
Nyholm Naval Quarters

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Main supervisor/ Michael Lauring
Technical supervisor/ Rasmus Lund Jensen

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Helene Johansen

Nicolai Fuglsang Torp

How do we preserve historical, cultural environments when the pressure of urbanization and climate change requires us to transform these environments into new urban areas?

Following the defence settlement of early 2018, the island of Nyholm in Copenhagen, which has been home to the Danish Navy for more than 300 years, is set to be transformed into a vibrant and iconic mixed-use district, combining the historical and cultural heritage of Nyholm with the need for sustainable housing developments. The Municipality of Copenhagen is looking for a holistic masterplan for the transformation of the area. In addition to the transformation of currently listed and preservation-worthy buildings, Nyholm will need to be revitalized through the addition of mixed-use buildings with predominantly housing. This intervention will be the primary focus of the thesis although transformation of the existing building mass will be a parallel and inseparable process that will help to inform both the aesthetical and contextual approach to the project.

The aim of the master thesis is to design a mixed-use urban development with predominantly housing in the southernmost third of the island of Nyholm in order to densify this centrally located area of Copenhagen. Given Nyholms unique building heritage, our aim is to propose a strategy for densification which both involves transformation of existing buildings as well as the addition of new building volumes on the site - which will be the primary focus of the project. In order to preserve the historical atmosphere on Nyholm, the Municipality of Copenhagen has suggested a relatively low building percentage on Nyholm. Our aim is to qualify the initial assessment of the building percentage through volume studies and microclimatic analyses.

With the purpose of creating a sustainable urban quarter, energy consumption related to the operation of the building and embodied energy calculations will inform the design process. Finally, achieving a high level of indoor comfort in the new buildings of Nyholm will be a central design aspiration.

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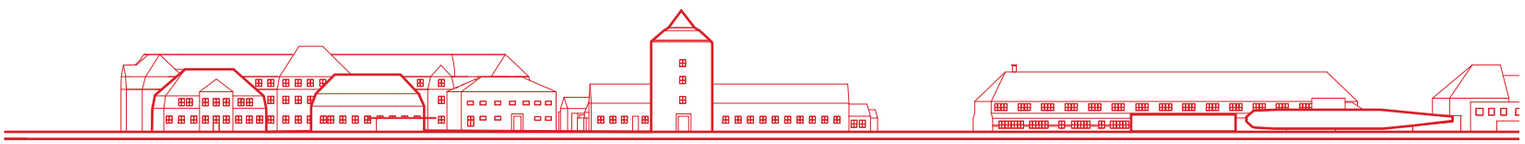

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Methodology

Methodology

Within the field of architecture, the methodological approach spans widely; social science as well as humanistic and natural science perspectives are combined to inform and develop holistically sustainable architecture.

Since Nyholm was placed on the political agenda in 2018, no building program or future masterplan has been proposed for the island. So far, only the visions and ideas of the local committee have been publicly presented. Therefore, this thesis will be based on the development of a conceptual masterplan and a detailed mixed-use housing typology in the southern third of Nyholm.

Mary-Ann Knudstrup's integrated design process (Knudstrup, 2004) is used as the overall methodology to structure a complex design process and integrate technical aspects. Problem, analysis, sketching, synthesis and presentation are the overall topics. These topics are divided into phases.

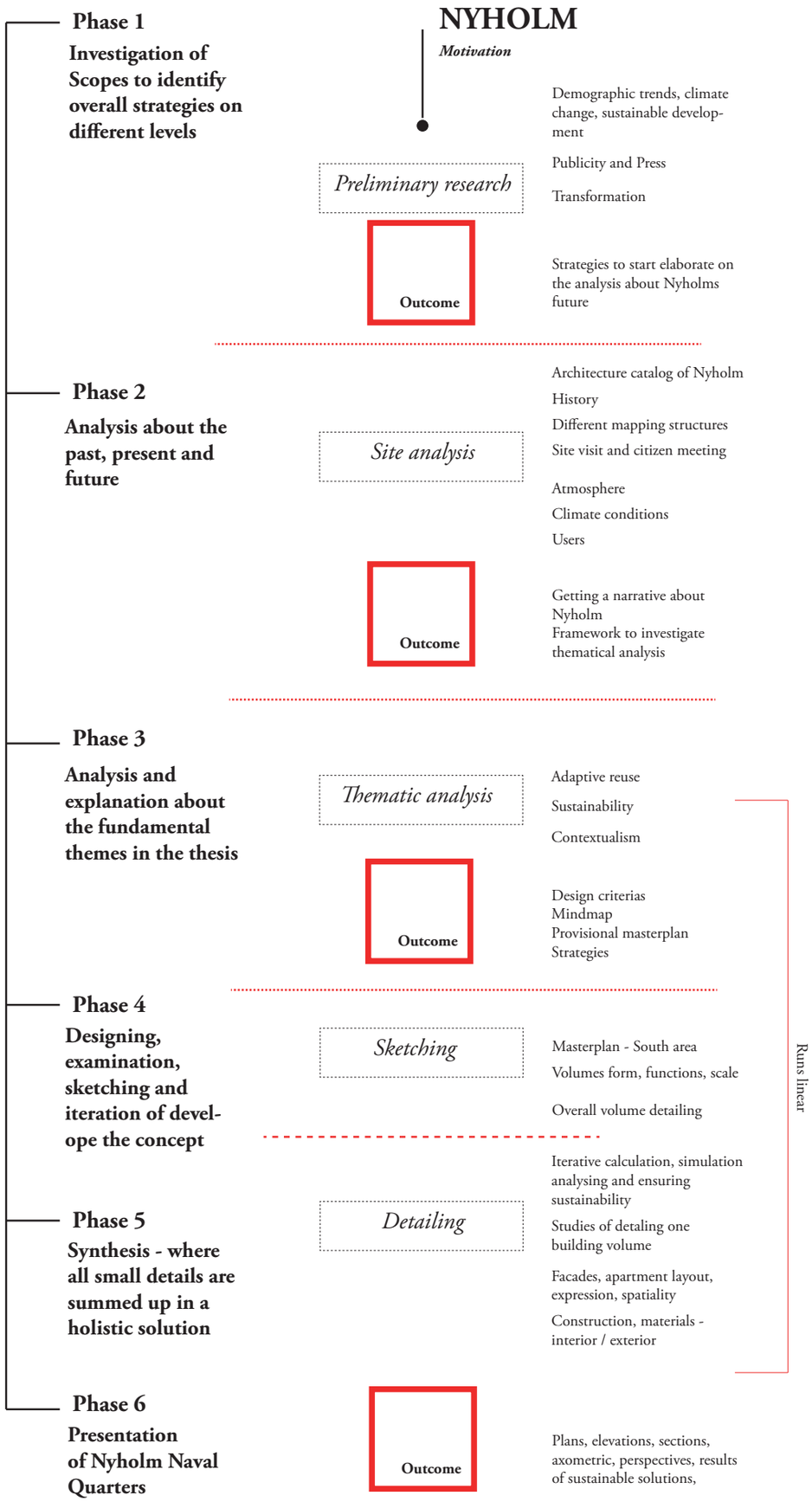
In the problem and analysis phase, we will use correlational research on urbanization, climate change and resource scarcity as well as changing social structures. This will primarily be used to understand global challenges now and in the future, in order to be able to incorporate it in the design process and widen the understanding and conception of context in an otherwise sensitive place. Regional research about demographic trends, housing challenges and sustainable development is used to investigate which specific types of housing are needed and which sustainable standards, certifications and definitions we use in Denmark. The local examination works with two aspects: historical research and analyzing method is applied to investigate and analyze the site both in order to map different layers of the site and surroundings, its historical background and the future agenda of Nyholm. A site visit, where we observe and systematically move through the site, and a citizen meeting on Nyholm in the beginning of the semester will deepen our understanding of the environment we are building into.

Many aspects of the problem and analysis phase runs linear with the actual design development; the research and analysis continuously contribute to new knowledge to the design, and therefore requires that these phases will be examined at the same time while the urban development takes shape.

The Vitruvian triangle constitute the three key parameters of architectural quality: utilitas, firmitas and venustas, which are translated to the three main thematical approaches: Contextualism, adaptive reuse and sustainability. This methodical approach is described more in detail in chapter 003.

The design phase contains sketching, synthesis and presentation and becomes the development of the southern area.

Different thematic chapters are made to structure the iterative processes and help to summarize the essential aspects of the different chapters. Using different tools such as 3D programs, models and sketches, provides designs we can elaborate and develop on and combine it with simulation programs such as BSim, microclimate simulations and verification from LCA and BE18. We use the different tools to simulate the environmental impact, ensure good indoor environment and ensure a coherent design. These different designs and results will guide and inform the design throughout the process, thus achieving sustainable, integrated and holistic solutions.



Methodical scheme

Research

Historical research:
Handling the contextual history from books, texts and site visit to a narrative and interpretation of the importance of the sense of place

Correlational research:
Categorical facts, interval and ratio scales, statics to clarify and compare the relation between the first analyzing phase.
(Grout, Wang, 2013)

Data collection

Site observation

Mapping

Phenomenology of perception

The Vitruvian approach

Figure ground maps

Simulation of micro climate

Sketching approach

Mock-ups

3D modelling

Visualizations

Analysis about embodied energy - LCA

Thermal and visual indoor comfort simulations - Bsim / Velux daylight

Verification about energy performance - Be18

Verification about energy performance - Be18

Ill. 01

LCA design approach

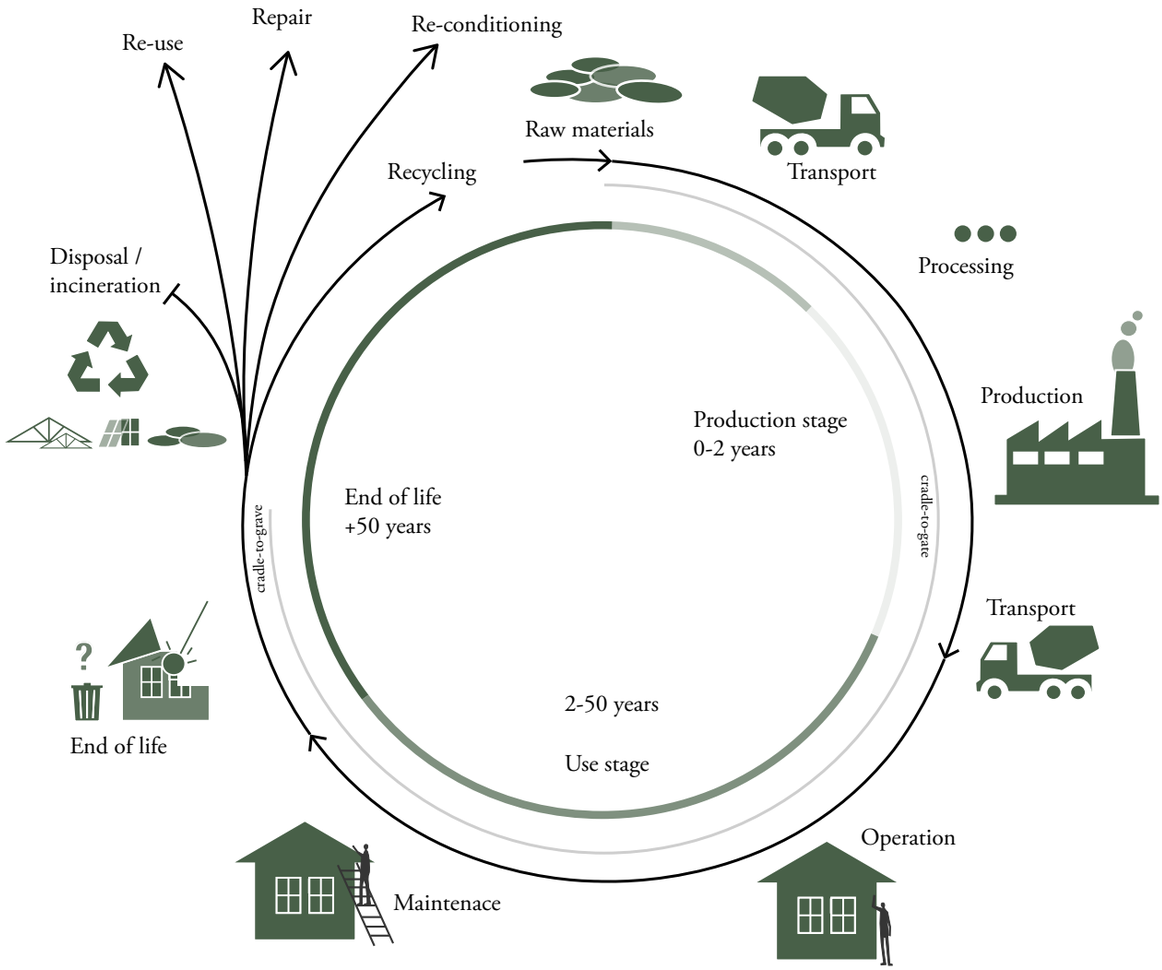
For many years the discourse on environmental sustainability has focused on the energy consumption of buildings; driven by continuous innovations in material production and increasingly ambitious energy legislation, the operational energy consumption of buildings has been reduced drastically over the past decades. Today, zero-energy consumption is achievable, which has moved the focus of the sustainable agenda to the embedded energy of buildings (Kanafani, et al., 2019).

The DGNB certification is currently the most ambitious standard in Denmark with regards to sustainable design practice. Within the weighting system of the DGNB, life cycle analysis constitute a significant share of the calculated environmental score of a building. However, the DGNB system lacks a more precise description of how to apply LCA as a tool in the design phase. This thesis aims to incorporate LCA in the early design stages to quantify environmental impact and performance. Consequently, it is important to clarify DGNB as a certification system and LCA as a method and their demarcation for this thesis.

DGNB is a certification system for future-proofing buildings. A DGNB certification has the implication that the building is considered to be sustainable on several parameters. The system is divided into five categories: Environmental, economic, socio-cultural and functional, technical and process quality. DGNB is used as an evaluation method, where the building is awarded a score. LCA belongs to the category of environmental quality and is intended to make a holistic assessment of resource consumption and potential environmental impacts for the entire building's lifetime.

LCA (Life Cycle Assessment) is used as a method for qualifying and comparing environmental profiles for given building constructions and materials. It is an in-depth analysis of production processes, identification of environmental problematic materials and processes, for which they can be used as design strategies. LCA is divided into five phases: Construction process, use, potential for recycling, recycling and recovery and product. The full scope and detail of the various procedures cannot yet be met, since all data and knowledge are not available in the Danish construction industry. (Kanafani, et al., 2019) Lack of data must therefore be replaced with an estimate. If the design and material are not determined, a precise environmental profile cannot be calculated.

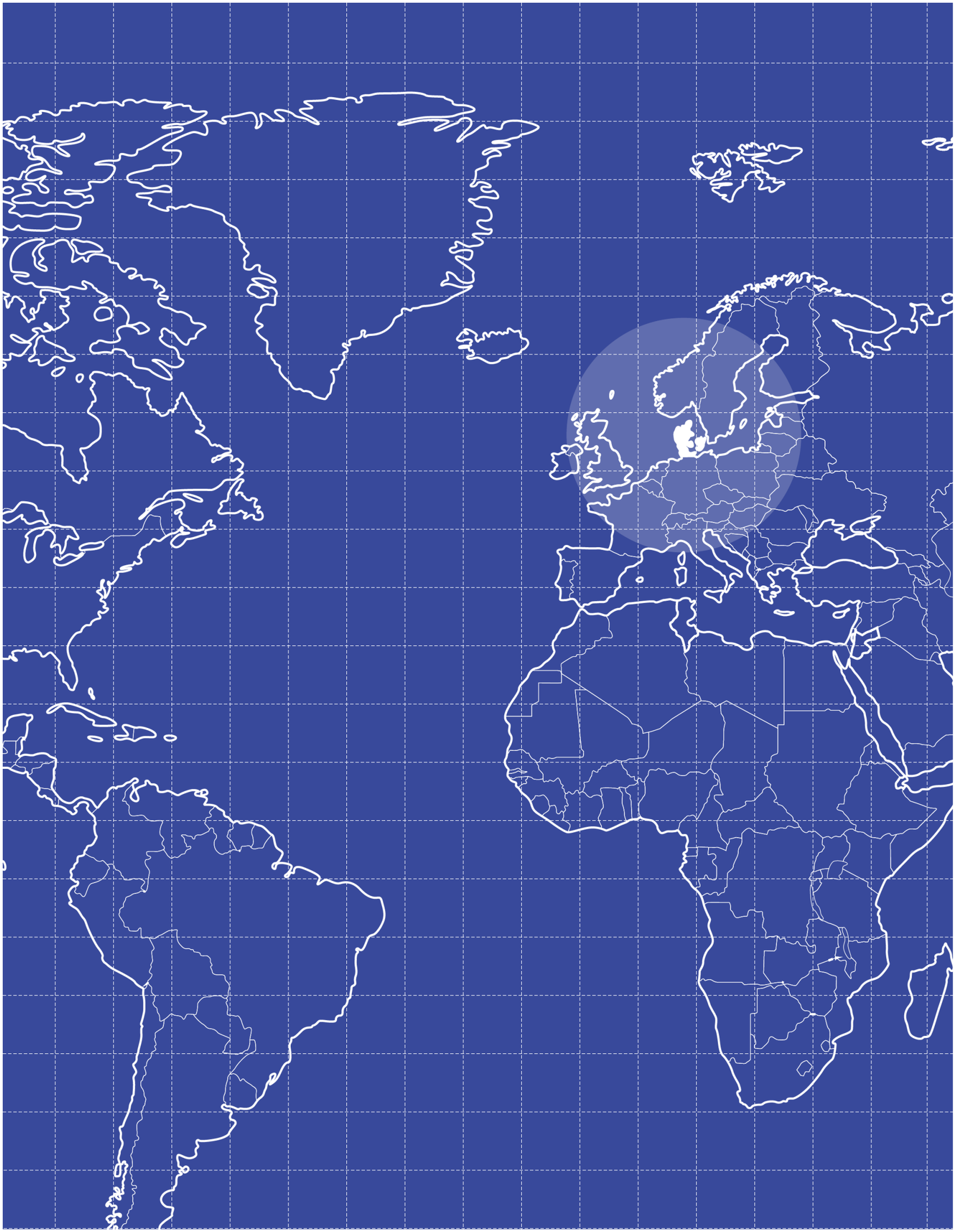
We have a desire to integrate a model for how LCA can be used continuously in the design phase so the calculations follow the development of the design. By examining different designs and its materials, we can compare and evaluate during the process on the design's environmental profile. The present thesis will focus on Global warming potential (GWP), primary energy consumption (PEtot) and Ozone Depletion Potential (ODP) as they have a strong correlation with the other parameters include in the life cycle analysis (Kanafani, et al., 2019).

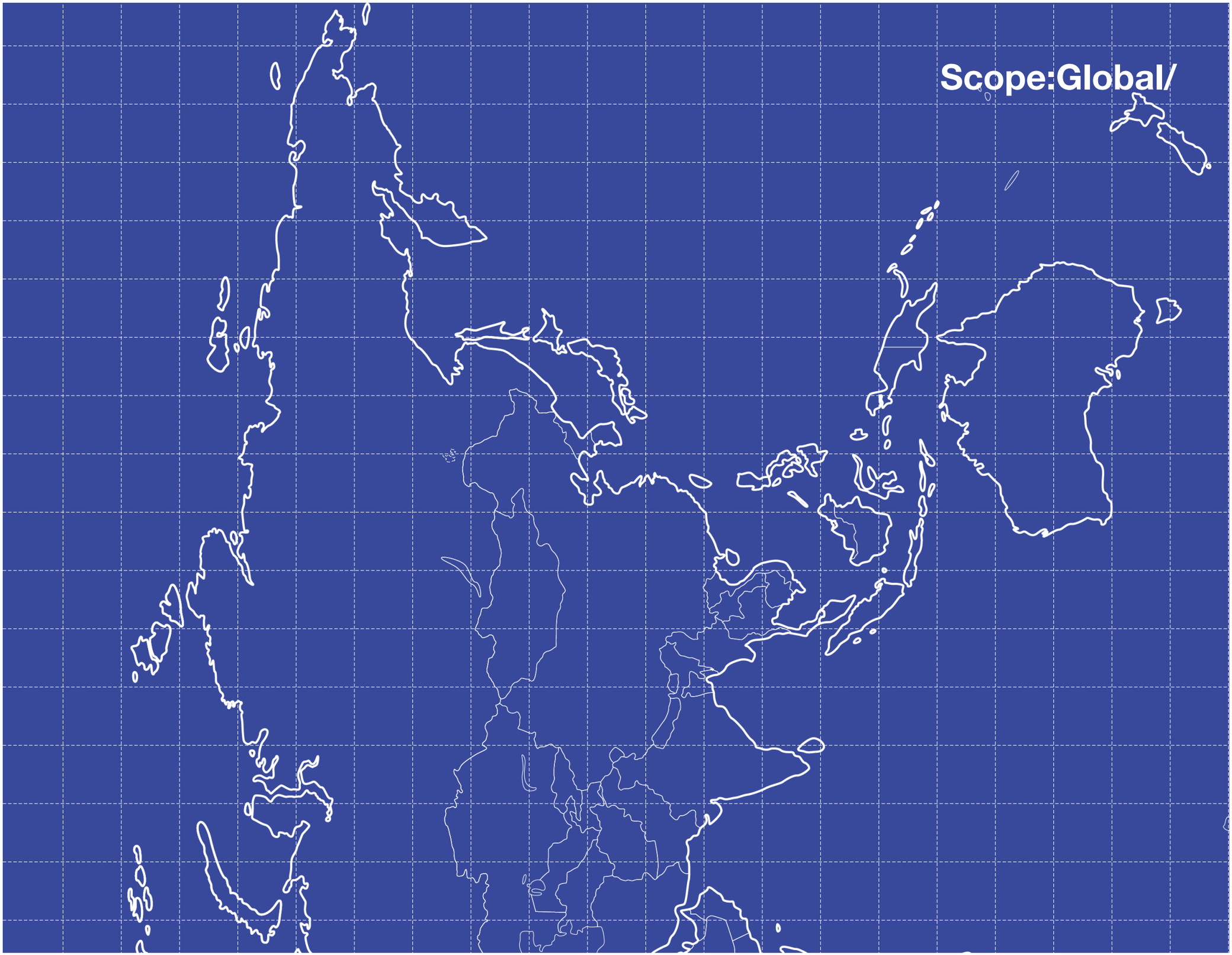

Re-use
Repair
Re-conditioning
Raw materials
Transport
Recycling
Disposal /
incineration
Processing
Production
Production stage
0-2 years
End of life
+50 years
cradle-to-grave
cradle-to-gate
Transport
2-50 years
Use stage
End of life
Operation
Maintenace

Ill. 02

001.

Scope




Scope:Global/

Scope:Global

Like most other industries, architecture and engineering have over the last few centuries had to adapt to the increased complexity brough about by globalization. The implications of exponentially increasing construction activities on the globe has directly contributed to a number of unintended environmental and social issues, the most prominent and devastating, environmental degradation, being driven by exponentially increasing greenhouse gas emissions and unsustainable resource consumption.

What are the most impactful global trends with regards to architecture and construction? How are they interconnected? What can architects and engineers do to combat these issues and how are these strategies applied in a context-specific design process?

Urbanization

May 23rd 2007 marked a symbolic turning point in human history; for the first time the demographic composition of the world's population shifted to a predominantly urban population (NCSU, 2017). Today, almost 12 years after, the proportion has increased to more than 55% and is expected to reach 68% by 2050. This trend, along with the overall growth of the world's population, could potentially add 2.5 billion people to urban areas by 2050 (United Nations, 2018). Not all regions of the world will experience the same pace of urbanization over the coming years, with developing regions in Asia and Africa expected to drive the majority of the global urbanization. The Americas, followed by Europe, are currently the most urbanized regions, the latter having gone through the transformation to a predominantly urban continent in the mid 1900's (Ritchie and Roser, n.d.). Although the speed of urbanization in Europe has slowed down, the share of the urban population continues to grow. The combined effect of an increasing population and steady urbanization is an immense pressure on cities, resources and social structures (Opentextbc.ca, 2012). In order to ensure sustainable development in cities and society in general, the impacts related to urbanization and populaton growth needs to be understood and adressed.

Ill. 03

The proportion of a country's population living in urban areas is highly correlated with its level of income (Bloom, 2008). This has historically been the primary draw of cities since it meant more job opportunities and higher standards of living in urban areas. The increased income promised by urban life has nonetheless had a number of unfortunate side effects, the most noticeable today being the environmental degredation produced by higher consumptions of energy and resources that are related to urban life. This had led to assumptions about the incompatibility between economic growth and environmental sustainability. In addition to the environmental impact driven by higher economic wealth, a more general increase in population numbers inevitably leads to increased stress on our planet's resources through - once again - higher consumption of energy and resources.

In the context of environmental sustainability and urbanisation it is imperative to understand the significant role of density in urban areas. Although the speed of urbanisation has accelerated simultaneous with the emissions of greenhouse gasses, the densification of people has a number of positive effects on environmental degredation. Densifying cities will no doubt save resources, as transportation needs are reduced, housing is significanly smaller and more compact than in rural areas and the resulting need for goods are comparatively smaller as well. This creates a clear incentive to keep people in the center of the cities as studies show a lower carbon footprint when density is high(Bæk Pedersen and Andersen, 2011). There is however a trade-off between city density and the comfortability of living in such a setting. A potential increase in pollution as well as restricted access to large green areas and possible impacts of high building density on daylight levels are some of the primary concerns of increasing building density

Climate change & resource scarcity

The consumption of energy and resources have always been deeply ingrained in the succes of human societies. But as population grows, becomes more prosperous and urbanized, the externalities related to consumption presents a major challenge to our planet. Since the end of WWII global energy consumption has skyrocketed (Ritchie and Roser, 2019), which has proved beyond any reasonable doubt that our planet is unable to support current models of production and consumption. Global warming, rising sea levels, droughts, flooding and other natural catastrophes are the immediate reaction of a fragile environment to the impact of our lifestyles.

The building sector is currently responsible for approximately 36% of final energy use and 39% of energy related carbon-dioxide emissions (Iea.org, 2019). The energy used to supply buildings are primarily produced from fossil fuels, such as oil, coal, natural gas etc. The transformation of natural ressources to energy releases big amounts of carbon-dioxide which contribute to the ongoing greenhouse effect; all the while depriving our planet of finite resources. The greenhouse effect causes the average temperature on the planet to rise which ultimately results in extreme weather conditions and climate change. To prevent this process and lower carbon-dioxide emissions, the building industry has for the past few decades begun to explore solutions to lower the energy consumption of buildings by implementing more energy efficient products, techniques and design tools. In that process, concepts such as Zero Energy Building (ZEB) was born along with certifications such as LEED, BREEAM, DGNB etc. A shift in public awareness and commitment to rethink the current paradigm of uncritical consumption combined with strict environmental regulations - and of course the aforementioned sustainability certifications - has pushed the building sector to improve the energy consumption of buildings drastically. At this point, any improvements to the energy are of course beneficial but in relative terms not nearly as significant as reducing the energy used in other parts of a buildings lifecycle.

Even the most optimistic projections of global warming predict a temperature rise of about 2 degrees(Ipcc.ch, 2014). The forecasts are becoming increasingly alarming

for each passing day, suggesting that the likely scenario will be one of severe climate change in some of the most exposed regions of the world. This creates a strong argument for what is termed resilient architecture; an architecture designed to withstand the potential consequences of climate change in a local context. Although Europe on average is the least vulnerable region in the world with regard to climate change, there is a growing concern over extreme weather events, even in the most developed parts of the world.

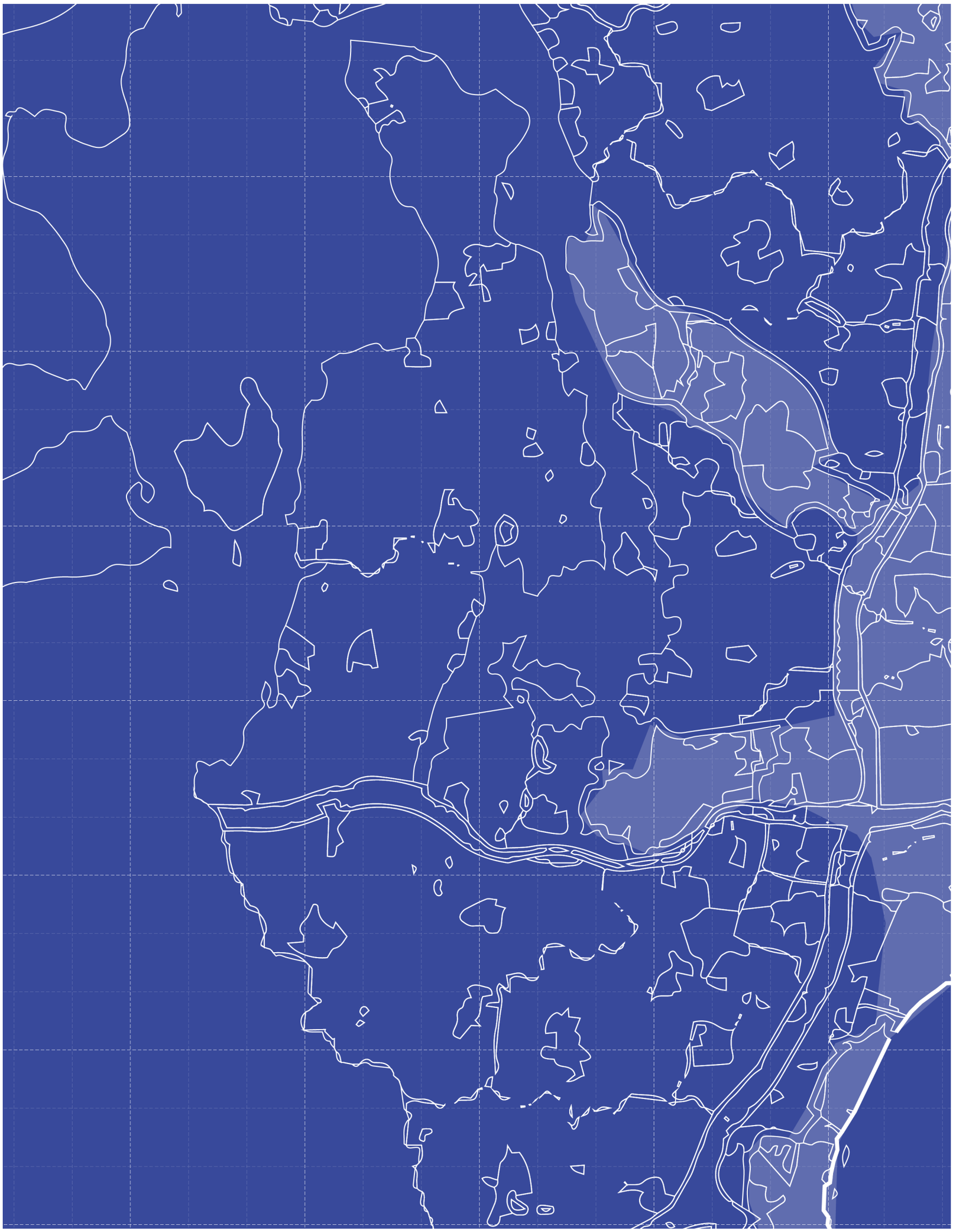
Social structures

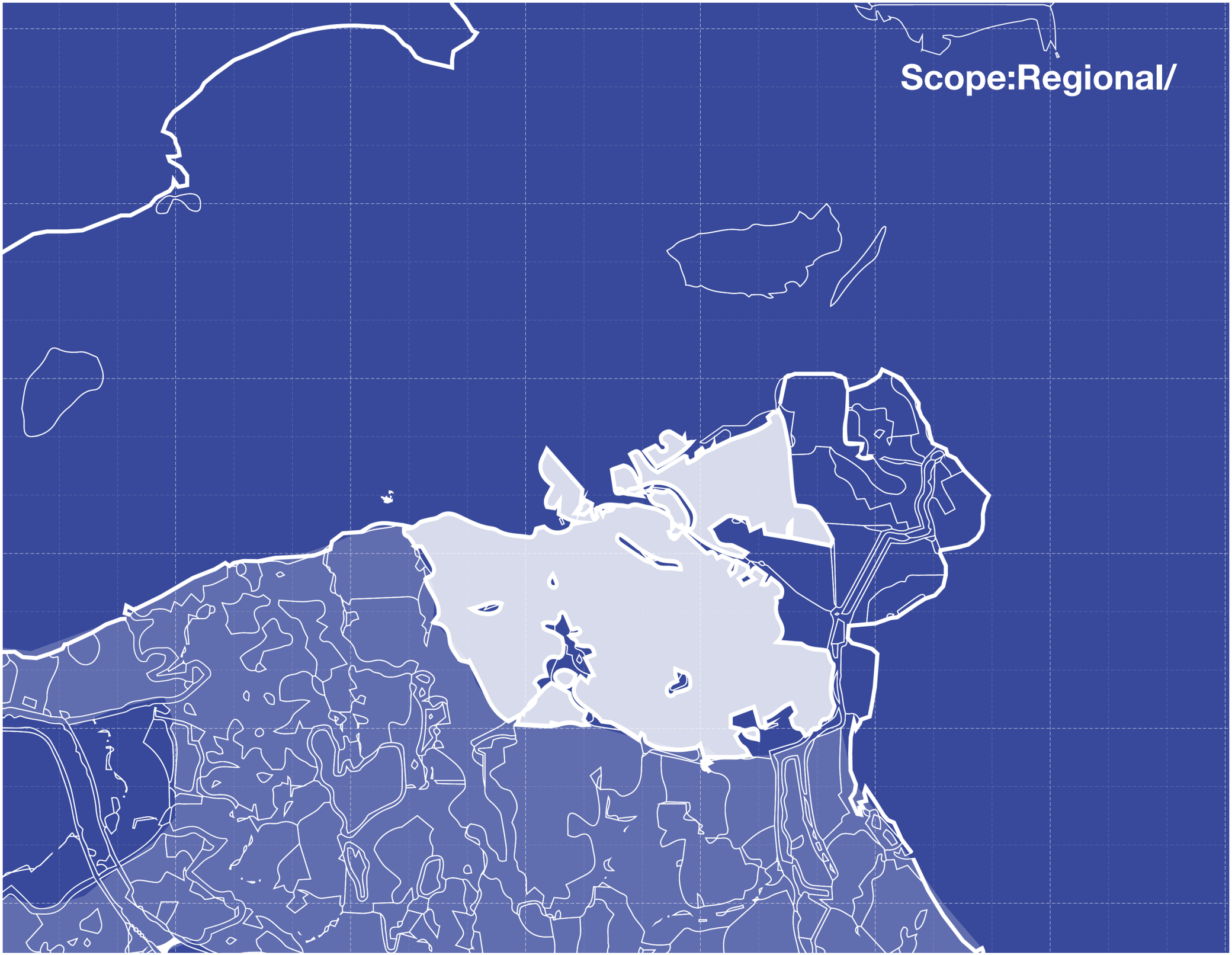
Changing social structures can be attributed to a range of factors, including the urbanisation of society. When populations become increasingly urban they tend to display characteristics different to predominantly rural populations such as higher levels of diversity, independence and weaker social attachments[11]. Social change is a multifaceted phenomenon which can be driven by several forces such as technology, population and environment(Taylor & Francis, 2014). The implications of changes to one of these forces can be great and manifest itself in changing lifestyle choices related to consumption, worklife, family patterns etc.

