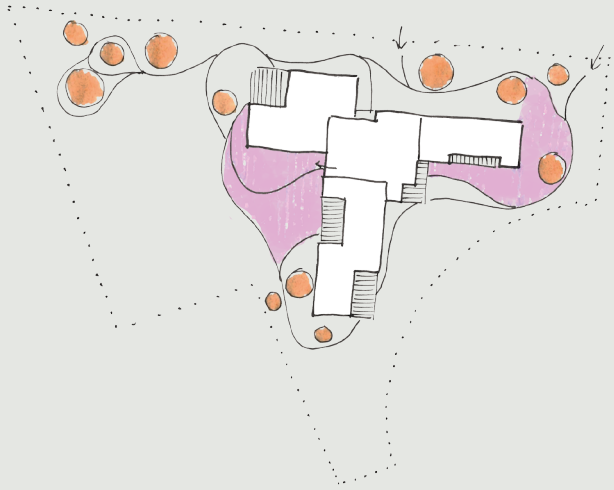
Ill:. 183 Movement loop

Ill:. 184 Movement loop

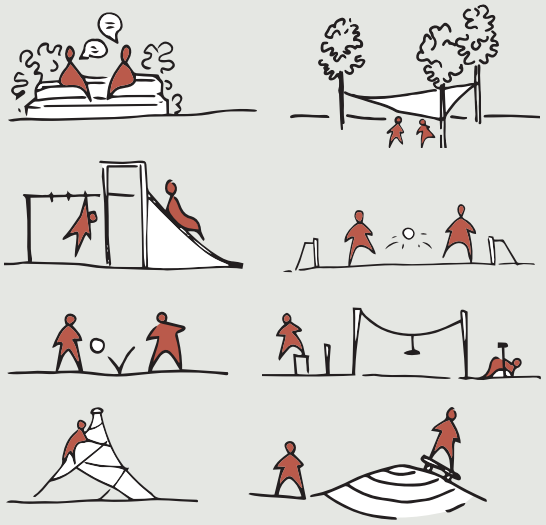
OUTDOOR SPACES

PROXIMITY

The placement of different outdoor facilities is done to create various levels of proximity. The playing field for the youngest is located in proximity to the building. Furthermore, the learning facilities have a close connection to learning rooms. The intention is to place the facilities for the older pupils further away from the school because they are more independent. This creates a closer connection between the pupils and the surrounding nature.



Ill:. 185 Proximity: Purple = close connection to building. Orange = Facilities that are spread out in nature



Ill:. 188 Examples of activities

ARRIVAL

The arrival to the school must stand out and be a meeting place for the pupils and the locals. We have integrated a shared space for walking and bike users. The arrival area shall consist of bike parking, seating, trees, and rises where the children can skate.

Ill:. 187 Example of arrival area

TERRACES IN CONNECTION TO THE BUILDING

In close connection to the building, there are placed several terraces. The terraces must be practical and have an architectural relation to the building. The function is investigated as well as the use of different materials. It is decided to establish the terraces in wood which is the primary material of the façades.

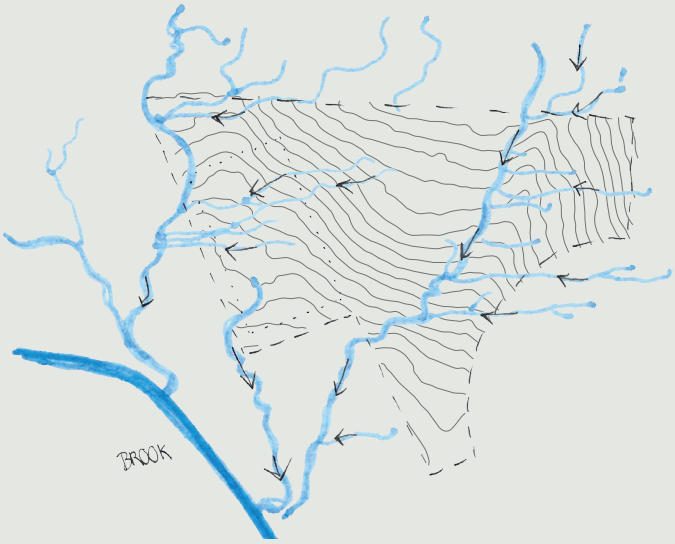
Ill:. 186 Terrace in close connection to building

OUTDOOR SPACES

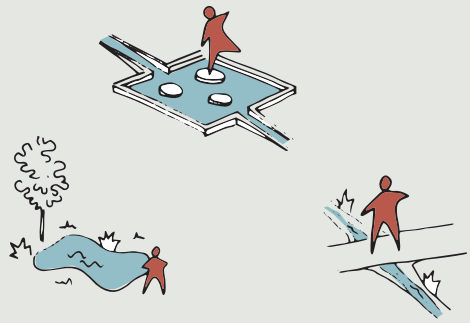
NATURAL FLOW PATHS OF RAINWATER

According to UN-Goal 6.1 and 6.2, an investigation of the natural water movement must be made. Subsequently, LAR solutions can be added.

Illustration 189 represents the water movement at the site. The water must be diverted in another direction to ensure the building plot. The terrain slopes in two directions, which affect the movement of the rainwater. Illustration 189 further illustrates that all the water paths end in the brook located Southwest of the site.



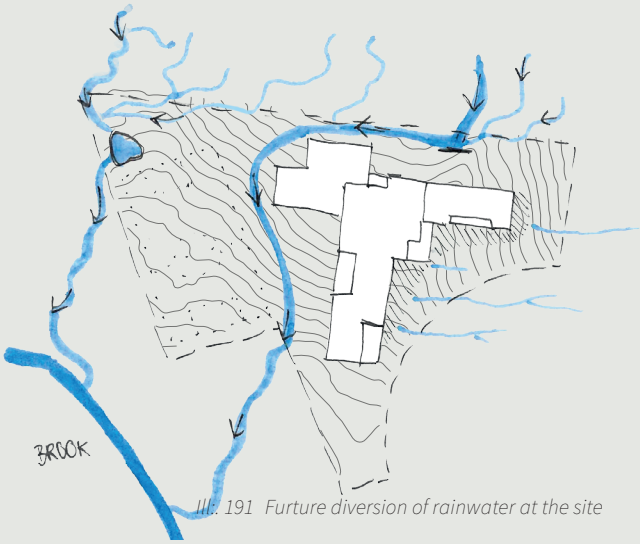
Ill:. 189 Natural flow paths of rainwater



Ill:. 190 Elements to be integrated in the water diversion system

LEARNING ABOUT WATER

The intention is to change the rainwater direction by creating new water channels, ponds, and greenery which can lead and absorb the rainwater. The diagrams at ill. 190 represents examples of elements that must be integrated into the diversion solutions to promote the learning element of water.



Ill:. 191 Furture diversion of rainwater at the site

CREATION OF RAINWATER SOLUTIONS

Diagram 191 illustrates our diversion of the rainwater. The focus has been to lead the rainwater away from the building. Greenery must be placed close to the eastern part of the building to absorb water from the small paths of rainwater. It is essential to stop the main path of rainwater in the Northern area and divert the water towards the west. This leads the water away from the building and in the slope direction of the terrain. Furthermore, we want to divert the water away from the playing field, by establishing a pond in the north-western corner of the site.

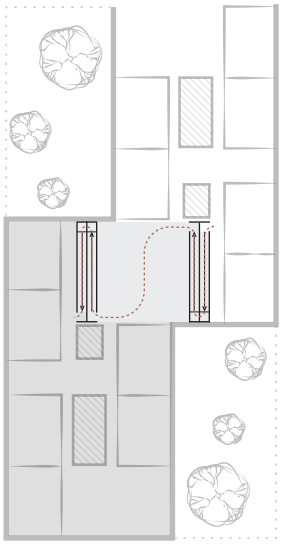
ACCESSIBILITY

Creating a school with different levels requires consideration about accessibility. The intent is to create fun and engaging ramps to ensure the feeling of equality amongst the users. Furthermore, the intention is to incorporate the ramps into different activities to further signify equality. The illustrations 193 - 197 show ideas of different ways to incorporate accessibility throughout the school and use the ramps to create separate spaces in rooms. Inspiration for the accessibility ramps is found through case studies which can be seen in appendix 54.

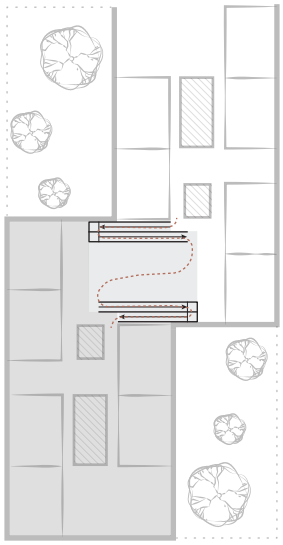
The inclination of an accessibility ramp must not exceed 1:20. The ramps needed throughout the school vary in height from 1750 mm in the lecture zone to 1500 mm in the common space.

Based on the different iterations, a combination of ill. 196 and 197 will be used throughout the school.

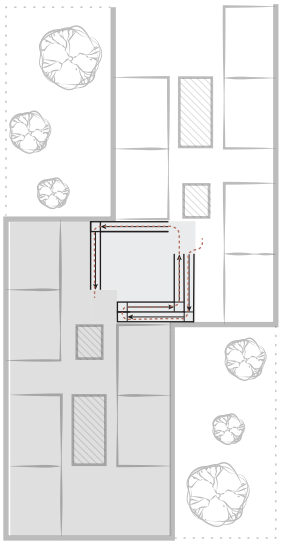
Ill:. 192 Example of accessibility ramp 1:20 inclination



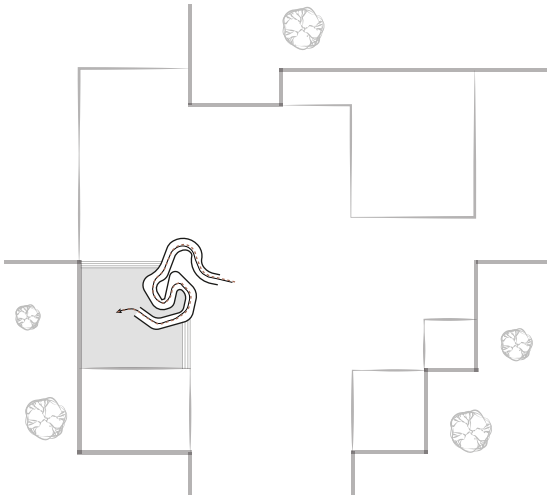
Ill:. 193 Iteration 1, lecture zone



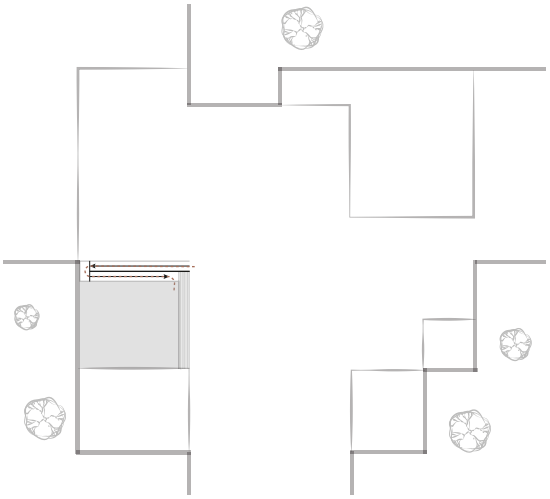
Ill:. 194 Iteration 2, lecture zone



Ill:. 195 Iteration 3, lecture zone



Ill:. 196 Iteration 1, common space



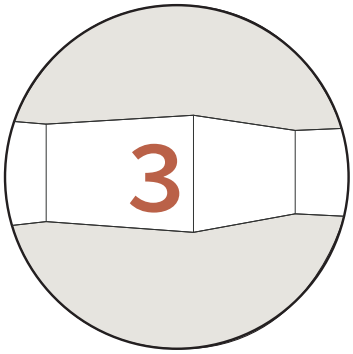
Ill:. 197 Iteration 2, common space

WAY-FINDING

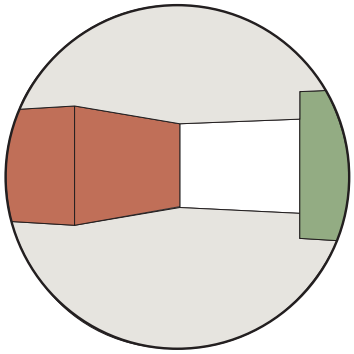
The school is 10,000 m^2, which creates a need for easy way-finding. Pupils, teachers, and visitors should navigate easily, and therefore way-finding is necessary. Way-finding is especially useful for visitors and the enrolment classes in navigating throughout the school. The young pupils should be included when designing for way-finding because they can not read. To ensure every user of the school understands the signs, the signals must be clear.

A combination of illustraion 200, 201, 202 and 203 will be used in the way-finding of the school.

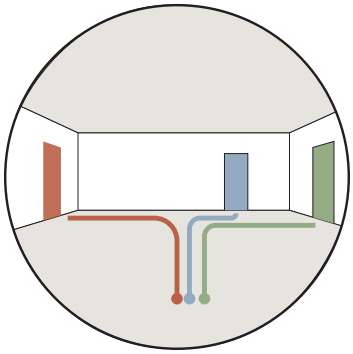
By integrating way-finding in the design of the building and its interior spaces **UN- Goal 3.4** regarding way-finding are fulfilled.



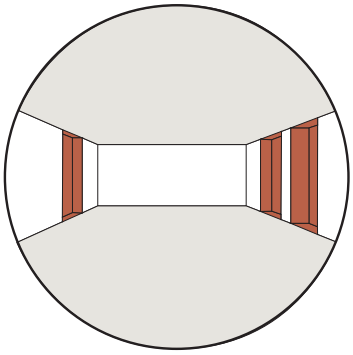
Ill:. 203 Way-finding by clearly marking different functions by numbers.



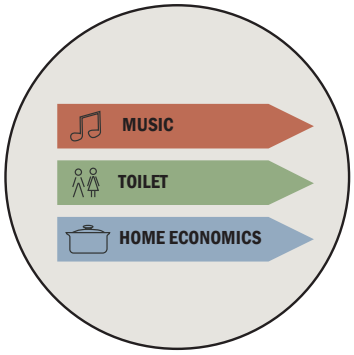
Ill:. 198 Way-finding by clearly marking different functions by colours.



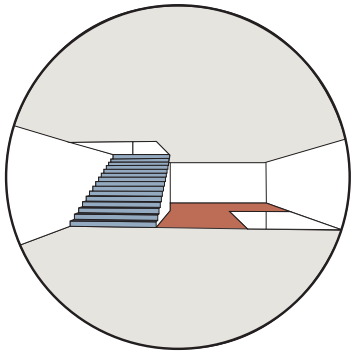
Ill:. 199 Way-finding by directory on the floor.



Ill:. 200 Way-finding by subtle colour changes on different floors.



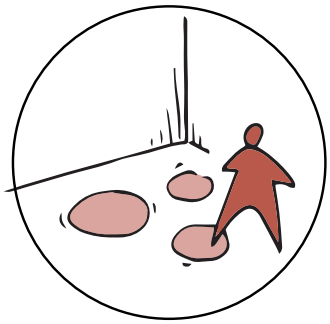
Ill:. 201 Way-finding by signs with icons for young pupils.



Ill:. 202 Way-finding by clearly marking different functions by colours.

SENSES

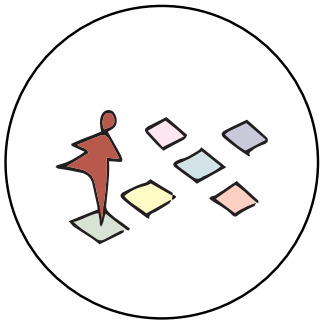
To activate the senses both indoor and outdoor, as stated in **UN-Goal 4.3** a study was made to clarify how to activate senses in the school setting. This study will be used to place facilities throughout the school, to activate senses. These studies are shown through illustrations 204-208 and shall be seen as examples of how to incorporate sense stimuli and not as direct design solutions.



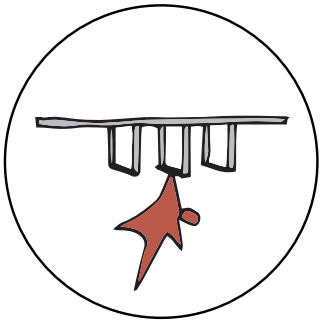
Ill:. 204 Sense of touch activation - Different materials can create a difference in the feel of a surface. This can happen either by a difference in temperature or by the hardness of materials.

Ill:. 209 To activate the sense of movement and balance different activities are required. This can be both indoor and outdoor installations through tightrope walking.

