URBAN CO-LIVING

MSc04 - 20 // May 2018

COLOPHON

PROJECT THEME
Sustainable co-housing in an urban context

PROJECT TITLE
Urban Co-living

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NUMBER OF PAGES
157

APPENDIX
10

SIGNATURE

ABSTRACT

The present report is a master thesis concerning the design of an sustainable urban co-housing situated at Godsbanen south in Aarhus, Denmark. The thesis is a result of an integrated design between engineering and architectural aspects of the building design, focusing on sustainability as the main specialization

The designing of an urban co-housing is based on different themes, which is handled throughout the integrated process from problem statement, analysis, sketching, synthesis and towards the presentation. The main themes of the project is respectively belongingness, co-living and social sustainability, which is reflected in the final design.

Urban Co-Living reflect the aspects of co-housing by centering dwellings around communities in which the inhabitants gathers and creates social interactions. Designing dwellings to a wide spread of user segment bridges ages and creates different needs, from which the co-housing is designed. The focus on social sustainability brings the user in center of the design both in terms of functionality, comfort and accessibility.

CONTENT

PROLOGUE

Readers guide

This Master Thesis contains illustrations and text concerning the design of Urban Co-Living divided into 5 chapters, respectively analysis, presentation, design process, epilogue and appendix. The chapters are divided into smaller sub-chapters numbered in the order they appears in the report. The conclusion on the analysis phase rounds up the chapter and articulates the demands and criteria for the project. The project is presented in the presentation chapter and the process of the architectural and engineering considerations in the project are seen in the Process chapter. The conclusion and reflection rounds up the whole project in the end of the report.

Appendix is placed in the end of the report consisting extra material referred to in the report. When referenced to appendix the number of appendix is mentioned. Example: (App. 3).

Illustrations are numbered in the order of which they are placed in the report. Example: Ill. 31: Name of illustration.

The direction of North is illustrated with the following signature:

The references throughout the report is made by the use of Harvard reference method and contains a reference list at the end of the report.

This present Thesis is developed by student Kirsten Hofmann Thomsen, MSc04 Arch group 20, at Aalborg University.

The theme of the project is sustainable co-housing in an urban context, and redefines the therm of co-housing by designing with modern architecture in mind and take inspiration in the suburban qualities of Co-housing and bring into a urban context. The southern part of Godsbanen in Aarhus is chosen for the project, consisting visions for a future city district along with the heritage on the site.

Both engineering and architectural considerations creates the foundation for the holistic sustainable design of this project, using the integrated design method.

INTRODUCTION

Motivation

The living form, the family structure and the relations we enter into has changed along with changes in the society, as result of a change from industrial society to a society of knowledge and the welfare state that Denmark is today. Individualism and self-realization are key-words that influent the way we live today, and a tendency of self-sufficiency and "we-are-our-self-enough" is reflected both in the family structure and the way we live alongside each other. At the same time a growing demand for community initiatives are rising, and theories as the humans basic need to belong questions if this individualism is affecting our well-being and our satisfaction of our social relations. This master thesis will profound belongingness as a theme and how co-housing can oblige the need for a positive social interaction between inhabitants and contribute to a housing project with high level of social sustainability.

What?

Although the society reflects the increasing individualism, this is not an expression of less need of social life, as the man basically will create its identity through other people´s recognition. (Lauesen, A. 2008)

Different types of Co-Housing have challenged the traditions in housings through the past century, sharing functions and space in particular. This project will focus on how this housing type can help different user groups benefit from each other both in a sustainable sense, where different demands of space and facilities are solved jointly, as well as how a community orientated living form can provide positive relations between the inhabitants and create bonds.

Where?

As a result of the knowledge society, there has been an increasing urbanism in the bigger cities in Denmark, as these cities offers a higher amount of educations and jobs. This project will focus on a project site within Aarhus, being the second biggest city in Denmark. The placement will be at Godsbanen in Aarhus city center, as this site will be developed as a new city district, including education, occupation and housing.

Aarhus is a city with growth in population and new buildings and with a rich number of cultural offers. The project site of Godsbanen Aarhus has a lively an creative environment, which will be strengthened in the future Godsbanen area.

Who?

The project will focus on a variety of users as it will embrace all kinds of range in age containing both singles, couples, families as well as elderly. Meanwhile, the project will not include student apartments or dormitory, as these are already located around the site at Ceres district.

Ill. 001: Topic

Ill. 002: Location

METHODOLIGY

This master thesis will be based on the methodology of Mary-Ann Knudstrup, the Integrated Design Process, developed to integrate both architectural and engineering aspects of the building design. The method consists of five phases in which several iterations must be made, respectively the problem of the project, sketching phase, synthesis and the presentation. In this way the method should not be seen as a linear process but a process with loops between the different phases and within a phase itself.

Problem

A question consisting the main problem of the project, which is formulated in the prologue of this report and specified at the end of the program. The problem question how co-housing can counter the need of housings today, concerning sustainable, social, practical and economic aspects.

Analysis

The analysis that underlies the sketching phase and further process. Here different methods and tools are applied for respectively the architectural analysis and the engineering, which terminates a program consisting design criteria for the master thesis. In this project, mapping, phenomenological analysis and empiric data is used on the site, while literature and an interview is used to cover the theme and case studies. These become the foundation of the work, amongst other analysis.

Sketching

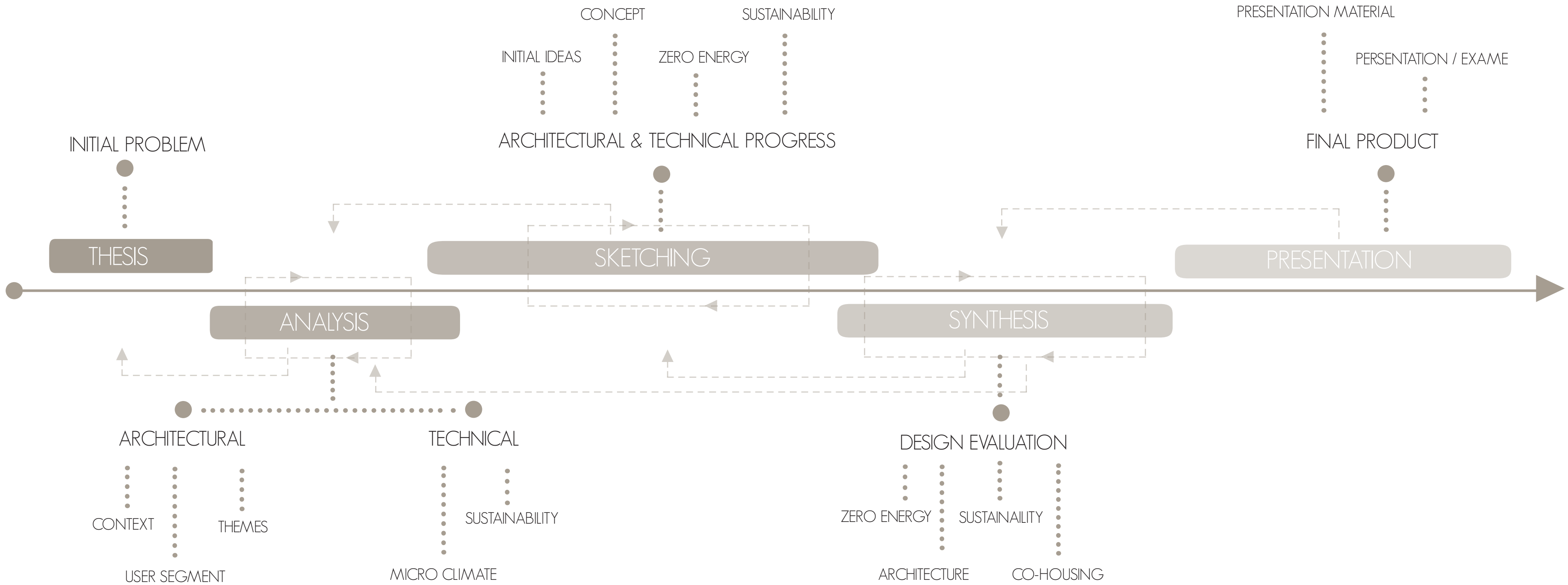
The phase where architectural, constructive and environmental considerations are combined in sketches of the building, Different tools are used to mediate the ideas, respectively sketching, modeling, simulating and calculating. To kick start design ideas, workshops concerning the form and planning, indoor environment and construction was executed, to encourage the work within these themes.

Synthesis

The different aspects, engineering and architectural, as well as the themes falls into place. Here a synthesis is made, based on the previous phases. The design is evaluated on the design criteria made in the end of the analysis phase.

Presentation

The product of the previous phases leads into a presentation of the design process, along with a presentation of the final building design. A report, additional drawing map, posters and model are made, to visualize the project and its potential along with calculations, illustrations and text that reflects upon the design.



Ill. 003: Methodoligy

INITIAL PROBLEM:
Mativation, topic: research emperic data

USER SEGMENT
User profile: Qualitative interview, emperic data

THEMES:
Co-housing: Phenomenological, qualitative interview, emperic data
Sustainability: Emperic data, qualitative interview
Sustainable tectonics in architecture: emperic data
Case studies

CONTEXT:
Mapping: Kevin Lynch
Phenomenologic: Serial Vision
Municipality Plan: Aarhus Kommune

MICROCLIMATE:
Wind: DMI.dk
Sun: Revit, DMI.dk
Noise: MiljøGIS.dk
Weather: DMI.dk

INITITIAL IDEAS:
Form and appearrance: Sketching on site
Design Criteries: Sketching

PROCESS:
Masterplanning: Sketching, foam modelling, AutoCAD
Building form: Sketchup, hand sketches
Simulating microclimate: on design: Revit, FlowDesign
Plan and function: Sketching
Environmental: Bsim, Velux, Be15, Excell
Materiality: Rendering, physical modeling

EVALUATING:
Checking design on design criteria

PRODUCING:
Plans: Drawing, 3d modelling in Revit
Spatial and materials: Renderings and modeling
Masterplan: Revit and AutoCAD
Energy consumption: Be15
Indoor climate: Bsim, Velux
Sustainability: Illustrating paramters chosen, drawings aditional with renderings, calculations and simulations

REPORT:
Printet repport: Presentation of final design, process, analysis etc.

PRESENTATION / EXAME:
Presentation: Powerpoint, Posters, model and oral presentation

1 | ANALYSIS

1.1 THEMES

1.1.1 Belongingness

The following analysis will enlighten the topic of belongingness and its importance of the present. The analysis will create a basis for the choice of co-housing as a housing project in the present master thesis. The analysis is based on empiric data.

Belongingness is a term of the man's basic need to belong in social connection to people and the desire for interpersonal attachment as a fundamental human motivation. Belongingness is essential for the man's well-being, hence stable and constant contact with other human beings can prevent from physical and mental illness. (Baumeister, R. F, 1995)

The belongingness theory that articulates the human motivation to form and maintain interpersonal bonds is not new, as the British priest and poet John Donne states; "No person is an island, entire of itself" (Donne, J., 1967) Meaning that people are depending on and involved in humankind. Abraham Maslow's hierarchy of needs states social need to be one of the 5 needs for human motivation, in this particular theory a motivation to strive for recognition and self-realization through a achievement in the social need aspect.

The basic desire for humans is to maintain social bonds for survival and reproductive benefits, but seems to increase with possible harm, such as illness, danger, nightfall and disaster. The sociologist Roy F. Baumeister states that belongingness is a fundamental need and reactions to a loss of belongingness could go beyond negative affect to have physical consequences, such as stress, social or emotional loneliness. (Baumeister, R. F, 1995)

Festinger, Schachter, and Back (1950) found that more proximity was an essential factor in relationship formation, because people seemed to develop social bonds with each other simply because they lived near each other. Nahemow and Lawton (1975) replicated those findings showing that best friends who differed by age or race were particularly likely to have lived very close together, suggesting that extreme proximity may overcome tendencies to bond with similar others. (Baumeister, R. F, 1995)

As the late modern society increasingly is a product of the individualism, the need to belong seems even more essential. It emerges a need to create spaces for people to meet and develop social bonds between people. As this need does not relates to a cultural or age specific, there lies an importance to create an environment accommodating relations between humans in it's pure sense. Young as elderly. Men as women.

"No man is an Ireland, entire of itself" (Donne, J., 1967)

Ill 004: Belongingness diagram

Ill 005: Maslow's hierarchy of needs

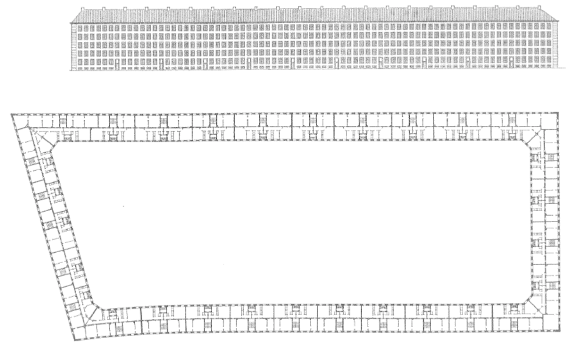
1.1.2 Dwelling typology through time

A brief analysis of the typologies in urban dwellings from 1900-2017 provides a basic understanding of the tendencies over the past century. The analysis is based on empiric data and will function as a underlaying analysis of dwelling typologies for the elaborating analysis of the topology, Co-housing, at page 19-20.

During the industrialization in the 19th century, European cities became heavily overcrowded, which resulted in unhealthy living environment for the inhabitants. It was a result of the societies transitioning from agro-society where most people lived on the country, which changes from around 1840 where people moved for jobs in the cities. Because of the Danish Grundloven the cities were now only economical responsible for the cities themselves and the city-borders were removed. This led to an expansion of the cities, where the districts; Brokvarterene, aroused in the 1850s as apartment blocks. The connection between bigger European cities was enhanced with train service between the biggest cities, which led to an additional urbanization. In the late 1800 and the beginning of the 1900 the first city planners leaved one´s mark on the development of the cities, Hack Kampmann amongst one of them planning parts of Aarhus. The first solutions for electricity, tap water and gas for household, but in the inter-war period not all inhabitants could afford these apartment, hence they lived in basements and attic rooms. A long for the rural nature aroused and green squares were planned in the inner city, and there was an aim for more light and fresh air in the cities and the apartments. (byhistorie.dk)

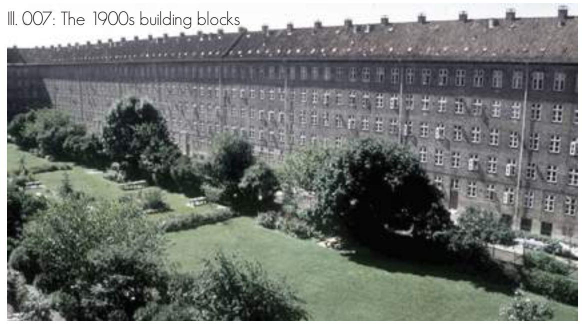
Alongside the residential district aroused and provided homes for the middle class, with great comfort and large gardens. Ideas about bringing the gardens into the city was established with the first plan lows in 1925 and 1938. It was an idea about having small parcel gardens with small houses on, in that way the detached houses with gardens was designed, although many people had to settle for allotments at first. In that way the horizontal cities, or the garden cities and the vertical cities for the industrial workers was the two most dominant typologies at the beginning of the 20 centuries. (Architecture & Design, Aalborg). Through the late 40s social issues was handled through planning of open-high block buildings placed in park areas, as these issues was increasingly considered a public matter.

With the automobile arrival in the average homes, the years after the 2. world war, the work place was increasingly separated from the homes, hence the gardens cities and a suburbanization began. Meanwhile, the bigger cities expanded and merged with market towns. Aarhus merging with Viby, Åbyhøj and Risskov is an example of this. The postindustrial cities in the 60s was characterized by the growing interest on the suburban houses. The oil crisis in 1973 resulted in recession which stopped planning of expansion of several cities. The increasing efficiency in the industry resulted in fabrics moving out of the cities. This de-industrialization of the cities resulted in lack of work places in the 70s and 80s, just before the more administrative, marketing, design and quality controlling jobs aroused, along with an expansion of the educations in the four largest cities of Denmark. Denmark went from being a country with a majority of people living on the country to a country where 86 percentage was city-dwellers in 2005. One of the significant chances along with the city planning of the 20 centuries was the establishment and build social housings or what today is known as public housings, from the 50s and 60s. These apartments and the houses in the garden cities made home for the inhabitants from that period and still does in a large amount, which reflect the welfare of to today. (byhistorie.dk) There are high standards to buildings in Denmark today, because of tightened demands for size, health, safety,



Ill. 006: Plan and Facade, 1900s building blocks

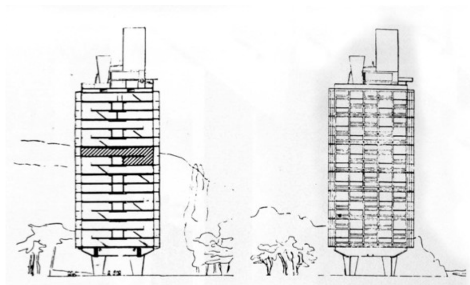
Ill. 007: The 1900s building blocks

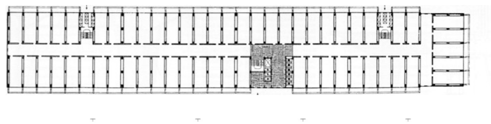


Ill. 008-009: Garden cities

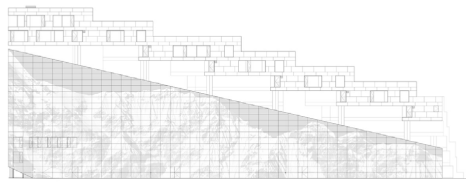
accessibility and environmental footprint etc. These demands ensure a high standard which appeals to the wide population but increases the rent as well.

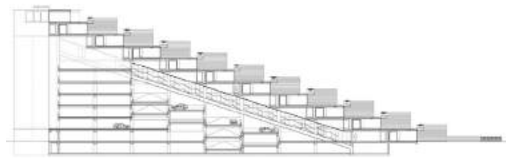
This urbanism of the European cities up through the past century presented different architectural expressions. CIAM (Congrés Internationaux d'Architecture Moderne), an avant-garde organization with le Corbusier, Gideon, Berlage, rietveld amongst others, had great influence on the European modernism in the post-war period in particular. Several congresses were held through the 20s and 30s, to proclaim modern city planning and architecture. An example of this city planning was the Plan Voisin for Paris in France (1925) consisting of a district of highpoint flats with a plan as a cross, creating an orthogonal grit of the site. Another pioneer in dwelling architecture was the Unité d'habitation for Marseilles in France (1952) designed by Le Coubusier, as a "super block" creating space for dwellings along with kindergartens, shopping center, barbershop and a nursery etc., connected by inner corridors. The large concrete block building was indeed a city in itself yet rejecting the surroundings as it were lifted from the ground floor. Eventually the modernism was replaced by the post-modernism as the modernism was criticized for being elitist and inhuman. Robert Venturi is considered as one of the most significant pioneering architects in this period, which architecture searched for more cultural relevant expression, concerning regional and contextual connection. In recent times, the Danish architect company Bjarne Ingels has made big impressions with his new interpretation of dwellings and city planning in general, which is seen in Ørestaden at Amager.


Ill. 010: Section and Facade, Unité d'habitation

Ill. 011: Plan, Unité d'habitation



Ill. 012: Unité d'habitation


Ill. 013: Facade, VM Mountain

Ill. 014: Section, VM Mountain


Ill. 015: VM Mountain


1.1.3 Co-Housing

The analysis of the housing type gives an impression of the ideas behind co-housing, the user segments today and how inspiration from this housing form can contribute to the issues and demands of today.

Most housing made in Denmark after World war 2 are designed for one household and to a traditional arrangement for own housekeeping. The traditional family is in center of the design with several rooms and space enough for two parents and children. Here, there are not much contact with neighborhood or the neighbors, other than the communities in the suburban areas. (Lauesen, A. 2008)

Co-housing, on the other hand, is a housing type that promotes common practical and social activities amongst the inhabitants. The housings are developed in Denmark in the 70's as low dense buildings with typically 12-30 housing units gathering around common space. These types were developed by originators and future inhabitants as a reaction on the different movements found in the 60's. It was a way to keep the family together and to bring quality in to their lives, when both parents worked outside the home. Today there are 50 co-housings registered in Denmark, all with different kinds of communities, organization, rules, combination of inhabitant and activities. Common for all of them is that the inhabitants have chosen to live in a community, which force interaction with your neighbors. Co-housing is designed with few number of square meters within the private home, weather it is for a family with 3 children or a student. The prioritized space is the common areas, that consists of a large kitchen and living space, workshops, outdoor areas and in some cases an indoor allay that combines the hole complex. The central activity that combines the community is the common dinner, which often is an everyday event, besides the weekends. This forces the inhabitant to interact with each other, and to be a part of the community both in the making of the dinner and while eating. Other activities are optional to some extent, but as the building is owned by the inhabitants in many cases, there is a need of different committees for maintenances, cleaning and leading the community. Besides an interest in social way of living, several of the co-housings had interest in the environment and applied different kind of renewable energy sources to the building. (Ranten, K., et al. 1988)

The advantages of the housing type and the living form in co-housing is something that did not only suit the lives of families in the 70's, many of the practical, social and economical issues along with environmental considerations are highly relevant subjects for people today. But living in co-housing has disadvantages too, naturally, as relationships between the inhabitants can evolve to disputes. Nevertheless, this living form is not only seen in these low dense buildings from the 70's. Commune-housings from the 30's was a practical offer to the families where the women were working outside the house. It was a way to relieve the women from having two jobs; one at the fabrics and one at their own home. Here, the household was bought as a service, where dinner was served at a common house for a certain amount of money. In the late 60's communes arouse in the larger apartments in the big city "escaping" from the authorities, the capitalism and the tradition family form. Today, people living in these communes might not have the same idealism, but still mainly consists of academic inhabitants in the age of 26-37. Another arrangement of a community in housings is the shared-flat, that is seen is different sizes, solutions and with different kinds of inhabitants, from students sharing an apartment to two single-parents that decides to tear down the wall between their homes. (Lauesen, A. 2008)

Co-housing is not only seen in Denmark, the housing type has aroused in the European countries and in The United States as well. In France and Germany co-housing has been developed for elderly as a political propose to alleviate solitude. (Tummers, L. 2016) The new-constructed co-housings in Europe differentiates both regarding the economic setup, the architectural language and the level of social community. In 2016, Schemata Workshop designed the Capitol Hill neighborhood in Seattle, creating a co-housing community in the urban settlements. The vision of the project is bridging generations and aiming for good neighborliness, and the value of sharing is highly weighted. (Capitolhillurbancohousing.org)

Several of the practical potentials could solve social challenges of today, without aiming for a particular utopia. A new thinking on the original co-housing could provide new, modern and relevant housings with high social and functional flexibility.

Ill. 016. Capitol Hill Co-housing

1.1.4 Sustainability

Sustainability is a widely used term, which is discussed in the political context. The building industry is responsible for about 40 % of the total amount of CO2 emission. (Beradi., U. 2013) The topic is highly relevant as the emission is damaging the climate, resulting in increased temperatures and water level. Furthermore, it provides more extreme weather conditions, releasing more extreme and frequently rainfall and heat-waves in Denmark. Changes like these has emerged focus on how we live, the use of resources and the amount of emission. Starting with an awakening after the first oil crisis in the 1973 and the publication of Limit to Growth released in 1972, the focus on the topic has increased through the past decades.

"Sustainable developement is developement which meet the need of the present without compromising the ability of the future generations to meet their own needs" (Brundland Comission, 1987, p. 15)

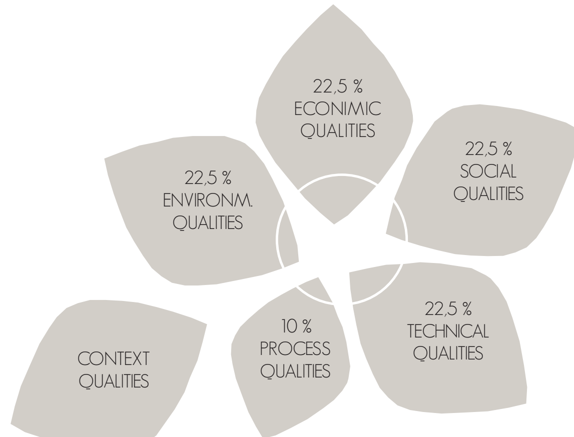
In the same time the topic has contributed to new building types, concerning the environment with different initiatives. From passive houses in the current century to active houses and to the sustainable certification methods that are influencing the aim in many designs today. The theories of designing with the environment in mind today requires an approach to the building design which combines environmental, economic and social aspects. The certification method has developed solutions on how to reach these goals. One of them is the Danish version of the DGNB (Deutche Geshellschaft für Nachhatiges Bauen) which was establish in 2010. The method relies on the three aspects of holistic environmental design but with an addition of other values, such as the process, technical and the building site itself, in which there are 40 additional sub criteria. A DGNB certificated building is evaluated on the buildings whole life-cycle, which makes the method holistic, and ensures that the buildings are evaluated on the same standard of references. The method requires integrated design and equal rating of the economic and social aspects. DGNB, BREEAM or LEED are all examples of methods that has high standards to the building performance, and is an optional method for a building owner to reach sustainability.

Through the past decades, from the 70's, the requirements from the Danish building regulation has aimed for higher sustainability, lower energy consumption and improved indoor environment amongst other regulations. This shows a political control of the topic in the building industry, clarifying that sustainable solutions in the building industry is not only an optional aim.

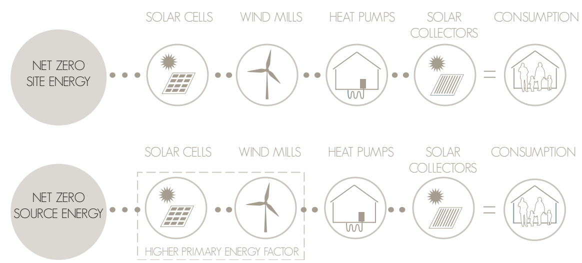
The project will embrace both passive and active initiatives, while taking inspiration in the certification method and its' social parameters, to reach a sustainable building. To clarify the approach for the energy consumption, different zero-energy strategies are analyzed. Different passive strategies can be applied to a project. These initiatives are evaluated as well, for inspiration to the work of sustainability.

Net zero energy strategy

Zero energy buildings are a building type aroused in the late 20th century with a particular focus on the energy use and how to minimize the use of energy from fossil fuels. It is a building which greatly reduced energy demand that is balanced by an equivalent energy generation from renewable sources. The aim for these buildings is a zero-energy consumption on an annual basis. There are different ways of defining the term, and two of the types are analyzed in this project, from which the strategy will be defined.



Ill. 017: DGNB Parameters



Ill. 018: Net Zero strategies

Net Zero Site Energy is a zero-energy strategy where the amount of renewable energy provided on-site is equal to the amount used on site.

Net Zero Source Energy is a zero-energy strategy where the site generates the same amount of energy as used on site, including energy used for transporting the energy to the building while accounting for the energy losses from transmission. In this strategy, the site needs to produce more energy than in the Net Zero Site Energy strategy.

In both cases it is important to integrate the passive strategies before applying renewable energy sources, as the focus is to bring down the carbon emission. If only applying active strategies without concerning the passive strategies, there will be a waste of resources by over dimensioning renewable energy sources for the site.

Passive strategies

Different methods can be applied in the building design itself. In this way the building is passively reducing the energy consumption and providing a better indoor climate. There are different initiatives depending on the aim, which are highly depending on the building site, the climate and orientation: Reduce the U-values of the building envelopes, ensuring optimal daylight factors in the building, less amount of m^2 per person, ensuring opportunity for natural ventilation, regulating the glazing area and orientation, adding passive solar shading when needed, amongst others.

Active strategies

The active initiatives is an supplement to the different passive initiatives, which will be needed to bring the energy consumption to a zero-energy standard. Meanwhile, the active initiatives should be implemented in the early stages of the process as well as the passive initiatives.

Heat pumps runs on electricity and produces domestic hot water and hot water for heating by transmission of outer hot air to refrigerant fluid in the heat pump. The liquid is further heated by a pressure rise and afterwards used to heat up the water. The high efficiency in the system ensures a cheaper solution, because it transport heat instead of producing heat and can exploit even low temperatures. Head pumps distinguish between air-to-water and liquid-to-water, whereas the last mentioned gets in contact with the heat through the soil.

Solar collectors heat water for domestic hot water and hot water for heating, by converting solar radiation into heated air or water through a fluid in the system. The collectors are often placed on the roof of the building.

Solar photovoltaics convert solar radiation into electricity, to cover the energy demand of the building. The exact exploitation of the PV cells depends on the orientation, inclination, amount of shading exposed to the cells and the type of technology.

Advantages and disadvantages of the different energy sources is described in the scheme.

Solar photovoltaics are chosen as renewable energy sources for the projects, as the project is located in the inner city of Aarhus, where district heating is already placed. The adding of solar collectors or heat pumps will therefor only contribute for material waste.

HEAT PUMP	Placement	Economy	Visibility	Noise
Geothermal (vertical pipes)	30-300 m in ground	Expensive (drilling)	Heat pump inside	None
Geothermal (horisonatal pipes)	15-20 m^2 in ground	More expensive than air-to-water	Heat pump inside	None
Air-to-water	Inside: Hot water tank + system Outside: Heat pump w. fan	Cheapest	Heat pump outside	Outside fan: 40-70 dB
SOLAR COL.	Placement	Economy	Visibility	Noise
Tube collector	On roof or facade, 2 m^2 /pers.	Cheaper solution	Black panels on envelope	None
Plane collector	—"—	Expensive, %heat loss	—"—	None
SOLAR PV-CELL	Placement	Production	Visibility	Efficiency
Monocrystalline	On roof or facade, 5-7 m^2/kW	140 - 190 kWh/m^2/ year	Black on black/white background	12-15 %
Polycrystalline	On roof or facade, 6-9 m^2/kW	120 - 150 kWh/m^2/ year	Blue on black/white background	10-13 %
Thin film (various types)	On roof or facade, 8-16 m^2/kW	150 - 110 kWh/m^2/ year	Black/ brown w. light stripes	5-9 %

1.1.5 Sustainable tectonics in architecture

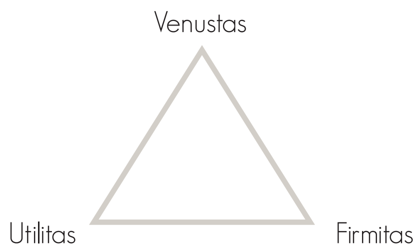
Creating a design which not only concerns the environmental issues, requires a focus on the importance of architecture within a project. Only in this way a sustainable design will be created, integrating all aspects; social, economic and environmental. The analysis will reflect on the different theories of tectonics to articulate a general understanding of architecture without focusing on a particular building style or historical epoch. In this way a fundamental definition of architectural qualities can function as a foundation to the design process.

Tectonic as a term originates from the Greek from the word 'Tekton' which means constructor or carpenter. The definition of tectonics covers a theory of the inner structure of a work of art and the shaping and joining of form elements to a unity. Architecture is a form of art that depends on laws of nature, context, economics and technology, which has been articulated by different philosophers through time. Greek philosopher Aristotle defined the 'four causes of nature'; the material, formal, efficient and final cause and is the first person associated with the tectonics. The roman writer, architect and engineer, Vitruvius, introduces the three requirements that ensures quality in architecture, respectively firmitas, utilitas and venustas which can be translated to structure, function and aesthetic. In 1851 the term tectonic was provided with a socio-cultural aspect, by "Die vier Elemente der Baukunst" (The four elements of Architecture) by the German architectural professor Gotfried Semper. He introduced a way of dividing architecture into these four elements, respectively Earthwork, Framework, hearth and Screen wall. (Semper, 1851) The element Earthwork was a way to articulate that architecture was not only a matter of construction and aesthetic, but also centers around humans needs in life. Another architectural professor defining the term tectonics is Eduard Sekler, who wrote the essay "Structure, Construction and Tectonics" in 1965, in which he defines the difference between structure and construction and describes how these where inseparable and depending on tectonics:

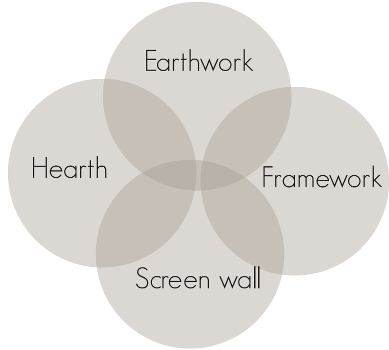
"When a structural concept has found its implementation through construction the visual result will affect it through certain expressive qualities which clearly have something to do with the play of forces and corresponding arrangement of parts in the building yet cannot be described in terms of construction and structure alone. For these qualities which are expressive of a relation of form to force, the term tectonic should be reserved." (Sekler, 1965, p. 89)

Throughout the history of architecture, tectonic principles have been changed from the pure structure issues into cultural and even digital subjects. It represents a pure term of architecture, that is neither new or abstract nor traditional and classical, instead it combined history with progress. Sustainable tectonics can function as a subdivision of tectonics discourse to extract influential parameters for analyzing the formal structure of sustainable buildings through tectonic parameters. Sustainable design can be formulated by sustainable tectonics by implementing tectonic factors to articulate different dimensions of sustainability. (Ruzbahani, 2016) In the same way as structure and aesthetic con not be divided in tectonic architecture, the aspects of social, economical and environmental aspects are what together creates sustainable architecture.

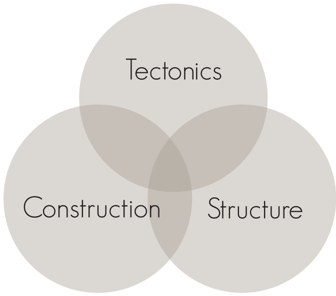
The integration of these different aspects is what will create quality in the architecture of this project.



Ill. 019: Vitruvius, from the ten books on architecture



Ill. 020: Semper, The four elements of architecture



Ill. 021: Sekler, from"Structure, construction and tectonics"

1.2 USER SEGMENT

1.2.1 User composition

Based on empiric data and an interview with realtor Peter Munch, this analysis will help create a picture of user groups that reflects the present society, to understand the demands of dwellings today.

The traditional family structure, the nuclear family, is an ideal for most people and the society is closely organized with this segment in mind. (Lauesen, A., 2008) But how has the family form changed along with changes in society and which challenges are we facing today?

As a result of the industrialization, Denmark changed from being an agricultural to industrial society and the work environment and production was divided from the homes and the private sphere. Thereby the three rooms apartment with kitchen and bath gradually became the dominant standard in the 20th century. Here the working dad and the home going mom was the standard form of the family. With the women's entry on the labor marked from the 1950s, the parents had evolved symmetrical roles in the family. This happened along with the developing of the welfare state and public institutions started taking care of the elderly and the children of the families. The changes meant that a man and woman were no longer together for economical reason and the age of marriage raised. Today Denmark and the Western countries has changed to societies of knowledge and there is a tendency of young people waiting to settle down with marriage and kids, caused by an increasing need of self-realization. (Lauesen, A., 2018) This creates a knew epoch in life, which should be considered as a segment in designs of dwellings.

Furthermore, there are 37 different family constellations with divorced couples and gathered children etc, as an result of the changes in society. (Restrup, A. K., 2014) To simplify this segment, the aim is to design dwellings for families in general, not differentiating in the constellation.

The life quality of the elderly segment of today shows increasingly solitude cussed by factors of disability, leaving the job market or becoming widow/widower. (Aeldresagen.dk, 2018)

The aim is to embrace different generations in life in the project and to create spaces from where the generations can benefit from each other.

This creates three different user segments that this master thesis will address; people without children, single or couples in the age 20-40, families with 1-3 children, and the third user group of elderly.

In this way different generations meets, benefit from each other and contributes to a lively co-living community. The following specifies the demands for the three different user groups:

Singles/Couples: Age 20-40

Everything from 9 m^2 and up, close to parks and grocery stores and public facilities in general, 1-2 room, kitchen and bathroom. transport by bus or bicycle, chosen interior solutions integrated in the design

Families: With 1-3 children

Car and economy of the dwelling is important, bedroom and living room, rooms for children, kitchen and bathroom in every apartment.

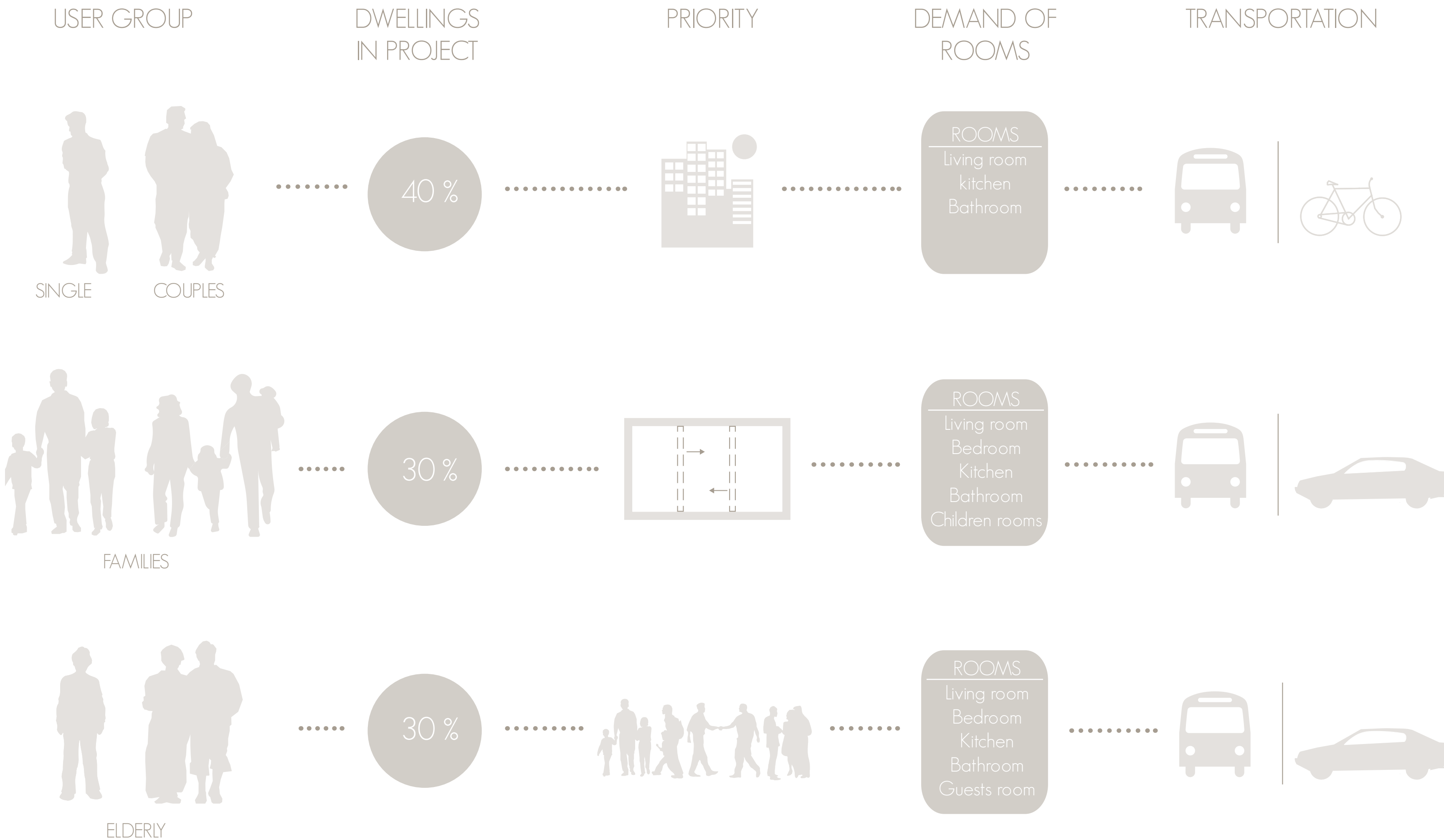
Elderly: age 60+

Car or bus, elevators and balcony/gardens are important, some can settle for 60 m^2, bedroom, living room, kitchen and bath. Accessibility to and inside the dwelling.

The demands are some of the things pointed out by real estate Peter Munch, which creates a base of knowledge for design of the dwellings.

The list of rooms and facilities can easily result in superfluous square meters and result in expensive homes, which will not address the whole variety of users chosen for the project. But what if some of these requirements could be solved jointly, creating common facilities as kitchens, activity and hobby rooms, what if we shared gardens or functions to strengthen the relationship between the inhabitants and prevent from solitude?

Ill. 022, right: User segment


USER GROUP
DWELLINGS IN PROJECT
PRIORITY
DEMAND OF ROOMS
TRANSPORTATION
SINGLE
COUPLES
40 %
ROOMS
Living room
kitchen
Bathroom
FAMILIES
30 %
ROOMS
Living room
Bedroom
Kitchen
Bathroom
Children rooms
ELDERLY
30 %
ROOMS
Living room
Bedroom
Kitchen
Bathroom
Guests room

1.3 CASESTUDIES

1.3.1 Co-housing

For inspiration to community-oriented and sustainable housing, the following analysis describes three different types of co-housing with various focus. Common for all of them is the prioritizing of common spaces and the sustainable approach in the projects. The analysis will contribute to an understanding of the many ways of incorporating community-solutions into a project. The analysis is based on a visit at Ådalen 85 co-housing in Randers additionally with an interview with one of the residents, Ditte Hamrum Jørgensen. Furthermore, a transcribtion of the interview can be seen in appendix page 161. The analysis is based on empiric data, and illuminates the different aspects: Community-oriented strategy, sustainability, architectural and functional qualities, advantages and disadvantages. The three projects analyzed is; Ådalen 85 in Randers, Capitol Hill Urban Co-housing in Seattle and Tietgankollegiet in Copenhagen.

Ådalen 85, 1987, Randers
Architect: Peter Krogh
Project size: 5 houses, 65 m^2 and 95 m^2 incl. common spaces

With inspiration in the co-housing project Drivhuset, Ådalen 85 was build by a group of people with same values and desire to live in a co-housing. It is considered as one of the original co-housing projects from the late 80s, as a low-dense building situated in a suburban context.

Their community-strategy is based on a strict system of participation and compulsory common meals every weekday. The inhabitants have joined themselves in one of the five different work-groups; the garden group, the kitchen group the street group, the maintenance group and the co-housing board, in which different responsibilities lies. The co-housing is thereby a self-driven habitation form, where everything it systematized, ruled and done by the inhabitants themselves.

The building is very sustainable for its time, as it was build with both active and passive initiatives in the 80s. The common indoor street that connects the whole complex is constructed in glass and aluminum and provides a huge amount of heat, which are transmitted to the housing units by the thin outer wall facing the street. Furthermore, PV-cells and solar collectors are installed on the roof, where as the solar collectors provides more heat than the complex can use. Rainwater is collected from the roof as well, connecting to a watering system that distributes to all the potted plants along the street. Large windows ensure that the houses are heated from south. Earlier, a vegetable garden was attached to their outdoor spaces, providing ecological vegetable to the household, but because of lack of time is was removed. Four different trash cans ensure a sustainable sorting of trash from the households and the common kitchen.

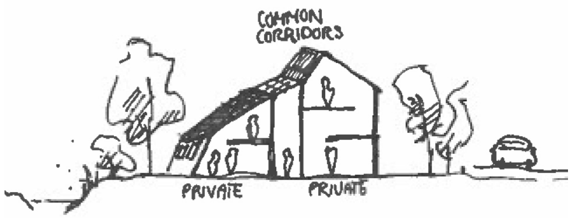
The co-housing complex is planned along the central indoor street that formed with an angle in the middle. The street creates a transparent merging of the housing groups, that stand side by side, and leads the way into the common spaces. Niches is made additionally to the street as a semi-private sphere, creating a gradual transition from the common areas to the private spheres. From the outside the building is oriented towards south, hence a larger part of the facade is glass at this side. The facade is covered in what seems to be dark grey fiber cement and light grey wave plates of steel, additional with the glazing of the common street. The relatively cold and appearance, which relates to the appearance of a greenhouse, is placed on a beautiful hilly landscape just beside a stream. The inside of the apartment is compressed to the most important functions with small square meters for each room. The apartments consist of stairs and deposited floors, which functionally will cull out disabled people.

The project consists of a high level of community-oriented solutions, where the community is compulsory, this will appeal to some and exclude others that cannot live within this structure of the daily life. The sustainable solutions were on a high level at the time it was build, but does not completely live up to the standards today, both in relation to the overheating, the energy consumption and accessibility for example. Because of the orientation of the openings towards south, the architecture appeals closed and private from the entrance in the north part. The collection of cold materials and colors doesn't quite reflect the warmth and sense of community you meet in the social part of the project.

Capitol Hill Urban Co-housing, 2016, Seattle
Architect: Schemata Workshop, Grase Kim
Project size: 9 homes, 440 m^2

The project in a moderns co-housing situated in a high-dense area in Seattle, where 9 apartments provide homes for users in all ages. Grase Kim is one of the inhabitants and is the architect behind the project. The apartments are placed in 4-5 floors around an outdoor common space.

Sharing is the bedrock of their community, and the inhabitants share meals every single day. They believe that being an active part of the community will prevent from an insular way of living. The common spaces are centered in the project, both inside and out, with a large common kitchen and living room for meal, an outdoor courtyard that embraces play, motion and talk, a roof top garden and terrace. The common spaces are connected by a vertical stairway as a vein through the building.



Ill. 023: Co-housing concept of Ådalen 85

Ill. 024: Outdoor area, Ådalen 85

Ill. 025: Common kitchen, Ådalen 85

Ill. 026: Corridor, Ådalen 85

Ill. 027: Common space, Ådalen 85

The building is described as a long-life building which is designed to minimize energy and water consumption through extensive integrated sustainable strategies. The compact homes are designed with open floor plans, which optimized the daylight factor and provides natural ventilation by cross ventilation. The roof top gardens provide ecological vegetables to the common meals, wishing to create a home that is healthy both for the inhabitant and the environment as well.

The primarily static outer form of the building does not make it unique in its context, the color on the other hand shows a chance in the function. The building is constructed in concrete casted on site, with heavy outer walls and light inner walls. A hollow center in the middle of the volume creates the common courtyard, which expresses the heart of the building. There is not much tactility in the facade, which can seem dismissive to the context. The apartments are compressed with only the most important functions, which allows a larger common space.

"I am not best friends with single person in my building, we even have differences and conflict. But living in co-housing, we're intentional about our relationships. We are motivated to resolve our differences." (Kim, G., 2017, at 8:30) The quote defines their values in a way that reflects the spaciousness these people get by living closely together and interfering each other's lives. The projects are dealing with e great amount of social sustainability, where other parameters might haven't been prioritized. For example, the handling and choice of materials is not expressed, and choosing concrete as the main material seems to be chosen for economic reasons rather than the holistic approach of the materials life-cycle.

Tietgenkollegiet, 2005, Denmark
Architect: Lundgaard&Tranberg Arkitekter
Project size: 360 housing units, 20.000 m^2

Tietgenkollegiet is a dormitory for almost 400 students in Ørestad on Amager, placed in a context of new build housings and occupation. The project contains common space and private homes as well.

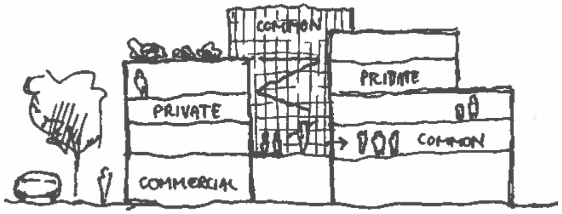
The project centers around the community as a main topic, which is the driven force for the placement of the common spaces which is oriented towards the center. As the building is formed in a circle, it is possible to experience the life in the different several common kitchens. According to experiences from living at Tietgenkollegiet, this creates a feeling of being welcome in every part of the complex: "Hvis jeg ser en stor fest et sted i huset kan jeg sagtens finde på at gå derover. Man føler sig velkommen alle steder I huset" Nicholas, inhabitant. (Tietgenkollegiet) besides the common kitchen there is living rooms, assembly hall, laundry, reading room, computer room, music rehearsal room and common terraces.

The building can be considered robust because of its architecture, which beautifully reflects the architecture of its time. Buildings with worth preserving architecture is more likely to last and not be teared down. The process of tearing down and compensate with a new building will contribute to a large amount of carbon emission, hence the great architecture is a sustainable strategy in relation to sustainability. Combining solid materials as concrete and organic materials as oak slaps and birch plates ensures a robustness and a tactile architecture.

Tietgenkollegiet is formed as a circle with a fragmenting façade of modules respectively pulls out of the façade or deviates. The fragmented facade additional with a use of wooden slats creates a tactility in the facade, both on the inside and to the surroundings. The placement of many of the common areas in the ground floor creates a lively meeting with the building, reflecting the community consisting in the dormitory. Materials of oak slats and treated copper, which will keep its dark red color, creates a warm and welcoming appearance. By forming the building in a circle, no exact backsides or dead corners are made, in this way every apartment is a part of the community. The apartments are held as small as possible, providing as much space for the common areas as possible.

The project combines architecture with functions, inside and out. Nevertheless, the corridors are not completely exploited other than distributing to the apartments and kitchens. The form of the building embraces itself, while it doesn't invite for visitors elsewhere than in the openings made in the ground floor.

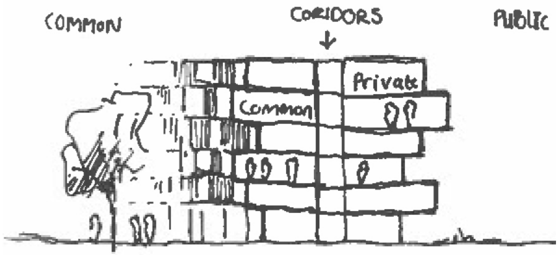
The challenge of the project will be to combine the values of the suburban co-housing with the qualities of urban context, as the original co-housing projects are closely connected to surrounding nature, with playgrounds and kitchen gardens. This project will focus on creating spaces for gardens and outdoor common space by include the roofing as well as terraces. Though inspiration can be found in planning of a co-housing in the analyzed cases, concerning the connection between private, semi-private and common areas, the only reference concerning architectural quality in the project is Tietgenkollegiet. The approach in the original co-housing project, aiming for high sustainability, inspires to aim for more than just an approved energy consumption.