One of the major social changes projected for the coming decade is a shift in family patterns. The traditional family, consisting of a married couple with children, is becoming less widespread as the frequency of divorce rates, cohabitation and single parenthood is increasing (Oecd.org, 2011). Single parenthood is projected to increase as a proportion of all family households with children. However, the fastest-growing household profile in the coming decade is single-person households, which is primarily driven by ageing populations but also rising and longer enrolment in education. By 2025-2030, single-person households are projected to constitute approximately 40% of all households in countries such as Germany, Norway, Switzerland, Austria, England, France and the Netherlands, which could ultimately put a considerable pressure on the housing supply. These changes are important in the context of housing in the cities as they add information about the specific types of housing needed for an increasingly urban population.

One possible response to the increased demand for housing lies in the already exisitng market for sharing services, products and spaces. The success of global services such as Uber and AirBnB demonstrate the potential of a sharing economy - although said services can contribute to inequalities in the housing and labour market(Penn and Wihbey, 2016). Co-living and co-working have likewise gained popularity over the last years given the economic, social and environmental advantages of sharing resources. Co-working involves sharing spaces with other people in a worklife/business context. It allows for professional sparring and sharing of ideas which makes it very attractive to start-ups and smaller businesses. Similarly, co-living offers the same concept of shared spaces while also holding a promise of increased social interaction and community attachment. One of the characteristics of urbanisation and digitalisation has been an increase in individualisation and digital relations. Consequently, traditional social structures have been challenged. By reintroducing communties in the form of co-living, dense urban environments can once again contribute to social cohesion and create a stronger local attachment.

The implications that these developments have on architecture - and spaces in particular - are remarkable. Growing populations and urbanisation paired with the significant demographic shift in particularly European countries puts an enormous pressure on housing. Even *without* population growth in the cities, changes in household profiles results in an increasing demand for housing since more people choose to live alone. This also raise the question of social stimulation in these households and whether there are approaches to social architecture that can alleviate some of this pressure on housing and reestablish social relations within small, local communities.




Scope:Regional/

Scope:Regional

The area of Greater Copenhagen has developed in response to a number of regional trends that can be attributed to demographic and structural changes in society, among several other factors. The regional trends are to a to a certain extent reflections of larger trends in similar urban contexts but in order to create a site-specific response to these issues the conditions of Copenhagen in particular must be observed.

The regional trends outlined in the following section are of particular importance to the socially and environmentally sustainable growth of the built environment in Copenhagen; they highlight important considerations of urban planning as well as the physical and spatial conernes of the building scale.

Demographic projections/

Like similar metropolitan areas around it, the Danish capital of Copenhagen is expected to have a rapid increase in population over the coming years. More specifically, the population is expected to increase with almost 102.000 inhabitants towards 2030, which is the second highest growth rate in any Danish city and a higher pace than cities such as Oslo and Hamburg (Transport-, bygnings- og boligministeriet, 2018).The trend of global urbanization is thus a phenomenon that spans all levels of development and regions in the world, but the resulting effects of the settlement varies just as much as the scale of urbanisation. The majority of new residents in Copenhagen are from the surrounding municipalities suggesting that many people move to Copenhagen for the opportunities that are connected to the city such as education, employment or the like. However, a slightly larger amount of Copenhageners move the other way, to municipalities around the capital, one possible explanation being that people leave in search of a more tranquil and secure setting to raise children in. There is an additional influx of residents from other countries, the majority of those being between 20 and 30 years old and therefore likely students which overall creates a net influx of residents to Copenhagen.

Compared to the rest of the country, Copenhagen has a younger - and declining - demographic composition, exemplified by a lower average age at 35,9 years compared to the average age of 41,52 in all of Denmark (Københavns Kommune, 2018). Comparatively, Aarhus, Odense and Aalborg - the 2nd, 3rd and 4th largest cities in Denmark, respectively - also have an average age below 40 years, suggesting a trend of a younger demographic composition where the largest educational institutions are placed. This can be seen as part of a larger societal transformation, from the primacy of industry to the primacy of knowledge, where the increased importance of education is manifested in the demographic landscape of Denmark. Forecasts in the age composition of Copenhageners towards 2030 however foresee a shift in demography; although all age groups are expected to increase, the increase in the number of people above the age of 80 is projected to be substantially higher than other groups. From the year 2028, a similar growth is expected in the age group 65-79 years. This will not only affect the social structure of the city but also carry economic consequences as the workforce will be reduced. The relative share of senior citizens compared to young people in Copenhagen is for the timebeing however relatively small but both factors have to be considered in a housing context.

A troubling development in the demography of Copenhagen is the increasing income gap between the richest and the poor. This is not a development unique to Copenhagen as it has been documented in many European cities(Ec.europa.eu, 2018). Domestically, the share of poor in Copenhagen is double the amount in the rest of Denmark. Furthermore, the gap between rich and poor has increased from 2000 to 2016 and contributes to the overall picture of growing inequality in the larger cities of Europe. Reducing inequality is a declared goal of the municpality of Copenhagen and the UN's Sustainable Development Goals. If the housing demand is not met with a rapid increase in supply, housing prices in Copenhagen will continue to increase, thus driving low-income families, couples and individuals out of the city and adding to the inequality.

The housing challenge/

The continuous urbanization of Denmark combined with the increasing inequality in Copenhagen presents a somewhat democratic problem in the city's housing market; as the population grows, so does the demand for housing in an already expensive city. As a result the square meter prices on housing in Copenhagen are significantly higher than anywhere else in Denmark, and the prices have been increasing for the past decade (Københavns Kommune, 2018). Of the individual city districts, Inner City Copenhagen is the most expensive with a square meter price of 49.156 kr, up 30% over the last decade The types of housing being developed reflect this trend as the share of privately owned and rental apartments have increased over the past 11 years while the share of cooperative housing have decreased. Additionally, the amount of housing owned by either the municipality or the Danish state have decreased in both share and absolute numbers. Instead, public investments seems to have centered on social and student housing in response to the changes in demography that have been discussed in previous sections. The relatively low supply of housing has been one of the main drivers of the price increase on housing in Copenhagen. If this trend continues it can lead to a higher degree of segregation in society as the low income groups are forced out of the city. Furthermore, it impairs the Municipality of Copenhagen's ability to provide affordable housing to people of all ages and backgrounds; something which is specified in UN's Sustainable Development Goals as a condition for sustainable development.

The shortage of housing relative to the demand is partially caused by the geographical restrictions of Copenhagen; the city is bordered by water, green areas and suburbs, which complicates the process of building new housing to accomodate an increasing population. Strict regulations and legislation has furthermore contributed to the complexity of the matter. The last few years has seen an intensification of building construction in Copenhagen, which will have to continue the following years to relieve the pressure on the housing market. By 2035, the supply must be increased by 110.000 homes, 26.000 of those by the end 2020.

The supply obviously has to address the demography of Copenhagen and the projected population development. The housing market currently has a deficit of certain housing types; small apartments for young people - often students - of less than 60

In January 2018, the Danish Transport-, Building- and Housing Administration produced a comprehensive analysis on the housing market in Copenhagen, highlighting potential problem areas and challenges in the market. The analysis also proposed a series of strategies to combat some of the challenges that it had found. The main conclusion of the analyses was that the difference in supply and demand on the housing market caused the prices to increase significantly, thus risking to widen the already increasing wealth gap and jeopardizing politcal ambitions, both domestically and internationally of creating accesible and affordable housing for all income groups.

The analysis proposes three strategies, ranked by the expected potential of each, to meet the housing demand:

Strategy 01

Identify areas, that have not yet undertaken city development, both in central Copenhagen and in the suburbs.
Potential increase in housing supply: 73.000

Strategy 02

Densify existing housing areas both in central Copenhagen and in the suburbs
Potential increase in housing supply: 13.000

Strategy 03

Improve on existing building mass

Potential increase in housing supply: 6.5000

The analysis estimates that all strategies can provide 270.000 new homes which far exceeds the projected demand of 110.000 by 2035. Although theoretically valid, the strategies may be difficult to carry out in practice due to obstacles in the political process related to housing construction. Nonetheless, the strategies outline important principles for meeting the housing demand.

m^2 are in high demand, as are midsized apartments for other residents. The deficits are currently at a minimum of 4.000 and 3.000 homes, respectively. The greatest relief on the demand will occur by increasing the supply in the center of Copenhagen, where both student apartments and apartments for families are in demand.

Sustainable development/

The issues related to the demographic composition of Copenhagen and inequalities in the housing market present a serious challenge to the social sustainability of the region. Traditionally, these issues have been managed politically although architecture has always strived for social utility. The expanding notion of sustainability in the field of architecture is however creating the breeding ground for socially conscious architecture and urban development as an inseparable dimension of holistic sustainability. However, the predominant architectural focus with regards to sustainability is still reducing the environmental impacts of buildings. A concerted effort across the building industry over the past decades has created a drastic improvement in the environmental profile of buildings.

Danish building legislation has become increasingly ambitious as the awareness of the projected impacts of climate change have increased. Simultaneously, architects, engineers and developers have aspired to reduce levels of energy consumption in buildings. A number of certifications have seen the light of day, some more comprehensive than others. In a Danish context, DGNB - a certification system from the German Sustainable Building Council - has been adopted in a modified version for the Danish building sector. DGNB is a holistic certification of buildings based on the three pillars of sustainability - environmental, social and economical - defined in the Rio Declaration on Environment and Development (1992)(Unesco.org, 1992). It is the declared aim of DGNB Denmark to break away from the current trend of ”green-washing” by creating a framework for the evaluation of sustainability. Concrete tools such as life-cycle analyses and life-cycle cost calculations are ideally used as integrated design tools in the first stages of concept development.

What DGNB suggest is the increasing relative importance of embodied energy and life cycle analysis. For the past decades the primary focus with regard to sustainable building design has centered on the reduction of energy consumption during the lifetime of a building. The progression in engineering knowledge and building products have reduced energy consumption to a relatively low level. In comparison, embodied energy makes up an increasingly larger share of a building’s total energy consumption. This trend necessitates an increased awareness of the environmental impacts of different building materials. Renewable materials such as timber are becoming more popular with this knowledge while energy-intensive materials such as bricks and concrete must be used wisely in order to keep down the energy spent in producing the building materials.


Søerne
Rosenborg Castle
Kongens Nytorv


Refshaleøen
Kastellet
Nyholm
lienborg
The Opera
Scope:Local/

Scope:Local

In January 2018, the Danish Government enacted the Danish Defence Agreement of 2018-2023, which stated that all naval activities on the island of Nyholm should be relocated to other parts of Denmark. This concluded, after more than 300 years, the history of Nyholm as the primary base of the Danish Navy. The consequential selling off of a culturally invaluable building heritage has instigated a public debate over the future use of both the buildings and the island as a whole. The central issue of this debate is the conflict between preservation and current regional challenges related to population growth and housing shortages.

Nyholm/

The island of Nyholm, a 120.000 m^2 unique culture-historical environment, will be vacant in the near future, leaving politicians and local interests to discuss and speculate in the potentials of future use of the area. Given the sensitive heritage of Nyholm, any interventions will have to be highly respectful and considerate of the historical and culturally significant past. Buildings, monuments and spaces will have to be preserved to maintain their authenticity and character. The main question with regards to architectural intervention thus becomes: Is there a way to approach the transformation of Nyholm that respects the unique conditions of the site while addressing the globally and regionally rooted issues of urbanisation, urban densification and environmental degredation?

With space at a premium, the potential transformation of Nyholm as a new urban development has a tremendous potential for supplying attractive housing in a very unique setting. The existing architecture of Nyholm is iconic with several listed and preservation-worthy buildings, steeped in the history of an impressive and innovative navy. The concentration of these buildings are highest in the northern part of Nyholm, although all areas of the island hold some kind of historical significance. Any architectural interventions on Nyholm will be dictated by the existing building heritage; geometry, scale, patterns, colors and materials are decisive parameters for the addition of new buildings which will either have to emulate the existing buildings or create a clear contrast. The architectural approach will be defined by a thorough investigation of the present-day architecture of Nyholm as well as a theoretical understanding of adaptive reuse practice.

Nyholm is located in the northern end of the Harbour of Copenhagen, a stone's throw north of the Royal Danish Opera. As a central harbour-front development, Nyholm has views to several landmarks on the Harbour of Copenhagen, including the Citadel and the Royal Danish Opera. The western waterfront is completely open to Copenhagen's Inner Harbour which also means Nyholm itself is a prominent figure on the skyline when looking across the Inner Harbour from the western shoreline. Nyholm can only be approached from two smaller acces roads which undoubtedly enhances its

independent character in the area of Christianshavn. The island is furthermore characterised by a relatively low building percentage; potentially providing adequate space for new developments on Nyholm if they can add to the qualities of the area and support the narrative of a maritime and cultural environment.

Press and publicity

Since the new defence settlement was enacted on January 28, 2018, Nyholm has gained significant attention in the media. A wide range of stakeholders have shown interest in Nyholm due to the distinct preservational qualities of the area, the history and not least the location in Copenhagen. The local committee of Christianshavn has organized several meetings to discuss the future of Nyholm and various media outlets have followed the development with news articles in the current years.

In a letter to the Ministry of Defence, the local committee of Christianshavn, have expressed a desire is to be included in the preparation of the overall plan in order to ensure Nyholm's qualities are not lost in the sale of the island. The local committee has previously been an active part of the development of the local plan for the other parts of Holmen, and therefore also wants to be involved and contribute to the overall plan for Nyholm. (Cohrt, 2018) The public debate is primarily about whether the function should be an experience and knowledge hub for the historic naval station, which must be structured out across the area, or whether there should be housing with cultural experiences. (Benche, 2018)

The Danish Government has published a series of initiatives to strengthen the metropolitan area, where Nyholm is also mentioned; similarly to the aim of the local committee, a desire for a holistic plan for the historic buildings on the northern part of Nyholm is expressed. However, space for the construction of new homes on the southern part of the island is also included. (Erhvervsministeriet, 2019) The Danish Defence have the greatest influence over the future of the area, as they are the current owners of the buildings. According to the local plan and the municipality, Nyholm is used for public objective, where it is only the Defence that decides what can be built or arranged in the existing buildings. If this has to be changed a change of the local plan is required, which most stakeholders believe must be made for the local plan.

In a discussion paper in Politiken Byrum, Jens Loft Rasmussen from the Local committee, describes that the government is not specific enough in relation to the development of Nyholm and in this connection asks questions about how the government will ensure a coherent plan for the whole of Nyholm and not just for the northern part. (Loft Rasmussen, 2019) In another article, also published by Politiken, Asser Amdisen, the director of the school ship, Georg Stage, expresses his concern that the development will focus on maximising the built square meters in apartments with the highest possible rent, thus, the Defence receive the highest profit on sales.

The discussion on which functions Nyholm should have in the future must be an open debate and dialogue between the citizens, which is represented by the Local Committee

from Christianshavn, the politicians, the Defence Committee and other stakeholders. Citizens' meetings are therefore organized, with the focus being on raising awareness and increasing knowledge of Nyholm. The citizens' meeting on February 26, 2019 deals with Nyholm's potential from different professional angles (Christianshavns Lokaludvalg, 2019) Here there will be a focus on architecture, cultural history and space for debate.

Preservation or adaptation?

The transformation of Nyholm has naturally prompted several visions for its future use although all interested parties agree that the significant past of Nyholm must have a strong presence in any future plans. Since the defence settlement was enacted in January 2018, several meetings have been arranged by the local commitee with architects, urban planners, historians and politicians invited to express their attitude towards the future of Nyholm. The debate has to some extent caused a polarization of interests with two opposing viewpoints emerging; preservation and adaptation.

Preservation/ The argument for preservation is deeply rooted in the appreciation of Nyholm's history and heritage. These interests are arguing for the cultural importance of preserving all buildings on Nyholm in order to showcase how Nyholm has evolved over time. In this case, all buildings - and consequently the island in its entirety - would serve as public, cultural spaces for museums or similar functions. Is has also been suggested that Nyholm could accomodate current maritime functions such as shipyards for the construction and maintenance of both new and old ships. This scenario doesn't include housing or institutions on Nyholm which is considered to disturb the clarity and authenticity of the island as the historical anchor point of Danish maritime heritage. There is however an openness to the possibility of small-scaled workspaces or workshops that can bring day-to-day life to Nyholm. These spaces can be placed in any of the soon-to-be abandoned buildings of Nyholm just as other, new functions can be accomdated in these. The island would in this scenario have a more public character, open to tourists and other visitors as well as those employed by the new functions.

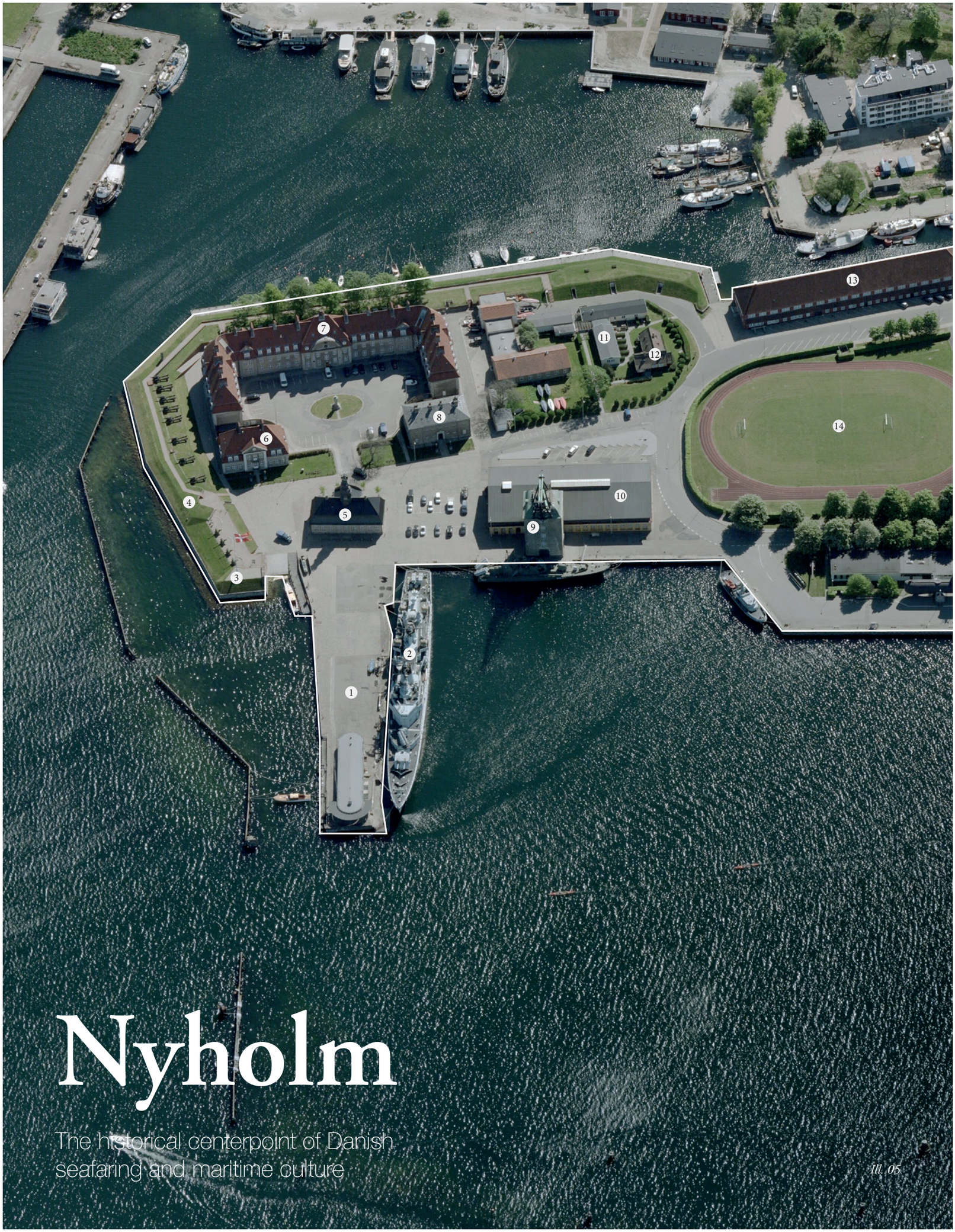
Adaptation/ In opposition to the preservation approach stands the vision of Nyholm as a new urban development with housing, retail and other common city functions. It is important to note, that the proponents of adaptation acknowledge the historical significance of Nyholm and agree that the history shouldn't be undermined by new development. The common viewpoint across all interested parties is that the northern half of Nyholm is ideal for a maritime museum and other functions contributing to the narrative of Nyholm. Those interested in adaptation consider the potential development to occur in the southern half of Nyholm, where the concentration of listed and preservation-worthy buildings is relatively lower. Apart from housing, several suggestions have been made regarding institutions such as a school or nursing home. The position of adaptation is characterised by a willingness to explore the potential uses, before settling on a specific direction. It is driven by concerns over the growth in population first and foremost but also a belief that housing, retails and institutions can bring life to Nyholm which will ultimately support and benefit the public functions.

There is inevitably a degree of adaptation involved with preservation - likewise, adaptation involves preservation. Could these seemingly opposing viewpoints birth a new common vision for Nyholm - one which is not focused on the presation of building heritage, but rather the preservation of a narrative and history while adding to and enhancing it through new development?

Ill. 04

002.

Site Analysis



Nyholm

The historical centerpoint of Danish seafaring and maritime culture

Ill. 05

The Atlas of Nyholm

Few places have a building heritage as significant as the one found on Nyholm. With a span of more than 200 years the current building heritage represents the evolving history of the Danish navy and the spaces they required for building and maintaining ships, storing materiel as well as housing, offices and education. The atlas of Nyholm serves to present the diversity of the current building mass.

05. Under Kronen/
The Main Guard House

1782 by Philip Lange
Originally used as a main guard house. Currently occupied by Georg Stage who has offices in the building

06. The Pavillon Building/
Administration Building

1910 Built by Valdemar Birkmand
As part of the barracks development

07. Militærbarakkerne/
The Naval Baracks

1910 by Valdemar Birkmand
Used for the barracks area, closed in 2000.

07. Militærbarakkerne/
The Naval Baracks

1910 by Valdemar Birkand
The home for the Naval Defence until 2000, where it was used as a "hotel" for the Defence

08. Nyholms Arrest/
The Jailhouse
1891 C.T Andersen
Built for barracks ships' arrest. After Holmen's relocation, the arrest has been used as a museum magazine

09. Mastekranen/
The Mast Crane

1751 by Philip Lange
Its purpose was to support the erection of masts at Holmen's naval ships.

10. Planbygningen/
The Plan Building

1741 - unknown architect
It could accommodate frames for warships, but in the later years it had been used as a gym for the Defence.

12. Radiostationen/
The Radio Station
1908 - KFUM
Called the "summerhouse". Built to house the "orlogshjem" and later it functions as a radiostation museum.

17. Søofficerskolen/
School of Navy Officers
1938 by Jens Klok and Holger Verner Sørensen
Originally used as the main officer school.

17. Søofficerskolen/
School of Navy Officers

1938 by Jens Klok and Holger Verner Sørensen
Same function as the main officer school.

22. Den Savtakkede/
The Saw-toothed
1940 - unknown architect
Originally used for workshops.

23. Søminekontoret/
Office of Sea Mining Administration

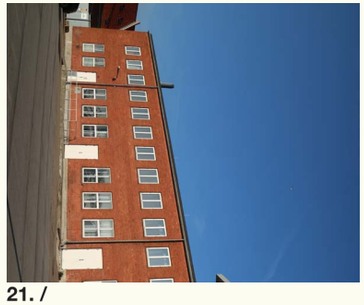
1778 - unknown architect
Office building for the department of handling passive mining equipments

24. Søminеværkstedet/
Sea Mining Workshop

1878 - unknown architect
Engineering Battalion's Marine Department, who had the task passive mining equipment and Navy Department which handle the active mining equipment.

21. /
The Naval Diving School
1911 -unknown architect
Functions today as part of the Diving school.

21. /
The Naval Diving School
1911 - unknown architect
Built to house torpedo boat equipments.



21. /
The Naval Diving School
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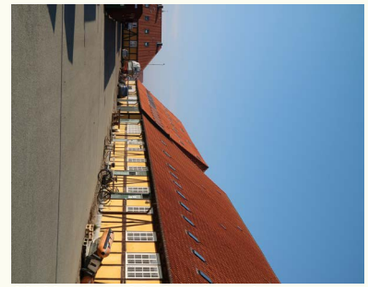


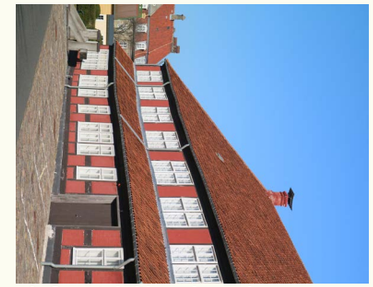
20. Vestre Takkelagehuse/
Western Rigging House
1729 built by Ole Judischær
when Nyholm's southern quay lay just here and the traffic to Frederiksholm was made difficult, in 1858 they removed the two middle bay, whereby a rail track was created right up to the Plan building.

20. Vestre Takkelagehuse/
Western Rigging House

2917 by Ole Judischær
Built to to store shipping goods

21. /
The Naval Diving School

Unknown date and builder
The diving school uses the sheds for large oxygen bottles



13. Spanteloftbygningen/
The Mould Loft Building

1741 by Philip Lange
Built to house chalups in the lower floor, while the ceiling should accommodate frames for new buildings.

18. Kontorbygningen/
The office Building

1801 - Unknown architect
Was supposed to among other things, houses The Director of the Naval Shipyard.

19. Østre Takkelagehuse/
Eastern Rigging House

1782 by Ole Judichær
Built in 1726 to house the Naval ship goods

The history **of Nyholm**

Similar to the surrounding city districts that served as naval areas, Nyholm was physically constructed in the 17th century by reclamation in order to relocate the Danish Navy away from the center of Copenhagen as the fleet of wooden ships presented a severe fire hazard. Nyholm was added to Holmen, a fortress city established around 1618, in 1690. Since then, the island has been home to the Danish Navy which makes it a significant part of the Danish cultural heritage. Nyholm is, more than any other harbour area in Denmark, the physical representation of Denmark as a maritime nation.

The purpose of the expansion of Holmen towards the north was to increase the size and quality of spaces to build large naval ships. In its early years only a few buildings were constructed with the purpose of building naval ships. The first ship launched from Nyholm was Dannebrog in 1692. In the 1720s, the fleet and three half-timbered warehouses were constructed with the purpose that the entire royal navy lay between Gammelholm and Nyholm in the safe harbor "Flådens leje" (Haugsted, 2015).

The island is home to several listed buildings, each with their own unique place in the history of Danish seafaring. The historical arrival point to Nyholm is the most secluded part of Nyholm today; ships arriving to the harbour of Copenhagen would dock in the northern end of the island - which was physically connected to the other side of the harbour near the Citadel - explaining the location of Nyholm's Main Guard House (Hovedvagten/Under Kronen). Immediately east of the Main Guard lies the Naval Baracks. To the North, the battery Sixtus and the Flag of the Kingdom is placed, where Dannebrog is raised every morning during saluting; a tradition that have existed since 1788.

Several of the iconic buildings of Nyholm have been designed by the architect and masterbuilder, Philip De Lange who designed many of the military, civil, church and industrial buildings of 18th century Copenhagen. After the destruction of the big fire in Copenhagen in 1728, Philip De Lange helped to rebuild the capital, and some of his most notable buildings are found on Nyholm, such as Hovedvagten, Mastekranen and Spantehuset (Nørregård-Nielsen, 2011)

1618/

Christianshavn is established as a fortress city in Copenhagen.

1690/

Nyholm is established through land reclamation at the northern end of the bastions of Copenhagen.

1692/

Dannebrog heads out as the first ship ever built on Nyholm.

1725/

The oldest remaining buildings, Østre and Vestre Takkelagehuse, are constructed.

1728/

The Great Fire of Copenhagen destroys large parts of the city including buildings on Nyholm

1730/

Philip de Lange, the masterbuilder of Copenhagen, begins construction on some of the most prominent buildings on Nyholm, such as Hovedvagten, Mastekranen and Spantehuset

1788/

The flag of the Kingdom, Denmarks official symbol of sovereignty, is moved from the Citadel to the southern tip of Nyholm.

1800/

Nyholm is expanded towards south. Prior to this, the island only reached as far south at Vestre Takkelagehus.

1910/

The marine barracks are completed in the northern end of Nyholm.

1940/

The modernist School of Naval Officers is constructed in stone, steel and glass and thus marks the one of few distinctly modern contributions to Nyholm.

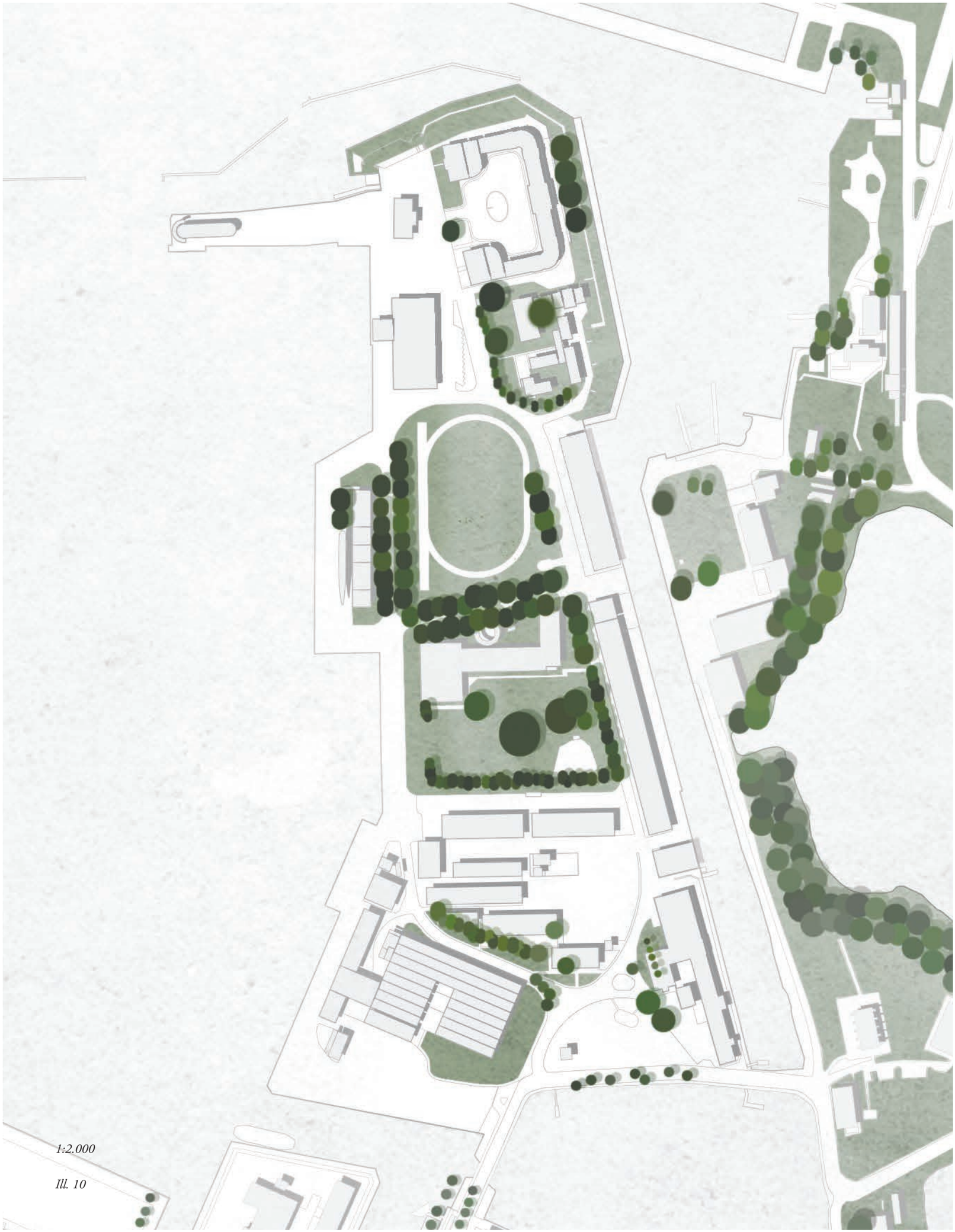
2023/

The Defence moves out of Nyholm and makes way for a public urban quarter.