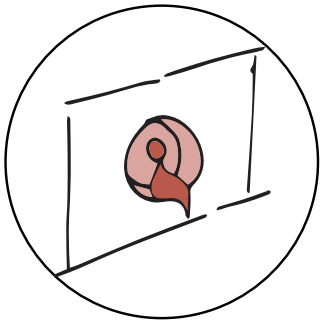
Ill:. 205 Being outside activates many different senses simultaneously. Touch, hearing, taste, and smell can e.g., be activated by gardening or eating food over a bonfire.



Ill:. 206 Different installations are placed throughout the school to activate the sense of movement and balance. This can e.g., be a part of the activity loop or learning facilities.



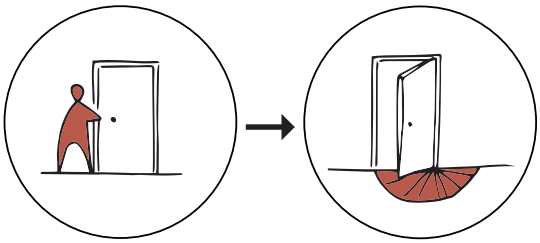
Ill:. 207 To activate the sense of movement and touch different activities are required. This can be both indoor and outdoor installations through brachiate.



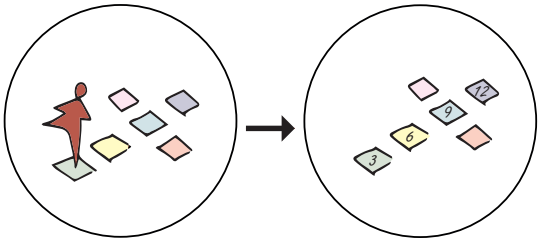
Ill:. 208 Activating of the touch and hearing sense - A difference in materials can happen in seating environments, where the pressure from seating material changes. Furthermore, activation of the hearing sense happens, when located in places where sound is significantly higher or muted.

PLAY, MOVEMENT, AND LEARNING

To ensure play, movement, and learning stated in **UN-Goal 3.3, 4.2, and 6.3**, scenarios were made to clarify how to motivate children to move more, play more, and learn meanwhile. These scenarios will be used to place facilities throughout the school to engage with the children. These scenarios are shown through illustrations 210-213 and shall be seen as examples of how to incorporate play, movement, and learning and not direct solutions. Furthermore, the success of these initiatives depends on the teachers and school mentality and vision.

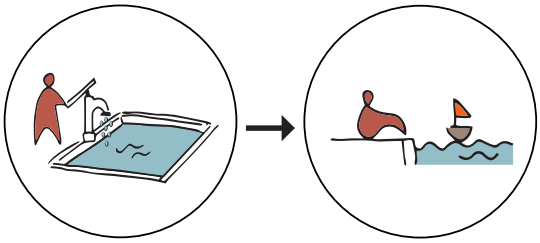


Ill:. 210 Learning through interaction with the building.
Learning through play can often be done anywhere, as this example of angular learning through visual representation shows.



Ill:. 211 Learning through movement.
Placing facilities that both indicate fun and learning ensures a longer attention span amongst the pupils.

Ill:. 212 Learning through movement and play.
By engaging with the surrounding facilities, play, movement and learning can be fulfilled. This scenario showcase how to use the surroundings and how the pupils easily can benefit from different learning settings.



Ill:. 213 Learning through interaction with rainwater.
By incorporating specific facilities that utilize NYE's vision of rainwater collection, the pupils can both play and learn from the water.

ATMOSPHERE

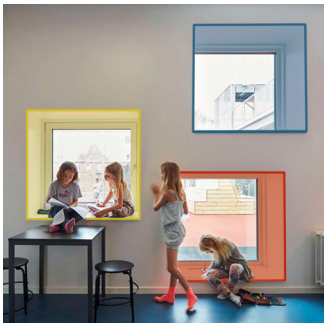
The following section includes short descriptions and examples of atmospheres in the different parts of the school. Atmospheres studies are created to explain a interior feeling and expression of the room.

BASES

From the hallway, the bases must appear clear and recognizable. Therefore, the bases must have another material that contrasts the primary material of the project space. Furthermore, the bases must be easy to recognise with doors in different colours.

The project surfaces must have a different appearance to indicate different learning environments. Additionally, the base windows can have a playful expression with different colours and sizes. The materials in the classes must be robust and differ from 'white walls' where dirt and contaminants are visible.

Ill:. 214 Change of materials.



Ill:. 215 Windowsills used as immersion area.

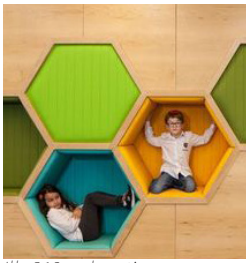
Ill:. 216 Lecture area, inspiration.

Ill:. 217 Change of materials.

PROJECT SURFACE

The project surface is characterized by open spaces with different functions. It must be a place that embraces multiple functions by implementing space for group work, solo work, play, and activity. The materials must be practical and robust for interaction with children. The project surface can be characterized by colored elements, that make the atmosphere childish.

Ill:. 218 Immersion area.



Ill:. 219 relaxation area.

ATMOSPHERE

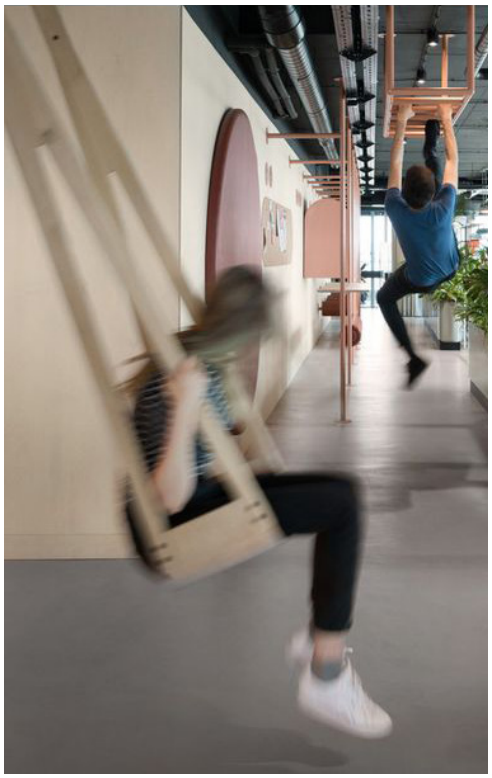
LIBRARY

The primary users of the library are the children. Therefore, the atmosphere must be playful by implementing colours.

The library must have a calm atmosphere marked by bookshelves. Soft seating must be implemented on a smaller scale for pupils to enhance the calm atmosphere.

Ill:. 220 Bookshelves and retraction area.

Ill:. 221 Seating arrangement, storytime.



Ill:. 222 Indoor activity course.

WALKING AREA - COMMON SPACE

The hallway must have a playful appearance, where the pupils want to interact with the facilities and thereby being activated. The intention is to establish colored elements and facilities to activate the pupils.

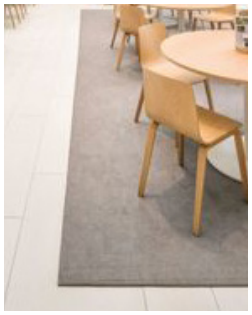
Ill:. 223 Playful seating area.

Ill:. 224 Climbing wall.

DINING AREA - COMMON SPACE

The common space includes several areas for dining, where changes in materials indicate different areas. Furthermore, smaller installations could be used for shielding areas. It could be by transparent wall units or indoor plants.

Ill:. 225 Shielding greenery.



Ill:. 226 Furniture in suitable size.

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Own illustrations are not represented.

THE FUTURE SCHOOL OF NYE

MASTER THESIS, MSC04 2021

TITLE PAGE

MASTER THESIS
NYE School

GROUP 21
MSc04 Arch,
Department of Architecture & Design
Aalborg University

PROJECT PERIOD
Spring 2020
01.02.2021 - 27.05.2021

MAIN SUPERVISOR
Lars Brorson Fich

REPORT INFORMATIONS
Pages: 32
Appendix: 4

GROUP MEMBERS

Katrine Zinck Thomasberg

Laura Ebbensgaard Kjær

Signe Winter

READERS GUIDE

The following report contains the final proposal for the future school of NYE. Before reading the proposal, knowledge and understanding of the projects must be gained from the program and design process.

Due to uncertainties caused by Covid 19, this report will be represented online. Therefore, this report is created as a single-page presentation. The digital display makes the appearance of scales, sizes, and colors depending on the screen used for reading. This report is fitted to the online format. Therefore, the scale of illustrations is created based on the possibility to zoom in on-screen. Unfortunately, the sizes of the illustrations might cause the schooling through the PDF or zooming to be heavy. All illustrations presented are own illustrations.

If the reader wishes to print the report, this presentation fits an A3 landscape style.

THE FUTURE SCHOOL OF **NYE**

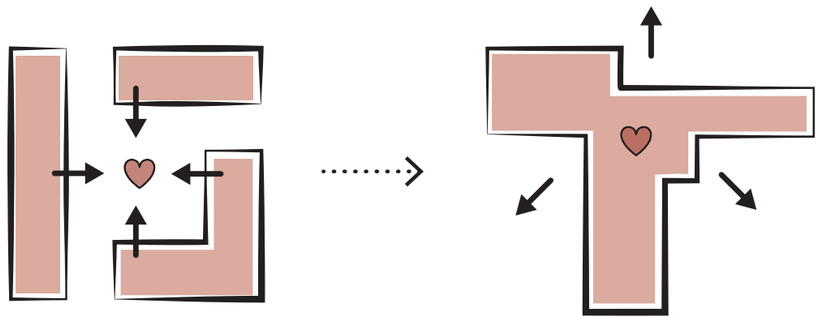
A building emerges from the landscape, rising as a peak from the sloping surroundings. The surrounding nature winds with the wooden façade, where outdoor spaces become gathering spaces for the playing children. The green and blue character of the area are underlined in the blue water channels trickling in the landscape, being an element of spirited children's game, and in the green roof of the building, which merges the voluminous form into nature. The building is the future school of NYE, where children are educated in sustainable settings. An alternative way of learning and teaching is practiced inside the school walls, where the setting inspires to learn, play and move.

CONCEPT

The concept is openess towards the people and bringing in nature.

The future school of NYE invites the users and locals inside by being open and orientated towards the three-parted surroundings. The building presents the life inside by creating views from outside. The building form invites the local community inside instead of rejecting them by being a closed and encircled building. Additionally, the form invites the pupils to interact with the surroundings, to investigate the landscape and to learn from the beautiful contexts surrounding them.

The future school of NYE is open, unfolded, and apply to the surroundings.

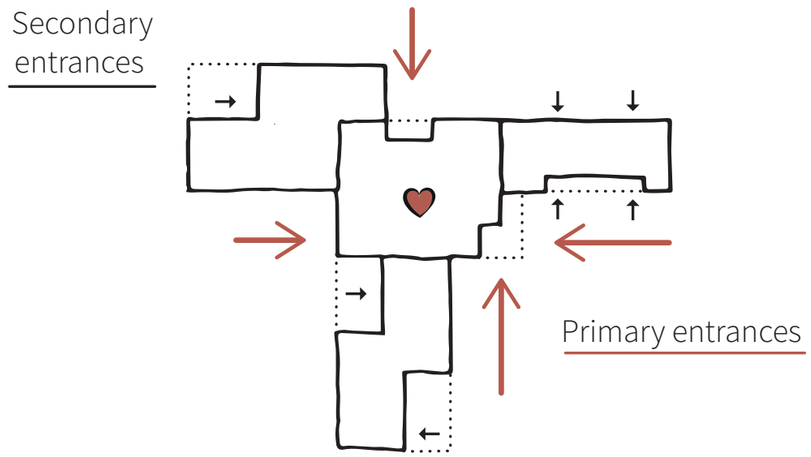


Ill:. 2 Concept

Ill:. 3 Masterplan 1:1000

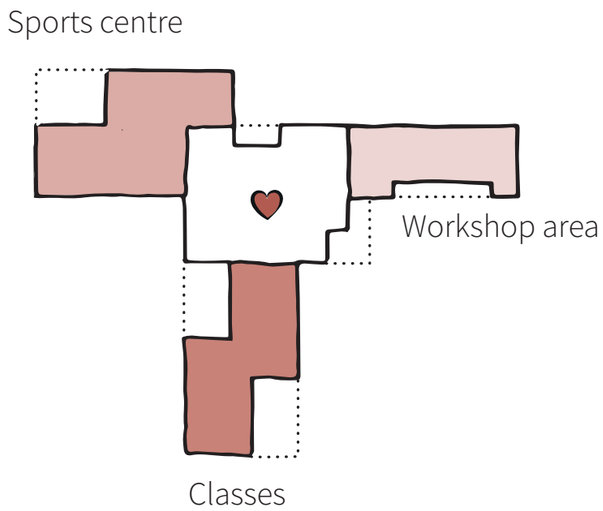
ARRIVAL

The pupils and future users of the school arrive from different pathways and directions. Mainly, the pupils will arrive on foot or by bike, because they will be living in NYE and Elev. The main entrance is orientated towards the east with a connection to The Ring and NYE. Secondary entrances are placed toward north and west, allowing to enter the building from multiple directions. Additionally, smaller entrances are placed around the building to embrace easy access to nature and to create a setting for outdoor school (UN-Goal 4.4). Furthermore, the placement of the building in the landscape makes it recognizable from far away.



FACILITIES OF THE BUILDING.

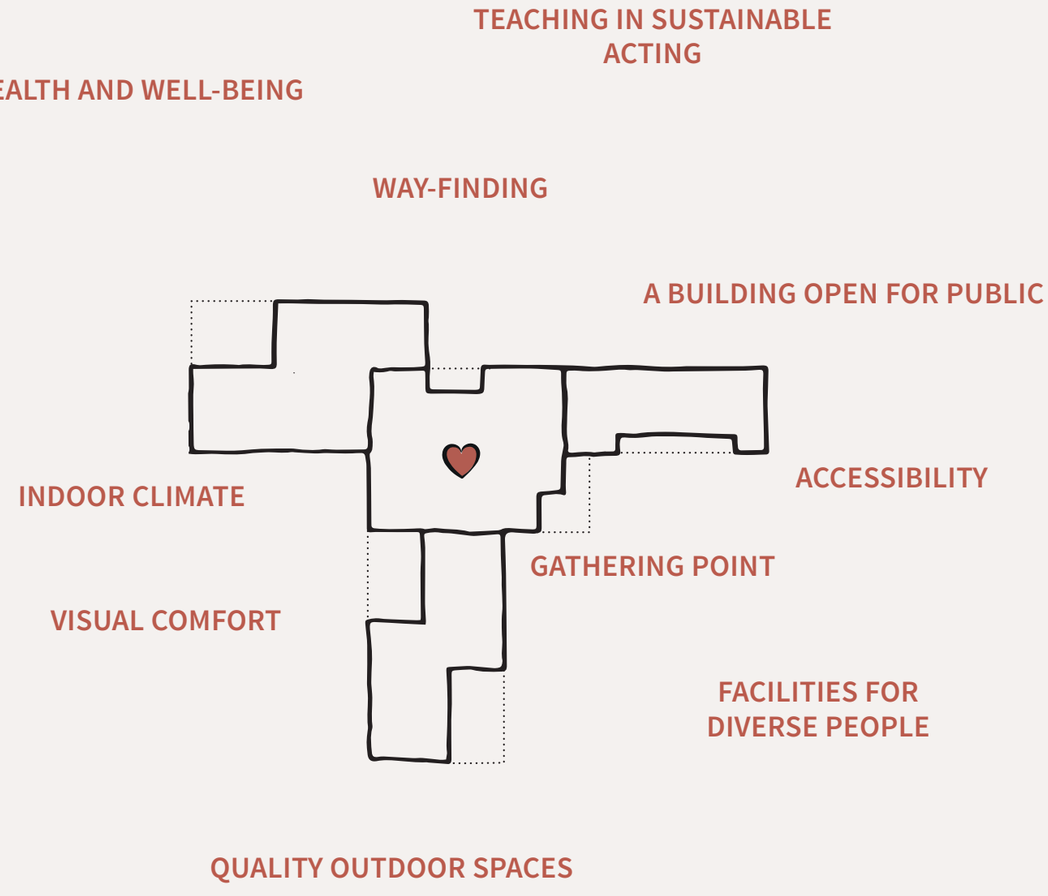
The future school of NYE consists of four zones with different facilities. The common space, the lecture zone, the workshop zone, and the sports facility zone. The common space, workshop, and sports facilities are facilities addressed to the local community as well as the pupils. The common space is the center of the building, where a diversity of people meets. This is a part of inviting the local community to utilize the school (UN-Goal 11.1).