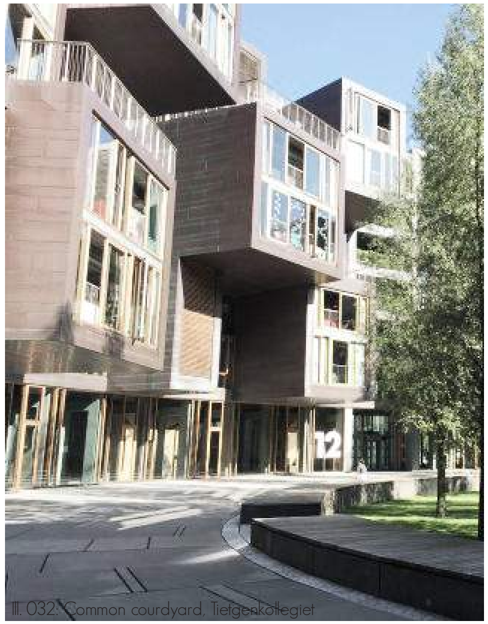
Ill. 028: Co-housing concept, Capitol Hill Co-housing

Ill. 029: Roof garden, Capitol Hill Co-housing

Ill. 030: Common courdyard, Capitol Hill Co-housing



Ill. 031: Co-housing concept, Tietgenkollegiet



Ill. 032: Common courdyard, Tietgenkollegiet

Ill. 033: Common kitchen, Tietgenkollegiet

1.3.2 Creating spaces to meet

The following study is an extension to the previous analysis of Co-housing case studies, which focuses on how to create spaces for people to meet in order to encourage social interaction between the inhabitants. The study is based on data of the three chosen case projects along with 5 similar projects around Europe, respectively from Berlin, Stockholm, Vienna and Amsterdam, listed in the scheme. The amount of reference projects in the study creates a more quantitative basis for the understanding of the community functions in co-housing compared to the age of the inhabitants, as well as a general understanding of the needs in which meetings are created.

The scheme consists of a list of indoor common spaces, outdoor common areas and urban functions of which inhabitants and the public can share. The quotes clarifies the importance of these different functions and the bonds that are created around them.

The study shows that the common dining and kitchen area is a very important and central element in a programming of co-housing. Hobby room for the seniors, bike and baby buggies for the families, reading room for the young, corridors for the children to run and play between the homes. These are the functions more age defined, where the common rooms and the garden areas is the functions that gathers all kinds of users in the co-housing. The study shows that the essence of the different common spaces is the activity that is made possible within, which is the function that make conversations and interaction between the inhabitants.

"Families as well as singles often find themselves in the community garden with treehouse and playground." (LaFond, M., 2012, p. 41)

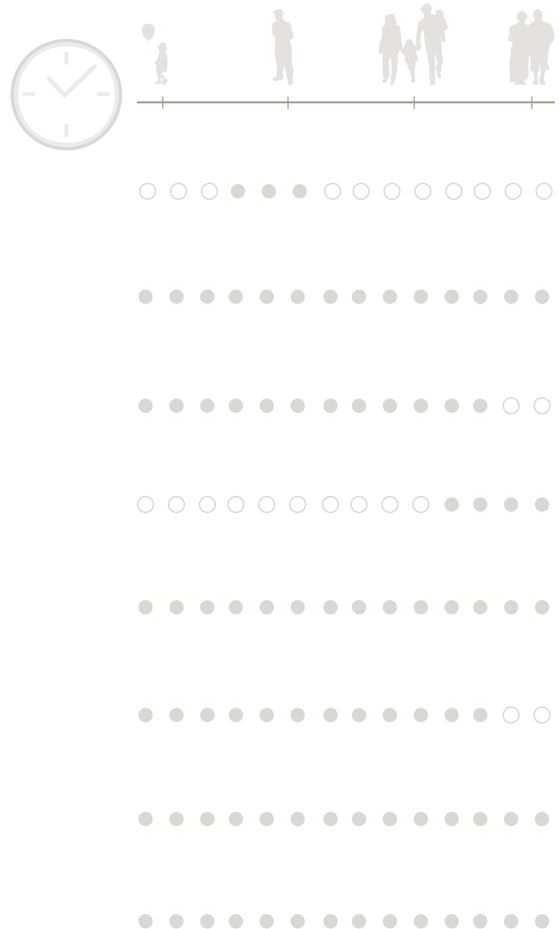
"Seniors and young people meet on the comfortable benches and neighborliness is practised without obligation." (LaFond, M., 2012, p. 57)

"The extra wide corridors allow people to meet each other often, and are equipped with seating areas and especially loved by children as a play area." (LaFond, M., 2012, p. 137)

"Vrijburcht's heart is its courtyard garden with greenhouse, which is the setting for cummunal dinner parties and festivities." (LaFond, M., 2012, p. 171)

"Those who eat together more frequently, experience higher level of communitas, spirit of community. It turns out, when you eat together you start planning more activites together, you share more things." (Kim, G., 2017, at 8:10)

"Working together is a central aspect of everyday life in the building. But the togetherness that arises around other activities such as excursions and parties is just as important." (LaFond, M., 2012, p. 73)



	Kitchen and dining room	Bike, baby buggies and storage room	Guest rooms	Laundry room	Photo-lab	Hoppy space	Workshops	Library	Corridors	Tv room	Rehearsal room, music etc.	Reading room
Tietgenkollegiet (Copenhagen)	●	●	○	●	○	○	○	○	●	○	●	●
Old School Karlshorst (Berlin)	●	●	○	○	○	○	○	○	○	○	○	○
Capitol Hill Urban Co-housing (Seattle)	●	○	○	○	○	○	○	○	●	○	○	○
Färdknäppen (Stockholm)	●	●	●	○	●	●	○	○	○	○	○	○
Ådalen 85 (Randers)	●	●	○	●	○	○	●	○	●	○	○	○
[ro*sa][22] (Vienna)	●	●	○	●	○	○	●	●	●	○	○	○
Trudeslund (Copenhagen)	●	○	○	●	○	●	●	○	○	●	○	○
Vrijburcht (Amsterdam)	●	●	●	○	○	●	○	○	○	○	○	○

	Car-free lanes	Sauna	Rooftop terraces	Garden	Playground	Greenhouse	Docks for boats and swimmers	Fire place
Tietgenkollegiet (Copenhagen)	○	○	○	●	○	○	○	○
Old School Karlshorst (Berlin)	○	○	○	●	●	○	○	○
Capitol Hill Urban Co-housing (Seattle)	○	○	○	●	○	○	○	○
Färdknäppen (Stockholm)	○	●	●	○	○	○	○	○
Ådalen 85 (Randers)	●	○	○	●	●	○	○	●
[ro*sa][22] (Vienna)	○	●	●	●	○	○	○	○
Trudeslund (Copenhagen)	●	○	○	○	●	○	○	●
Vrijburcht (Amsterdam)	○	○	○	○	○	●	●	○

	Daycar	Youth living	Commersial	Café	Theater
Tietgenkollegiet (Copenhagen)	○	○	○	○	○
Old School Karlshorst (Berlin)	●	○	●	○	○
Capitol Hill Urban Co-housing (Seattle)	○	○	●	○	○
Färdknäppen (Stockholm)	○	○	○	○	○
Ådalen 85 (Randers)	○	○	○	○	○
[ro*sa][22] (Vienna)	○	○	○	○	○
Trudeslund (Copenhagen)	○	○	○	○	○
Vrijburcht (Amsterdam)	●	●	●	●	●

1.4 CONTEXT

1.4.1 Authorities: District plan

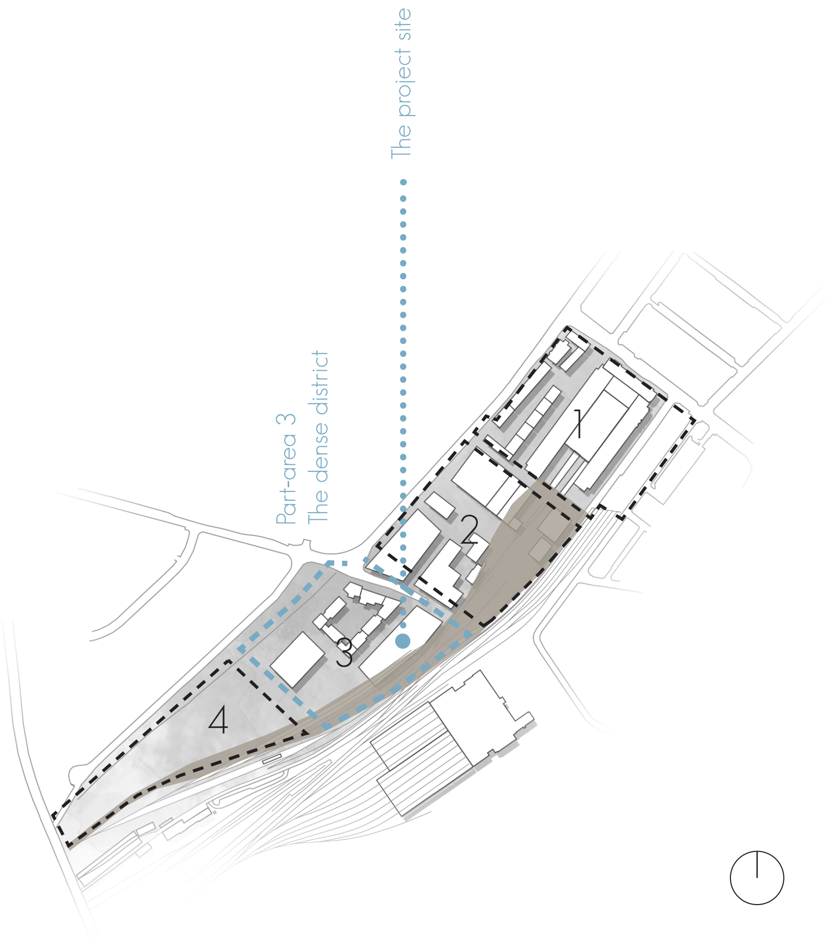
The analysis emphasizes the most significant topics of the future plans for Godbanen area in relation to the Aarhus municipality plan and the temporary district plan. This gives an insight in the authority's visions for the area and the demands concerning the function, height, volume amongst other parameters. It ensures a coherent city and a deliberated connection to the surroundings.

Godsbanen area is situated just outside the inner city, where the city structure mainly consists of block buildings. Near Ringgaden new district are build mainly in the 20th century with buildings block surrounded by larger green areas. Former traffic technical areas are potential for new districts of the city, Godsbanen being one of them, to consist city-relevant function with a great placement. According to the municipality plan of the area the function must be shops, offices, hotels, cinema ateliers and housings, but with no housings placed in the ground floor. The maximum building height must be 6 floors and with a building percentage of 150 %, in general there must only be constructed 50 % housings in the whole area, the rest must be occupation and public functions. (Aarhusplan/kort.htm)

The closest to a district plan for the area is the district plan for the future architect school in Aarhus, which is planned to be situated just beside the Godsbanen former terminal, on the south-west side, which is categorized as part-area 2, according to the municipality development plan for the Godsbanen district. The district plan of the part-area in which this master thesis will be designed, part-area 3, is at this point being evaluated, hence this project will relate to the development plan and take inspiration in the district plan for part-area 2.

The new city district must create its own atmosphere and identity and give space for crookedness and creative ideas as a vibrant and young district called Aarhus K. The area must connect new architecture with the postindustrial qualities of cultural buildings and tracks in an experimenting way. The already existing cultural institutions must be added with new cultural offers, educational institutions and housings in a coherent, diverse and lively district. Some of the specified functions on the site is the future architects school and a dormitory close to Carl Blochs gade. Det Jyske Kunstakademi, ReUseCenter, Børnekulturhuset and Ungdomskulturhuset has showed interest in the area as well, which is expected to drag many visitors to the new district. As the area is placed in a low part of the city, rainwater must be collected and integrated in the buildings and led to delay-basins and streams for further seepage. The municipality will make a strategy for the noise pollution in the area cost by the workshops for the trains, to reduce noise on a longer term. The overall plan of the area is based on a flexible grit of building squares that catches the direction of the old rail roads, with streets crossing orthogonal – one of them being an extension of Carl Blochs Gade through the site. Every building square is flexible and can be divided in several volumes. Within the public space between the buildings, there must be created flexible zones for car and bicycle parking. The architecture of the future area has a robustness, hence various typologies and height in the building can be added. The materials must be held in materials used in the surroundings, such as bricks, wood, concrete, steel or iron. The building height must increase from the 3 floors height from Mølleengen towards some of the buildings in the north end of the area being up to 10 floors. The green areas must be kept from the south end of the area, where it connects to Ådalen with consisting pedestrian paths. The green area must continue as a wedge towards Godsbanen culture production. The rails are kept as paths through this wedge and can function as a noise buffer as well. This will create a recreational and connecting space for the inhabitants and users. The different part-areas of the district consists respectively of; 1. The culture axis, 2. The creative district, 3. The dense district, 4. The event area, and lastly the green wedge. In the part-area 3, the plan is to create mixed use between housings and occupation in the field of 3576 m^2, where it will be connected to the extension of Carl blochs Gade. The Building percentage at this place must not exceed 150-200 % which correspond with 5364-7152 m^2. (Aarhus.dk)

As the development plan is published in 2015, and the districts plan for part-area 2 is from 2017, some of the building squares has been modified and some building has been specified as well. The actual site for this master thesis will be situated in one of these building squares defined in the district plan for part-area 2, though being placed in part-area 3 as seen in illustration 034. This site is 3500 m^2. The project must adapt to the demands of the municipality plan and the development plan for the area, but will deviate in relation to the vision about Aarhus K being a young district, as the project will incorporate both young, adults and elderly.



Ill. 034: District plan of par-area 2

Ill. 035: The Godsbanen area

Ill. 039 Godsbanen Terminal

Ill. 036-38: Materials, area

Ill. 040: Suggestion for use of rails

Ill. 041: Godsbanen area now

1.4.2 Mapping: Image of the city

With inspiration in the mapping method, 'Image of the City' by Kevin Lynch, the context is analyzed to get a better understanding of the different elements from the context that influent the project site. The categories mapped in this analysis is the different districts, the paths, landmarks and nodes.

Districts are small neighborhoods within the city, that differentiates from the surroundings in character, use, placement or architecture. (Lynch, L.,1960) The inner city, which originally has its center at the mouth of Aarhus Å, consist of various of cultural offers, such as Aarhus Domkirke, the main shopping streets and a rich café area around Aarhus Å. The architecture varies but with an overweight of building blocks and occupants up to 7 story's heights, with original architecture from the 19th century. Frederiksbjerg is an area build around 1900 with wide boulevards and squares planned beautifully between the housing blocks. The district contains small unique shops and cafés. Ceresbyen is a newly transform district, from the old Ceres Bryggeri to now housing units and the VIA university college. Ceres Panorama rises above it all with its 70 meters high apartment building. (Denstoredanske.dk) Åbrinken is an allotment neighborhood at the west end of the context, placed near the rail roads which is common for a lot of these small neighborhoods, the neighborhoods bring the context around Godsbanen down in a scale of 1 story height, with big gardens in an addition to it. Godsbanen as a district itself is an area defined by the old freight rail and terminal placed at Skovsgårdgade, which was the last remaining freight terminals in Denmark. Industries was established around the terminal, which emerged for a need of housings in the area. Today the terminal is transformed to a culture and production center and contributes to a lively area. Arhus has within the last few years taken over the southern part of Godsbanen area, with visions of a new education, housing and occupants district along with green areas. (Godsbanen.dk)

Landmarks is the characteristic buildings, differentiating from the remaining context in a way that the placement becomes familiar and it becomes a guidepost for people. The landmarks of the area are listed on the map starting with the placement of VIA university college as a central part of the new Ceresbyen area. The second landmark is the old Godsbanen terminal from 1923 placed on Skovgårdsgade, former center for goods in an out of Aarhus, now attraction for creativity, art and performances, which gives the Godsbanen district its identity. Landmark number three is Aros art museum, a big tourist attraction which marks itself in the city´s image with the colorful panorama rainbow. On the same side of Vester Allé is another large landmark, Musikhuset Aarhus, which houses 1200 different concerts, theater productions, comedy amongst other performances. The last Landmark mapped in this analysis is Aarhus central station, build in 1927 at Banegårdspladsen in neoclassicism style. The station functions as Århus' and Jutland's traffic center.

The paths which connects the city in this specific context and are used on daily basis are analyzed and differentiated in usage and size. The blue dotted path maps the course of Aarhus Å, which runs through the city center and on the northern side of the project site, being a attraction for the inhabitants and visitors of Aarhus. The brown dotted path maps a pedestrian path which runs across the Godsbanen area on the south-west site of the terminal. The thin, brown paths maps some of the more heavily trafficked streets in the context, respectively Søren Frichs Vej / carl Blocks Gade in the northern part of the context, Skovgårdsgade, Sonnesgade and Thorvaldsensgade being less heavily trafficked but still being an important part of the visitors at the Godsbanen area. The three main roads; Frederiks Allé, Vester Allé and vester Ringgade is seen in the context as well, though not directly passing the project site they are influencing the traffic in the context.

Nodes causes the inhabitants to encounter as they pass each other. It is places where people gathers as a result of paths grossing each other. One of the nodes mapped in the analysis is the meeting of Skovgårdsgade and Carl Blochs Gade, where the light traffic and more heavy traffic meets and the road-user influent each other as they meet. Furthermore, Folkestedet is placed in this meeting, which attracts people to this node in particular. Another node is at the south end of the Godsbanen terminal, where a small area of cafés and workshops in old train carriages and sheds opens, the pedestrians encounter with the people walking through the Godsbanen building towards this place.. The two other nodes are placed at the meeting between Skovgårdsgade and Sonnessgade as a parking place for Godsbanen is situated here, and the other at the entrance of Scandinavian congress center.

The analysis creates a foundation for design in relation to the context. The pedestrian paths though the side must be considered in entrances for the project site. Especially the path running directly through the site must be kept in some way in the design. The nodes as well as the landmark, Godsbanen, in the northern end shows that the public part of the project must connect towards north. The districts shows that the volume and height of the building must increase towards north.

Ill. 042: Mapping, Image of the city

1.4.3 Serial vision

A serial Vision analysis is made for a phenomenological approach to understand the site, with a threshold in four different paths towards the site. The observations are based on the visual impressions of the city space along the paths, where numeral contrasting impressions arises and changes along the distance of a walk. The method is applied with a description of the sense of space on the specific site.

Path 1

Picture 1: Staring from the inner city near Århus Musikhus, the meeting with the outer part of Øgadekvarteret defines a very orthogonal city planning, with red bricked building blocks. Their consisting measured window placement creates a continuity along Skovgårdsgade, and creates a private sphere as there are no occupants in the ground level. The housing area continues at the other site of the street, with newer constructed and yellow bricked building block. There is a little number of cars driven past and only pedestrians are walking past.

Picture 2: The meeting with Godsbanen and the belonging parking gives an impression of an area with life and visitors. People are carrying old stuff as they enter a market held inside Godsbanen. The space opens and a longer distance view is created as the building here is maximum 2 levels high.

Picture 3: Walking through Godsbanen gives an impression of a highly creative environment inside building, with workshops, café, market place and stages. Behind Godsbanen a completely different area of the city appears, and the red bricks and graffiti from each side leads the direction for the further walk. A concrete ramp leads directly to the area of sheds and old carriages, different forms, materials and colors appear in the area.

Picture 4: A gravel path creates a space with low speed traffic, with pedestrians and cyclists as the only users. The air seems fresh and for the first time on the path a sound of bird song fills the air. The colorful graffiti on the sheds and signs creates a lively atmosphere and gives associations with the Christiania district in Copenhagen, from this point as encouraging contrast to the surrounding context.

Picture 5: The no-mans-land of Godsbanen south consists of old railroads and carriages on a wild vegetation of grass sorts. The city appears in the horizon. The bridge of Vestre Ringade defines the horizon with the large span arches, with the inner city on the left side and vegetation on the right. Lots of lamps are hanging from wires upon the train garages and the along the rails towards the main rail roads. The sight creates a raw and non-friendly environment. Even though the distance to the trains are relatively short at this point, the noise from the trains are still lower than the noise from cars at Søren Frichs Vej.

Path 2

Picture 1: The path starts at the very end of a remaining rail road, where the bridge of Vestre Ringgade in some way creates an entrance to the whole site of the Godsbanen area. Piles of gravel and construction material lies around in the area as if it has been left behind. The vegetation grows wild and graffiti covers the foundation of the bridge creating a very deserted space.

Picture 2: The creative area of small sheds and carriages appears further down the path. The Rainbow Panorama at Aros along with the inner city is seen on the right side of the site and three story high red brick apartments creates a defining edge on the left side. Ceresbyen along with Prismen is raising in the background, expressing a city in rapid development, this specific site being a deserted spot in the middle of all of this development.

Picture 3: A group of temporary second-hand shops is placed on the left side of the path, painted in various colors and surrounded by a fence. Trains are parked on the right hand and for the first time the sound of engines humming in the background, drowning the more stressful traffic noise from Søren Frichs vej.

Picture 4: Small temporary kitchen gardens is created from pallet frames which at this point doesn't seem to be used. In the background the trains parked, and the rather industrial train garages creates a dismissive atmosphere to the area.

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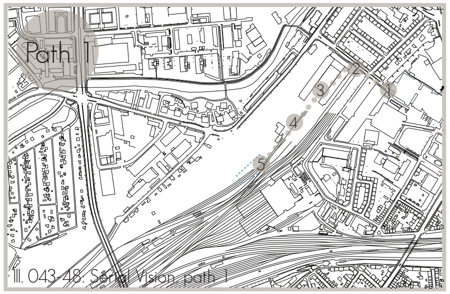
Picture 5: Entering the small area of cafeterias and creative shops behind Godsbanen, the characteristic roof form of Godsbanen is creating a dynamic end of the gravel path on the site.



Ill. 043-48: Serial Vision, path 1

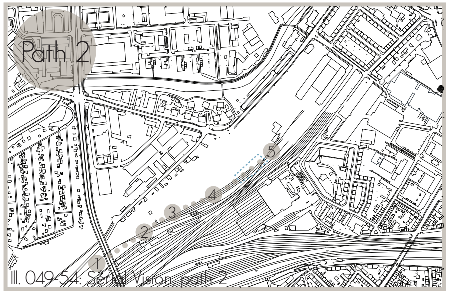

Picture 1

Picture 2


Picture 3


Picture 4


Picture 5



Ill. 049-54: Serial Vision, path 2


Picture 1


Picture 2


Picture 3


Picture 4


Picture 5

Path 3

Picture 1: From the starting point at the education building, VIA Aarhus, the context from the north side of the Godsbanen site is experienced. It as an area of new constructed buildings at a former industrial site, now called Ceresbyen. Colors diverge for grey scale building in concrete and glass. The horizontal lines in the VIA building stand in contrast to the building block in the background reaching for the sky.

Picture 3: A pedestrian bridge is crossing the water stream, Aarhus Å, and a calm and beautiful space is created, with the red brick scenery behind.

Picture 4: A row of low-dense buildings is placed along the water stream, creating an almost suburban atmosphere. Only a small pedestrian gravel path and a beech hedge are separating the inhabitants from the water stream.

Picture 5: Three story high apartment building appears in a green area, consisting trees and temporary kitchen gardens. The space is calm and restrained with the brown-yellow colored bricks.

Picture 6: From an opening in the apartment building the path leads to Carl blacks Gade and Godsbanen in the background A gravel pedestrian path from the north end of the site leads to the back side of Godsbanen. Here wild grass and bushes are creating a green and raw space.

Path 4

Picture 1: On the south side of the site starts the last path, on Eckersbergsgade in an area close to the train station. The area is defined by red bricked building block in three stories', consisting mainly apartments. Both cars and bicycles are parking along the street creating a traffic in relatively slow speed.

Picture 2: From the end of Gebauersgade the space opens towards the site of Godsbanen. The larger buildings of occupants create a marked contrast in the volume from the inner city to the rails and Godsbanen.

Picture 3: A gravel path brings the visitors closely past the parked trains, which creates a rather unique sight. The sight of Godsbanen appears and a traffic of pedestrians brings life to the space.

Registration from these four different paths towards and through the site shows that the biggest contrast in volume occurs from north-west, with high rise buildings blocks up to 20 stories' and lower blocks in 3-7 story height vs. the almost bare patch of land on the southern part of Godsbanen. On the other hand, there are no particular buildings in the context towards south west, hence the design of the co-housing must scale-down towards southwest. There is a contrast in materials from the very robust bricks and concrete building blocs to the light structured sheds and old train carriage in wood and trapezoidal steel boards, creating a more temporary space at the Godsbanen area. This gives a larger freedom in choice of materials, but as these materials and colors in particular brings a charm to the space, inspiration can be found in this. The placement of the site so near to the rail roads could contribute to noise pollution in the area, but as the trains passes in low speed, the sounds from the engines does not feel like a nuisance. The exact noise pollution is analyzed in the micro climate analysis, to specify if reduction is needed in the design.

Ill. 055-60: Serial Vision, path 3

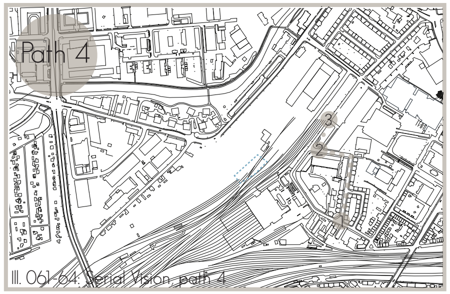

Picture 1


Picture 2


Picture 3


Picture 4


Picture 5



Ill. 061-64: Serial Vision, path 4


Picture 1


Picture 2


Picture 3

1.5 MICROCLIMATE

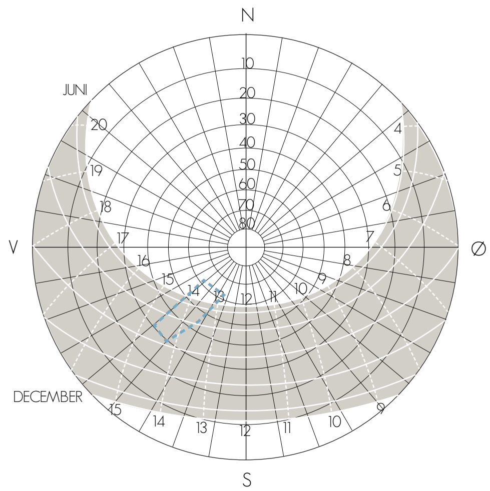
1.5.1 Sun and shadow analysis

To reach an understanding of the micro climate of the projects site, analysis of the sun and shadow on the project site is made, to clarify the potential and challenges of sun on the site. The analysis is based on a stereographic sun path diagram of Denmark along with an analysis of the annual shadow cast on the project site, simulated in the in winter and summer solstice and vernal equinox at 10 AM, 14 PM and 18 PM.

Visualized in the diagram (ill. 065), the angle between the sun and the ground changes over the year, due to the angle of which the earth is rotating around the sun. This affects the intensity of the heating of the sun and the length of the day. As seen on the diagram, with and angle of 10 degrees, the length of the day is about 7 hours at the 21th December, and at the 21 June the sun is up in 17 hours with an angle of almost 60 degrees at its highest point. This knowledge can help define the right orientation of the building in relation to placing windows to gain passive solar heating, if applying PV solar cell or solar panel on the building or when designing outdoor areas in the project. According to the sun path diagram, it will be necessary to orientate towards south-east to south-west to exploit the heating and intensity of the sun, depending on the purpose.

The sun path in correlation with the buildings in the context affect the amount of sun on the site, visualized on the diagram to the right (ill. 066). Based on the three chosen days of a year and in three different time of the day, the simulation shows that the projects site will be affected be the shadows casted from the train garages, used for workshop. Nevertheless, it is some of the less shadow affected space of the Godsbanen area, and when looking at the simulation in both March and June (app. 1), the project site will be fully exposed to sun during the day. The analysis does not conduct to the future plans of Aarhus K, which will be convey a much denser context, because of the missing district plan for the buildings in this exact area of Godsbanen. Despite this diffidence, the rail roads still create a certain distance to the train garages and the exploitation of the sun from south will be remained no matter the future plans for Aarhus K.

The project will focus on how to exploit the sun for passive heating of both the private and common areas as well as exploiting the sunlight in green common areas. The sun will be used for active initiatives such as PV cells.



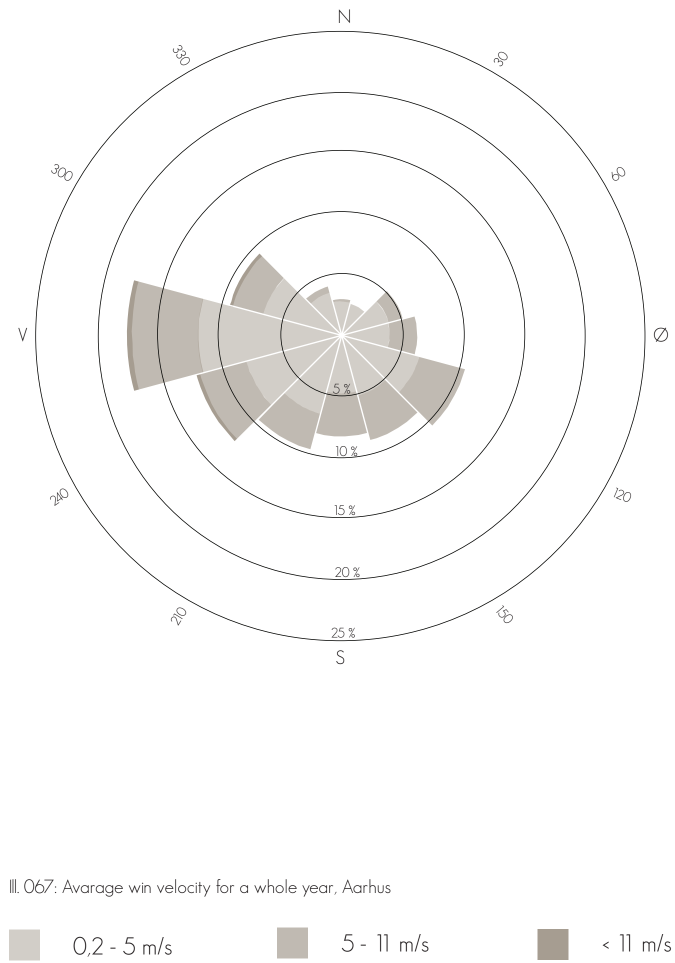
Ill. 065: Sun diagram for a whole year, Denmark

Ill. 066: Shadow intensity on site, from December to June

1.5.2 Wind analysis

To clarify wind direction in the location of the project site, an analysis of wind is made based on a wind rose from Ødum, outside Aarhus. (DMI.dk) The analysis will help clarify from which direction it will be most efficient to apply natural ventilation and in what way the building should be orientated in relation to shielding from the wind in outside areas.

The wind rose is illustrated on the diagram and shows the average wind direction and wind velocity based on a whole year at this specific area. It shows that the main wind direction is directly from west, with a wind velocity of 0,2-5 m/s 12 % of the time, 5-11 m/s 17 % of the time and upon 11 m/s 18 % of the time, which means that there is a relatively high velocity more than the half of the time the wind comes from west. The other frequent directions are west-southwest and south-southwest, where as the wind rarely comes directly from north. In this case, the orientation of windows in the building needs to be towards west, in order to ensure the needed amount of natural ventilation. As the project only will implement natural ventilation during summer, the wind direction is only verified through the summer month, June, July and August, which shows the same main wind direction. (app. 1) The same month are the relevant month in relation to designing outdoor space. As the future neighbor buildings are placed west from the project site, no screening from wind will be necessary. The wind analysis is not supplemented with a simulation of the wind flow through the site, as the future buildings around the project site will have a major impact on this, which are not designed yet.

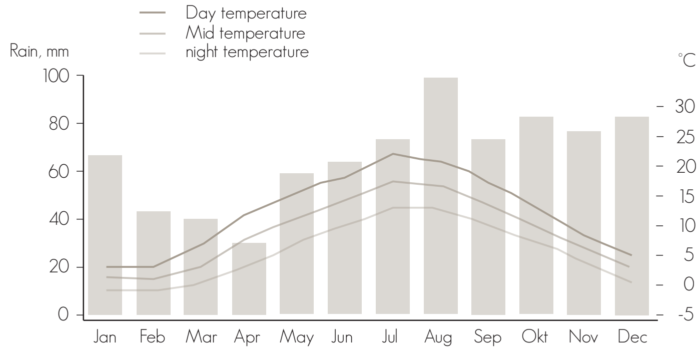


Ill. 067: Avarage win velocity for a whole year, Aarhus

1.5.3 Temperature and rain analysis

The analysis illustrates the weather standards in Mid Jutland measured from 1960 to 1990 and will create an understanding of the amount of rain and the temperatures of the project site. The knowledge will be brought into calculations and ideas of how to exploit rainwater to reuse in grey water systems, such as grey water for eventually washing machines and toilet flush. Furthermore, as mentioned in the development plan from the municipality, the project site is situated in a very low area, which will give problems on the site if not handled in the design. This will be elucidated in the design process.

The diagram shows that the average amount of rain in a month goes from 30 mm in April to 100 mm per month in August, and that the driest month is a period from February to April. In total the amount of rain water is 781 mm per year, cf. DMI. It will be relevant to calculate on the amount of rainwater possible to collect on the site, to clarify the possible grey water even in a dry period of 3 month. This makes basis for iterations in the design process, concerning usage of rainwater. As shown on the diagram the temperature rises towards the summer month, June, July and August, hence the exploitation of the outdoor spaces will increase in these month. As this is the month with the highest amount of rainwater, collection of the rainwater could be used as an integrated way in the building, creating water elements to embellish in the recreational areas.

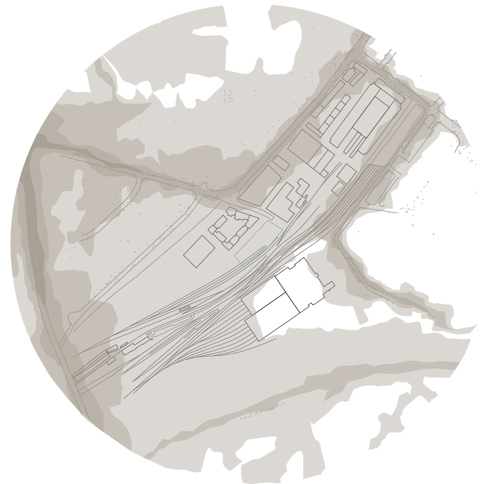


Ill. 068: Weather standards in Mid Jutland

1.5.4 Noice pollution analysis

The analysis illustrates the noise pollution from respectively cars and trains in daytime measured in a height of 1,5 meter. In corroborates the phenomenological observations made on site, described in the mapping. The knowledge will clarify if it is necessary to screen from the noise and in what amount.

When focusing on the illustration of the noise pollution from car traffic, it is very clear that Carl Blochs Gade contributes with traffic noise to the area, which I messsured to 55-60 dB at the project site. Both Vestre Ringgade and Sonnesgade contributes to this noise, but the observation on the site clarified that Carl Blochs Gade was the biggest sinner. Walking towards the south-west part of the Godsbanen area the noise from Vestre Ringgade became more dominant. As mentioned in the mapping, quantitative data would show if the sounds from the train traffic would have any impact on the project site. As illustrated on the second diagram (ill. 070) the noise from trains is not measured upon 55-60 dB, which means that there will have little or no relevance to screen from noise in this direction. Nevertheless, the data can be an expression of a larger interval between the trains passing by the area as well. The permitted level of noise in a newbuild housing area is 58 dB according to Miljøstyrrelsen, hence it will be necessary to reduce the noice pollution from Carl Blochs Gade.



Ill. 069: Noise pollution from car trafic, day 1,5 m height

Ill. 070: Noise pollution from train trafic, day 1,5 m height

55-60 dB 60-70 dB 70-75 dB < 75 dB

1.6 ANALYSIS CONCLUSION

1.6.1 Conclusion

Knowledge reached through the analysis must be integrated in the design from an early stage of the design process, in this way a holistic sustainable design will be reached. The conclusions from each analysis is combined to a list of design criteria, which will function as a driving force and a check list throughout the process, concerning the user segment, the themes, the context and the micro climate. The goal is to create a holistic sustainable and integrated design of an urban co-housing, which reflects its community-orientated strategy and its time.

1.6.2 Main design criteria

User segment:

Singles/couples, age 20-40, upon 9 m^2, close to public facilities, space for bicycles
Families, 1-3 children, flexibility, rooms for children, space for car
Elderly, 60+, elevator to apartments, balconies or terraces, accessibility, space for car
Common facilities: Requirements of room and facilities solved jointly. Kitchens, gardens, terraces, multi-rooms for activity, hobby rooms.

Themes:

Mixing user groups and bridging generations
Solving demands of dwelling today
Prioritizing common space seen in the strategy of private, semi private and public space
Passive initiatives: low U-value, demanded daylight, natural ventilation in summer, mechanical ventilation with heat recovery in winter, orientation of building
Active initiatives: renewable energy sources; PV cells
Zero energy strategy: Net Zero Source
Tectonic handling of the architecture and materials

Case studies:

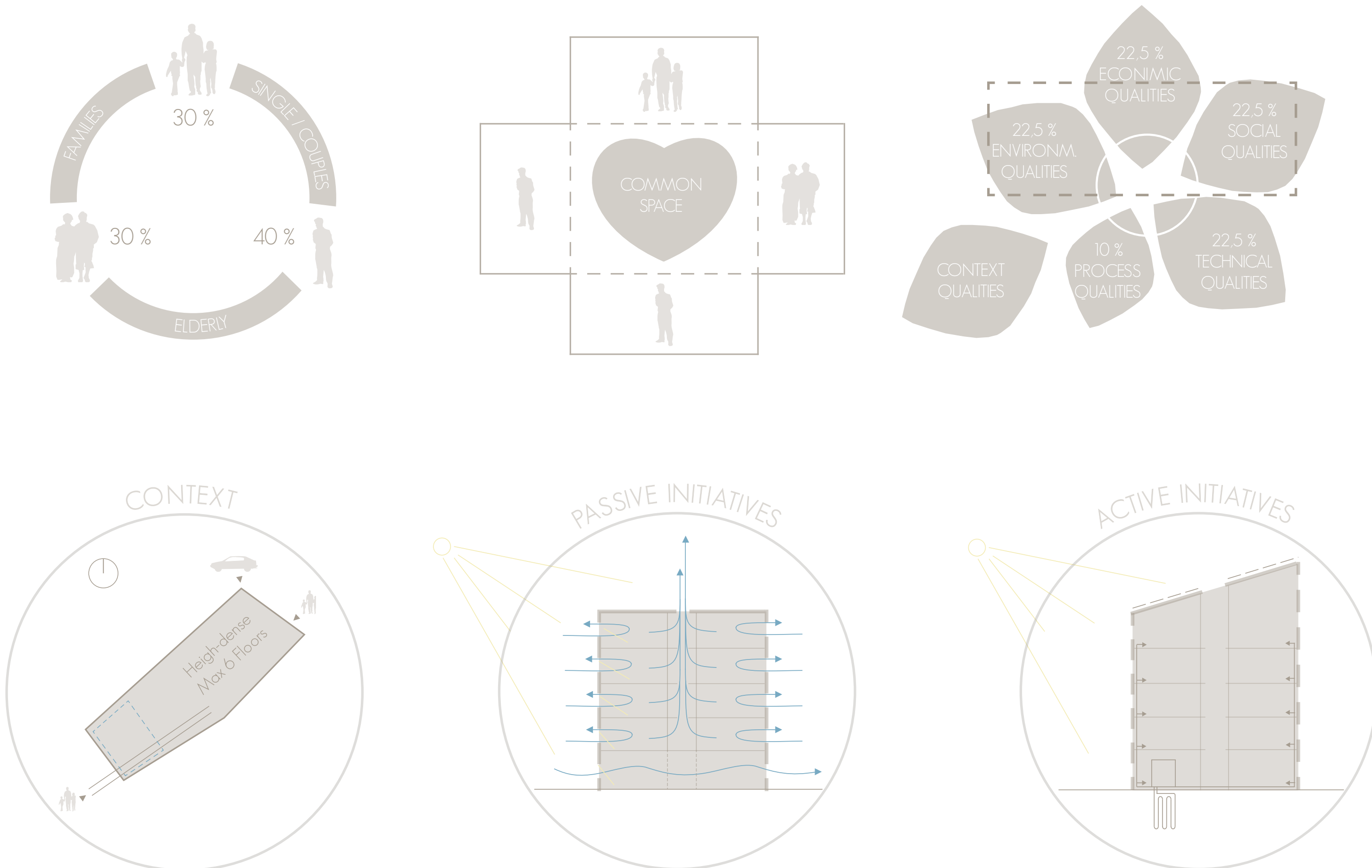
Bringing qualities of sub-urban co-housing into an urban co-housing
Compulsory community to some extend with common meals, activities, maintenance and cleaning
Sustainable choice of materials
Architectural language that reflects the community

Context:

Site at part-area 3 according to evaluation plan in Godsbanen south, the future Aarhus K
Maximum 6 floors height
Building percentage 150-200 ≈ 5364-7152 m^2
Incorporating existing rails on site as pedestrian path towards sub-area 4, the green area
Handling of rain water in delay basins
Using materials of bricks, wood, concrete, steel or iron
Creating a public ground floor
Experimenting in architecture in the creative area
Public part must connect to northern part of context
Density and height must increase towards north
Green areas must connect to the southern part of context with recreative areas

Micro Climate:

Exploitation of solar radiation with indoor solar heating, in green areas, for PV cells and eventually solar collectors facing south-west
Exploit wind from west in summer for natural ventilation
Exploit rainwater for grey water to toilet flush
Drain superfluous rain water via delay basins on site
Screen from noise from Carl Blocks Gade with either vegetation or as a part of the facade



Ill. 071: Design Criteria

1.6.3 Vision and problem statement

The vision of this master thesis is to create a new way of designing dwellings that meats the demands of today, focusing on the humans basic need to belong. With a high degree of social sustainability, the project should articulate why co-housing is the optimal way of designing dwellings in the future.

How can holistic sustainable co-housing in a urban context address the mans basic need to belong?

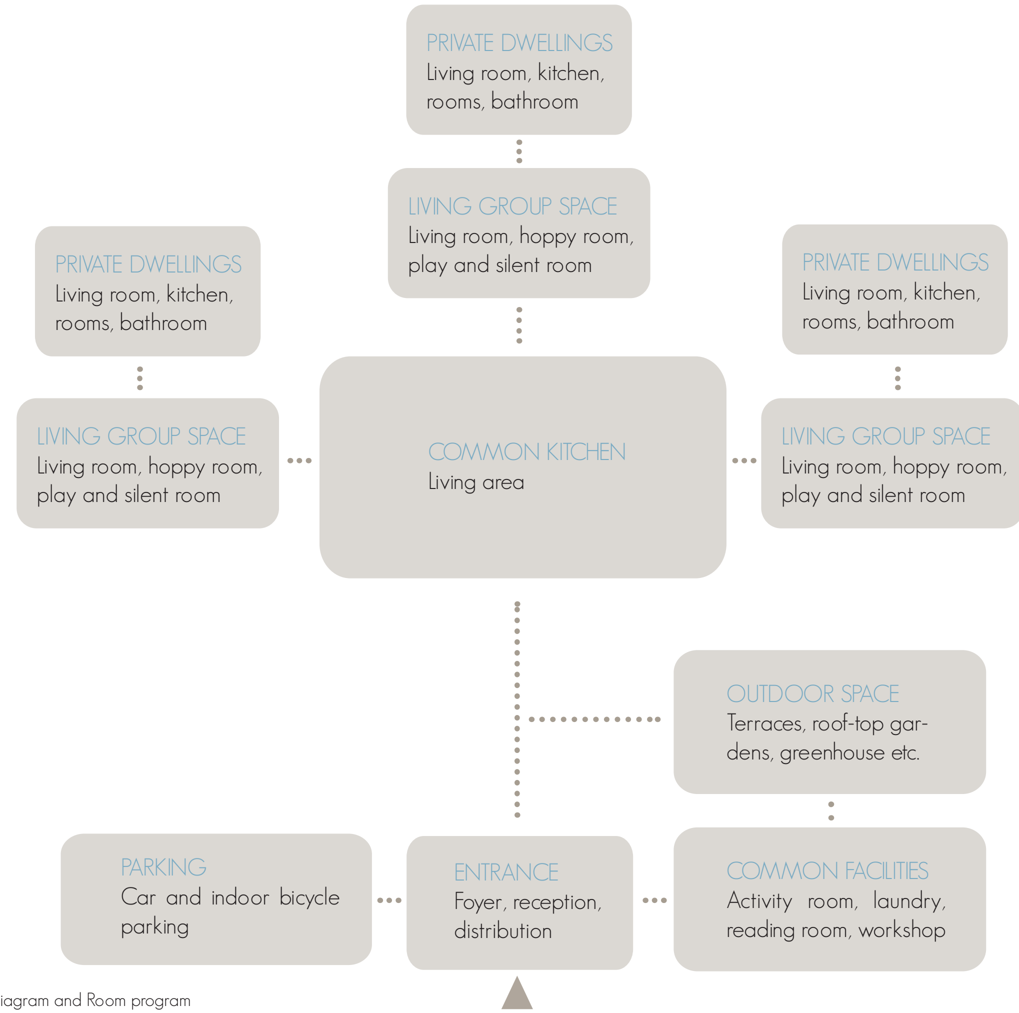
1.6.4 Function diagram

The function diagram illustrates the connection between the rooms desired in the project. It is a simplification of the room program, showing the overall strategy for connection between the areas in the co-housing.

1.6.5 Room program

The urban co-housing must preferably consist of 50 dwellings arranged in different living groups, whereas 25 units are for the single/couple user-group, 15 units are for the families and 10 units are for the elderly. The whole project should include maximum 5 % of commercial functions in the ground floor. The project should consist of common space, semi-private space created by facilities in the living groups, and private space in the dwellings. The properties of the different rooms are listed in the room program (Ill. 073) Designing 50 housing units with the chosen user groups, the project provide homes for approximately 150 people. The gross floor area is calculated to 2300 including a share in the common spaces and acess areas, by calculating the amount of dwellings multiplied by the maximum size of dwellings. Respectively 30 m^2 for singles/couples, 50 m^2 for elderly and 80 m^2 for families with max. 3 children. The space for the private rooms are challanged as a part of the project.

Additional to the rooms and facilities mentioned in the room program is both different outdoor spaces and secondary functions. The outdoor area must provide space for green houses, roof gardens, herb gardens, ball field, playground, intimate seating areas, eating areas and bicycle parking. The secondary function is car parking for private cars and eventually shared cars, indoor bicycle parking, storage, cleaning-, ventilation- and technique rooms. Calculation on fesh air supply see aap. 1.



Ill. 072-073: Function diagram and Room program

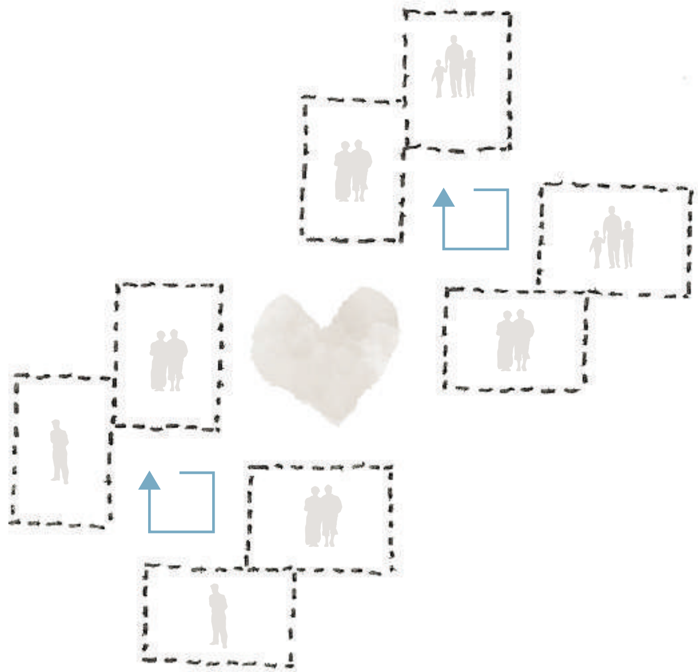
COMMON SPACE (total ca. 920 m^2)	Space, m^2 / room	Functions	Capacity (people)	Architectural quality	Fresh air supply, l/s	Ventilation type	Daylight factor, %
Common kitchen + living room	280 m^2 + 20 m^2 (If 2 m^2 / pers. + kitchen)	Common coockery, meals. meetings	140 pers.	Light colors and materials, open and transparent, integrated noise absorbtion, welconing atmosphere	1237 l/s + 20 l/s	M + N	3 %
Reception / adm.	10 m^2 (1-2 persons)	Welcoming guests, administrating	1 - 2 pers.	Minimalistic in form and use of material, colors, grafic or lighting that catches the eye	0,3 l/s	M + N	3 %
Activity rooms + bath fascilities	280 m^2 + 50 m^2 (if 2 m^2 / pers + baths)	Exercise, dance, yoga and taking bath	140 pers.	Hard-wearing materials, light colors, integrated noise absorbtion, expand room hight	1414 l/s	M	3 %
Common laundry room	30 m^2 (4 WM + 4 Dryers)	Doing laundry, drying close	10 pers.	Functional, comftable seatings for waiting area, warm colors, smooth surface thats easy to clean - invite for sojourn	20 l/s	M + N	3 %
Common reading room / office space	100 m^2 (for 50 pers. at same time)	Studiyng, reading, shearing information, meetings	50 pers.	Light colors and transparent facades, flexible rooms-deviding elements, integrated noise absorbtion	15 l/s	M + N	3 %
Workshops: wood, metal bicycle repair etc.	150 m^2 (for 30 pers. at same time)	Creating, handicraft, fix and maintain common property, repair bicycles	30 pers.	Raw-looking materials, reused materials, surfaces easy to clean, light rooms and transparent facade, visible installations	860 l/s	M + N	3 %
LIVING SPACE, incl. (total ca. 3500 m^2)							
Kitchens / kitchenets	4 - 8 m^2 (Depending on user group)	Private coocking, conversation	1 - 2 pers.	Compact, flexible, light and minimalistic	20 l/s	M + N	3 %
Bedroom	6 - 14 m^2 (Depending on user group)	Sleeping, changing, storage close etc.	1 - 2 pers.	Compact, light, eventually incoorporated furnitures	0,3 l/s	N	3 %
Living room	10 - 20 m^2 (Depending on user group)	Sojourn, conversate, eating,	1 - 5 pers.	Compact, light, eventually incoorporated furnitures, views towards outdoor common spaces	0,3 l/s	N	3 %
Childrens room	8 - 12 m^2 (For different ages)	Sleeping, changing, storage of close and toy	1 pers.	Compact, light, eventually incoorporated furnitures, flexible both inside the room and between neighboor-room	0,3 l/s	N	3 %
Bathroom	2 - 6 m^2 (Depending on user group)	Go on toillet, taking a bath, changing	1 pers.	Compact, light and minimalistic, accesable in homes for elderly, sufaces easy to clean, tiles and wetroom paint	15 l/s	M	-
COM. LIVING SPACE IN LIVING GROUPS							
Living room (w. kichen in chosen living groups)	10 - 16 m^2 (2 m^2 / pers. in living group)	Sojourn, conversation, watch tv, or listen to music, coocking	5 - 8 pers.	Warmth, tactility, comftable seatings, equality distributing to the private homes of the living group	0,3 l/s	M + N	3 %
Hobby-room	10 - 16 m^2 (For 5-8 pers. at same time)	Creating, rehearsing, share knowledge	5 - 8 pers.	Raw-looking materials, reused materials, surfaces easy to clean, light	0,3 l/s	M + N	3 %
Play room (only in chosen living groups)	16 m^2 (All children in livving group)	Playing, singing	8 pers.	Warmth, surfaces easy to clean, flexible furnitures in childrens hight, integrated arbsorbing material	3,5 l/s	M + N	3 %
Silent zone	10 - 16 m^2 (For 5-8 pers. at same time)	Reading, relaxing, yoga	5 - 8 pers.	Warmth colors, less daylight, tactility, integrated noice absorbtion, comftable seatings	0,3 l/s	N	3 %
ACCESS AREA (counted in BBR)							
Common access area	Preferible max. 10 % of total amount of square meters	Walking, conversation, sojourn, exhibit, grow plants	2 people passing, 1,3 m	Light colors and materials, claen sufaces proviting space for exhibition, integrated noise absorbtion, niches	0,3 l/s	N	3 %
Local acces area	Preferible max. 5 % of total amount of square meters	Walking, conversation, sojourn - preferible as part of functions	2 people passing, 1,3 m	Light colors and materials, integrated noise absorbtion, preferibly as a part of other functions in the living group, more private atmosphere	0,3 l/s	N	3 %
TOTAL BUILDING	5985 m^2	Co-housing	ca. 100 pers.	Architecture that reflects the community-strategy, sustainable choice of materials, combining rawness and tectonic architectre	Total energy consumption: 30,0 kWh/m^2/year		

2 | PRESENTATION

2.1 CONCEPT

2.1.1 The concept: Urban Co-living

The project is based on the concept of urban co-living, which create inspirational living spaces that encourage a sense of community and social interaction in the builidng and in the developement of the city. The collaborative housing types embraces the common area, accessed by cores in the center of the housings. With focus on social sustainability the design are centered around the inhabitants comfort along with the environmental considerations.