Ill. 07_Painting of Dannebroge on fire at the battle of Køge Bugt, 1710.

Ill. 08_Vestre Takkeladshus, a half-timbered house, on Nyholm. One of the oldest existing structures on Nyholm.

Ill. 09_The Naval Harbour, as seen from the west. Mastekranen, can be seen in the background.



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Ill. 10

The heritage **of Nyholm**

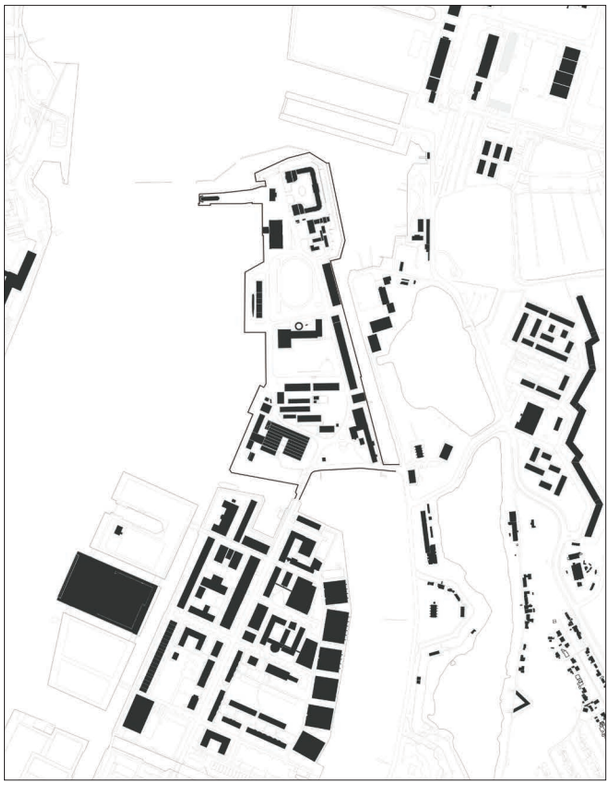
The building heritage of Nyholm has adapted to changing needs over time. The remaining buildings are thus a mix of buildings from different periods in time. Among the currently used buildings are the School of Naval Officers and the School of Naval Technology and Diving. These institutions will be relocated to other parts of the country following the Defence Settlement (Fmn.dk, 2018)

A few of the existing buildings and the frigate Peder Skram currently house museums that aim to disseminate the history of Denmark as a maritime nation. Peder Skram shows a selection of the history of the Navy's war activities from the 16th century to the Cold War. Denmark's first coastal radio station, built in 1908, is also located at Nyholm and run as a radio museum today. (Københavns nye åndehul, 2019) In addition, the active school ship Georg Stage is docked at the southern quay of Nyholm and has expressed a desire to stay and participate in the future development of Nyholm. Georg Stage hopes to have spaces for education and storage as well as smaller workshops to which they would have a more active presence at Nyholm. (Asser Amdisen, Manager - Georg Stage, 2017)

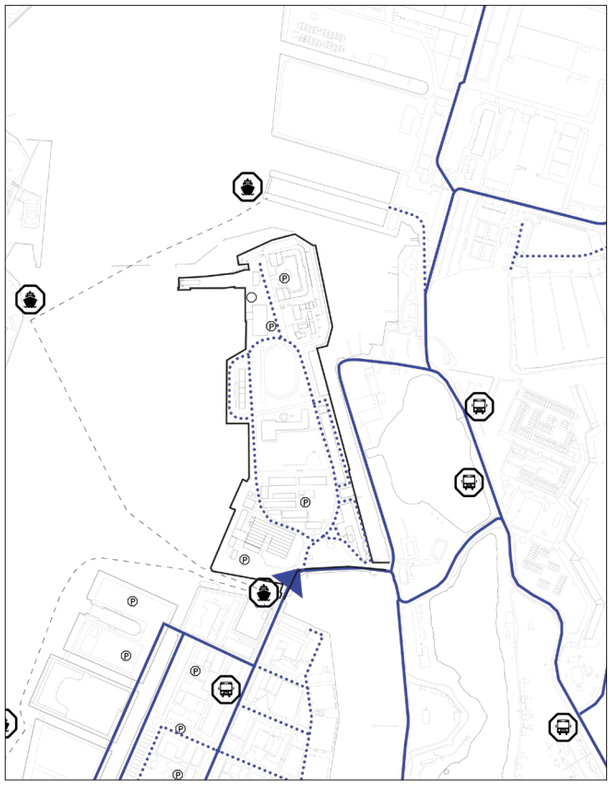
The entire area of Nyholm is designated as a preservation-worthy cultural environment by the Danish Agency for Culture and Palaces. All buildings, facilities, monuments and urban spaces are regarded as part of the unity that makes up this historical environment. The designation alone however does not provide any specific protection; it is instead the individual listing of significant buildings that offer protection against any future interventions.

Protected buildings/
Nyholm is home to a total of 29 buildings of which 22 are either listed or designated as "worthy of preservation". The latter category consists of further two subdivisions depending on their preservation value. The *listed* buildings are protected against any significant physical alterations. The buildings *worthy of preservation* are protected to the extent, that changes are possible only after they have gone through a public hearing. Their preservation value exists in their narrative potential as part of the overall understanding of the history and heritage of Nyholm. These buildings have held particular and significant functions throughout the history of Nyholm.

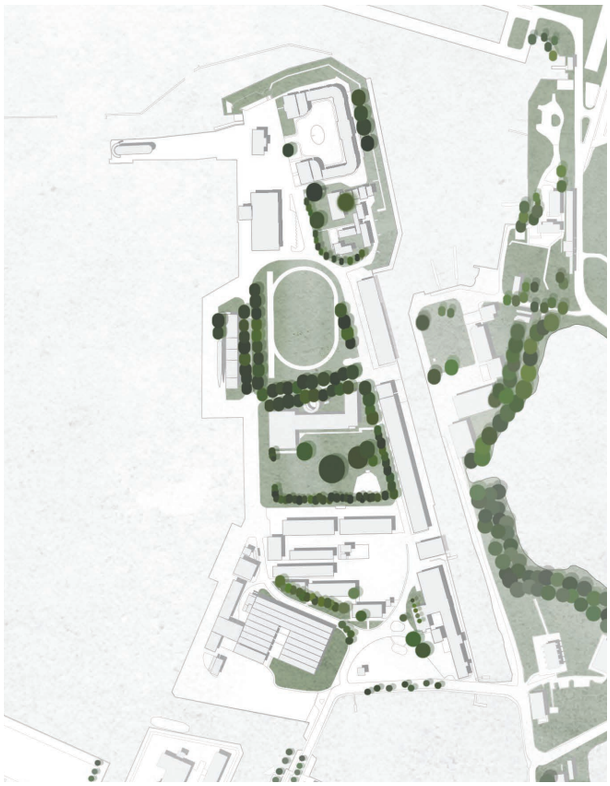
In principle, all buildings that are not listed or designated as worthy of preservation have an uncertain future. The placement of these buildings indicate potential areas for new development. We believe three areas have, to varying degrees, potential for new development. These areas are described in the following based on their potential. The descriptions are ranged by the expected scale of new development, starting with the area of smallest scale.



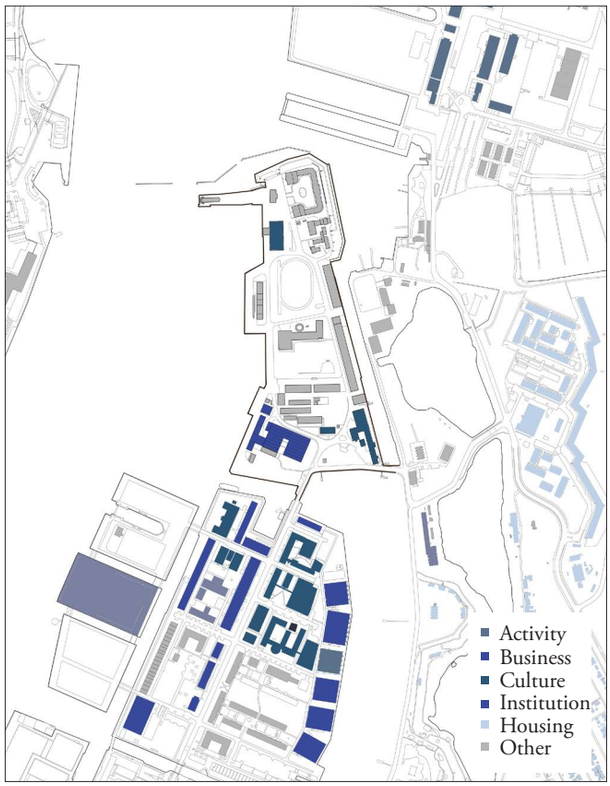
Ill. 11_Figure-ground map 1:5.000



Ill. 12_Infrastructure map 1:5.000



Ill. 12_Vegetation map 1:5.000



Ill. 13_Functions map 1:5.000

The maps **of Nyholm**

Urban spaces & density/
Over time, the layout of Nyholm has evolved into its current state which has a few but distinct organizing principles. All buildings adhere to one of three perpendicular grids; the building's located on the eastern guay of Nyholm are all arranged perpendicular to that quay while the same is true for the western building's and quay. The southwestern part of Nyholm, both quay and edge, are angled about 22 degrees clockwise compared to the almost directly north-south running quay and building's to the north. The rectilinear buildings are contrasted by several curved roads that create a more fluid and organic movement through the site.

The scale and density throughout Nyholm is fairly balanced although a few buildings distinguish themselves either through scale, form or material composition. A figure-ground analysis reveals a concentration of building volumes in the southwestern corner of Nyholm which is one of the areas identified as a potential transformation site.

Compared to surrounding city districts, Nyholm generally has a fairly low plot ratio, which is considered to be an important characteristic and quality of the site. Although varying throughout the site, the general plot ratio is comparatively lower than in the neighbouring district of Frederiksholm and the difference is even more pronounced when comparing it to other central areas in Copenhagen. The urban open spaces can be defined as either green areas, harbour front plazas or enclosed plazas. In addition, the scale of the spaces vary from small, intimate spaces to large, public ones.

The most noticeable harbour front plazas are located in each their end of Nyholm. In the northern part, a large plaza encircles Nyholm's Main Guard House and extends out onto the mole known as the Elephant. The second plaza, located in the southwestern part of Nyholm, is very open to the quay and thus have the potential of being a very attractive urban open space in any future plans. In addition to the harbour front plazas, one enclosed plaza in particular is interesting due to its location in the southern third of Nyholm and because of the downscaled building volumes that delineate the plaza.

Infrastructure/
Nyholm is situated between Refshaleøen, Holmen and Christiania and its part of Christianshavn. There is only one point of access to Nyholm, which makes it an important infrastructural node. Given the future transformation of Nyholm, assessing the infrastructural capacity of the island as a whole might have significant impact on the design of this point of access. When proposing new functions, it should be considered how pedestrian, bicycles and cars will arrive at Nyholm, in the case of both visitors or residents. Nyholm is currently not affected by the congestion problems of inner-city traffic of Copenhagen which is positive with regards to the noise level of the area. Finally, the site has easy access to public transport possibilities such as harbour buses and regular buses.

Vegetation/
The green spaces make up about a quarter of the surface of Nyholm. In addition to Henrik Gerners Plads in the southern end of Nyholm, the largest green spaces are found centrally on Nyholm. Marsmarken, with the characteristic running track, and the green area on the southern side of the Royal Danish Naval Academy, constitute the majority of green space on Nyholm. Both areas are bordered by vegetation which provides it with a sense of enclosure. The final significant green space is found in the northeastern corner of Nyholm; the raised rampart known as the Battery Sixtus stretches from the Flag of the Kingdom, around the Naval Baracks, and all the way down to Spanteloftbygningen. A gravel footpath runs on top of the rampart most of its length which makes it accesible to pedestrians.

The planting at Nyholm is an important part of the island's character. The chestnut tree avenues in the middle of the island emphasize the order of the overall layout and are protected because of their significance. The trees contribute to the perception of different axes and lines of sight.

Functions/
The site is located in a very recreational and cultural area with the Opera to the southwest and Refshaleøen with many different activities to the north. The primary functions on Nyholm and around, are business and institutions. These include The Royal Danish Academy of Fine Arts as a neighbor to Nyholm. Creative companies like 3XN, Vandkunsten and C.F. Møller are also located here. The housing area relates mostly to Christiania, which is a free town, where around 1000 people are living in small homemade houses and sheds. (Christiania.org, n.d.) This is a great contrast to the otherwise very structured society that exists at Christianshavn.

The atmosphere **of Nyholm**

300 years of naval history has turned Nyholm into one of the most unique and culturally important sites in Denmark. It has a central place in the history of Danish seafaring and shipbuilding, which, over time, has produced a distinct building heritage. The atmosphere of Nyholm is the result of a complex juxtaposition of elements, architectural and urban, that overall create a distinctive, historical and cultural environment. Although some elements can be intangible, the following chapter examines the individual elements of Nyholm in order to assess the unique qualities present on this site.

Arrival & flow/
Nyholm is connected to the neighbouring districts by two roads attaching to the southern edge of the island. One road, Danneskiold-Samsøes Allé, connects Nyholm to Christianshavn to the south.The second road, Kongebrovej, is an extension of Krudtløbsvej and Refshalevej, which connects nyholm to either Refshaleøen to the northeast or Christiana to the southeast. The intersection of Danneskiold-Samsøes Allé and Krudtløbsvej mark the only entrance to Nyholm, from where the road continues 50 meters into the site.

The singular point of entry to Nyholm signifies the importance of the southern buildings and spaces as a marker of Nyholm's identity and atmosphere. On the eastern side of Danneskiold-Samsøes Allé lies the semi-circular lawn, Henrik Gerners Plads, which opens up the area and organizes the buildings around it. The building's that encircle Henrik Gerners Plads appear very homogenous in materials, colors and scale. The buildings to the west of Danneskiold-Samsøes Allé (01), the nearest one being the saw-toothed building which is part of the aforementioned semi-circular arrangement of buildings, have a more diverse appearance with differences in geometries, colors, materials, patination and so on. The area is very open with the closest building being approximately 45 metres from the edge of the quay.

When entering Nyholm from Danneskiold-Samsøes Allé the road takes an s-curved path around the office of the Sea Mining Administration. The road then continues north, now named Spanteloftvej, before turning 180 degrees around the running track and returning south again (Henrik Spans Vej). The road turns east just before the "Saw-toothed" building (01) and short after intersects Danneskiold-Samsøes Allé again, thus concluding the elliptical loop that defines the distinct and organizing flow of Nyholm.

Views/
The primary road(s) of Nyholm form an elliptical shape which is stretched along a north-south axis. This creates straight roads running north-south on Nyholm, which offers views of almost 300 meters on the island along both Henrik Spans Vej (03) and Spanteloftvej (05). Perpendicular to these roads are a number of smaller roads and sightlines, that provide views across the island and over the inner harbour of Copenhagen. The southernmost of these two east-west running roads is Takkeladsvej (04), while the northenmost is H.C. Sneedorffs Allé (06). The latter in particular offers a unique view across the harbour to the Marble Church. Several of the more

01/

02/

03/

04/

05/

06/

Ill. 15

prominent views throughout Nyholm are further emphasized by symmetrical rows of large chestnut trees.

The western quay edge on the island is completely open, offering great views across the inner harbour of Copenhagen. From this side of Nyholm it is possible to see the Opera House to the south as well as Amalienborg, the Marble Church and the Citadel to the west. The northeastern harbour fronts of Nyholm are bordered by the Battery Sixtus, a rampart and several canons. From here there are great views to Refshaleøen and northen Copenhagen. Contrary to the western edge of the quay, the eastern quay appears more closed off, although all points on the quay are accesible. The urban spaces here are more narrow and defined due to the buildings running parallel to the 25 meters wide canal (02).

The layout of Nyholm repeatedly provides views towards the inner harbour west of the island, which also highlights a variance in building density on the site; particularly the central part of Nyholm is perceived as open but also the northern part has a lot of free space between the buildings. The southern end on the other hand is more dense which consequently results in shorter sightlines and less views to the harbour.

Materials & colors
The color palette of Nyholm is distinctly, traditional Danish with the majority of facade colors spanning from a light yellow to a deep red (0). The effect of these warm colors are quite significant on the perception of the atmosphere, which is particularly evident in the dense areas of Nyholm such as the small plaza south of Vestre Takkelagehus.

The materials used on Nyholm share the qualities of the warm colors; bricks, timber and tiles are very tactile materials which speak to more than just the visual sense. In the case of plaster surfaces, which is found on the facades of the half-timbered houses, bright red and yellow colors, as well as the visible timber elements, are utilised to create warm and appealing surfaces. The most common facade material is the pale, yellow brick used for buildings in both the north and the south of Nyholm. These bricks are paired with either red roof tiles (in the north) or dark grey roofing felt (in the south). The red roof tiles are similarly the most common roofing material which, in the presence of mostly pitched roofs, becomes a very visual characteristic of the physical environment.

The clear dominance of warm colors and tactile materials, as shown in the pictures on the left, create a particularly sensuous environment. However, an important aspect of this quality is undeniably tied to the patina that all surfaces have gotten over time. The quality of aging can be seen in the oldest buildings as well as those buildings that have received visual maintenance over the years. These buildings bear marks of time that are unique to each building.

The architecture **of Nyholm**

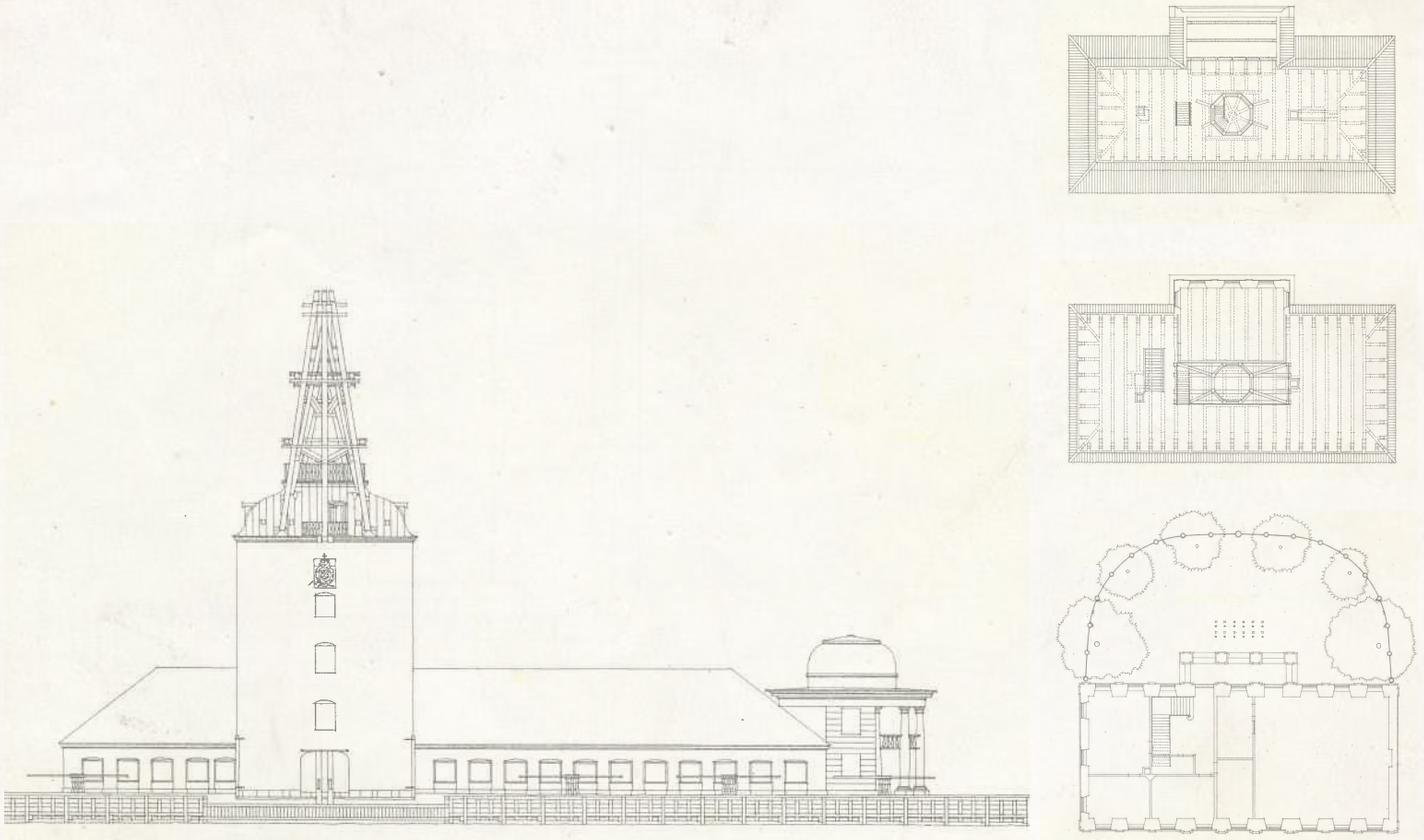
The architectural legacy of Nyholm can for the most part be ascribed to the ideas and craftsmanship of Philip de Lange. Influenced by the prevailing architectural traditions and style of the time, de Lange built some of the most iconic buildings of Holmen after baroque ideals. Perhaps the most stylistically pure, Hovedvagten (the Main Guard House) is a prime example of the defining characteristics of baroque. Hovedvagten was built next to the Sixtus Battery in 1744, and was the first significant solid brick-building on Nyholm. It represents the beginning of an extensive reorganization and expansion of Holmen's area during the following decades. The building is classic baroque style and characterized by its roof and the spire with a royal crown on the top, which represent the Danish Navy and Kingdom. The roof and crown are oversized in relation to the building's scale in order to symbolically assert the historical and military value of the building. The symmetrical exterior has a steady rhythm as expressed by the equally distanced windows and pilasters.

Another important contribution of Philip de Lange is the iconic mast crane which was a functional structure used to raise the masts of ships. The mast crane is the tallest structure on Nyholm and a landmark for the surrounding area. It consists of a wooden structure encased in a brick-shell. The timber crane was a particularly inpressive example of engineering work at the time of its construction. In order to emphasize the height of the structrue, a vertical window band is present on each facade.

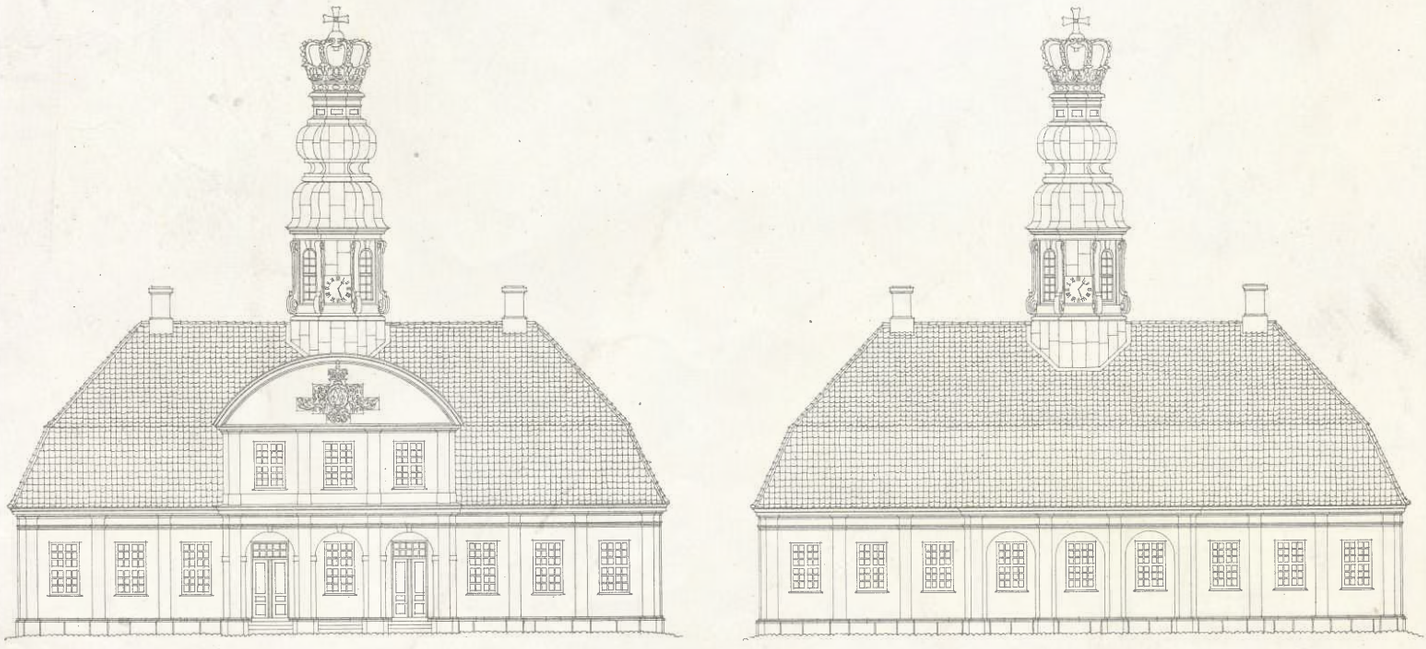
The oldest existing buildings on Nyholm are the half-timbered houses known as Østre and Vestre Takkelagehus. Both buildings were constructed around 1725, thus pre-dating the great fire of Copenhagen in 1728. The devastation caused by the fire resulted in the gradual phasing out of half-timbered houses in Copenhagen because of the fire risk they posed. These buildings are characterised by their massive, over-dimensioned hipped roof clad with red tiles that rest on a relatively low exterior wall. The scale and materiality of the buildings produce a very humane gesture to the space around it.

Some of the later additions to the architectural heritage of Nyholm include the School of Naval Officers, which was built in 1939 and the torpedo workshop, commonly referred to as the Sawtooth, which was finished around 1951. The School of Naval Officers is a distinctly modern building; both formally and materially distinguished by the new design aesthetic of the mid-19th century, the building adds to the architectural diversity of Nyholm. The same applies to the industrial typology of the Sawtooth building, which adopts a more functional approach to form.

The architectural landscape of Nyholm is a strangely balanced composition of different formal expression and construction types. The buildings span a period of more than 200 years and thus include a number of different architectural styles. Still, the buildings are perceived as



Facades and plan Mastekranen: 1748 (original drawings)



Facades of Hovedvagten: 1744 (orginial drawing)

Ill. 16

The climate **of Nyholm**

Examining the microclimate of Nyholm provides insight into the optimal approach to the design of urban and interior spaces. Microclimatic topics include wind, sun, precipitation etc. The following section will explore the specific conditions of Nyholm by topic.

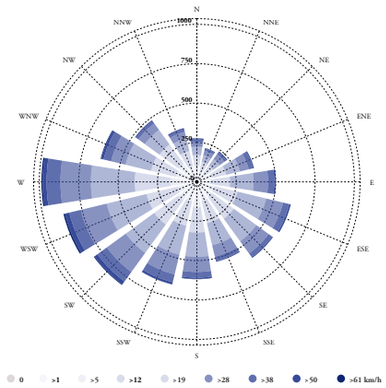
Wind rose/
The wind rose is a visual representation of the predominant wind direction, frequency and speed measured in Copenhagen. The dominant wind direction is west with a fairly even distribution of measured wind speeds. The variation in wind direction is however also significant when observing wind directions between west and south.

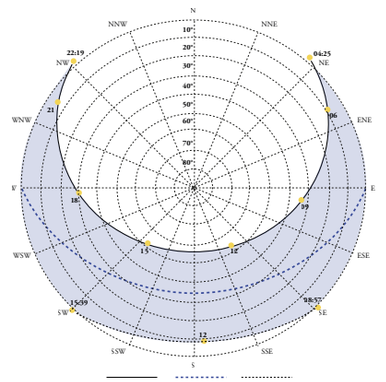
Understanding wind directions, frequency and speed can aid the design of comfortable outdoor spaces. In a cold climate, such as the Danish, avoiding harsh winds is typically favourable. Given the exposure of Nyholm towards the inner harbour of Copenhagen to the west, designing for shelter by addition of building volumes or vegetation can be a sound microclimatic strategy.

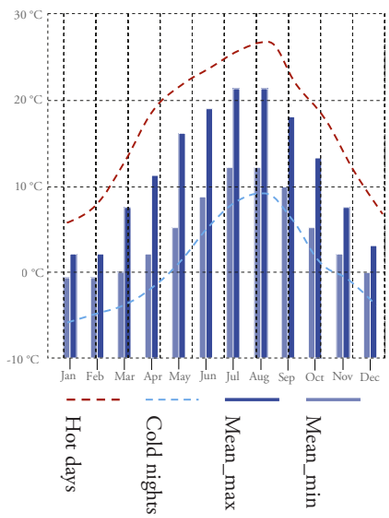
Another consideration with regards to wind is the positive contributions it can have on indoor climate. Creating a natural ventilation strategy means working with the prevailing wind direction to improve the thermal and atmospheric indoor climate.

Sun diagram/
The sun diagram illustrate the angle of the sun and path over Copenhagen during a year. The sun is an essential parameter when designing buildings and outdoor spaces. Solar heat gain is one example of the passive strategies that can be integrated in the building design. Furthermore the sun is important when designing outdoor spaces, people are attracted to sunny spots therefore making solar radiation and shadows studies are important to inform the project. On the other side the sun can also have negative consequences, such as overheating plobems during the summer. Strategies about building enevelope, material choice and orientation should be integrated in the sketching phase. The use of the sun path is also relevant if we want to apply active strategies such as photovoltaic panels to the project.

Temperature chart/
The temperature charts illustrate the temperature levels and fluctuations in Copenhagen on a monthly basis over a year in 2018. The range of the temperatures is between -1 °C and +4 °C in the three coldest months, December, January and February. In the summer months June, July and August, the average maximum temperature is 20 °C. Considering the higher temperatures in the design of the buildings is important in order to avoid overheating in the summer period. At the same time, the relatively low temperatures in the winter period can be countered by the integration of passive solar heat. Temperatures and the sun path along with knowledge about the wind direction can also contribute to create good outdoor spaces between the buildings.

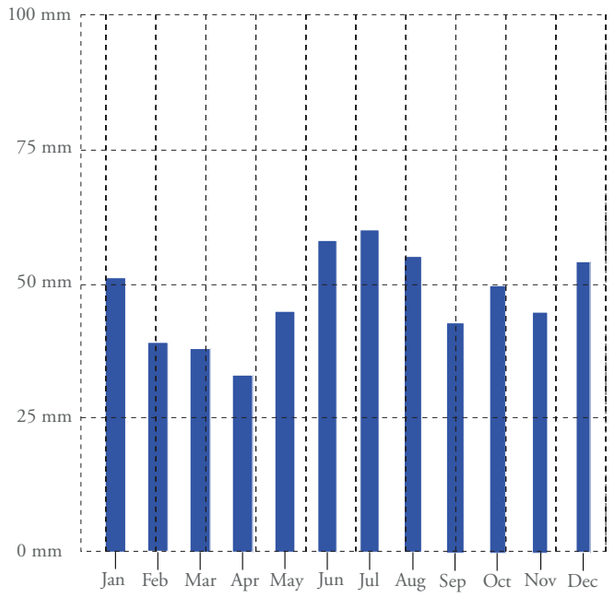




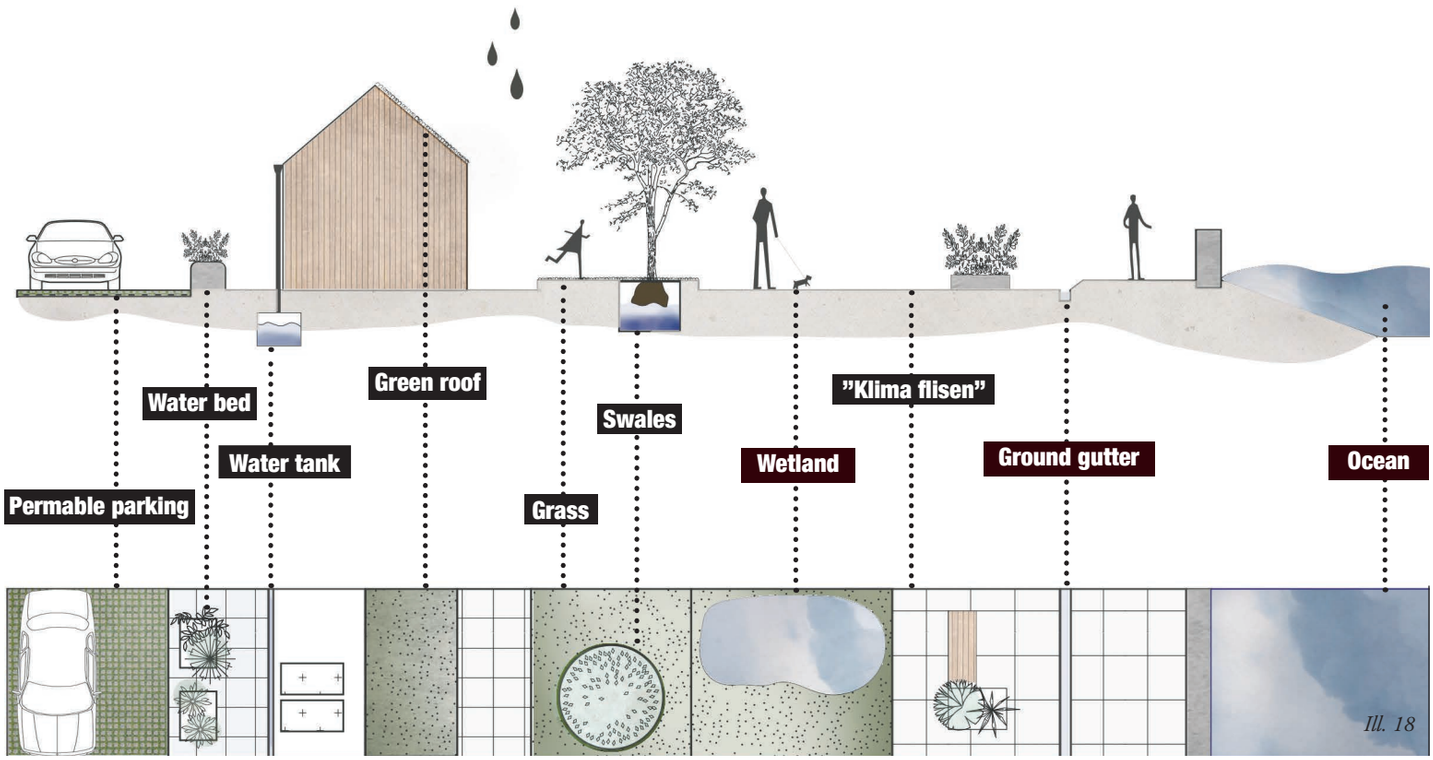


Ill. 17_Microclimate data

Precipitation/
The precipitation chart illustrate the avarage precipitation for Copenhagen on a monthly basis over a year. The chart shows that the majority of precipitation falls in the months of June, July and August. This could influence the use and quality of the outdoor spaces. The municipality of Copenhagen works with different strategies of rainwater management in order to limit the effects of storm surges in the future. Green environments between the buildings can help handle local rainwater as well as reuse the rainwater in the building.