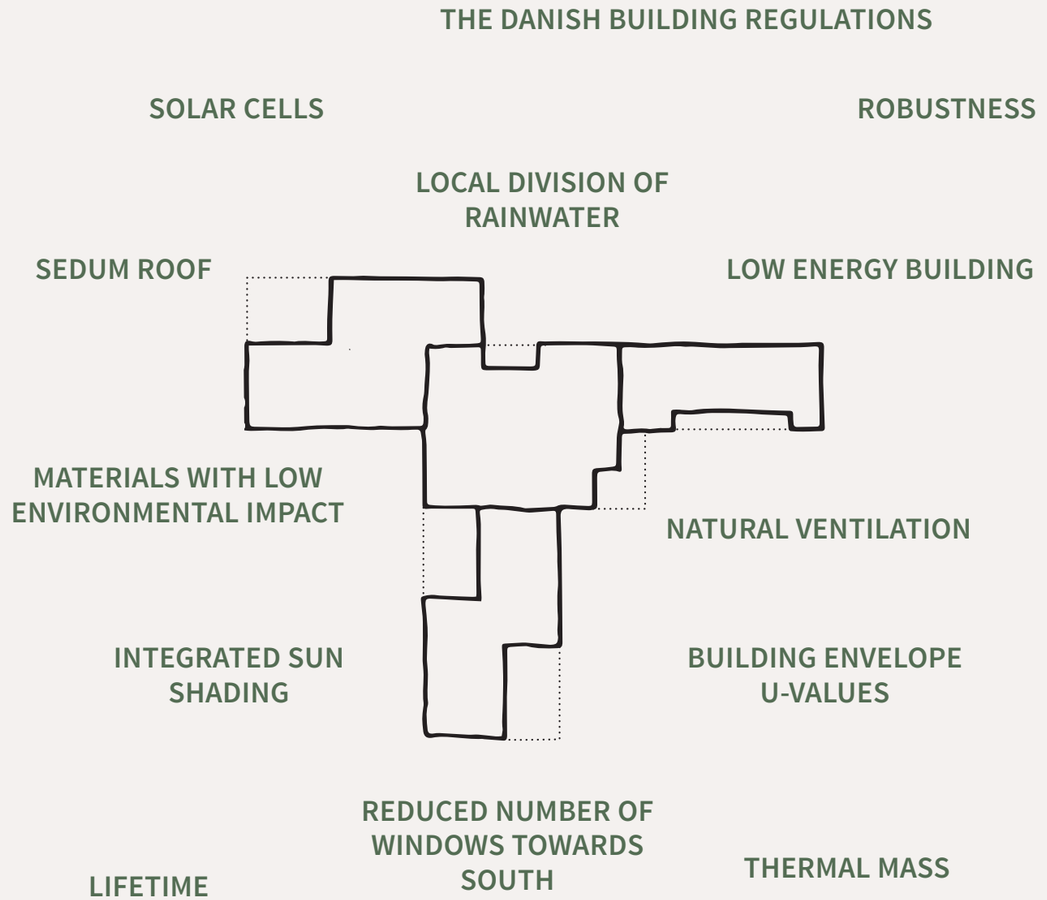
LOCAL COMMUNITY

The local community utilizes the school, and the people are considered users (UN-Goal 11.2). The building is a gathering point for the citizens of Elev and NYE and a landmark of the surroundings. Old and young can use the facilities and create a strong associational life. The sports facilities and workshop are settings for people to enjoy physical activities or shared creative interest in after-school hours or weekends.

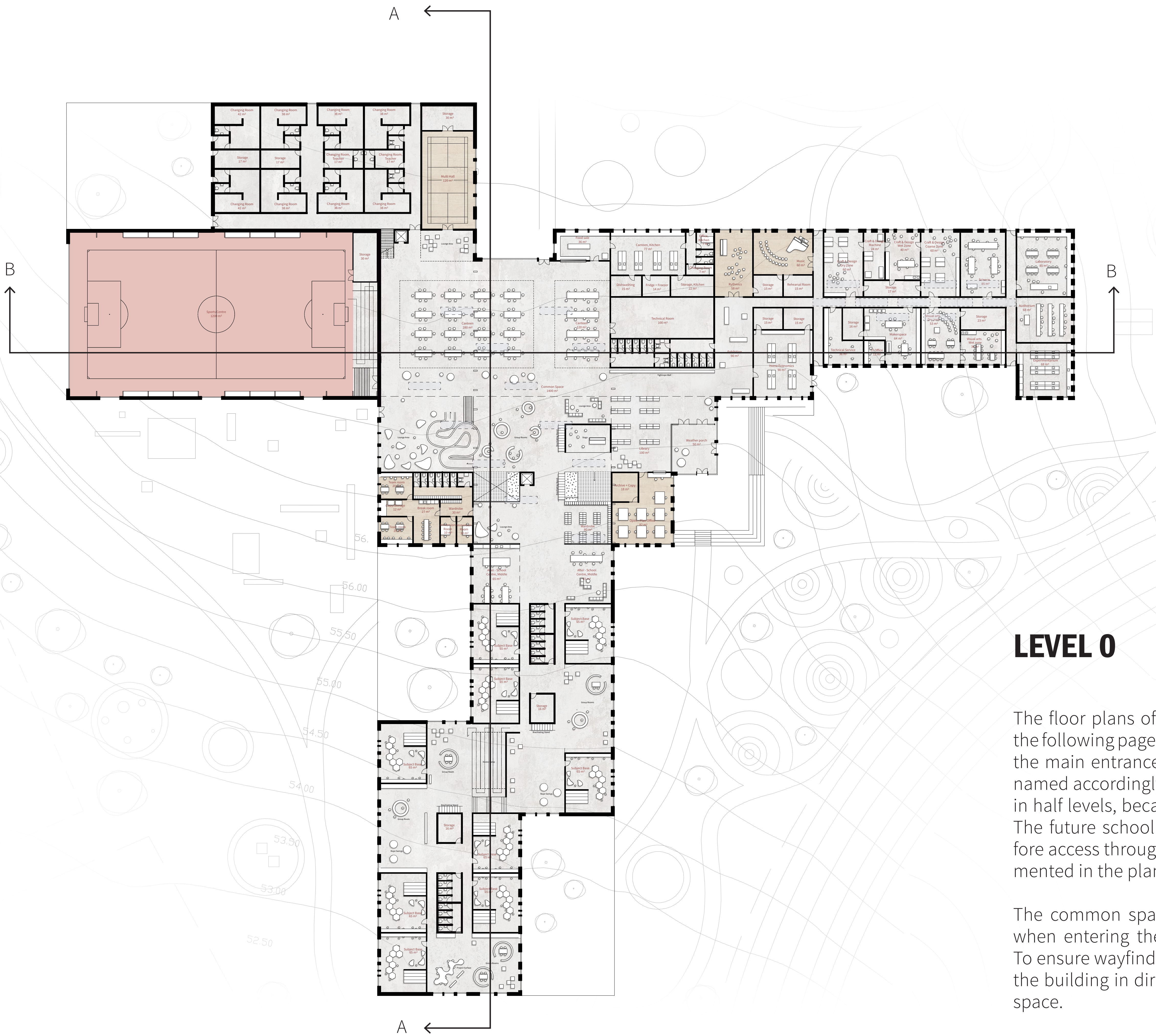
A SUSTAINABLE SCHOOL



SOCIAL SUSTAINABILITY



ENVIRONMENTAL SUSTAINABILITY

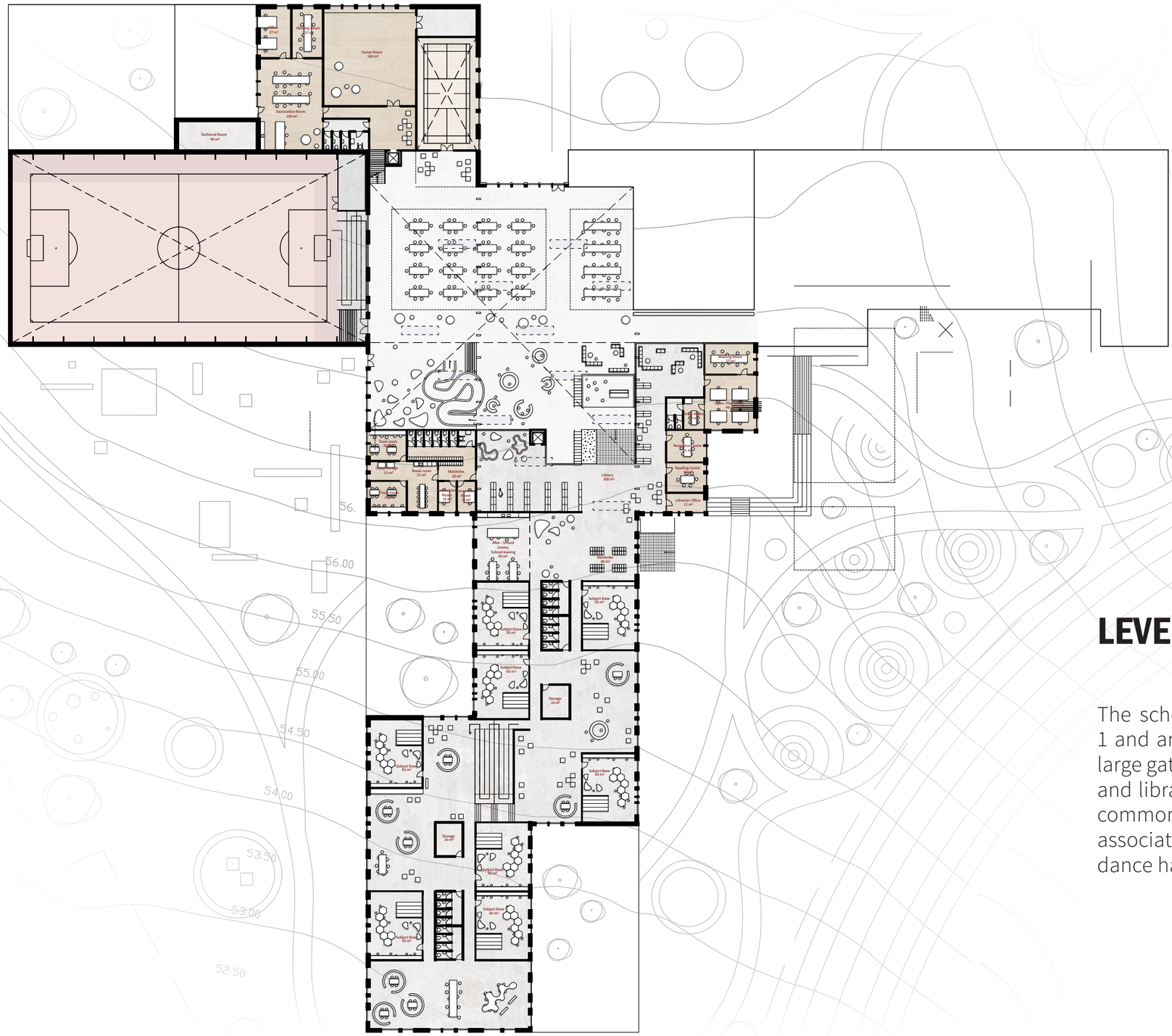


LEVEL 0

The floor plans of the building are presented on the following pages. Level 0 is the access level from the main entrance, and the additional levels are named accordingly. The floor plans will be shifted in half levels, because of the sloping topography. The future school of NYE is for everyone. Therefore access through ramps and elevators is implemented in the plan design.

The common space is the first space you meet when entering the building from the entrances. To ensure wayfinding (UN-Goal 3.4) the 3 wings of the building in direct connection to the common space.

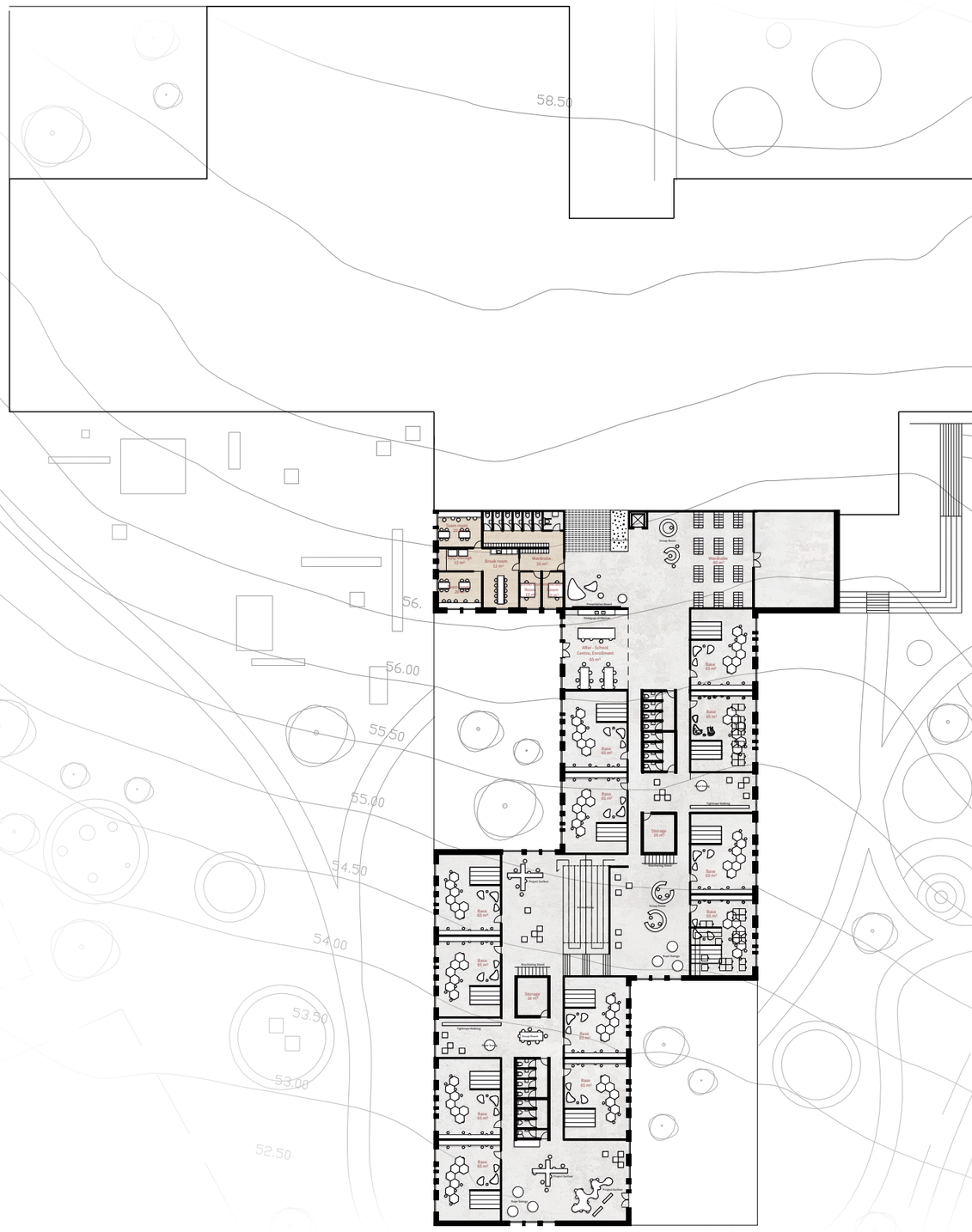
Ill:. 4 Level 0, 1:600



LEVEL 1

The school leaving classes are located on level 1 and are connected to the common space by a large gathering staircase. From the project surface and library, there is an overview of the life in the common space. In the sports facilities, a room for associational life is located with connection to the dance hall.

Ill:. 5 Level 1, 1:600

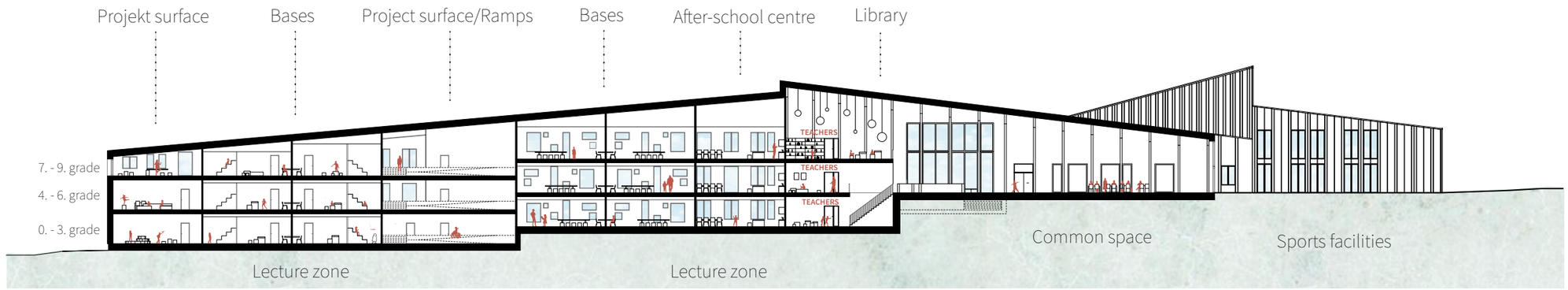


LEVEL - 1

The enrolment classes are located at level -1 as the only function. Due to the sloping landscape level -1 is not a basement but a full level with direct access to the surrounding nature. A large and playful staircase connects the enrolment class with the common space.