Ill. 074: Concept diagram

2.2 DESIGN

2.2.1 Principles of the design process

The design is based on the criteria articulated in the analysis phase, concerning the context, passive and active strategies, user segment and themes.

The first step illustrates the needed orientation of the building on the narrow projects site along with the considered accesses from the context.

A building field is divided into housing units with individual orientation to only one side (step 2).

Each housing units are rotated 45 degrees to create individual orientation in two directions, respectively west/north and south/east, to enhance the view and passive strategy of daylight and natural ventilation in summer. The rotation creates squared areas in between the housing units. These areas becomes stair and elevator cores and the larger squares creates space for the common areas (Step 3)

The principle in the masterplan is raised to a building volume and the volume is sloped from north east down to south west. In this way the building connect to the future plans of the area in relation to hight and the meeting with the building from the green wedge. (Step 4)

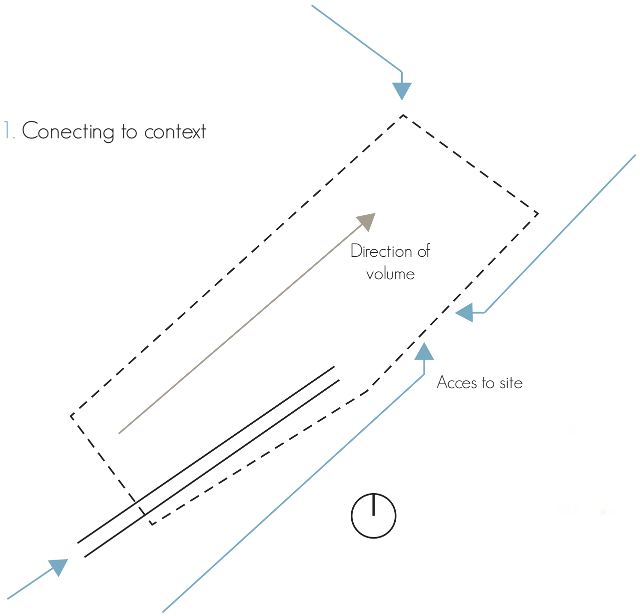
To minimize the footprint of the building and create a more public ground floor, all the private and semiprivate zones are lifted 5 meters from the ground, remaining only the public facilities and entrances on the ground. This provides more green area, which enhances the absorption and seeping of rain water on the site. (Step 5)

The fifth facade is utilized for respectively common roof terraces for the living groups, roof garden for the whole co-housing and solar cells on the roof area which is not visible for the inhabitants and the public. In this way the passive and active initiatives creates a zero energy building and a social sustainable building.

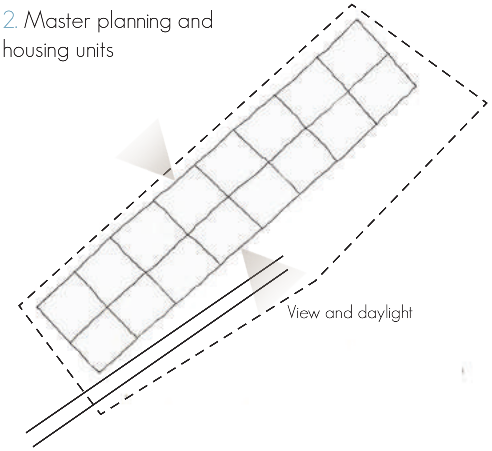
An elaborated description of the design process is seen in chapter 3: Design Process.

Ill. 075: Right: Principles of design process

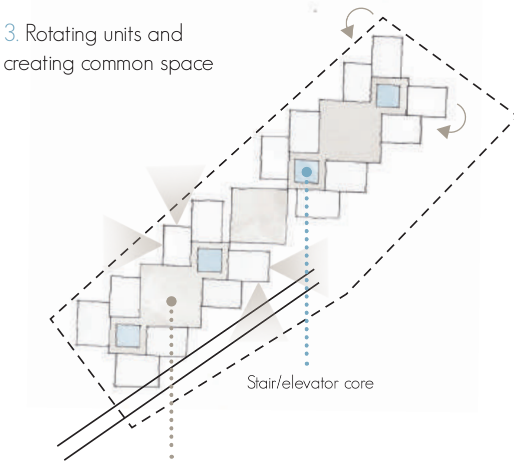
1. Conecting to context



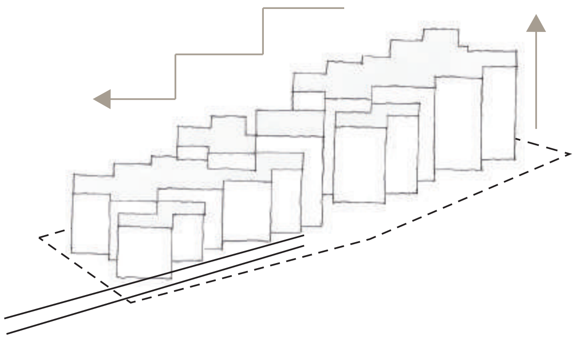
2. Master planning and housing units



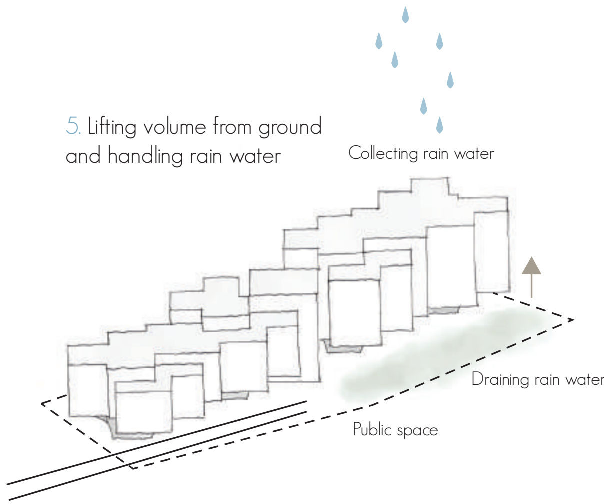
3. Rotating units and creating common space



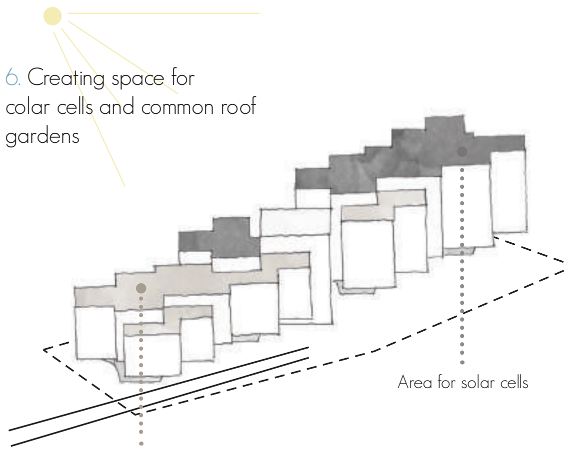
4. Rising building volume and sloping towards north



5. Lifting volume from ground and handling rain water

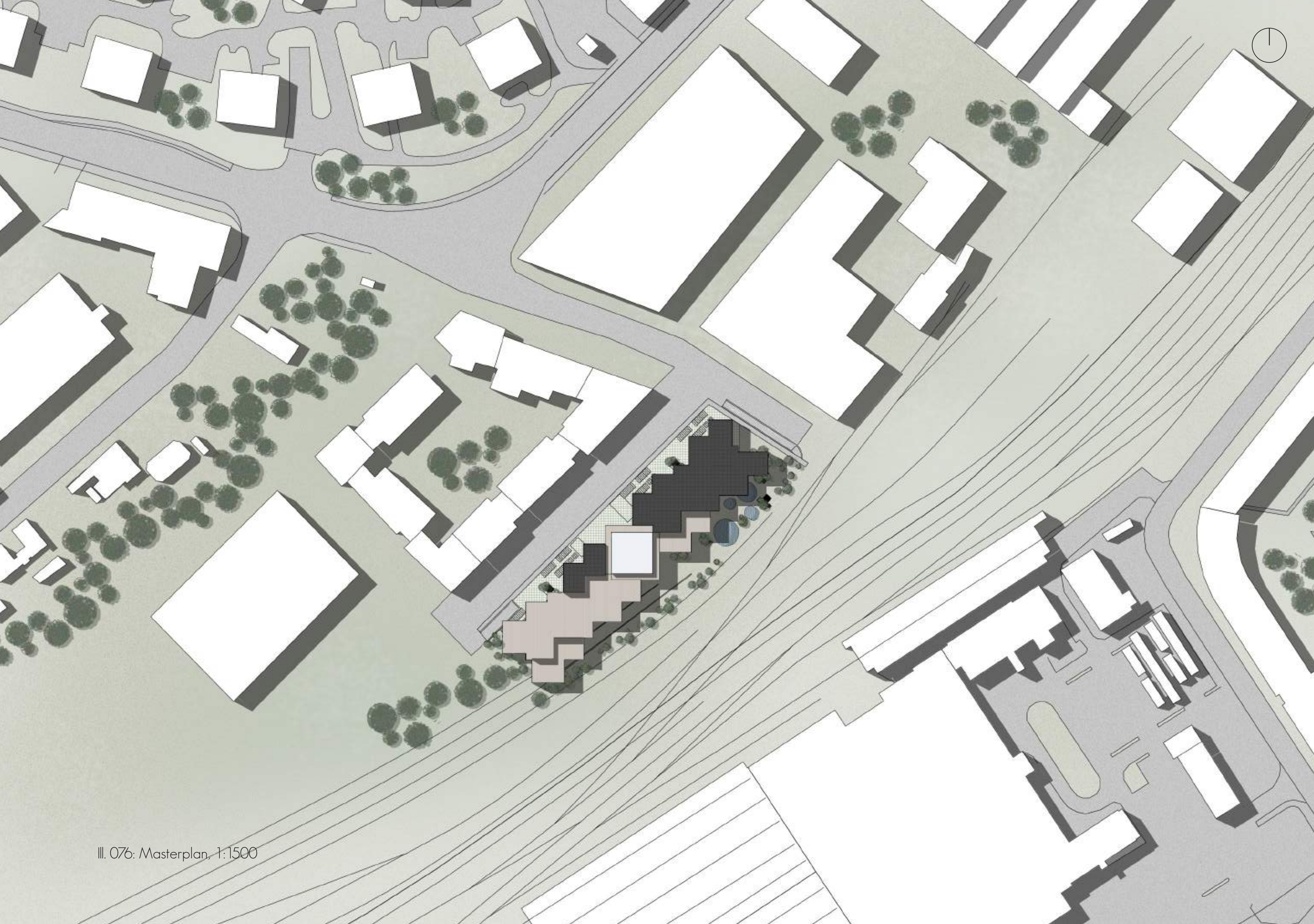


6. Creating space for colar cells and common roof gardens



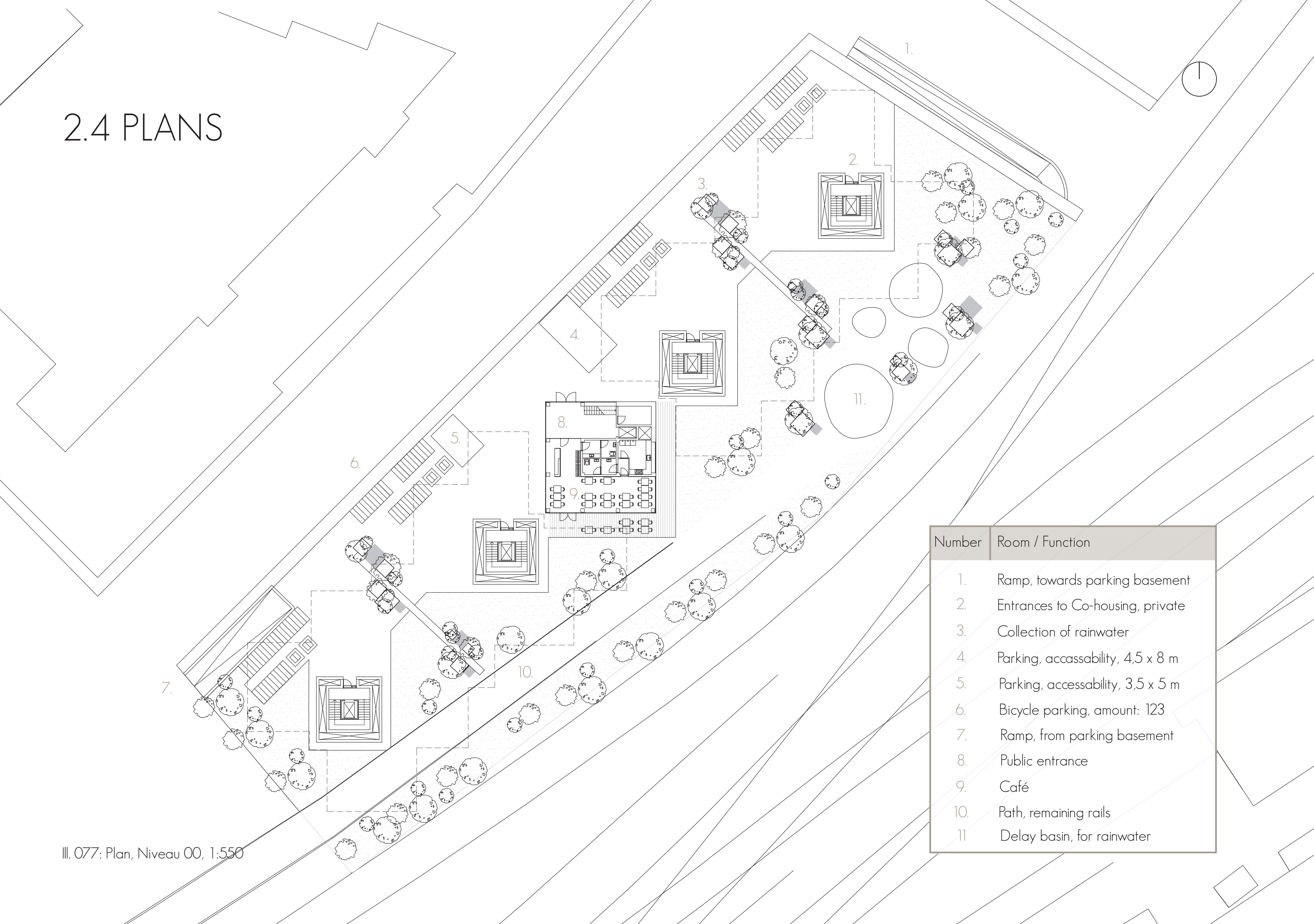
2.3 MASTERPLAN

Urban Co-Living is a 7679 m² sustainable co-housing complex consisting homes for single, couple, families and elderly in a variety of 6 different apartment types. 58 apartments are created and located around the common spaces, which functions as an extension to the apartments and encourage for inhabitants to interact. Additional common areas for the whole complex is placed int he center of Urban Co-living and becomes the heart of the site. From here the common spaces transits into the public spaces placed in connection to the public ground floor and green area. Plans, elevation, sections and renders illustrates the principles of Urban Co-living throughout this chapter.



Ill. 076: Masterplan, 1:1500

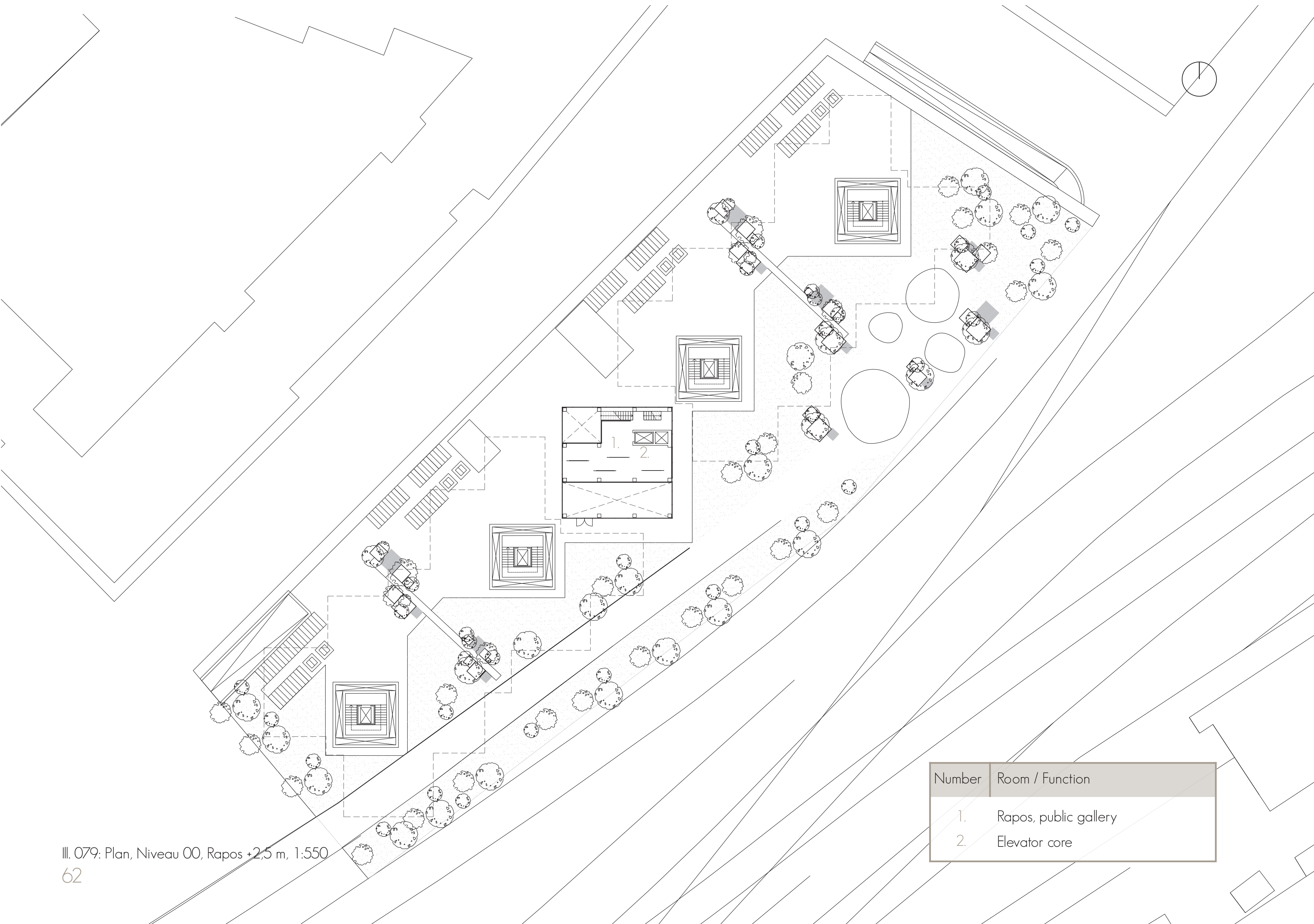
2.4 PLANS



Number	Room / Function
1.	Ramp, towards parking basement
2.	Entrances to Co-housing, private
3.	Collection of rainwater
4.	Parking, accassability, 4,5 x 8 m
5.	Parking, accessability, 3,5 x 5 m
6.	Bicycle parking, amount: 123
7.	Ramp, from parking basement
8.	Public entrance
9.	Café
10.	Path, remaining rails
11	Delay basin, for rainwater

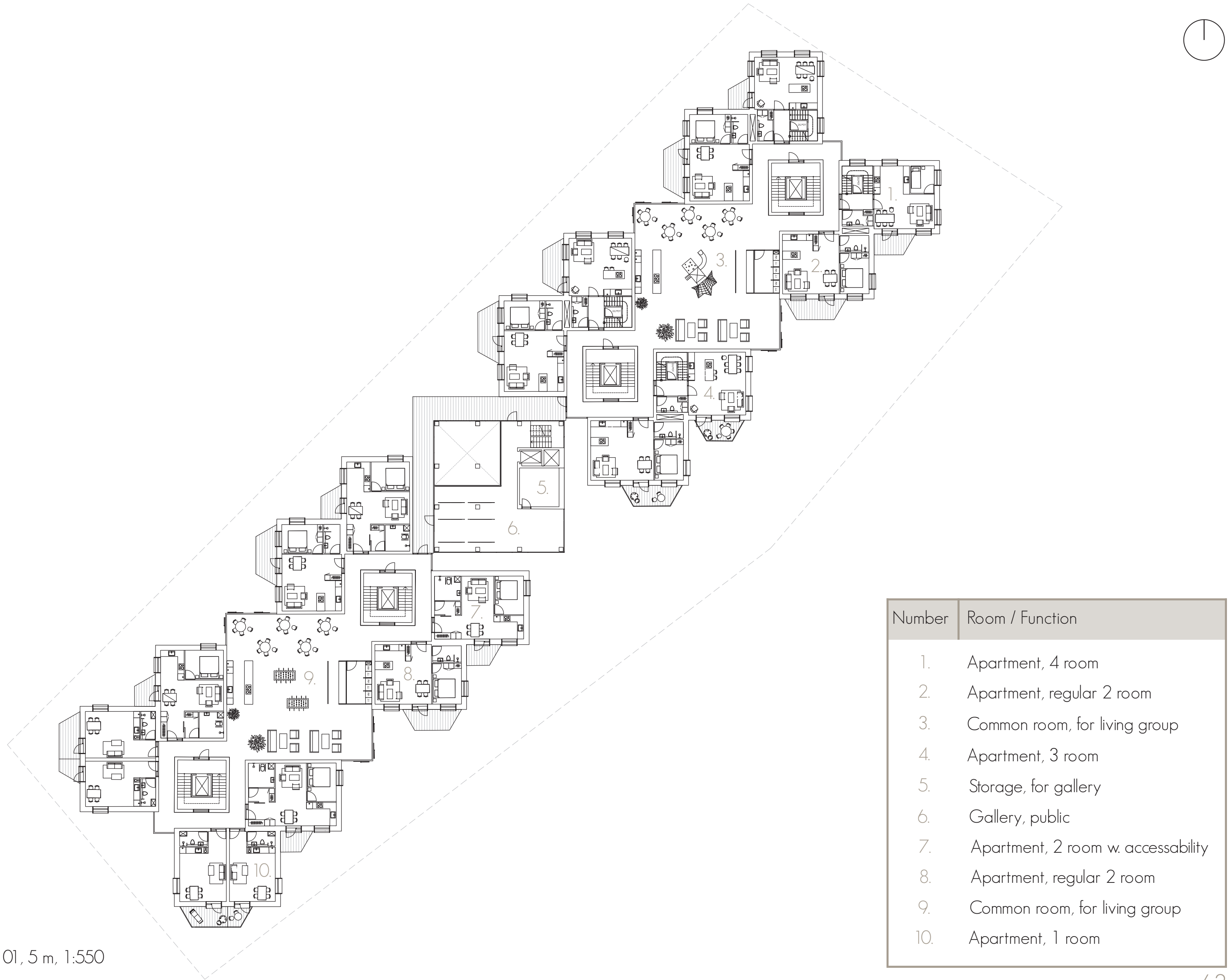
Ill. 077: Plan, Niveau 00, 1:550

Ill. 078: Render: public green area



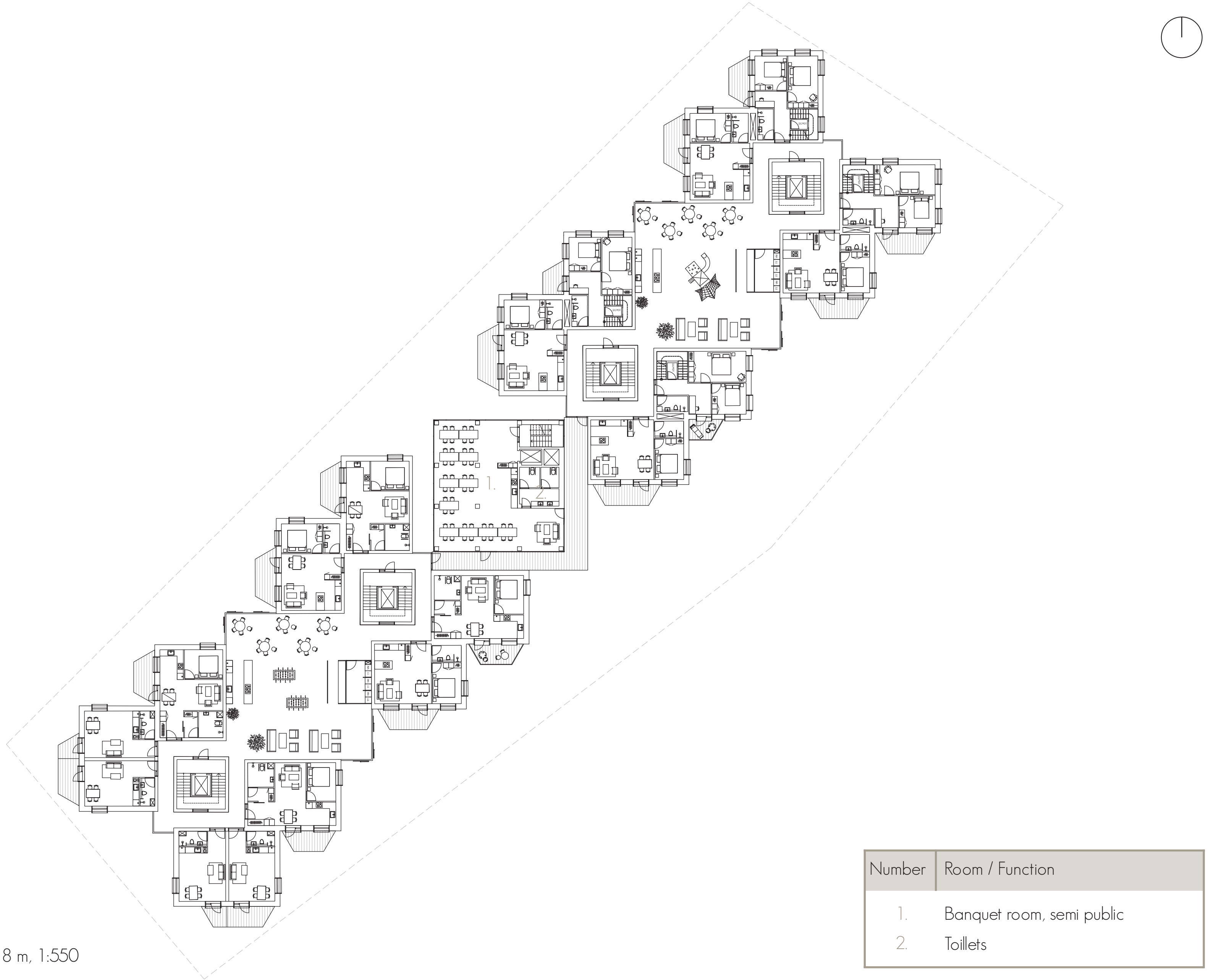
Number	Room / Function
1.	Rapos, public gallery
2.	Elevator core

Ill. 079: Plan, Niveau 00, Rapos +2,5 m, 1:550



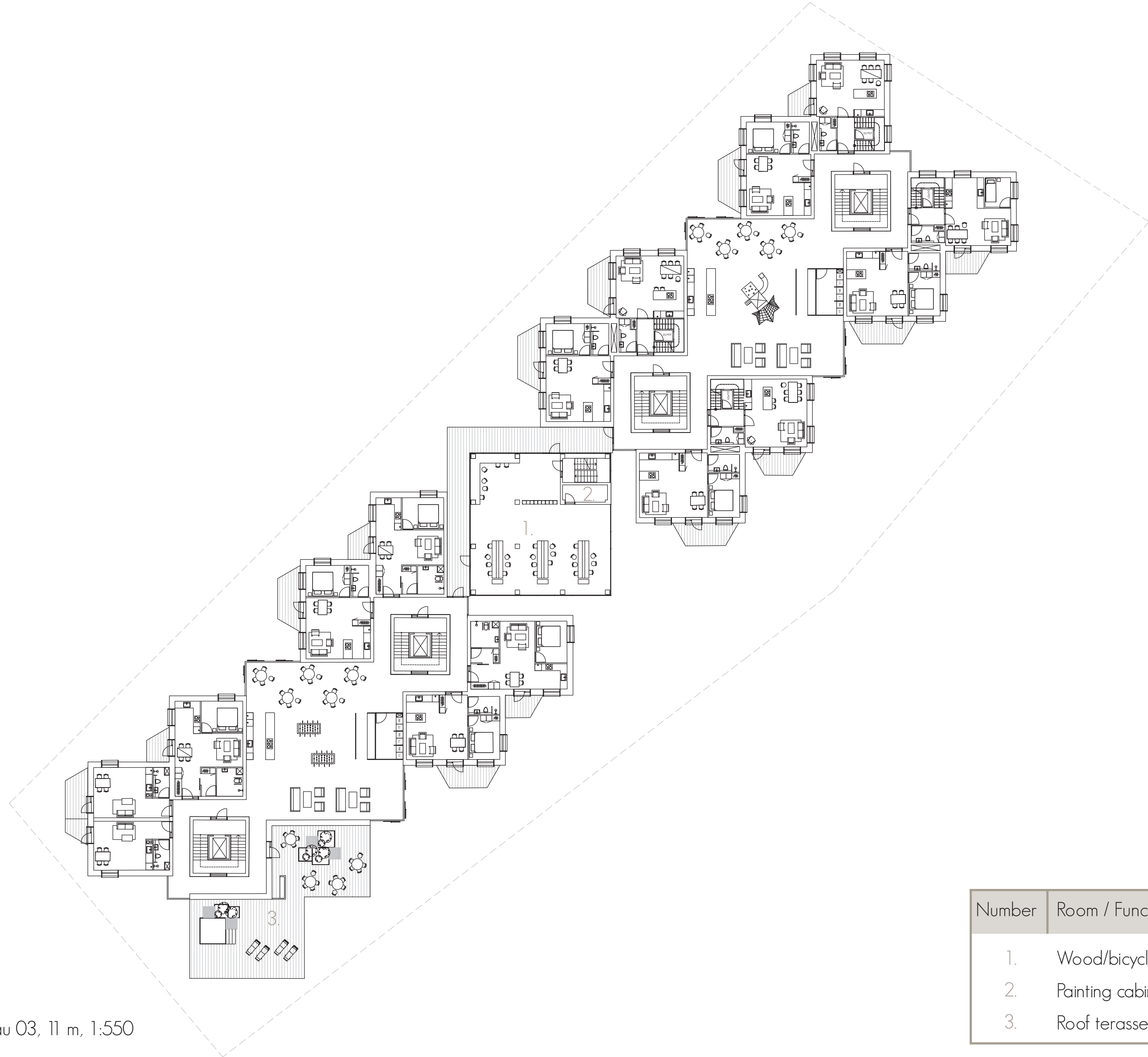
Ill. 080: Plan, Niveau 01, 5 m, 1:550

Number	Room / Function
1.	Apartment, 4 room
2.	Apartment, regular 2 room
3.	Common room, for living group
4.	Apartment, 3 room
5.	Storage, for gallery
6.	Gallery, public
7.	Apartment, 2 room w. accessability
8.	Apartment, regular 2 room
9.	Common room, for living group
10.	Apartment, 1 room



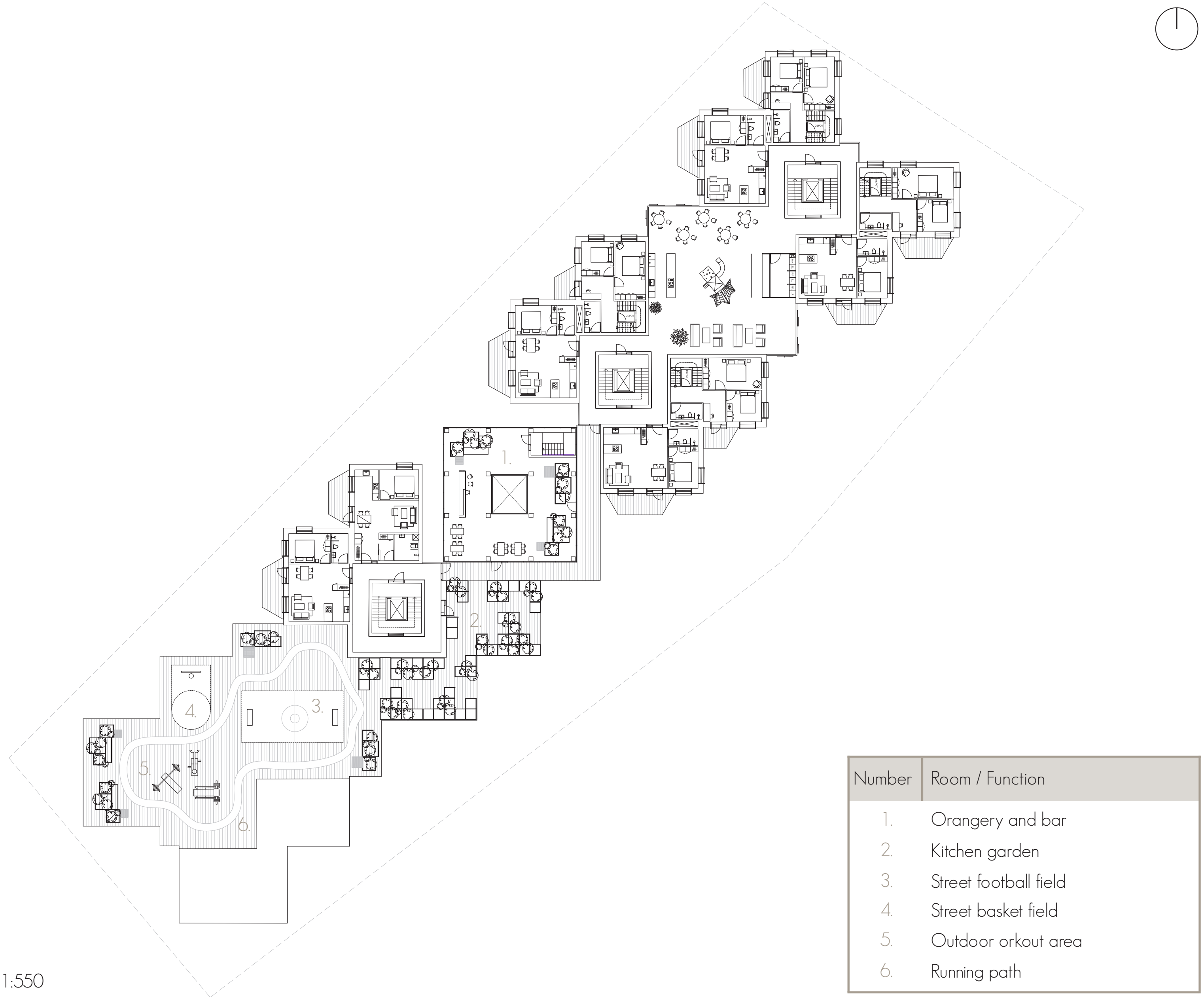
Number	Room / Function
1.	Banquet room, semi public
2.	Toillets

Ill. 081: Plan, Niveau 02, 8 m, 1:550



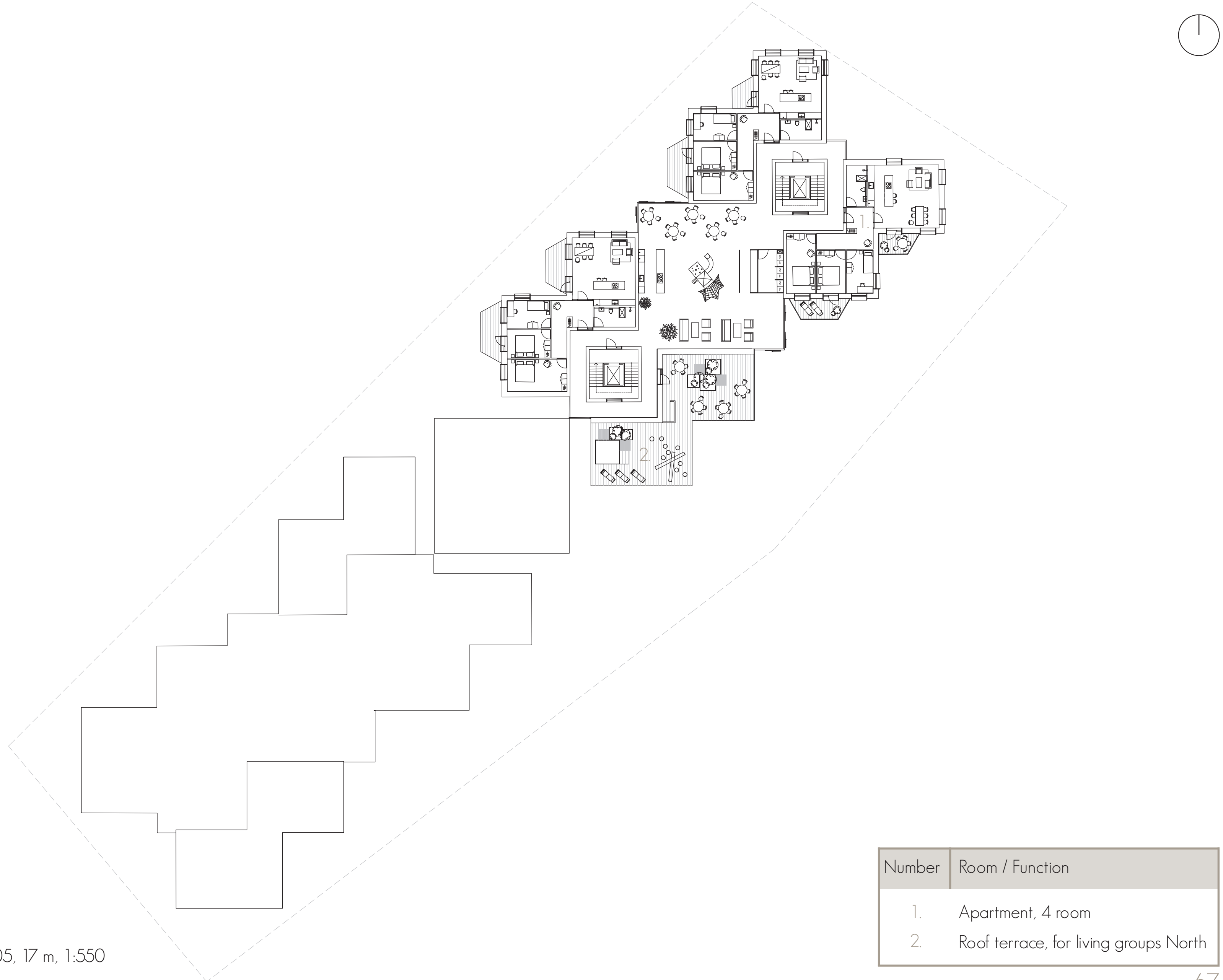
Number	Room / Function
1.	Wood/bicycle workshop and atalier
2.	Painting cabin
3.	Roof terasse, for living groups South

Ill. 082: Plan, Niveau 03, 11 m, 1:550



Number	Room / Function
1.	Orangery and bar
2.	Kitchen garden
3.	Street football field
4.	Street basket field
5.	Outdoor orkout area
6.	Running path

Ill. 083: Plan, Niveau 04, 14 m, 1:550

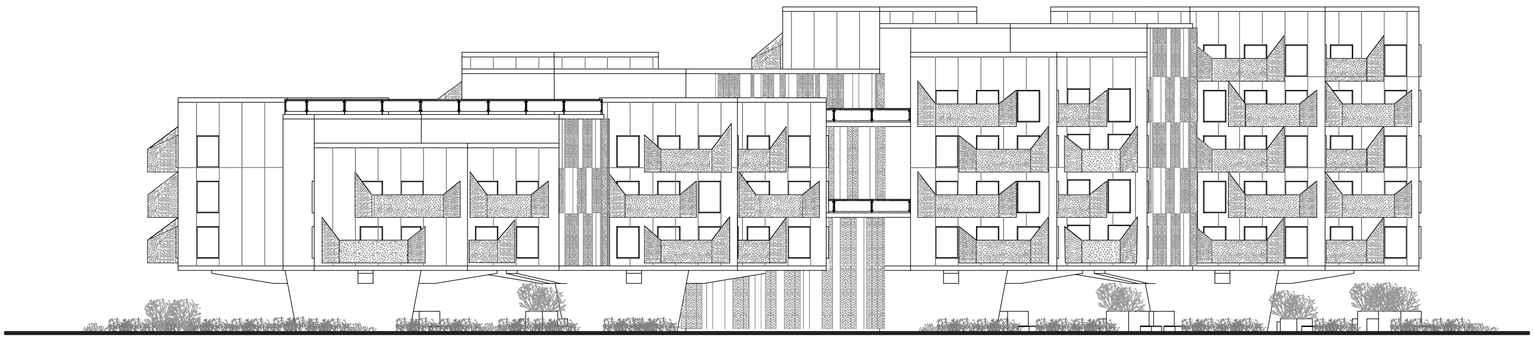


Ill. 084: Plan, Niveau 05, 17 m, 1:550

Number	Room / Function
1.	Apartment, 4 room
2.	Roof terrace, for living groups North

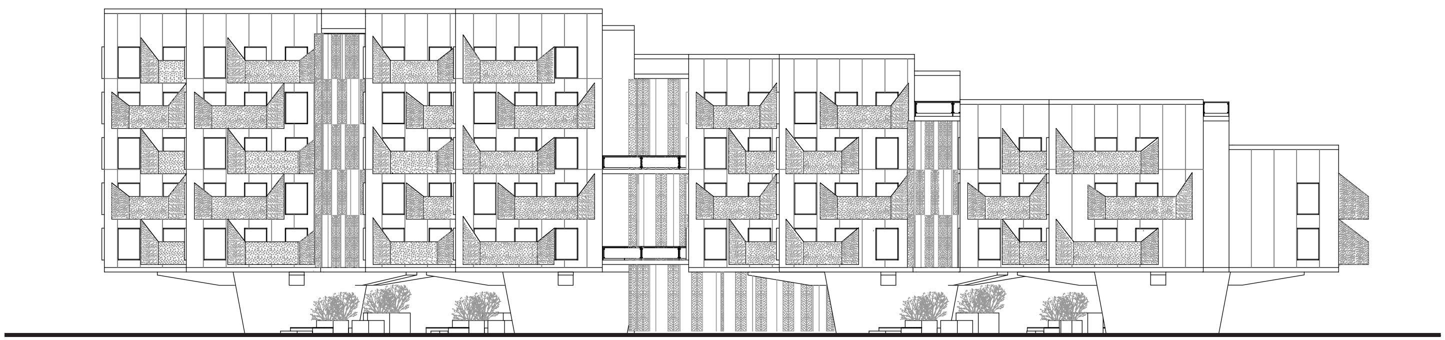
2.5 ELEVATIONS

Ill. 085: Elevation, North, 1:500



Ill. 086: Elevation, South, 1:500

Ill. 087: Elevation, East, 1:500



Ill. 088: Elevation, West, 1:500

2.6 SECTION

To connect with the context and the future area of Aarhus K, the central building segment is a mixed public and semi public space, consisting both commercial functions and common spaces of which differentiates from the common rooms within the living groups. The section and the associated list of rooms describe the transition from the public functions to the functions that are reserved the co-housing.

The public entrance is orientated towards north to connect with the future district and opens in a 3 floor high room, from where the café and the gallery is visible. From this entrance the public facilities and the remaining floor plans are accessible with a stair and elevator.

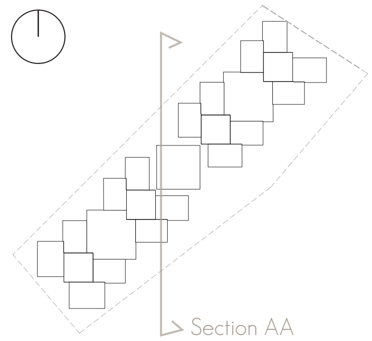
The café creates a transparent facade towards south and east, from where visitors are reached as an extension of the path created by the rails and the green area on the ground floor.

Nivaeu 02 consists of a banquet room which is rentable for both the inhabitants and the public, creating a semi public transition to the remaining floors which is reserved the co-housing.

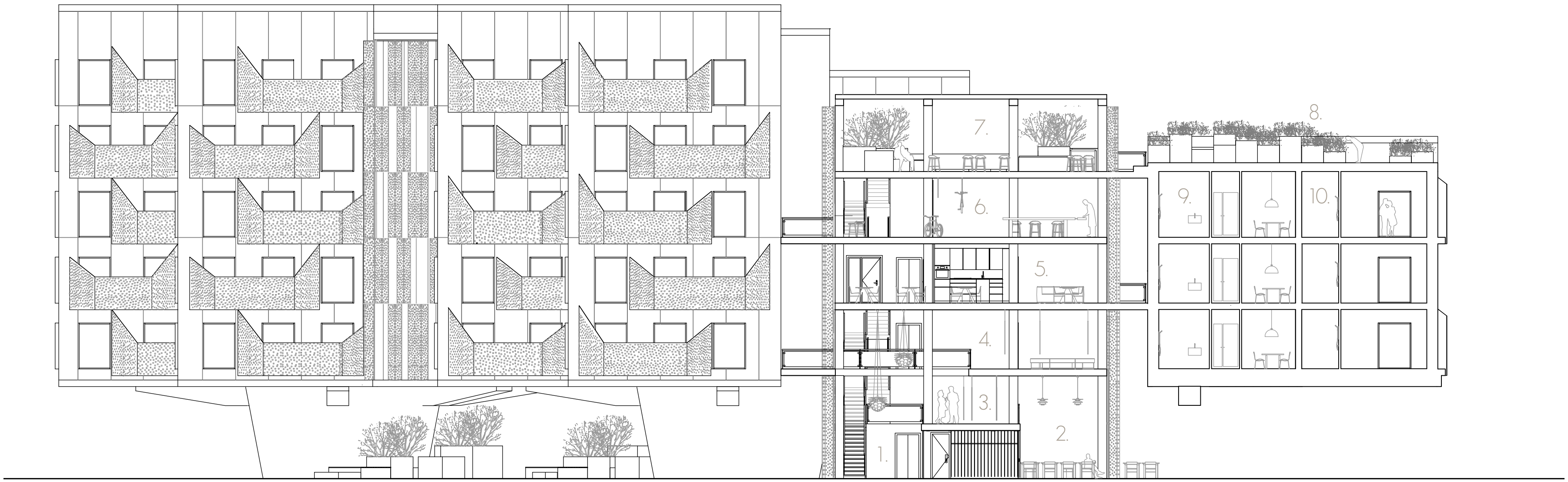
The combined wood workshop and atelier is placed on the Niveau 03 and opens as a double high room in the center, to connect with the orangery and bar on Niveau 04. The combined orangery and bar is design with a transparent facade and roof, for a transition to the roof gardens associated with this room. Urban elements for vegetation and seatings along with a bar desk are placed in the room, creating an urban atmosphere.

The whole building segment is held transparent by using glass facades and adding mobile perforated corten steel lamella external on the facade.

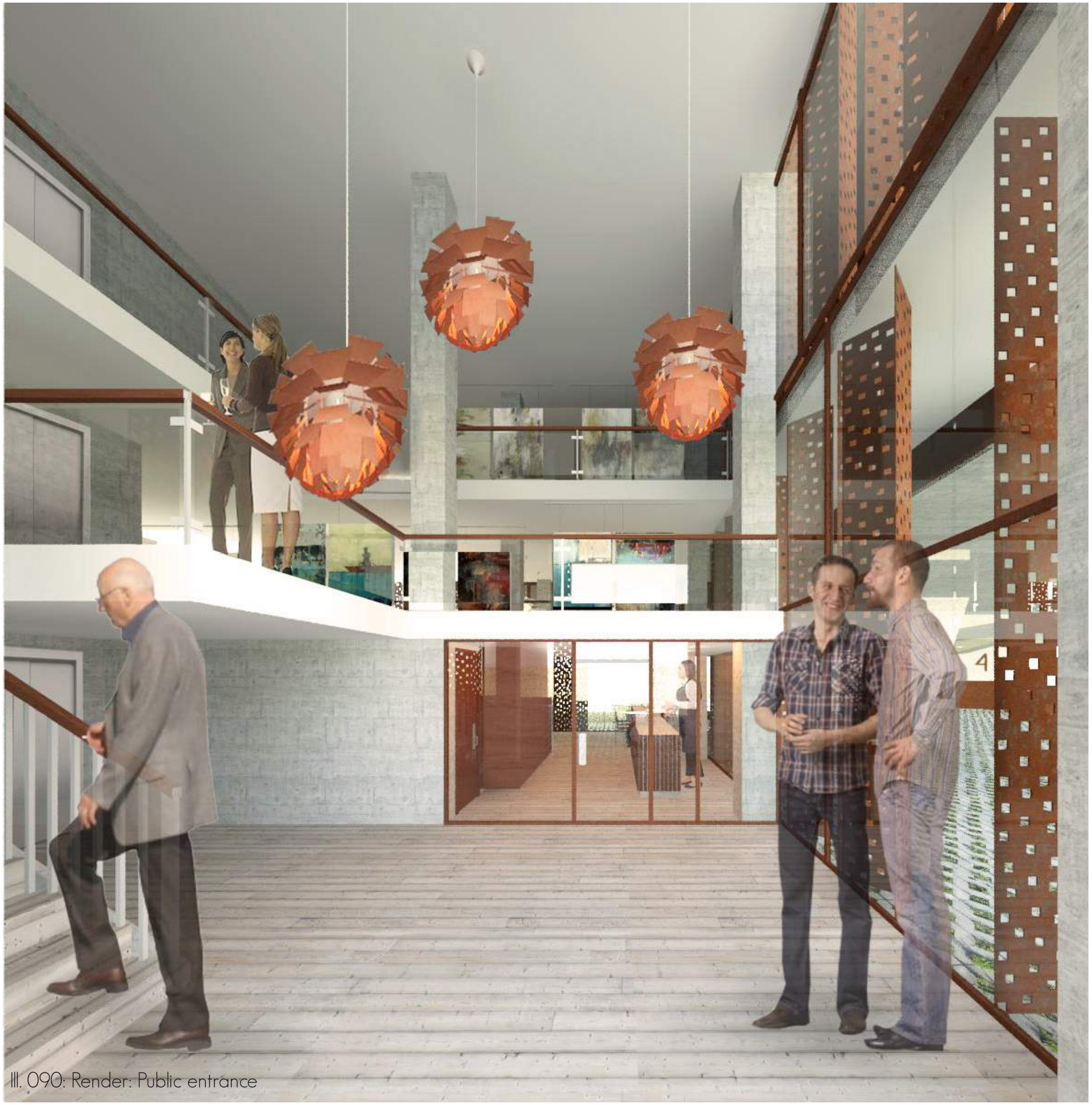
An selection of the rooms and functions are visualized in the next few pages.