Local drainage of rainwater is a way of climate adaptation, which results eliminating sewage systems when there is a lot of precipitation in a relatively short time. LAR is a creative solution for how rainwater can be handled in different contexts. For Nyholm, an urban context applies with many urban spaces. Climate tiles by TREDJE NATUR will be applied to collect rainwater from sidewalks and roofs and will be used as a resource in the urban space. The climate tile has small puncture in the tile and via integrated pipes the water is transported to the desired collection point or to green areas. Water flower beds and green areas functions as the tiles to infiltrate and delay the water. Ground gutter is drain in the street and is ideal in an urban landscape near the water, where the rains run directly out to the harbour instead of overload the sewer system.



Ill. 18

The regulations **of Nyholm**

The Municipality of Copenhagen continuosly seeks to develop the city by addressing the demand for housing, improving the harbour front of the inner city and making policies for the creation of quality architecture in the future. Therefore, these themes are highlighted in relation to Nyholm, in order to be able to apply this knowledge as design strategies.

The Harbour
In recent years, Copenhagen's inner harbour has developed into a more active urban space with the addition of several residential, commercial and cultural projects with different characters and activities. In addition, the infrastructure for cyclists has been radically upgraded, thus creating better links between the different neighborhoods.

The harbour front of Nyholm is - compared to surrounding districts - fairly underdeveloped. A harbour boat connection from the water between Nyholm and Christianshavn is currently the only connection in the area. The potential transformation of the northern part of Nyholm makes a boat connection to this area an interesting possibility which would support the aim of attracting more people to the island while integrating it better with the rest of the inner harbour. The Municipality of Copenhagen has also presented the idea of a guest harbour in the southern part of the island, which could contribute to and continue the maritime identity of the area.

Architecture policy
The main focus of the architectural policy of the Municipality of Copenhagen is the people; creating urban life before spaces and buildings is a declared aim of the Municipality (Teknik- og Miljøforvaltningen, 2017)

The architecture policy in relation to Nyholm is about creating new architecture based on Copenhagen's identity and building on the cultural values with a contemporary stamp. An interpretation that focuses on the architecture telling and strengthening when new is built. The story should not only be told in the present, but also in the future and therefore it is important to see the story as a linear axis that continues and not just stops when the buildings have earned their usual function.

The Local and Municipality Plan
The local plan 331 for the area includes Nyholm and additional places around Holmen. The area should, according the local plan, allow for a mixture of everyday life combined with the recreational and living history.

The local plan merely supports the purpose of transforming the naval military area into an attractive integrated urban area where emphasis should be placed on Nyholm's cultural-historical buildings and not least the architectural character. In the local plan, it is further described that the building percentage must not exceed 60 %. (Københavns Kommune, 2012) However, it requires a change and supplementation of the local plan in order to be able to transform and construct new buildings at Nyholm. Therefore

Architectural Policy of the Municipality of Copenhagen, 2017-2025 (Kulturministeriet, 2017)

01/
More activities in and on the water

02/
More places of residence and better access to the water

03/
Better routes and connections

04/
Events and temporary use

05/
Focus on water quality and the nature of the harbour

06/
The narrative harbour

"The word architecture comes from Latin and means building art. But the concept of architecture does not cover only buildings. Architecture is also urban planning, landscapes and gardens on the large scale and design of utensils and spatialities in the small scale. //..// Architecture is created to meet a practical need - such as the need for a place to stay or occupation. At the same time, there is an artistic purpose in architecture. Architecture is a processing of space, volume, fabric, colors, light and sound to achieve a certain aesthetic expression."

(Red, Dansk Arkitektur Center, n.d.)

Ill. 19

a unifying strategy for the area is needed, since the Defence currently owns and manages the functions in the area.

When looking more closely at the municipal plan for and the local plan, it becomes apparant that the two regulation plans conflict with each other. The former sets the plot ratio at Nyholm 110%. However, both documents are subject to change if any plans are pushed to the front of the political agenda.

In line with the development of Nyholm, it is difficult to predict how large an area is to be used for new buildings. Both the local plan and the municipality's plan are not planned for the future, therefore it is necessary to examine the percentage of buildings and establish hypotheses so as to qualify scale, spatialities and connection between new and old.

Furthermore, a design parameter will be to create an urban area in connection with the water, to make it an attractive harbour environment, which can be used both for the residents of Nyholm but also by visitors.

The people **of Nyholm**

In order to create a socially sustainable urban development, knowledge must be gathered on the future users of Nyholm and the surrounding area. The demographic composition of Copenhagen has already been covered in a previous section; therefore, the following examination will focus more on the specifc wishes of two main user groups; 1) families and 2) couples and singles.

Families
In general, modern families have a busy work-life structure where most parents are working from 8-16 between Monday and Friday and the children are in institutions. Therefore, it is important to emphasize the living spaces within the apartments in order to create good conditions for social interaction. The orientation of the apartment is preferably towards the south or southwest, as this provides heat and light from the afternoon sun for the living spaces and balconies. In general, family apartments should have a size of 90-100 m2 with a minimum of two rooms. Flexibility of the room distribution is beneficial to expand the lifetime for the families, because when the children gets older and moves to their own places, it should be easy to adapt the spaces to a new purpose in relation to the family's particular life situation.

Couples and singles
Couples and singles share some of the needs described for the families. This category can be further subdivided into a category of low income and one of high income. The location of Nyholm in the center of the Inner Harbour of Copenhagen will likely result in a high m^2 price for apartments, townhouses or similar housing typologies. Because of this, creating a new housing development for an upper class target group might be sensible as they have the economic capital to pay for such a location. However, aiming for a socially diverse area will necessitate additional housing typologies for low income groups. Considering how to combine these groups on a relatively small area is essential to create a socially sustainable development.

Addressing a low income target group might entail housing typologies such as dormitories, where residents share some common areas and other facilities. These co-living concepts also provide social benefits. Analysis of the co-living trend show that people who lives in shared communities would like to share kitchen and they do not have the same need of space, if they have common areas, where they can socialize. (Oneshared, 2019)

Common for the new housing development, is that we must accommodate housing types that are demanded by our target users. We want to create good indoor environments with high requirements to indoor climate. This will be expressed in materiality, functionality, viewpoints and flow in and around the housing development.

We address to users, across age, who want to take part in the maritime environment where there is the opportunity to have their boat, use the harbor basin for sport activities, use shared attractive outdoor space and take part in the common workshop areas, in order to create a new community at Nyholm.

people who are of all ages, and are in any life situation, from all countries, on average

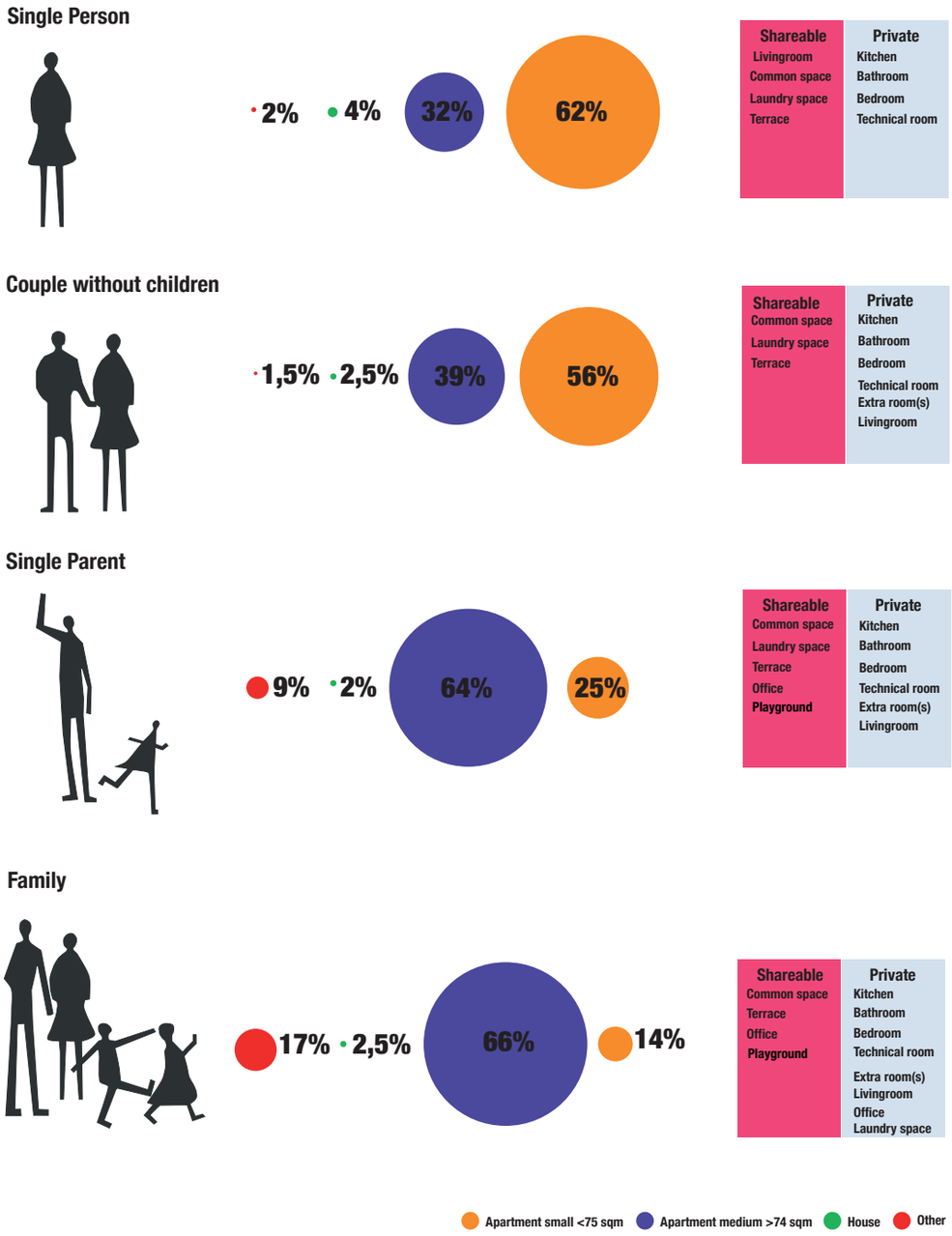
prefer to live in the city

want house-members from different walks of life

would rather have set private and communal spaces with clear boundaries of use

are most comfortable sharing internet, self-sustainable garden and workspaces

(Onesharedhouse, n.d)


Single Person
2%
4%
32%
62%
Shareable
Livingroom
Common space
Laundry space
Terrace
Private
Kitchen
Bathroom
Bedroom
Technical room
Couple without children
1,5%
2,5%
39%
56%
Shareable
Common space
Laundry space
Terrace
Private
Kitchen
Bathroom
Bedroom
Technical room
Extra room(s)
Livingroom
Single Parent
9%
2%
64%
25%
Shareable
Common space
Laundry space
Terrace
Office
Playground
Private
Kitchen
Bathroom
Bedroom
Technical room
Extra room(s)
Livingroom
Family
17%
2,5%
66%
14%
Shareable
Common space
Terrace
Office
Playground
Private
Kitchen
Bathroom
Bedroom
Technical room
Extra room(s)
Livingroom
Office
Laundry space
Apartment small <75 sqm
Apartment medium >74 sqm
House
Other

Ill. 20

003.

Design Framework

Framework

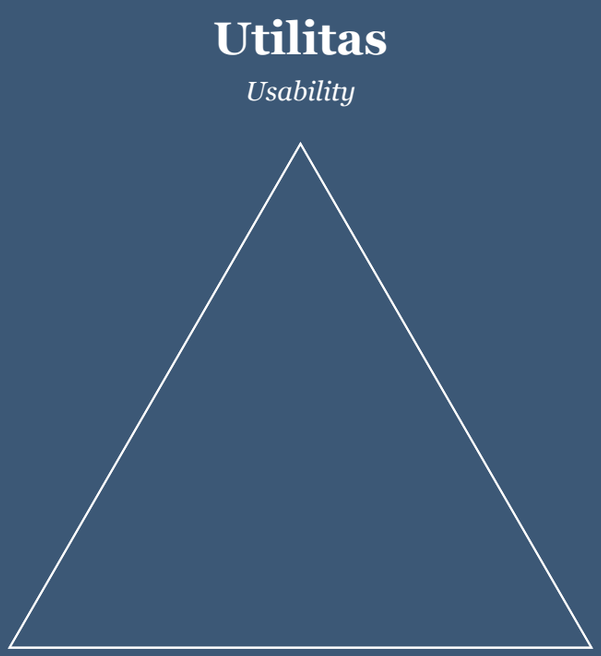
Adaptive reuse is one of many terms used to describe the act of intervening in an existing structure with the purpose of infusing it with new life through one or several new functions. Consequently, adaptive reuse can be interpreted as a an expression of the first virtue in the Vitruvian Triangle, usability. The following text will present the practice of adapative reuse more broadly in order to understand the implications of transforming buildings.

The Vitruvian virtues originated from the Roman architect and author, Marcus Vitruvius Pollio, who contended that all buildings were based on three universal qualities; utilitas - usability, fimitas - durability and venustas - beauty. Each virtue represent part of a an architectural unity, inseparable from the other constituents. The quality of the structure in its totality is derived from the interaction between the three virtues and should thus be considered as mutually codependent. However, for the sake of understanding the relationship between the three virtues, an exploration of each is first needed.

Utilitas/
Utilitas, or usability, represents the architectural elements that influence the functionality of the building. As such, it requires a fundamental understanding of the specific building typology at hand as well as the context in which it is situated. Contextual considerations are not limited to the physical characteristics of the surroundings nor the climate; rather, it is a complex issue related to the cultural environment in which the building is situated. Such considerations will vary over time and a present-day interpretation of the usability of a building will have to factor in the complexity of contemporary society.

Firmitas/
Firmitas, or durability, is more closely related to the construction and maintenance of a building and its ability to withstand the impact of time. While it has historically been concerned mostly with the physical construction of buildings, durability is becoming increasingly important - and complex - in the context of climate change. Furthermore, firmitas is not limited to the structural durability of a building. It is highly dependent on the other virtues of the Vitruvian triangle. This relationship is also addressed in current discussions on sustainability; can a building be durable if its not functional or beautiful?

Venustas/
The final virtue, venustas, or beauty, is perhaps the most dynamic of all three considering the aesthetical preferences of different cultures in place and time. The original notion of beauty however, was one of universal and eternal principles for the creation of beauty. Vitruvius believed in mimicking natural order in the pursuit of beauty; specifically, ideals for proportions, light, texture and patterns were aspired to. Contemporary society holds it own coneptions of aesthetics not necessarily in line with the ideals of Vitruvius. Additionally, the complexity and subjectivity of aesthetics might mean that beauty might be subject to change depending on the physical context of a building.



Ill. 21

Adaptive reuse

Utilitas

Adaptive reuse is one of many terms used to describe the act of intervening in an existing structure with the purpose of infusing it with new life through one or several new functions. Consequently, adaptive reuse can be interpreted as a an expression of the first virtue in the Vitruvian Triangle, usability. The following text will present the practice of adapative reuse more broadly in order to understand the implications of transforming buildings.

Restoration or Conservation/

Although the traces of adaptive reuse reach far back in time, the debate - ongoing to this day - over methods for adaptive reuse was primarily formed through the works of Eugéne Emmanuel Viollet-le-Duc in mid 19th century Paris. Viollet-le-Duc represented the style of restoration, an approach intended to restore the parts of a building to their own, original style: (quote) The implications of restoration, as expressed by Viollet-le-Duc, proved to be highly controversial, although the definition met approval in France, the USA and other European countries. Among the most influential critics were John Ruskin and William Morris, both involved in the early modern conservation movement in England and advocates of a conservation approach to building heritage. In *The Seven Lamps of Architecture*, Ruskin states that restoration "means the most total destruction which a building can suffer..." while Morris' consolidated authenticity of heritage as an inclusion of additions and alterations. Ruskin and Morris' message of maintenance and repair as an alternative to the restoration approach of Viollet-le-Duc resonated with architects, artists and writers throughout Europe and thus created a polarization of viewpoints on the issue of heritage preservation.

"To restore an edifice means neither to maintain it, nor to repair it, nor to rebuild it; it means to reestablish it in a finished state, which may in fact never have actually existed at any given time."

- Viollet-le-Duc

Athens Charter 1931/

As the debate over the preservation of heritage continued over the next decades, theories on preservation matured and became increasingly nuanced. The recognition that the continued existence of buildings was premised on an intervention that extended beyond mere maintenance and repair was particularly important to following developments in the field of preservation. In addition, the notion of heritage, and thus the extent of protection, expanded significantly and raised questions on preservation values that still exists to this day. How do we define heritage? What do we preserve? And, equally important, what do we not preserve?

The devastations of World War I underlined the importance heritage preservation. Through the League of Nations, an international organization established directly after World War I to promote peace and international cooperation, the Athens Charter of 1931 was enacted, which was the first international policy on conservation. The Charter established the modern practice of adaptive reuse as we know it by acknowledging the importance of continuity and functional purpose in the reuse of historical building. Furthermore, it stated that new design intervention must introduce modern materials, where it is not possible to reinstate any original fragments of the building.

"Let them take the greatest possible care of all they have got, and when care will preserve it no longer, let it perish inch by inch."

- John Ruskin

"... the Venice Charter - by requiring us to make distinct the breach between the past and present, has likewise often caused the spirit to fly from old buildings and places."

- Prince Charles of Britain

"Preservation is overtaking us."

- Rem Koolhaas

Ill. 22_Tate Modern London/ Herzog & de Meuron, 2000

The Venice Charter 1964/

More than 30 years and a second world war later, the principles of the Athens Charter were reexamined at a United Nations Congress in Venice which further contributed to international policy on conservation. The new charter was partially inspired by the theories of Cesare Brandi who, in the preceding year, had expanded the notion of restoration by differentiating between the restoration of industrial products (also termed common objects) and works of art. The Venice Charter solidified the importance of these common objects by widening the definition of monuments to include modest and socially useful objects or buildings. In addition, the charter stated about design interventions that "any extra work which is indispensable must be distinct from the architectural composition and must bear a contemporary stamp," thus providing a solid mandate for the distinctively modern design interventions and additions which have defined adaptive reuse practice until today.

Conclusion/

The historical development in preservation practice provides an insigth into the underlying assumptions of contemporary approaches to adaptive reuse. Firstly, the wording of the charters is significant; by recommending a distinctive and contemporary design intervention, the charters created a platform for architects to combine the aged aesthetic of historical buildings with contemporary materials and building techniques. Secondly, the architectural ideals and aesthetic preferences of 20th century modernism came to be associated with adaptive reuse practice. Concrete, glass and steel, the marks of contemporary design at the time, became inseparable from such projects, which might explain the predominant use of these materials in adaptive reuse projects until this day. These assumptions create adaptive reuse projects founded on contrast and distinction. Current trends in architecture however show a growing inclination towards natural, tactile materials and contextual, human-oriented design. These ideals are also supported by the growing consideration of social and environmental sustainability in architecture, thus begging the question, if a new aesthetic could come to redefine the practice of adaptive resue.

In addition to the aesthetical implications of the charters of Athens and Venice, the inclusion of modest and socially useful objects or buildings in the realm of conservation has had a significant influence on the practice. It raises questions over the extent of preservation today, which is broadening by every passing day. In the book *Preservation is Overtaking Us,* Rem Koolhaas argues that there is an increasing fascination with historical buildings and monuments and that this fascination drives us to preserve buildings without substantial quality. Is this trend expressing a romantical inclination to preserve history? Is it related to the increased resourcefulness of the sustainable agenda? And finally, is heritage preservation limiting our capability to create architectural and cultural value of our own time?

Sustainability

Firmitas

The discourse on sustainability in the field of architecture has generally related to the consumption of energy and material resources. Sustainability as a concept is however hard to delimit as the implications of construction reach far beyond the environmental impacts. The social and economic dimensions of sustainability also contribute siginificantly to a building's sustainability. Although firmitas is commonly associated with the construction and duraility of a building, the second of Vitruvius' virtues is more appropriately related to the pursuit of holistically sustainable architecture in a contemporary context.

The importance of sustainable design practices is hard to overstate given the critical state of the natural environment around the globe. International efforts have been intensifying over the last decades with several landmark agreements, such as the Paris Climate Agreement, pushing the sustainable agenda to all parts of the world. Still, most efforts to combat climate change are restricted by concerns over the economic consequences of regulating the energy sector and the consumption-driven economic model that has provided the western world with a historically high income level. Rethinking the consumption-driven and wasteful economic model that has come to define most industries and products is critical to the pursuit of true sustainability.

In addition to national legislation on energy consumption, which has become increasingly ambitious over the last decades, several voluntary certification systems have pushed the building industry towards higher standards of sustainable building design. One such certification is DGNB - a non-profit organization working to promote sustainable practices in the Danish building industry. DGNB is based on the three pillars of sustainability defined in the Rio Declaration of 1992, environmental, social and economic, with the addition of two categories specific to the building industry; technical quality and proces quality. The scope of this project does not include all DGNB-criteria but use those that are relevant to the specific design task. Two different weighting systems exist in the DGNB system; one for buildings and one for urban areas. Creating a holistically sustainable and *durable* architecture is achieved by complying to current Danish legislation on energy consumption and indoor climate but more importantly, using the criteria and tools of the DGNB certification to optimize the building design with regards to more complex issues such as the embodied energy of materials as well as the social and architectural dimensions of sustainability.

Environmental sustainability/
The operational energy consumption of buildings have been the primary focus of past efforts to reduce the environmental footprint of buildings. Improvements in building products and construction knowledge has resulted in a drastic reduction in operational energy consumption of particularly new buildings. As a consequence, energy consuming processes prior to and after the operation of buildings have become increasingly important to the overall energy consumption. The energy em-

bedded in materials have been of little significance in the past but has become an important aspect of the environmental profile of buildings due to the reduction in operational energy consumption. Although not currently addressed by the Danish Building Regulations, life cycle analysis - which is a calculation tool for the embodied energy of materials - is an important measure in a DGNB certification. Research into the embodied energy of materials and buildings, along with important innovations in material production, have created a significant shift in the conception of sustainable architecture. Working with this knowledge and exploring new approaches to the sustainable aesthetic is essential to the construction of sustainable architecture.

Social sustainability/
Although much attention has been given to environmental sustainability, the other dimensions are of equal importance to a balanced development. The weighting system in DGNB reflects this equality as both the environmental and social - as well as the econimocal and technical - constitute 22.5 % of the total DGNB score respectively. The final 10 % is attributed to the category process quality. Social sustainability in the DGNB certification is measured differently on a building scale and an urban scale. The criteria related to a building scale include evaluation of the thermal, atmospheric and visual indoor climate. Furthermore, plandisposition and architectural quality is included in the social category of DGNB. The remaining criteria for the building scale have certain overlaps with the criteria for the urban scale; accessibility, safety and security as well as the quality of outdoor areas are evaluated. In addition, social and functional diversity, social and commercial infrastructure, identity of place, social interaction potential and outdoor comfort are important aspects of the urban quality assessment. Finally, and highly relevant to the following thesis, the functional and aesthetical integration with the surrounding environment, formal concepts and the use of exisiting structures and references are assessed in the weighting of the area. Given the context of this thesis, designing according to the DGNB systems social sustainability criteria is crucial to the succesful planning of a new urban quarter.

Architectural sustainability/
As an extension of this argument, the notion of architectural sustainability - not to be confused with sustainable architecture - should be considered given the complexity of any intervention in the culture-historical environment of Nyholm. This also ties back to the interpretation of *firmitas* as an expression of sustainability. Architectural sustainability should be understood as the ability of architecture to prove durable both physically, functionally and aesthetically. It entails a number of additional considerations, particular in the context of transforming existing structures to fit new functions. Architectural sustainability implies a more conscious effort to design buildings that contribute positively to their surroundings. In the context of Nyholm, the assumption with regards to architectural sustainability is that the cultural and historical significance of the existing urban fabric by far outweighs the need for a unique and distinct contemporary landmark on the Copenhagen harbour front. The aesthetical and formal approach to a new urban quarter must represent a certain sensitivity to the surrounding environment if the development is to be considered architecturally sustainable.

Contextualism

Venustas

Contextualism in architecture is commonly associated with visual references of new buildings to the surrounding urban environment. Several architectural movements have applied contextualism to a varying degree as a means to assimilate new buildings with their physical context. Contextualism thus becomes a partially aesthetical endeavour aimed at creating a relationship between the added and the existing. Given the architectural heritage of Nyholm, contextualism becomes an aesthetical ideal for the design of new residential typologies in the area.

Origin/

What is the importance of context to the creation of architectural quality? Historically, contextualism has had different names and implications. An early example of the architectural sensitivity to place is the Roman principle, Genius Loci, which in architecture has been translated to the spirit of a place. Several other similar terms have been used throughout architectural history to underline the importance of understanding the surrounding environment when making architectureal contributions to it.

Contextualism, as an architectural concept, was introduced in the 1960's by Colin Rowe who asserted the importance of cohesion and continuity in the relationship between the present environment and new buildings (Daglioglu, 2015). His views were opposed to the modernist ideals of universal design solutions that could be applied without regard of the context. Rowe favoured the use of figure-ground diagrams to reveal spatial relationships in urban environments. This methodology was also a reaction to the objectification of both building volumes and urban spaces - solids and voids - that had defined much of urban planning in the preceding decades. This argument was later echoed by Rem Koolhaas, who proclaimed the "death of urbanism" due to the lack of interconnections and relations between buildings in the city (Koolhaas, 1993).

Current use of contextualism/

The traits of contextualism have a strong traditon in Nordic architecture with the works of architects such as Alvar Aalto, Sverre Fehn and Jørn Utzon illustrating how buildings can assimilate to the specifics of a place in order to create beautiful and sensory spatial experiences. This tradition is reflected in many contemporary works of architecture, particularly evident in the later years with projects such as Vadehavscenteret by Dorte Mandrup Arkitekter and Krøyers Plads by COBE showcasing exemplary ways of working with the natural and urban context, respectively. Another showpiece of contextual, urban architecture is Kannikegården in Ribe by Lundgaard & Tranberg Arkitekter. The building adopts a formal expression familiar to the surrounding environment as well as a similar materiality and color palette. Material articulations and

Ill. 23_Kanikkegården, Lundgaard & Tranberg, 2015

structural detailing however distinguish the building as a contemporary contribution to the historical environment of Ribe. The design of Kannikegården demonstrate the architectural and urban qualities of respecting the architectural heritage of a place while interpreting it within a contemporary and urban framework. Furthermore, it shows how the values embedded in historical buildings can be adopted by new developments in order to create a narrative of continuity, architectural consistency and homogenity across time.

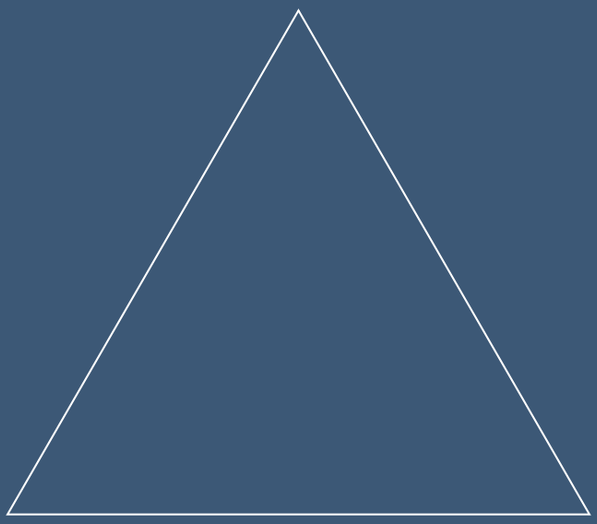
Physical characteristics/
Using the aforementioned cases as a basis for a further discussion of the physical characteristics of contextual architecture, a number of common features stand out; 1) geometry and formal expression, 2) scale and proportions, 3) color and materiality, 4) patterns and rhythm, 5) solidity and lightness. The applicability of these characteristics will no doubt vary from project to project and should thus serve as a starting point for any explorations on volumes, materials and detailing. In addition, it should be noted that the characteristics not only relate to the design of buildings; equally important are the urban characteristics and how they are spatially affected by the introduction of new surfaces and volumes. Once again, understanding the interplay between solids and voids is the fundamental condition for a succesful urban contextualism.

Although the physical imitation of the surrounding environment is important in order to achieve visually contextual architecture, the issue extends far beyond this aspect. Contextualism relates to both literal and abstract characteristics of the environment it is built in. Although sometimes associated with a particular style, contextualism cannot be described as such, as it is a reflection of the environment it is situated within. Given the variation of natural and built environments, contextualism is therefore more reminiscent of an idea or methodology towards place-specific design which also includes historical and cultural references. In addition, the impact of global trends on even local communities means that the notion of context has become much wider as the world has gotten more connected. Issues such as globalization and climate change are essential to the understanding of urban development and should thus also be addressed in any design proposals.

Sustainable contextualism/
The case for a contextual design approach becomes even stronger when considering the overlaps between sustainability and contextualism. Part of a contextual design approach involves an examination of the surrounding natural environment. Integrating the building with the climatic conditions of the site has several positive effects on the energy consumption and indoor climate of a building. The utilization of passive cooling and heating is one example of a sustainable and contextual design approach. The compatibility between sustainability and contextualism also has a visual representation; vernacular architecture. Vernacular architecture was developed over centuries as a response to the natural environment. An important part of vernacular architecture is the use of passive strategies to heat and cool a building which ultimately creates a better indoor climate. In addition, vernacular architecture uses locally sourced, easily accessible and durable materials because of its inherent resourcefulness. These are all values shared by contemporary sustainability and thus an argument for a contextual approach in the pursuit of sustainable architecture.

Adaptive reuse

Utilitas



Contextualism

Venustas

Sustainability

Firmitas

A new urban quarter in the culture-historical environment of Nyholm has an immense potential of enhancing the current environment through the transformation of strategically selected areas. In order to preserve the cultural and historical heritage of Nyholm in the proposed intervention, the ancient Vitruvian virtues of architectural quality have been interpreted in a contemporary and urban context; the interaction of adaptive reuse, sustainability and contextualism will guide the design development and demonstrate the functional potential of adaptive reuse practice, the practical potential of sustainability and the aesthetical potential of contextualism. More importantly the synergy between the interpretations of the Vitruvian virtues will demonstrate their relationship; adaptive reuse is a sustainable aspiration due to its reuse of resources, sustainability creates contextual buildings and contextualism produces architecture which is based on cohesion and assimilation, in turn making it sustainable.

Ill. 24

Design strategies

Adaptive reuse

Create a unifying strategy for the island of Nyholm that can support its culture-historical heritage and identity

Preserve the buildings that have the highest historical significance and can support new urban or maritime functions.

Adpat the buildings that are functionally outdated to accomodate new functions.

Strengthen the maritime traditions and urban qualities of Nyholm through the introduction of new maritime functions.

Sustainability

Create a socially sustainable development through the design of different housing typologies

Apply passive and active strategies to the design of new and existing buildings on Nyholm in order to comply with the Danish Building Regulations

Choose materials based on their environmental and health-related profiles.

Achieve high architecural quality through a distinctly urban and contemporary expression.

Design for thermal, visual and atmospheric comfort both indoors and outdoors

Contextualism

Enhance the material environment of Nyholm through the use of tactile materials with references to the surrounding area.