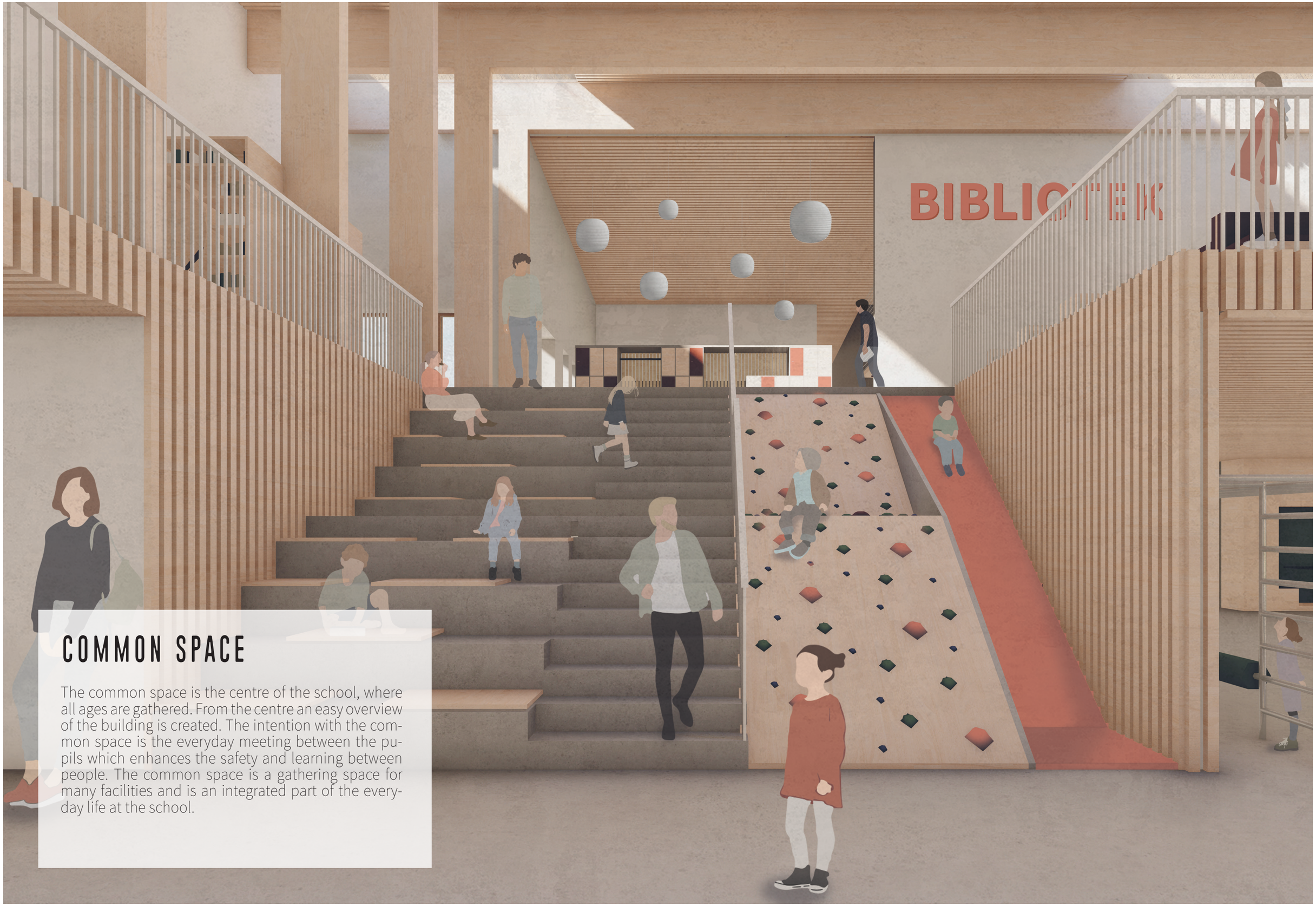
Ill:. 6 Level -1, 1:600

SECTIONS



Ill:. 7 Section AA 1:500

Ill:. 8 Section BB 1:500



COMMON SPACE

The common space is the centre of the school, where all ages are gathered. From the centre an easy overview of the building is created. The intention with the common space is the everyday meeting between the pupils which enhances the safety and learning between people. The common space is a gathering space for many facilities and is an integrated part of the everyday life at the school.

COMMON SPACE

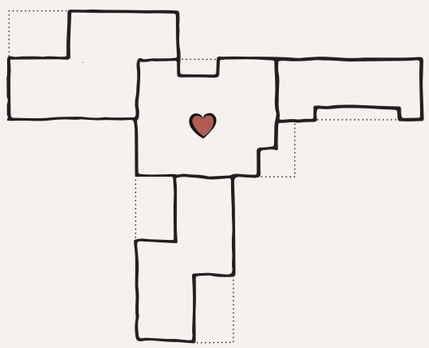
The common space is the central meeting point of the school and local community with different functions such as a library, seating arrangements, and a canteen. The main meeting point of the school is the staircase leading towards the school-leaving classes - a gathering staircase where the intended use is assemblies, presentations, and lounging.

The canteen consists of multiple eating arrangements and a food sale. This area is the primary dining area during the eating recess. Additionally, the canteen can be rented by the community for different occasions or activities (UN-Goal 11.1).

The library is divided into two floors. The section on level 0 primarily caters to the local community. The library on level 1 is a retraction and meeting space for the year groups where it is possible to immerse in books.

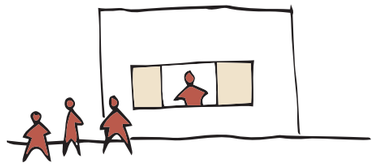
A visual connection towards the sports center, workshop area, and lecture zone is present when exploring the common space, which enhances the wayfinding of the school for the visitors, pupils, and teachers (UN-Goal 3.4).

Multiple play installations and learning elements are implemented in the common space of “The future school of NYE” to motivate pupils to lead an active lifestyle (UN-Goal 3.3).

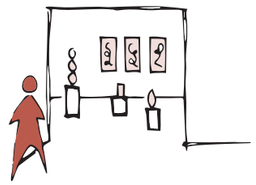


VISIBILITY TO SPORTS CENTRE

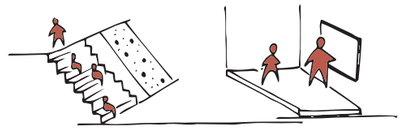
FOOD SALE IN RELATION TO CANTEEN



SEATING ZONES



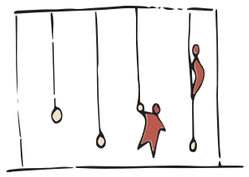
VIEW TO WORK-SHOP AREA



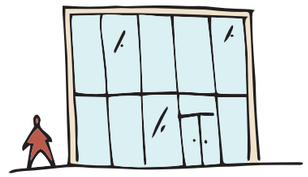
GATHERING STAIR IN RELATION TO A STAGE

CANTEEN

LIBRARY



TIGHT ROPES - A PLAYING ELEMENT



WINDOWS PLACED WITH A VIEW TO ELEV, FUTURE NYE AND NATURE

BASES

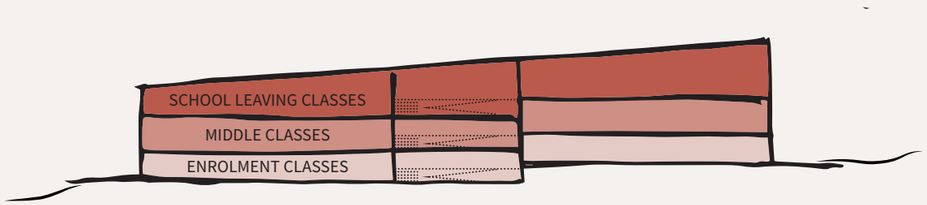
The bases are the foundation of learning and where the pupils spend most of their school day. The bases are designed as an inspiring environment that includes the different individual learning styles of the pupils (UN-Goal 4.1). The rendering represents a base from the enrolment classes showcasing a glimpse of the everyday life at the school. The pupils can change work settings throughout the school day based on the lecture's nature. From every base, there is an incredible view of nature, ensuring a calm setting for the pupils (UN-Goal 4.3).

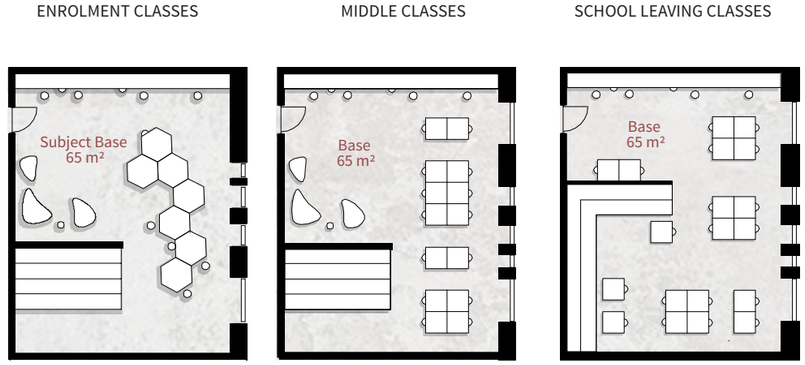
BASES

The classes are located in the southern part of the building with a vertical displacement that follows the terrain. The grades are divided based on similar room functions, wayfinding, and the inclination of the site.

The bases are connect by a shared project surface that further enhances the pupil's ability to differentiate in the learning setting. The shared project surface includes areas for assignment solving individually and in groups, being active, and playing (UN-Goal 4.2). Both bases and project surfaces vary from enrollment classes, middle classes, and school-leaving classes.

In the enrollment classes, there is a greater need for creating a safe environment for young students. Therefore, the proportion of shared project surfaces varies where the smallest surface is in the enrollment classes. Furthermore, the base's function also differs throughout the floors. The enrollment classes' surface is playful where the school-leaving surface supports their growth and individuality.





Ill:. 9 Bases, 1:100

PRESENTATION STAIR

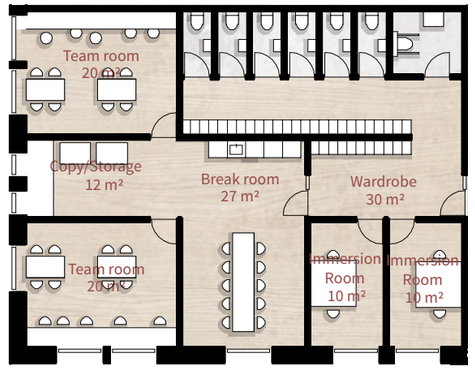
TABLES FOR GROUP WORK

WINDOW WITH SEATING SPACE FOR IMMERSION

STAFF SPACE

The teacher’s rooms are located at each grade level containing several functions supporting the relationship between the teachers while ensuring a beneficial setting for the teachers’ preparation time.

The teachers’ rooms are located on each grade level to reduce the time spent moving distances at the school. Furthermore, the teachers need a screened area to retract into, this increases their concentration when preparing for the lectures. The teacher’s room expression must be private to ensure a break from the pupils. An additional benefit of the teacher’s room placement close to the common space the visibility.



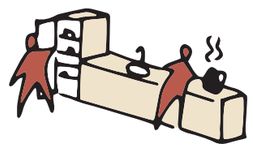
Ill:. 10 Plan layout, Staff area. 1:100

WARDROBE

TEAM ROOM

IMMERSION ROOM

COPY SPACE



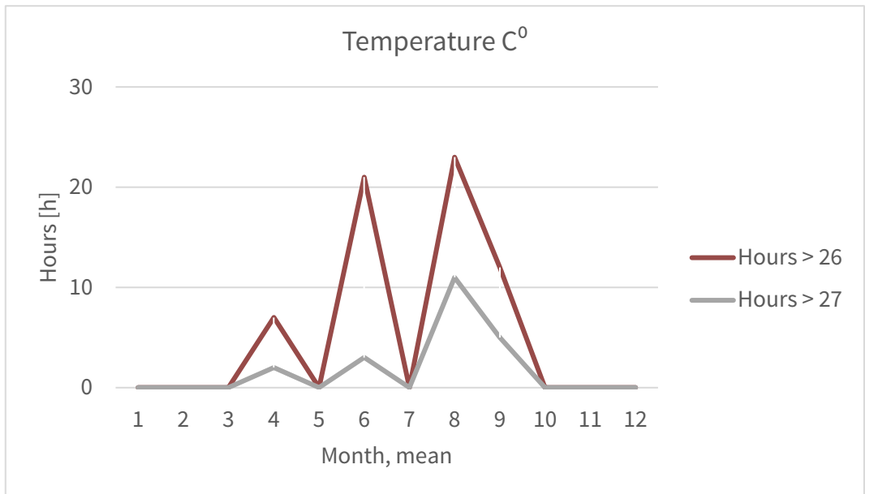
BREAK ROOM WITH KITCHENETTE

INDOOR ENVIRONMENT IN SCHOOL

To create a beneficial learning setting a good indoor environment is integrated according to the building regulations (UN-Goal 3.1). The bases are designed with solutions which ensures a good air quality, visual comfort, acoustic properties, and thermal comfort.

THERMAL COMFORT

The relation between the room size and the amount of people results in heat gain. Furthermore, the requirement according to daylight, results in a high amount of glass area, that also affect the temperatures. The following diagram is a selection of results from analysis made in BSim. The results proofs that the desired temperatures in the bases are preserved.

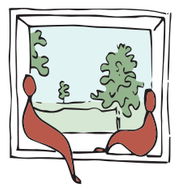


VISUAL COMFORT

Visual comfort is ensured with a good quality of light which meets the requirements (UN-goal 3.2). Windows are placed according to function and amount of daylight required in the interior spaces. The view to nature is consistent through the building.

	Base	Sports center	Craft & design
D_T > 2.1 %	2.71 %	2.93 %	2.43%

FULL HEIGHTS VIEW TO NATURE



SEATING SPACE IN WINDOW FRAMES

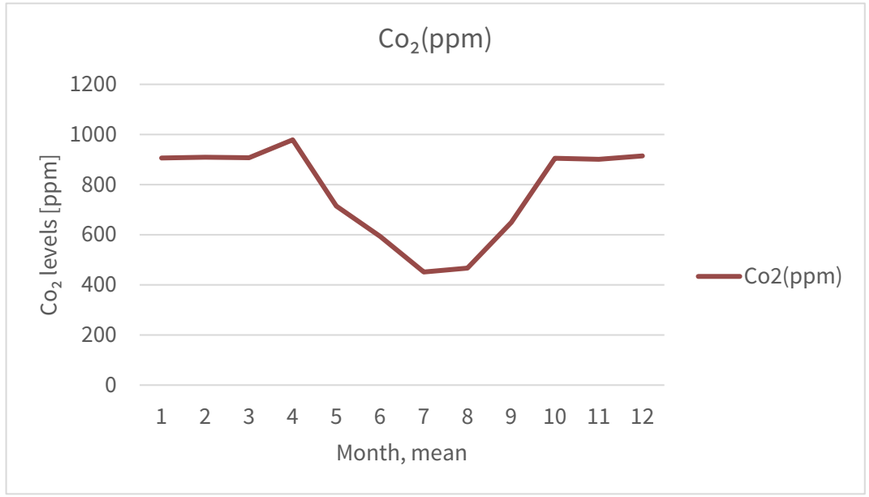
SKYLIGHTS THAT LIGHTS UP THE HALLWAY IN THE WORK-SHOP AREA

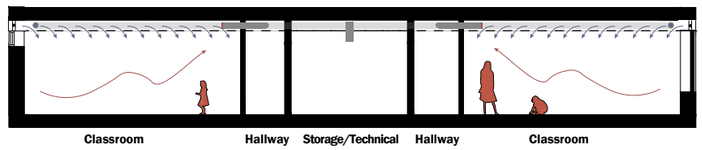
ACOUSTICS

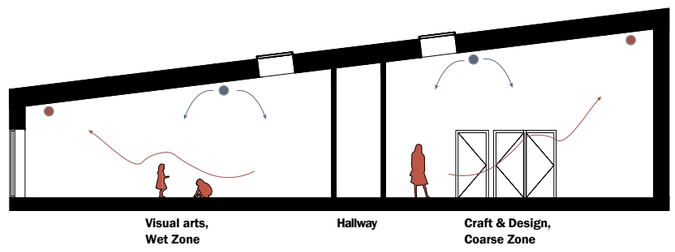
In the voluminous spaces, such as the common space, sound absorbing materials are placed to create a good acoustic environment. Additionally, an interior wall thickness of 145 mm is chosen to minimalize background noise in the bases.