Number	Room
1.	Public Entracne, Niveau 00
2.	Café, public, Niveau 00
3.	Atalier, Niveau 00 Rapos
4.	Atalier, Niveau 01
5.	Banquet room, Niveau 02
6.	Workshop, Niveau 03
7.	Orangery/Bar, Niveau 04
8.	Kitchen garden
9.	Apartment, 2 room w. accessibility
10.	Apartment, regular 2 room



Ill. 089: Section, common/commercial, 1:300



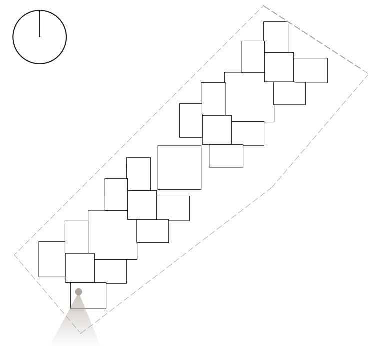
Ill. 090: Render: Public entrance

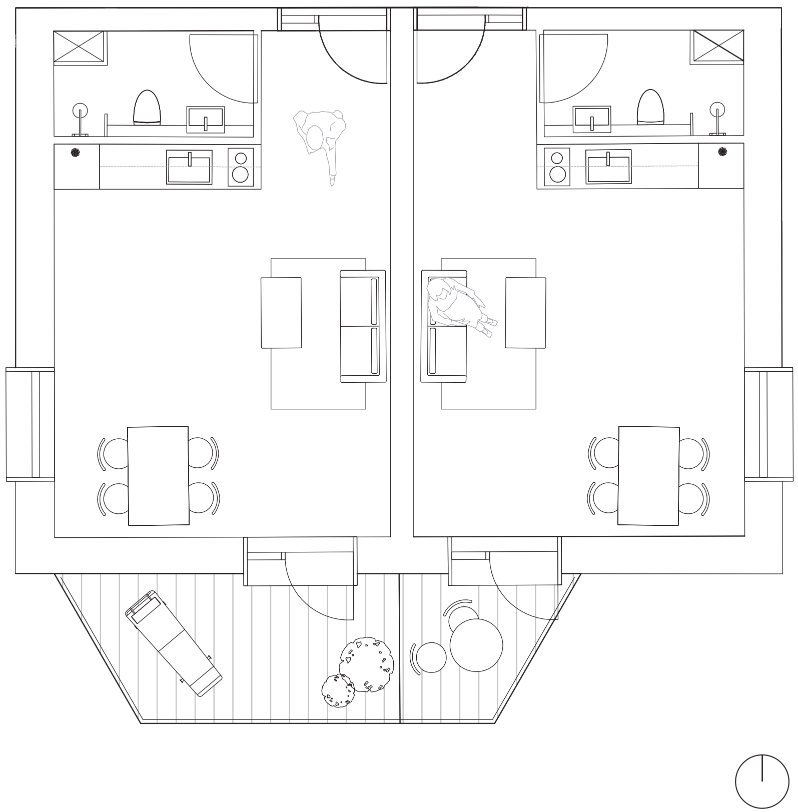
Ill. 091: Render: Café and gallery

Ill. 092: Render: Workshop and atalier

Ill. 093: Render: Bar and Orangery

2.7 APARTMENT TYPES



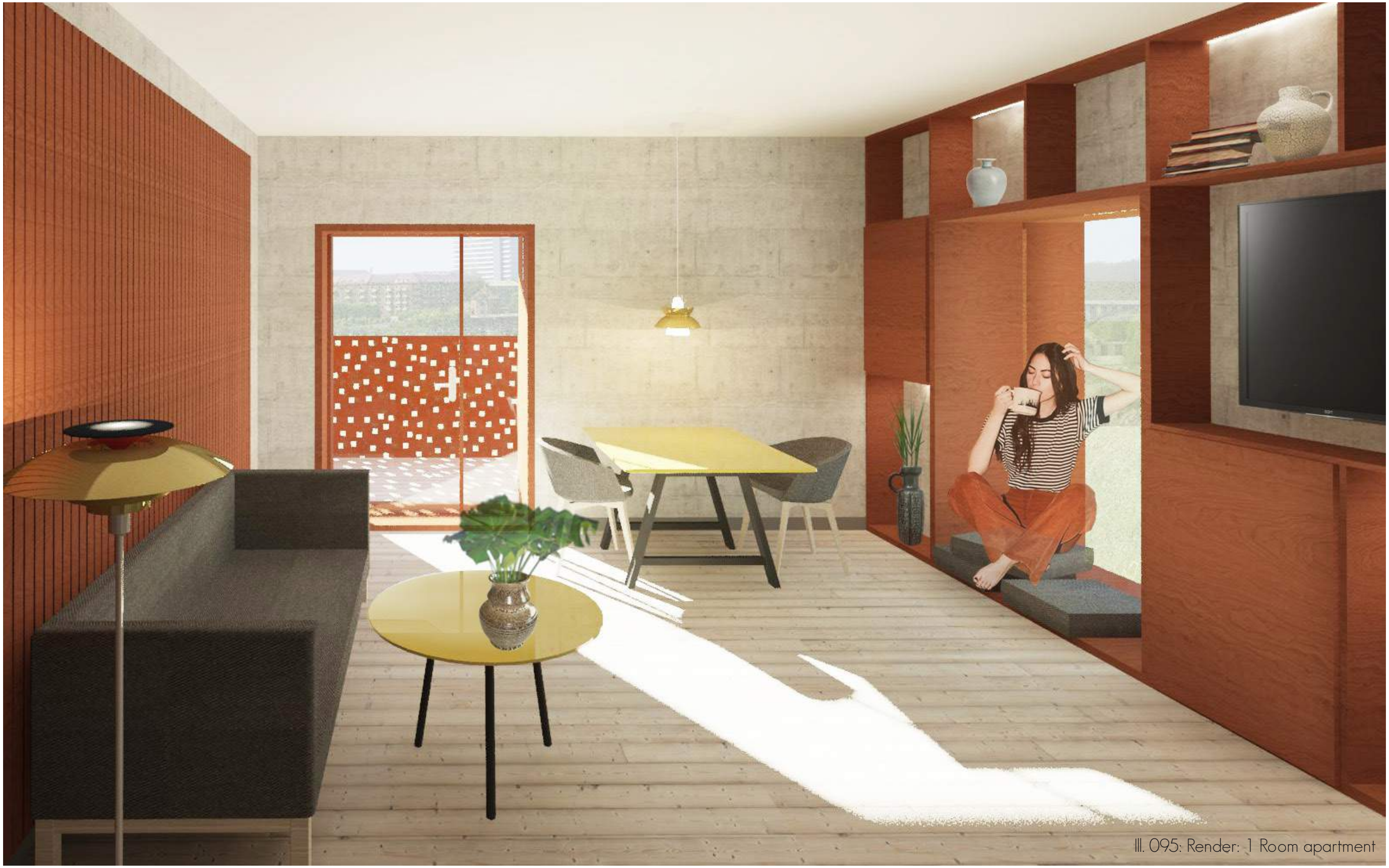


Ill. 094: Apartment plan, 1 room, 1:100

Apartment size, brutto:	37 m^2
Rooms:	1
Number of types in building:	10

Describtion:

Open 1 room apartment with kitchenet and a small bathroom. Openings in two directions and functional interior solutions in Jabota wood.


Ill. 095: Render: 1 Room apartment

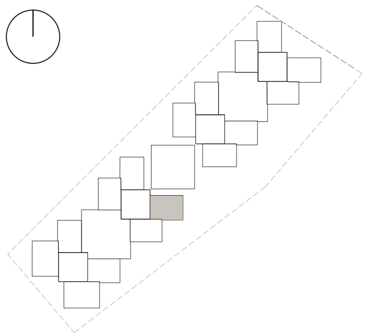
Apartment size, brutto: 61 m^2

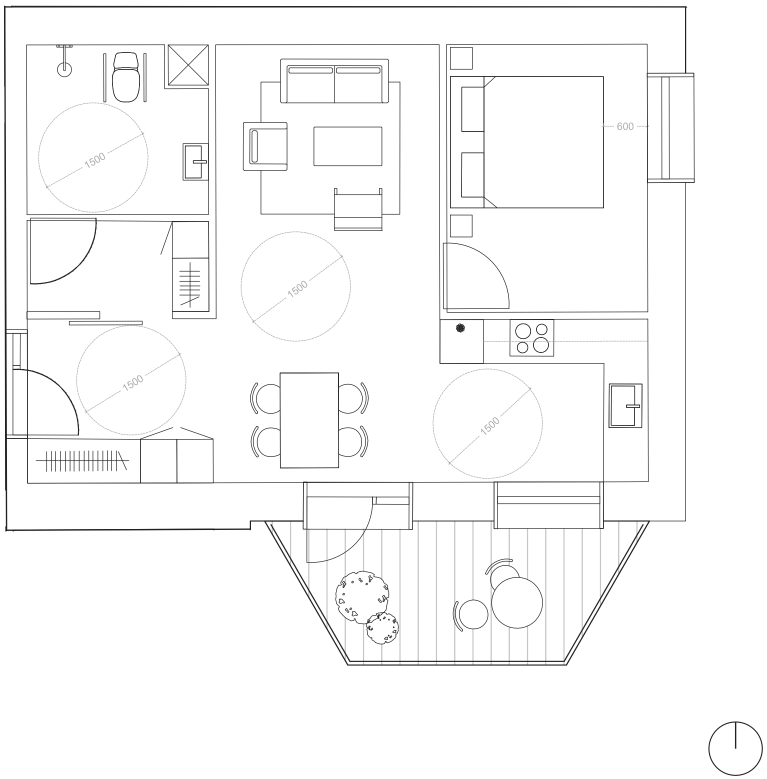
Rooms: 2

Number of types in building: 12

Describtion:

2 room apartment with acessability in terms of manovre area and disability friendly bathroom. Suitable for elder-ly, both singe or couples.





Ill. 096: Apartment plan, 2 room with dissability, 1:100

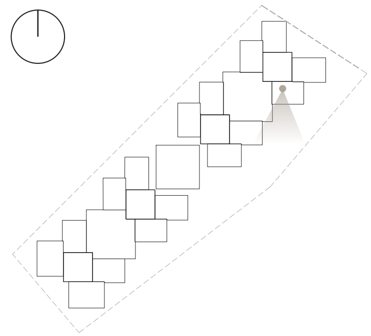
Apartment size, brutto: 61 m^2

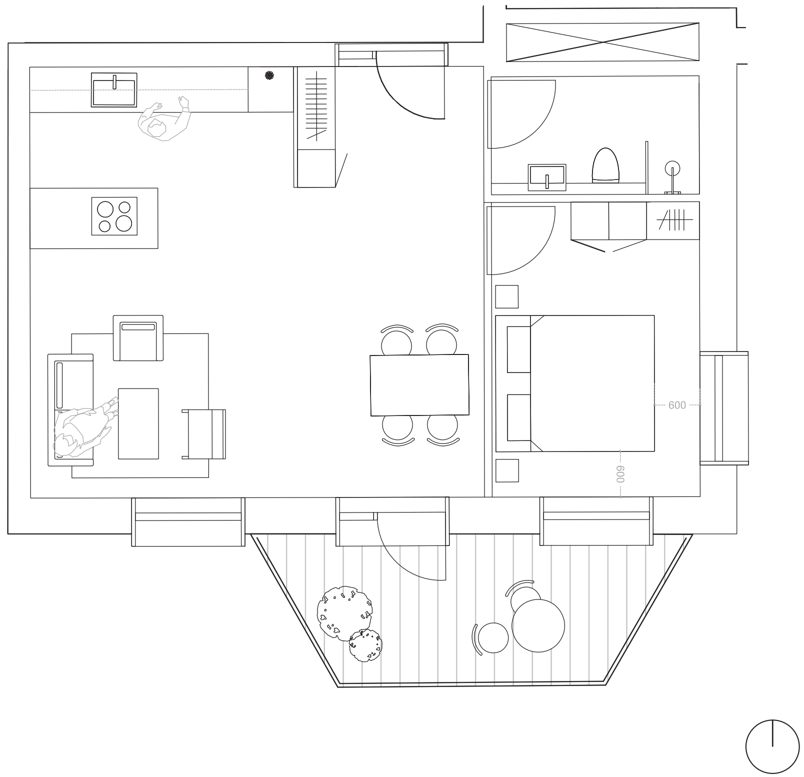
Rooms: 2

Number of types in building: 23

Describtion:

Regular 2 room apartment with open kitchen and living room and a open entré. Openings in two directions and interior details of Jatoba wood.





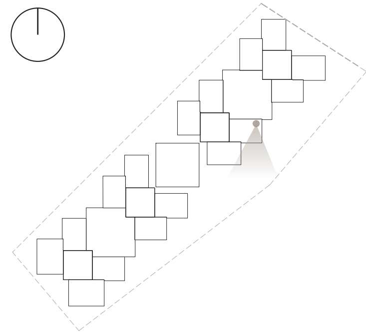
Ill. 097: Apartment plan, ordinary 2 room, 1:100

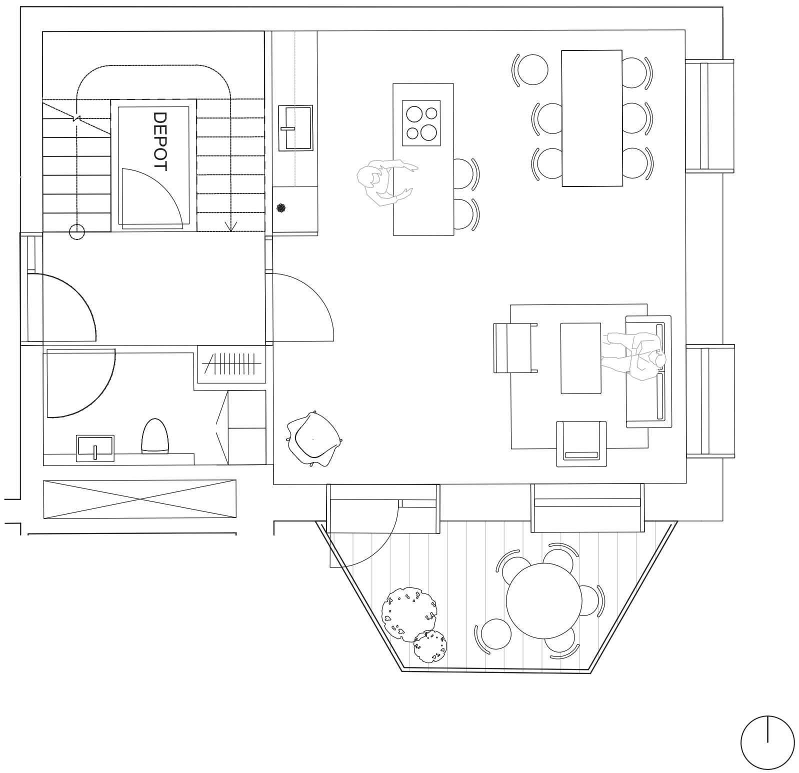
Ill. 098: Render: 2 Room apartment

Apartment size, brutto:	124 m^2
Rooms:	3
Number of types in building:	6

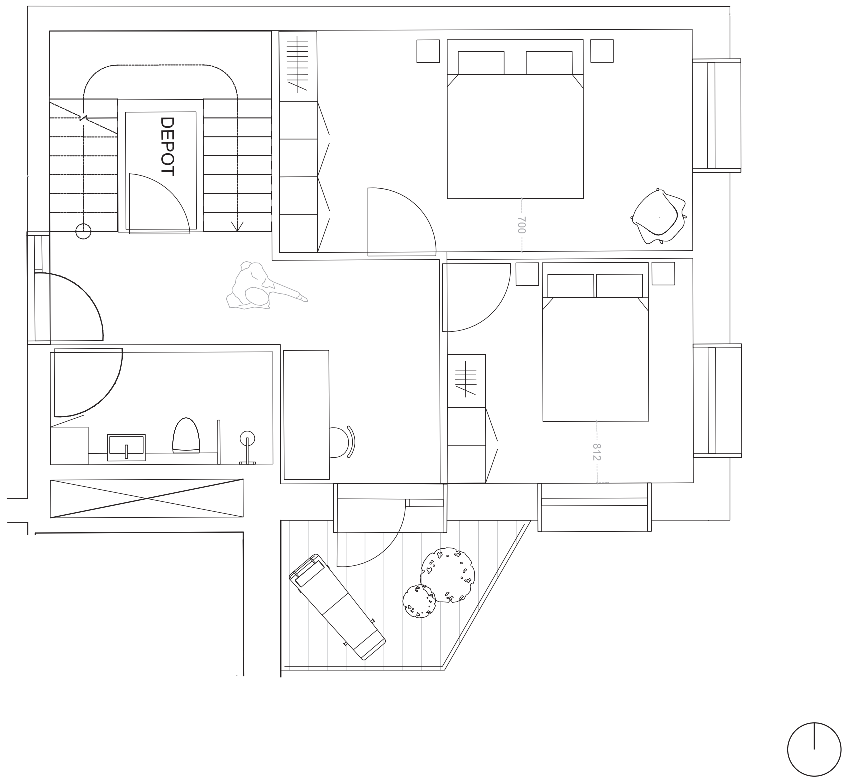
Describtion:

A two-story apartment with entrance, guest toillet and kitchen-living room at the 1. floor, and bedrooms, bathroom and a little office area on the 2. floor.

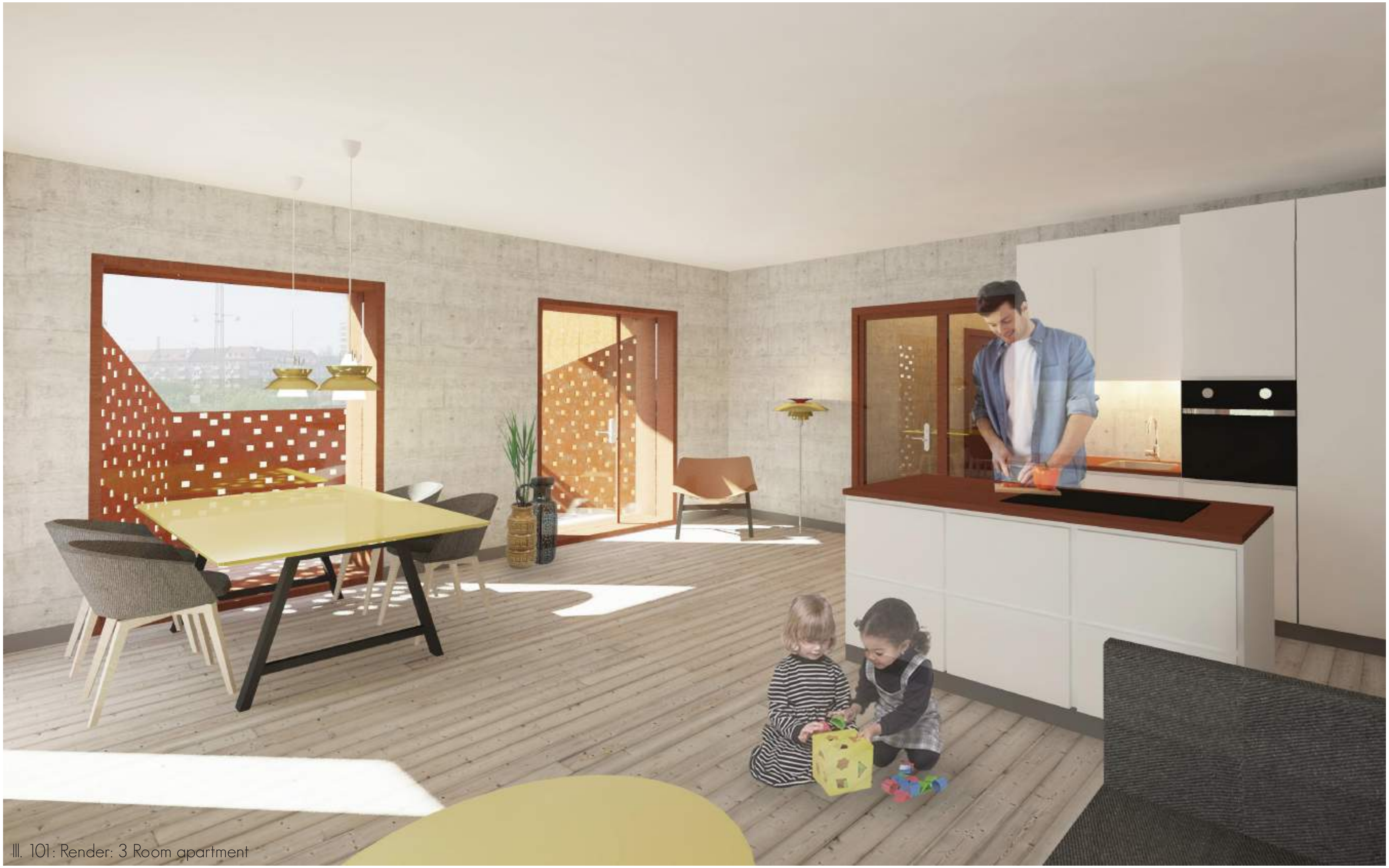




Ill. 099: Apartment plan, 3 room, lower level, 1:100



Ill. 100: Apartment plan, 3 room, upper level, 1:100



Ill. 101: Render: 3 Room apartment

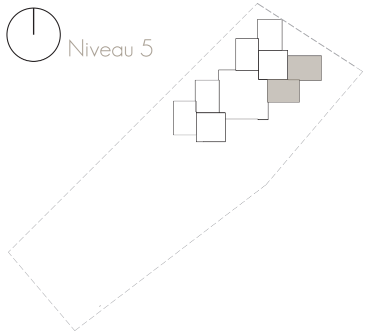
Apartment size, brutto: 118-132 m^2

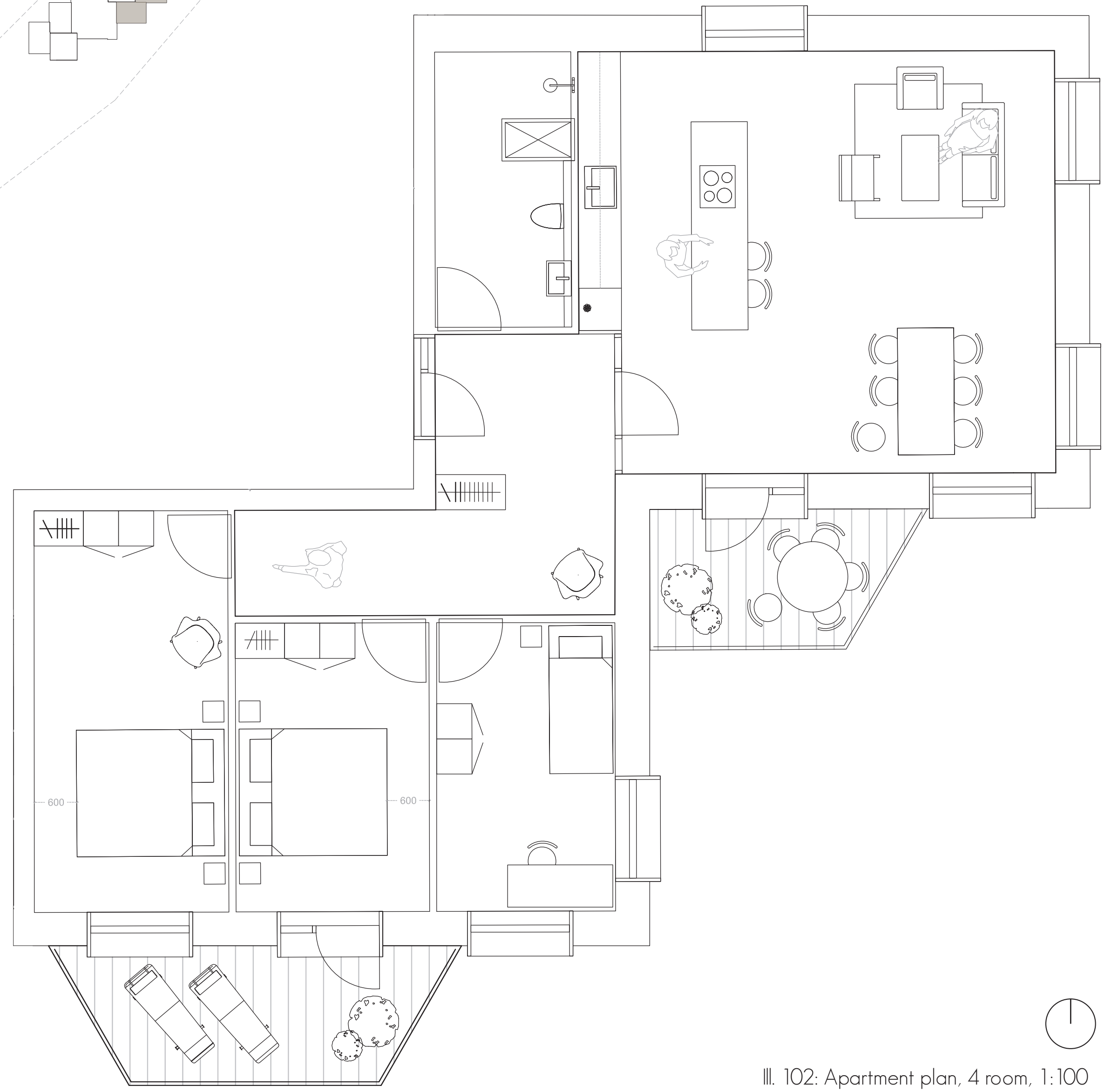
Rooms: 4

Number of types in building: 7

Describbtion:

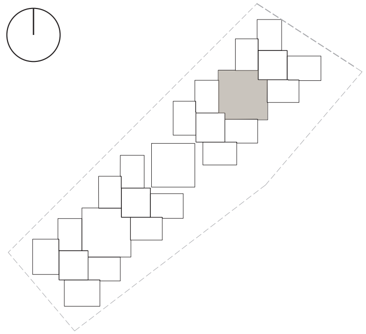
Two types of 4 rooms apartment, 1 type in two-story (as 3 room ap.) and this type in same floor. Window openings in 3 directions.

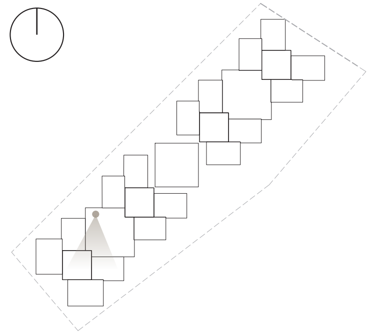




Ill. 102: Apartment plan, 4 room, 1:100

2.8 COMMON ROOMS



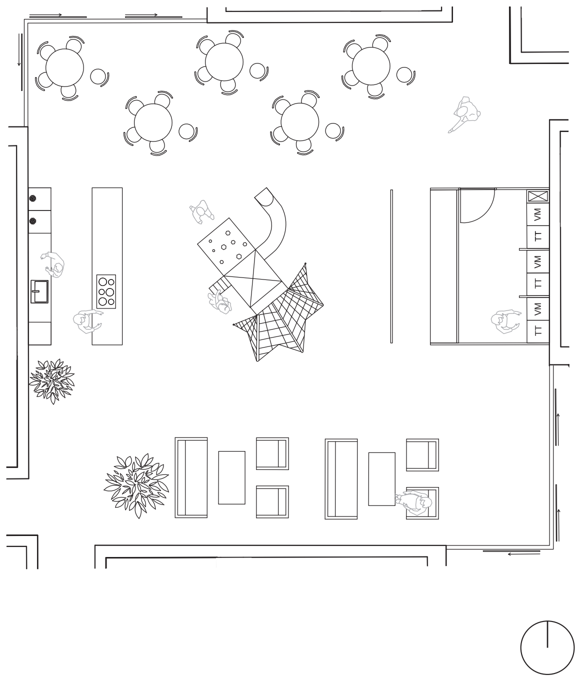


Common room, brutto: 183 m²

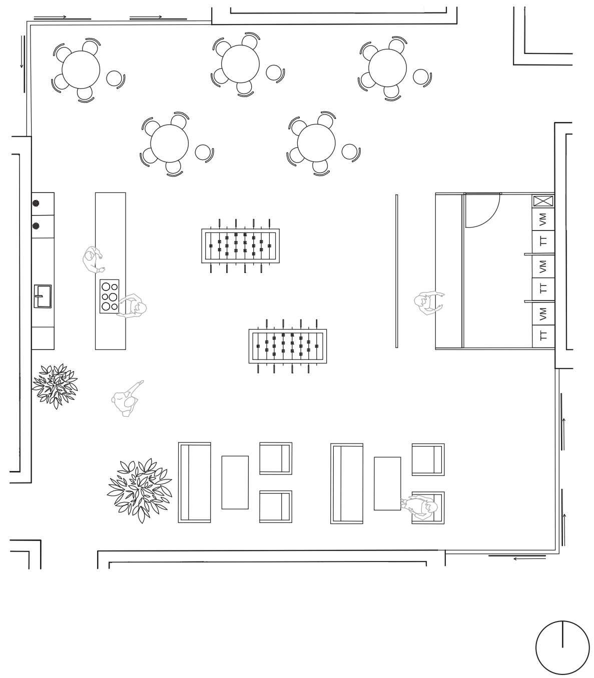
Functions: Common kitchen space
Common dining space
Common living/tv space
Common laundry space
Common play/game area

Describtion:

Common room located in center of each living group. Open floor plan.



Ill. 103: Common room North, plan 1:200



Ill. 104: Common room South, plan 1:200

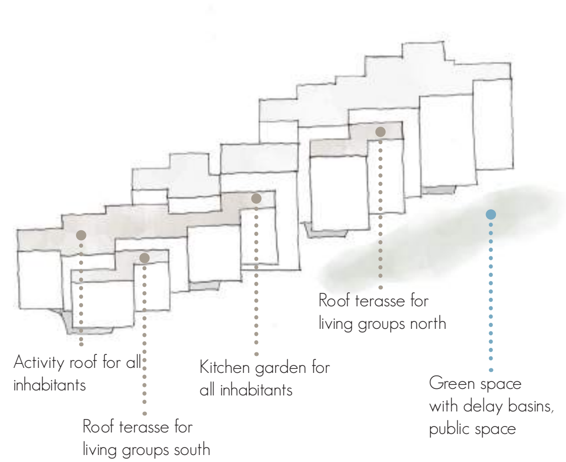
Ill. 105: Render: Common room South

2.9 URBAN SPACE

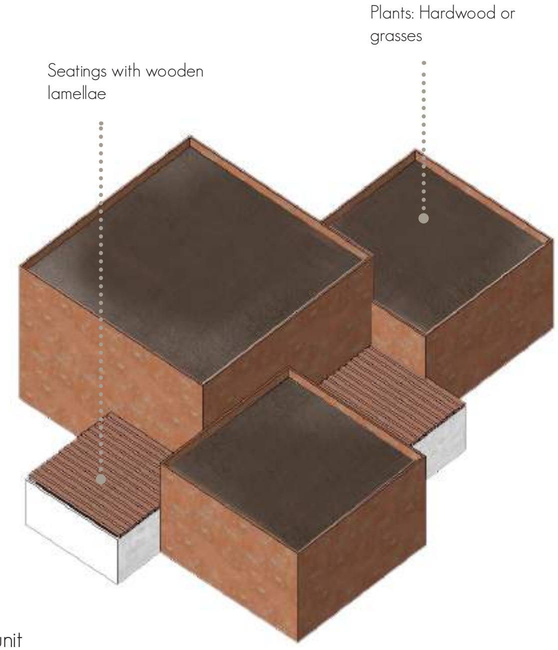
A design of a co-housing lifted from the ground level creates a minimized footprint on the project site, creating space for green surface and for urban elements for public sojourn. The project site connects with the future green wedge on the south-east side of the site, extending the space for vegetation. The remaining rails on the site ends in a space where delay basins for rain water are created. Urban units of corten boxes and seatings encourage sojourn in the space. The placing of commercial functions in connection to the green area emphasizes that the space is public.

The urban units are designed for Urban Cc-living and are continuous throughout the whole design, creating space for vegetation and seating in both public spaces and common outdoor spaces. (ill. 107) As seen in illustration 108 the units functions as containers for vegetable in the kitchen garden, both ergonomic for the adults and in height with children.

The fifth facade creates space for terraces and roof gardens, both for the living groups and for the whole co-housing complex. In this way the outdoor common spaces are held private in a way that encourage for usage without the feeling of being watched or interrupt by public visitors. The exact functions and furnishing of these spaces are seen in the general plans.



Ill. 106: Placement of urban spaces



Ill. 107: Urban unit

Ill. 108: Render: Kitchen garden, roof

2.10 MATERIALITY

To embrace the heritage of the Godsbanen area, the material from the remaining rails are complimented by the choice of corten steel as the main material on the facade of the building. Wide panels of 1500 x 6000 mm are mounted on the facade. External 400 mm wide perforated corten panels are added to the facades of the common and commercial areas. They are mobile and can be pushed aside if more daylight is wanted. Perforated corten elements are furthermore used as handrails of the apartment balconies.

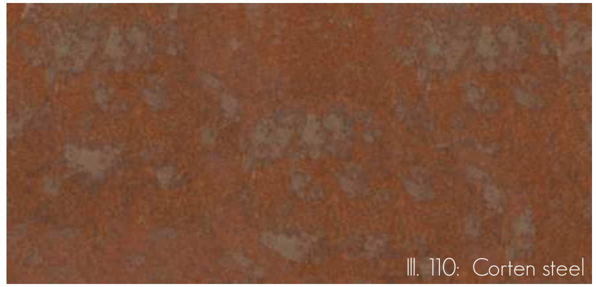
Additional to this, concrete is used for the cores and the bearing elements and becomes visible in more central parts of the building, to articulate how loads are collected in the cores and lead to the ground This material becomes visible in the interior for a more raw appearance.

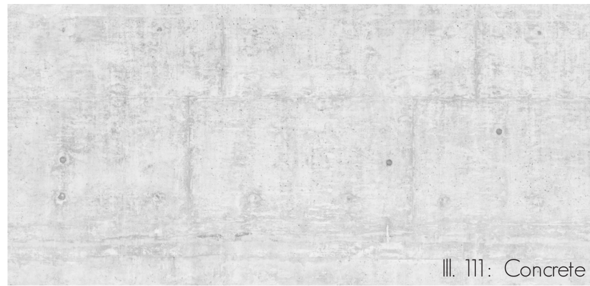
Additional to concrete and corten steel, red FSC Jatoba wood continues the warmth from the colored steel into the interior and creates details that breaks the raw concrete. The elements creates both functional and acoustic solutions. The panels placed in the apartments and in common areas are supplemented with acoustic foam on the back, to regulate the internal noise pollution.

All flooring used in the building is light pine wood, for a more local and sustainable choice of material, and to ensure a light appearance in the base in every room.

A raw appearance and warmth is created both in the external and internal appearance, reflecting the spirit of the space and the alternative housing type created in the project.


Ill. 109: Light pine wood


Ill. 110: Corten steel


Ill. 111: Concrete


Ill. 112: Jatoba wood

2.11 SUSTAINABLE APPROACH

Sustainability reached in the project concerns the comfort of the users in relation to indoor climate, accessibility and quality in the architecture both indoor and out. Furthermore the sustainable considerations in the project concerns the environmental impact in relations to the energy consumption, the footprint and reuse of rainwater and considerations about choice of materials. In this way the Co-housing is designed with holistic sustainable matters and reaches a state of Zero Energy Building.

The focus takes inspiration in the following DGNB parameters, respectively: PRO 1.2 Integrated Design Process, SOC 1.1 Thermal comfort, SOC 1.2 Indoor air quality, SOC 1.4 Visual Comfort, SOC 1.6 Quality of outdoor spaces, SOC 2.1 Accessibility, ENV 2.2 Rain water and SOC 3.1 Architectural quality.

The integrated design process aimed in the project is described in the early analysis phase and shows the interplay between engineering tools and architectural considerations throughout the project, which has let to the presented design.

The thermal comfort is analyzed in relation to Operative temperature with the dynamic simulation tool BSim, where the temperature of the reference apartment is lowed to 23 degrees in summer through iterations of windows and glass type in the reference apartment. Additional to this the Co2 concentration is held down by the use of natural and mechanical ventilation,

The visual comfort is analyzed with the simulation tool Velux Visualizer, concerning daylight factor. The BR18 demands of lux is converted to daylight factor for comparison. Through iterations of the windows, choice in facade, balconies and handrails the daylight factor reaches 2,8 DF in half of the living room, in the reference apartment.

The outdoor spaces creates both public, semipublic and private spaces. The fifth facade is used for terraces and gardens that encourage for either sojourn and interaction with neighbors in the living groups or invite for collaboration, play or activities. Urban units are design for the project and used for different functions depending on the placement.

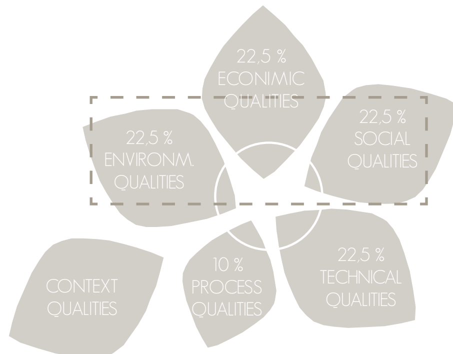
Designing every access core with elevators and designing 20 % of the apartments with accessibility creates optimal access for disabled people in the building. Furthermore the disabled parkings are placed near the entrances of the commercial areas.

A strategy for the rainwater has enabled reuse of rainwater for toilet flush, by collecting rain water from 91 % of the roof top, and has created a wild and green area for the public space in the ground level.

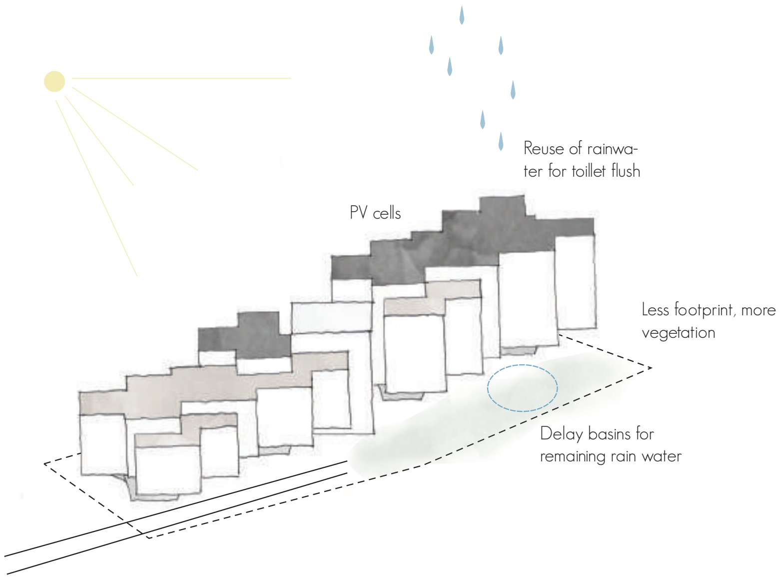
Considerations about the context and the heritage of the remaining rails and the connection to the former Godsbanen terminal has let to the choices of materials and thereby the general appearance of the architecture. Combined with use of local and sustainable choice of wood in the flooring, the architecture of the materials creates a raw expression, which reflects both sustainable matters and the awareness of the spirit of the context.

Additional to these initiatives PV cells are applied to the none-visible part of the roof tops, from where energy is produced on site to the whole complex. The choice of PV panels is Sinosola 300W mono-crystalline PV cell, dimensioned in the process.

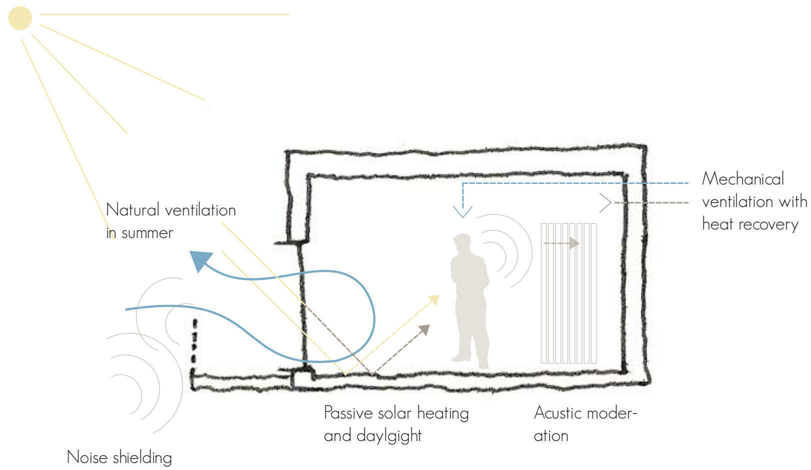
The passive initiatives combined with production of energy on site results in a Net Zero Source building, where the energy consumption reaches 37,3 kWh/m^2/ year with passives and 1,3 kWh/m^2/ year by adding PV cells to the project. In this way the BR18 demand of 30 i kWh/m^2/ year s almost reached with passive initiatives before the active initiatives are applied.



Ill. 113: DGNB parametre



Ill. 114: Environmental considerations

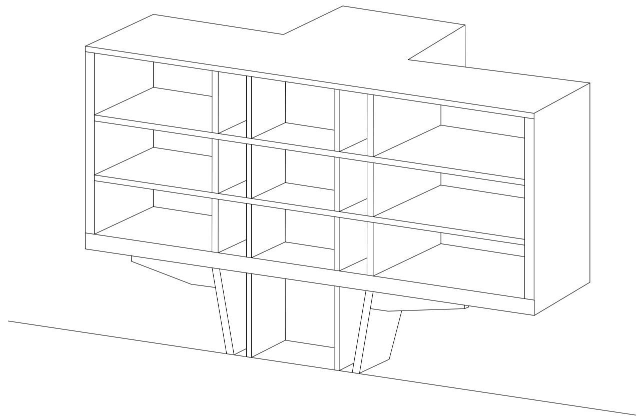


Ill. 115: Comfort considerations

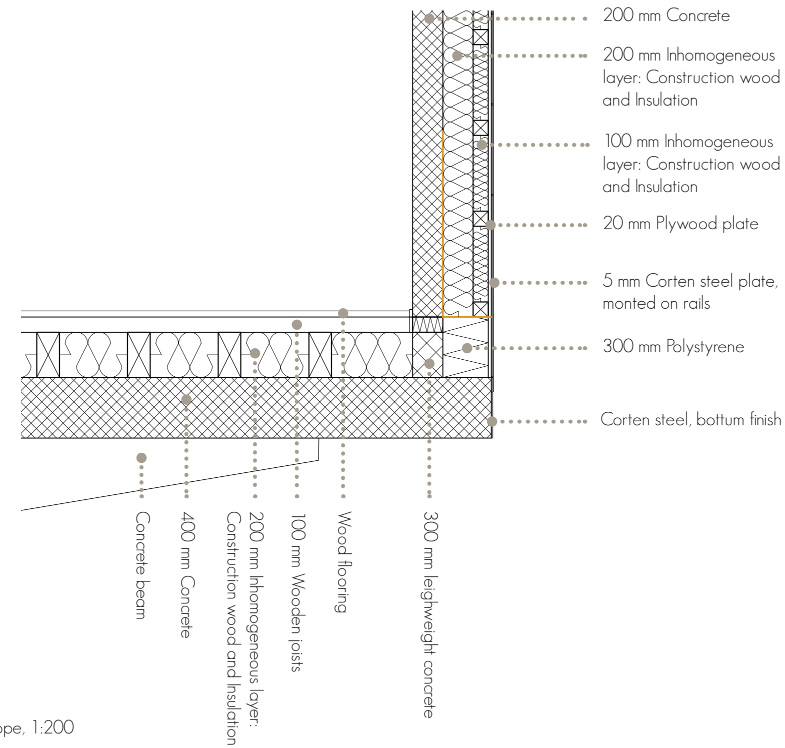
2.12 CONSTRUCTION

The general structural principles of the co-housing consists of groups of apartments being carried by central cores. The stair and elevator core within the bearing core are stabilizing the constructions. Bearing outer walls and inner walls between apartment and corridors lead the roof and dwelling load down to the lower floor slap. The lower floor slap are constructed as cantilevers and supplemented with a single beam reaching out for the four different apartments. (ill. 116)

The building envelope consists of bearing concrete inner layer, inhomogeneous wood and insulation outer layer in the middle and plywood facing outside. The corten panels are mounted on rails on he plywood. (ill. 117) The U-value of the outer walls are 0,12 W/m^2*K.



Ill. 116: Construction principle



Ill. 117: Construction detail: Builidng envelope, 1:200

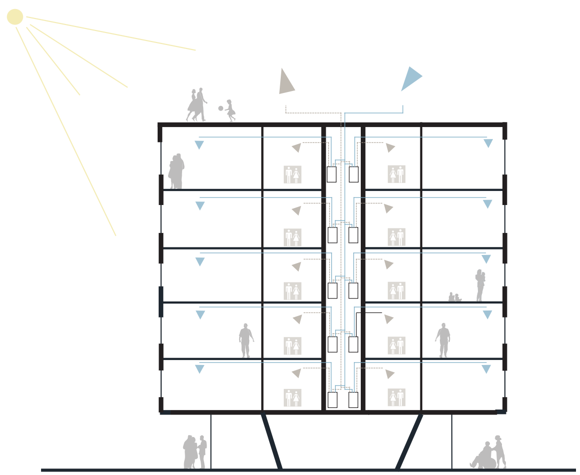
2.13 INSTALLATIONS

The general strategy of installations is routing of pipes through the installations shafts through the apartments, collecting them in central shafts around the cores and lead the installations through the service room in the basement. The only Installation handled from the service room is the reuse of rain water for toilet flush.

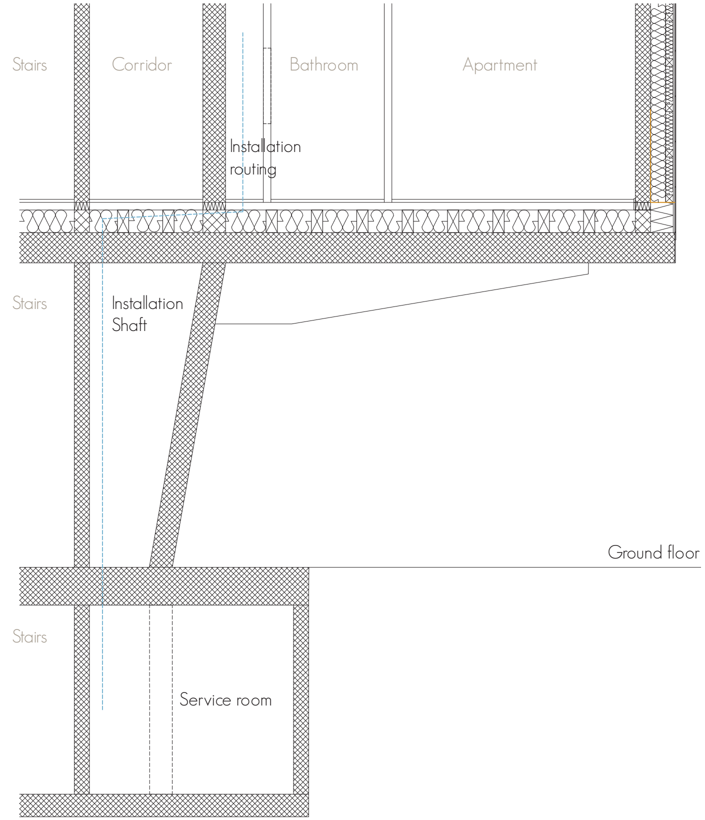
Mechanical ventilation is chosen in apartments and common room with the choice of decentralized ventilation systems. The aim is to recover the heat generated in the building to minimize the use of heating through radiators. The aggregates are mounted in the shafts from the apartments, from were it can be controlled.

Instead of water tanks for the whole complex every apartment is equipped with small water heaters, which is less energy demanding.

Rain water is reused for toilet flush in every apartment, and collection of rain from 91 % of the roof top is needed to collect enough water, inclusive a dry period of two month.