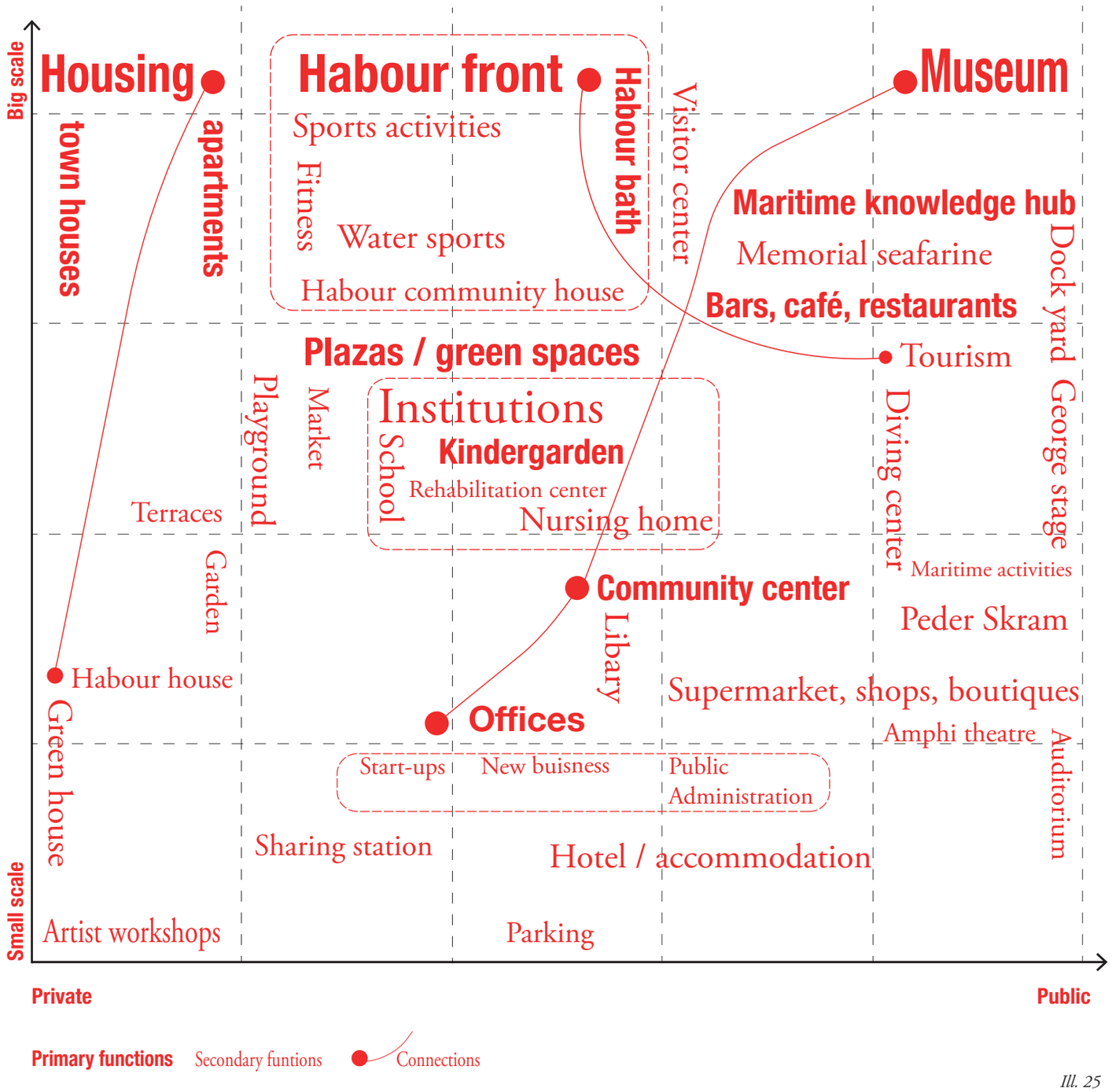
Preserve the qualities of openness in the new urban spaces of Nyholm.

Use formal references for the new building volumes in order to create a harmonious environment.

Achieve functional and aesthetical synergy between the existing buildings and the new.

Enhance the interaction between Nyholm and the inner harbour of Copenhagen by creating new recreational spaces along the harbour front.

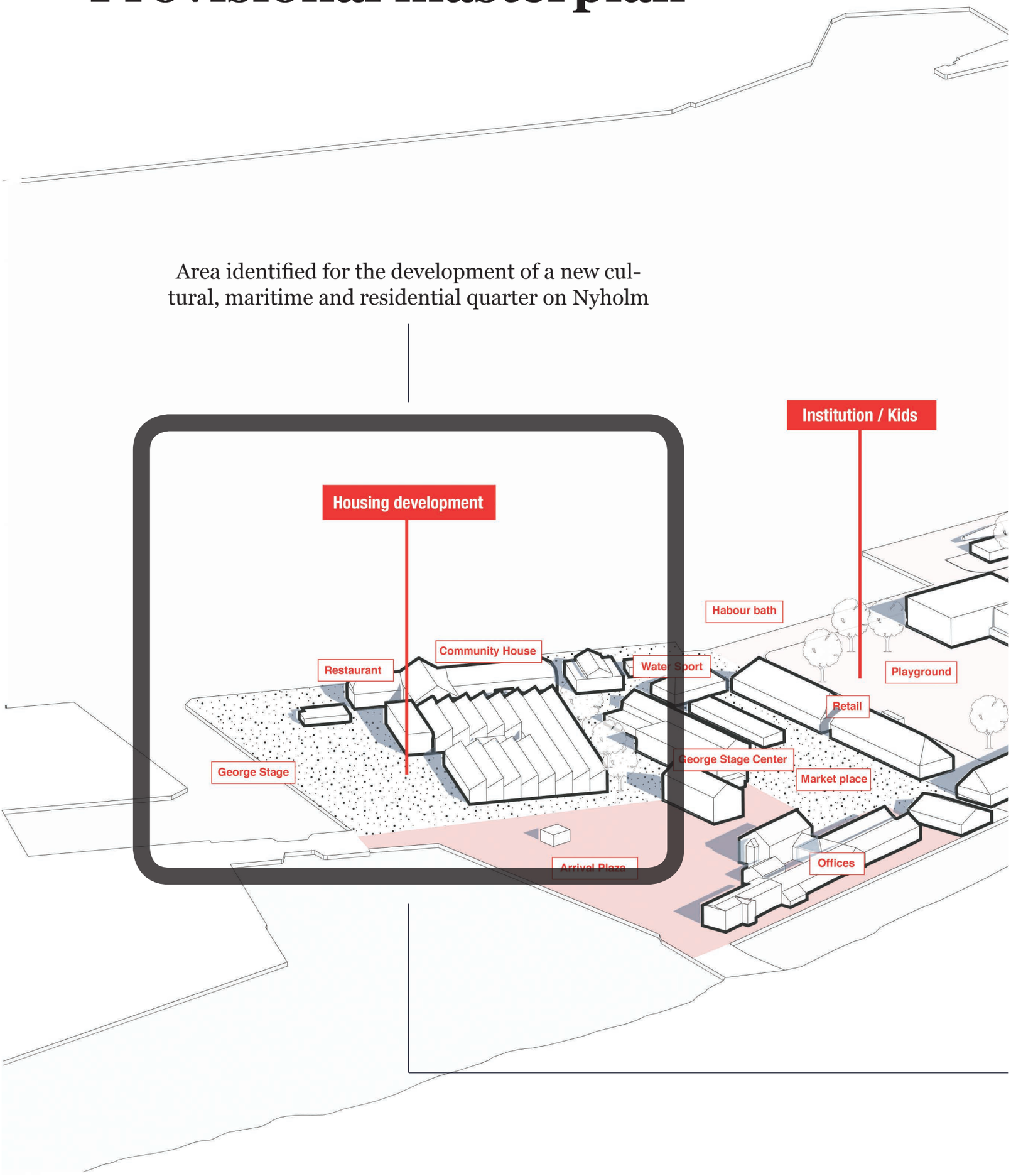
Adaptive reuse diagram showing a wide range of new functions that could be placed in the new and existing buildings of Nyholm. The functions are ordered by scale and a private-public axis. Furthermore, they are visually represented by their significance to a new conceptual masterplan. The diagram is translated into a provisional masterplan for the entire island of Nyholm; this masterplan will serve as a conceptual framework for the detailed urban and building design of a smaller area in the southwestern corner of Nyholm

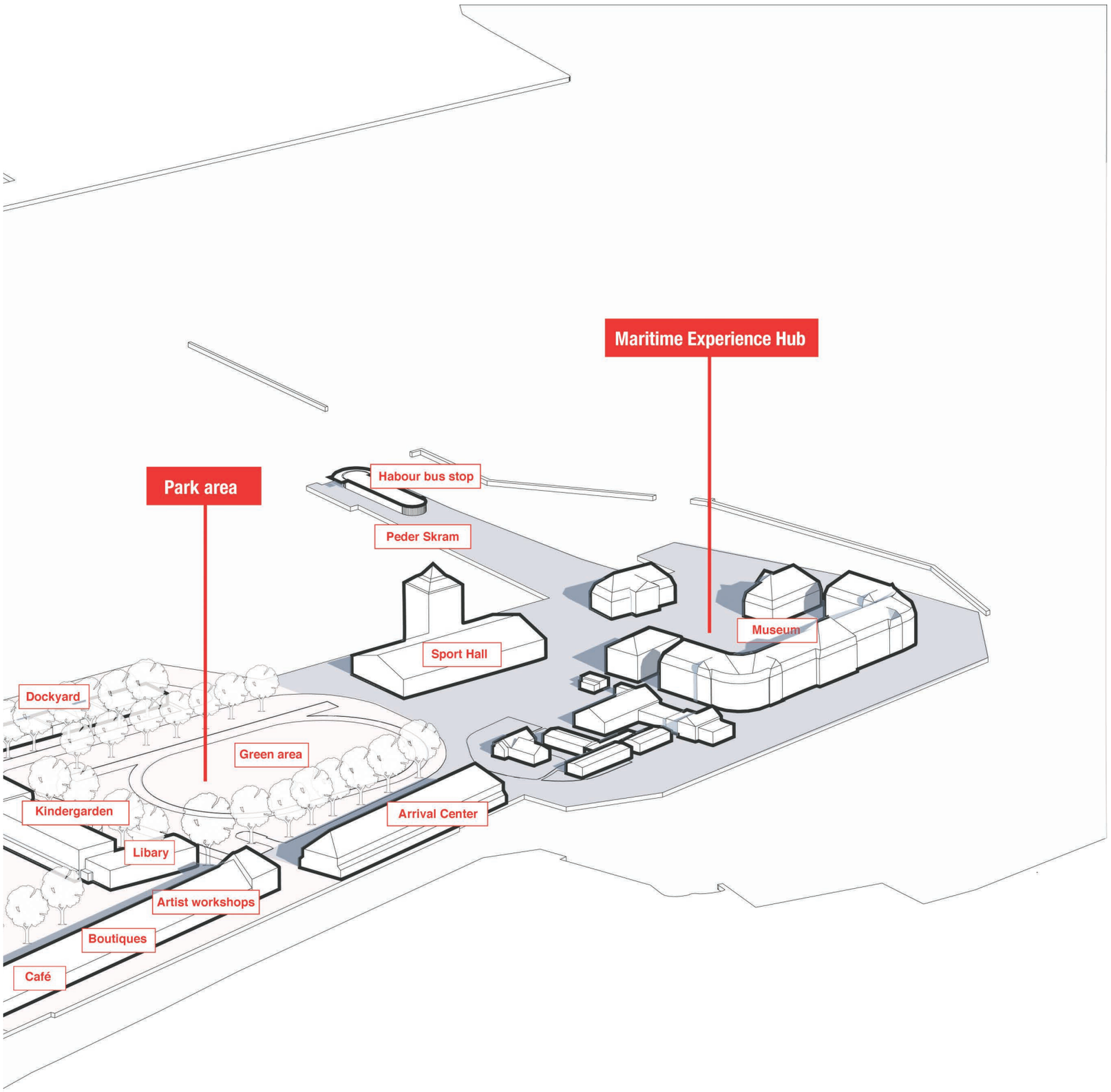

Big scale
Small scale
Private
Public
Housing
town houses
apartments
Habour front
Sports activities
Fitness
Water sports
Habour community house
Habour bath
Visitor center
Museum
Maritime knowledge hub
Memorial seafarine
Bars, café, restaurants
Dock yard
George stage
Tourism
Plazas / green spaces
Playground
Market
Institutions
School
Kindergarden
Rehabilitation center
Nursing home
Terraces
Garden
Diving center
Maritime activities
Community center
Peder Skram
Libary
Habour house
Supermarket, shops, boutiques
Amphi theatre
Offices
Green house
Start-ups
New buisness
Public Administration
Auditorium
Sharing station
Hotel / accommodation
Artist workshops
Parking
Primary functions
Secondary funtions
Connections

Ill. 25

Provisional masterplan

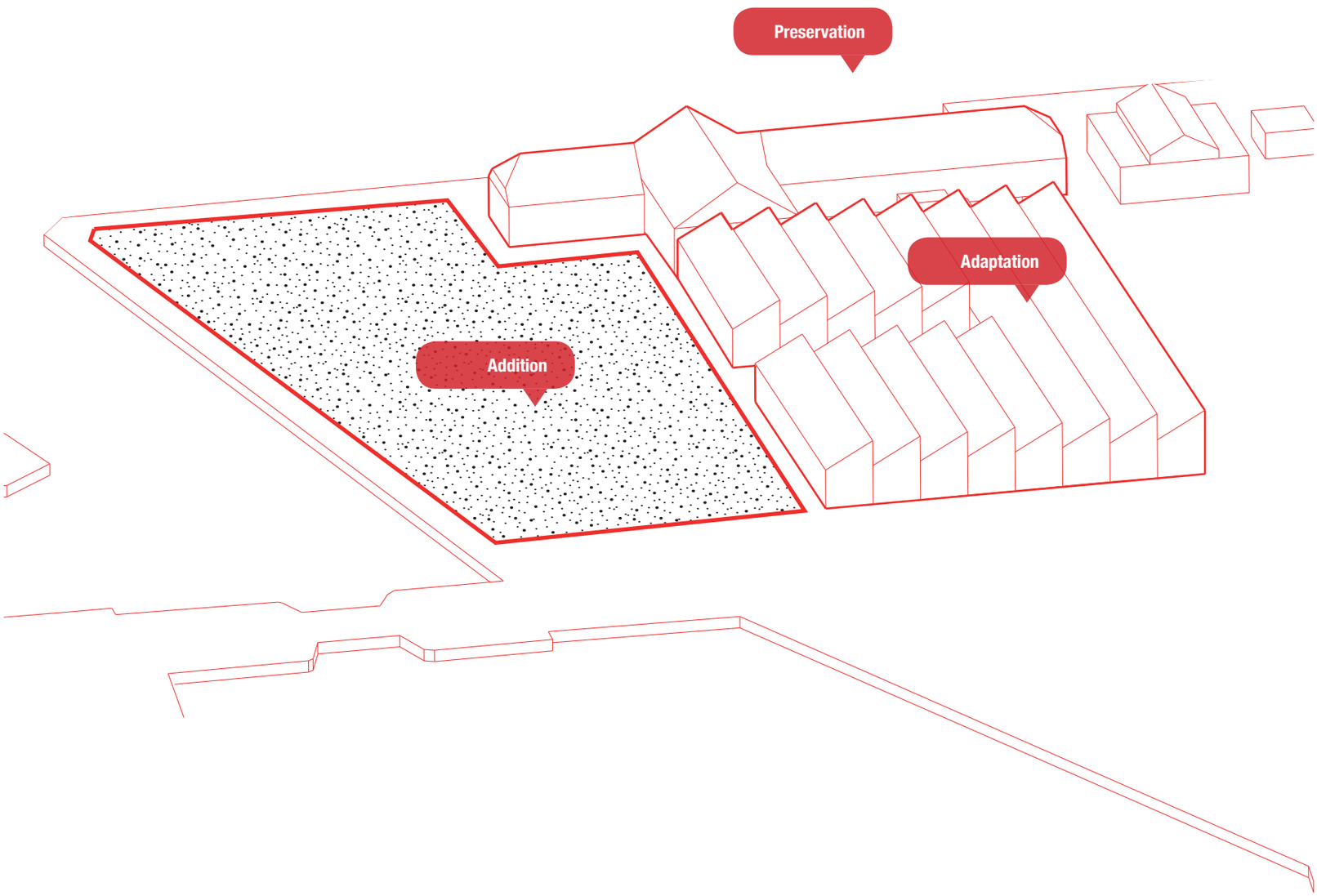
Area identified for the development of a new cultural, maritime and residential quarter on Nyholm





The area in the southwestern corner of Nyholm is the most ideal area for a thorough urban renewal. The connection to the water, physically and visually, makes the potential of a new urban quarter very high compared to other areas on Nyholm. The existing buildings in the area will be examined more closely in order to determine their functional and aesthetical value to a new urban development. Based on these findings, an approach to the urban design of the area can be formulated

Ill. 26



Ill. 27

Design approach

The area proposed for urban renewal currently includes two existing buildings that will be part of the transformation of the entire area. Based on a thorough analysis of these buildings, three general approaches to the transformation will be presented.

Preservation

The Brick Building facing the western harbour front is currently designated a building of high preservation value. It has recently undergone renovation which makes it functionally and aesthetically valuable to the overall transformation of the area. The Brick Building will serve as a case for the first strategy of urban renewal; preservation. Preservation in this case is the act of functionally adapting the building to serve a new purpose while respecting the defining qualities of the building. This includes the aesthetic value of the building for which only interior renovations can be part of the final design proposals.

Adaptation

The characteristic roofscape of the industrial Sawtooth building is arguably the most distinctive feature of the southwestern area. The architecture of the building is however not unique and does not serve any particular purpose to the area in itself. As part of the history of development of Nyholm, the building does however represent an important place in time and should thus be preserved for its part in a larger composition of building heritage. In order to enhance the functional value of the building a different deign intervention is needed than in the case of the Brick Building. Therefore, the second strategy, adaptation will apply to the Sawtooth building. Adaptation implies a physical intervention in the building structure both in the interior and on the exterior. The defining qualities of the building should however still be preserved.

Addition

While the strategies of preservation and adaptation are of high importance to this thesis they will only be adressed on a coneptual design level. The main focus is the addition of new building volumes to the southwestern area of Nyholm. The strategy for addition is defined by the overall design framework of the project which aims for a sustainable and contextual urban development. The process related to the design of new buildings will be outlined in the following chapter.

004.

Design development

004.1
Masterplan

While the preceding chapters addressed the entire island of Nyholm, this and the subsequent chapters will deal with the development of a new urban quarter in the southwestern area of the island which was previously outlined in the provisional masterplan.

The design development is presented in thematic chapters. Although presented as a chronological process, it is important to state that the entire design development has been an iterative process moving between different chapters and scales in a non-linear workflow. Decisions made in the final chapters have influenced design studies presented in the beginning chapters and vice versa.

Essential to the development of the masterplan is the synergetic relationship between the urban and interior spaces - between the city and the building - but also the relationship between the new additions and the existing buildings. Furthermore, the main characteristics of Nyholm that should be reflected in the new development is the tactility of materials and surfaces, the prioritization of open spaces and plazas, the urban scale and the formal language of buildings.

Having established the southwestern corner of Nyholm as the primary building plot for new urban development, the first studies focused on developing reference model with different plot ratios in order to understand different scales of intervention.

The strategies proposed on the following page show a significant difference in the spatial qualities when the plot ratio is increased from 60 % to 80 % and likewise from 80 % to 100 %. Particularly the latter seems to have a negative impact on the potential quality of the urban spaces; solving this will likely have to include building volumes that are distinctively different in scale and proportions to the current building stock on Nyholm. A plot ratio of 80 % appears to produce a built environment more consistent with the neighbouring buildings allthewhile producing a fairly dense area. Finally, the strategy of 60 % leaves the majority of the harbour front open and airy, but doesn't provide a lot of added volume for housing.

Determining the density of this area is ultimately a balancing of the need for new housing on Nyholm and the preservation of the current environment. The generic volumes used for this study do not emphasize formal, spatial or logistical considerations. Thus, the purpose of this initial study is not to determine a specific plot area ration nor an interval but rather to start developing a framework for the following studies on volumes and spaces.

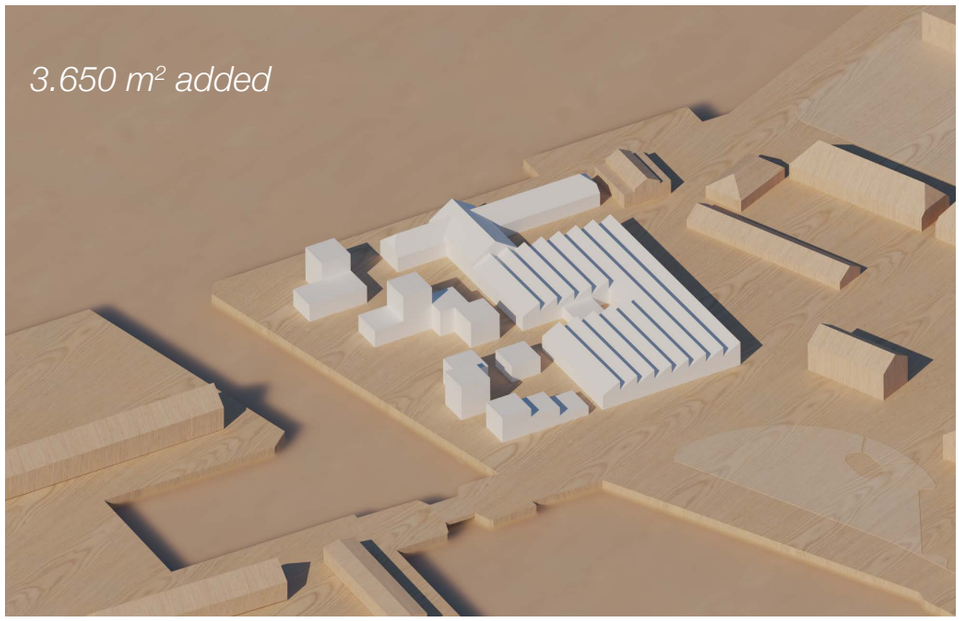
Total plot area
15.500 m^2

The Sawtooth
3.650 m^2

The Brick building
2.000 m^2

Strategy 001

/ 60 %



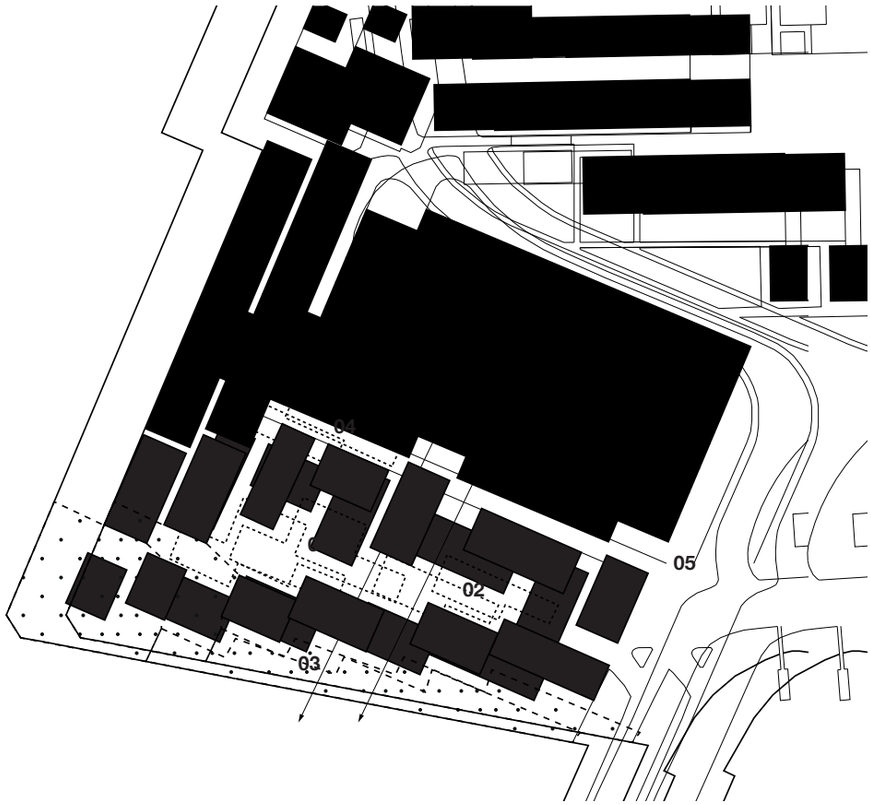
Strategy 002

/ 80 %

Strategy 003

/ 100 %

Ill. 28



Ill. 30

Figure-ground study/
Given the decidedly urban approach to the development of a new urban quarter on Nyholm, the first specific design studies focused on the qualities of the urban spaces, view- and flowlines as well as the interplay between the new building facades and the exisitng. For this purpose, figure-ground maps were used as a way to explore the urban environment using only solids and voids.

Illustration 30-34 show the preferred layout out of several different plan options. The references on the right are meant to illustrate the spatial qualities and dimensions of the spaces between the buildings. Essential to the organization of the new buildings is the orientation of the existing buildings; all exterior walls are parellel and thus create an ordered layout when looked at in plan. The spatial experience is varied through a differentation of building scale. The new buildings have significantly smaller footprints than the existing which, combined with the seperation and misalignment of these volumes, create more spatial pockets throughout the site.

The harbour front towards south is delineated by several building volumes that create a definition of the space. The row of buildings is strategically punctured to create views from within the area out towards the harbour front which also support the main flowlines. In the southwestern corner, the outermost solitary building is conceptually perceived as a marker or landmark building which represents a strong urban statement in an otherwise sensitive environment. It follows the relatively deep setback of the northwestern building volume on the harbour front and thus creates a more linear harbour front on the western quay.

Generally, the solids are arranged as a peripheral, punctured block with additional building volumes within. Behind the harbour front buildings to the south and west, two small plazas provide space for different activities and functions. The meeting between the existing buildings - the brick building and the sawtooth building - and the new buildings is conceived as smaller green paths for the residents of the area.

The following page will briefly present other examples of figure-ground maps that may include organizational, functional or spatial qualities that could provide useful alternatives in the further development of the layout.

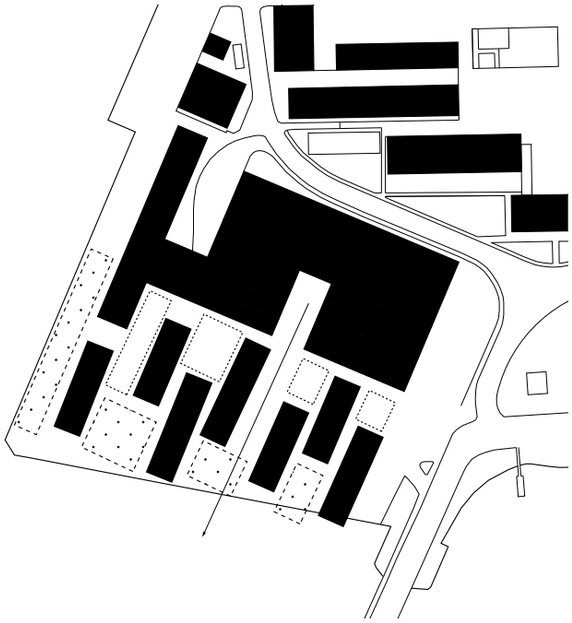
Ill. 30

Ill. 31

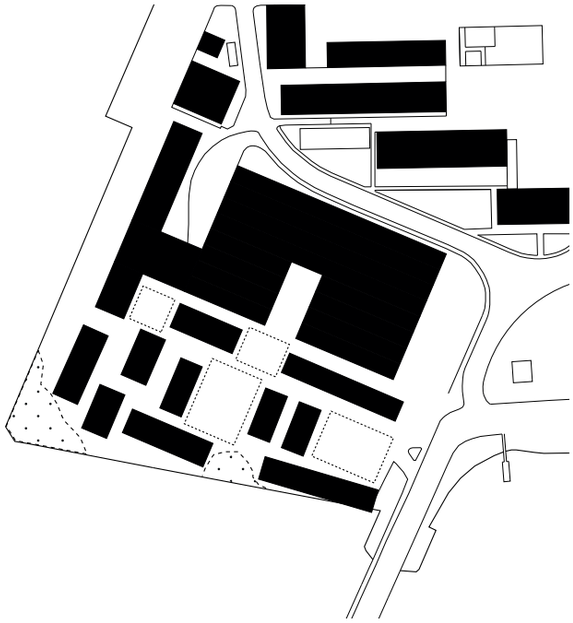
Ill. 32

Ill. 33

Ill. 34

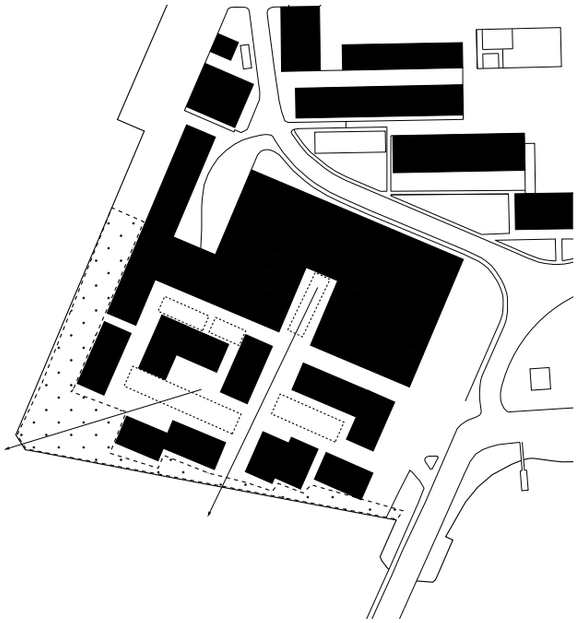


Inspired by the image of gables standing perpendicular to the quay as seen many other places in Christiansholm, this layout has a distinct rhythm while the volumes are shifted in relation to eachother. This creates voids that alternate between harbour front plazas and enclosed coutyards.

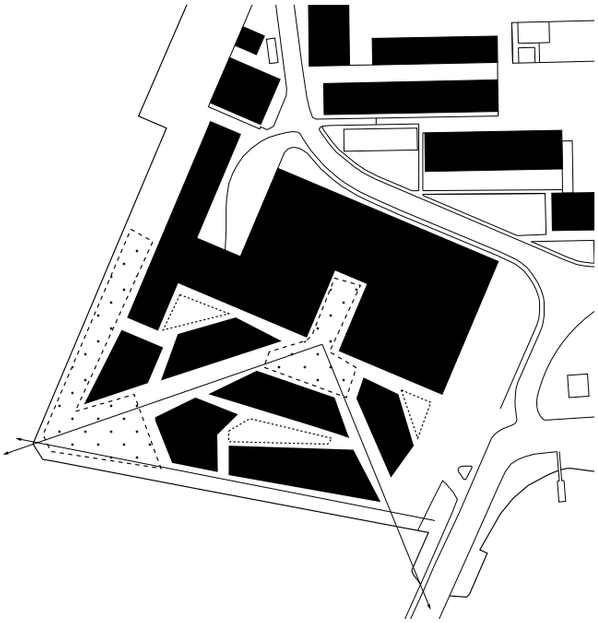


A seemingly random organization of solids which in turn creates a varied spatial experience in the area. The scale of the urban spaces make the area appear less public; however it also creates potential issues for the apartments within the buildings due to lack of distance between volumes.

In many aspects similar to the layout presented on the preceding page, option four creates a narrow and intimate path between the sawtooth and the added buildings. Two central plazas are again created and the row of buildings to the south is preserved. The main difference is the absence of a marker building in the southwestern corner, instead making way for an open plaza overviewing the inner harbour of Copenhagen.



A distinctively different appraoch to flowlines and consequently also building shapes. This layout creates views and flowlines from the centerpoint of the sawtooth to the southern corners of the area. Additional voids are created within each building block. Although the proposal is spatially interesting with regards to the urban spaces, the angles of the building shapes may cause problems for the usability of interior spaces.



Ill. 35_Figure-ground maps

In addition to figure-ground sketches, a physical model of Nyholm was used throughout the design process of the urban layout. All volumes are 3D printed in order to speed up the process of exploring spatial compositions. The volumes seen on the picture are all a result of a study on formal concepts presented in the following chapter

Ill. 36

004.2
Volumes

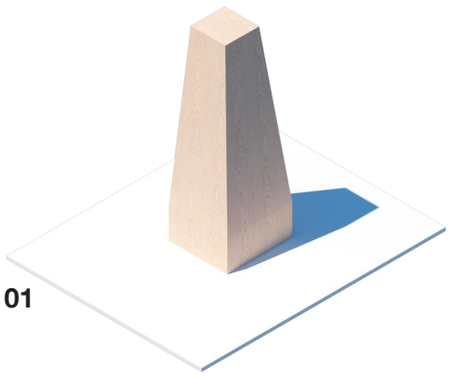
Extruding the two-dimensional figure-ground maps of the preceding episode requires an exploration of the formal language of new building volumes as shown on illustration 37. The assumptions prior to the development of volume concepts was that formal contextualism one imorpant aspect of assimilating the new development with the existing building stock of Nyholm. The common characteristic for most of the shown volume concepts is the interpretation of the pitched roof which is characteristic not only to the island of Nyholm but to Christiansholm and the greater Copenhagen in general.

The volume concepts are divided into low-rise, mid-rise and high-rise buildings in order to establish a library of different typologies and understand their relationship to eachother. The volumes have been tested in different compositions, three of which are presented on the following spread.

High-rise/
The high-rise typologies consist of more than seven stories. In order to reduce the spatial impact of the volumes, different effects have been used to make the volumes appear smaller such as slanted exterior walls (1), a separation of the volumn into slender ”columns” (2) and a transparent, structurally light exterior (3). Particularly option 1 was appealing due to its formal relation to existing buildings on Nyholm and several other volumes proposed in the mid- and low-rise category.

Mid-rise/
The mid-rise category consists of several pitched roof concepts ranging from four to six stories. In addition to more familiar formal expressions (6 and 7) other variants have been explored in order to create a contextual, yet contemporary aesthetic. This is mostly achieved through an exaggeration and distortion of the roof shape (5 and 8). Finally, a contrasting grid-like structure was conceptualised for its aesthetical and additive qualities which could provide a large area for raised roof terraces and green surfaces.