AIR QUALITY

To ensure atmospheric comfort according to the building regulation (UN-Goal 3.1) in the bases, a yearly simulation is made. This shows the CO_2 levels of the classrooms complies with the building regulation. Mechanical ventilation is used during the heating season and a mix between natural inlet and mechanical outlet in the summertime.







ELEVATIONS

Ill:. 11 East elevation 1:500

Ill:. 12 North elevation 1:500

ELEVATIONS

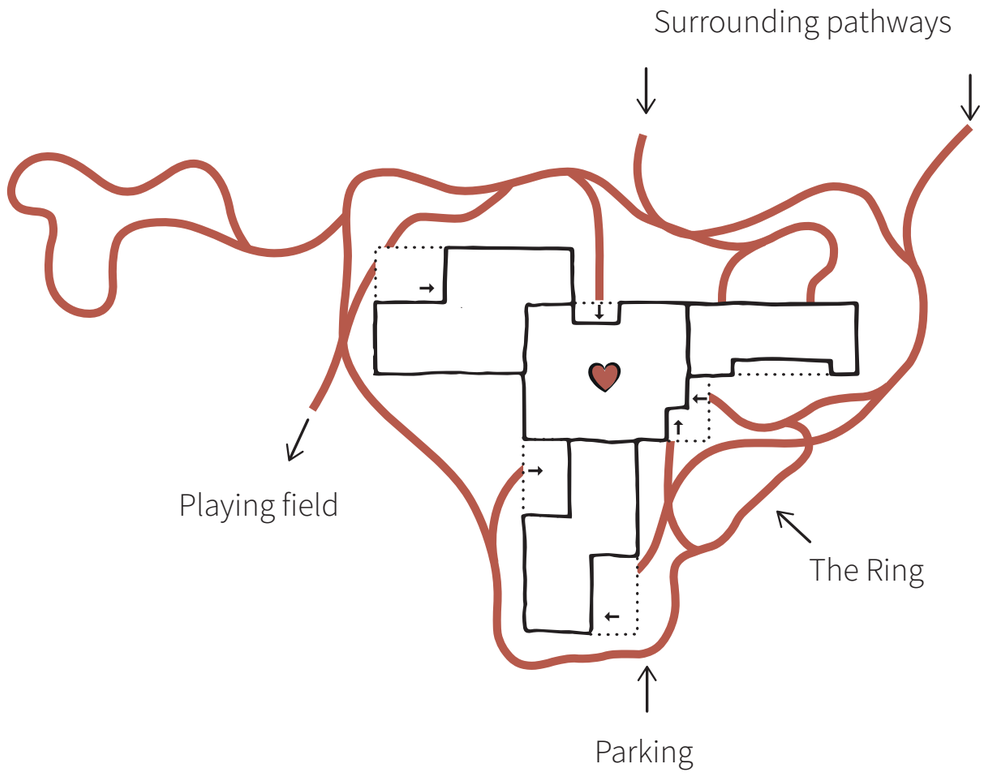
Ill:. 13 West elevation 1:500

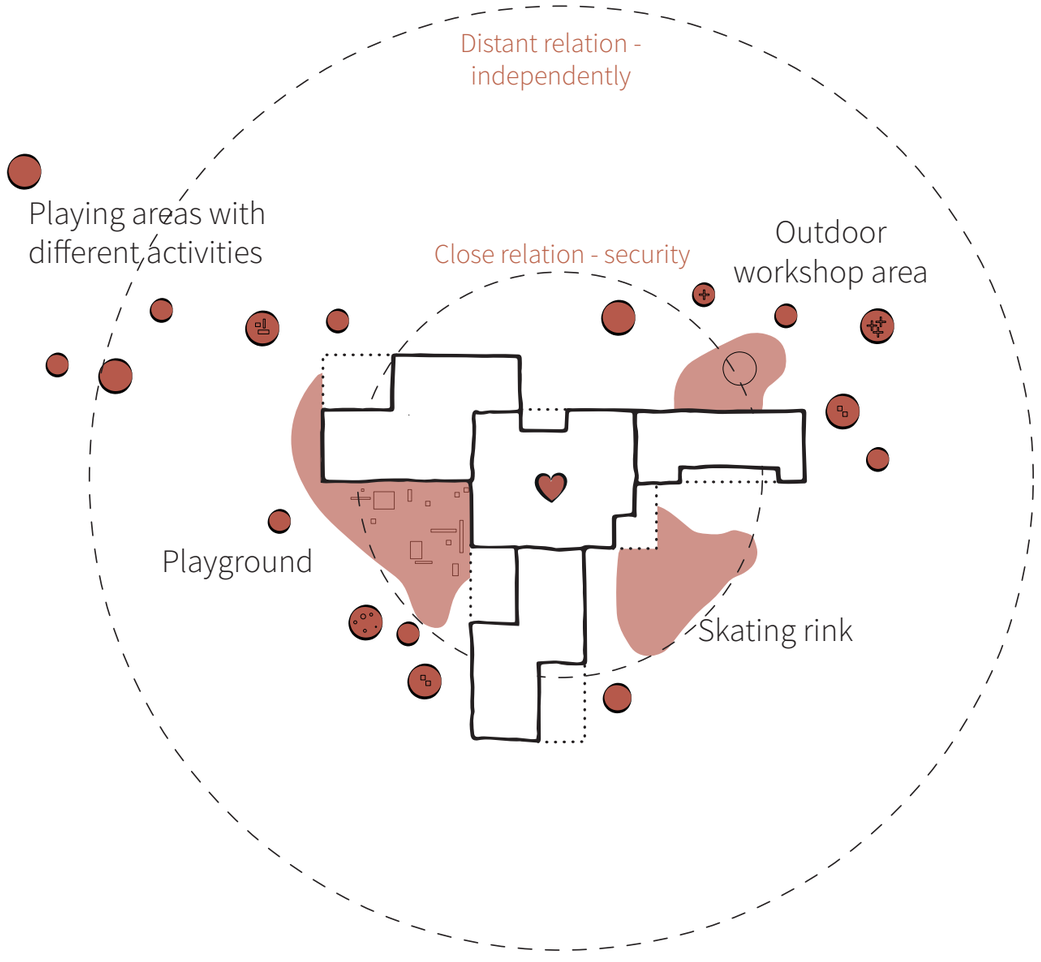
Ill:. 14 South elevation 1:500

THE LOOP OF MOVEMENT

The loop of movement is a particularly noticeable sign for the future school of NYE. The loop connects the surroundings and the site by encouraging pupils and visitors to be active and play (UN-Goal 3.3). Furthermore, the loop of movement connects different school facilities and encourages users to explore what the school offers. This ensures easy way-finding and navigation throughout the school (UN-Goal 3.4).

The loop of movement is an experience, where you experience nature and the surroundings from different sides, depending on your route on the loop of movement. Additionally, you meet various outdoor spaces that offer play, movement, stay, and learning.

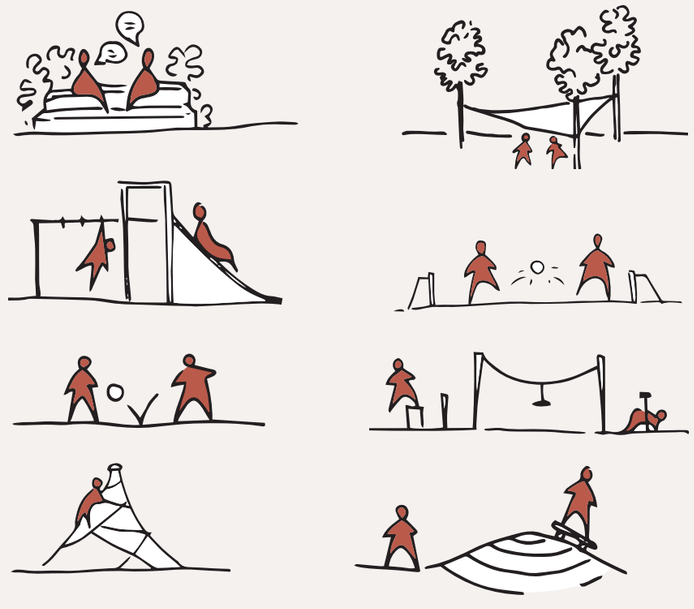




PROXIMITY

The future school of NYE does not have a traditional schoolyard. Instead, the outdoor spaces are separated into different zones with different proximity to the building. The playground aimed at the younger pupils is in the proximity of the building, supporting the security feeling.

The outdoor workshop area is in connection with the indoor facilities to ensure easy inclusion in lectures and promote outdoor schooling (UN-Goal 4.4). Furthermore, it is important to ensure the teacher has an easy overview of the pupils while working in the workshop area to prevent accidents. Around the building are located smaller zones with different facilities. These facilities are in further distance to the building as they are designed for the older pupils, who are more independent and dare to explore.



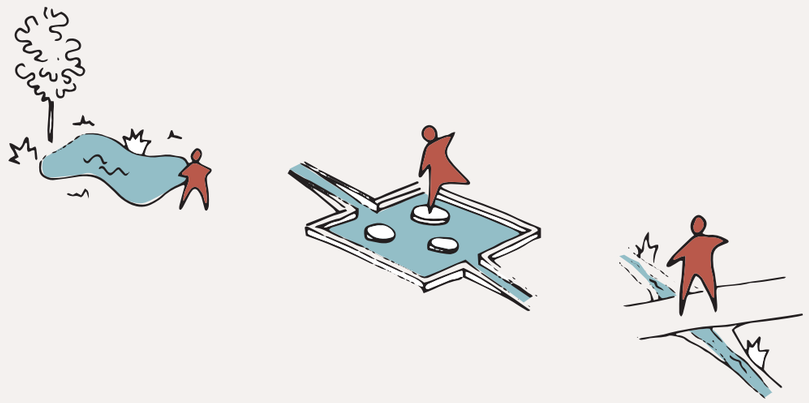
GREENERY

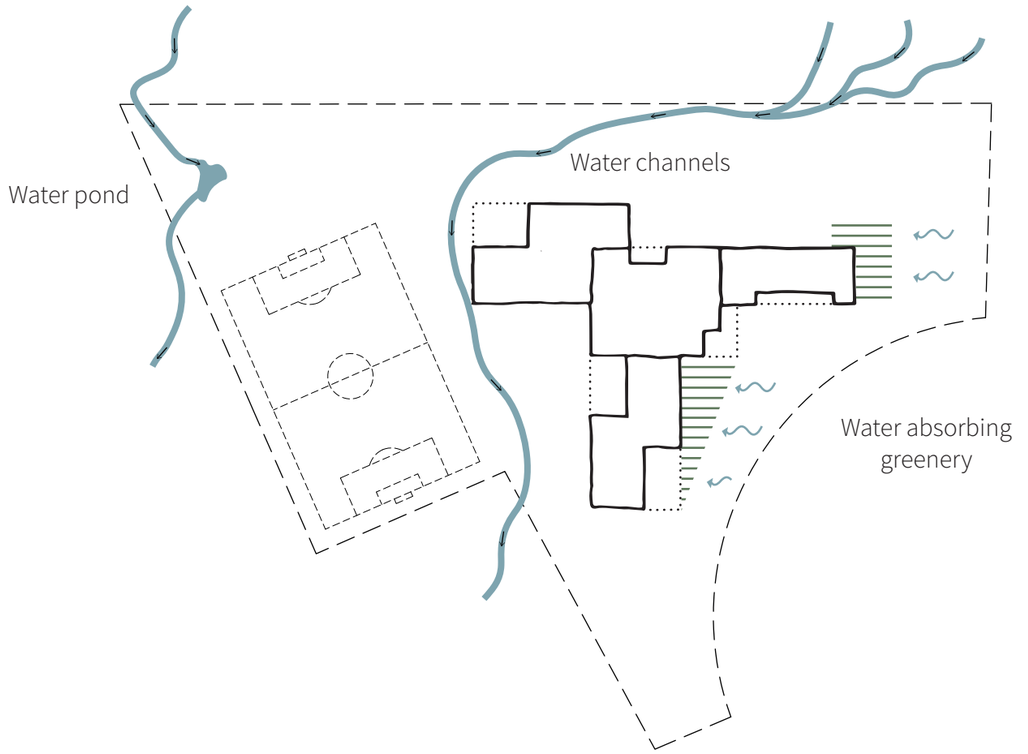
The existing site is defined by an open field in which the new site layout contrasts. Trees and greenery are established on the site to create a relationship with the nearby forest areas while delimiting specific zones such as parking, ball field, and the ring. In addition, several trees have been placed on the western part of the site to shield outdoor areas from the wind.

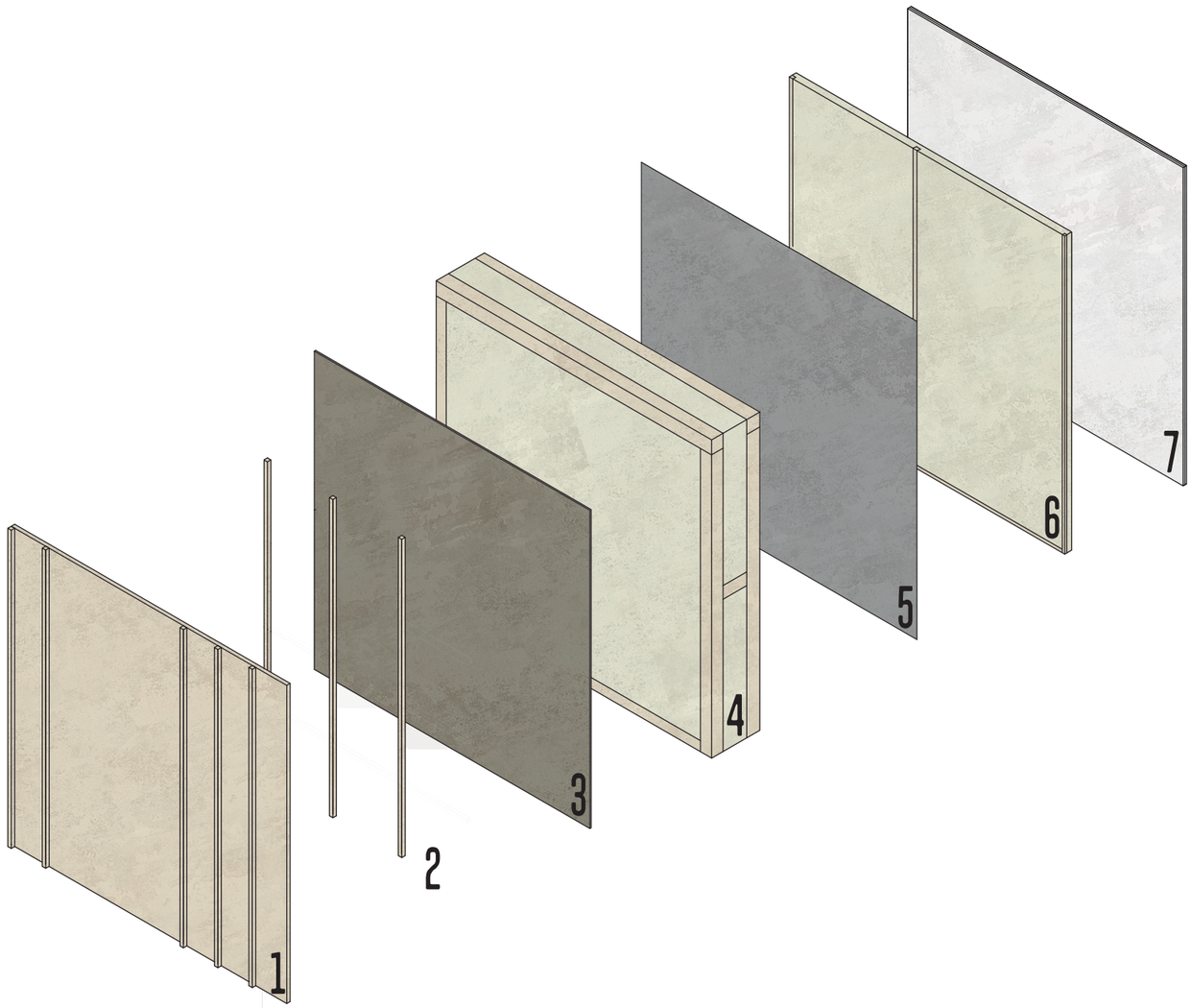
LOCAL WATER DIVERSION

Local water diversion is visible on the site to include it in the learning and play (UN-Goal 6.3). By establishing elements that invite students to integrate with the water, the water division can become a part of teaching as well as a natural part of play and activity. Besides being a play and learning element the diversion of the rainwater protects the building from heavy rain. Due to the location and inclination of the site, multiple natural water channels exist throughout the site. A new system has been designed to direct the rainwater away from the building. The new canals follow the terrain and end up in a stream south of the site (UN-Goal 6.2). Furthermore, a system towards the North-Western corner of the site redirects the water around the football field.