Ill. 118: Mechanical ventilation principle, decentral system



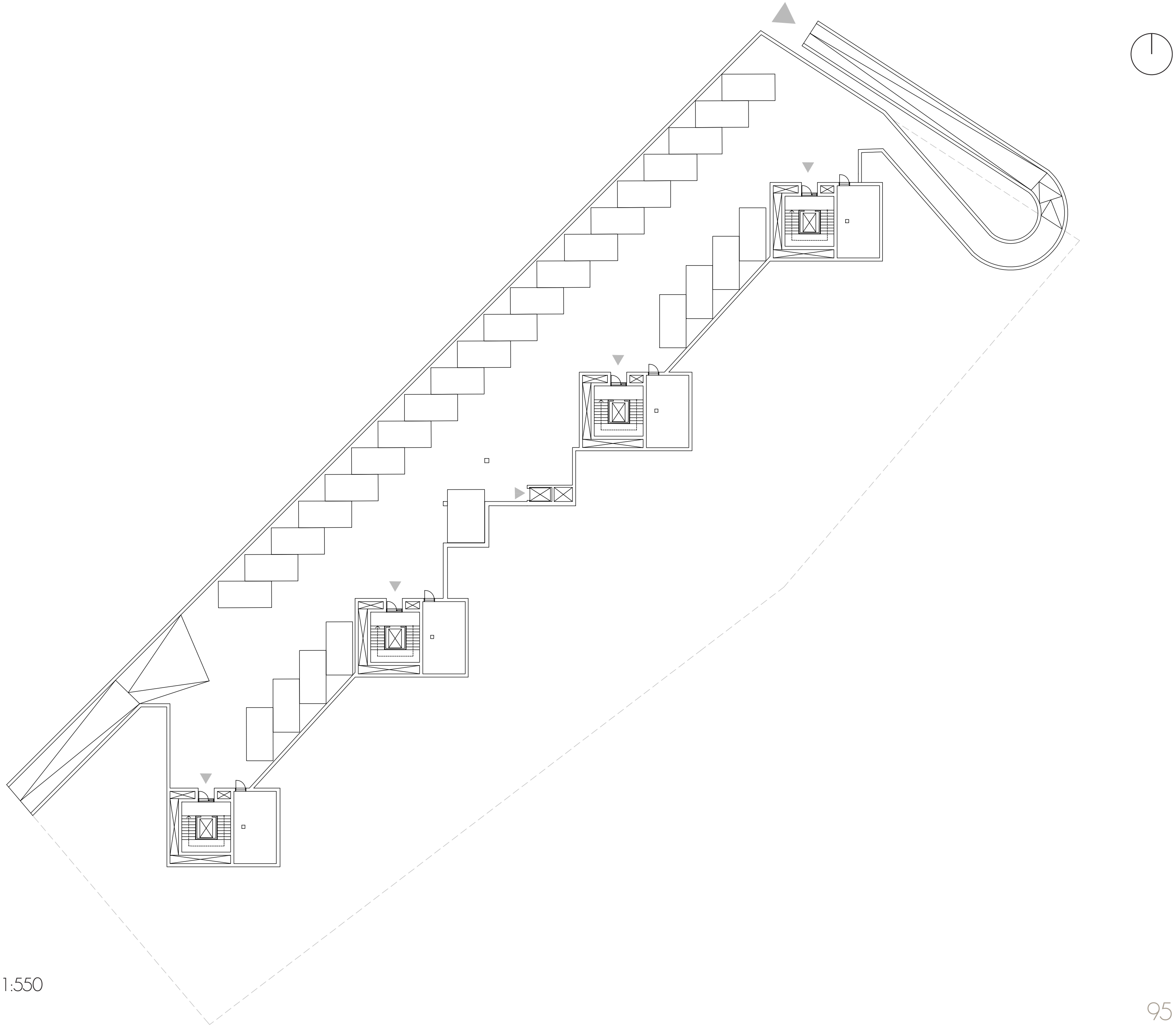
Ill. 119: Installation principle: Relation between construction and installation shaft, 1:100

2.14 PARKING

The parking lots are dimensioned for the housing units, according to the demands of Aarhus municipality within city zone 1, of which the project site is placed. This requires 1/2 parking lots per housing units. As the developments plan for the future Aarhus K illustrates placements of parking in two of the neighbor sites, the dimensioning of parkings in this project does not concern the commercial part.

The parkings are created in a parking basement, with access from the northern part of the site, consisting 28 parkings and one for disabled people. The exit is placed in the southern part of the basement.

The basement is held towards the western side of the project site, to prevent from enterfearing with the rain water strategy on the eastern side. From the parking basement there are access to all stair ways and elevators, inclusive the elevator for the commercial part. Furthermore the service rooms for technical installations concerning the general complex are placed adjacent to the four cores in the basement.



Ill. 120: Plan, Niveau 05, 17 m, 1:550

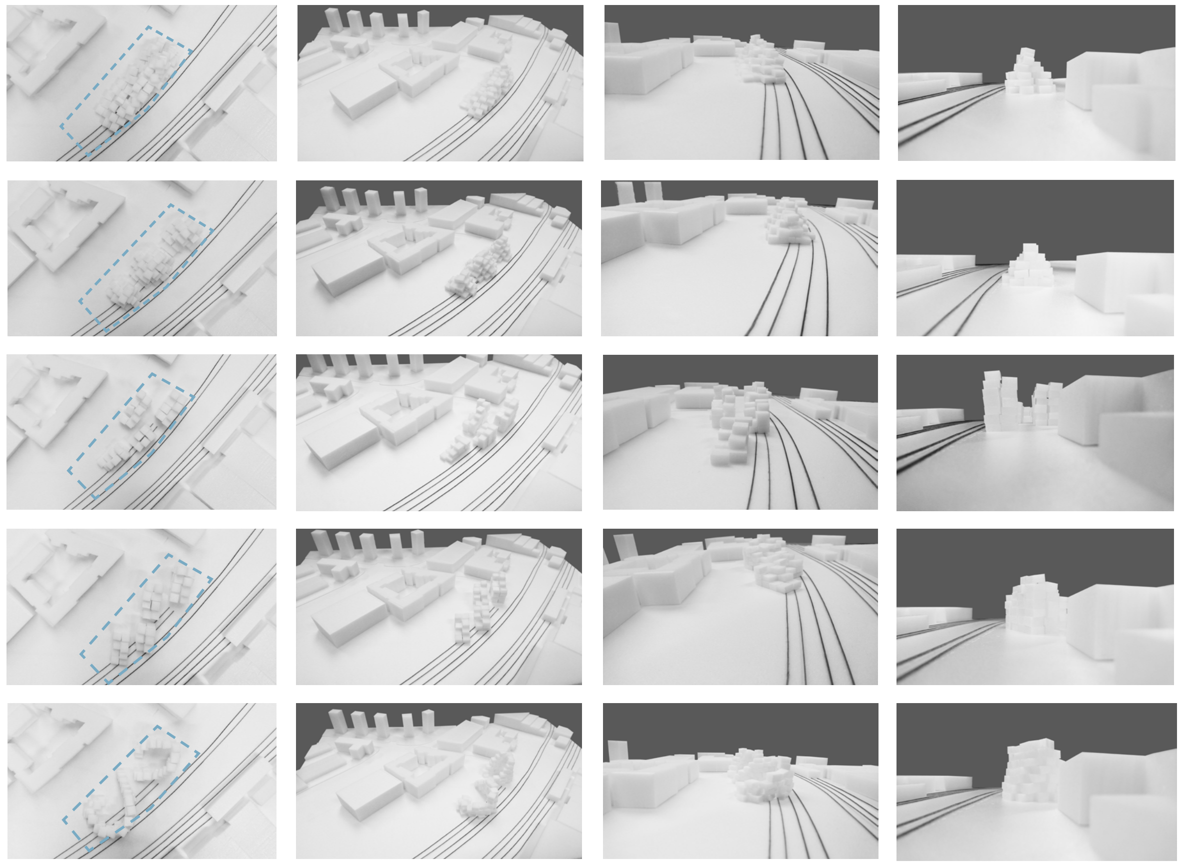
3 | DESIGN PROCESS

3.1 MASTERPLAN PROCESS

3.1.1 Initial form study

The study is a form workshop of the future building on site. It relates to the context model and the design criteria made in the program. The different building forms is evaluated for a better understanding of the potentials of the site.

Ill. 121-70: Form workshop, on physical model



1. Form follows the direction of rails. Gradually increasing towards north. One whole form with no division or opening in the volume, which does not invite public. The form naturally grows from the ground and up till 6 floors height. It does not show a clear connection to the grit of future buildings.

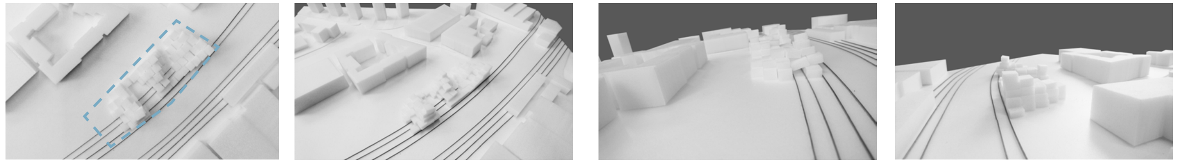
2. The form consists of three masses which merges into each other. The form increase towards north, and from the sides to the middle. Openings are created in connection to the rails for public space., Which will only reach midday sun. The maximum height is 5 floors.

3. The 4 different rectangular blocks following the direction of rails and creating positive space both in the space between them and to the surrounding. Buildings increasing towards north. Is blocking and creating an edge from the northern part instead of inviting the public.

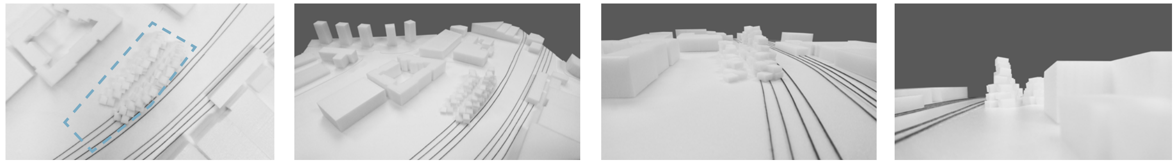
4. The 4 different rectangular blocks diagonally directed on the rails, and breaks with the direction. Creating positive space both in the space between them and to the surrounding. Buildings increasing towards north. Here the view is not block in the same way, as you see the form in perspective.

5. The form is created from curves that opens towards west, and increases towards north-east. This composition creates two central spaces between the volumes, but closes around itself and only invites from west.

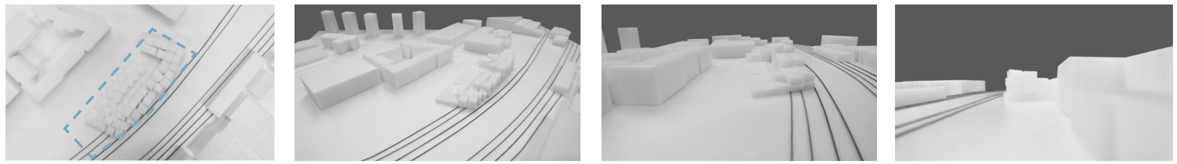
6. The form of 3 triangles merging together and alternately increasing towards west and east. Positive space is created between the volumes towards the rails in east, and open space appears in the south. Seen from north the volume creates a direction pointing east. The volume breaks with the rails direction.



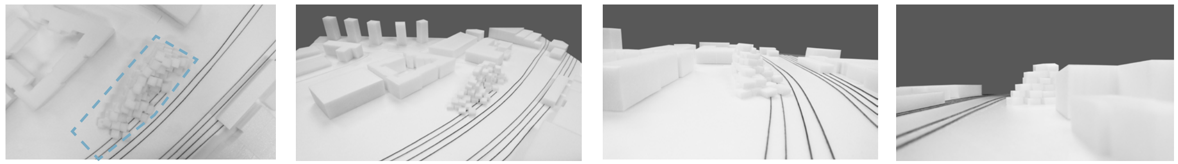
7. The two rows of volumes follows the direction made by rails, the rails on site going straight through the one to the right. The volumes increases towards north and rises like a hilly nature. The space created between the volumes is narrow, but a larger open space is created at the south part.



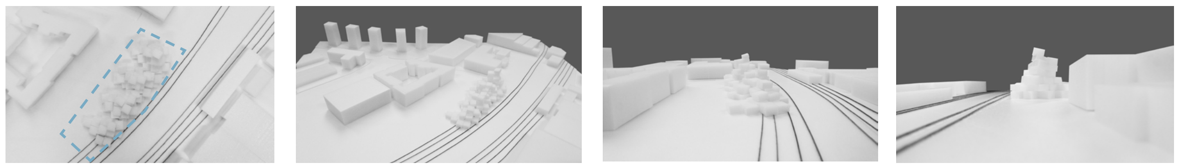
8. The volume relates to the future neighbor building on the west side of the site. As a rectangular building block with a opening in north-est and with a narrow court yard, the volume fills up much of the site and does not leave much for open space. The volume is only 4 floors high.



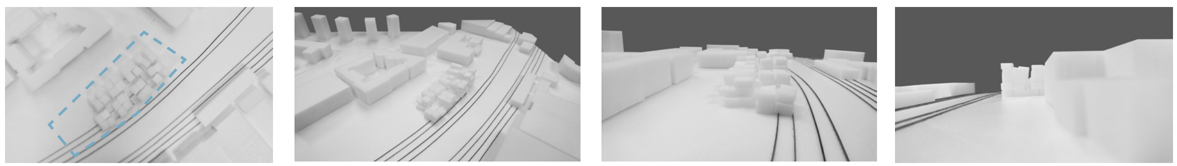
9. The form is created from one coherent volume that creates positive space with niches towards the rails in est. It increases from all sides but primarily towards north. The volume does not create a barrier from north and connects discrete with the rails.



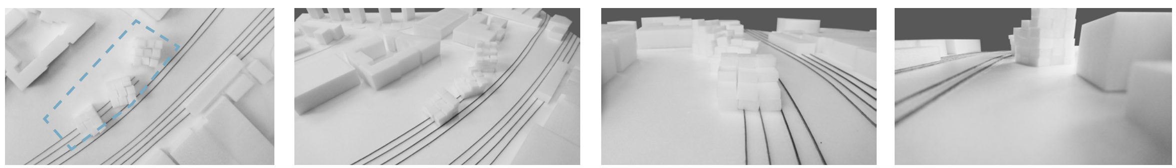
10. The same form as suggestion 9, but with an orientation towards west which creates more attractive open scape in between in relation to sun-path. The volume increases towards north and ends on a tip of 7 floors. The volume relates to the direction of rails.



11. 8 Smaller slabs creates a grit of positive space in between and a larger open space in the south end. The slabs increase in height individually towards north. The volume creates an edge and blocks the view from north.



12. 3 larger slabs creates a very open site but without really creating any positive space for sojourn. The slabs are randomly orientated but are placed from the rails and distributes from here. The meeting with the volumes is an edge both from north and from south.

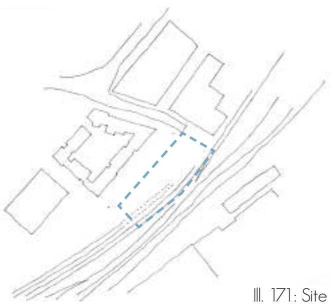


3.1.2 Initial master planning

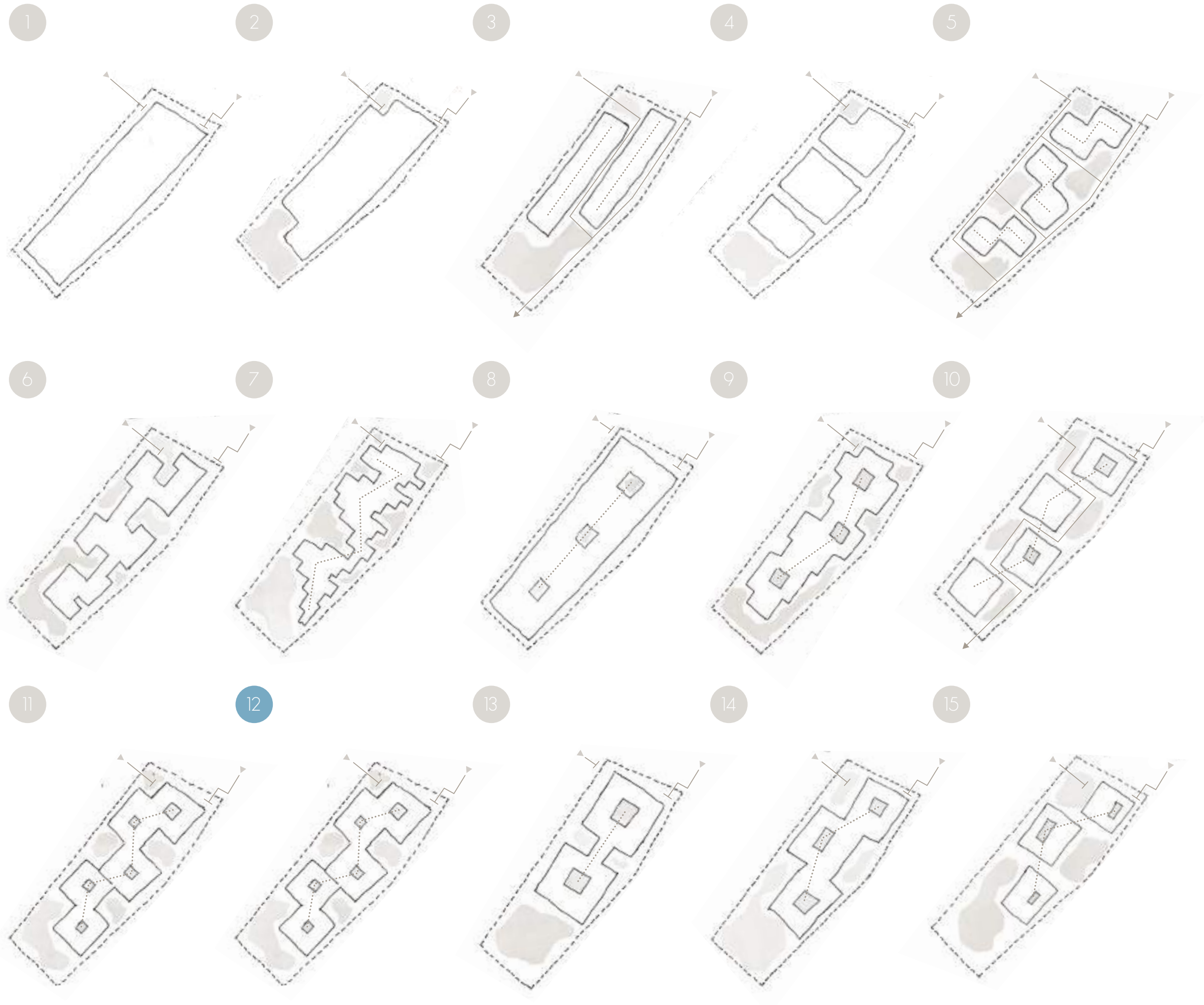
This study analyzes the potentials of the project site, by master planning on a 2D map. The sketches clarify different compositions of geometrical forms and subtracts, and analyze whether they are able to create positive space in between, as well as creating a flow from the desired accesses towards the rails in south. The compositions relates to the design criteria made and the most potential suggestions acts as inspiration for the further process.

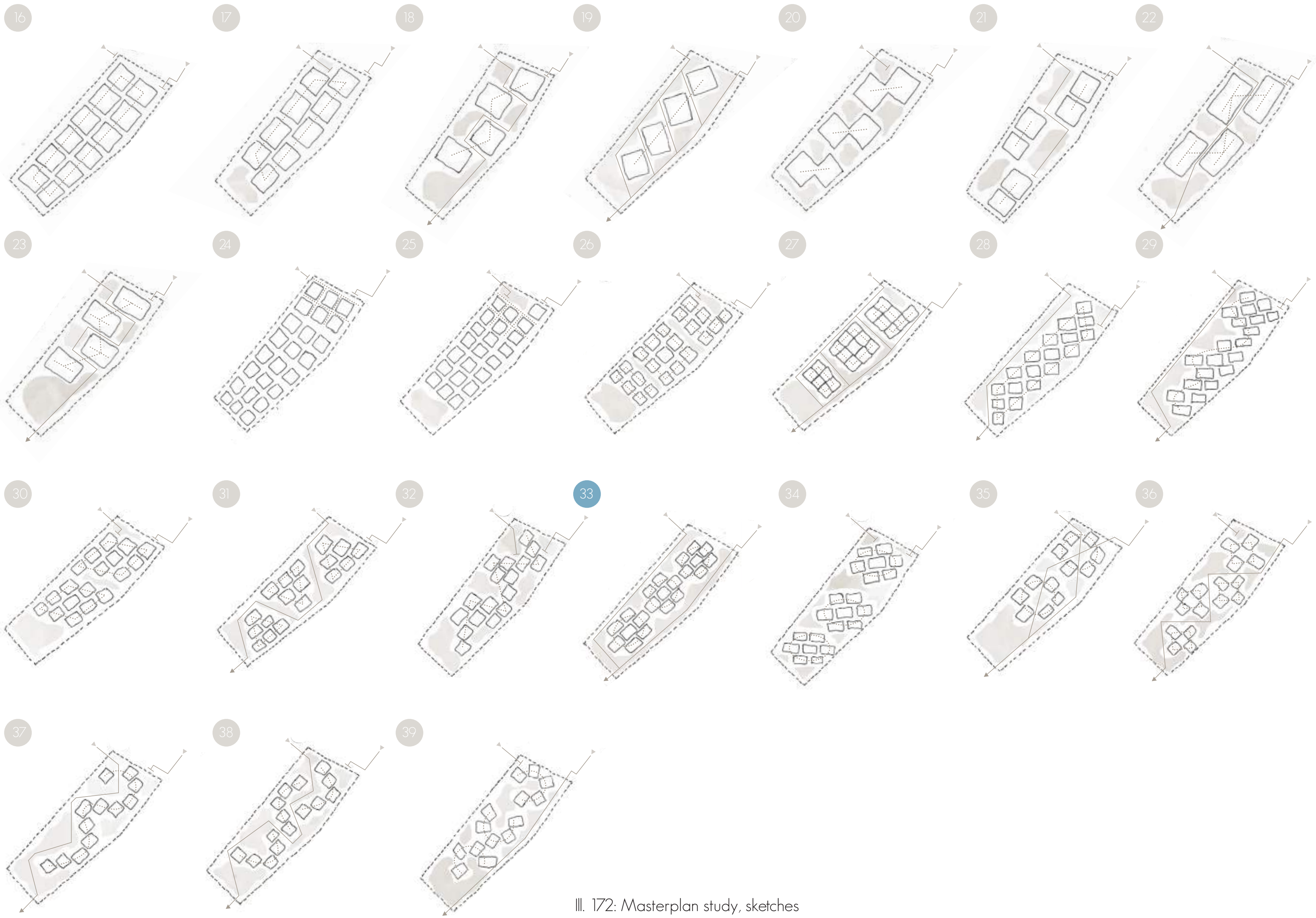
The access from Carl Blocks Gade and from Godsbanen building in north is pointed out on the sketches and dragged into the site, defining the flow caused by the composition of the geometries. Positive and open space is painted between the volumes to clarify the potential of common or public outdoor space. The dotted lines outlines the pattern of the composition, whether it's orthogonal, diagonal or axial on the volumes. The volumes transforms, fragments and subtracts through the different suggestions.

Composition number 12 and 33 create positive space potential for both common and public space. While nr. 12 is creating more private space in the center of the volumes. It does not create a good flow through the site, which nr. 33 on the other hand does.



Ill. 171: Site placed on context





Ill. 172: Masterplan study, sketches

3.2 PROGRAMMING

3.2.1 Initial programming study

The study investigates different ways of placing the common areas in relation to the private homes in a co-housing building. The proposals differs between vertical distribution to the living groups (nr. 1-10) and horizontal distribution (nr. 11-15). The different compositions and ways of programming will affect the appearance of the co-housing building in general, hence it is investigated in this early stage.

The study clarified the advantages and disadvantages by programming the living group in blocks with only vertical distribution and with horizontal. In suggestion 1-10 there is little or no opportunity to create flexibility between the housing units, as the contact face between them is very little. Furthermore it is a challenge to create a good orientation in relation to sun, wind and view. In suggestion 11-15 there is a higher opportunity to create flexibility between the housing units, but will have a even bigger challenge to create the right orientation for every housing units. Nevertheless, suggestion nr. 3 and 12 respectively consider the right orientation and a merging of the living groups to create a bigger contact face. The further process will reference these suggestions.

Ill. 173: Community programming study, sketches

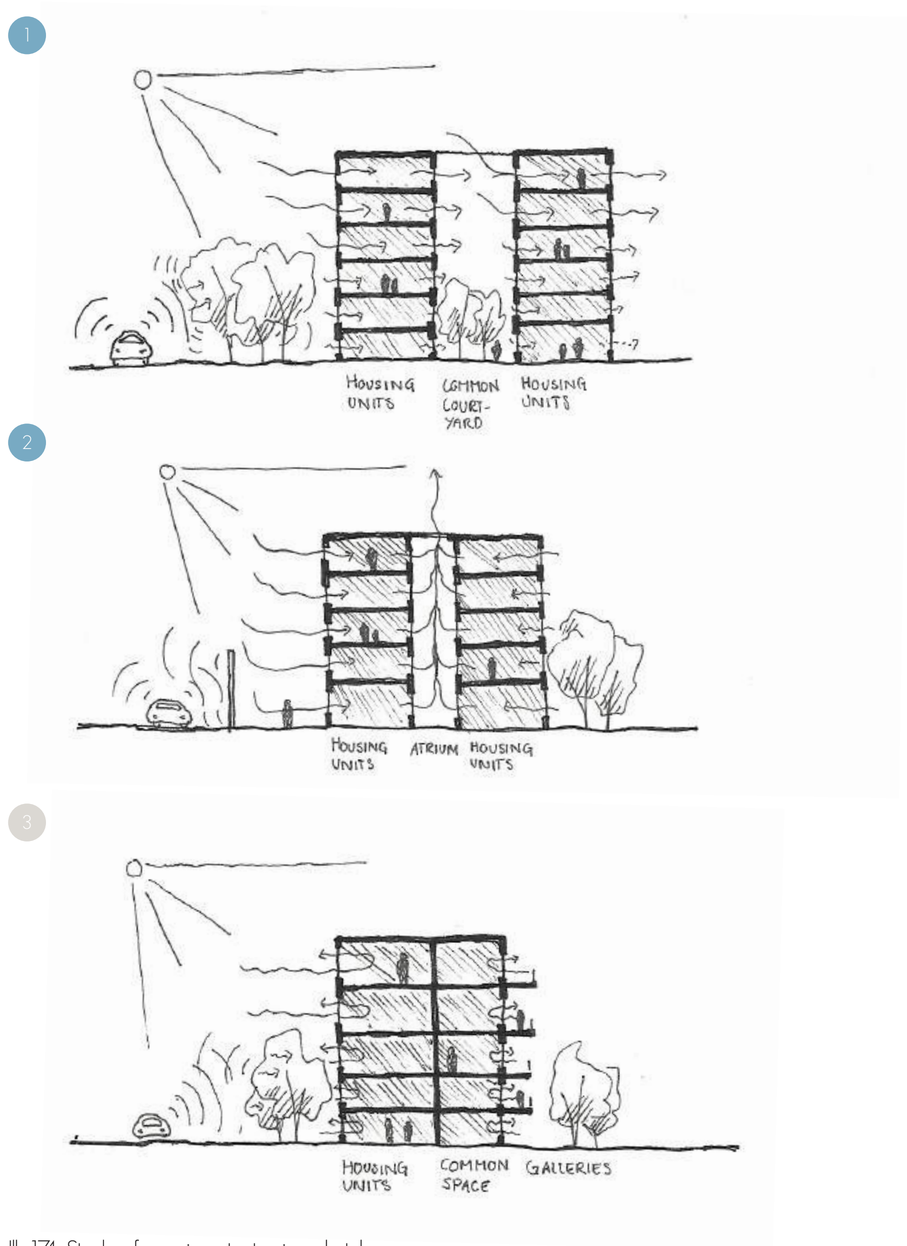
3.3 PASSVE INITIATIVES

3.3.1 Study of passive initiatives

The study is based on the design criteria about applying natural ventilation in the summer to minimize the running of mechanical ventilation, create daylight in the apartments as well as in the common space, shield from car traffic noise, amongst others. These initiatives are investigated through initial drawings, as the overall strategy will affect the appearance of the architecture in general.

The different suggestions clarify qualities and weaknesses in every case. In suggestion number 1 the width of the courtyard will affect how well natural ventilation can be applied, as one building side may shield for the other. Nevertheless, this solution enables cross ventilation as a strategy. Daylight can easily be obtained, but as with natural ventilation, the width of the courtyard will affect the amount of daylight factor in the building behind. The noise pollution can be shielded from or minimized by applying vegetation between the road of Carl Blocks Gade and the building, where the vegetation will partly absorb or reflect the sound waves. Suggestion number 2 consists of a strategy where the natural ventilation is applied by thermal buoyancy through an atrium in the middle, which requires that the apartments have openings towards the atrium as well. The amount of daylight in the apartments will depend on the width of the atrium and the solution in the roofing. Noise is shielded from by a effective external fence, but is blocking the view from the apartments. In suggestion number 3 the natural ventilation is handle by one-sided ventilation on both sides. This solution will affect the opportunity for fresh air from the shielded side, from east for example, and the need of fresh air may not be obtained. It will be more difficult to obtain the right amount of daylight factor from east or north, in this case where the rooms are unilaterally illuminated.

Nr. 1 and 2 will be further investigated in the process.



Ill. 174: Study of passive strategies, sketches

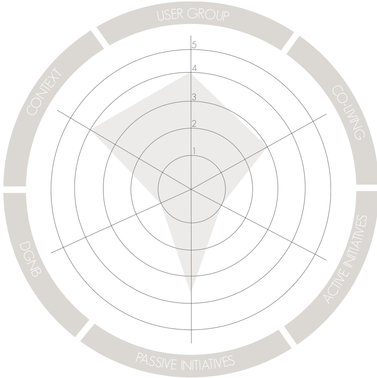
3.4 PROCESS OF DESIGN

3.4.1 Conceptual designs

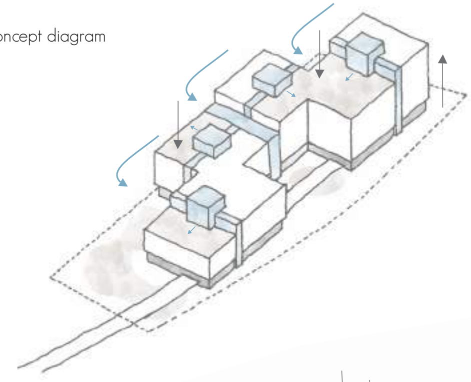
The following 3 concepts are created on basis of the previous form, program, plan and indoor climate studies. The three concepts are weighted upon the design criteria, illustrated in the diagrams, to compare their performance in order to create a sustainable design of an urban co-housing. On the next pages the three concepts are analyzed in relation to their plan layout / concept of co-living, the architetural expression an the meeting with the building in perspective drawings, as well as the concept of passive initiatives.

1. Concept

Score in design criteria



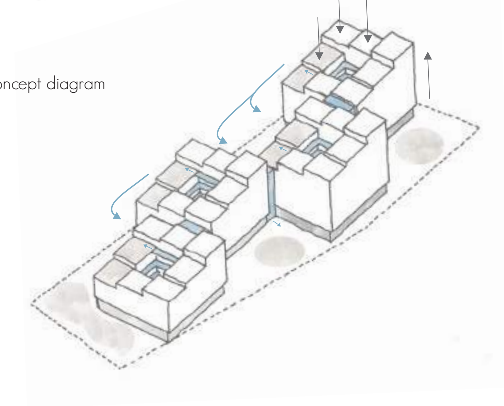
Concept diagram



2. Concept

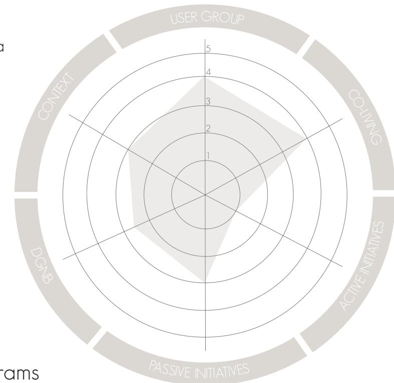
Score in design criteria

Concept diagram

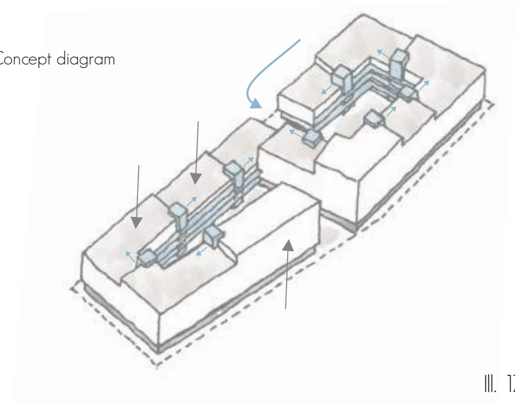


3. Concept

Score in design criteria



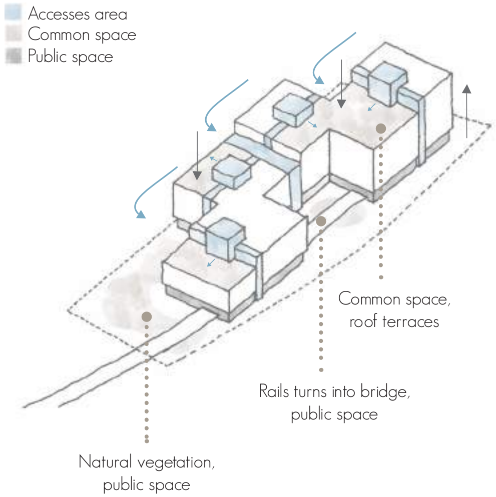
Concept diagram



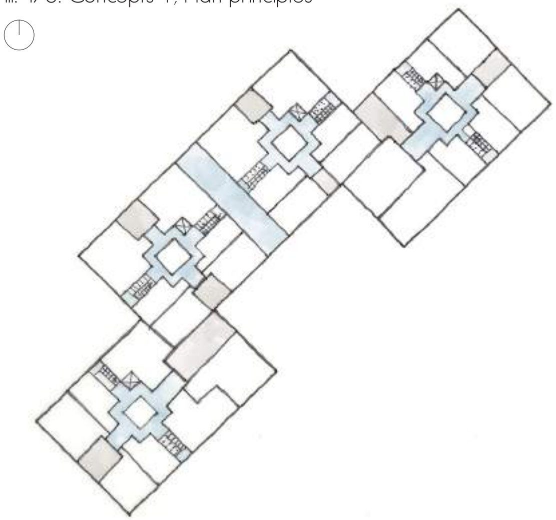
Ill. 175: Weighting of concepts, diagrams

Ill. 176: Concepts

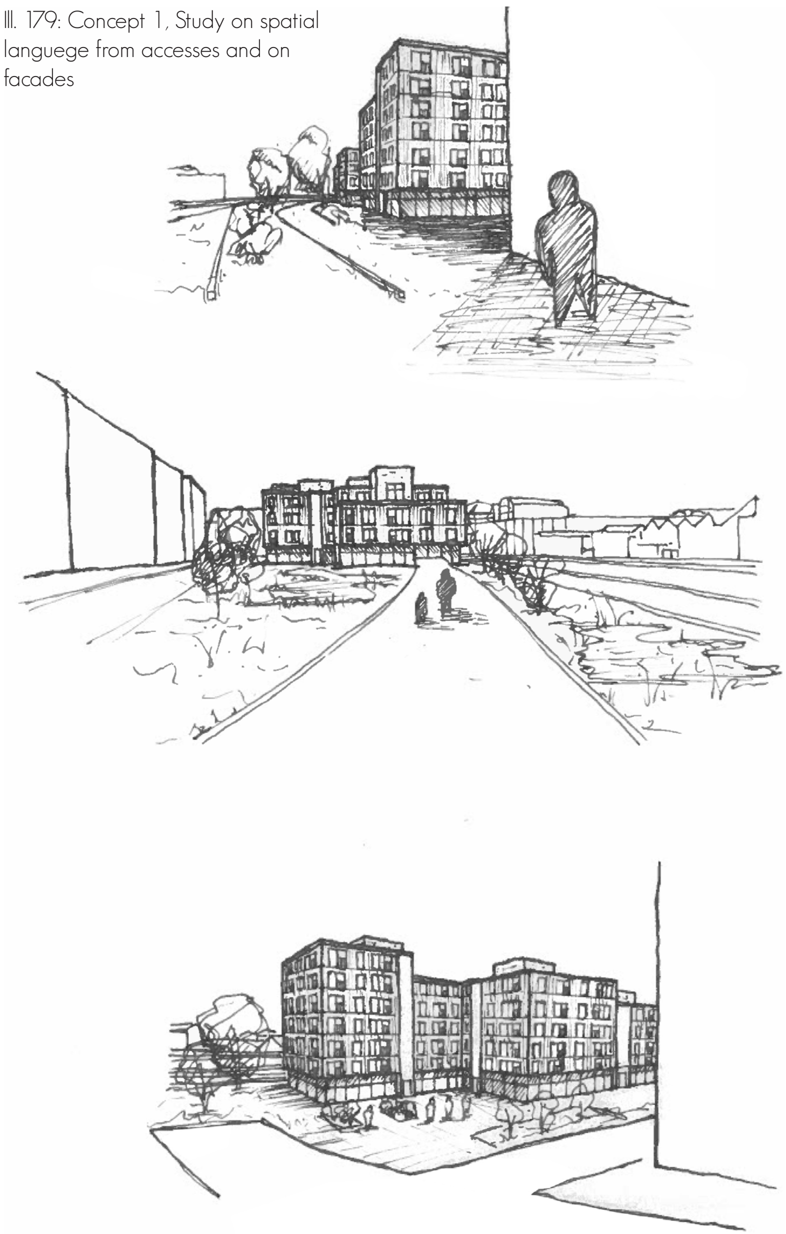
Ill. 177: Concepts 1, axonometri



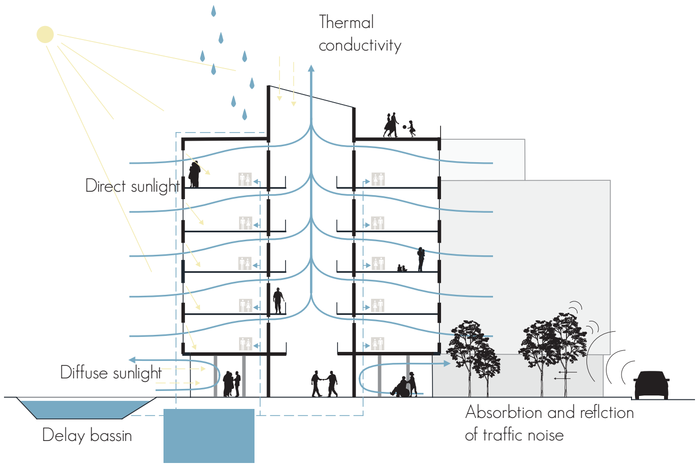
Ill. 178: Concepts 1, Plan principles



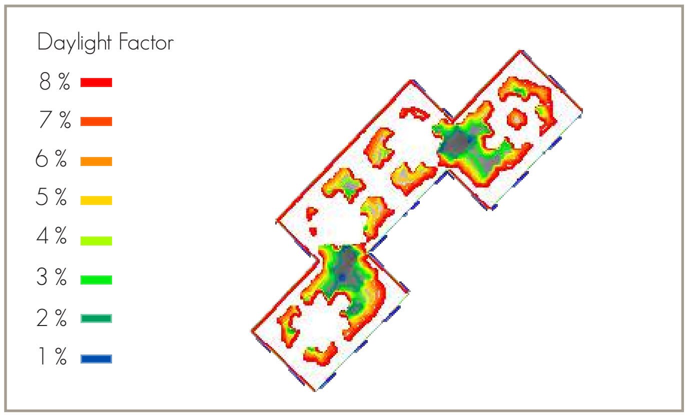
Ill. 179: Concept 1, Study on spatial languege from accesses and on facades



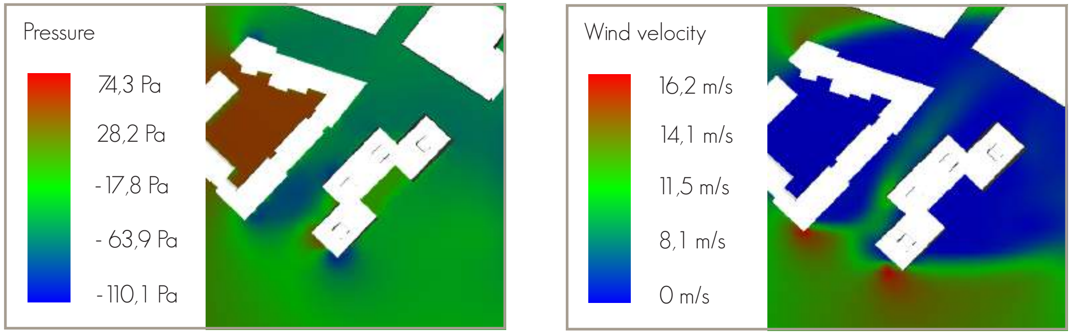
Ill. 180: Concept 1, passive strategy
Including considerations of natural ventilation, sunlight, rain water and noise pollution. Same considerations are calculated or simulated, for an documentation on Whether the strategy is possible.



Ill. 181: Concept 1, Daylight factor analysis



Ill. 182-183: Simulations of the air pressure and the wind velocity on the design, made in FlowDesign. The simulations shows an pressure difference but with suction on each sides. The design makes turbulence on the south corner.



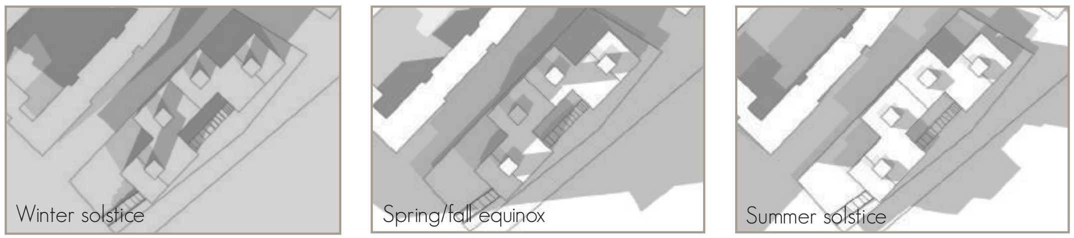
Below: Calculation of exploitation of rain water for toilet flush in apartments, with threshold in collection on roof top, imperial data are collected from DMI.dk and Energitjenesten.dk. 88 % of the roof area needed for collection.

Inhabitants	Toilet flush pr. person Avarage number	Days pr. year	Water used pr. flush, avarage, L	Need of grey-water for toillet flush, whole building, L
140	5	356	4,5 L	(140 pers. x 5 flush x 365 days/year) x 4,5 = 1.121.400 L/year

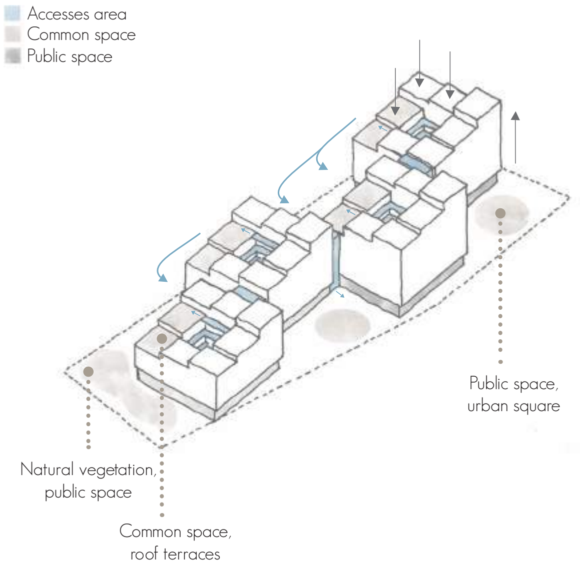
Anual rain fall, L	Size of roof, m	Possible collection of water from roof, L/year	Amount of roof needed for rain water collection, %
781 L/m²/year	1632 m²	781 L//m²/year x 1632 m² = 1.274.592 L/year	1.121.400 L/year / 781 L/m²/år = 1435, 9 m² 1435,9 m² / 1632 m² x 100 = 88 %

Left: Daylight factor simulated in Velux Visualizer, with properties of the highest amount of DF as possible: Outer walls of glazing material and surfaces held white, in that way it is easy to see the challenging places. In this proposal, the area where the triangles are merging, there will be limited exploitation of sunlight.

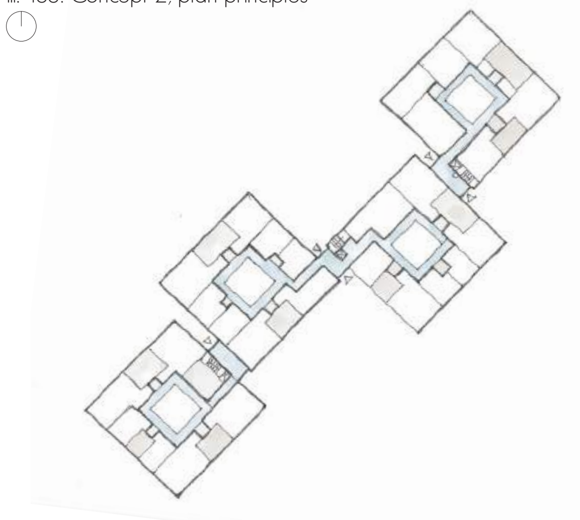
Ill. 184-186: Sunlight/shadow simulation, both the roof and the south area are highly exposed for sunlight. Analyzed at 10 AM, 14 PM and 18 PM, at winter solstice, equinox and summer solstice.



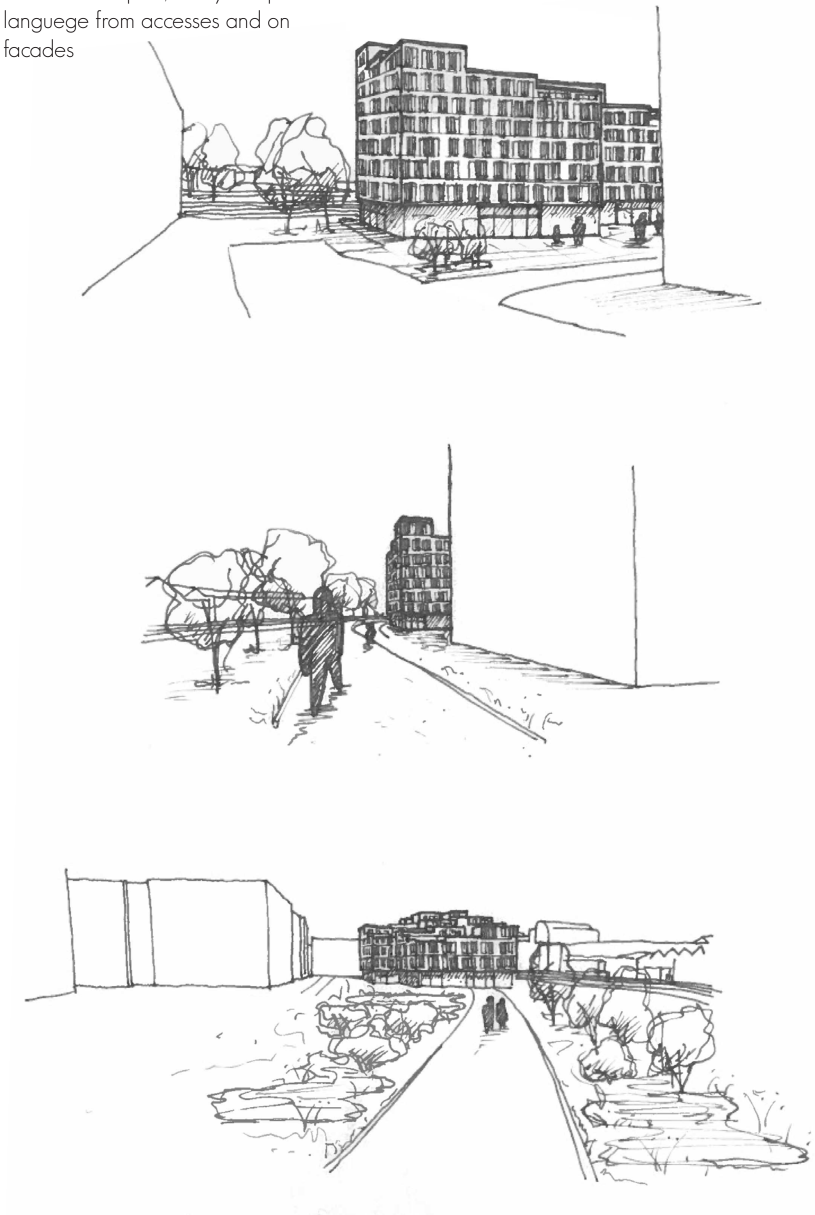
Ill. 187: Concept 2, axonometri



Ill. 188: Concept 2, plan principles

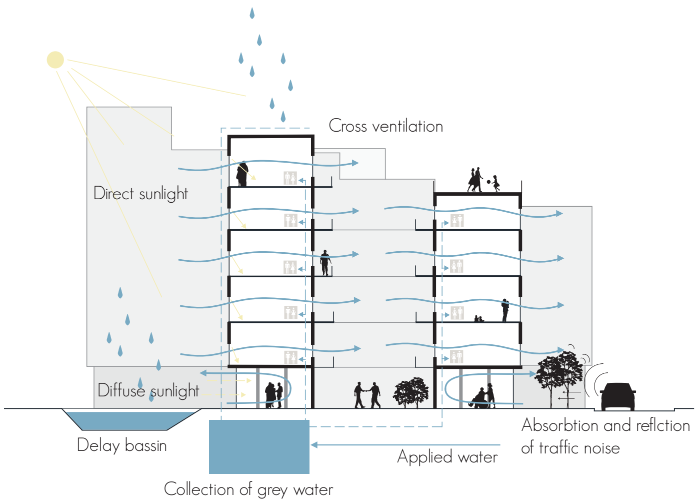


Ill. 189: Concept 2, Study on spatial languege from accesses and on facades

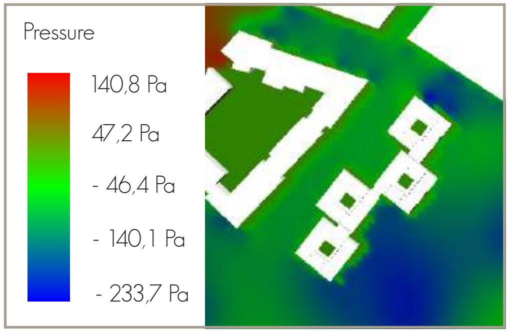


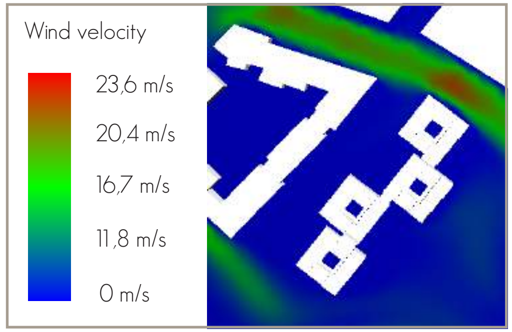
Ill. 190: Concept 2, passive strategy

Including considerations of natural ventilation, sunlight, rain water and noise pollution. Same considerations are calculated or simulated, for an documentation on whether the strategy is possible.



Ill. 192-193: Simulations of the air pressure and the wind velocity on the design, made in FlowDesign. The simulations shows an pressure difference but with suction on each sides. The design creates no chances in the wind flow.



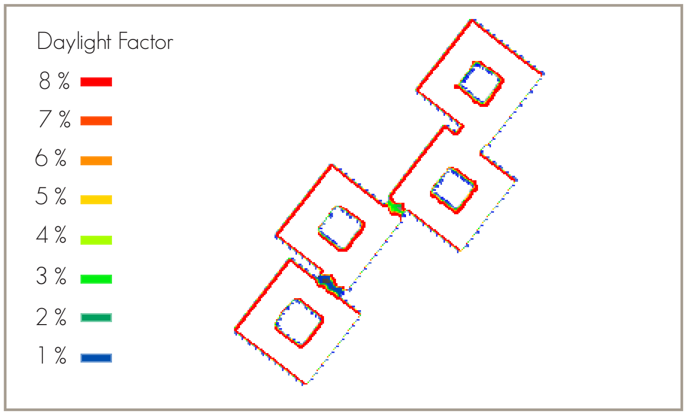


Below: Calculation of exploitation of rain water for toilet flush in apartments, with threshold in collection on roof top, imperial data are collected from DMI.dk and Energitjenesten.dk. Not enough roof area to collect water for toilet flush.