Low-rise/
The low-rise buildings are intended to hold townhouses that are slightly larger than the apartments of the mid- and high-rise typologies. The height doesn’t surpass three stories and thus provide a more human-scaled addition to the typologies. Once again, the common theme with regards to formal expression has been ptiched or angled roofs in order to relate the added building to the existing building stock of Nyholm. Given the comparatively smaller volume of the low-rise typologies, the functionality of the interior spaces has been prioritized over formal aspirations.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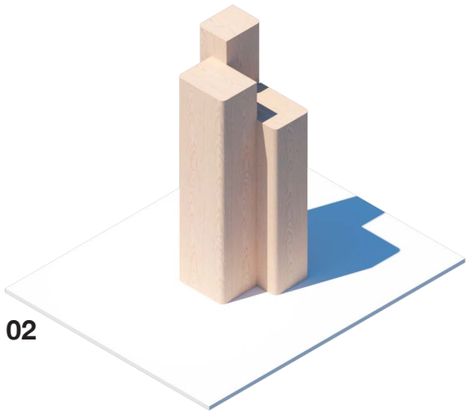
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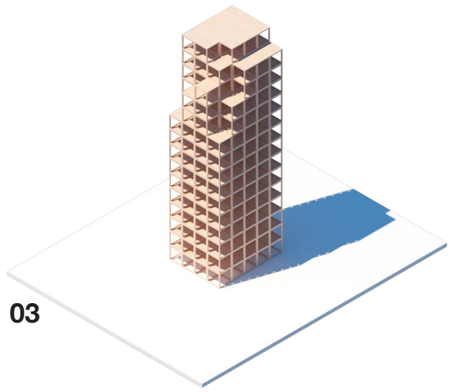
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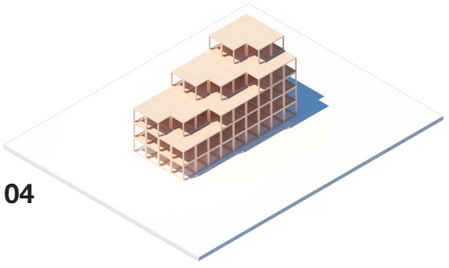
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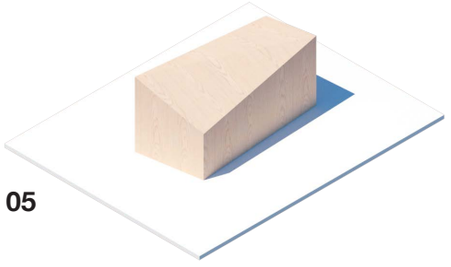
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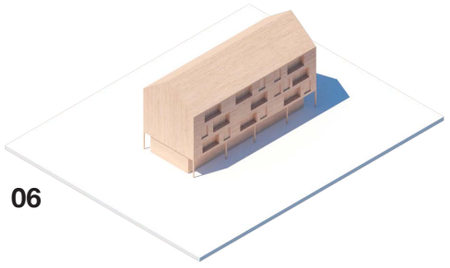
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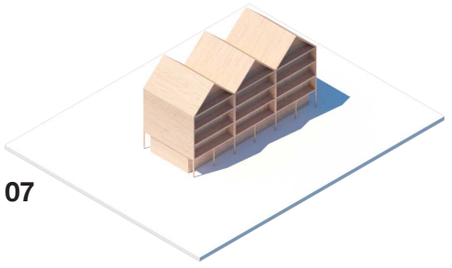
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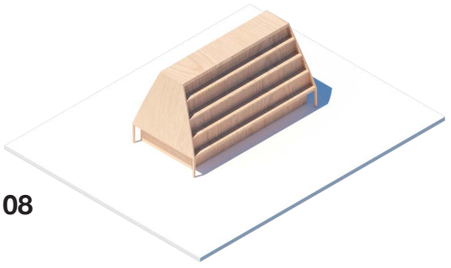
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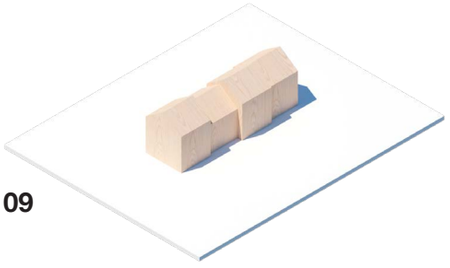
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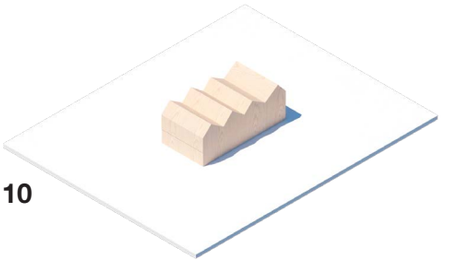
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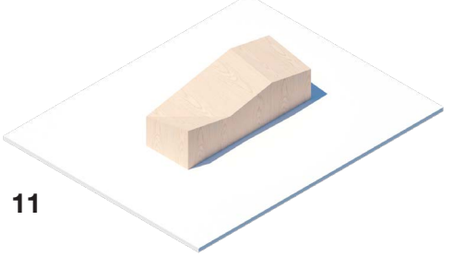
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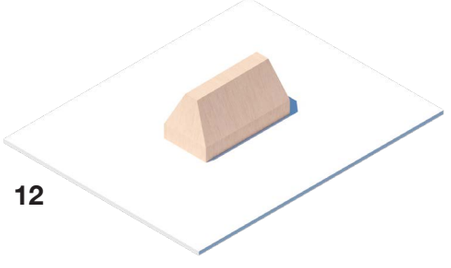
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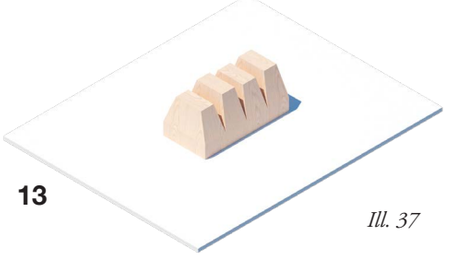

13

Ill. 37

Volume Concept 01

Concept 01 relies on two different typologies to create a formally contrastful composition. The typologies are derived from two current trends in Danish architecture; the pixelated, terraced typology which allows residents to occupy private roof gardens and the traditional pitched roof typology which has been interpreted widely the last decades in order to create contextual developments.

The architecture appears independent from the existing building stock of Nyholm although some formal references are made. The concept is an extrusion of the preferred figure-ground map (ill. x) presented on page . It aims to preserve the urban qualities of the layout while creating a development with a relatively high plot area ratio.

Volume Concept 02

Concept 02 was favoured and presented at the midterm seminar as a highly contextual, homogenous and human-scaled development. The formal language of the buildings stems from the pitched overdimensioned roofs of the iconic half-timbered houses on Nyholm Additionally, it reflects both the architectural-formal traditions of Copenhagens warehouses and residential buildings as well as certain contemporary interpretations of the regional building heritage.

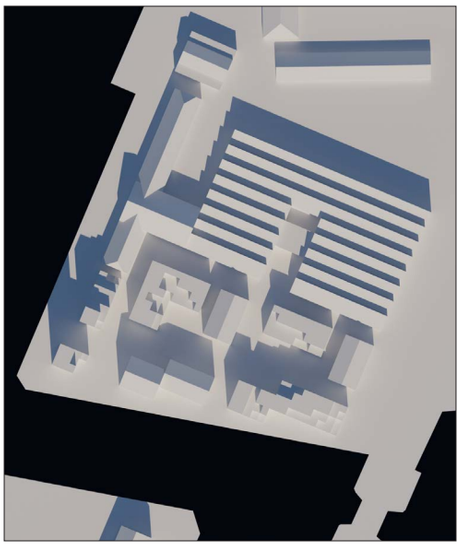
Inspite of the contextual and human-scaled qualities of the concept, it arguably lacks some of the more urban qualities that are present in similar, succesful projects on the harbour front of Copenhagen. The atmosphere of the urban spaces and building geometries allude to rural environments which may not be the appropriate design response to an urban context.

Volume Concept 03

Largely a progression of the former concept, concept 03 adopts a more urban scale by increasing the footprint and height of the harbour front building volumes. In addition, the volumes towards the west have been stretched vertically to reintroduce the marker building to the composition. The inner volumes are marginally downscaled to create larger urban spaces which can acommodate a number of different functions and activities.

The varied but coherent formal language of concept 03 creates a solid foundation for a contextual design. In addition, the volumes towards the western harbour front provide some microclimatic benefits such as protection against winds but also reduce the amount of sun on the area.

Ill. 38_Volume renderings



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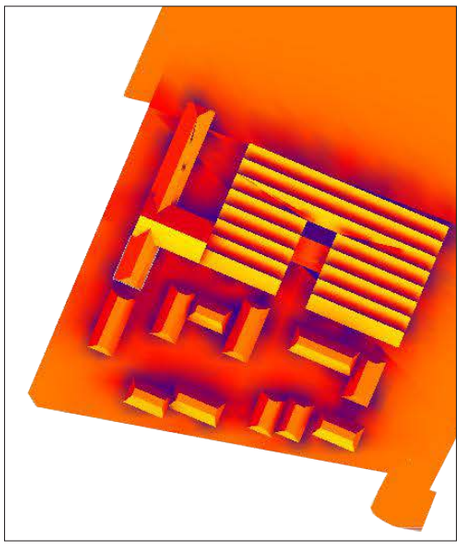
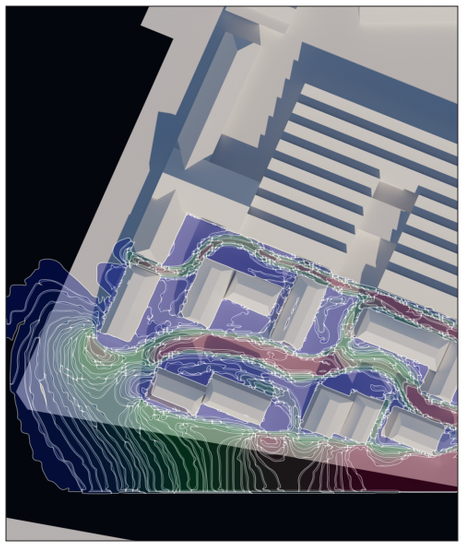
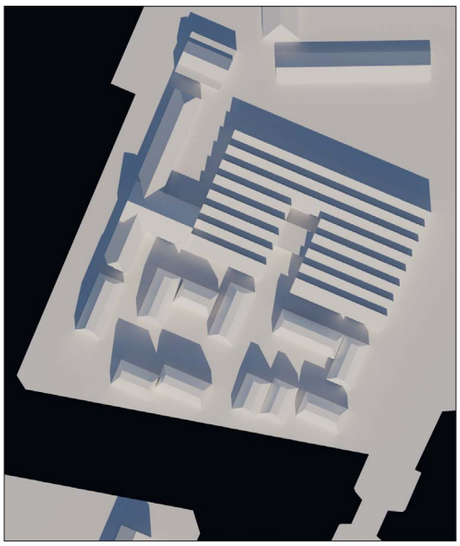


Solar radiation, measured on a yearly basis



Wind flow, direction: west, speed: 6 m/s



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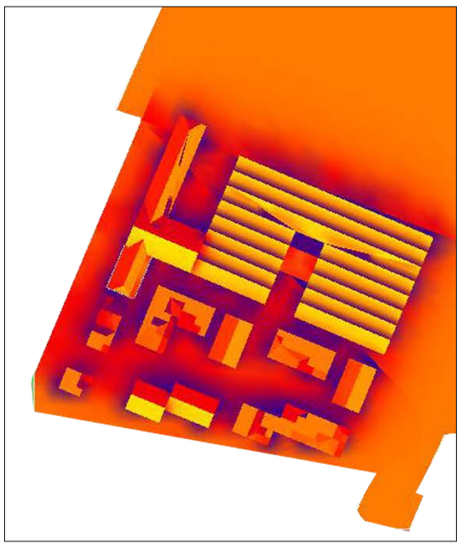
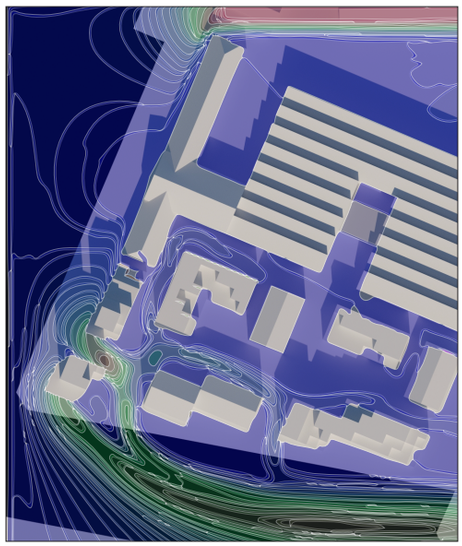
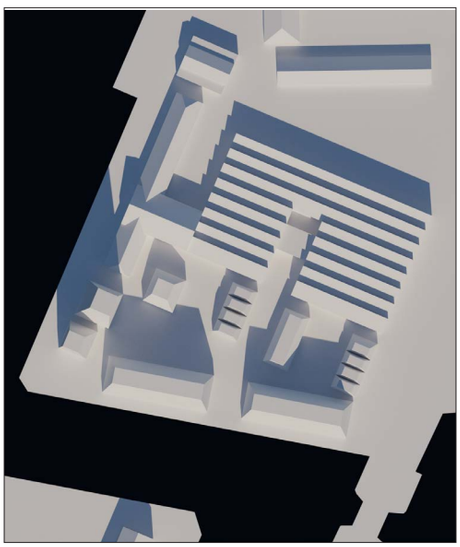


Solar radiation, measured on a yearly basis



Wind flow, direction: west, speed: 6 m/s



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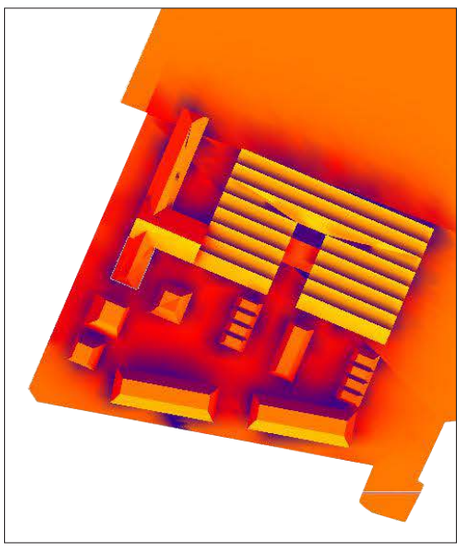
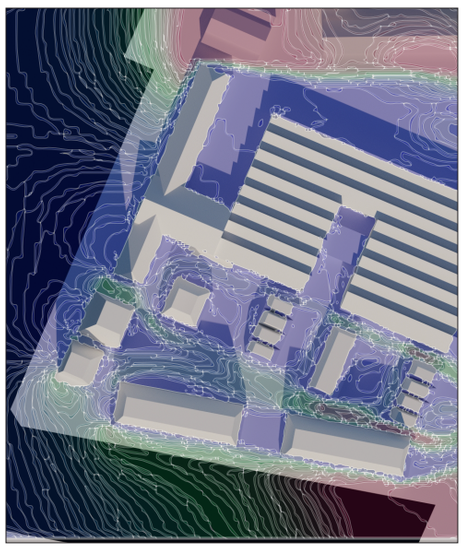


Solar radiation, measured on a yearly basis



Ill. 39_Climate studies

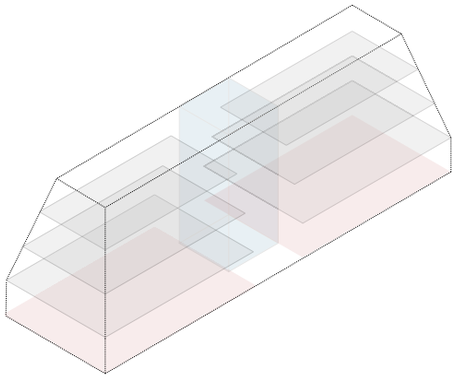
004.3
A_Type

Progressing from an urban scale to a building scale, the typology referred to as the A-type will be detailed in the remaining sections of the design development chapter. The A-type is central to the new development on Nyholm due to its formal and material relation to several existing buildings on Nyholm. Furthermore, it serves as the formal basis of the remaining buidings on the site, including the townhouses and the marker building.

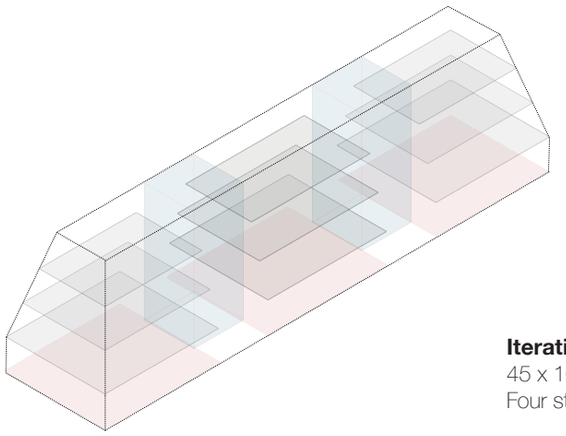
Following the ideation of conceptual volumes a more detailed study on building proportions, functional organization and distribution was initiated for the A-type. Based on previous experience with the residential typology, a central stairway leading into the apartments was preferred due to its effective layout and limited impact on the spatial qualities of the apartments. The first conceptual iterations of the A-type included a singular staircase in a 25 x 10 m building footprint (ill. 41). This was not deemed effective on the specific site; as a result, different proportions were explored to find both an appropriate building footprint and height. Apart from the functional possibilities inside the volume, the building had to conform to the already established urban volume concept which specifically meant that a building length above 45 meters would have severe consequences for the urban layout. Increasing the building volume to this length allowed for the addition of a secondary stairway resulting in an overall more compact typology. Creating a compact typology not only includes certain contextual advantages; more importantly, it creates far better conditions for minimizing both the energy consumption of the building but also its embodied energy, since less compact building volumes have higher material consumption (the definition of compactness being the surface to volume ratio). A condensed design proces related to the dimensioning of the A-type is visually presented on the following page.

Characteristic to the A-type is the inclination of the exterior walls that converge towards the top of the building. The inclination has a distinct spatial impact on both the urban spaces surrounding it and the interior spaces. Understanding the effect of this inclination was essential to the further development of the typology. Ill. 42 diagrammatically shows the process related to this aspect of the building design. In addition to the inclination itself, the height from which the inclination begins and a potential setback in the ground floor facade was studied through a number of different media.

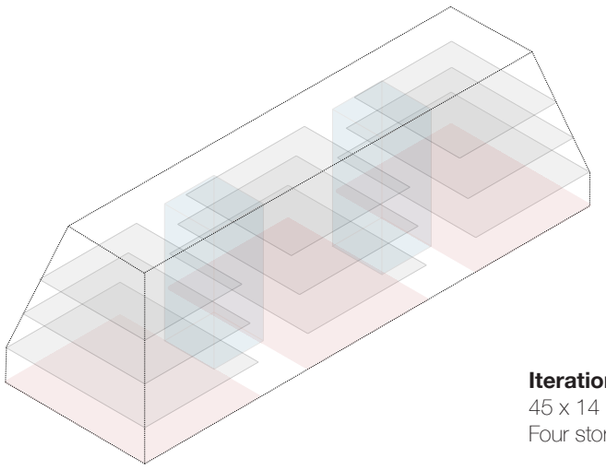
Finally, the interior space of the building was divided into different zones representing rough apartment outlines (ill. 43). Considerations on user groups, spatial qualities and indoor climate was of particular importance to the organization of apartments. The final proposal contains a total of 15 apartments as well as a common roof terrace and a public ground floor.



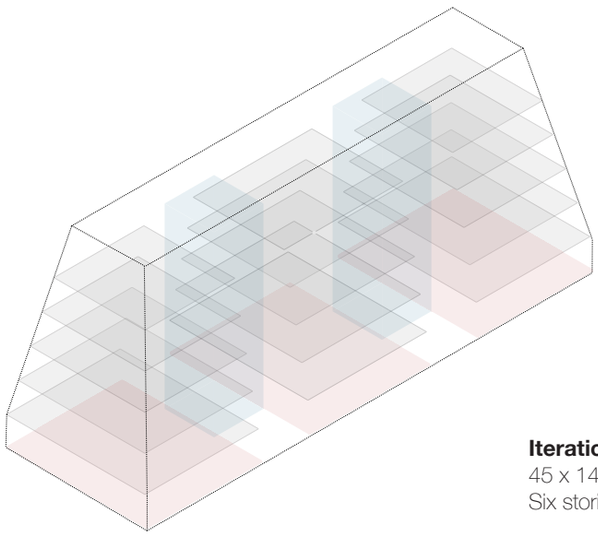
Iteration 01
25 x 10 m footprint
Four stories



Iteration 01
45 x 10 m footprint
Four stories

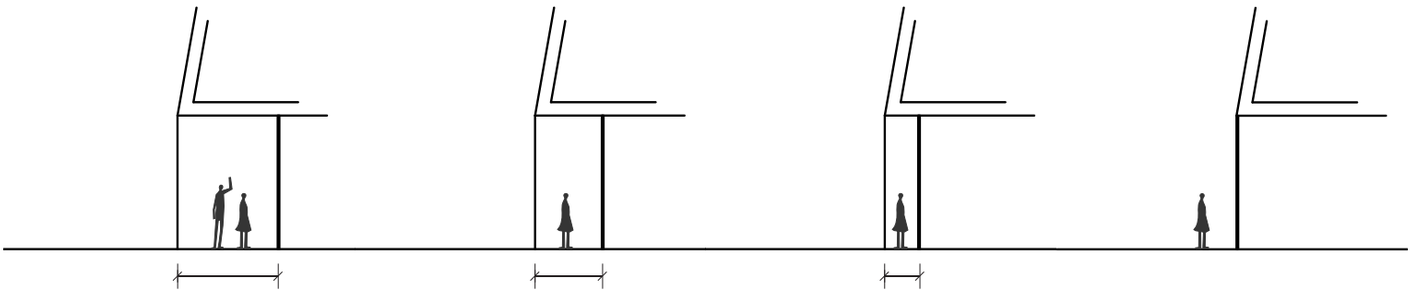


Iteration 01
45 x 14 m footprint
Four stories



Iteration 04
45 x 14 m footprint
Six stories

Ill. 41

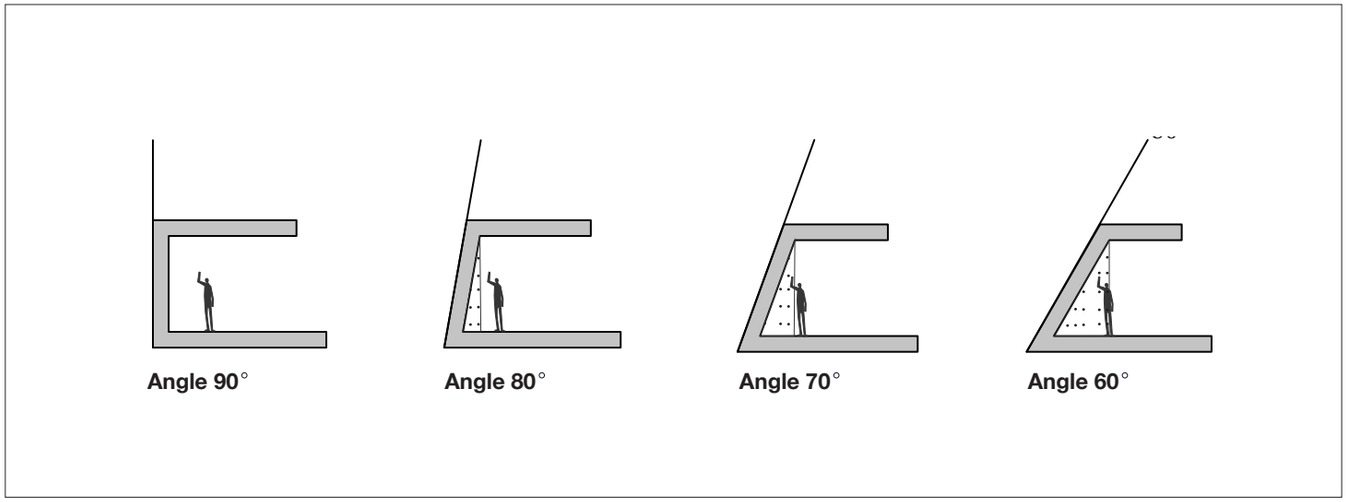


Setback 01
2,5 m

Setback 02
1,5 m

Setback 03
0,5 m

Setback 04
0 m

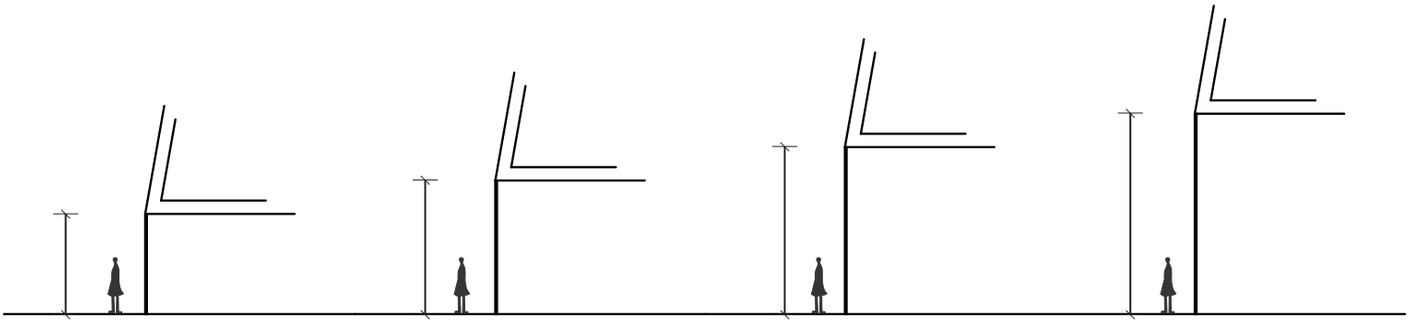


Angle 90°

Angle 80°

Angle 70°

Angle 60°



Ground floor height
3,0 m

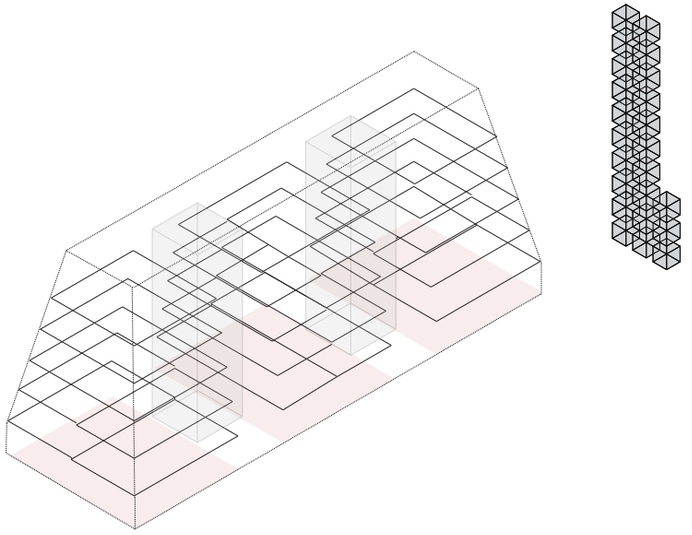
Ground floor height
4,0 m

Ground floor height
5,0 m

Ground floor height
6,0 m

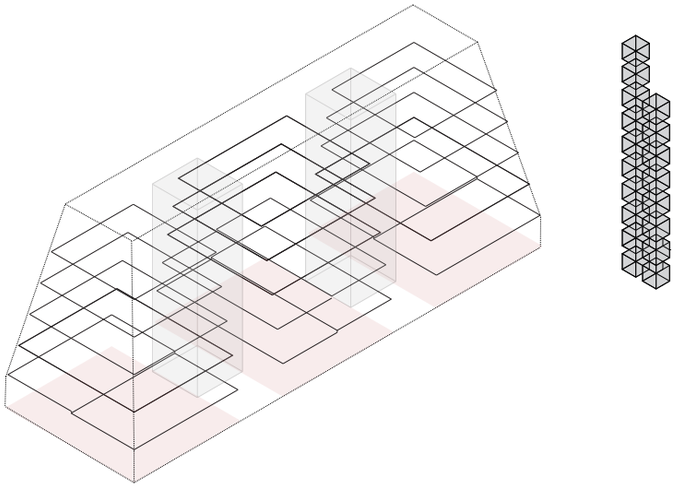
Ill. 42_Design studies

A graphical and conceptual study on the different organizational potentials of the A-volume. The outlines represent different the apartments of the building/



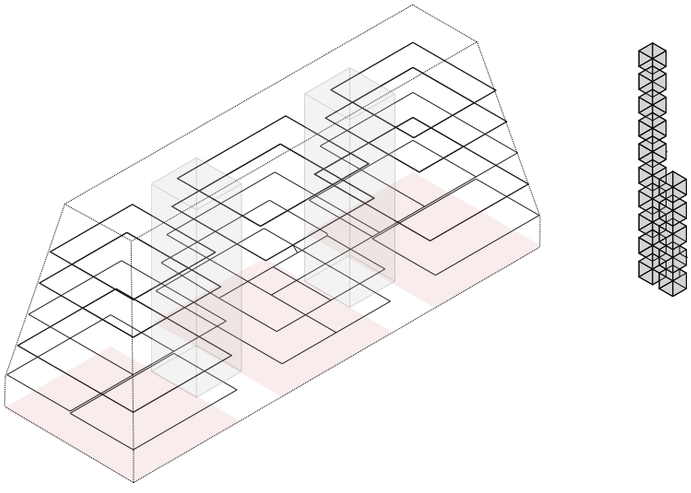
Iteration 01
23 apartments

The initial proposal was focused on creating mid-sized apartments in an effective yet climatically sound layout. Compared to later proposals, the spatial qualities of the apartments are lacking due to the rational approach to sizing. In addition, the wishes of the target users were not deemed to be fulfilled in this layout.



Iteration 02
18 apartments

Reducing the number of apartments provided a higher spatial potential as well as better conditions for eg. natural ventilation. However, particularly the apartments located between the two staircases lacked some of the unique qualities that the site demanded.



Iteration 03
15 apartments

The final proposal has the lowest amount of apartments in total but manage to provide 15 spatially unique apartments. By creating double-height spaces, duplex apartments, large balconies, cross-ventilation and views to multiple sides, the reduced effectiveness of the layout was justified by an overall increase in the quality of living in each of the apartments.

Ill. 43_Distribution studies

004.4
Facades

An outside-in approach to the design of the A-type allows for an early exploration of the technical performance of the building volume with regards to energy consumption and indoor climate. Several facades were investiageted for the A-type but particularly two proposals were of interest given their technical and contextual potential.

The main difference between the design proposals is the addition of an exoskeleton on facade A which provides all apartments with a substantial outdoor area as well as solar shading to the south, east and west. Although the choice could be based entirely off an architectural discussions regarding the aesthetical and contextual qualities of the proposals, the facade design has primarily progressed through an iterative study using LCAByg, Be18, BSim and Velux Daylight Visualizer to determine the specific technical performance of each proposal.

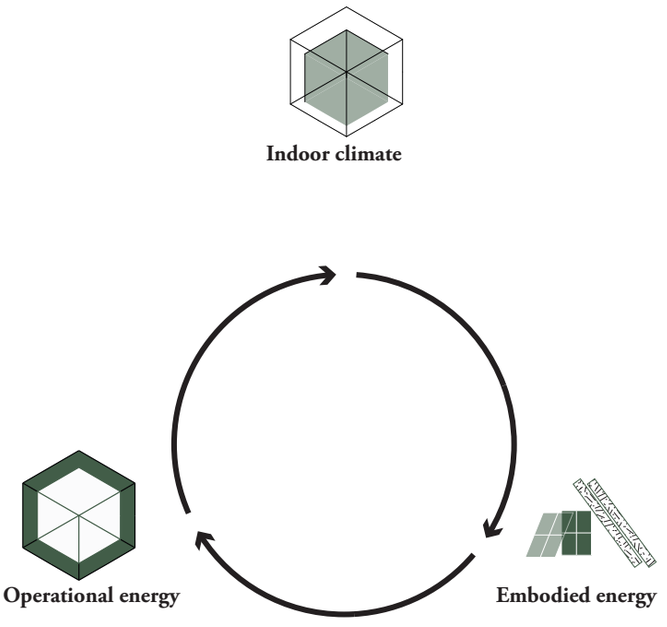
Existing litterature on life cycle analyses show a considerable environmental impact from buildings that have a high amount of glass and aluminium frames. As a consequence, and in order to produce a meaningful comparison between the two design options, the glazing percentage is similar in the two options. Additionally, the gross floor area (which according to the Danish Building Regulations is calculated without balconies) is identical in the two options since the geometry and compactness of the building results in a high contribution to the environmental impact from this construction element.

All models used for the evaluation of both proposals are based off a proximation of a full building design. Certain data has been excluded from the comparison and other preliminary assumptions have been made in order to test the different technical aspects. For the LCA, only the ten primary building elements have been included. For more details on the calculation see appendix 04. Similarly, the BSim model is based off a preliminary apartment design.

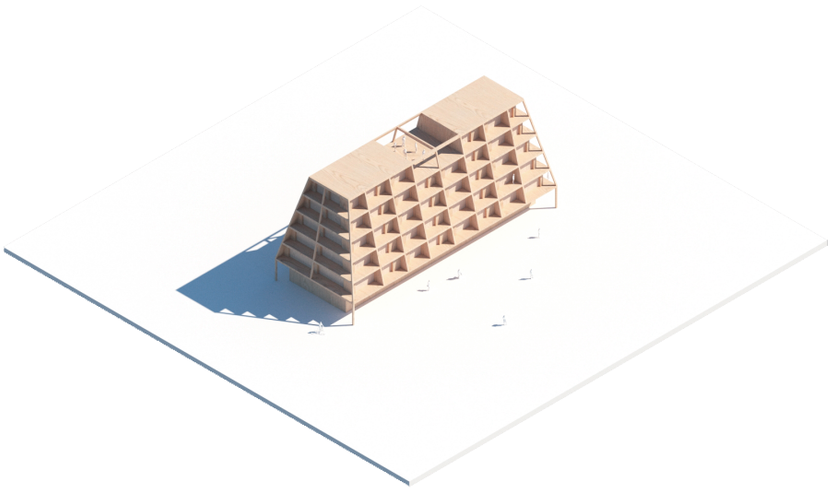
All results related to the comparison are presented on the following spread with comments and discussion. Subsequently, one facade will be chosen and optimized in order to reach a satisfying level in all categories related to energy and indoor climate.

aim

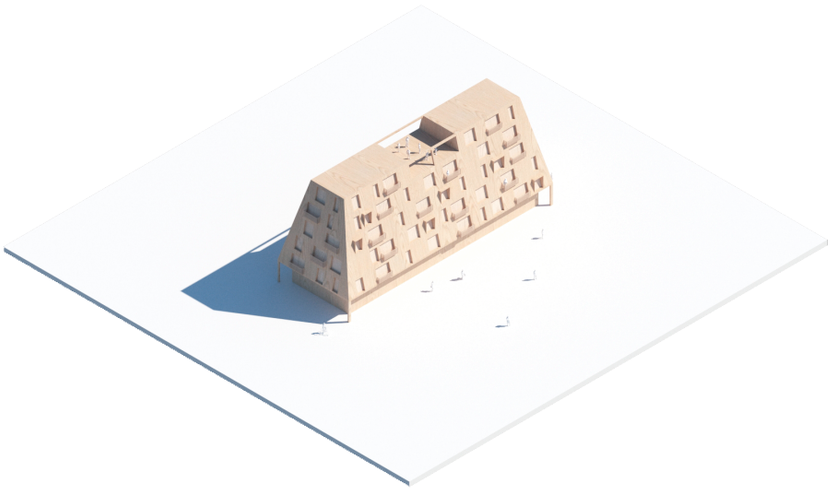
To investigate the optimal ratio of the most commong building materials with regards to energy consumption - operational and embodied - and indoor climate. The study will apply an iterative process of evaluation through software such as Be18, LCA Byg, BSim and Velux Daylight Visualizer.