The rainwater channels towards the east are small where greenery can protect the building by absorbing the water. Furthermore, the building is designed with a sedum roof that collects rainwater (UN-Goal 6.1).







WALL STRUCTURE AND MATERIALS

The final wall construction is created with the LCA analysis, robustness, and atmosphere in mind. The facade cladding and system are chosen to unite the façades. The areas of the school have various functions, which cause the windows to be different to gain the right amount and quality of daylight. Therefore, the facade system gathers the expression of the building. The wood was chosen because of its signalling effect toward sustainability.

Interior the gypsum was chosen to highlight the details of the wood. The white gypsum walls embrace the view towards nature. By creating a simple setting, the details of wood and concrete are highlighted. The elements induce the difference in the areas of the school as the staircases, the large glass areas with nature views, and the warmth of the wooden elements.

The construction of the wall is additionally considered according to local materials (UN-Goal 11.4). Even though bricks were deselected because of their appearance, the wooden facade cladding still relates to the surroundings. The organic materials fit within nature and create a clear sustainable connection to the vision of NYE.

1 - 25 mm pine-wood boards with battens
2 - 50 x 50 mm batten and air
3 - 10 mm wind barrier
4 - 350 mm rock wool on construction wood
5 - 2 mm damp proofing
6 - 50 mm rock wool on battens
7 - 2 x 12.5 mm gypsum boards

LIFE CYCLE ANALYSIS

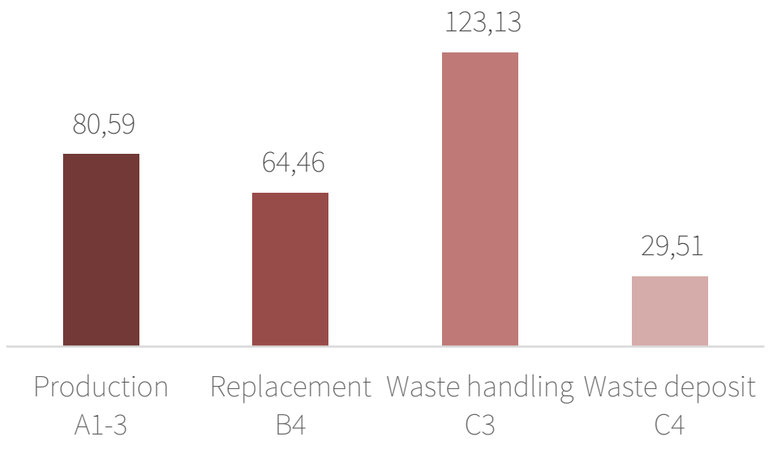
The life cycle analysis includes the main elements of the building: Foundation, exterior walls, and roofs. The total number within the circles indicates roughly the gasses released by the lifecycle of the materials for the building envelope. The life span of the building is 100 years.

The roofs are constructed with Rockwool in wooden construction, but have different roofing materials: Sedum roof, photovoltaic roof and steel.
The foundation is a concrete foundation.

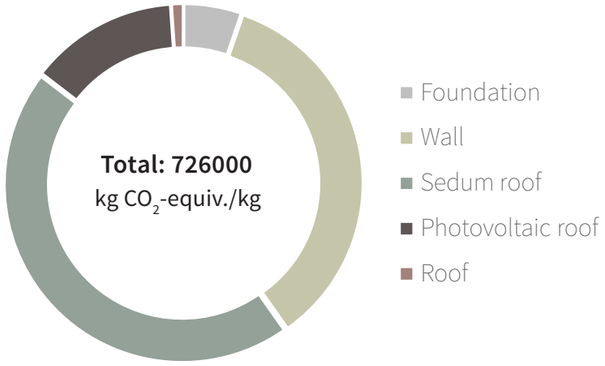
The results indicate a high emission of gasses when handling the waste of the materials. This is possible to lower when utilizing the materials for reused or recycling. Furthermore, the replacement of materials is high because of the solar cell roof, which requires replacements twice in the lifespan.

BUILDING PHASES

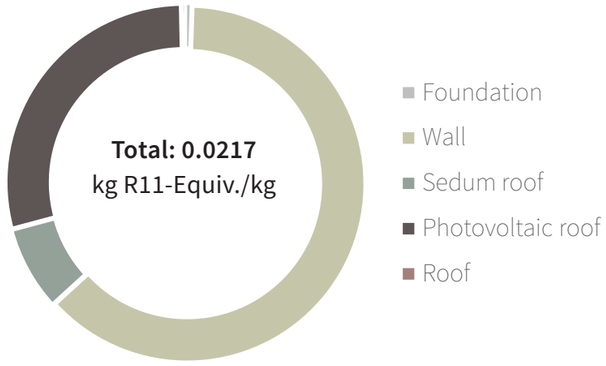
kg CO_2-eq.



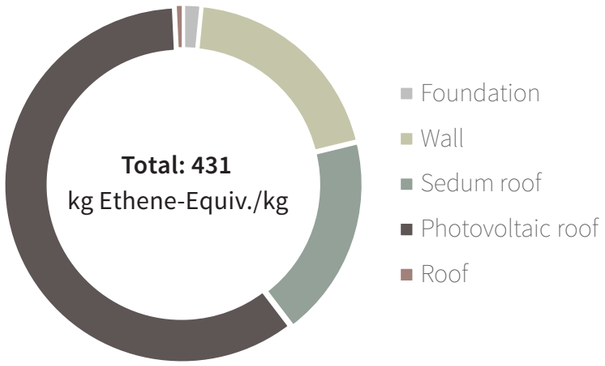
GWP



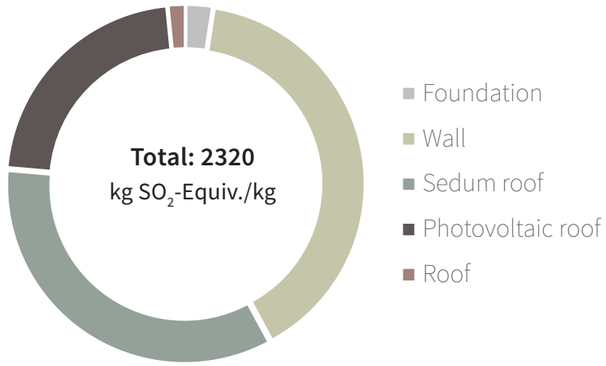
ODP



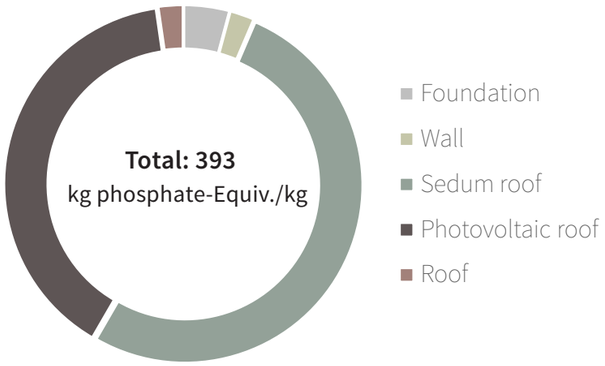
POCP



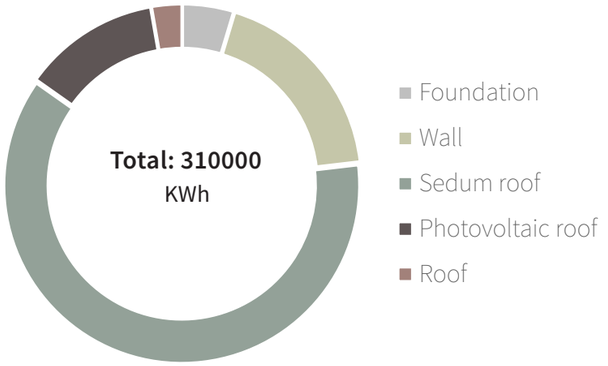
AP



EP



EMBODIED ENERGY

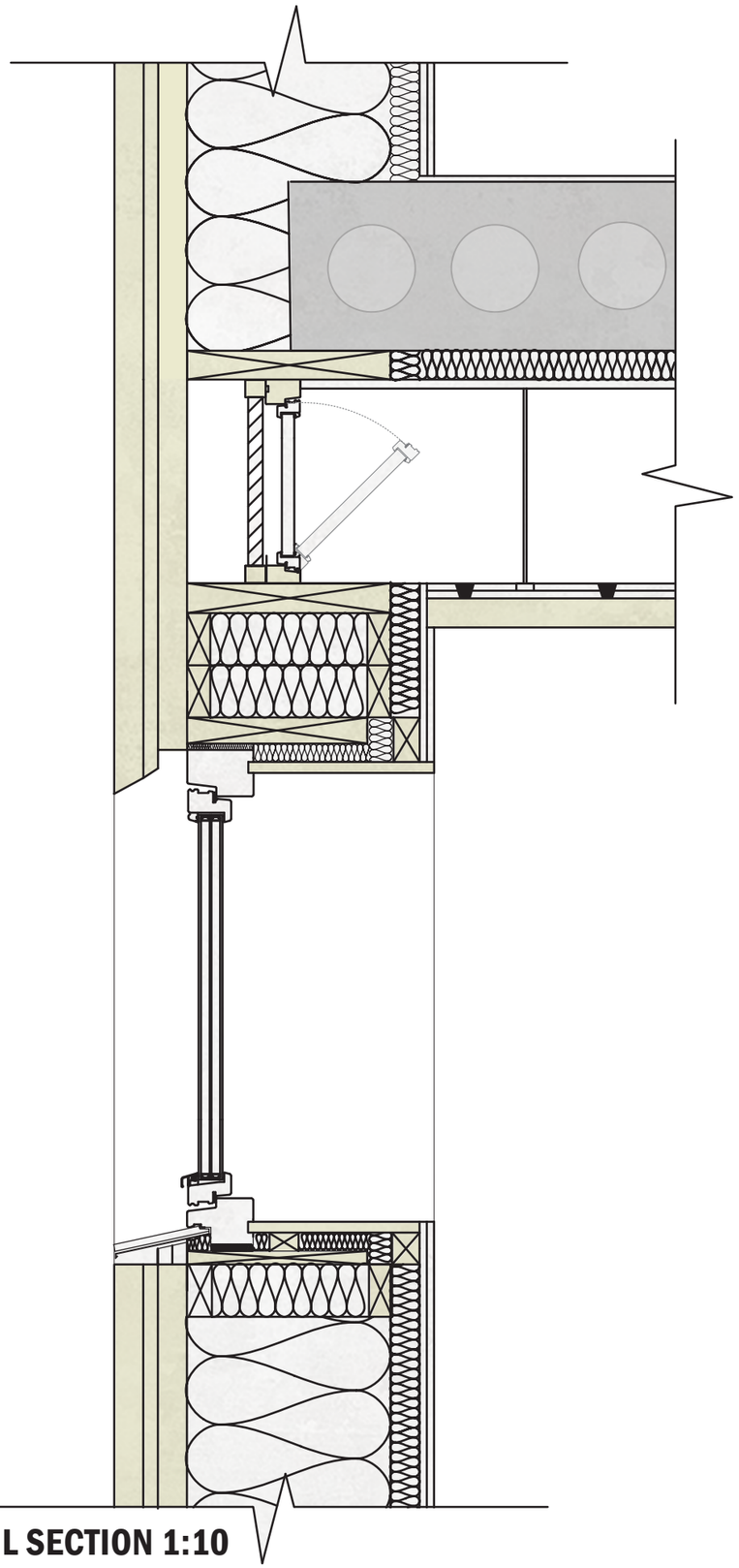


DETALJETEGNINGER + VÆGOPBYGNING

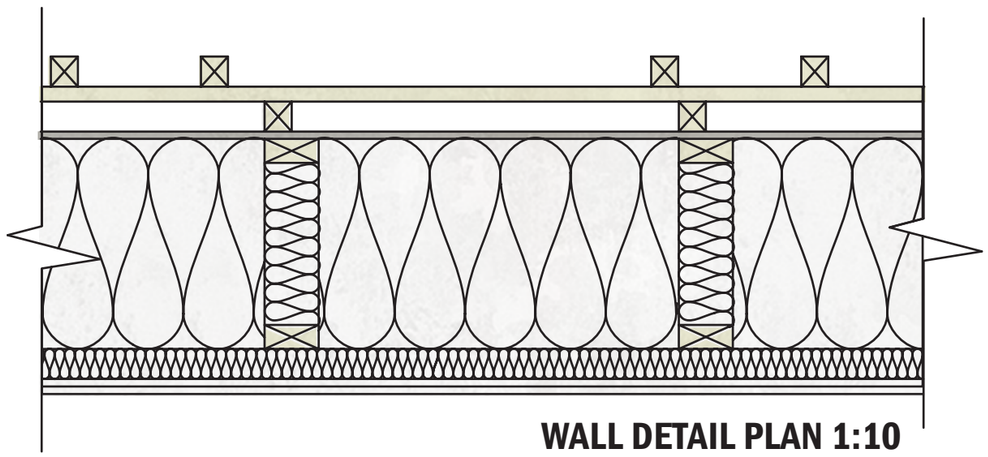
The detail section illustrates the detail of a window and wall connection in a base. The dimension of the window is 750 x 750 mm.

The final building envelope is designed regarding energy consumption (UN-Goal 11.3). The properties of the envelope ensure an overall low u-value of the individual parts. Furthermore, the floor slab is a hollow concrete slab used because of its strength, thermal mass properties, and materials saving properties.

Additionally, the diffuse ceiling is a strategy to ensure natural ventilation in the classroom during the summer and works as a passive solution. The air for the diffuse ceiling will enter behind the facade board in the air gap between battens, where the mechanical extraction will allow the air to enter the classroom.



DETAIL SECTION 1:10



WALL DETAIL PLAN 1:10

CONCLUSION

With departure in the tender documents from Aarhus Municipality, a design proposal for the future school of NYE is created. With the UN-Goals as a main part of the design, the future school of NYE is designed to be socially and environmentally sustainable. The building reach the requirements for a low energy building of 33 kWh/m² pr. year.

Energy Consumption	Without renewable energy	With 925 m² solar cells
Energy Requirement	36,5 kWh/m² pr. year	11,5 kWh/m² pr. year

The setting of the school is beneficial for the learning and well-being of the pupils. The bases are designed to embrace alternative learning, with the indoor environment as a focus. Further, learning spaces and environments are designed with nature views and are connected to the center of the building, the common space. Other facilities within the building invite the local community to utilize the building after school hours. Thereby the school becomes a gathering point of the locals in the surroundings of Elev and NYE.

The building respects the unique location surrounded by nature and the surrounding cities, Elev and NYE. The large volume relates to the landscapes but still becomes a landmark with its peak point. The wooden façade, green roof, and solar cells embrace the expression of sustainability to not only be a setting for education but an educational setting.

The future school of NYE is a sustainable and educational gathering point.

REFLECTION

The size of the project.
The size of the project surprised us because the design of a school is a complex matter. This caused us to leave parts of the building with a lower detail level. The need for selection and deselection caused us to compromise to get to the final design, and the areas that had not been a design focus became clear and left with a lower detail level.

An additional challenge was to select the focus points because of the size of the project. The holistic and integrated design approach learned through our education though us to consider the whole building at once. Therefore, the form of the building and the plan layout was essential to design a united building. On the opposite, dividing the building into zones because of the size was necessary to get an overview and a starting point for the plan layout. When designing the plan layout, the room program and the function diagrams were essential to maintain an overview. The early choice of a concept and initial form helped us moving forward and creating a plan layout.

The tender documents.
We have had access to the tender documents for the competition of the future school of NYE throughout the project. The tender documents have been a big help and guidance, but they became a challenge. All the extra knowledge forced us to consider the design differently. We create this project as a master thesis and not a real-life competition.

Furthermore, we needed to relate and further investigate the statements of the tender documents and wishes as our own. Some of the wishes became a hindrance for the project and limited the design because they conflicted, which required us to reconsider the importance of the individual wishes. On the opposite, this forced us to make this project our own by responding critically to the tender documents.