Inhabitants	Toilet flush pr. person Avarage number	Days pr. year	Water used pr. flush, avarage, L	Need of grey-water for toillet flush, whole building, L
140	5	356	4,5 L	(140 pers. x 5 flush x 365 days/year) x 4,5 = 1.121.400 L/year

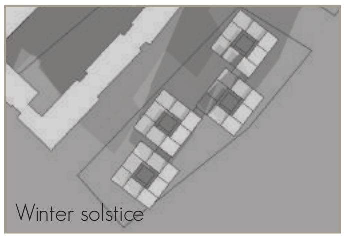
Anual rain fall, L	Size of roof, m	Possible collection of water from roof, L/year	Amount of roof needed for rain water collection, %
781 L/m²/year	1383,6 m²	781 L//m²/year x 1383,6 m² = 1.080.591 L/year	1.121.400 L/year / 781 L/m²/år = 1435, 9 m² 1435,9 m² / 1383,6 m² x 100 = 103,8 % (must be supplied with claen water)

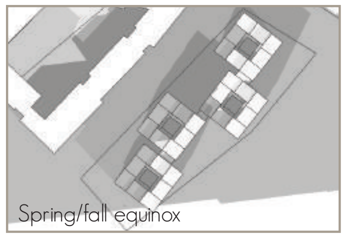
Ill. 191: Concept 2, daylight factor analysis

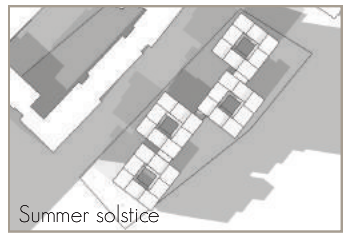


Left: Daylight factor simulated in Velux Visualizer, with properties of the highest amount of DF as possible: Outer walls of glazing material and surfaces held white, in that way it is easy to see the challenging places. In this proposal, only daylight in the vertical stairways will be a challenge.

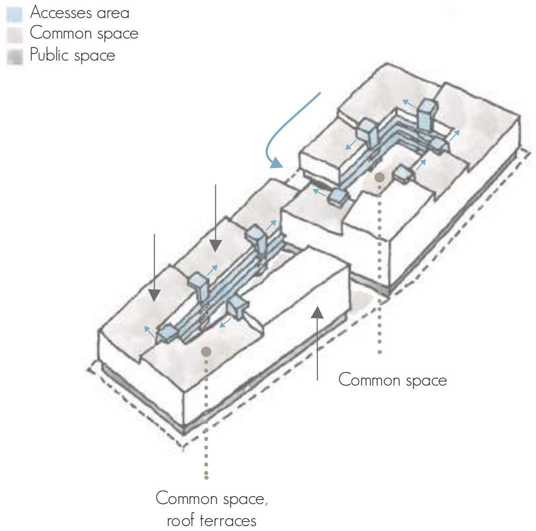
Ill. 194-196: Sunlight/shadow simulation, both the roof and the south area are highly exposed for sunlight. Analyzed at 10 AM, 14 PM and 18 PM, at winter solstice, equinox and summer solstice.



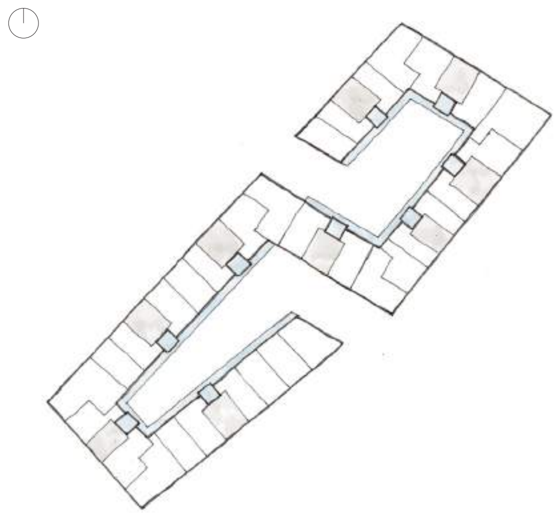




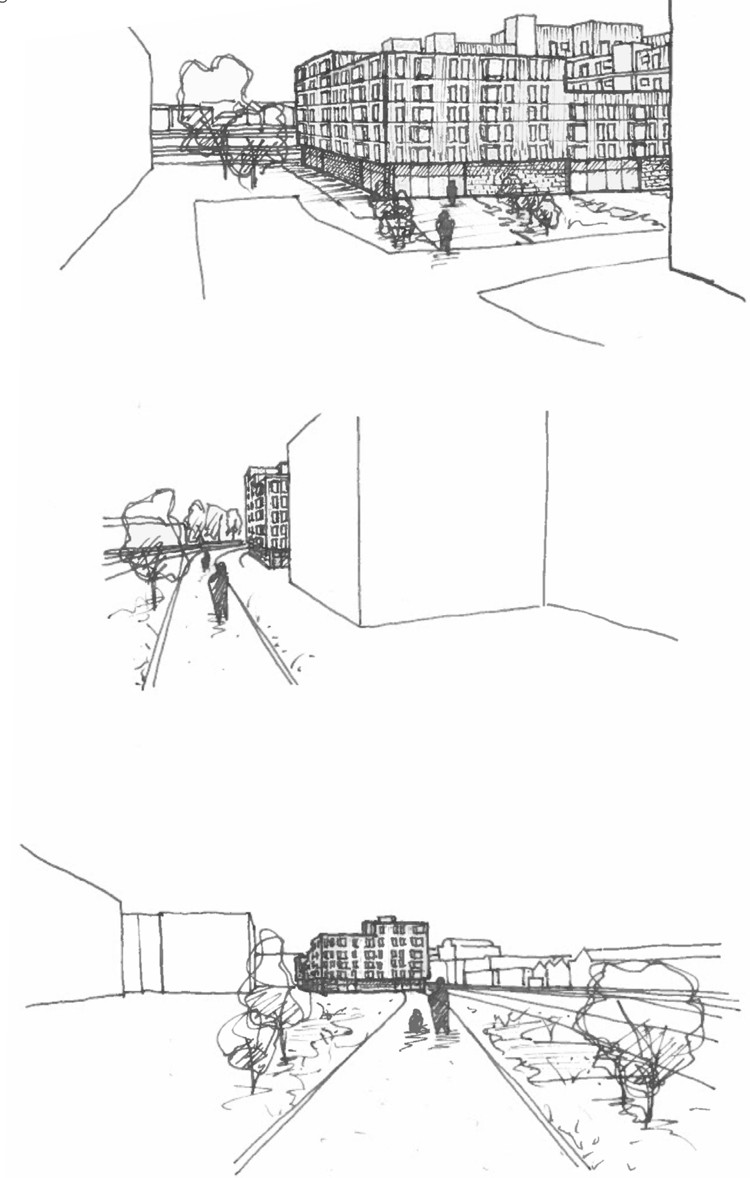
Ill. 197: Concept 3, axonometri



Ill. 198: Concept 3, plan principles

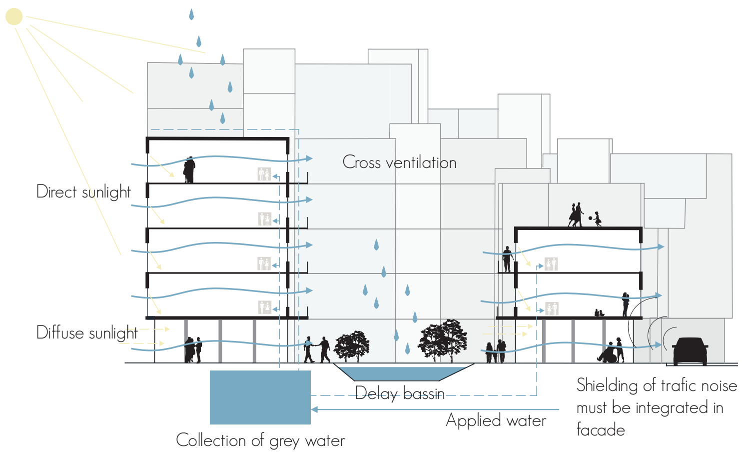


Ill. 199: Concept 3, Study on spatial languege from accesses and on facades

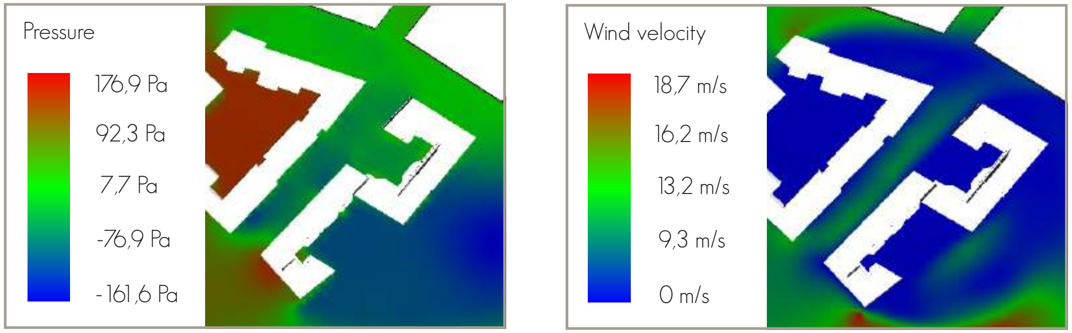


Ill. 200: Concept 3, passive strategy

Including considerations of natural ventilation, sunlight, rain water and noise pollution. Same considerations are calculated or simulated, for an documentation on whether the strategy is possible.



Ill. 202-203 Concept 3, Simulations of the air pressure and the wind velocity on the design, made in FlowDesign. The simulations shows pressure on south side but suction on every other side. The design creates turbulence in south corner and wind through the space between the building and the neighbor building on the left.

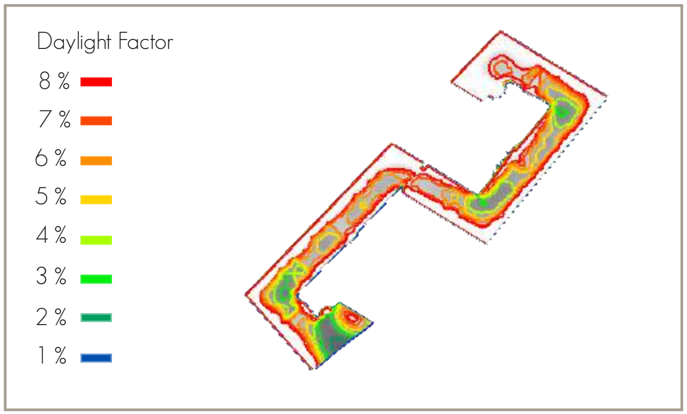


Below: Calculation of exploitation of rain water for toilet flush in apartments, with threshold in collection on roof top, imperial data are collected from DMI.dk and Energitjenesten.dk. 68 % of the roof area needed for collection.

Inhabitants	Toilet flush pr. person Avarage number	Days pr. year	Water used pr. flush, avarage, L	Need of grey-water for toillet flush, whole building, L
140	5	356	4,5 L	(140 pers. x 5 flush x 365 days/year) x 4,5 = 1.121.400 L/year

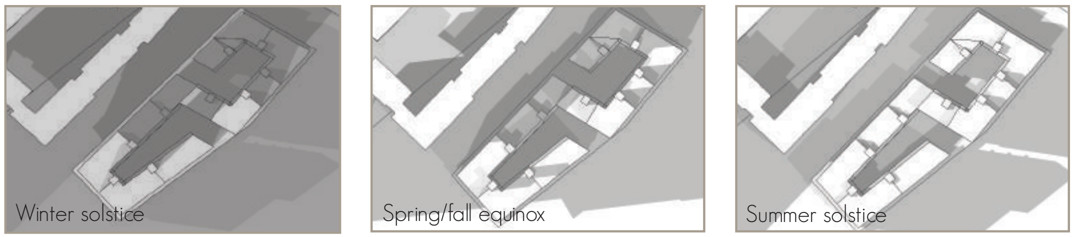
Anual rain fall, L	Size of roof, m	Possible collection of water from roof, L/year	Amount of roof needed for rain water collection, %
781 L/m²/year	2099 m²	781 L//m²/year x 2099 m² = 1.639.319 L/year	1.121.400 L/year / 781 L/m²/år = 1435, 9 m² 1435,9 m² / 2099 m² x 100 = 68 %

Ill. 201: Concept 3, daylight factor analysis



Left: Daylight factor simulated in Velux Visualizer, with properties of the highest amount of DF as possible: Outer walls of glazing material and surfaces held white, in that way it is easy to see the challenging places. In this proposal, only daylight in the vertical stairways will be a challenge.

Ill. 204-206: Sunlight/shadow simulation, both the roof and the south area are highly exposed for sunlight. Analyzed at 10 AM, 14 PM and 18 PM, at winter solstice, equinox and summer solstice. Changes in the hight needs to be done.



3.4.2 Design suggestions

The following study contains 9 different proposals of designs with 3D sketching and plans that in different ways takes threshold in the previous 3 initial concepts: Respectively the stock buildings with indoor corridors and common areas turning inwards and a concept of with outdoor galleries. The flow is important in every suggestion, as the access area distributes to the common areas, which should be the heart of the co-housing. The designs are weighted to find the proposal which fulfills the design criteria the best. In this study the comparison concentrates on 3 different aspects from the design criteria, respectively: Co-living, passive strategy and the context.

Design number 2 and 9 is chosen as the best performing designs in relation to the 3 parameters, and is further investigated. In these proposals the integration between the theme of co-living, the context and the passive strategies is weighted higher than the remaining proposals, but the 2 proposals themselves are very different.

Proposal number 2 catches the surrounding blocks and shapes and reverse S as is follows the site. It embraces the access area of galleries following the shape, which distributes to the common areas placed in between the apartments. The apartments are trans-illuminated and the fellowship arises in the common room placed pr. Every fourth apartments.

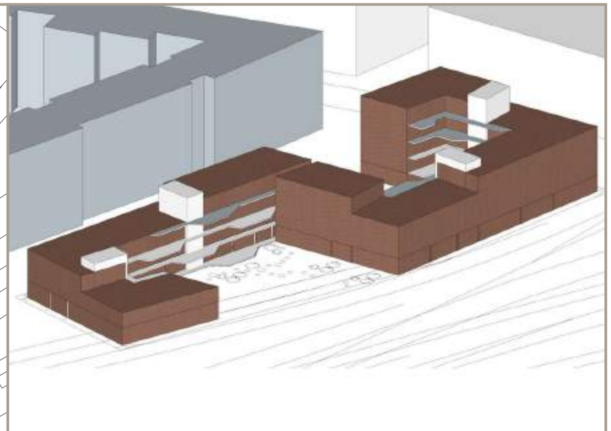
The Access areas and common spaces are highlighted on the plans, for a better comparison on how the concepts are reach in the designs.

Ill. 207-225: Design suggestions, plan and perspective

Access areas

Common spaces

Design 1

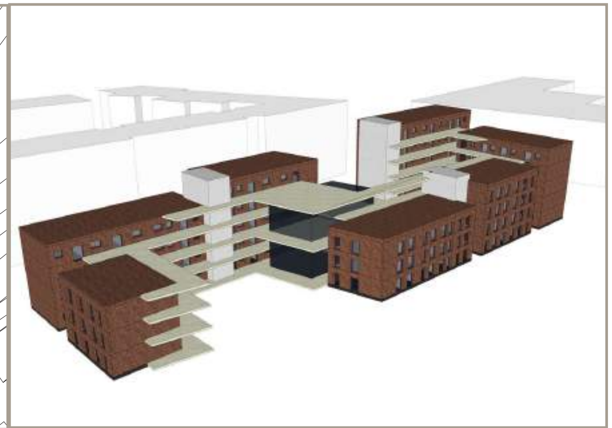


Design weighting:	Co-Living	●●○○○
	Passive strategy	●●●○○
	Context	●●●●○

Gross floor area:	6346 m^2
Building envelope:	5995 m^2
Building envelope pr. m^2 floor area:	0,95 m^2
Number of apartments:	70

Design number 1-3 takes threshold in concept 3 from the previous concept suggestions and variate in size, sloping, outer form and placements of the common areas. This effects the amount of building envelope compared to the gross floor area and the number of apartments.

Design 2



Design weighting:		
	Co-Living	●●○○○
	Passive strategy	●●●●○
	Context	●●●●○

Gross floor area:	7488 m^2
Building envelope:	8200 m^2
Building envelope pr. m^2 floor area:	1,1 m^2
Number of apartments:	80

Design 3

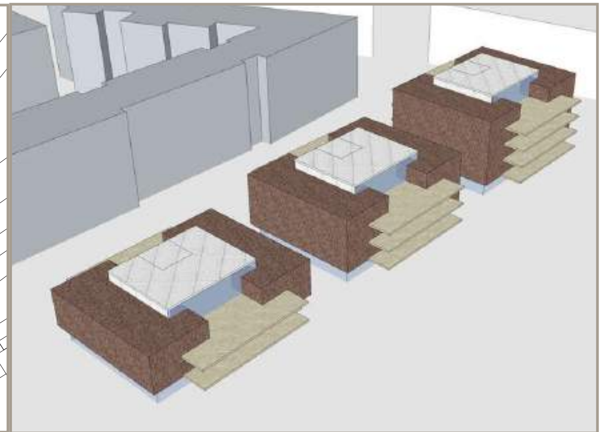
Design weighting:		
	Co-Living	●○○○○
	Passive strategy	●●●○○
	Context	●●●●○

Gross floor area:	7665 m^2
Building envelope:	9388 m^2
Building envelope pr. m^2 floor area:	1,2 m^2
Number of apartments:	80

floor area and the number of apartments.

Design number 4-7 takes threshold in concept 1 from the previous concept suggestions and variate in size, overall design, sloping and outer form. Common for all of them is that the common areas is places in the very center of the living groups and is accessible without having to go outside. In these design proposals the appearance is very dominant and static in some of the suggestions, although the galleries tries to compensate. The connection to the context is vague and little of the ground floor is left for green areas. The number of apartments is not nearly enough compared to the vision of 70 co-housing apartments. These conditions affects the weighting in a negative way.

Design 4



Design weighting:		
	Co-Living	●●●○○
	Passive strategy	●○○○○
	Context	●○○○○

Gross floor area:	6252 m^2
Building envelope:	6611 m^2
Building envelope pr. m^2 floor area:	1,1 m^2
Number of apartments:	46

Design 5

Design weighting:		
	Co-Living	●●●●○
	Passive strategy	●●○○○
	Context	●○○○○

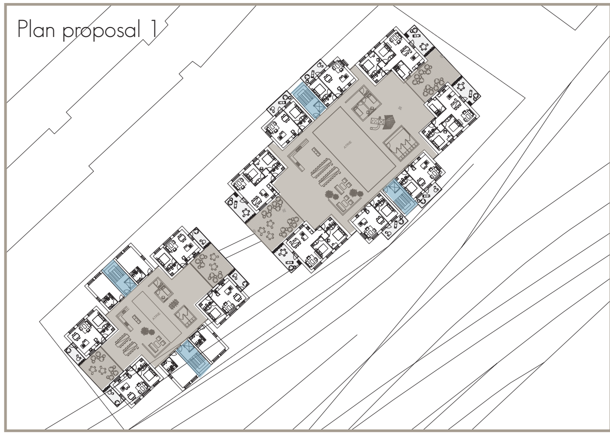
Gross floor area:	7545 m^2
Building envelope:	6457 m^2
Building envelope pr. m^2 floor area:	0,8 m^2
Number of apartments:	48

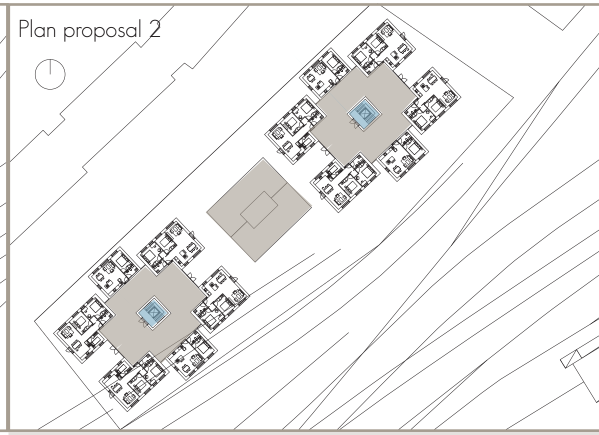
Design 6

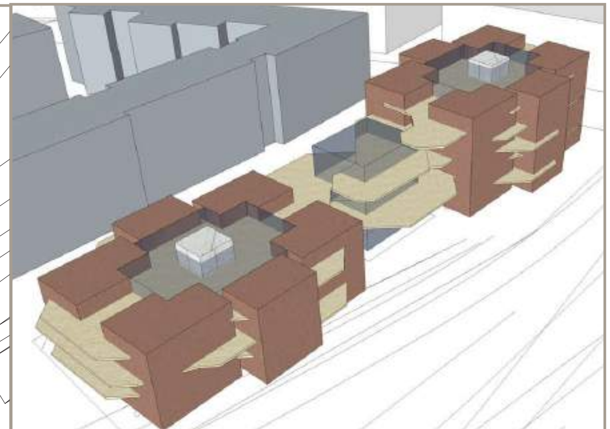
Design weighting:		
	Co-Living	●●●●○
	Passive strategy	●●○○○
	Context	●○○○○

Gross floor area:	6325 m^2
Building envelope:	5503 m^2
Building envelope pr. m^2 floor area:	0,9 m^2
Number of apartments:	38

Design 7







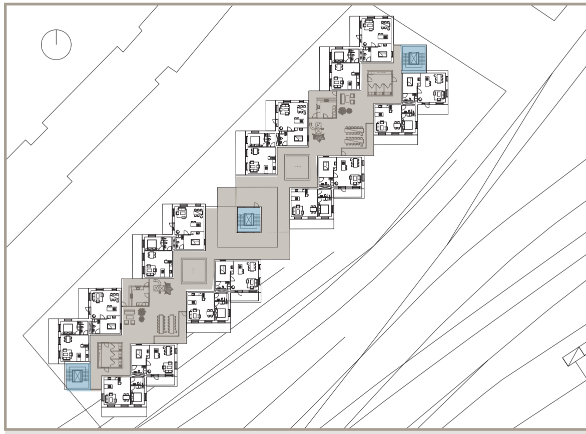
Design weighting:		
	Co-Living	●●●●○
	Passive strategy	●●●○○
	Context	●○○○○

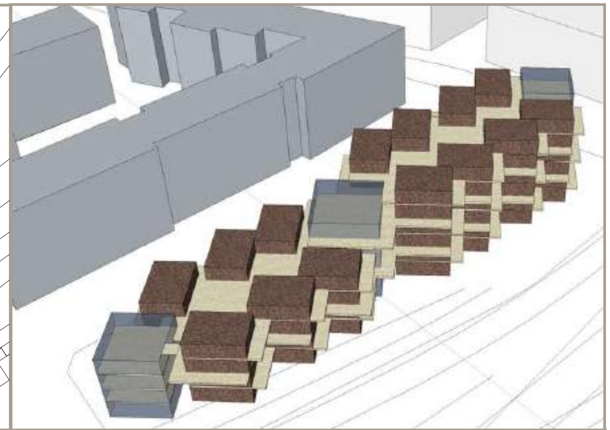
Gross floor area, 2:	8737 m^2
Building envelope, 2:	8389 m^2
Building envelope pr. m^2 floor area:	0,9 m^2
Number of apartments 1 and 2:	60 and 80

Proposal number 9 is following the direction from the old rails and following the narrow site from south-west to north-east. Every apartment has facades turning in two directions at least, respectively west and north and on the other side of the building turning south and east. In this way, view, daylight and natural ventilation i made possible. The common areas are the central part of the building surrounded by private areas.

Both design proposals 8 and 9 is concerning Co-living, passive strategy and the context on a acceptable level, but as design number 9 create more apartments and slopes better in relation to the context, this i the design chosen to work further work.

Design 8

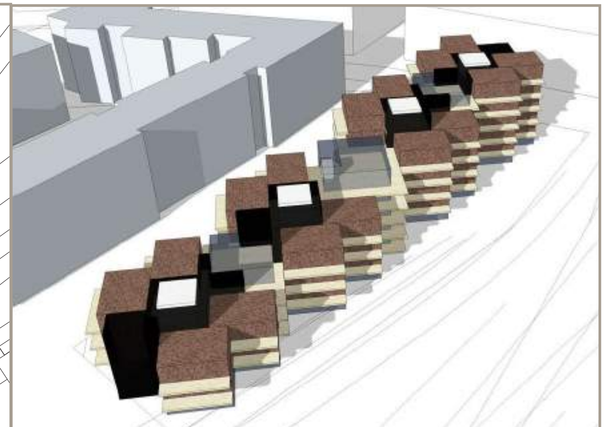




Design weighting:		
	Co-Living	●●●○○
	Passive strategy	●●●●○
	Context	●●○○○

Gross floor area:	7588 m^2
Building envelope:	6776 m^2
Building envelope pr. m^2 floor area:	0,9 m^2
Number of apartments:	42

Design 9



Design weighting:		
	Co-Living	●●●●○
	Passive strategy	●●●○○
	Context	●●●○○

Gross floor area:	7204 m^2
Building envelope:	8175 m^2
Building envelope pr. m^2 floor area:	1,1 m^2
Number of apartments:	59

3.4.3 Visual comfort and facade expression

The following comparison simulates both designs which were chosen to work further on with. Windows where applied to both designs and daylight was simulated in Velux visualizer. In this way it is possible to analyze the daylight factor in the buildings and thereby one of the factors of the visual comfort. In the same time, 3D sketches visualize the facade expression of the placement of the windows. Based on these simulations and architectural considerations, one of the designs is chosen for the further process.

The plans is a ground floor plan with a variation of family, couple, single and elder apartments. The BR18 demands for daylight in each living room is 300 Lux in minimum half of the room floor area, which is converted to Daylight factor in this project:

300 lux (indoor) / 10.000 lux (outdoor) *100 = 3 % DF

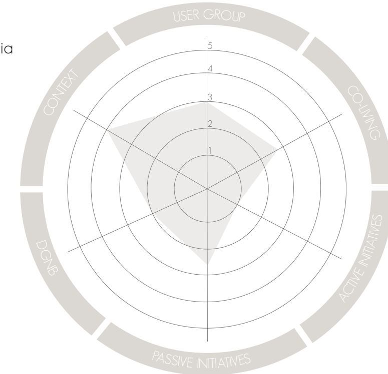
As seen in the plan view, all apartments is trans-illuminated in design number 2 and in design number 9 the windows are placed in two adjacent facades. The indoor materials is semi-glossed gypsum and light wooden flooring. The light transmittance of the glazing is set to 78 %. There are made two variations of windows of design number 2, and the second variation of window sizes are applied to design 9.

As seen in design number 2 simulation number 2 there is a big different of the amount of daylight from apartment to apartment. In the south part of the building the apartments are too exposed to daylight and in the apartments in north west the apartments get little or none sunlight on the in half of the apartment. Compared to design number 9 the daylight is in general lower but it is more balanced and equal in all apartments because of the way they are offset to each other. These considerations will affect the energy consumption and the thermal indoor climate, hence design number 9 approaches the aim the best.

The facade expression and the overall design of number 2 create more space inwards, but creates only common space through the galleries that connects the apartments. This makes the co-living of the building very seasonal, which is not preferable.

Design number 9 is more dense and only creates space for the public outwards. Instead it allows common spaces to appear in between the apartments with direct access through indoor access space. This will allow the inhabitants to gather in the common space without forcing them to go through unheated space. As the project centers around the co-housing theme, design number 9 will be most suitable for the further process.

2. Concept
Score in design criteria

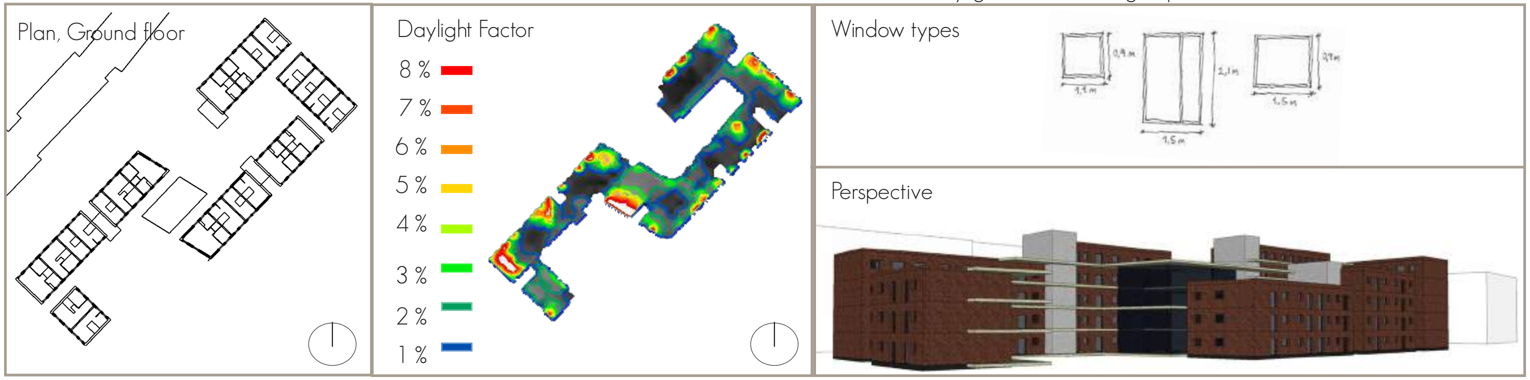


9. Concept
Score in design criteria

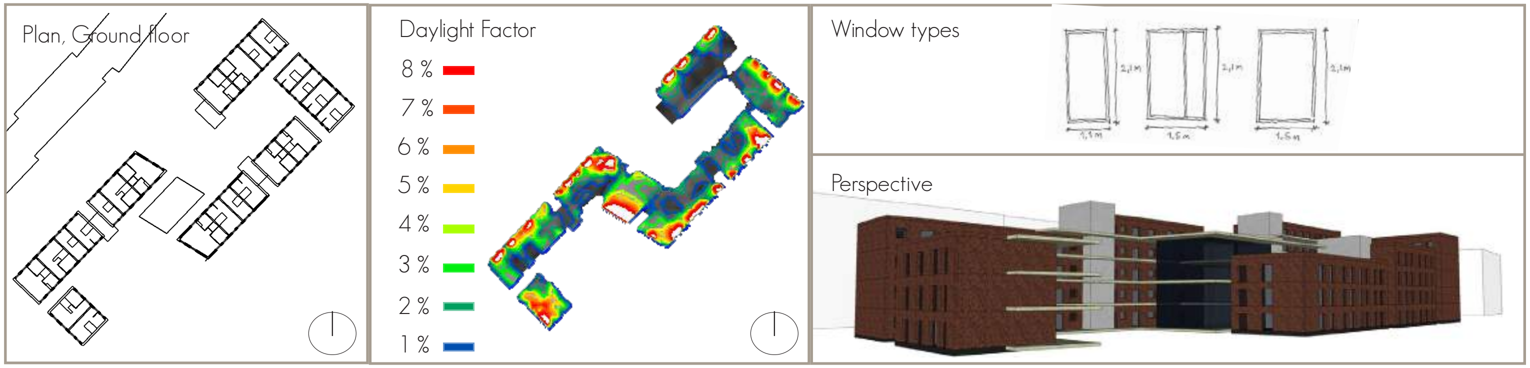
Ill. 226: Weighting of designs, diagrams

Design 2 window type 1

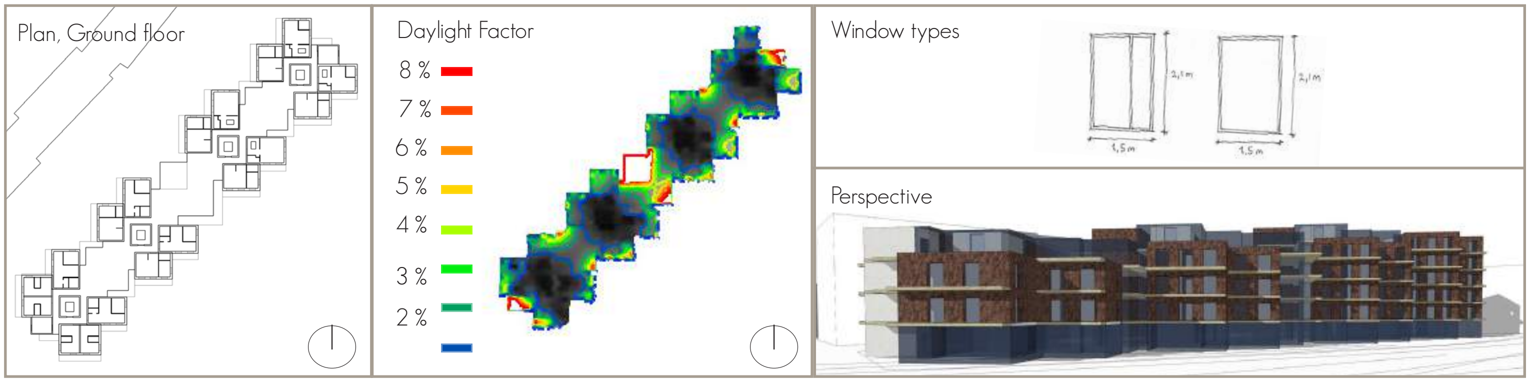
Ill. 227-238: Daylight factor of designs, plans, simulations, windows and facades



Design 2, window type 2



Design 9



3.5 ENERGY USE

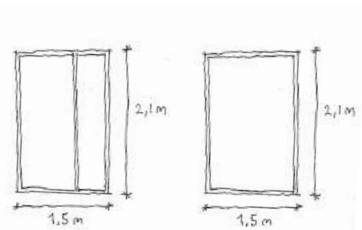
3.5.1 Process of energy consumption, Be18

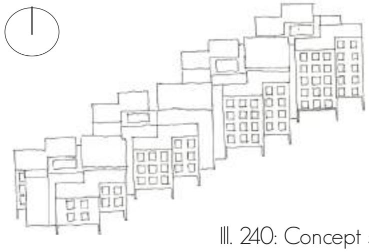
As concept 2 is developed for the further design process, iterations concerning the energy consumption has been made, based on the static simulation tool Be18 referring to the Danish standards and regulations.

The initial study of the energy consumption is based on a simulation with the building seen in the diagram. (Ill. 240) The informations about the building envelope is a compound of exact informations about surfaces and orientation and assumptions of the U-value and line loss, which is set to the demands from BR18. The measurements of the window openings is referring to the types shown below. Concerning internal loads, SBI213 standard values is used. For water supply, recommended values from internal course material, Zero Energy Building, is used. In this way, it is possible to see the different loads and in which way these energy needs should be handled.

As seen in the scheme for output, there is a heavily load on energy for removing overheat, hence overhangs/ balconies is studied in the 1. iteration.

Ill. 239: 2 types of openings: Glass door and wide window

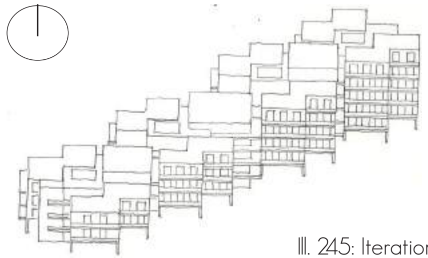




Ill. 240: Concept start point

Input	
General information	Gross floor area: 7204 m^2, Heat capacity: Medium light construction = 80 Wh/K*m^2 Heat supply: District heating Other supplies: None
Building Envelope	Outer walls: 4047 m^2, U-value = 0,3 W/m^2*K, temperature factor (b) = 1 Roof: 1770 m^2, U-value = 0,2 W/m^2*K, temperature factor (b) = 1 Foundation: 678 m^2 = 0,2 W/m^2*K, temperature factor (b) = 1 Joints around foundation: 287 m, 0,4 W/m^2*K, temperature factor (b) = 1 Joints around Windows and doors: 1692 m, loss = 0,06 W/m*K, temperature factor (b) = 1 Windows and doors: Windows S front: 520 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,65 (3-layer clear glass), shadows = none Windows S back: 88 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,65, shadows = none Windows W front: 465 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,65, shadows = none Windows W back: 107 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,65, shadows = none Windows E: 495 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,65, shadows = none Windows N: 441 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,65, shadows = none
Internal heat Sypply	Whole building: 7204 m^2, people load = 1, 5 W/m^2, Appliance = 3,5 W/m^2 (night = 0)
Heat distribution plant	Heat pumps: Supply pipe temp. = 70°, Return pipe temp. = 40°, Dual pipe-type Heat pipes outside the heated area: Pipe length = 200 m (2 times the building length), transmission loss = 0,22 W/m*K (highest energy class, DS452 table 5.1), b=0
Hot domestic water	Avarage use for the building = 250 L/år * m^2 Domestic water system temperature = 55° Hot water tank: Connecting pipes to hot water tank: Approximately 40 m, Transmission loss = 0,22 W/m*K (highest energy class, DS452 table 5.1), b=0 Circulation pump: Amount = 2, Effect = 80 W Pipes inside and outside: 300 m (Pipes outside heated space + pipes inside: L =n*2*(e-1)*h, where n=number of vertical pipes, e=floor, h=height/ floor), Transmission loss = 0,45 W/m*K, b = 0,7 (if pipes within heated space)
Output	
Energy Frame BR15/18	128,7 kWh/m^2/ year

Supply for energy need	Netto need	Electricity need
Heat = 11,4 kWh/m^2/ year Energy for operation = 13,1 kWh/m^2/ year Overheat in room = 86,8 kWh/m^2/ year	Room heating = 9,5 kWh/m^2/ year Hot domestic water = 13,1 kWh/m^2/ year Cooling = 0 kWh/m^2/ year	Lighting = 0 kWh/m^2/ year Heating of hot domestic water: 13,1 kWh/m^2/ year Ventilation = 0 kWh/m^2/ year



Ill. 245: Iteration 1

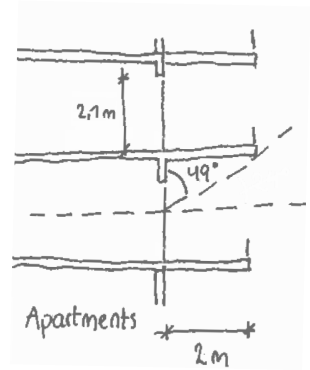
Be18 Iteration 1, shadows

In the first iteration an addition of balconies of every window is exploited to reduce the overheat. The change will be seen in the energy used to removed overheated air.

These conditions is expressed in the shadow scheme and shown in the drawings below. All other conditions which is not mentioned in this scheme is held the same as in the start-point of the Be18 calculation, page 102. For shadows from sides and for the horizon, average considerations are made, seen in the illustrations..

This iteration shows that balconies has a good effect on the energy consumption and the energy used to remove heated air. A small scheme below shows the effect on different depth of these galleries. Depth of 2 meters is the chosen, as the highest effect was reach vs. the extra depth.

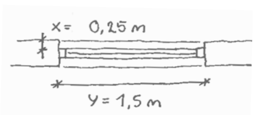
Ill. 246: Overhangs/balconies



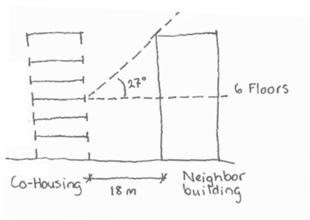
Overhangs

Balcony depth, m	Overheat in room	Heating
1 m	64,6 kWh/m²/ year	6,3 kWh/m²/ year
2 m	53,7 kWh/m²/ year	6,9 kWh/m²/ year
3 m	43,5 kWh/m²/ year	7,7 kWh/m²/ year

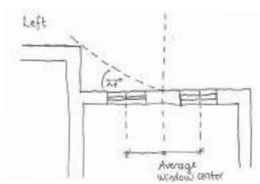
Ill. 241: Windowsill



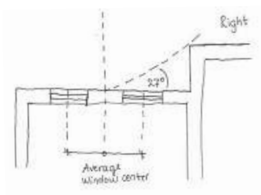
Ill. 242: Horizon



Ill. 243: Side shadow, West

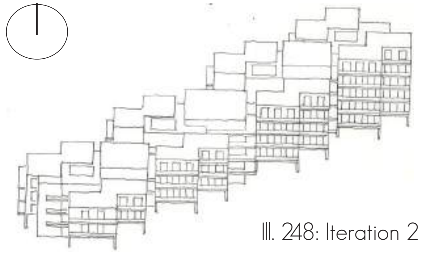


Ill. 244: Side shadow, South



Input	
Building Envelope	Windows and doors: Windows S front: 520 m², U-value = 0,6 W/m²*K, b = 1, Part of glass = 0,9, G-factor = 0,35 (3-layer clear glass), shadows = balconies Windows S back: 88 m², U-value = 0,6 W/m²*K, b = 1, Part of glass = 0,9, G-factor = 0,35, shadows = balconies, from right Windows W front: 465 m², U-value = 0,6 W/m²*K, b = 1, Part of glass = 0,9, G-factor = 0,35, shadows = balconies, horison Windows W back: 107 m², U-value = 0,6 W/m²*K, b = 1, Part of glass = 0,9, G-factor = 0,35, shadows = balconies, from left, horison Windows E: 495 m², U-value = 0,6 W/m²*K, b = 1, Part of glass = 0,9, G-factor = 0,35, shadows = balconies Windows N: 441 m², U-value = 0,6 W/m²*K, b = 1, Part of glass = 0,9, G-factor = 0,35, shadows = balconies, horison
Output	
Energy Frame BR15/18	92,1 kWh/m²/ year

Supply for energy need	Netto need	Electricity need
Heat = 6,9 kWh/m²/ year Energy for operation = 13,1 kWh/m²/ year Overheat in room = 53,7kWh/m²/ year	Room heating = 5,1 kWh/m²/ year Hot domestic water = 13,1 kWh/m²/ year Cooling = 0 kWh/m²/ year	Lighting = 0 kWh/m²/ year Heating of hot domestic water: 13,1 kWh/m²/ year Ventilation = 0 kWh/m²/ year



Ill. 248: Iteration 2

Input	
Ventilation	Zones: Living room, ap: 3378 m^2, Fo = 1, q(M., W) = 0,3 l/s/m^2, Recovery = 0,95, ti = 0°, q (N, W) = 0,1, SEL = 1, q(M, S) = 0,3, q(N,S) = 1,5, q(n) = no Bathroom, ap: 680 m^2, Fo = 0, q(M., W) = 15 l/s/m^2, Recovery = 0,95, ti = 0°, q (N, W) = 0,1, SEL = 0,8, q(M, S) = 15 q(N,S) = 1,2, q(n) = no Common, g.: 1494 m^2, Fo = 1, q(M., W) = 10,3 l/s/m^2, Recovery = 0,95, ti = 0°, q (N, W) = 0,1, SEL = 1, q(M, S) = 0,3 q(N,S) = 1,2, q(n) = no Commersial: 1188 m^2, Fo = 1 q(M., W) = 0,3 l/s/m^2, Recovery = 0,95, ti = 0°, q (N, W) = 0,1, SEL = 1, q(M, S) = 0,3 q(N,S) = 1,2 q(n) = no Access area: 2128 m^2, Fo = 1, q(M., W) = 0 l/s/m^2, Recovery = 0, ti = 0°, q (N, W) = 0,1, SEL = 0,8, q(M, S) = 0 q(N,S) = 1,2, q(n) = no
Output	
Energy Frame BR15/18	63,6 kWh/m^2/ year

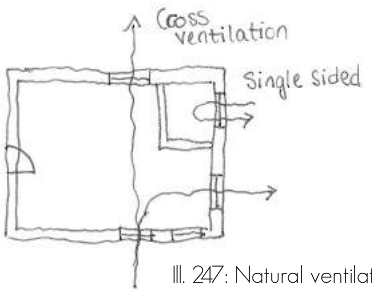
Supply for energy need	Netto need	Electricity need
Heat = 20,8 kWh/m^2/ year Energy for operation = 15,9 kWh/m^2/ year Overheat in room = 32,2 kWh/m^2/ year	Room heating = 4,4 kWh/m^2/ year Hot domestic water = 14,5 kWh/m^2/ year Cooling = 0 kWh/m^2/ year	Lighting = 0 kWh/m^2/ year Heating of hot domestic water: 13,1 kWh/m^2/ year Ventilation = 5,9 kWh/m^2/ year

Be18 iteration 2, ventilation

In this iteration natural and mechanical ventilation is applied in the Be18 calculation, to remove the overheat and polluted air and provide fresh air with heat recovery.

The amount of natural ventilation is calculated with threshold in one of the apartments, and BR18 demands is applied in every other case. The calculation for natural ventilation is shown on page 128-129. Here the result for cross ventilation in living rooms shows 3,3 m^3/s, and the qn(summer) will be: 3300 l/s / 35 m^2 = 94 l/s/m^2, which is too much. This will be set to 1,5 l/s instead. All other input is held the same as in the previous iteration.

The results shows less energy used to remove overheated air and the energy consumption is down to 63,6 kWh/m^2/year.



Ill. 247: Natural ventilation

Iteration 3, water heaters for direct district heating

In this iteration the hot water tank is replaced with small water heaters that is installed in the apartments. The hot water tank is therefor set to 0. The result is seen in the below scheme. All other inputs are held the same.

In this way the transmission loss from the hot water tank is removed. This change is seen in the output under heating of hot domestic water and brings the energy consumption down to 40,1 kWh/m^2/year.

Iteration 3

Output	
Energy Frame BR15/18	40,1 kWh/m^2/ year

Supply for energy need	Netto need	Electricity need
Heat = 21,3 kWh/m^2/ year Energy for operation = 1,8 kWh/m^2/ year Overheat in room = 18,4 kWh/m^2/ year	Room heating = 5,8 kWh/m^2/ year Hot domestic water = 14,2 kWh/m^2/ year Cooling = 0 kWh/m^2/ year	Lighting = 0 kWh/m^2/ year Heating of hot domestic water: 0 kWh/m^2/ year Ventilation = 5,9 kWh/m^2/ year

Iteration 4, new shadows, new U-value

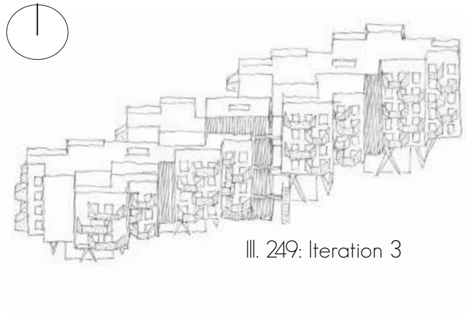
To bring the energy used on removing overheat even further down, iterations are made in the facade to prevent too much passive heating. The iterations of the facade along with the balconies are seen in the chapter of daylight process for an 1 room apartment. The result from the last iteration and the final facade is used as input for new shadows.

The changes is the extra depth of window sills, which is the sills continuing 10 cm out from the facade. Furthermore, perforated handrails for the balconies are applied, which continues in the high on both sides of the balconies, to create more privacy on each balcony. In the common and commercial areas the glass facades are applied with lammella of 20-40 cm depth.

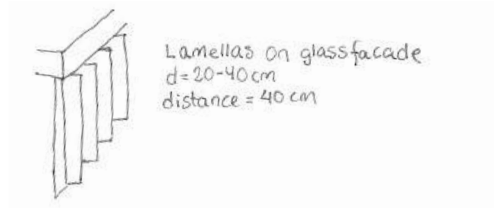
In the same iteration the Building envelope is improved, as the results so fare shows a load on energy used for heating. The building envelope of the outer wall is improved to 0,12 W/m^2*C and the roof to 0,07 W/m^2*C, by using Kingspan as insulation material. The layers and the calculations are shown in the construction chapter. All other inputs are held the same.

The changes are illustrated in the small sketches and the results are seen in the output.

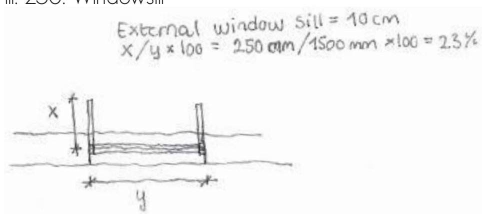
The results shows less energy used for ventilation and less overheat. At the same time the energy used for lighting has increased, but as the total energy consumption is reduced to 37,3 kWh/m^2/ year no further passive iterations are made.



Ill. 249: Iteration 3



Ill. 251: Lamellas on glasfacade



Ill. 250: Windowsill

Ill. 252: Side shadow, Handrails on balconies

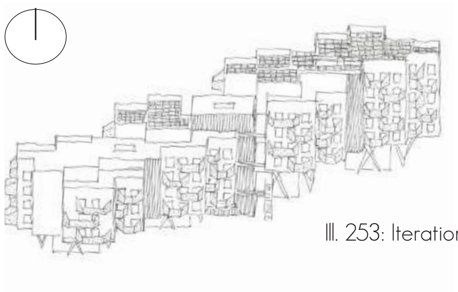
Input	
Building Envelope	Outer walls: 4047 m^2, U-value = 0,12 W/m^2*K, temperature factor (b) = 1 Roof: 1770 m^2, U-value = 0,07 W/m^2*K, temperature factor (b) = 1 Windows and doors: Windows S front: 126 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,35 (3-layer clear glass), shadows = balconies, sides Windows S back: 88 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,35, shadows = balconies, from sides Windows W front: 465 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,35, shadows = balconies, horison, from sides Windows W back: 107 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,35, shadows = balconies, from sides, horison Windows E: 495 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,35, shadows = balconies Windows N: 441 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,35, shadows = balconies, horison W. common (S,E): 791 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,35, shadows = balconies, from sides W. common (N, W): 6017 m^2, U-value = 0,6 W/m^2*K, b = 1, Part of glass = 0,9, G-factor = 0,35, shadows = balconies, horisan, from sides
Output	
Energy Frame BR15/18	37,3 kWh/m^2/ year

Supply for energy need	Netto need	Electricity need
Heat = 19,8 kWh/m^2/ year Energy for operation = 1,8 kWh/m^2/ year Overheat in room = 16,8 kWh/m^2/ year	Room heating = 4,3 kWh/m^2/ year Hot domestic water = 14,2 kWh/m^2/ year Cooling = 0 kWh/m^2/ year	Lighting = 0 kWh/m^2/ year Heating of hot domestic water: 0 kWh/m^2/ year Ventilation = 1,8 kWh/m^2/ year

Iteration 5, Active initiative, PV cells

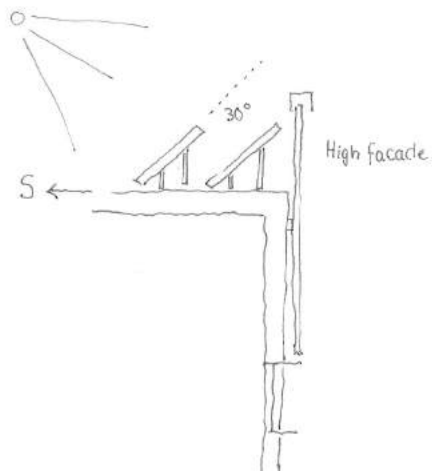
The last iteration made to reach a zero energy building is a active initiative of applying PV cells, which will compensate for the remaining energy use. As mentioned under design criteria, the aim is to reach a zero energy building by the Net Zero Source strategy, where the building is connected to the grit at the same time as it produces energy on site. By this method there is produced enough energy on site as used. The calculation of PV cells are shown at page 146-147.