Ill. 44

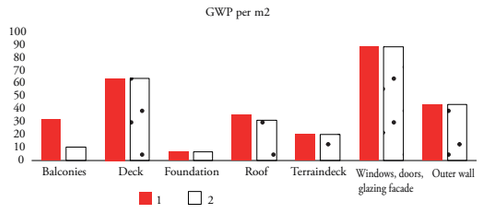


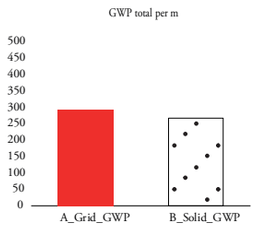
Facade A utilizes an exoskeleton on three sides to create balconies for every apartment in the building while providing shading for the subjacent floor. The structure is supported by visible columns and beams which, if constructed in timber, gives it a distinctly tectonic expression and produces a clear reference to the maritime environment it is situated within. Although the balconies increase the total material usage for the building their impact on the indoor climate and operational energy consumption could potentially outweigh the embodied energy. Finally, the functional-spatial qualities of balconies are a definite advantage.

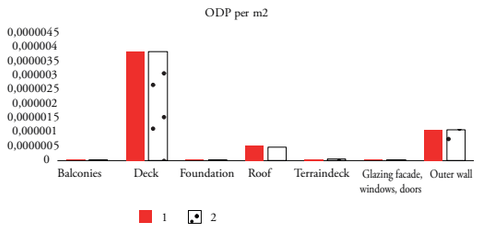


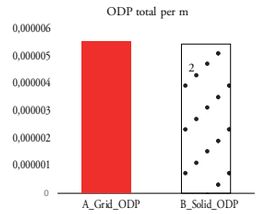
Ill. 45

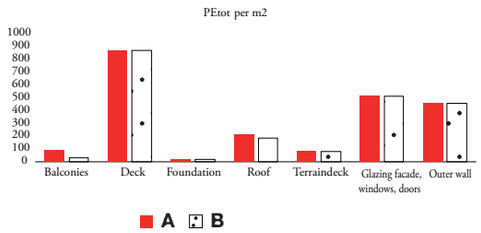
Facade B is arguably the more contextual option of the two given its solid appearance. All exterior walls have an inclination which has a significant spatial impact on the interior spaces in particular. Contrary to facade A, the glazing is largely unprotected from sun exposure. Smaller balconies are provided by pushing in some of the glazed areas which in turn also provides a degree of shading. The clean geometry has a considerably smaller use of materials on the exterior facade which will likely produce a lower environmental footprint from embodied energy in materials. On the contrary, the lack of solar shading will likely affect the indoor climate as well as the total energy consumption negatively.

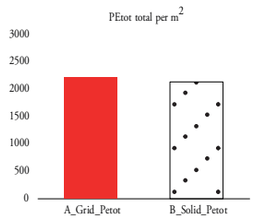


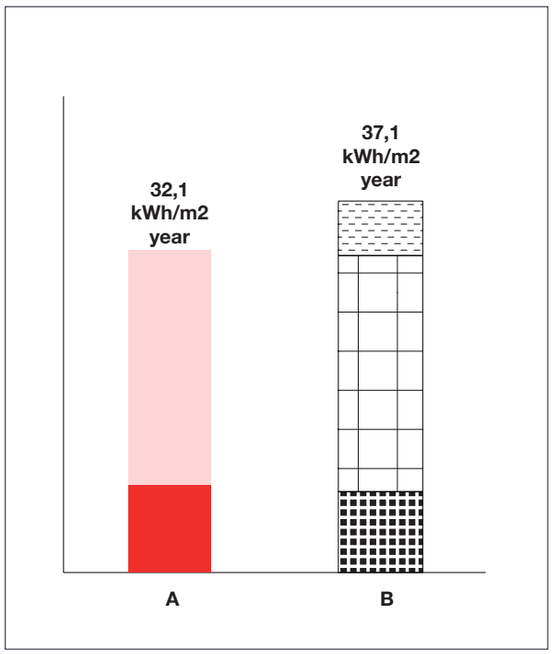








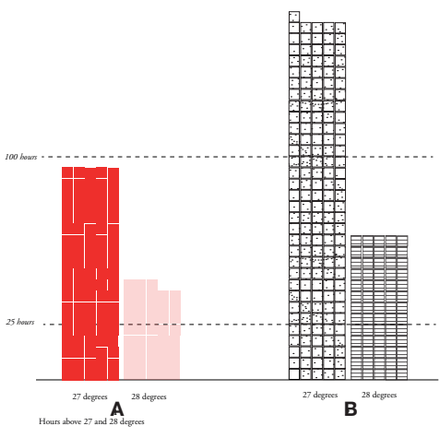


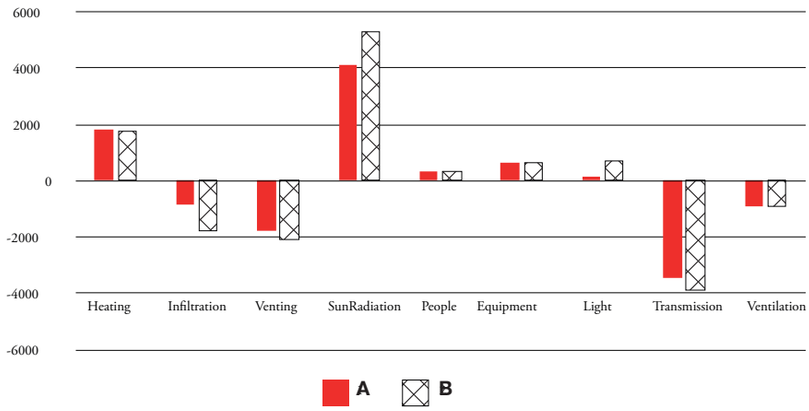


△ **Be18**

◁ **LCA**

▽ **BSim**





Ill. 46

Comparative analysis

Be18/ Operational energy consumption

Neither design proposal meet the current energy frame of 27,0 kWh/m^2 year; as expected facade A performs considerably better with a total energy consumption of 32,1 kWh/m^2 year compared to 37,1 kWh/m^2 year for facade B. Although the demand for heating and the electricity usage in proposal B is higher than proposal A, the primary cause of the increased energy usage stems from excess temperatures in the building.

LCA/ Embodied energy consumption

Since the comparison is based on differences in facade design, the majority of values in the life cycle analysis are identical; consequentially, the difference in embodied energy is directly related to material usage in both design proposal. The added material consumption in facade A results in a 10 % increase in global warming potential, 2 % increase in ozone depletion potential and 4 % increase in primary energy consumption. The difference is predominantly produced by the added material consumption of balconies and railings. However, smaller differences in exterior wall and roof surfaces should also be noted.

In addition to a general comparison of the design proposals, the analysis provides valuable insight into the environmental impact of each construction element. The majority of the embodied energy stems from windows and floor decks. While the impact of the former element was expected, the floor decks have a unusually high score in all categories. This can be explained by two main factors; first of all, the compactness of the building increases the share of floor deck in the building, which is common for apartment blocks. Secondly, the structural material used in for the floor deck in the analysis is made up of a composite timber-concrete deck since this is assumed to affect the indoor climate positively due to concrete's heat capacity. This effect, along with the environmental impact of the floor decks, will be investigated in a subsequent chapter.

BSim/ Thermal indoor climate

The model in Bsim is based on a single apartment with the two different facade designs. The model is set up with the same window area, constructions and systems to be able to compare and evaluate the results between the two facade expressions. By excluding the remaining apartments in the simulation, there will naturally be some deviations from the location of the apartment in the building. This apartment has been chosen on the basis of assumptions about overheating, a comparatively large glass area to the south and west and the fact the apartment is relatively small. The thermal zone is defined as the kitchen and living room, as this zone is exposed to solar radiation. To see the setup of the system for the thermal zone see appendix 02.

Based on the two different types of façade, proposal A performs better in relation to the energy balance; furthermore the frequency of overtemperatures is higher in facade B due to lack of solar shading. In order to reduce the overtemperatures for facade B, an external solar shading would have to be added, which will influence the environmental profile and the expression of the facade. The indoor climate is more balanced in relation to the CO2 level and on the hottest days the temperature is more evenly distributed (appendix 02).

Velux Daylight/ Visual indoor climate

Velux Daylight Visualizer was used to examine the visual indoor climate of each design proposal. Given the decreasing depth of the building towards the top floor, the first floor of the building - which also serves as the first residential level - was used for the study as it is the deepest. Although facade A has an overall increased building depth due to the added balconies, the results show a satisfying daylight level throughout the building. Only a small zone in the center of the building has a daylight level below 2 %. Although facade B provides a better visual indoor climate, the results are not significant and therefore not decisive to the choice of facade design. The results of the daylight analysis can be found in appendix 03.

Optimization

The results of the study illustrate the complexity of energy consumption and indoor climate related to building physics. Although valid technical arguments can be made for either facade, the results show a general favourability of facade option A that incorporated solar shading as an integrated design solution. Although the added material usage increased all LCA parameters, the indoor climate and operational energy consumption was significantly improved by the added geometry. In addition, the visual impact of the shading was insignificant and thus not decisive to the choice of facade design.

A more detailed look at the life cycle analysis showed that the relative share of embodied energy was lower than the operational energy when measured in GWP, ODP and PEtot (appendix 04). The ratio is likely to change significantly with a more precise building model; first and foremost, the operational energy consumption must be brought down to a lower level if the Danish Building Regulations is to be met. Secondly, the LCA building model was a simplified model containing only the ten known construction elements which did not include ventilation, heating or a structurally detailed description of foundations and ground deck. Rather than progress with one aspect outweighing the other, a more nuanced approach have been applied to the development of the facade.

Considering the functional, spatial and aesthetical qualities of each proposal provides additional knowledge to the choice of a facade design. Facade option B has a number of aesthetic qualities, some of which provide a contextual ly superior appearance. The solid and pure geometry relates well to the surrounding environment; the slanted exterior walls can be interpreted as a reference to the characteristic over-dimensioned roofs on Nyholm. In addition, the legibility of the building shape and the retraction of the upper floors creates a strong connection to the surrounding hipped roof buildings. However, the strict and rigid formal language prohibits integrated design solutions to reduce the impact of solar heat on the long, exposed facade towards the south.

In order to address the issues identified in the technical study and create a contextual and aesthetical building exterior, the qualities of the two facade concepts were merged into a unified architectural expression; the northern facade, facing the inner plaza, reflects the solid option and is used interplay with other buildings and the urban spaces. Towards south, and the harbour front, the terraced facade would provide extraordinary views and outdoor spaces, while also shading from the primary sun direction. Eliminating the balconies on the eastern and western facades would create a more clearly defined building volume and demonstrate the formal expression of the building; however it also requires additional simulations on the thermal indoor climate as the sun will affect these facades. Also the embodied energy of the building will be reduced by removing balconies on these facades.

Upon settling on an exterior expression another round of design iterations were used to improve and optimize the energy performance and indoor climate of the building. The strategies presented are directly related to the findings in the first study and should thus provide a well-informed and significant reduction in energy consumption and improvement in the thermal and visual indoor climate. The following page show the new energy and indoor performance of the building after applying the strategies. The reference used for the comparison is facade option A. Further studies can be found in appendix 03 and 04.

Strategy 01/

Reduce balcony area

Strategy 02/

Improve u-value

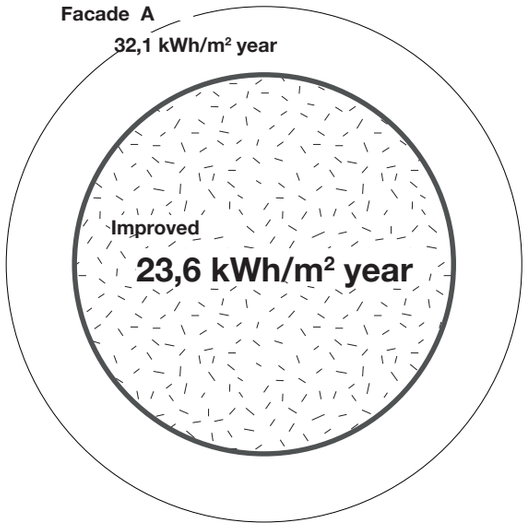
Strategy 03/

Reduce total glass area

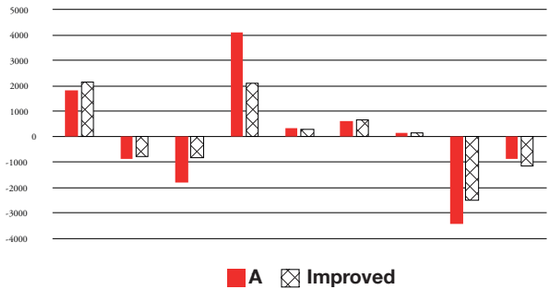
Strategy 04/

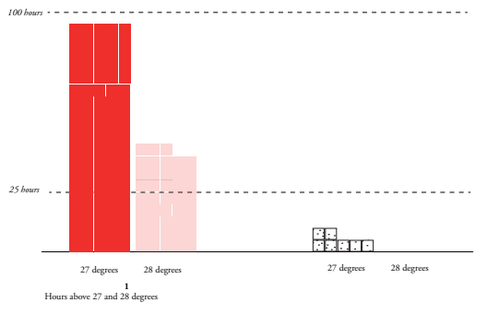
Improve constructions and material choices

Be18 ▷

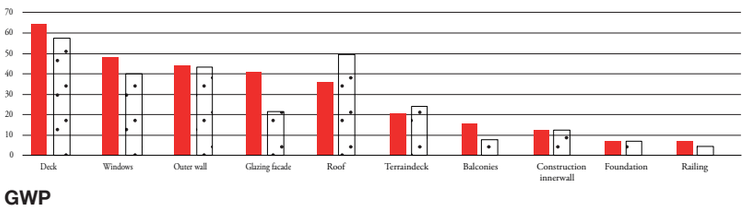


BSim ▷

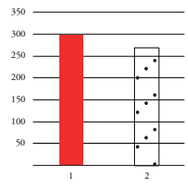


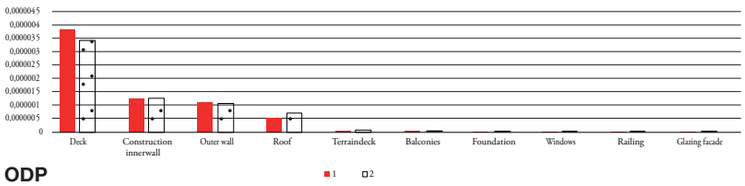


LCA ▷

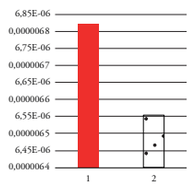


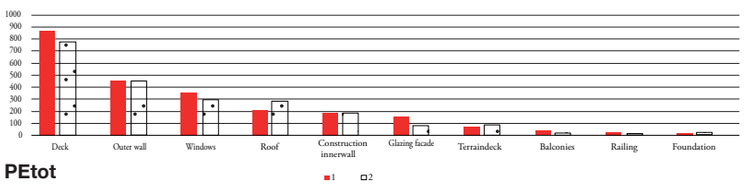
GWP



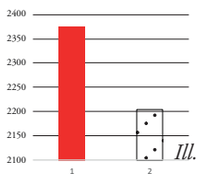


ODP





PEtot



Ill. 47

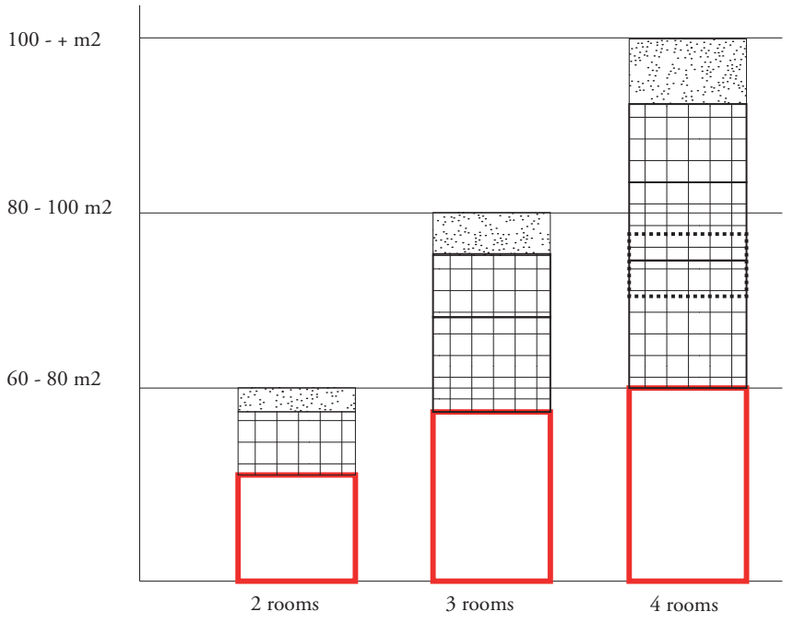
004.5
Apartments

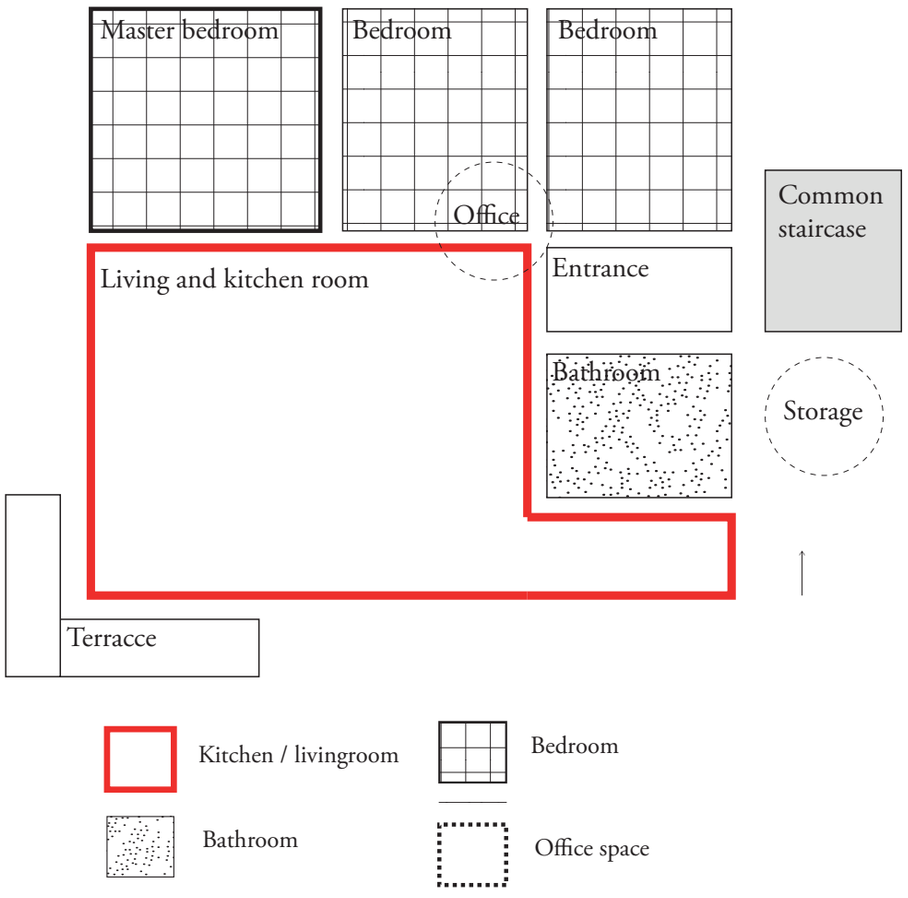
Creating apartments of high architectural quality means formulating spatial, functional and technical ambitions at an early point in the design phase. Overall, a distinction can be made between strategies and tactics of achieving architectural quality; strategies describe a more general design intent such as creating a comfortable indoor climate while the tactics describe actual design decisions that are expressed in the final design. The strategies and tactics shown here have been developed parallel to the design development of volumes and facades and is thus a good example of the non-linear and iterative workflow of designing a housing development.

Since the A-type is the detailed focus of this thesis, a room program has been developed for its spatial configurations and demands (appendix 01). The room program takes predefined technical aims into considerations; it also functions as a guideline in the process of ensuring compliance with the Danish Building Regulations and the Danish Standard for Indoor Environment. The energy frame for residential projects in the low-energy class is currentl set at 27,0 kWh/m^2 year. With regards to the indoor climate, category 2 is used as it covers a normal level of expectation. Indoor temperatures cannot exceed 100 hours above 27 degrees and 25 hours above 28 degrees. CO2 concetration must be below 850 ppm with an average air change of 0,35 l/s m^2.

Parking is not included in the room program as it otherwise should be; our wish is to make Nyholm a car-free zone due to the economic and environmental costs associated with it. In practice, this would entail applying for exemption at the municipality which is naturally not within the scope of this project.

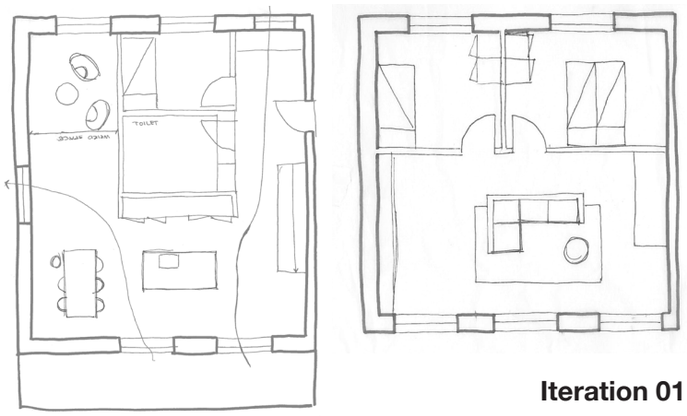
Strategies	Tactics
Create optimal connections between the indoor and outdoor spaces of the apartments	Provide level free access from from the interior to the balcony
	Use sliding doors for the balcony access that have an opening width of more than 1,5 m
Create a healthy and comfortable indoor climate	Living spaces must have windows on two facades to take advantage of natural ventilation.
	Detail the window design to improve the visual indoor climate and to take advantage of natural ventilation principles
	Integrate an exterior solar shading to prevent overheating in the apartment.
Create apartments of high spatial quality	Use window placement to create optimal views to the surrounding harbour.
	Use variations in floor height to create spatial diversity.
	Use building geometry to emphasize room quality.
	Create multifunctional zones in the living spaces that are both connected and separated.
Create apartments of high functional quality	Integrate storage in the interior walls in order to maximize floor space
	Minimize the number and size of corridors.
	Create spatial niches in the apartment to increase its perceived size.
	Optimize the plan layout of the apartment to reduce the length of installations and pipes in the floors and ceiling.


100 - + m2
80 - 100 m2
60 - 80 m2
2 rooms
3 rooms
4 rooms


Master bedroom
Bedroom
Bedroom
Office
Common staircase
Living and kitchen room
Entrance
Bathroom
Storage
Terracce
Kitchen / livingroom
Bedroom
Bathroom
Office space

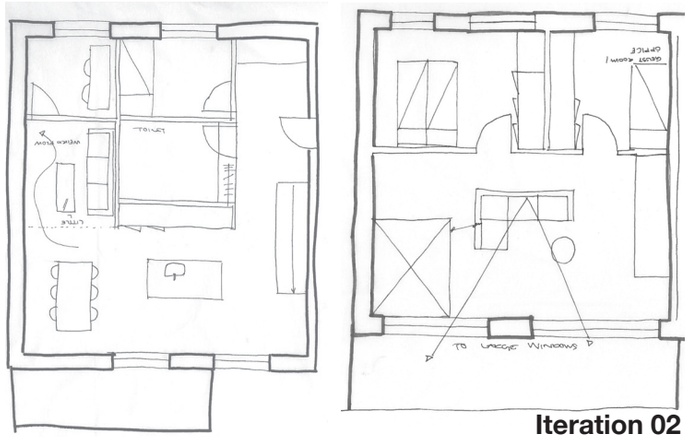
Ill. 48

In order to illustrate the process of developing a high-quality floor plan one of the apartments is shown in four different iterations on this page. Specifically, this apartment is located in the top corner of the A-type. The dimensions of the apartment have been predetermined by the overall distribution concept for apartments and stairwells. The total area of the apartment is 110 m² which would optimally include three bedrooms. Central issues to the development of this particular plan is functionality, spatial niches, views and the design of a double-height space in the living area.



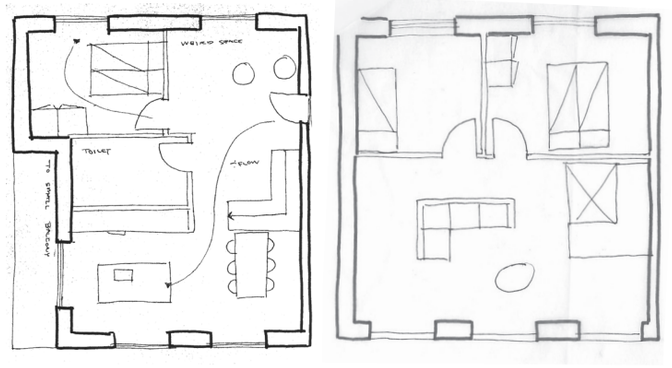
Iteration 01

In the first and second iteration, the kitchen and the bathroom are centrally located which creates long, narrow spaces on all sides of the core. The rooms and the living spaces become very small because of this and the space is not used functionally. The separation of the double-height space and the staircase does however provide the apartment with much variation in the spatial experience and, compared to the other proposals, an additional bedroom (a total of four) has been included.



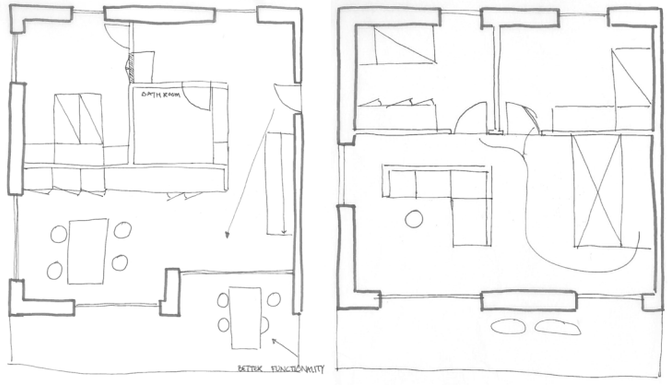
Iteration 02

Tbe third iteration includes an angled stair that provides the space with a dynamic quality. However, it also presents a potential conflict with the view from the entrance area to the southern windows. Good functional spaces are provided in this plan both to the north and south although there is a larger undefined space to the north outside the bedroom. On the upper floor, two functional bedrooms are placed to the north while a large living area is faced south.



Iteration 03

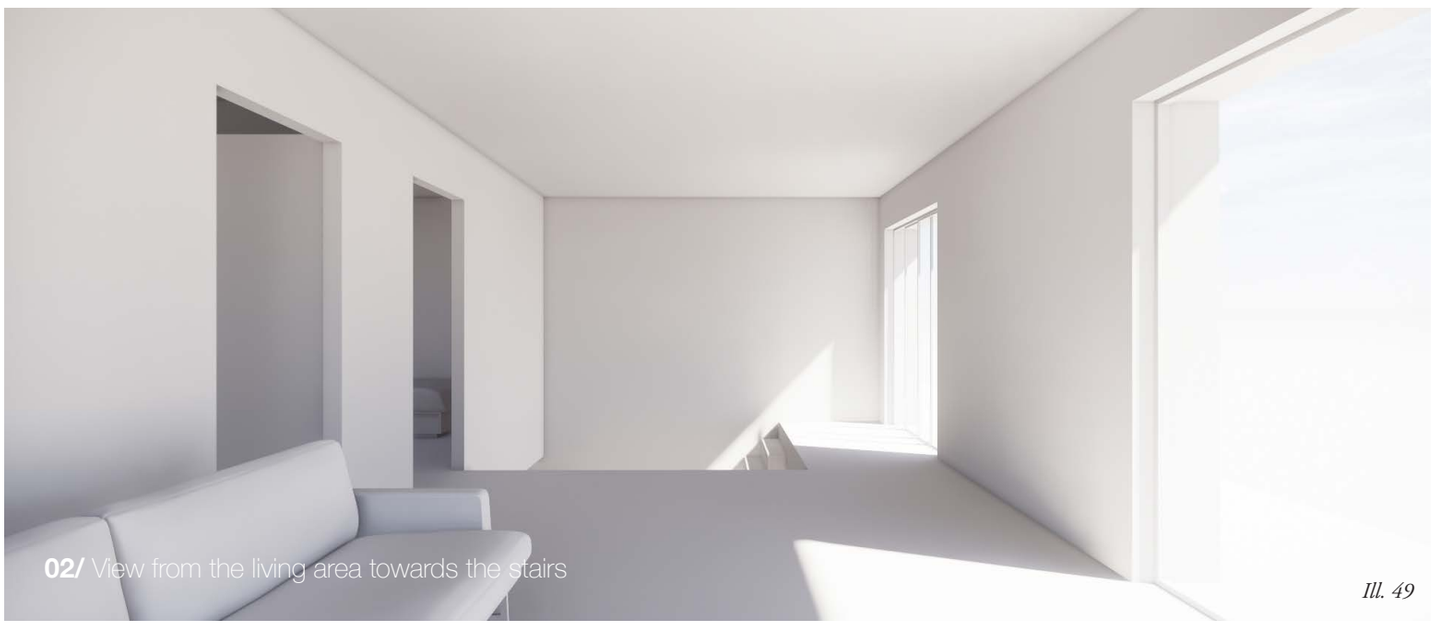
In iteration four the plan has been solved in relation to view lines, flow, functionality, daylight, ventilation and spatial quality. An additional aspect of the design has been the integration of the pipe and installation placement of the underlying apartments. Furthermore, achieving a balanced piping system has been important. The relationship between inside and outside has also been addressed in iteration four; a large, functional terrace to the south has been integrated in the final proposal.



Iteration 04

01/ View from the stairs on the upper level

02/ View from the dining area towards the stairs



02/ View from the living area towards the stairs

Ill. 49

004.6
Materials

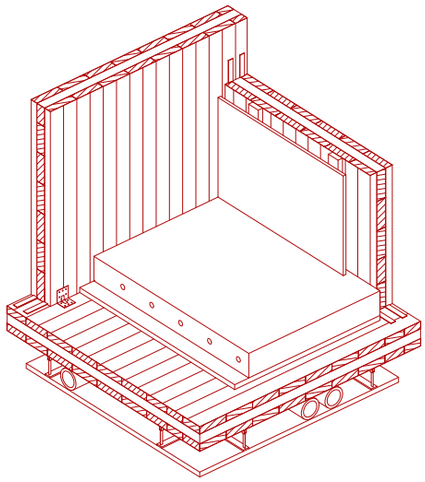
Architecture is intrinsically tied to the thoughtful and critical use of materials. Material selection and composition is one of the most impactful design tasks of architecture given the psychological, physical, aesthetical and functional impacts of materials. The sensory impact of materials relate to a wide range of aspects; light, tactility, acoustics, smell, color, beauty. In addition, building materials can be chosen for their health-related properties as certain materials can improve the thermal and atmospheric indoor environment of a space.

The physical context of Nyholm constitutes a variety of different materials, textures and colors that produce a certain atmosphere in the area. The addition of new building volumes requires a thoughtful approach in order to preserve the existing qualities of Nyholm while accentuating its material identity. The image on the following page is a visual representation of the intended exterior expression of the new urban development on Nyholm. The materials are chosen in order to create a contextual development that imitates the materials and colors of the existing buildings of Nyholm.

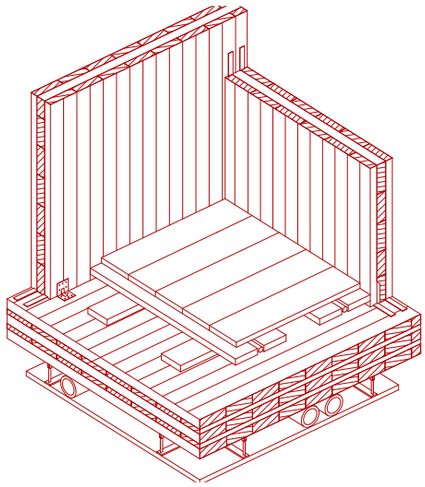
In addition to the cladding of the interior and exterior surfaces of the buildings, the construction of the A-type has been significant to the aim of creating an environmentally sustainable building. Prior project-specific LCA research and studies have shown the favourability of a timber construction, which is why the building is conceived as a CLT panel construction. The floor decks however also utilize the thermal properties of concrete as it is assumed to produce a more thermally stable indoor environment due to its heat storage capacity.