The intersection between architecture and engineering.
When designing a building the goal is a building with a high architectural value and sustainable profile. A building with a low environmental impact. When acting as both the architect and the engineer, it is hard to decide according to professional competency. It can be a dilemma to choose a insufficient architectural design when having knowlegde about the indoor environment, sustainability, and energy consumption. Even though the integrated design process engages sustainable solutions and architectural quality compromises are still needed. Hopefully, when finding the challenges early the compromises can add value in both areas.

Evidence-based and research-based knowledge.
As a point of departure, we wanted to use evidence-based and research-based knowledge to gather knowledge about the users. We knew it was impossible to create an evidence-based design because our design process would lack multiple phases in the evidence process. It was challenging to find evidence regarding the subjects wanted in the project. The reason could be that children are hard to investigate because of their age. Therefore, a high amount of research-based knowledge is applied to understand the children and their needs and wishes. Optimal, we would have collected some evidence ourselves, but due to Covid 19. the number of school visits where limited.

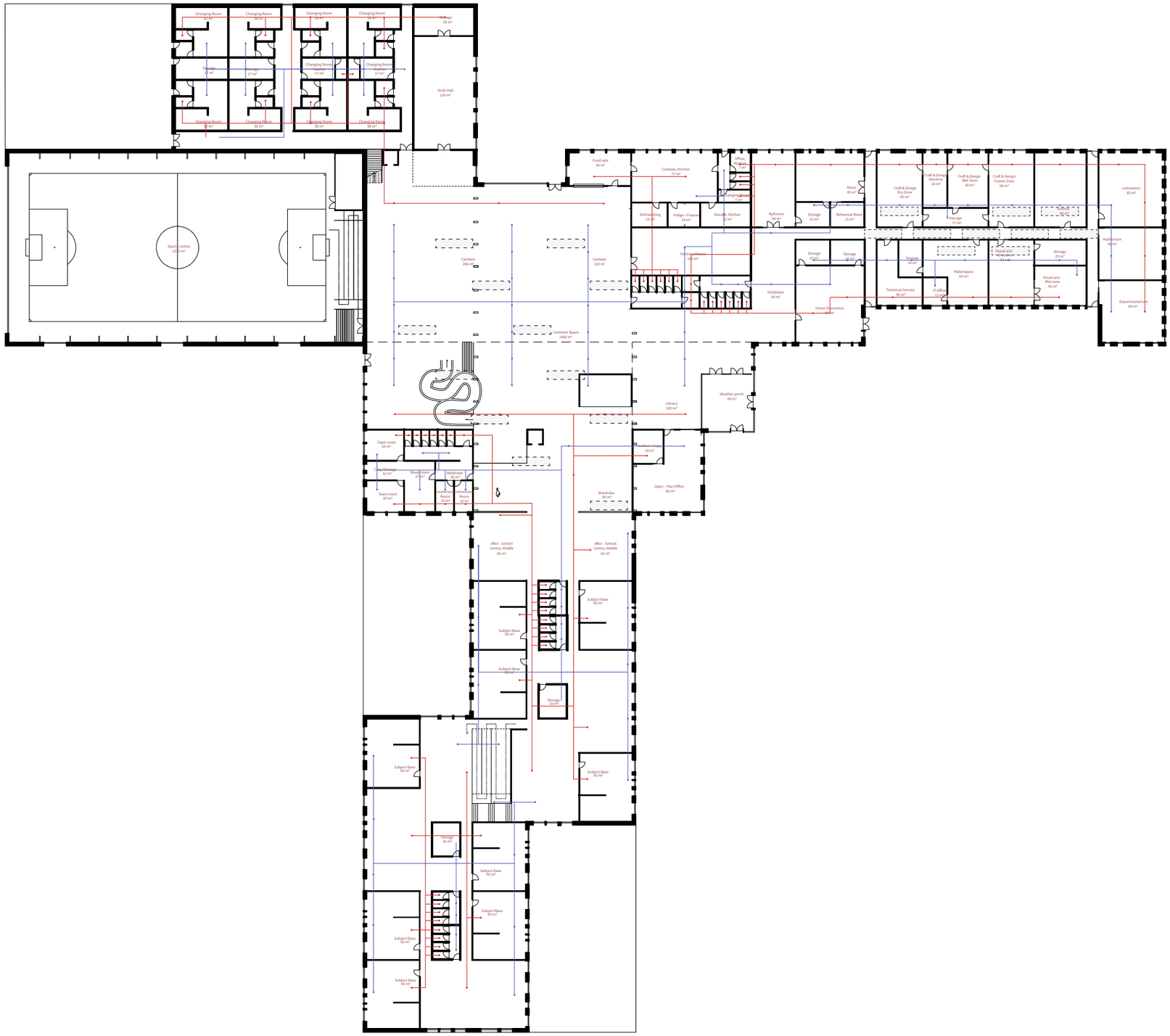
Designing with UN-Goals
As a new approach, we have tried to work with the UN-Goals as a method. In past projects, DGNB was implemented, which caused architectural quality to be second of importance because it is easier to relate to something measurable. We learned that it is hard to create a method with goals that are not measurable. There are no recipes for good architecture because there is attached importance to subjective opinions. While we reach the purpose with the UN-Goals through this project, further work is necessary for others to use this method.

The problematics of creating architectural goals for each of the UN-Goals will probably be found when working with all the UN-goals. Furthermore, the question regarding the use of the method will arise. Will architects and engineers use a method not rewarded with a certificate?

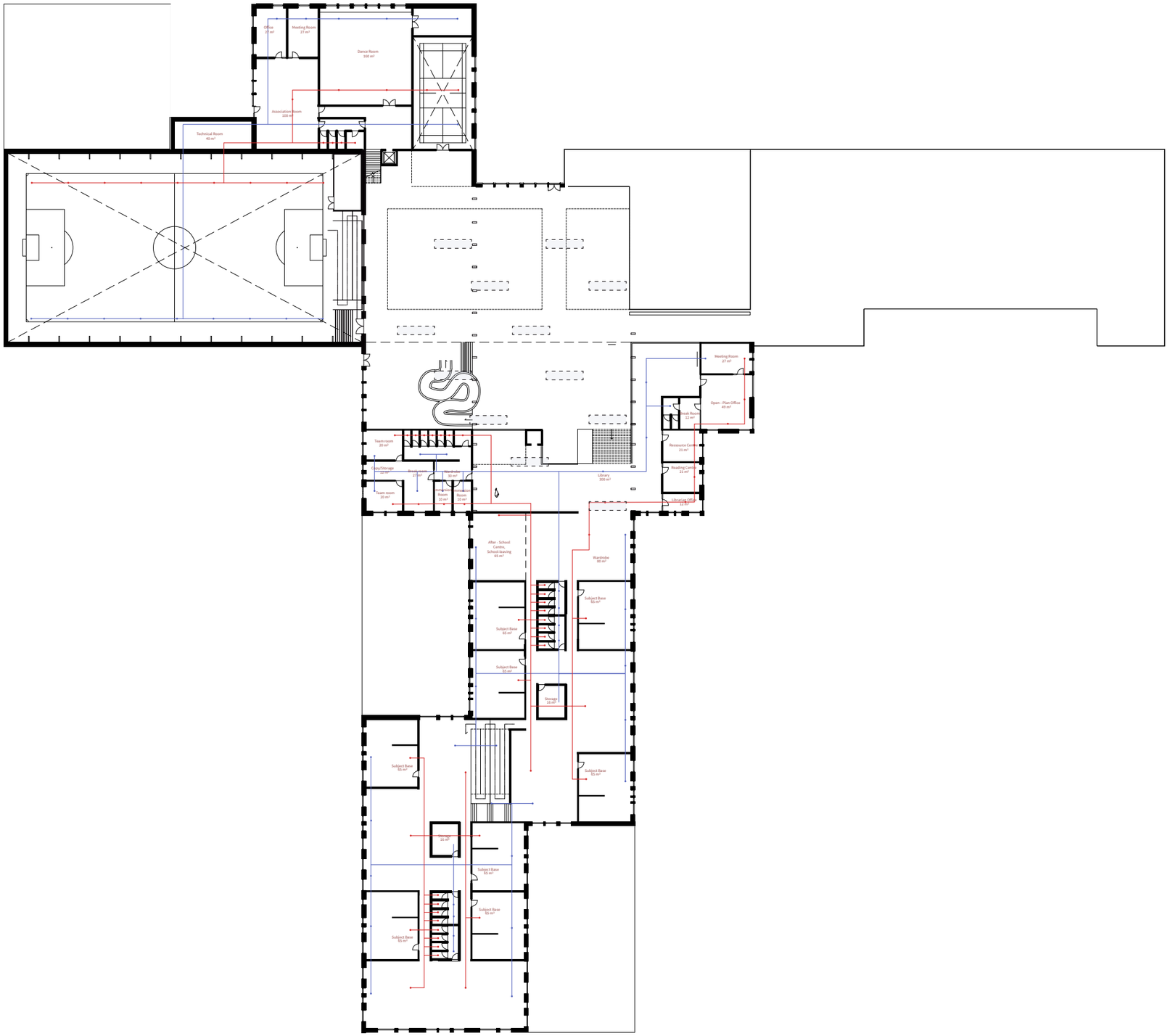
Sustainable materials
The wish for implementing sustainable materials in the projects led to multiple considerations. Various elements influence the building, which became clear to us during the project. We discovered that even though the material appears sustainable, its lifecycle might prove otherwise. Organic materials are often more sustainable than inorganic materials, but they have a short documented life span. Therefore, when buildings need a long life span, the inorganic materials are sustainable to use instead of having negative environmental impact caused by replacing materials. The amount and life span of the materials also influenced the life cycle assessment. Added to that, considerations regarding qualities of the materials such as diffusion, appearance, and contrast influence the choice. An additional aspect was that we designed a school, which requires strong and robust materials with low maintenance. Therefore, the whole discussion regarding organic materials which need more replacements vs. strong inorganic materials ended up in a mix of organic and inorganic materials for the building.

APPENDIX, PRESENTATION

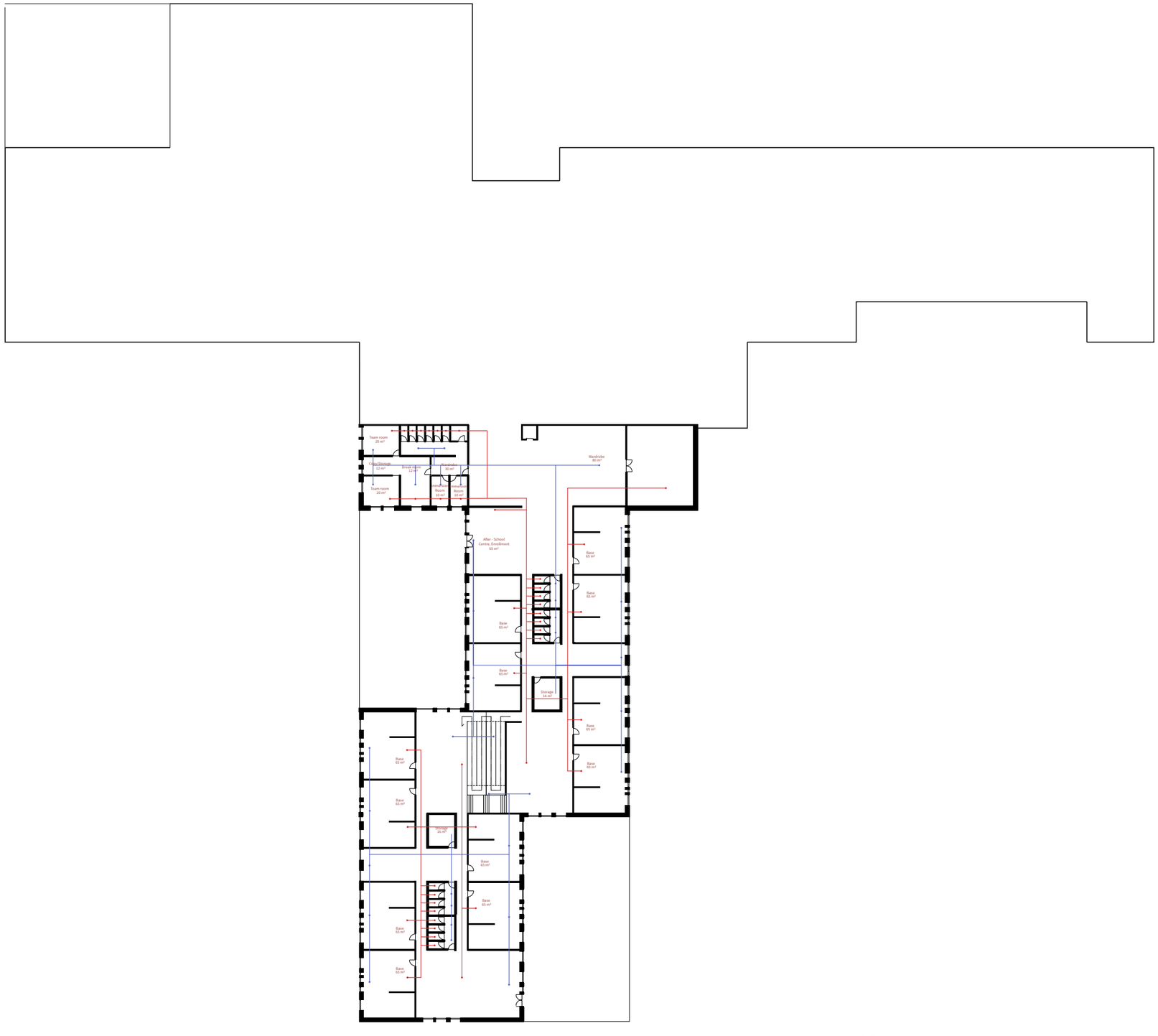
APPENDIX 1 - VENTILATION, LEVEL 0



APPENDIX 2 - VENTILATION, LEVEL 1



APPENDIX 3 - VENTILATION, LEVEL - 1



APPENDIX 3 - BE18

This appendix showcases the input in BE18, these numbers are based on Bsim, calculations and estimations.

Building

Name: New Building

Other — Detached house (detached single-family house) / Semi-detached and nondetached houses / Multi-storey house, Store etc or Other (non-residential)

1	Number of residential units	7,85	Rotation, deg.
12180	Heated floor area, m²	12180	Gross area, m²
0	Heated basement, m²	0	Other, m²
7511	Developed area, m²		
60	Heat capacity, Wh/K m²	Start at	End at (time)
45	Normal usage time, hours/week	8	17

Heat supply

District h — Basis: Boiler, District heating, Block heating or Electricity

Heat distribution plant (if electric heating)

Contribution from (in order of priority)

☐ 1. Electric panels ☐ 2. Wood stoves, gas radiators etc.
☐ 3. Solar heat ☐ 4. Heat pump ☑ 5. Solar cells ☐ 6. Wind mills

Total heat loss

Transmission loss 92,0 kW 7,6 W/m²
Ventilation loss without HRV 583,0 kW 47,9 W/m² (in winter)
Total 675,0 kW 55,4 W/m²
Ventilation loss with HRV 87,5 kW 7,2 W/m² (in winter)
Total 179,4 kW 14,7 W/m²

Ill:. 15 Be18, "New building tab"

	External walls, roofs and floors	Area (m²)	U (W/m²K)	b	Ht (W/K)	Dim.Inside (C)	Dim.Outside ((	Loss (W)
		19737		CtrlClick	1774,89			56796,5
1	Ydervægge	4571	0,09	1,00	411,39			13164,5
2	Tag	7655	0,08	1,00	612,4			19596,8
3	Terræmdæk	7511	0,1	1,00	751,1			24035,2

Ill:. 16 Be18, "External walls, roofs and floors tab"

	Foundations and joints at windows	l (m)	Loss (W/mK)	b	Ht (W/K)	Dim.Inside (C)	Dim.Outside ((	Loss (W)
		4148,8		CtrlClick	124,464			3982,85
1	Samlet linjetab, vinduer	2287	0,03	1,00	68,61			2195,52
2	Fundament	631,8	0,03	1,00	18,954			606,528
3	tag	930	0,03	1,00	27,9			892,8
4	dør	300	0,03	1,00	9			288

Ill:. 17 Be18, "Foundations and joints at windows tab"