The results shows an low energy consumption, approaching 0 with 1,3 kWh/m²/year. In this way the project comes near to an zero energy building.



Ill. 253: Iteration 5

Ill. 254: PV cells on roof



Input	
Solar cells	System: Panels: 1070 m², Peak power = 0,3 kW/m², Efficiency = 0,75, Orientation = South, Inclenation = 30°, Shadows = none
Output	
Energy Frame BR15/18	1,3 kWh/m²/ year

Supply for energy need	Netto need	Electricity need
Heat = 20,4 kWh/m²/ year Energy for operation = -8,2 kWh/m²/ year Overheat in room = 5,4 kWh/m²/ year	Room heating = 4,3 kWh/m²/ year Hot domestic water = 14,2 kWh/m²/ year Cooling = 0 kWh/m²/ year	Lighting = 0 kWh/m²/ year Heating of hot domestic water: 0 kWh/m²/ year Ventilation = 1,8 kWh/m²/ year

3.6 INDOOR CLIMATE

3.6.1 Visual comfort, daylight factor

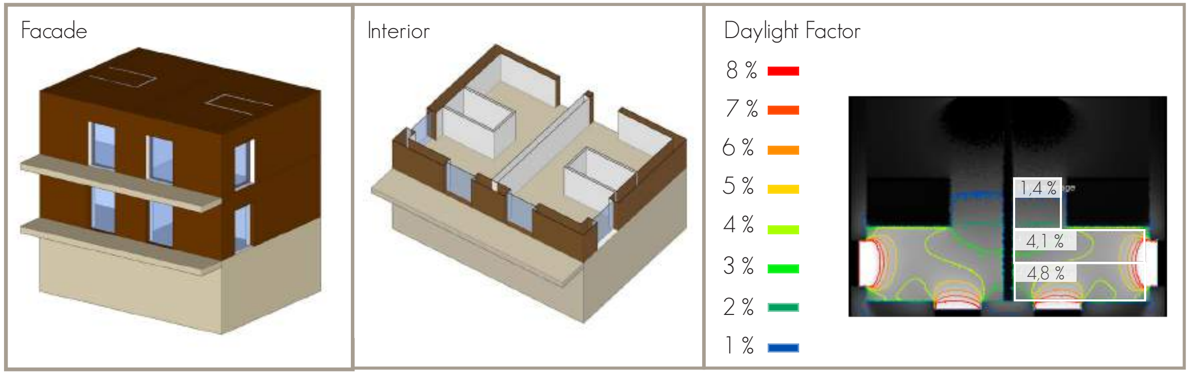
This study is an extension to the daylight analysis made on a whole 1 floor plan on the design. In this study a 1 room apartment is simulated in relation to daylight factor to create a good visual comfort within the apartment, with threshold in the choices of the design. The apartment is facing south and east. In all simulations the materials is white painted walls and light wooden flooring.

In the starting point the 1 room apartments are planned with a central bedroom core to divide the room in two zones of respectively the living room area and the sleeping area. In between these zones is the kitchenette. As seen in the simulation the core is blocking for daylight to enter both the kitchen and the sleeping area.

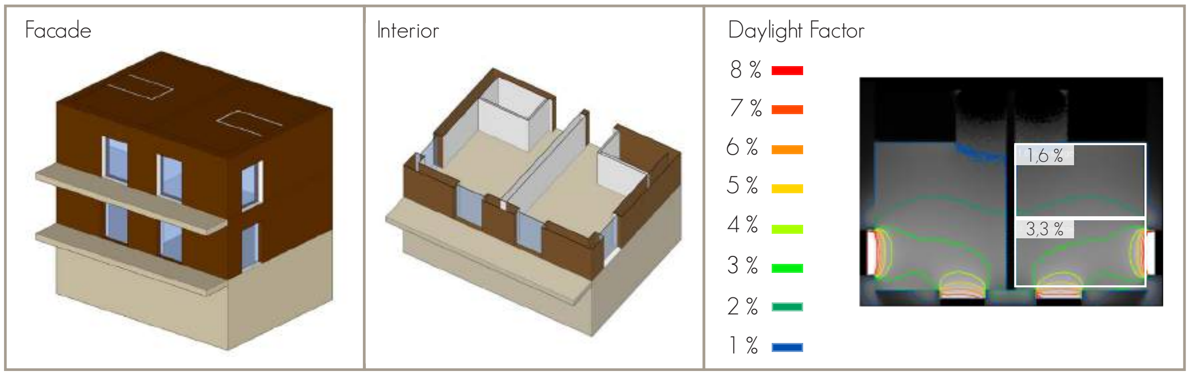
Iteration 1: here the core is moved to the back of the room, letting the daylight enter more floor area. In this simulation the daylight factor is 3,3 % in half of the room. As the aim is to provide enough daylight without creating overheat, the daylight factor will be brought slightly down.

Ill. 255-269: Daylight factor analysis, facades, interior and simulations

Starting ponit: Toillet core in middle of apartment



Iteration 1: Toillet core moved to back of the apartment

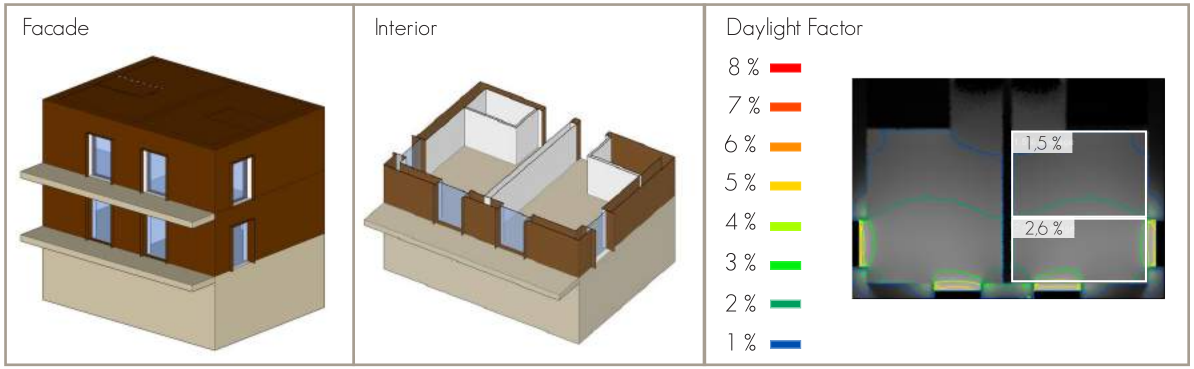


Iteration 2: External window sills are applied to the windows with the depth of 20 cm. This shows a big change in the daylight, which is down to 2,6 % in half of the room, which need to be approved again.

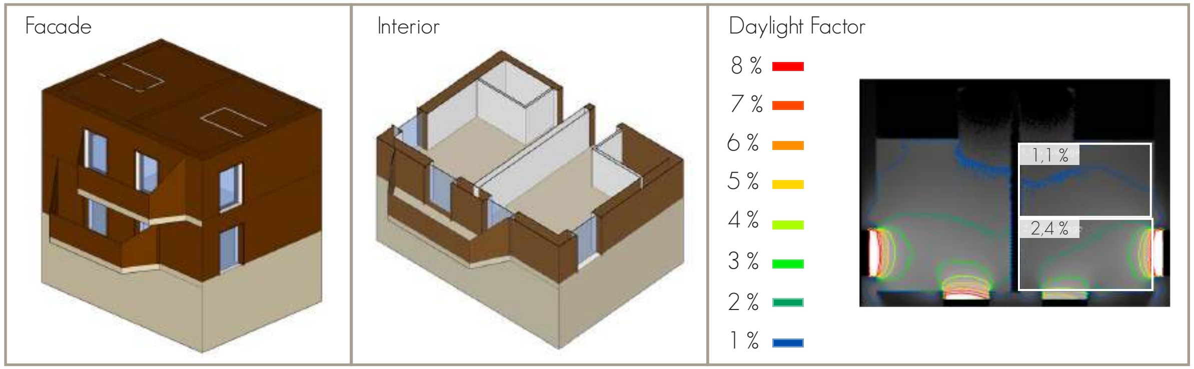
Iteration 3: The external window sills are changed to 10 cm depth. Furthermore, the balconies are reduced and offset from each other, to let more sunlight in and in the same time create a pattern on the facade. The balconies are applied with cortan handrails, which continues up on the sides and create privacy. This privacy is especially needed in the apartments that lies close to the common rooms. Unfortunately this brings the daylight factor even more down, to 2,6 % in half of the room. The handrails needs to improved.

Iteration 4: In this iteration the closed handrails are exchanged for perforated corten handrails, which will let more light pass through. The iteration shows a improvement in the simulation, where the daylight factor is 2,8 %. This solution will be applied to the rest of the facade.

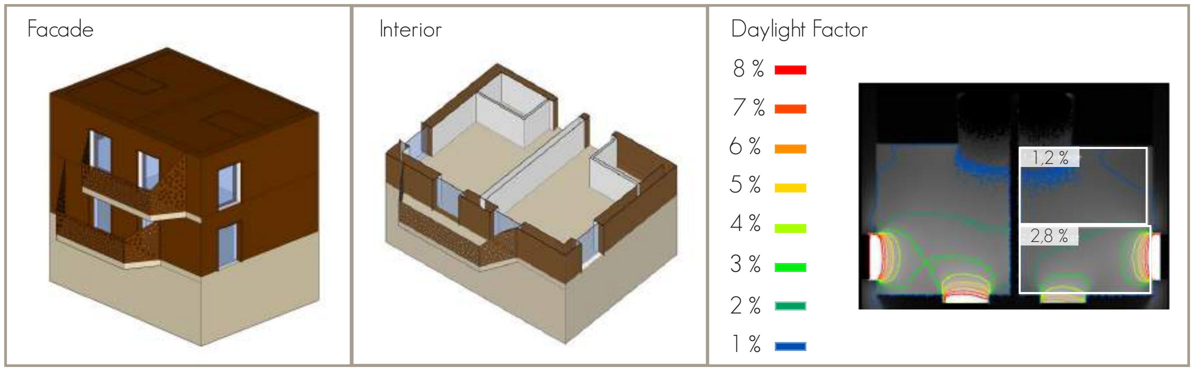
Iteration 2: External window sills 20 cm



Iteration 3: External window sills 10 cm, reduced balcony and with shielding handrail



Iteration 4: Perforated handrails



3.6.2 Natural and mechanical ventilation

For an understanding of the possible natural ventilation in the apartments, the following calculations is made. Initial for the consideration of natural ventilation during summer in the design, simulation of the pressure around the building is made in Flowdesign. The simulation shows that the neighbor building will shelter for wind on the side. Nevertheless, as the simulation method makes rough considerations and thermal buoyancy will be possible either way, natural ventilation will be considered as a passive strategy in the design during summer.

Natural ventilation

Initial the natural ventilation for single sided and cross ventilation is calculated with the rule of thumb equations, the measurements are based on a 4 room family apartment placed on the 1. floor and with all windows of 1,5m * 2,1m:

Cross ventilation through the living room:
$W_{room} < 2*5*H_{room}$
6 m < 2*5*2,7 m = 27

Single sided ventilation in smallest bedroom:
$W_{room} < 5*H_{room}$
2,6 m < 5*2,7 m = 13,5

For calculation of cross ventilation the attached scheme is used (Excel sheet, VMETEO input), which analyses the amount of fresh air traveling through the apartment with natural ventilation. The wind velocity used for the calculation is calculated with use of the following equation:

Wind velocity: Vh = Vg * (h/hg)
Vh = 5,5 m/s * (5,1 m / 10 m)0,4 = 4,2 m/s

Vh = Wind velocity in the height (h), m/s
Vg = The geostrofic wind velocity, m/s = 5,5 = average velocity (SBI 202, p. 32)
ht = Height of the top of the opening above the floor, m
hg = the geostrofic height, m = 10 m
a = The roughness coefficient = 0,40 = Wind velocity profile city center (SBI 202)

The air flow rate calculated in the excel scheme is then: 3,3 m3/s
For calculation of single sided ventilation the equation is based on thermal buoyancy:

q = 1/3 * A * ((g *(Ti-Tu)*(Ht-Hb))T)
q = 1/3 * 3,15 m^2 * ((8,92 m/s^2 (22-10)*(2,1m - 0m)) / (273K + (22-10)/2)) = 1,44 m3/s

q = Air flow rate, m3/s
A = Area of opening in the window or door, m^2
g = Gravity acceleration, m/s^2
Ti = internal design temperature, °C
Tu = External design temperature, °C
Ht = Height of the top of the opening above the floor, m
Hb = height of bottom of the opening above the floor, m
T = Kelvin + ((Ti-Tu)/2)

Compared to the demands for fresh air supply in living rooms, 0,3 l/s = 0.0003 m3/s:
Cross ventilation: 3,3 m3/s > 0.0003 m3/s - ok
Single sided ventilation: 1,44 m3/s > 0.0003 m3/s - ok

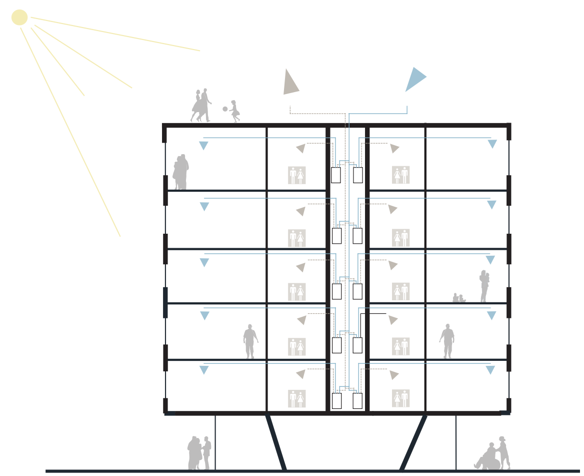
This shows that natural ventilation can be applied during summer in the apartments.

Mechanical ventilation

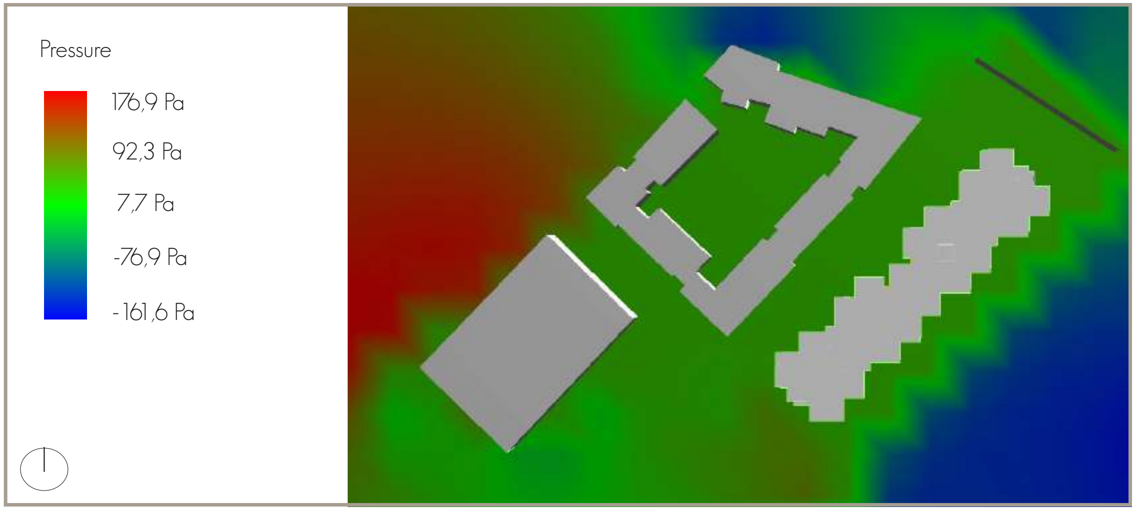
The strategy is to apply mechanical ventilation for the apartments, as the heat recovery will make advantage of the heat that is generated within the building. The amount of daylight demanded to create into the apartments will also provide passive heating, and as the U-values of the building envelope is demanded to be low, heat will be stacked in the building. The aim is to use this heat in a ventilation system, in this way the building will be provided with fresh and heated air without the need to turn on the radiators during the winter.

The system chosen for the project is: HERU T EC AR, 10 V for family apartments and 8V for smaller apartments, which is a rotary heat exchanger with a heat recovery of 86 %. The system is a decentralized system, for a better heat recovery and less pressure loss, and thereby less energy use.

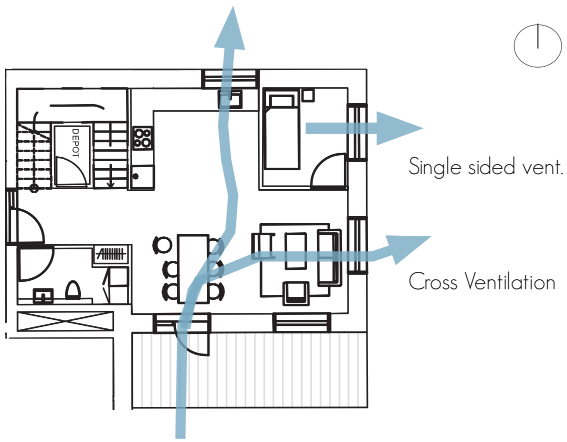
Ill. 270: Mechanical ventilation strategy



Ill. 272: Pressure simulation, FlowDesign



Ill. 271: Natural Ventilation, 4 Room appartment, for calculation



Cross ventilation scheet, wind velocity and thermal boyancy

Pressure Coefficient		**Windfactor**	0,57	**Pwind**	3,6 pa	
Windward	0,06	**Vmeteo**	4,2 m/s	**Pmin**	-1,4 pa	
Leeward	-0,38	**Vref**	2,394 m/s	**Pmax**	0,2 pa	
roof	-0,38					
Location of neutral plan, I	5,1 m			**Buildingvol.**	m3	
Outdoor temperature	12 C			**Volume**	m3/section/floor	
Zone temperature	22 C					
Discharge coefficient	0,7			**Internal pressure,**	pa -0,72	-0,72
Air density	1,25 kg/m3					

	Area m2	Eff. Area m2	Height m	Thermal Buoyancy pa	AFR (thermal) m3/s	Pres Coefficient	Wind pressure pa	AFR Wind) m3/s	Wind pressure pa	AFR total m3/s
1. floor	3,15	2,205	5,1	0,000	0,00	0,2	1,433	3,339	1,433	3,339
1. floor	3,15	2,205	5,1	0,000	0,00	-0,6	-1,433	-3,339	-1,433	-3,339
2. floor	0	0,000	0	2,122	0,00	0,06	0,931	0,000	0,931	0,000
2.floor	0	0,000	0	2,122	0,00	-0,38	-0,645	0,000	-0,645	0,000
Roof	0	0,000	0	2,122	0,00	-0,38	-0,645	0,00	-0,645	0,000
				Massebalance	0,00		Massebalance	0,00		0,00

3.6.3 Thermal and atmospheric comfort

The following study is investigating the thermal and atmospheric comfort in the apartments, with use of the dynamic simulation program BSim. The first analysis is based on the living room of an 1 room sized apartment facing South-East. The settings for the last iteration becomes the basic for a simulation of a similar living room facing West-North. Some of the important factors of the input is described below.

BR18 and own demands for thermal and atmospheric comfort in living rooms:
1000 PPM CO_2
Max. 100h upon 27°C /year
Max. 100h upon 27°C /year
Temperature: 21-24°C

1 Room apartment, living room

Measurements of room: d = 3m, w = 5m, h = 3m
Placement: Denmark DRY, height 3 meters (1. floor), urban terrain

Building envelope:
North: Towards rest of apartment, East: Towards other apartment, South: Outer-wall, West: Outer-wall

Outer-wall: Concrete and wood construction, U-value = 0,3
Floor: Concrete and wood construction, U-value = 0,2

Windows: 1,5m x 2,1 m = 3,15 m^2, effective opening = 3,15 m^2, Super Low E glazing: g= 0,63, U-value = 0,6 W/m^2*C, Overhang: distance = 0,9 m, depth = 2 m

Systems:
Heating: Temperature set point = 21°C, Time schedule = oktober-martch, Factor: 1 (winter), 0,5 (spring/fall)

Infiltration: Basic air chance = 0,5 h^{-1}, Wind factor: 0,4 s/m/h high disposed building, Time schedule = Always

Venting: Basic air chance = 0,5 h^{-1}, max- air change = 2,5 h^{-1}, Natural ventilation type = cross ventilation, Wind factor: 0,4 s/m/h, Temperature set point: 21°C, CO_2 Set point = 1000 PPM, Time schedule: always (activated if exceeding limit)
Equipment: Heat load = 1 kW (TV), part to air = 0,7, time schedule = weekends = 12h, workdays = 7h

Lighting: General light = 0,06 kW, lux = 300, time schedule = weekends = 12h, workdays = 7h

Ventilation: Air supply = 0,003 m^3/s, Total effect = 0,5 (smaller systems), Max heat recovery = 0,9, Heat or cooling element = none, Min. temp. = 22°C, Max. temp. = 24°C, Time schedule = All winter hours (okt. - march)

People Load: Number of persons = 1, Time schedule = weekends = 12h, workdays = 7h

Results:
Thermal heat balance (operative temperature) for summer and winter solstice (Ill. 274 - 275): The temperature reaches nearly 27°C at 17 PPM, and there are 335 hours upon 27°C (scheme) which must be reduced.

Iteration 1

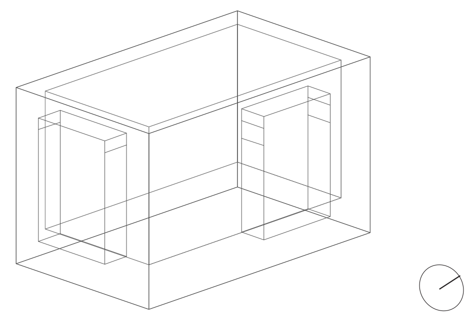
In this iteration the glazing of the windows has been changed with lower heat transmittance:
g-value = 0,35 (3 layer Super Low E)

Results: 151 hours upon 27°C /year, of which will need to be reduced even more.

Iteration 2

Adding shading in summer month: Simple type, Shading control = max. 24°C, Time schedule = All summer hours

Results: 30 Hours upon 27°C /year and balance in summer solstice = 21-23°C. CO_2 concentration = 350 PPM.
The demands are fulfilled.

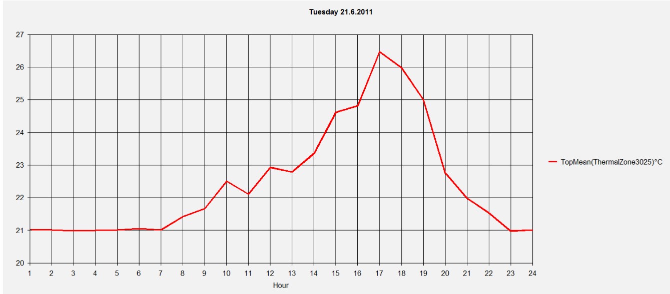


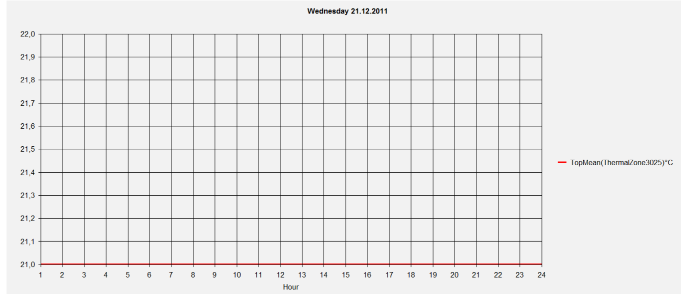
Ill. 273: Simulation model

Ill. 274-281: Right, Simulation results, graphs

Starting point

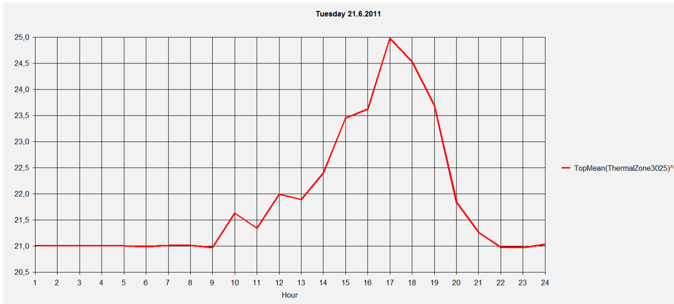
Co2(ppm)	350,0
PAQ(-)	0,5
Hours > 21	3475
Hours > 26	589
Hours > 27	335
Hours < 20	0

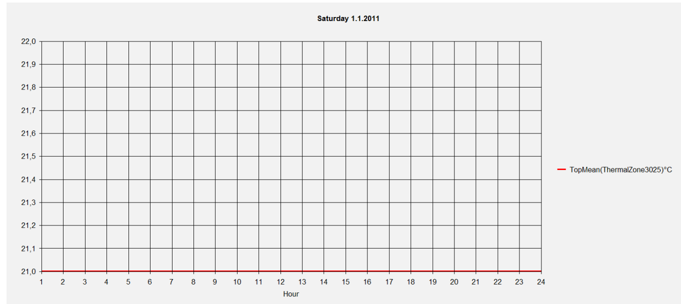




Iteration 1

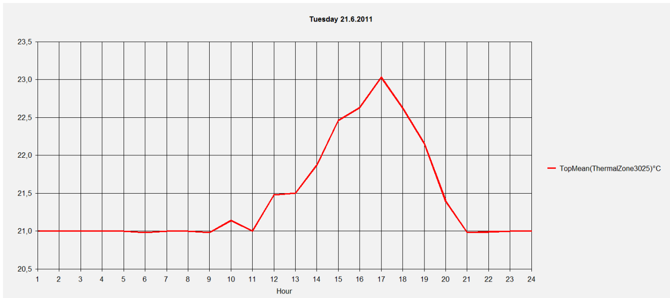
Co2(ppm)	350,0
PAQ(-)	0,5
Hours > 21	3050
Hours > 26	281
Hours > 27	151
Hours < 20	0

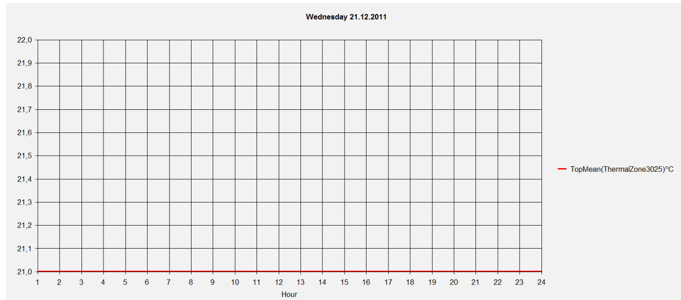




Iteration 2

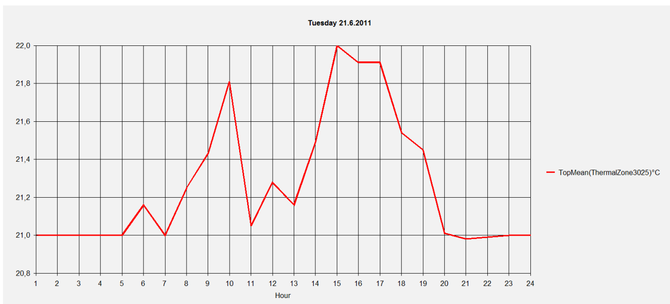
Co2(ppm)	350,0
PAQ(-)	0,5
Hours > 21	2818
Hours > 26	98
Hours > 27	30
Hours < 20	0

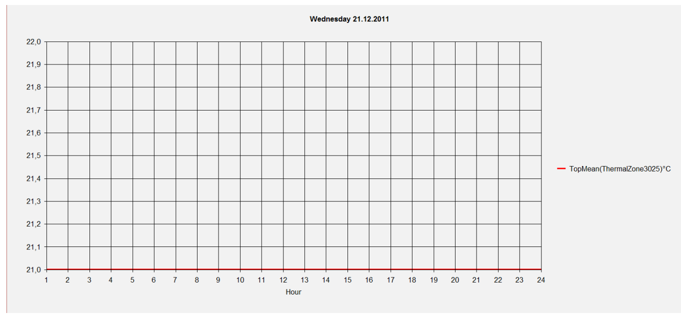




North-Vest apartment

Co2(ppm)	350,0
PAQ(-)	0,5
Hours > 21	2362
Hours > 26	37
Hours > 27	4





3.7 CONSTRUCTION

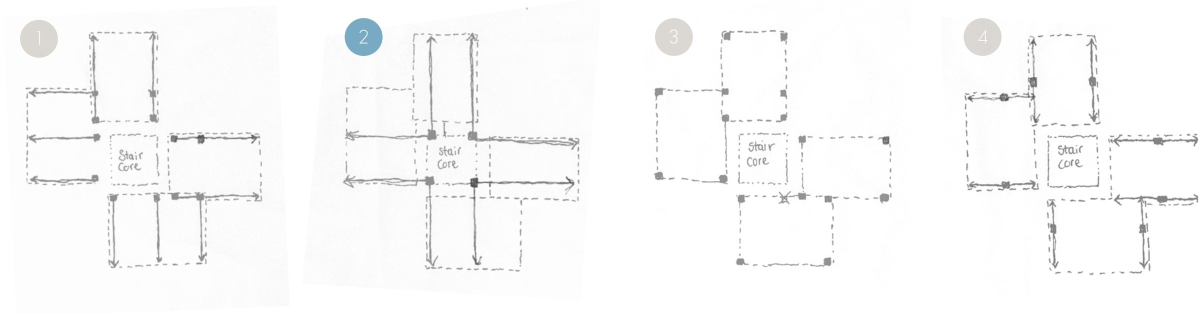
3.7.1 Structural considerations

The structural considerations has been studied as a sustainable and architectural consideration, concerning the general structure, building envelope, the choice of materials and the finish of the facade, which process is described in the following pages. The choice of structure and construction is based on conceptual considerations about handling of loads, general dimensioning based on strength of different columns described in Dimensioning med diagrammer, as well as architectural expression.

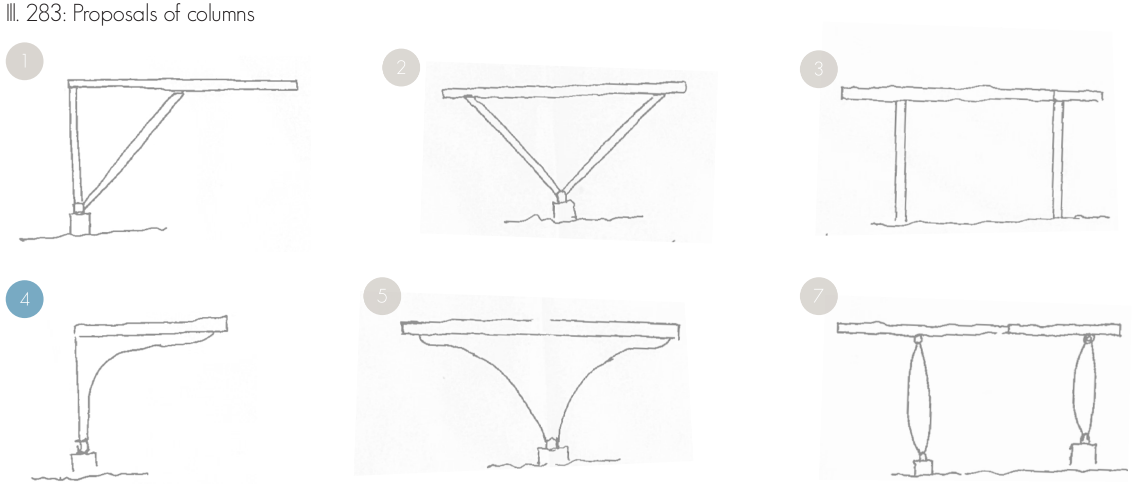
As one of the demands from the development plan from Aarhus Municipality is that no dwellings can be placed in the ground level, the aim in the project is to create space for either public functions, common spaces or public spaces in this level. As the design has a depth of 25 m in specific places, is will be difficult to create enough light all the way through in this height. The challenge is furthermore to create a lighter expression of the building as you enter the site. Therefor, the process shows different ways of lifting the private spaces of the building from the ground, so the ground floor and the more activated common areas is revealed.

Choice of structure takes inspiration in solution number 6 of this stduy, and is further developed towords the presented design.

Ill. 282: Proposals for handling of loads



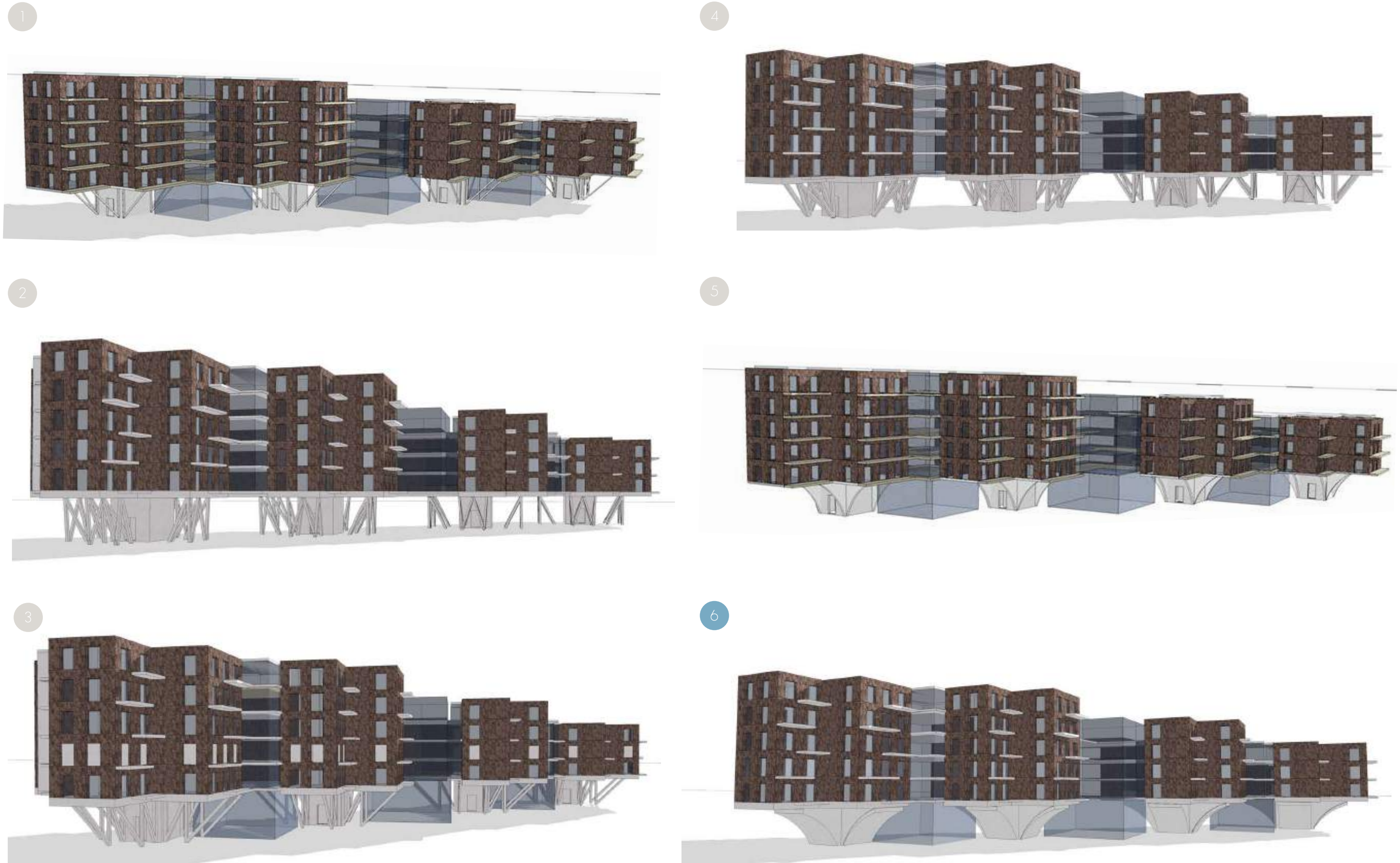
Ill. 283: Proposals of columns



Rough dimensioning of coloums and plates with canitlevers, concrete as the bearing elements (Dimensionering med diagrammer)

Load Type	Construction element	Profile	Material	Load catchment	Element dim.	Profile section
Housing load	Columns	Rectangular	Concrete, B30	(d= 10m x w= 5m) x max. 5 floors = 250 m^2	Column length: 6 m	250 x 360 mm
Housing load	Beams, c/c 30 / Floor	Rectangular	Wood, L40	0,3 m	Beam span: 10 m	115 x 700 mm

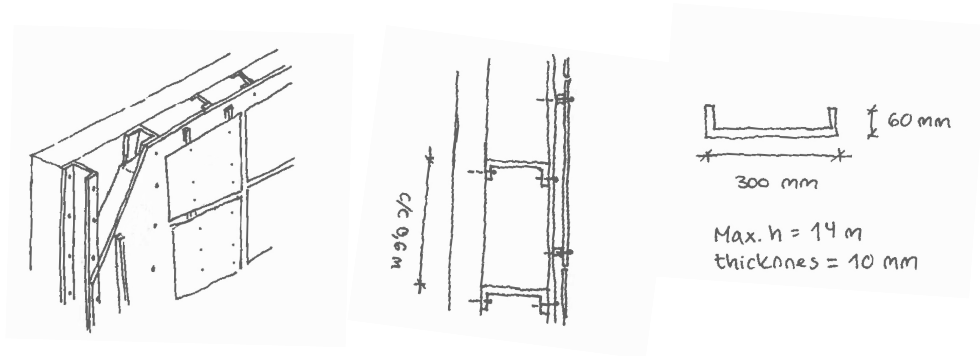
Ill. 284: Proposals applied to the design



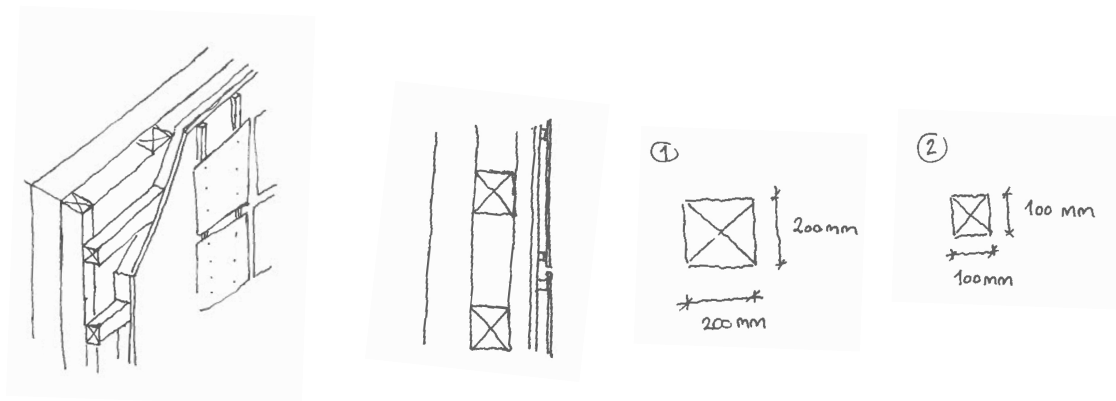
3.7.2 Building envelope

To clarify the possible U-value for proposals of material and dimensions of the building envelope, the following calculations are made. The general concept is to collect the load in inner parts of the outer walls through concrete plates, where a structure of either steel and insulation or wood and insulation creates the insulating layer. The structure is necessary for mounting of facade finish. As seen in proposal 1, it requires a big amount of insulation to reach the BR18 demands, whereas the wooden construction easily reaches below 0,3 W/m²*C. The combination of bearing concrete elements and wooden structure is chosen for the design, and used in the input of indoor climate simulations as well.

Ill. 285: Building envelope, proposal 1
Concrete, Steel profils UNP / Insulation, steel plate, Corten steel finish



Ill. 286: Building envelope, proposal 2
Concrete, construction wood1 / Insulation, construction wood2 / insulation, Plywood, Corten steel finish



Calculation of U-values on bearing outerwall (horisontal heat transmission) INHOMOGENIOUS:

Proposal 1 (concrete and steel, steel profil: UNP 300)	**Diameter, d m**	**Thermal conductivity, λ W/m*c**	**Thermal resistance, R = d/ λ W/m^2* C**	
Outer transition isolans	-		1/a(out) = 1/25 =	0,04
Steel plade	0,01	8,09	0,00	
Inh. layer insulation / Construction, steel	0,55	0,181	3,03	
Concrete	0,2	1,6	0,13	
Inner transition isolans	-		1/a(in) = 1/8 =	0,13

Isolanses is added in the equatio for U-values:

U = 1 / (R(in) + ΣR + R(out))

U-value, (W/m^2 * C): 0,30

The indhomogenious layer (insulation / steel members) is calculated with the upper surface resistance, with the equation (the areas are calculated per meter through the two inhomogenious layers, below:

The inner inhomigenious layer:

λ' = Aa * λa + Ab * λb / (Aa + Ab)

	A: Areal	**λ, Thermal conductivity**	**λ * A**
The layer is calculated with the insulation, Kingspan:	0,98	0,02	0,0196
The layer is calculated with the steel members:	0,02	8,09	0,1618
Total	1		0,1814
Total thermal conductivity, final ((λ * A) / A total)			0,181

Calculation of U-values on bearing outerwall (horisontal heat transmission) INHOMOGENIOUS:

Proposal 2 (Concrete and wood, Wood profil: construction wood 15x30mm)	**Diameter, d m**	**Thermal conductivity, λ W/m*c**	**Thermal resistance, R = d/ λ W/m^2* C**	
Outer transition isolans	-		1/a(out) = 1/25 =	0,04
Plywood	0,02	0,1	0,20	
Inh. layer Insulation / construction, wood	0,1	0,044	2,27	
Inh. layer insulation / construction, wood	0,20	0,036	5,56	
Concrete	0,2	1,6	0,13	
Inner transition isolans	-		1/a(in) = 1/8 =	0,13

Isolanses is added in the equatio for U-values:

U = 1 / (R(in) + ΣR + R(out))

U-value, (W/m^2 * C): 0,12

The indhomogenious layer (insulation / wooden members) is calculated with the upper surface resistance, with the equation (the areas are calculated per meter through the two inhomogenious layers)

The inner inhomigenious layer:

λ' = Aa * λa + Ab * λb / (Aa + Ab)

	A: Areal	**λ, Thermal conductivity**	**λ * A**
The layer is calculated with the insulation:	0,7	0,02	0,014
The layer is calculated with the wooden members:	0,3	0,1	0,03
Total	1		0,044
Total thermal conductivity, final ((λ * A) / A total)			0,044

The outer inhomogenious layer:

λ' = Aa * λa + Ab * λb / (Aa + Ab)

	A: Areal	**λ, Thermal conductivity**	**λ * A**
The layer is calculated with the insulation:	0,8	0,02	0,016
The layer is calculated with the wooden members:	0,2	0,1	0,02
Total	1		0,036
Total thermal conductivity, final ((λ * A) / A total)			0,036

ROOF

Calculation of U-values on roof (vertical heat transmission) INHOMOGENIOUS:

Proposal 2 (rectangular construction cross section, 15x30mm)	**Diameter, d m**	**Thermal conductivity, λ W/m*c**	**Thermal resistance, R = d/ λ W/m^2* C**	
Outer transition isolans	-		1/a(out) = 1/25 =	0,04
Inh. layer Insulation / construction, wood	0,5	0,044	11,36	
Inh. layer insulation / construction, wood	0,05	0,028	1,79	
Plywood	0,015	0,130	0,12	
gypsum	0,02	0,17	0,12	
Inner transition isolans	-		1/a(in) = 1/8 =	0,1

Isolanses is added in the equatio for U-values:

U = 1 / (R(in) + ΣR + R(out))

U-value, (W/m^2 * C): 0,07

The indhomogenious layer (insulation / wooden members) is calculated with the upper surface resistance, with the equation (the areas are calculated per meter through the two inhomogenious layers)

The outer inhomigenious layer:

λ' = Aa * λa + Ab * λb / (Aa + Ab)

	A: Areal	**λ, Thermal conductivity**	**λ * A**
The layer is calculated with the insulation:	0,7	0,02	0,014
The layer is calculated with the wooden members:	0,3	0,1	0,03
Total	1		0,044
Total thermal conductivity, final ((λ * A) / A total)			0,044

3.8 RAIN WATER MANAGEMENT

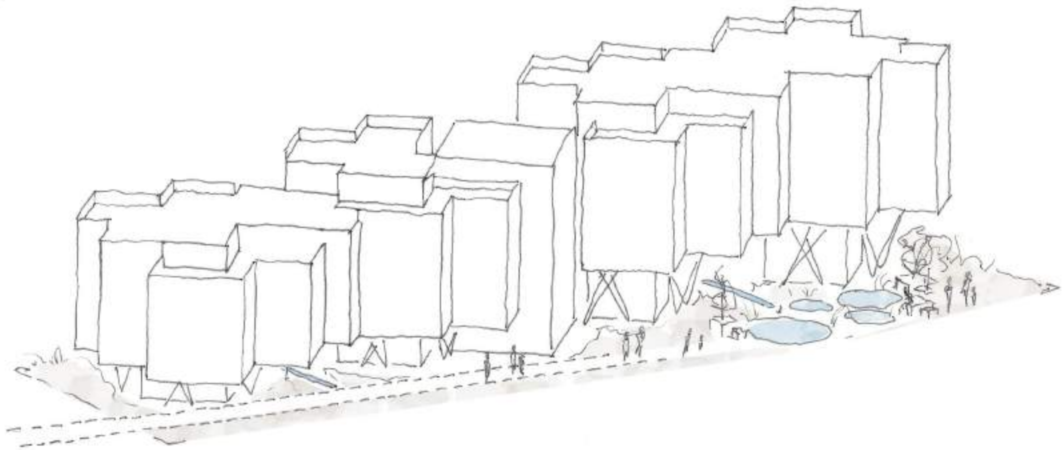
3.8.1 Rain water strategy

As included in the early concepts the handling of rain water is one of the sustainable strategies in the project, both for reuse in toilet flush and by collecting remaining rain water in basins creating recreative green areas and in that way leading the rain water quietly into the soil.

The strategy is to collect enough rain water to reuse as toilet flush in all apartments, hence a calculation on this is made. The collection will only be from the roof in the areas of which hard surfaces is used. In other surfaces where the roof are covered with vegetation the water is expected to be absorbed or evaporated to some extend.

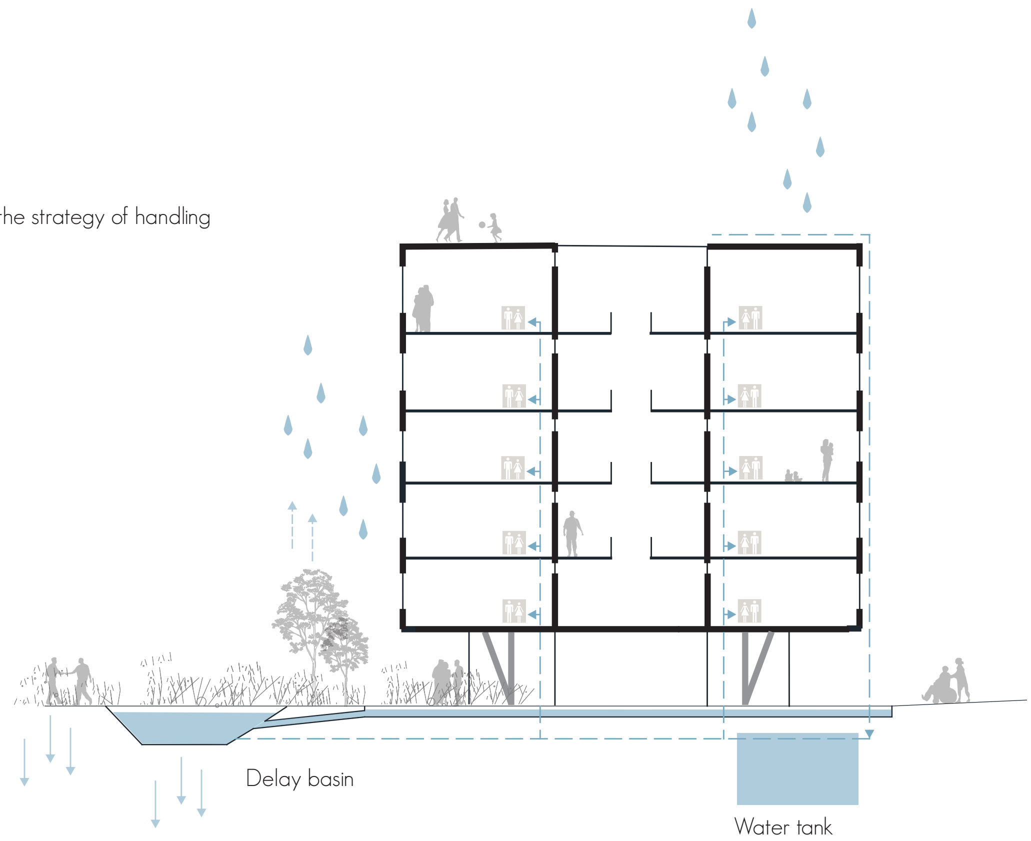
On the ground level towards north-west the surfaces are covered with tiles that slopes down towards two small streams created in the design. From the ends of the streams there are tubes collecting the water and leading the water to the basins on the east side of the building. The basins creates a green oasis alike space connecting to the future green wedge of the area. The size of the green area on the east side of the building is optimized for a better absorption and seepage of the water.

The rain water basin is handle on a conceptual level and is not dimensioned.



Ill. 287: Sketch of the delay basins in the green public space

Ill. 288: Setion cut of design that shows the strategy of handling of rainwater



Right: Calculation of exploitation of rain water for toilet flush in apartments, with threshold in collection on roof top, imperial data are collected from DMI.dk and Energitjenesten.dk. Calculation shows enough rain water for flush.

Inhabitants	Toilet flush pr. person Avarage number	Days pr. year	Water used pr. flush, avarage, L	Need of grey-water for toillet flush, whole building, L
150	5	356	4,5 L	(150pers. x 5 flush x 365 days/year) x 4,5 = 1.231.875 L/year

Anual rain fall, L	Size of roof, m	Possible collection of water from roof, L/year	Amount of roof needed for rain water collection, %
781 L/m²/year	1729 m²	781 L//m²/year x 1729 m² = 1.350.349 L/year	1.231.875 L/year / 781 L/m²/år = 1577 m² 1577,3 m² / 1729 m² x 100 = 91 %

3.9 MATERIALY PROCESS

3.9.1 Materiality and facade study

The following study is a study of materiality and facade expression in the project. The aim is to connect to the project site by choice of material.

As the project is placed at Godsbanen the old rails are some of the more characteristic elements on the site. The dark steel finish is relevant to relay on the expression on the building. Corten steel is a material that corresponds both with the old red bricks of the former Godsbanen terminal and with the rails on the site. The material has a raw finish and a worm color, as it patinates over time. The rust gives the steel protection from the weather and does not need further maintenance. The study investigates the use of the material with facade inspiration of which the corten steel is used in different ways.

The project takes inspiration in different ways of handling the steel plates, as seen in the reference pictures to the right. Here the corten steel is used for both plane solutions on the facade to lamella or perforated solutions. These solutions shows that the material can be used to create really plane and simple facades and other hand be an architectural element by adding patterns to the material.

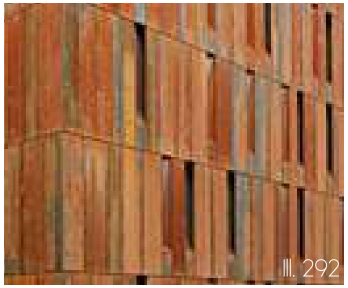
A study of facade solution with physical models in scale 1:100 was made to investigate different solutions and dimensions with threshold in the inspiration facades. Some of these solutions was tested on the digital 3D model, to see their potential along with the overall shape and the windows.

The wide plane panels was chosen for the general facade on the dwellings, and the same panels was used as lamella on the facades of the common areas to reveal the life inside. In relation to the comfort inside the dwellings, perforated panels was chosen as protection on the balconies, to let sunlight pass through while shielding for more privacy at the same time.


Ill. 289

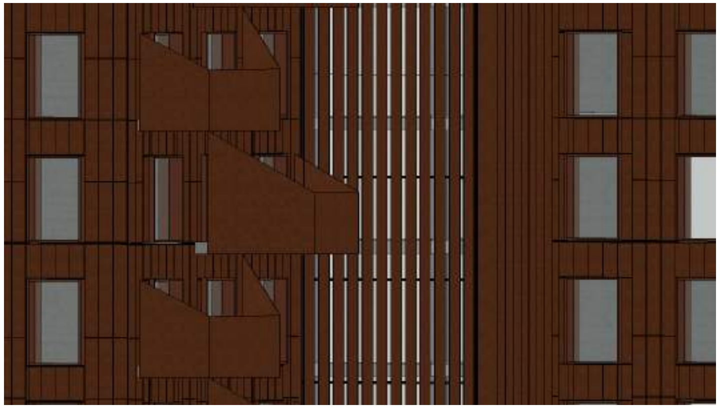

Ill. 290

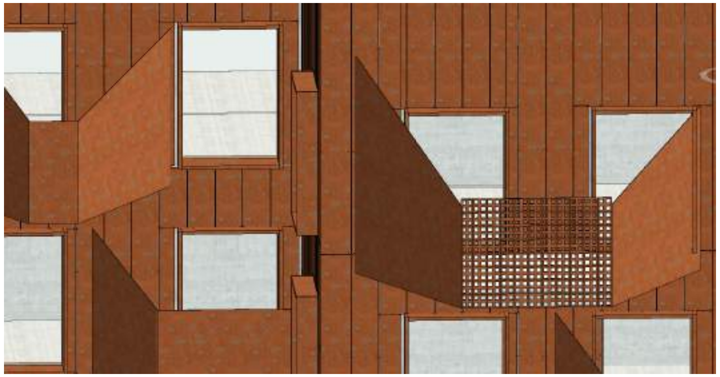

Ill. 291


Ill. 292

Ill. 293: Facade study

Ill. 294- 296: Facade on 3D model





3.10 URBAN PROCESS

3.10.1 Sun and shadow study

The following pages shows the amount of sun and shadow on respectively the outdoor space on the ground and potential on the roof, as well as the sun and shadows on the facade and the balconies.

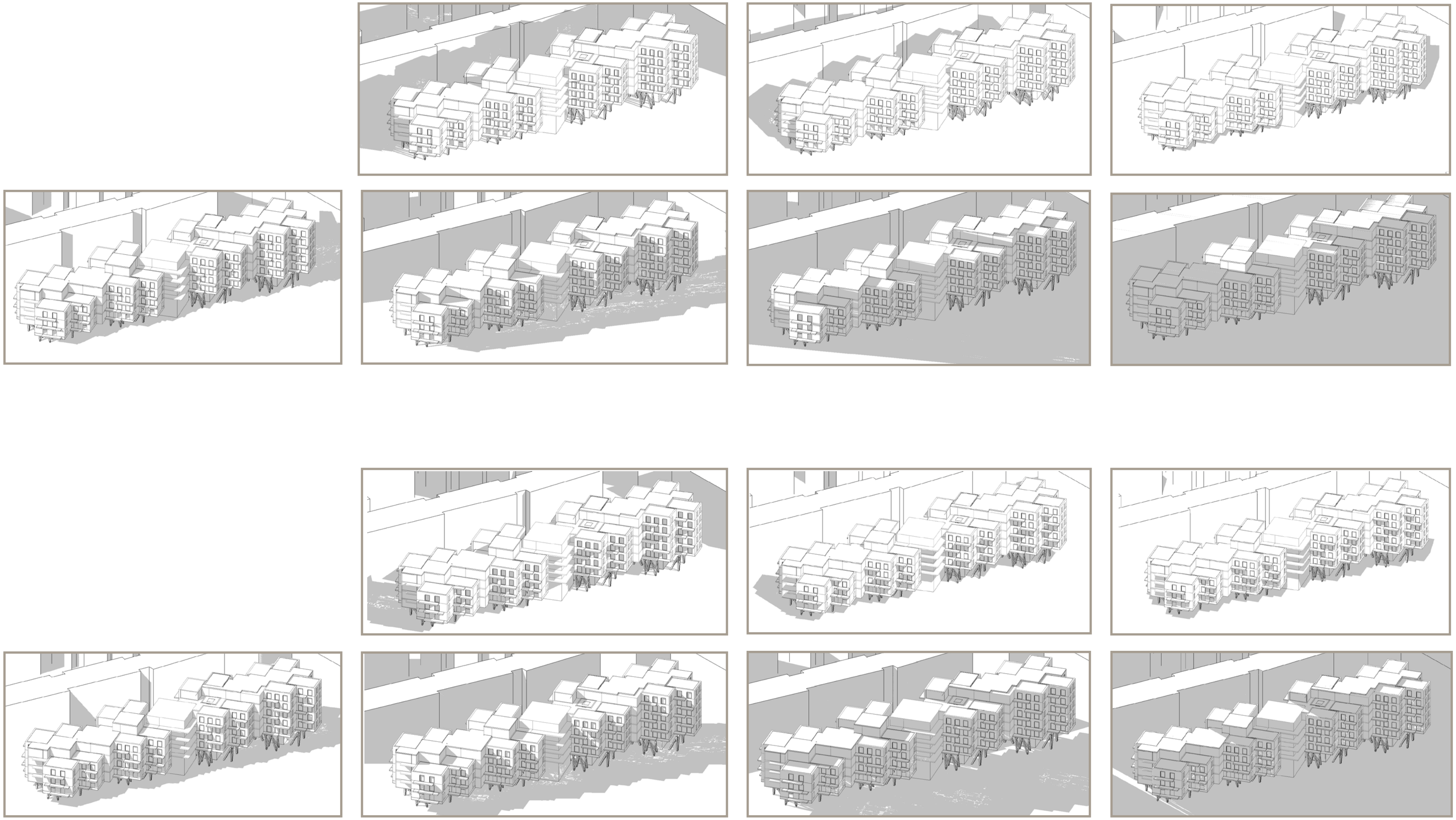
The analysis shows that the upper part of the roof towards north-east is potential for placing solar cells, as the surfaces are exposed to sunlight from 08 AM - 20 PM both in equinox and summer solstice. The west part of the south end of the roof tops are also exposed to sunlight until minimum 18 PM and is accessible from the stair cores. This place will be ideal for common outdoor facilities with activity. The east part of the souther end is exposed to sun until 16-18 ca. which is ideal for the more private roof terraces for the living groups.

On the ground floor the lifted dwelling accommodates the sunlight to reach under the building, expanding the narrow space for a more public oasis.

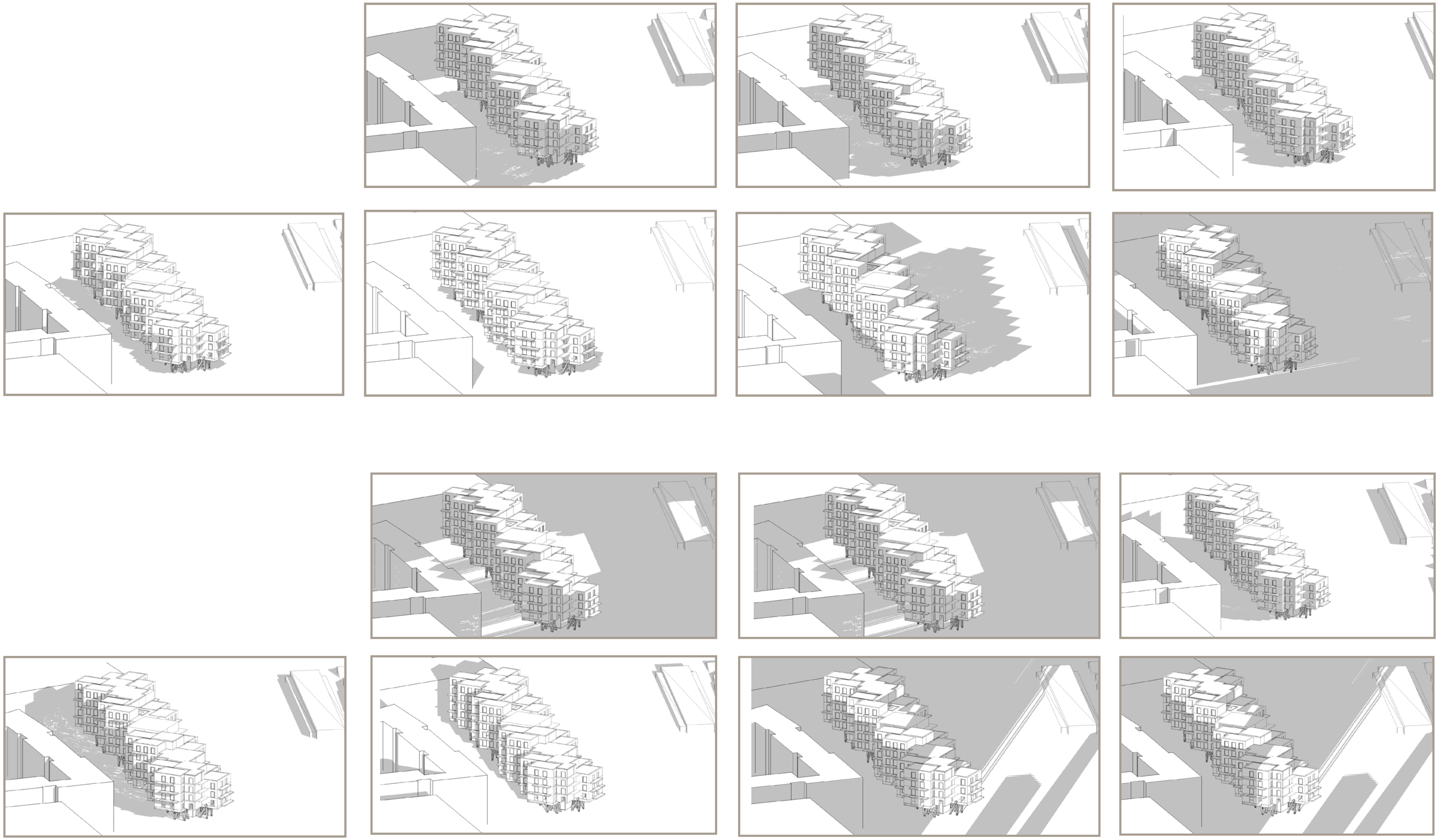
The offset dwellings creates a pattern of sunlight and shadows on the facade, preventing the building from an expressionless building block appearance.

As the hight of the lifted ground floor has been changed after this study, the amount of sunlight in the ground floor has been reduced.

Ill. 297-325: Sun and shadow analysis on design



On the North-West facade the same pattern on the facade is created, starting from 14 PM. The main access to the site with car, bicycle or pedestrians common from the west of the district is exposed to sun in the afternoon before the neighbor building casts shadow on the site. In this way the access to the apartments will be lightened in the most common arrival time when returning from school and work.



3.10.2 Design process of outdoor space

To create an urban space in the ground floor that relates to the green wedge going all the way along the south-east side of the project site and that accommodates the inhabitants as well as visitors, sketches was made.

Naturally the north-west side needed to be designed as a transit space, to create rational and visible access to the apartments and make space for bicycle parking. The other side of the building lays adjacent to the future green wedge and has the remaining of old rails coming from south going through the site. The aim is to keep this side of the site more wild and natural in its vegetation and create space for collection of rain water.

As one of the design criteria was to use rain water as a architectural element, two of the proposals was to collect the rain water in small tile streams from north-west towards the more wild delay basins in south-east. In that way the rain water articulate the same transition from the arrival space to green setting as aimed in the design.

The sketches upon the outdoor ground floor sketches are proposals for the three roof terraces, whereas the first is reserved for the living groups in the southern part of the building, containing seating area, herb gardens and relax area.

Suggestion for the second roof terrace lays adjacent to the greenhouse/orangery and extends as a kitchen garden with vegetation of different vegetable and elements for collection of rain water creating an oasis atmosphere. Adjacent to this is the main roof terrace for the whole complex, with elements for activity, ball fields, shelter and seatings, work-out elements and a running or walking path that connects it all.

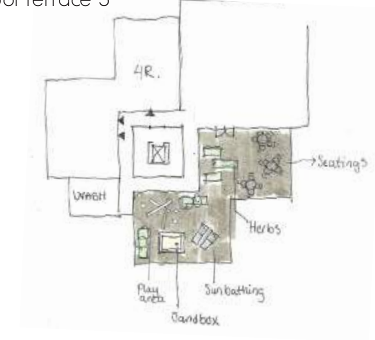
A suggestion for the last terrace, reserved for the living groups in the northern part of the building complex, contains elements for smaller kids to play, such as sandbox and small climbing wooden elements.

Ill. 326: Outdoor space, proposal 1

Ill. 329: Idea for roof rerrace 1

Ill. 330: Idea for roof rerrace 2

Ill. 331: Idea for roof rerrace 3



Ill. 327: Outdoor space, proposal 2

Ill. 328: Outdoor space, proposal 3

3.11 ACTIVE INITIATIVES

3.11.1 Active initiatives, PV cells

As one of the design parameters was to apply active initiatives when the passive initiatives was reached to create a zero energy building, the following calculation investigates the possibilities of solar cells on a chosen amount of the roof.

As seen in the Be18 calculation the passive initiatives have brought the energy consumption down to 37 kW/m^2*-year which nearly makes the design follow the BR18 demands. The aim is to bring the remaining energy consumption down to as near as possible 0, by applying PV cells.

The PV cells are therefor calculated with threshold in the last Be18 calculation, where the first scheme contains the el ectricity consumption, which is a number converting el.ectricity Consumption to primary energy and the energy need.

The second scheme contains the energy consumption the solar cells need to cover, as well as information of how much the PV cells need to cover when including appliances. The appliances is dimensioned with the average use pr. Household times the amount of apartments in the project: 1.600 kWh/year x 39 1-2 room apartments + 4.450 kWh/year = 14.6950 kWh/year.

The third scheme contains different factors that affects the PV cells efficiency, used in this calculation method.

Chosen PV cells: Mono-crystalline
High efficiency: 15 %
Orientation: 30° towards south (hidden behinds the lifted facade)
Solar radiation (south and 30°) = 1152
System factor: 0,8 (Free standing, high efficiency inverter)

The fourth scheme shows how much kW the PV cells need to provide.

Last scheme shows how much kW/m^2 every PV cell need to provide.

As seen in the calculation the needed peak power is 0,15 and 0,30 kW/m^2 with appliance, which is used to select to suitable PV cell type. A mono-crystalline PV cell is chosen, with max power at 0,3 kW: Sinosola 300W watts mono-crystalline photo-voltaic solar roof panels. This type of solar cell is the more expensive kind to provide enough energy for the building, as the PV cell will not perform 100 % all of the time. Meanwhile, the costs of applying this active strategy will pay back itself over time because of the energy provided on site.

As the net zero source strategy is chosen for this project, the overproduced energy will be given back to the grit as well as the building will use from the grit when necessary.

These cells are placed on the roof of the northern part of the building where they will not be visible because of the lifted corten steel facade in the whole design.

Ill. 232: Sinosola 300W mono-crystalline PV cell

Calculation of the needed production of energy from each solarcells

Sum of total el. Consumption

	Total el. Consumption	Energy factor	Total energy requirement BR2020	Sum of total el. consumption
	BE15		BE15	kWh/m^{2}year
	36,5	1,8	29,6	95,3

Energy consumption the solar cells need to cover

Area	Sum of total el. Conssumption	Energy factor	Solar cells cover	Solar cells cover	Lighting and appliances	Total
m^2	kWh/m^{2}year		kWh/m^{2}year	kWh/year	kWh/year	kWh/year
2854,33	95,3	1,8	52,94	151120,92	146950	298070,92

A: Total area of modules (m^2)	1070	Roof (m^2)
B: Module efficiency (%)	15	
C: Installed power kWpeak	Calculated	
D: Evaluation of system factor	0,8	Optimal system with high efficiency inverter (Free standing)
E: Solar radiation intensity (kWh/m^2)	1152	Horizontal, syd, 30% angle

How much kW do the solar cells need to provide

	Solar cells cover	Solar cells cover (with appliances)	Evaluation of system factor (D)	Solar radiation intensity (E)	Installed power (C)
	kWh/year	kWh/year		kWh/m^2	kWpeak
without appliances	151120,92		0,8	1152	163,98
with appliances		298070,92			323,43

How much kW/m^2 do the solar cells need to provide

	Area	Installed power (C)	Installed power (peak power)
	m^2	kWpeak	kW/m^2
Without appliances	1070	163,98	0,15
With appliances		323,43	0,30

4 | EPILOG

4.1 CONCLUSION

Urban Co-living is a sustainable urban co-housing which embraces different user segments and encourage the meeting between the inhabitant in both indoor and outdoor spaces. The sustainable considerations creates an comfortable environment within the individual apartments, in the common spaces as well as in the outdoor spaces. By the use of materials that compliments the heritage of the contexts, the appearance of Urban Co-living connects to the surroundings with respect while experimenting with the architectural language in the form at the same time.

The design of the central common areas encourage for the inhabitants to interact with each other, as the functions are an extension to the individual apartments. The interaction will have an impact on the mans connections to the space and the inhabitants within the co-housing. The extension of the individual apartments through the common spaces creates a transition from the private sphere through semi private sphere to the public areas. The connection of the semi private areas connects with the public areas in the central building segment, consisting functions that gathers both inhabitants and visitors of the site.

The design expresses the passive strategies in the project and becomes and integrated part of the architecture, hence a sustainable building is reached. As the PV cells are applied to the building Urban Co-living reaches a Net Zero Source building with the energy consumption of 1,3 kWh/ m^2/ year.

The structural matter becomes visible in the architecture, as the Co-housing is lifted from he ground, revealing the bearing elements of the building. In this way the buildings physical footprint is minimized and the green area is optimized, creating a green area for visitors that connect with the paths from the old rails.

Indeed Urban Co-living expresses the intension of collaboration and connecting of inhabitants. The relationship between the apartments and the common areas are investigated throughout the process, which create a co-housing with focus on the community without compromizing with the private homes. In this way, a holistic sustainable co-housing in a urban context has been made, addressing the mans basic need to belong.

4.2 REFLECTION

The process of Urban Co-living has developed complications in the design, whereas some is solved through the integrated work and the iterations within and others is downgraded caused by the time scape, of which the co-housing is designed. The following lists some of the complications and reflects upon them.

The common rooms within the living groups are now design as large flexible rooms with every function placed in the same room. This could possible cause a room where there are not room for absorption in the same way as wished in the project. On the other hand, dividing the common room into even smaller rooms reduces the flexibility and the time the inhabitants spend together in the room. Furthermore a division of the common room in this particular design would reduce the amount of daylight in the room.

The space used for stair and elevator cores and the corridors around them could have been reduced with more consideration about the flow in these specific areas. With more iterations of the flow the corridors and the stairs could have been integrated with each other to reduce the amount of m^2. Nevertheless, the stair cases needed to be closed for fire considerations.

The choice of materials could have been added with LCA analysis, for evidence of the assumptions made for the material choice. In this way the sustainable intentions could have been either approved or dismissed in order to make the right choices.

The building percentage exceeds the demands from Aarhus development plan of the site with approximately 500 m^2. Which means that the building percentage is upon 200 %. Both the access area and the common rooms within the living groups are the spaces in the project, of which could have been reduced. Unfortunately the design does not allow the common rooms to narrow, as not enough daylight will enter the room.

More iterations could have been made concerning the noise pollution from Carl Blocks Gade, as the only element shielding in the design is the perforated handrails in the facade. Nevertheless these handrails are only placed on the west and south facades along with the balconies. An solution could be to add the perforated elements as shutters on the norther facade as well, knowing that this will change the facade expression.

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Ill.001 Own production
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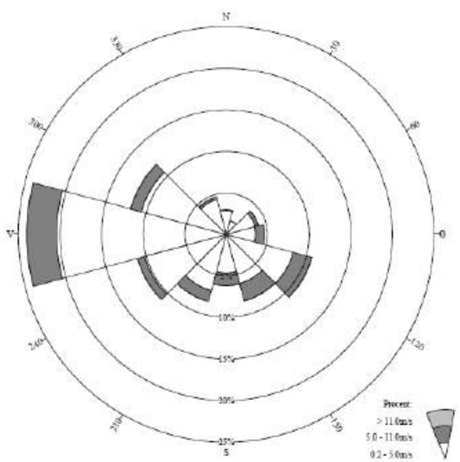
5 | APPENDIX

APPENDIX 1

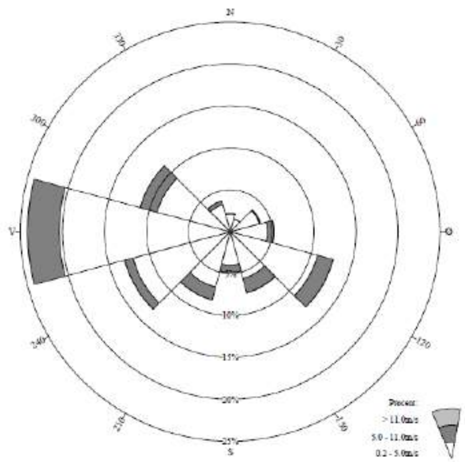
Wind analysis

From summer month: June, July and August, in ralation to applying natural ventialtion durring summer. The wind-roses is from DMI.dk

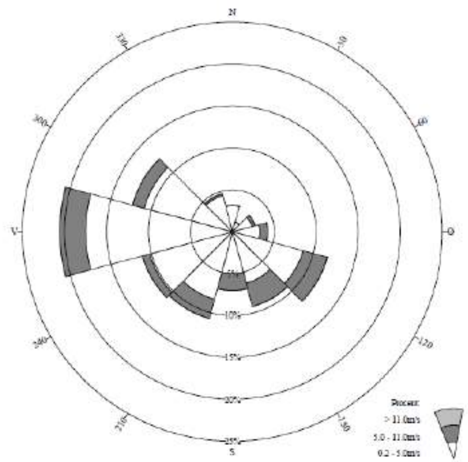
June



July



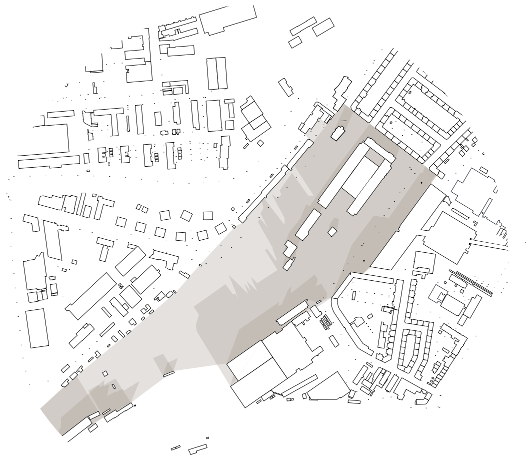
August



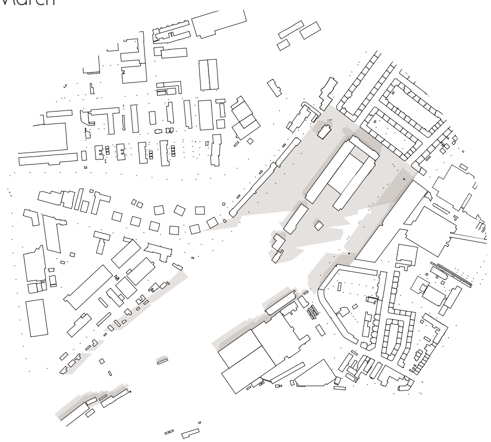
Shadow analysis

Analysis made on the site on the 21. Dec, 23. Martch and 21 June in the three different times: 10 PM, 14 AM and 18 AM.

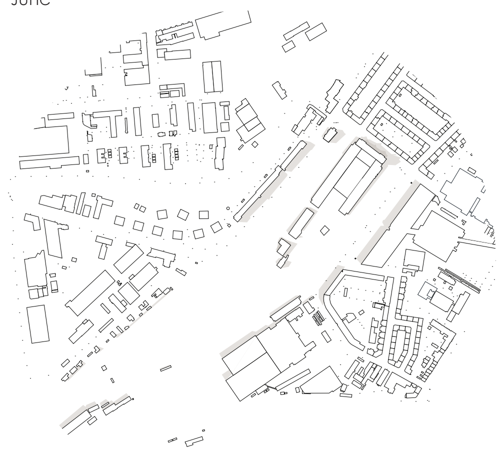
Decmeber



March



June



Calculation of fresh air supply

The need of fresh air supply is calculated in the most loaded rooms in terms of persons pr. m^2. The need is calculated both in relation to olf affection and CO_2, where the highest demand of l/s will set the demand in the room program.

Calculation of fresh air supply in relation to olf, Co-housing, 140 persons

persons	140
personer	30

Room height =	3,5

Room	Area	Activity niveau	Materials and systems	Polution source strength	Experienced air quality	Polution in fresh air	Fresh air supply	Converted	Room wolume	Air change per hour	Converted
	m^2	q (olf)	q (olf)	q (olf) ialt	c (decipol)	Ci (decipol)	l/s	m^3/h	m^3	$[h^{-1}]$	m^3/s
		pers*aktivitetsniveau	areal*olf-belastning	Olfbelastninger lagt sammen	bestemmelse ud fra skema	altid 0	V(L) = 10 *q/c+Ci	V(L)/1000*3600	V = m^2*h	$n = q_{tot} / V$	V(L)/1000
Common living room	280	140	0,4	140,4	1,4	0	1003	3610	980	3,7	1,00
Activity room	280	560	0,4	560,4	1,4	0	4003	14410	980	14,7	4,00
Workshop	150	120	0,4	120,4	1,4	0	860	3096	525	5,9	0,86

Olf affection, from activity niveau	**Olf**
stillesiddende:	1
aktiv:	4
meget aktiv:	10
Rygende person:	6
Olf affection, from materials etc.	
Bioffluenter (pers. pr. 10 m^2)	0,1
yderligere belastning fra 20% rygere	0,1
Yderligere belastning fra 30% rygere	0,2
Yderligere belastning fra 40% rygere	0,3
materialer og ventilationssystem, eksisterende bygninger	0,4
materialer og ventilationssystem, lavolfbygninger	0,1

Schedule of experienced air quality		
Kategori	Oplevet luftkvalitet	
A	PD < 15%	dp < 1,0
B	PD < 20%	dp < 1,4
C	PD < 30%	dp < 2,5

Calculation of fresh air supply in relation to Co2, Co-housing, 140 persons

Room	Area	Activity niveau	Experienced air quality	Polution in fresh air	Fresh air supply	Room wolume	Air change per hour	Converted
	m^2	q (m^3/h)	c (m^3/m^3)	Ci (m^3/m^3)	V(L) (m^3/h)	m^3	$[h^{-1}]$	l/s
		pers * Co2pårvirkning	aflæst i skema	altid	V(L)=q/c+Ci	V = m^2*h	$n = q_{tot} / V$	V(L)*1000/3600
Common living room	280	2,94	0,00066	0,00038	4455	980	4,5	1237
Activity room	280	3,36	0,00066	0,00038	5091	980	5,2	1414
Workshop	150	0,72	0,00066	0,00038	1091	525	2,1	303

Co2 affection from humans, m^3/h:			
Stående			0,024
siddende			0,021
Hvilende			0,014
Schedule of experience air quality			
kategori B	660 PPM	--> omregnet:	0,00066
Co2 icontent in fresh outdoor air = 380 PPM, converted:			0,00038

APPENDIX 2

Transcription, interview at Ådalen 85

Indledende

Hvem er jeg: Kirsten H. Thomsen, AAU, Mcs04 Speciale, arbejdstitel: Bæredygtige Bofællesskaber i en Urban kontekst
Spørgsmål: Der vil være spørgsmål om dig (Ditte) og dit forhold til stedet og bofællesskabet generelt
Optagelse af interview?

Beboer ved Ådalen 85, Randers: Ditte Hamrum Jørgensen

Beskæftigelse, arbejde/uddannelse/hjemmegående?
Jeg er lærer på en friskole, 12 km herfra lige uden for byen.

Eneboer, med familie eller partner?
Jeg har en kæreste men vi ikke gift endnu. Vi har 3 børn på 1, 3 og 5 år.

Hvad er du selv opvokset i? Suburban (forstads villa/parcel-kvarter, villa på landet, lejlighed/hus i storbyen)?
Jeg er vokset op i en almindelig villa, i en slags sove-landsby eller hvad man kalder det. Det er en lille bitte landsby, hvor der ikke sker så meget, virkelig langt ude på landet. Mine forældre kommer ud af kollektivmiljøet, så hele tanken om at dele og bo med andre har jeg ikke direkte oplevet men selvfølgelig snakket med mange om det her. Så mange af tankerne kan godt komme derfra. Jeg har en søster som bor i bofællesskab, hun flyttede et par år før jeg gjorde, så jeg havde også nået at snakke med hende om boformen inden.

Hvor mange år har du boet i bofællesskabet?
Vi har boet her i lidt over 2 år. Forinden det boede jeg i lejlighed i Silkeborg og Sønderjylland.

Hvad fik dig til at vælge at bo her?
Vi rykkede til Midtjylland fordi Mads har familie her og vi har altid haft en tilknytning hertil. Han synger i kor på et højt niveau, så vi skulle rykke hertil og prøvede med base i Silkeborg og finde et bofællesskab der passede. Vi vidste godt at vi ville noget der var sådan hvor man ville naboerne og man delte, og så har vi kigget på rigtig mange bofællesskaber i Midtjylland for at finde noget der passede. Vi endte med at rykke længere væk end vi regnede med, fra både Århus og Silkeborg fordi der var nogle ting her der passede os. Det handlede om noget med værdierne i forhold til mad og i forhold til graden af organisering. Kan man stole på at der er mad når der er mad? Eller er det meget tillidsbaseret: Måske er der mad i dag måske er det ikke lige gjort. Så vi var meget opmærksomme på hvad vi havde af behov og hvad er vi for nogle typer og hvad lægger vi så vægt på. Så derfor endte vi her. Så det var et ønske om struktur og fælles værdier og noget helt lavpraktisk såsom kort rejsetid til Århus for at kunne få det til at hænge sammen på den måde. Vi ville gerne have kort til byen, jeg er blevet lidt afskrækket af det der med at bo i en alt for meget sove-landsby. Så at kunne cykle ind til centrum og kunne bruge det er i en by. Samtidig er vi også udendørs mennesker, så vi skulle være tæt på natur og det skulle være til at købe for penge.

Beboers oplevelse med Ådalen 85:

Hvad er din største fordel ved at bo sammen på denne måde?
Nabofællesskabet, det at man har noget med hinanden at gøre. Det savnede jeg da jeg boede i lejlighed, for selv om man hilser på hinanden så snakker man faktisk ikke rigtig sammen. Det synes jeg var specielt at bo så tæt op ad mennesker uden at have noget at gøre med dem. Generelt er det også en kæmpe fordel at have fællesspisning, man for ordentligt og meget varieret mad og det kan man / kunne vi ikke få til at hænge sammen med to fuldtidsjob. Da blev det mere ensformig og så ender det tit med en nødplan hvor man bare skal lave noget der er hurtigt. Her spiser vi bare ordentligt og veltilrettelagt mad, hvorimod man jo ikke kan lave mad fra bunden når man ikke laver det så tit. Men når man har en på 3 år, som har brug for meget søvn, har vi også oplevet at det kan være svært at få et døgn til at hænge sammen. Det vi så gør er at vi nogle gange spiser med forsinkelse, og varmer maden fra dagen før som vi har hentet. Så når vi synes det er spidsbelastet og ikke lige kan nå det til kl 6 så gør vi det på den måde. Det er ikke helt optimalt men det er også kun i en periode imens børnene har en bestemt alder. Det der med når det skal til at droppe middagsluren så kan det være svært at få døgnet til at hænge sammen. Men derfor er der også en stor tolerance for at sådan gør man, hvis det er det man har brug for. Derudover sparer man penge og forhindre madspild når man laver til så mange. Vi følte tit: Åh så køber man et helt blomkålshoved og så bruger man et kvart osv.

Hvilke gener/ulemper oplever du ved at bo i et fællesskab?
Det er en præmis men det er også en udfordring det med at man ikke selv kan bestemme tidspunktet for spisning. Men det er en præmis vi har været bevidste om så det er ikke en gene, men det er selvfølgelig hårdt i nogle perioder. Men vi er nogle typer der godt kan lide at tingene er sat i system, for det er aldrig problemfrit og uden konflikter, men jeg kan høre på andre der oplever nabokonflikter at så fungerer det uden en måde at løse det på. Når vi har konflikter her så bliver de jo taget op i et forum på et fællesmøde, hvor vi snakker om det og finder en løsning. For mig gør det at det ikke går og vokser sig stort, og man er indstillet på at nu skal det løses, så for mig gør det også at det er en fordel at det er sat i system og at man snakker om tingene.

Jeg kan næsten ikke holde ud at man ikke snakker om tingene. For nogle tror jeg at det er hårdt at man snakker om alting, men de fleste har valgt det til. Der var en tidligere beboer der forklarede for mig et forhold han havde haft til en nabo: Vi havde boet ved siden af hinanden i 20 år, men pludselig sad vi en dag og lærte hinanden at kende og så fandt jeg ud af at han er sgu også en fin fyr og han er sgu god at snakke med. Men oplever jo heldigvis ikke kun de trælse sider af folk, man får også en eller anden sympati for dem. Når man f.eks. står og laver mad med dem. Men dermed sagt, vi er jo også bare private nogle gange, det er formaliseret når vi er sammen og så kan man så trække sig vær til sit når man brug for det.

Hvordan sikrer i Jer er alle beboere tager lige del i fællesskabet? Bidrager til arrangementer/spiser med de øvrige til fællesspisning m.v.?
Det er meget organiseret, man ska fysisk placere nogle brikker så det er åbenlyst hvis der er nogle der mangler. Det går en stafet rundt, så der er det her pres på, man kan ikke lige snige sig uden om. Jeg sammenligner det tit med min søsters bofællesskab, de har et meget mere tillidsbaseret system hvor man har en liste hvor man skriver sig op ca. 3 gange i måneden, men der er ikke nogen der tjekker det eller et antal af brikker og hvis der ikke er nok på så aflyser de. Hvor her sker det helt systematisk. På samme måde foregår det med gaderengøring, der er så mange poster som der er personer og så skriver man sig på en. Men vi har en lige nu som er sygemeldt og i kræftbehandling. Det har vi taget op på fællesmødet og er blevet enige om at hun træder helt ud af tjanser og vi tager over for hende. Men det er man nødt til at tale med fællesskabet om.

Hvordan håndteres kontroverser imellem stridende beboere?
Det kommer an på om det er stort eller småt. Hvis det er reelle kontroverser tager vi det op på fællesmødet. Der har været en enkelt, som er flyttet nu, hvor det handlede om holdningen til hvor meget roder ude i gaden på fællesarealet. Du kan se der er meget flydende grænser mellem det private, som man selvfølgelig selv styrer, og så er der nicherne som officielt er fællesareal. Altså hvor meget kan man rode i en niche før at det genere det fælles og hvor meget kan man have børnekøretøjer stående osv. Altså hvor meget må man rode i gaden. Det havde vi en hel visionsdag om, hvor vi så prøvede at have nogle visioner for hvad forbinder vi med det gode og ser vi os selv som tolerante med højt til loftet og en idé om at folk kan være nogle rodehoveder men stadig må have lov at være her, eller ser vi det som en kvalitet at vi rydder op og husker hinanden på at vi skal tage os sammen eller er vi helt nede i at skal have opmålt meter for hvor grænsen går mellem fælles og nicher. Der endte vi så på en løsning med at man tager hensyn men at vi slet ikke vil have nogle regler for antal af meter. Men der var en familie der gerne ville have det meget stringent og den holdning tog vi så op og diskuterede, men de var allerede på vej ud fordi de måske i virkeligheden gerne ville have mere privathed.

Hvilket forhold får man til de øvrige beboere i bofællesskabet? Og er dette forhold anderledes i forhold til at bo i almindelige lejligheder eller i et villa/parcelhus kvarter?
Sådan gammeldags landsby. Men der er meget forskel. Der er nogle af vores naboer vi ser meget til og nogle man har mindre at gøre med. Men man her lidt det der landsbyforhold, og man er jo også interesseret i hinanden, spørger ind til hinanden. Men der er meget vælge til og fra, jeg ser ikke alle privat. Der er naboskaber der overgår til venskaber, og der er andre familier med børn hvor børnene løber frem og tilbage, fuldstændig som det lige passer dem. Børnene har sådan et forhold at de måske ser mere til vores naboer end vi selv gør. Men man kan vælge at engagerer sig meget i det og man kan vælge at trække sig mere tilbage og mest deltage i de formelle ting.

Har du planer om at bo i et eller andet form for fællesskab hele livet? Og hvorfor/hvorfor ikke?
Lige nu tænker vi at blive her rigtig mange år frem. Det er planen.

Bofællesskabet Ådalen 85

Hvad er aldersspredningen i bofællesskabet?
Den yngste er 1 år. Den ældste er 85 år. Vi er efterhånden ret blandede, men der er lidt flere af de 60+ årige. Men det er jo naturligt i forhold hvornår bofællesskabet er fra, der er nogle der har boet har siden da. Men ellers synes jeg vi er godt blandet. Vi mangler nogle i midte-kategorien, dem hvor børnene snart flytter hjemme fra. Mange af de bofællesskaber vi kiggede på havde et problem med generationsskifte, men vi fornemmede at vi var i gang med generationsskiftet her. For os var det også nok at vi var 3 småbørnsfamilier, så er behovet repræsenteret. Da de startede her var der 25 børn og der var spisesalen halvt så stor, så der har været gang i den. De var alle sammen samme alder og havde alle sammen samme alder. Det er lidt mere roligt nu.

Hvem er de typiske ansøgere i dag? Har dette ændret sig siden begyndelsen i slut 80'erne?
Der er rigtig mange 60+ årige, overskudsagtige veluddannede som har børn der er flyttet hjemme fra og har haft en drøm om at flytte i bofællesskab når de gik på pension. Så har de måske boet i villa det meste af deres liv og NU skal der ske noget nyt. Men der har ikke været nogle af

de der har fået de boliger vi har haft til salg. Vi har til dels været opmærksomme på at vi gerne ville beholde en aldersblanding. Det er der heller ikke enighed i. Men hvis vi ikke sørger for en blanding bliver det en anden type bofællesskab. Der er også nogle fysiske krævende opgaver her, så vi SKAL have nogle der kan kravle op på stillads, beskære frugttræer og slå græs på de meget skrånede arealer. Det er ikke en lille tjans. Dvs. hvis 75 % af beboerne har rygproblemer så kan vi pludselig ikke få det til at køre rundt. Derudover har vi mange som pludselig opdager det med trapperne når vi viser rundt, da kan man prøve at kigge 5 år frem. Så det er endt med at være nogle yngre der flytter ind. Men der er kommet gang i den igen. Der har været en død periode inden vi kom til, hvor det hele var gået lidt i stå. Men der er kommet en ny energi over det og sidst hvad havde noget til salg blev det solgt lige med det samme, vi nåede nærmest kun lige at lave salgsmateriale, så havde vi en køber. Vi har også gjort mere for at få tingene solgt, førhen blev det blot lagt på hjemmesiden og så var det lidt en tilfældighed om folk så det. Men jeg har sagt at jeg vil ikke have det stående i årevis. Hvis nogle ikke gider at være her og gerne vil ud, så skal vi sælge det aktivt. Det andet er en frygtelig strategi. Økonomisk går det kun ud over den enkelte andelshaver når det står til salg, men for mig går det ud over fællesskabet når nogen har noget til salg og egentlig ikke vil bo her. For mig er det vigtigt at vi hele tiden bor nogen der vil det.

Fællesspisninger: Er der god opbakning hertil, og bruger beboerne i reglen resten af aftenenerne i fællesskab, eller går man oftere hver til sit herefter?
Man trækker sig efter spisning. Man kan godt side her lidt, men det er også en hverdags ting. Altså det er dejlig og man hygger sig men så tager man også hjem igen. Vi spiser sammen fra Søndag til Torsdag.

Værkstedet: Hvilke aktiviteter finder sted her og hvor ofte?
Det er bare et værksted, så aktiviteter er mere hvad de enkelte gerne vil. Så er der de to i udvalget der går og ordner alting, de har tit sådan en hæle af børn rendende efter dem. Men vi afholder ikke specielle workshops. Vi har før besøgt nogle lidt større bofællesskaber hvor man så f.eks. kunne gå til yoga, så det har lidt med størrelsen at gøre.

Lejlighedsstørrelser og fællesområder: Føler du at du får mere ud af din bolig på denne måde eller føler du at du betaler for en del ekstra arealer og faciliteter du ikke har gavn af?
Nej jeg er glad for at have fællesarealer, vi har meget gavn af det. Børnene render jo rundt i gaden og i fællesarealerne og det giver ligesom noget mere plads, så de ikke løber rundt i hjemmet og opfører sig som aber. Så det der med at man lige kan komme ud og i et afgrænset område og have mere areal og plads. Vi har også brugt spisesalen meget til at holde fest.

Fælles arbejde: Hvilke opgaver har I i fællesskab?
(Rengøring/havearbejde/vedligeholdelse af bygning mv.)
Vi har fælles arbejdsweekender og 5 grupper (udvalg):
Have, køkken, vedligehold, bestyrelsen, gade.

Hvordan oplever du indeklimaet, hhv. i din egen bolig og i glasgangen?
Lys, temperatur, luftkvalitet?
Det meste af året handler det om at få lukket varmet ud. Så snart der er sol, så er der varmt i dagen. I April måned kan der hurtigt blive 50 grader oppe under glasgangen. Vi varmer gaden op med solvarmere fra taget, og vi har for meget varme det meste af året. Så der laver en vindtunnel hvor vi åbner det hele op.

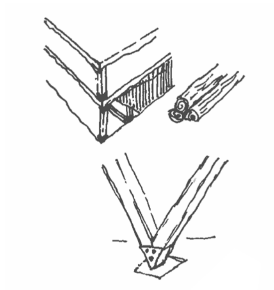
På Jeres hjemmeside, Energi-dukse, hvilke ting gør i helt konkret for at spare på energiforbruget?
Vi har etableret solceller og solvarmere på taget, men det er et byggeri fra 80érne hvor der er nogle ting der er for store at gøre noget ved nu. Men i det private hjem er der ingen restriktioner for hvordan energien bruges. Vi har fællesenergimåling, men det vil blive dyrere at etablere individuelle målere end hvad vi kan indtjene igen.

APPENDIX 3

Inspiration projects

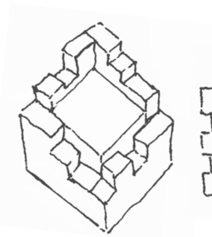
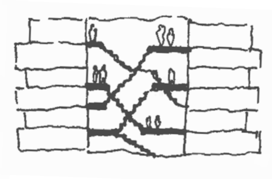
The pictures illustrate projects that have given inspiration to the project, either in it's architectural expression, programming or suatainable choises. Elaborating casestudies of chosen references is seen in the analysis: Case Studies.



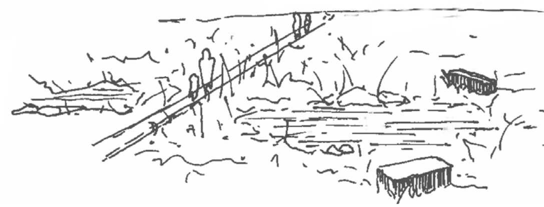





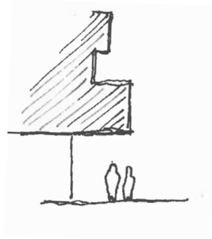


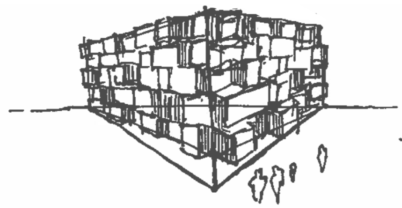



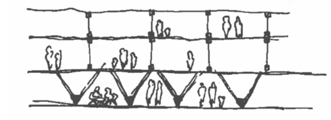












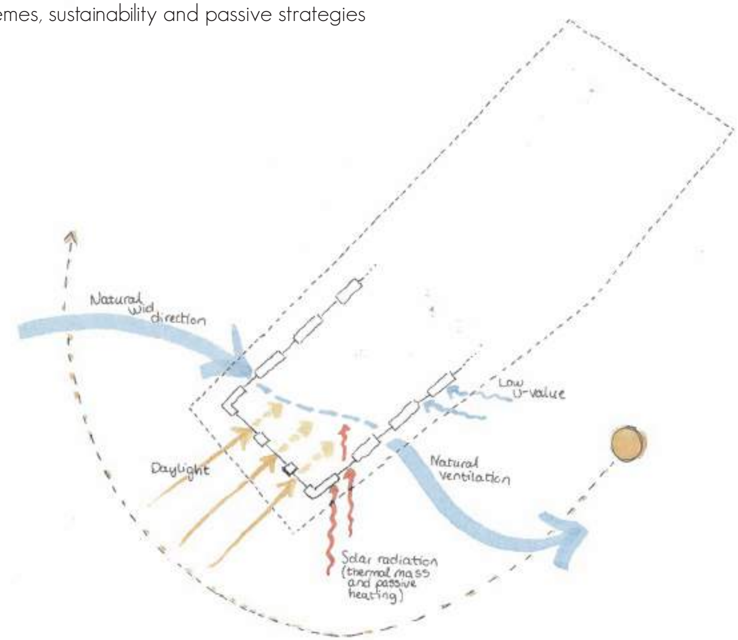




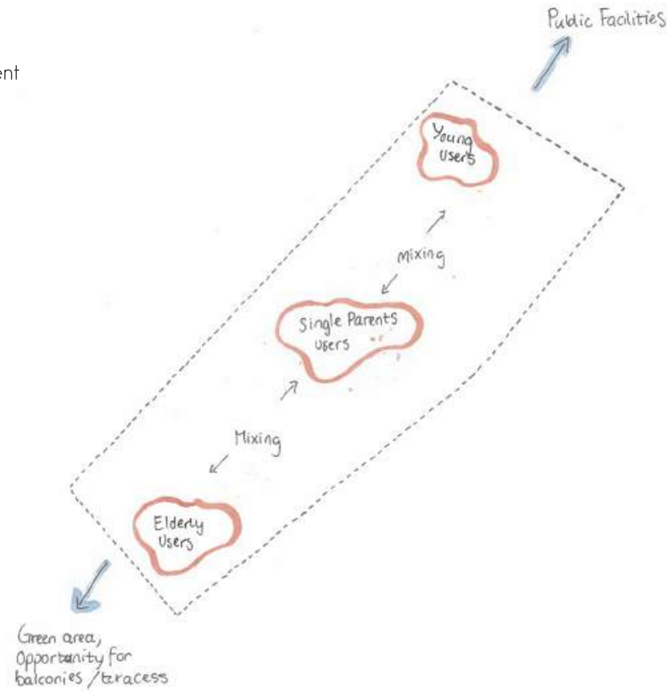

Design criteria on site

The following diagrams is illustrating the design criteria on the actual site, for a better understanding of the consequences and opportunities the different demands will create. The criteria are sketched on transparent paper upon a map of the site and context.

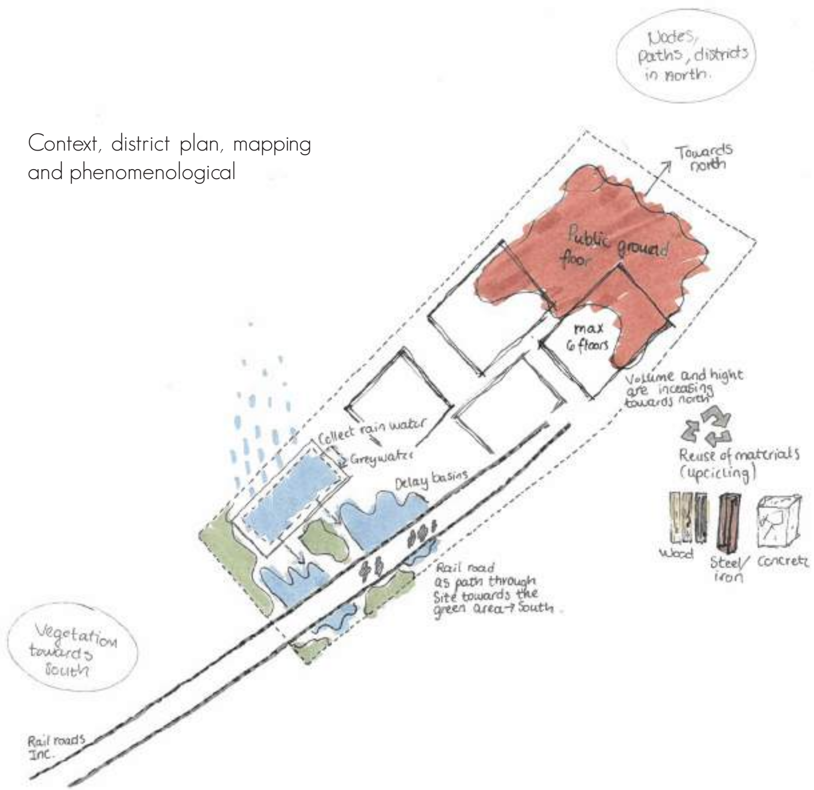
Themes, sustainability and passive strategies



User segment



Context, district plan, mapping and phenomenological



Themes, sustainability and active initiatives