	Windows and outer doors	Number	Orient	Inclination	Area (m²)	U (W/m²K)	b	Ht (W/K)	Ff (-)	g (-)	Shading	Fc (-)	Dim.Inside	Dim.Outsic	Loss (W)	Ext
		209			336,805		CtrlClick	269,444			CtrlClick				8622,21	0/1
+1	type 1	16	e	90	1,125	0,8	1,00	14,4	0,7	0,63	Lam skygg	0,8			460,8	0
2	2	22	e	90	3	0,8	1,00	52,8	0,7	0,63	Lam skygg	0,8			1689,6	0
3	3	7	e	90	2,25	0,8	1,00	12,6	0,7	0,63	Lam skygg	0,8			403,2	0
4	4	28	e	90	0,56	0,8	1,00	12,544	0,7	0,63	Lam skygg	0,8			401,408	0
5	5	14	e	90	2	0,8	1,00	22,4	0,7	0,63	Syd vindu	0,8			716,8	0
6	6	13	e	90	0,25	0,8	1,00	2,6	0,7	0,63	Lam skygg	0,8			83,2	0
7	7	36	e	90	1,5	0,8	1,00	43,2	0,7	0,63	Lam skygg	0,8			1382,4	0
8	8	19	e	90	1,125	0,8	1,00	17,1	0,7	0,63	Lam skygg	0,8			547,2	0
9	9	5	e	90	4,5	0,8	1,00	18	0,7	0,53	Lam skygg	1			576	0
10	10	3	e	90	2,25	0,8	1,00	5,4	0,7	0,63	Lam skygg	1			172,8	0
11	11	22	e	90	1,5	0,8	1,00	26,4	0,7	0,63	Lam skygg	0,8			844,8	0
12	12	2	e	90	2,25	0,8	1,00	3,6	0,7	0,63	Lam skygg	0,8			115,2	0
13	13	2	e	90	1,5	0,8	1,00	2,4	0,7	0,63	Lam skygg	1			76,8	0
14	14	20	e	90	2,25	0,8	1,00	36	0,7	0,63	Syd vindu	1			1152	0

Ill:. 18 Be18, "Windows and outer doors tab 1"

	Windows and outer doors	Number	Orient	Inclination	Area (m²)	U (W/m²K)	b	Ht (W/K)	Ff (-)	g (-)	Shading	Fc (-)	Dim.Inside	Dim.Outsic	Loss (W)	Ext
		144			302,31		CtrlClick	241,848			CtrlClick				7739,14	0/1
1	Type 1	16	w	90	1,125	0,8	1,00	14,4	0,7	0,63	Lam skygg	0,8			460,8	0
2	2	22	w	90	3	0,8	1,00	52,8	0,7	0,63	Lam skygg	0,8			1689,6	0
3	3	1	w	90	2,25	0,8	1,00	1,8	0,7	0,63	Lam skygg	0,8			57,6	0
4	4	28	w	90	0,56	0,8	1,00	12,544	0,7	0,63	Lam skygg	0,8			401,408	0
5	5	13	w	90	0,25	0,8	1,00	2,6	0,7	0,63	Lam skygg	0,8			83,2	0
6	6	14	w	90	2	0,8	1,00	22,4	0,7	0,63	Syd vindu	0,8			716,8	0
7	7	36	w	90	1,5	0,8	1,00	43,2	0,7	0,63	Lam skygg	0,8			1382,4	0
8	8	10	w	90	0,94	0,8	1,00	7,52	0,7	0,63	forening v	1			240,64	0
9	9	2	w	90	1,5	0,8	1,00	2,4	0,7	0,63	forening v	1			76,8	0
10	10	4	w	90	4,5	0,8	1,00	14,4	0,7	0,63	Lam skygg	0,7			460,8	0
11	11	12	w	90	4,5	0,8	1,00	43,2	0,7	0,63	commonro	1			1382,4	0
12	12	16	w	90	1,5	0,8	1,00	19,2	0,7	0,63	Lam skygg	0,8			614,4	0
13	13	2	w	90	0,56	0,8	1,00	0,896	0,7	0,63	Lam skygg	0,8			28,672	0
14	14	2	w	90	0,75	0,8	1,00	1,2	0,7	0,63	Lam skygg	0,8			38,4	0
15	15	2	w	90	0,93	0,8	1,00	1,488	0,7	0,63	Lam skygg	0,8			47,616	0
16	16	2	w	90	1,125	0,8	1,00	1,8	0,7	0,63	Lam skygg	0,8			57,6	0

Ill:. 19 Be18, "Windows and outer doors tab 2"

	Shading	Horizon (°)	Eaves (°)	Left (°)	Right (°)	Window opening (%)
+1	Default	15	0	0	0	10
2	Syd vinduer	0	0	8	8	60
3	Lam skygge	0	0	8	8	10
4	Skygge indhap lærer	13	0	8	75	60
5	skygge indhap skole	0	0	75	8	60
6	workshop syd	0	0	20	20	60
7	commonroom vest	0	0	75	8	10
8	forening vest	0	0	8	67	10

Ill:. 23 Be18, "Shading tab"

	Windows and outer doors	Number	Orient	Inclination	Area (m²)	U (W/m²K)	b	Ht (W/K)	Ff (-)	g (-)	Shading	Fc (-)	Dim.Inside	Dim.Outsic	Loss (W)	Ext
		144			235,13		CtrlClick	188,104			CtrlClick				6019,33	0/1
+1	Type 1	16	s	90	1,13	0,8	1,00	14,464	0,7	0,63	Syd vindu	0,8			462,848	0
2	2	12	s	90	1,87	0,8	1,00	17,952	0,7	0,63	Syd vindu	0,8			574,464	0
3	3	6	s	90	1,125	0,8	1,00	5,4	0,7	0,63	skygge inc	0,8			172,8	0
4	4	12	s	90	1,5	0,8	1,00	14,4	0,7	0,63	skygge inc	0,8			460,8	0
5	5	3	s	90	1,5	0,8	1,00	3,6	0,7	0,63	Syd vindu	1			115,2	0
6	6	16	s	90	1,125	0,8	1,00	14,4	0,7	0,63	Syd vindu	1			460,8	0
7	7	2	s	90	2,25	0,8	1,00	3,6	0,7	0,63	Syd vindu	1			115,2	0
8	8	4	s	90	4,5	0,8	1,00	14,4	0,7	0,53	Syd vindu	1			460,8	0
9	9	5	s	90	2,25	0,8	1,00	9	0,7	0,63	Syd vindu	1			288	0
10	10	30	s	90	1,125	0,8	1,00	27	0,7	0,63	workshop	0,8			864	0
11	11	8	s	90	4,5	0,8	1,00	28,8	0,7	0,63	Syd vindu	0,7			921,6	0
12	12	24	s	90	1,5	0,8	1,00	28,8	0,7	0,63	Skygge inc	1			921,6	0
13	13	6	s	90	1,31	0,8	1,00	6,288	0,7	0,63	Skygge inc	1			201,216	0

Ill:. 20 Be18, "Windows and outer doors tab 3"

	Windows and outer doors	Number	Orient	Inclination	Area (m²)	U (W/m²K)	b	Ht (W/K)	Ff (-)	g (-)	Shading	Fc (-)	Dim.Inside	Dim.Outsic	Loss (W)	Ext
		119			262,845		CtrlClick	210,276			CtrlClick				6728,83	0/1
+1	type 1	6	n	90	1,125	0,8	1,00	5,4	0,7	0,63	Lam skygg	0,8			172,8	0
2	2	12	n	90	1,5	0,8	1,00	14,4	0,7	0,63	Lam skygg	0,8			460,8	0
3	3	4	n	90	0,93	0,8	1,00	2,976	0,7	0,63	Lam skygg	0,8			95,232	0
4	4	12	n	90	1,5	0,8	1,00	14,4	0,7	0,63	Lam skygg	0,8			460,8	0
5	5	2	n	90	3	0,8	1,00	4,8	0,7	0,63	Lam skygg	0,8			153,6	0
6	6	24	n	90	4,5	0,8	1,00	86,4	0,7	0,63	Lam skygg	1			2764,8	0
7	7	4	n	90	4,5	0,8	1,00	14,4	0,7	0,63	Lam skygg	1			460,8	0
8	8	6	n	90	3	0,8	1,00	14,4	0,7	0,63	Lam skygg	1			460,8	0
9	9	20	n	90	1,125	0,8	1,00	18	0,7	0,63	Lam skygg	0,8			576	0
10	10	24	n	90	1,125	0,8	1,00	21,6	0,7	0,63	Lam skygg	0,8			691,2	0
11	11	5	n	90	3,375	0,8	1,00	13,5	0,7	0,63	Lam skygg	0,8			432	0
12		0		0	0	0	1,00	0	0	0,63	Lam skygg	0			0	0
13		0		0	0	0	1,00	0	0	0,63	Lam skygg	0			0	0
14		0		0	0	0	1,00	0	0	0,63	Lam skygg	0			0	0

Ill:. 21 Be18, "Windows and outer doors tab 4"

	Windows and outer doors	Number	Orient	Inclination	Area (m²)	U (W/m²K)	b	Ht (W/K)	Ff (-)	g (-)	Shading	Fc (-)	Dim.Inside	Dim.Outsic	Loss (W)	Ext
		41			141,15		CtrlClick	74,49			CtrlClick				2383,68	0/1
1	Ovenlys	23	n	7	3,75	0,8	1,00	69	0,7	0,63		1			2208	0
2	Døre	10	n	90	1,89	0,1	1,00	1,89	0,7	0,63		1			60,48	0
3	Døre	8	ø	90	4,5	0,1	1,00	3,6	0,7	0,63		1			115,2	0

Ill:. 22 Be18, "Windows and outer doors tab 5"

	Ventilation	Area (m²)	Fo. -	qm (l/s m²)	n vgv (-)	b (°C)	El-HC	qn (l/s m²)	qi,n (l/s m²)	SEL (kJ/m³)	qm,s (l/s m²)	qn,s (l/s m²)
	Zone	5536,7		Winter			0/1	Winter	Winter		Summer	Summer
1	Klasselokaler (IKKE workshop)	1885	0,8	5,23	0,85	18	0	0	0,13	1,8	2	6,6
2	Workshopslokaler	771	0,5	5,23	0,85	18	0	0	0,13	1,8	2	6,6
3	Toiletter	350	0,1	4	0,85	18	0	0	0,13	1,8	4	0
4	omklædning	512	0,2	4	0,85	18	0	0	0,13	1,8	4	0
5	Køkken	191	0,3	2,2	0,85	18	0	0	0,13	1,8	2,2	2
6	Haller	1435	0,5	2	0,85	18	0	0	0,13	1,8	0	6,6
7	Kantine	404	0,2	0,5	0,85	18	0	0	0,13	1,8	0,5	4
8	Mødelokaler	534	0,3	2,75	0,85	18	0	0	0,13	1,8	0	4
9	Depot	456	0,1	0,5	0,85	18	0	0	0,13	1,8	0,5	0
10	Bibliotek	300	0,3	1,2	0,85	18	0	0	0,13	1,8	1,2	2
11	Forening	156	0,2	3,5	0,85	18	0	0	0,13	1,8	0	4,5
12	Projektflade + gang	2904	0,8	1	0,85	18	0	0	0,13	1,8	3	4

Ill:. 24 Be18, "Ventilation tab"

	Ventilation	Area (m²)	Fo. -	qm (l/s m²)	n vgv (-)	b (°C)	El-HC	qn (l/s m²)	qi,n (l/s m²)	SEL (kJ/m³)	qm,s (l/s m²)	qn,s (l/s m²)
	Zone	5536,7		Winter			0/1	Winter	Winter		Summer	Summer
1	Klasselokaler (IKKE workshop)	1885	0,8	5,23	0,85	18	0	0	0,13	1,8	2	6,6
2	Workshopslokaler	771	0,5	5,23	0,85	18	0	0	0,13	1,8	2	6,6
3	Toiletter	350	0,1	4	0,85	18	0	0	0,13	1,8	4	0
4	omklædning	512	0,2	4	0,85	18	0	0	0,13	1,8	4	0
5	Køkken	191	0,3	2,2	0,85	18	0	0	0,13	1,8	2,2	2
6	Haller	1435	0,5	2	0,85	18	0	0	0,13	1,8	0	6,6
7	Kantine	404	0,2	0,5	0,85	18	0	0	0,13	1,8	0,5	4
8	Mødelokaler	534	0,3	2,75	0,85	18	0	0	0,13	1,8	0	4
9	Depot	456	0,1	0,5	0,85	18	0	0	0,13	1,8	0,5	0
10	Bibliotek	300	0,3	1,2	0,85	18	0	0	0,13	1,8	1,2	2
11	Forening	156	0,2	3,5	0,85	18	0	0	0,13	1,8	0	4,5
12	Projektflade + gang	2904	0,8	1	0,85	18	0	0	0,13	1,8	3	4

Ill:. 25 Be18, "Ventilation tab"

	Internal heat supply	Area (m²)	Persons (W/m²)	App. (W/m²)
	Zone	12180,0	48720,0 W	36540,0 W
1	Internt varmetilskud, hele bygningen	12180	4	3

Ill:. 26 Be18, "Internal heat supply tab"

	Lighting	Area (m²)	General (W/	General (W/	Lighting (lux	DF (%)	Control (U, M, A	Fo (-)	Work (W/m²)
	Lighting zone	12180	Min.	Inst.			U,M,A,K		
1	Undervisningszoner	3086	2	6	300	3	M	0,8	1
2	Hal	1435	2	6	300	3	A	0,5	0
3	Omklædning	338	2	4	200	0	A	0,3	0
4	Kerner	678	0	0	0	0	A	0,1	0
5	Køkken	191	2	6	300	3	A	0,3	1
6	Gang, grupperum, mødelokaler, fællesrum	6452	2	4	100	3	A	0,2	0

Ill:. 27 Be18, "Lighting tab"

Heat distribution plant

Composition and temperature

Description	Dimensioning	
	70	Supply pipe temperature, °C (at outdoor temp. of -12 °C)
	35	Return pipe temperature, °C
Anlægstype	2	Type of plant: 1: unified or 2: dual

Ill:. 28 Be18, "Heat distribution plant tab"

	Pipe lengths in supply and return	l (m)	Loss (W/mK)	b
		300		
1	Fremlæb	200	0,027	1
2	Tilbage løb	100	0,027	1

Ill:. 29 Be18, "Heating pipes tab"

Description: Varmt brugsvand

Hot-water consumption (water 55 °C, cold water 10 °C)

100 — Average for the building, litre/year per m² of floor area

Domestic hot water system

55 — Domestic hot water temp., °C

Add an hot-water tank by right-click on Domestic hot water at the left

Ill:. 30 Be18, "Domestic hot water tab"

	Pipe lengths in supply and return	l (m)	Loss (W/mK)	b
		250		
+1	Fremløb	200	0,027	1
2	Tilbageløb	50	0,027	1

Ill:. 32 Be18, "Heat loss tab"

Hot-water tank

Description: Ny varmtvandsbeholder

2	Number of tanks	0,8	Part of hot-water consumption, -
150	Tank volume, litre (For solar heating containers, state total volume)		
65	Supply temperature from central heating, °C		
Nej	El. heating of DHW (If 'No' the boiler operates in summer)		
☑	Solar heat tank with back-up power (Correction for temp.layering)		
0,05	Heat loss from hot-water tank, W/K		
0	Temp. factor, b for setup room, - (Heated zone: b = 0, Outdoor: b = 1)		

Charging pump

For combi-pump, state effect as 0 W — Effect, W: 0 — ☐ Controlled — Charge effect, kW: 0

Ill:. 31 Be18, "Hot water tank tab"

Description: Nyt solcelle anlæg

Solar cells

925	Panel areal, m²
0,2	Peak Power (RS), kW/m²
0,75	System efficiency (Rp), -

Orientation and shadows

s	Orientation, S, SE, E, ...		
15	Slope, °, 0, 10, 20, 30, ...		
0	Horizon cutoff, °		
0	Left shadow, °	0	Right shadow, °

Ill:. 33 Be18, "Solar cells tab"

Energy frame BR 2018

Without supplement	Supplement for special conditions	Total energy frame
41,1	0,0	41,1
Total energy requirement		11,5

Energy frame low energy

Without supplement	Supplement for special conditions	Total energy frame
33,0	0,0	33,0
Total energy requirement		11,5

Contribution to energy requirement		Net requirement	
Heat	17,9	Room heating	13,0
El. for operation of bulding	-1,9	Domestic hot water	5,7
Excessive in rooms	0,0	Cooling	0,0
Selected electricity requirements		**Heat loss from installations**	
Lighting	6,4	Room heating	0,3
Heating of rooms	0,0	Domestic hot water	0,5
Heating of DHW	0,0		
Heat pump	0,0	**Output from special sources**	
Ventilators	4,8	Solar heat	0,0
Pumps	0,0	Heat pump	0,0
Cooling	0,0	Solar cells	13,2
Total el. consumption	18,3	Wind mills	0,0

Ill:. 34 Be18, "Key numbers tab"