A study on the thermal and environmental impact of a composite timber-concrete floor deck is presented on the following spread. The aim is to weigh the potential thermal benefits of concrete against its environmental profile. A Be18 model and daylight simulation have also contributed to the outcome of the study but are only included in appendix 05. Ill. 50 show the different construction types that have been selected for the study. They are all related to the final construction method of the A-type and thus also include considerations on the the placement of pipes and services, heating, assembly and finally aesthetics.

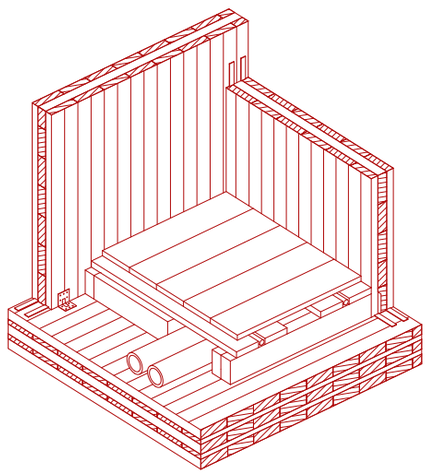
The final pages of this section include a life cycle analysis of different cladding options. The materials have been selected based on their relation to the surrounding context and their tactile qualities. A total of eight visualizations of facade materials accompany the LCA study which only covers five different materials; some of the visualizations are merely variations of similar materials included in the LCA study. The comparison is based on 1 m^2 of exterior wall which also explain the relatively small, but significant, variation in the results.



Option 01
Floor_Concrete (structural)
Walls_CLT (cladding)
Ceiling_CLT (cladding)



Option 02
Floor_Oak parquet (cladding)
Walls_CLT (structural)
Ceiling_CLT (structural)



Option 03
Floor_Oak parquet (cladding)
Walls_CLT (structural)
Ceiling_Wooden slats (cladding)

Ill. 50

Ill. 51

Option 01
Floor_Concrete (structural)
Walls_CLT (cladding)
Ceiling_CLT (cladding)

Option 02
Floor_Oak parquet (cladding)
Walls_CLT (structural)
Ceiling_Wooden slats (cladding)

Ill. 52

Option 03
Floor_Oak parquet (cladding)
Walls_CLT (structural)
Ceiling_CLT (structural)

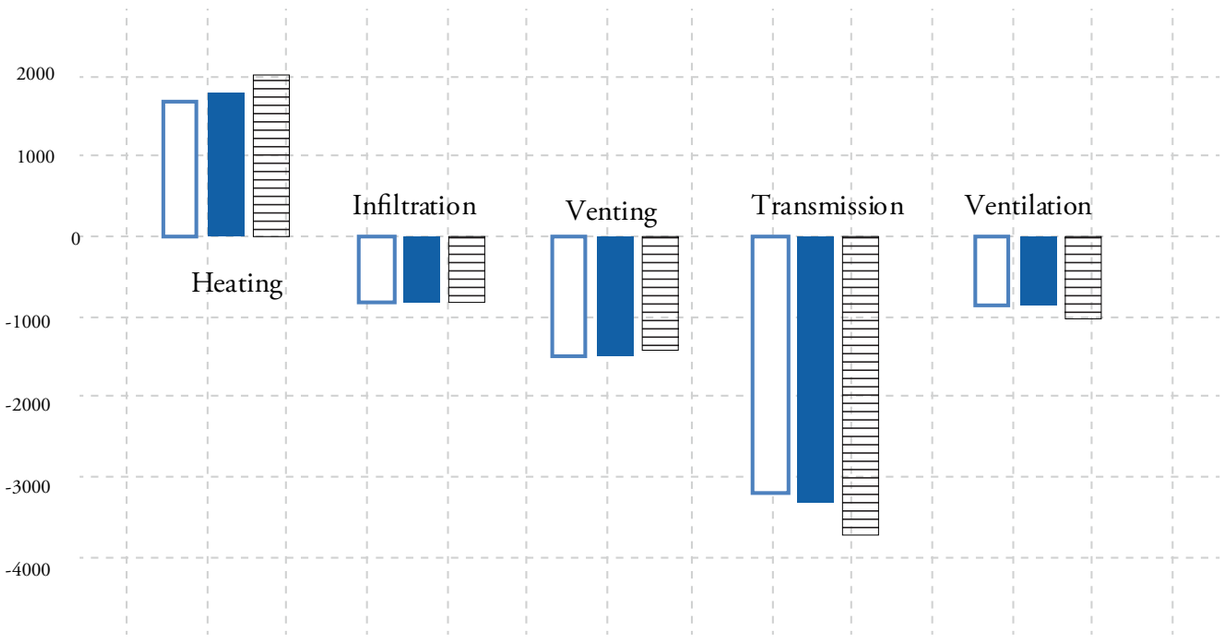
The following study will test the thermal impact of composite timber-concrete floor deck in BSim compared to a an exposed CLT floor and a light structure clad with an oak parquet floor. The BSim results will be evaluated against the embodied energy of the three options as calculated in LCA Byg.

With regards to BSim, the study is set up with the same geometry and system to be able to measure the effect of three different deck constructions. We are specifically investigating the heat accumulation capacity of different deck constructions and whether it has a significant influence on the thermal indoor climate. The aim is to utilize the thermal mass to even out the variation of the room temperature and thereby create a more stable indoor climate, ultimately reducing the need for heating. The constructions have the the same amount of insulation, however, the u-values deviate because of the variation in the construction material. The evaluated parameters in BSim are heating, infiltration, venting, transmission loss and ventilation, since sunradiation, people, equipment and light are static.

The results show that the light construction performs the worst, which is expected due to it lower heat capacity. The difference between the concrete and CLT floor deck is however far smaller than expected. Exposed concrete only provides a minimal improvement in the thermal indoor climate although has a significantly higher heat capacity than CLT. The cause of the results does however not relate to the thermal properties of the materials; instead, CLT - and solid timber-based products in general - have a higher moisture accumulation capacity. The process of adsorption and desorption in materials have an energy impact equal to heat accumulation which results in an improvement in the thermal indoor climate for the CLT deck.

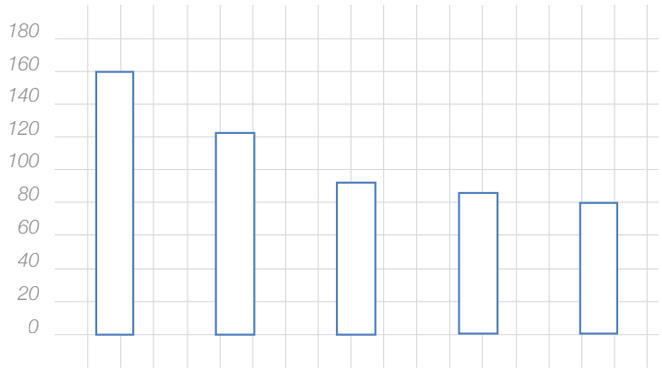
The life cycle analysis of the same floor decks show the favourability of option 03, which has exposed CLT panels on walls and ceiling (appendix 04). The floor is a parquet floor resting on top of wooden battens and in between them space for ventilation pipes and other service installations. The CLT deck have the lowest score in global warming potential and primary energy use.

The combined results of the studies show that the CLT floor deck should be chosen on the basis of its environmental profile and its contribution to the indoor climate.

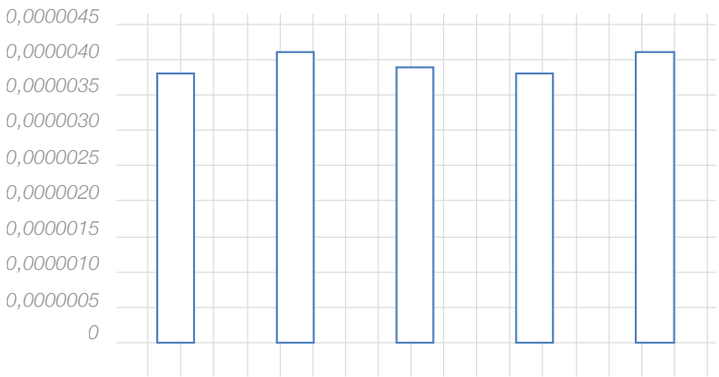


Ill. 53

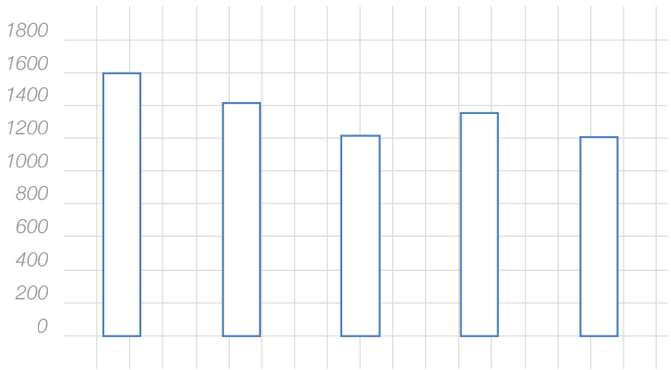
GWP



ODP



PEtot



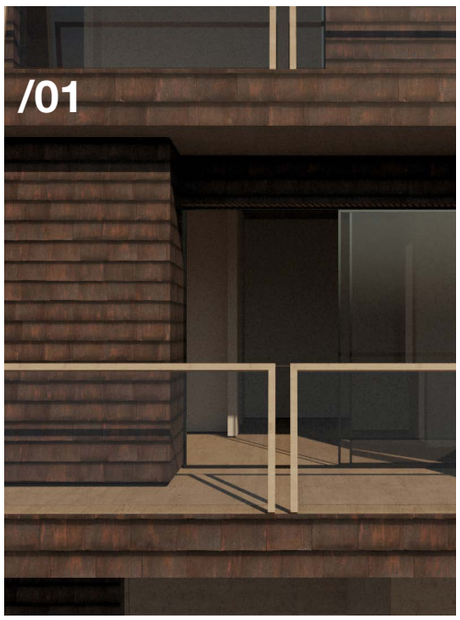
Natural stone

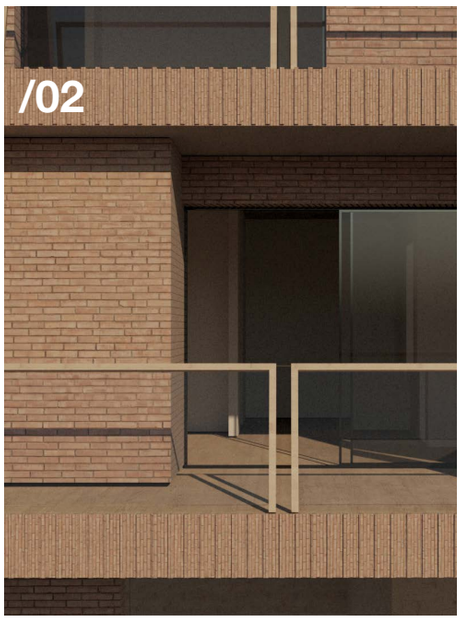
Brick

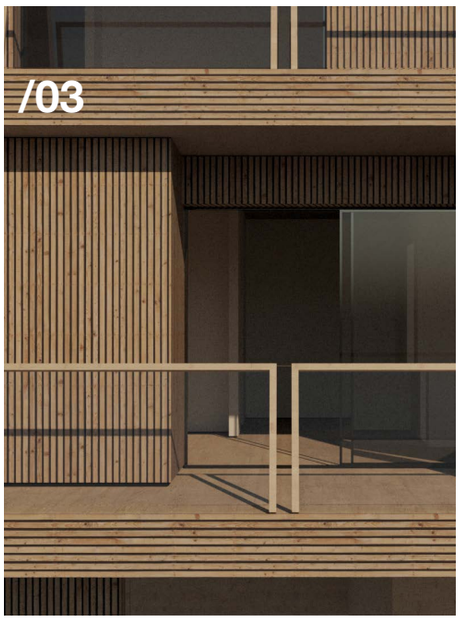
Wood, pine

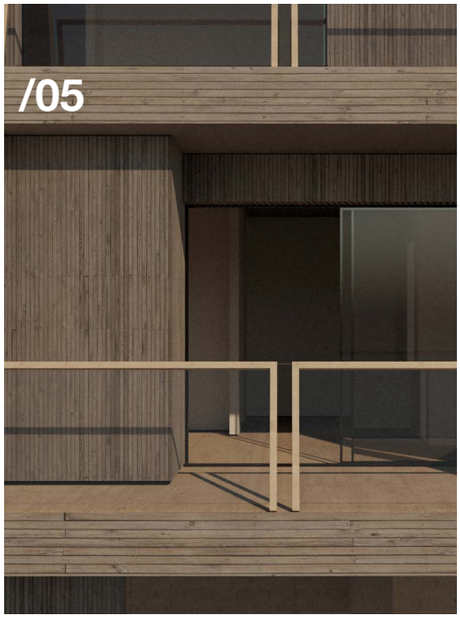
Tile

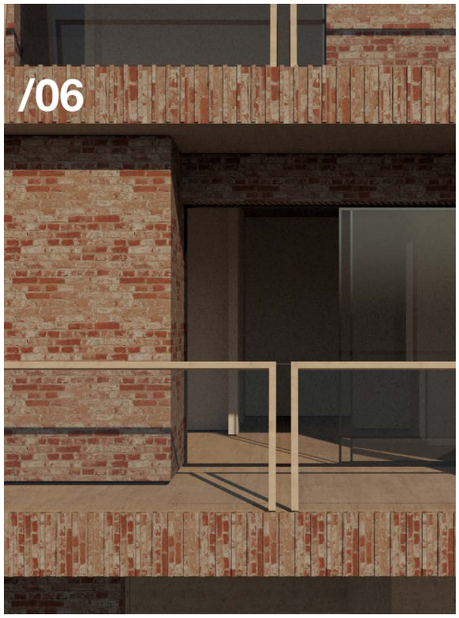
Reused brick

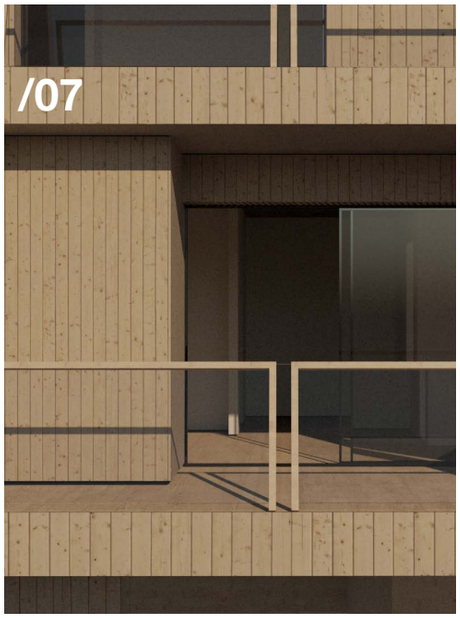


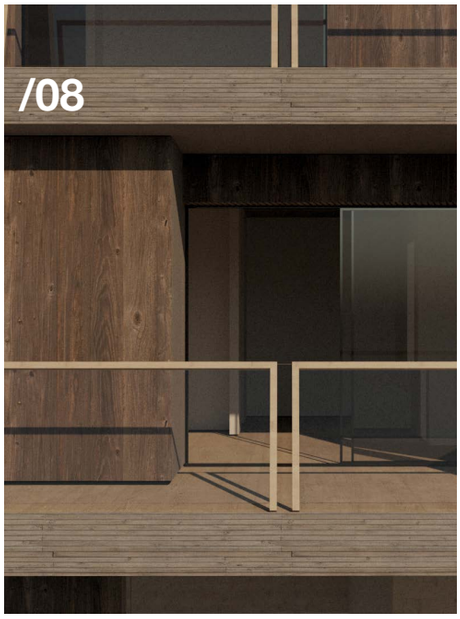












Ill. 54

In conclusion, when basing the study off all materials included in the exterior wall, the difference in the LCA are less pronounced than when materials are compared specifically against eachother. The environmental footprint of the materials studied and presented here does however show the importance of such calculations when deciding on an exterior cladding. The global warming potential of an exterior wall clad with natural stone is roughly double the value of reused brick. The latter show generally good results across all categories and should thus be considered a sustainable option for cladding. In addition, wood cladding also represent a fairly good option as it uses the lowest amount of primary energy. Considering that wood can be used for energy production after it has served its purpose as cladding, the primary energy score is even better as it is embedded in the material.

005.

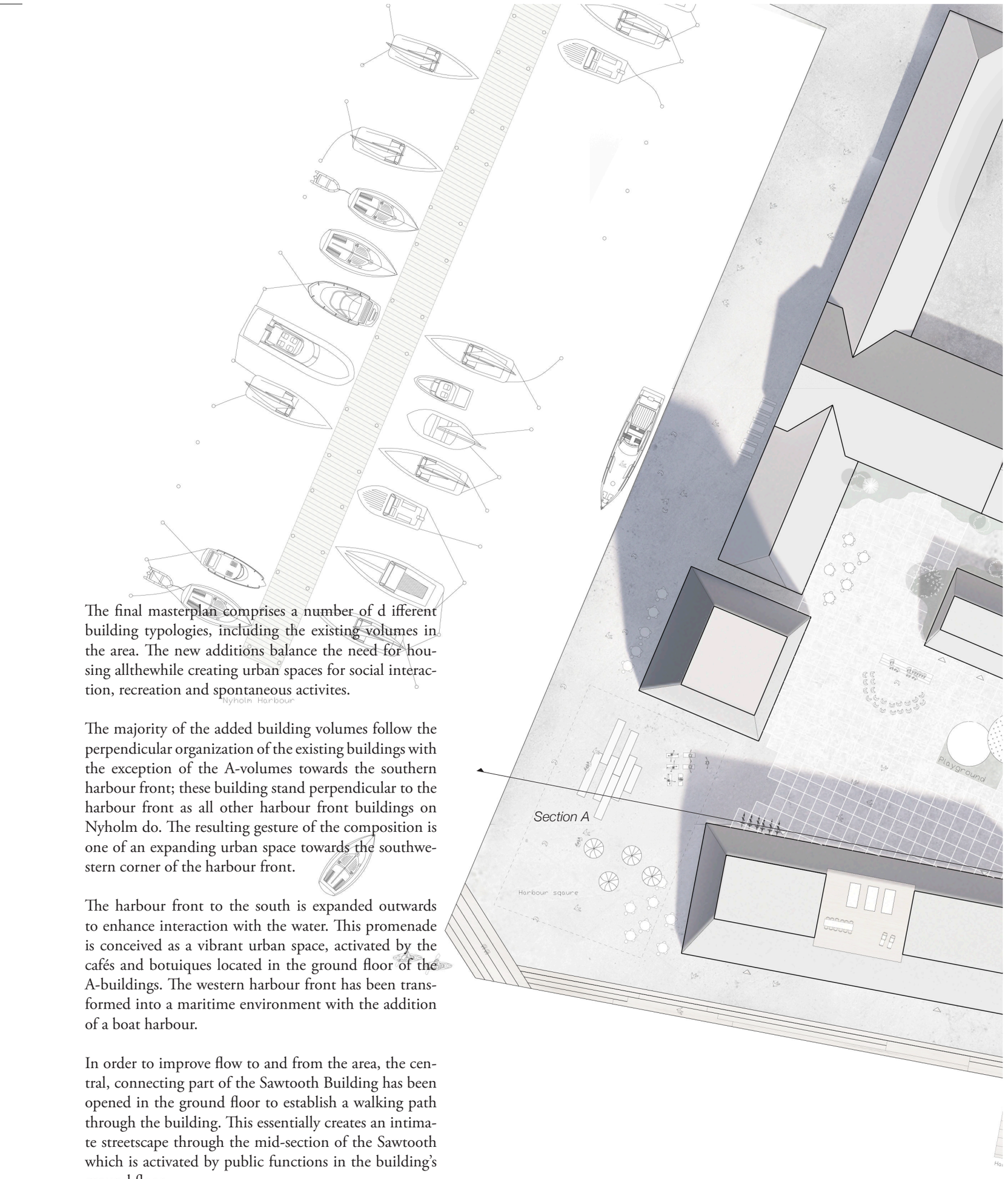
Presentation

Nyholm Naval Quarters

The cultural-historical environment of Nyholm is given new life through a contemporary and sustainable urban quarter. As a landmark development, Nyholm Naval Quarters stand as the symbol of the ongoing transformation of the island into a unique cultural, historical and residential environment for the city of Copenhagen. The defining qualities of Nyholm are preserved through a humble and respectful approach to the transformation of buildings and urban spaces, while new activities are introduced to enliven the island.

The following presentation will focus on the urban renewal of Nyholm through the design of a mixed-use residential quarter; subsequently, the strategies of preservation, adaptation and addition will be presented to show the meaningful synergy that can arise out of a contextual and sustainable transformation of a culture-historical city district

Ill. 55



The final masterplan comprises a number of d ifferent building typologies, including the existing volumes in the area. The new additions balance the need for housing allthewhile creating urban spaces for social interaction, recreation and spontaneous activites.

The majority of the added building volumes follow the perpendicular organization of the existing buildings with the exception of the A-volumes towards the southern harbour front; these building stand perpendicular to the harbour front as all other harbour front buildings on Nyholm do. The resulting gesture of the composition is one of an expanding urban space towards the southwestern corner of the harbour front.

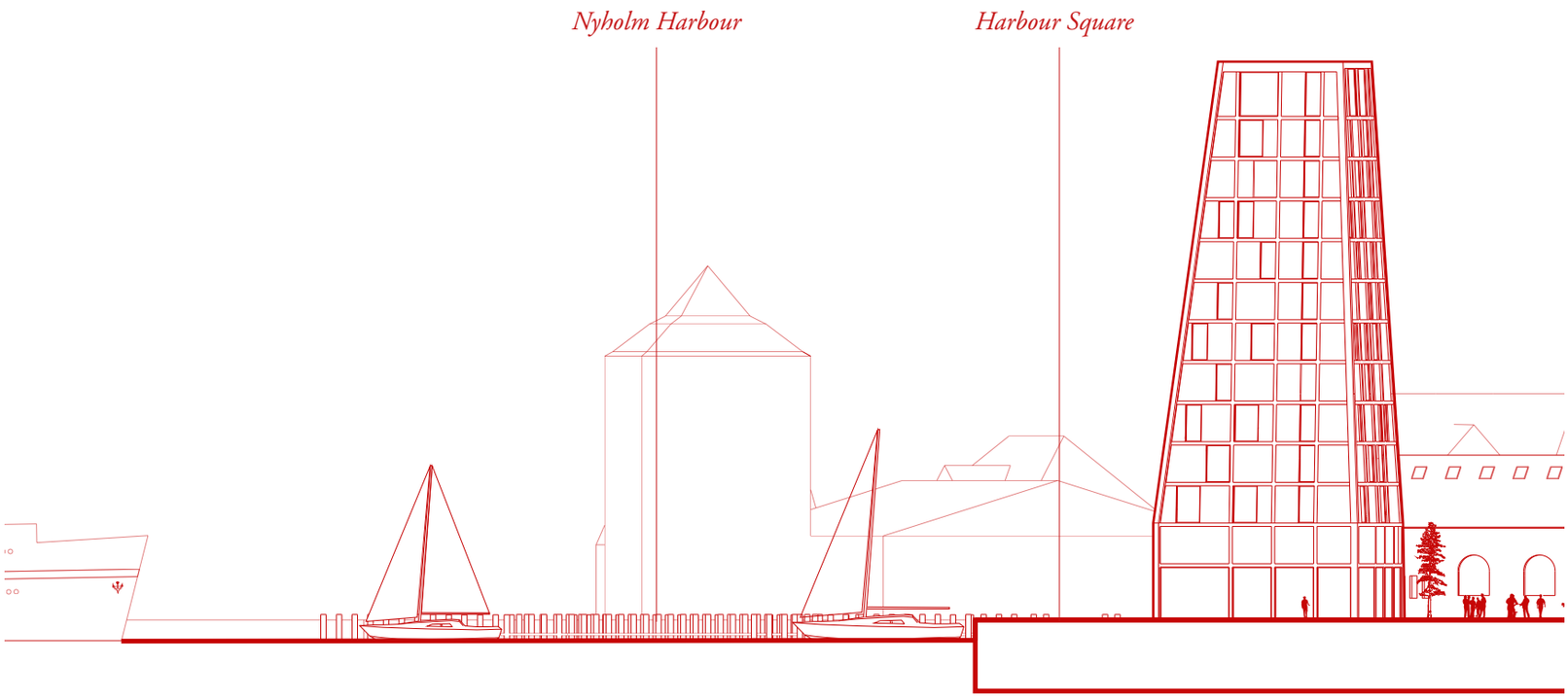
The harbour front to the south is expanded outwards to enhance interaction with the water. This promenade is conceived as a vibrant urban space, activated by the cafés and botuiques located in the ground floor of the A-buildings. The western harbour front has been transformed into a maritime environment with the addition of a boat harbour.

In order to improve flow to and from the area, the central, connecting part of the Sawtooth Building has been opened in the ground floor to establish a walking path through the building. This essentially creates an intimate streetscape through the mid-section of the Sawtooth which is activated by public functions in the building's ground floor.

Masterplan

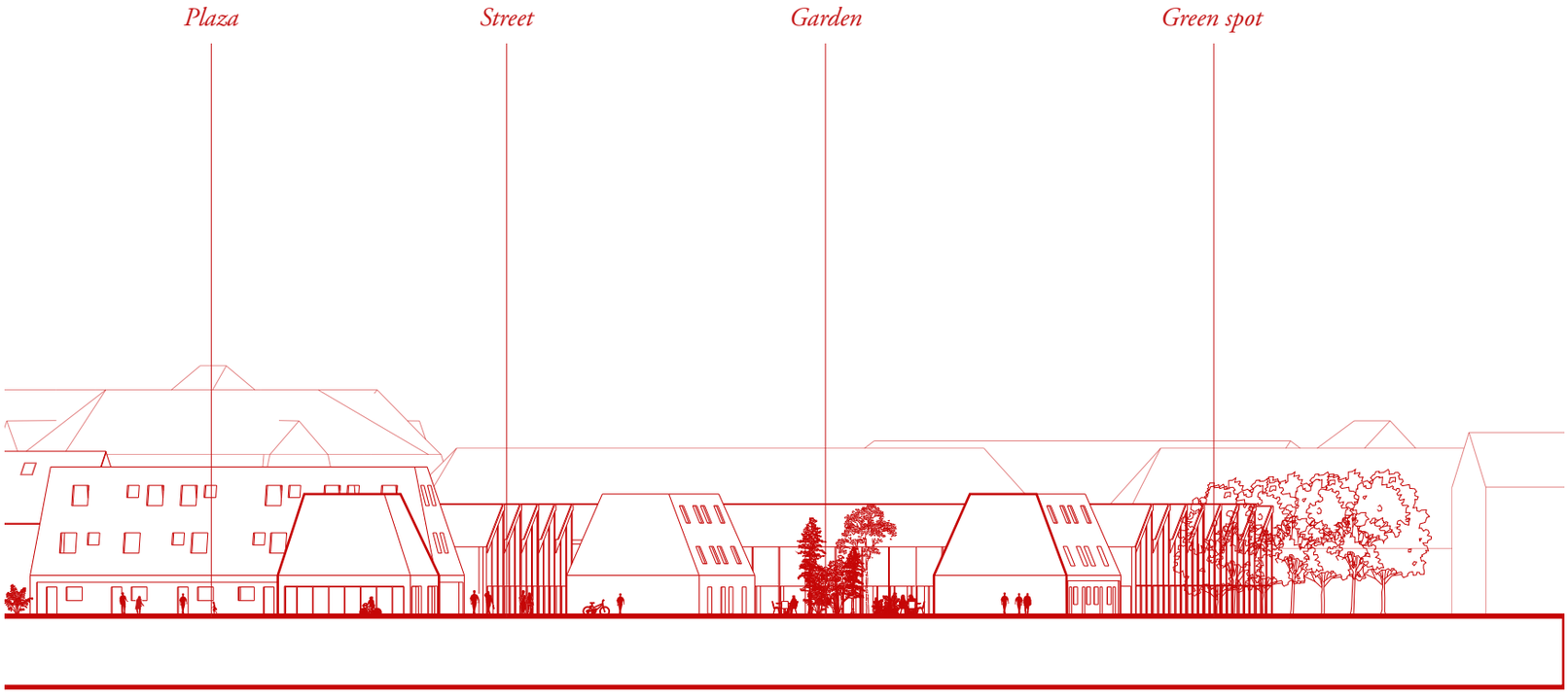
1:500

Ill. 56


Nyholm Harbour
Harbour Square

Section A

The contrast in the urban spaces must be found in the open spaces and building scale towards the harbour, where the street, the green strip and the garden between the townhouses convey a human scale, which the remaining Nyholm possesses. Cohesion is a key word for the new harbour area at Nyholm, which is part of the experience of the whole. The outdoor facilities and the facilities of the buildings support the maritime functions that can take place in and around the water.



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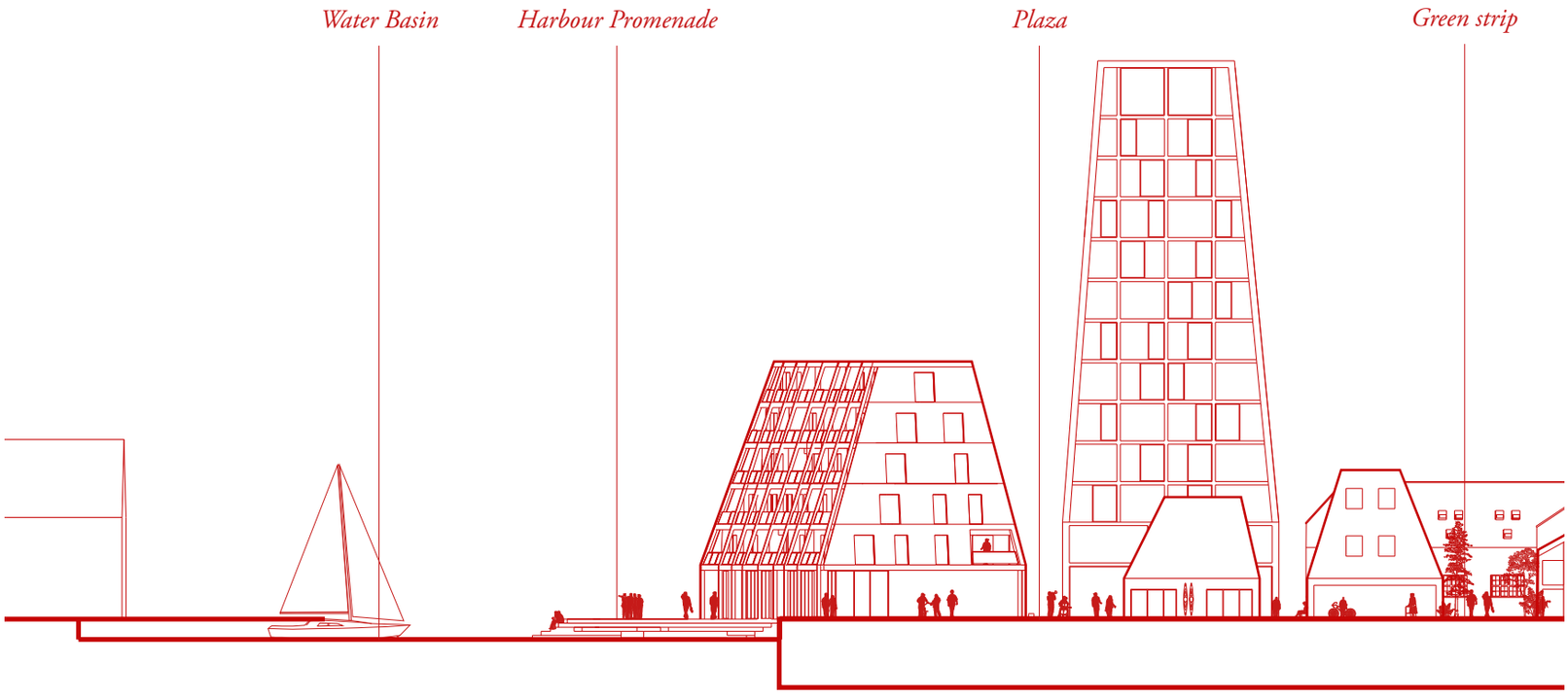
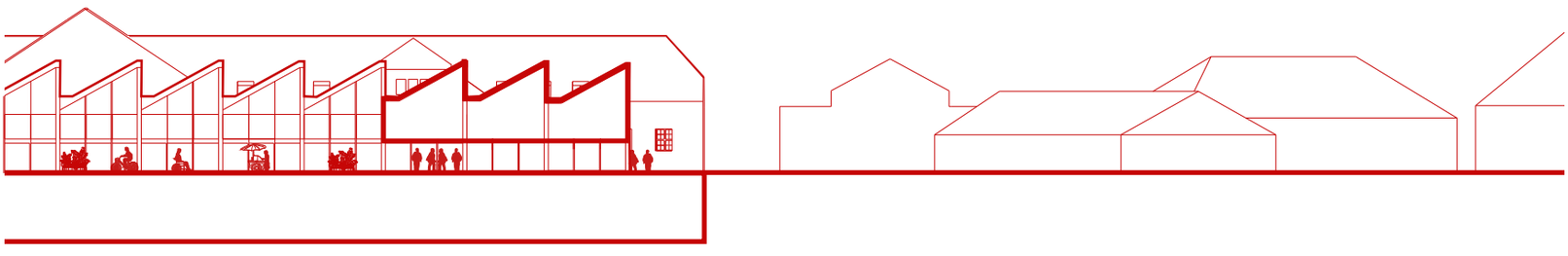

Water Basin
Harbour Promenade
Plaza
Green strip

Section B

The various urban spaces create spatial experiences and niches for the benefit of both residents and visitors. The ground floors vivid and transparent expression that opens up to the square, the harbour and the promenade invite to stay. With references to the existing buildings, the tall marker building humbly leans back in respect of the Brick Building next to it.



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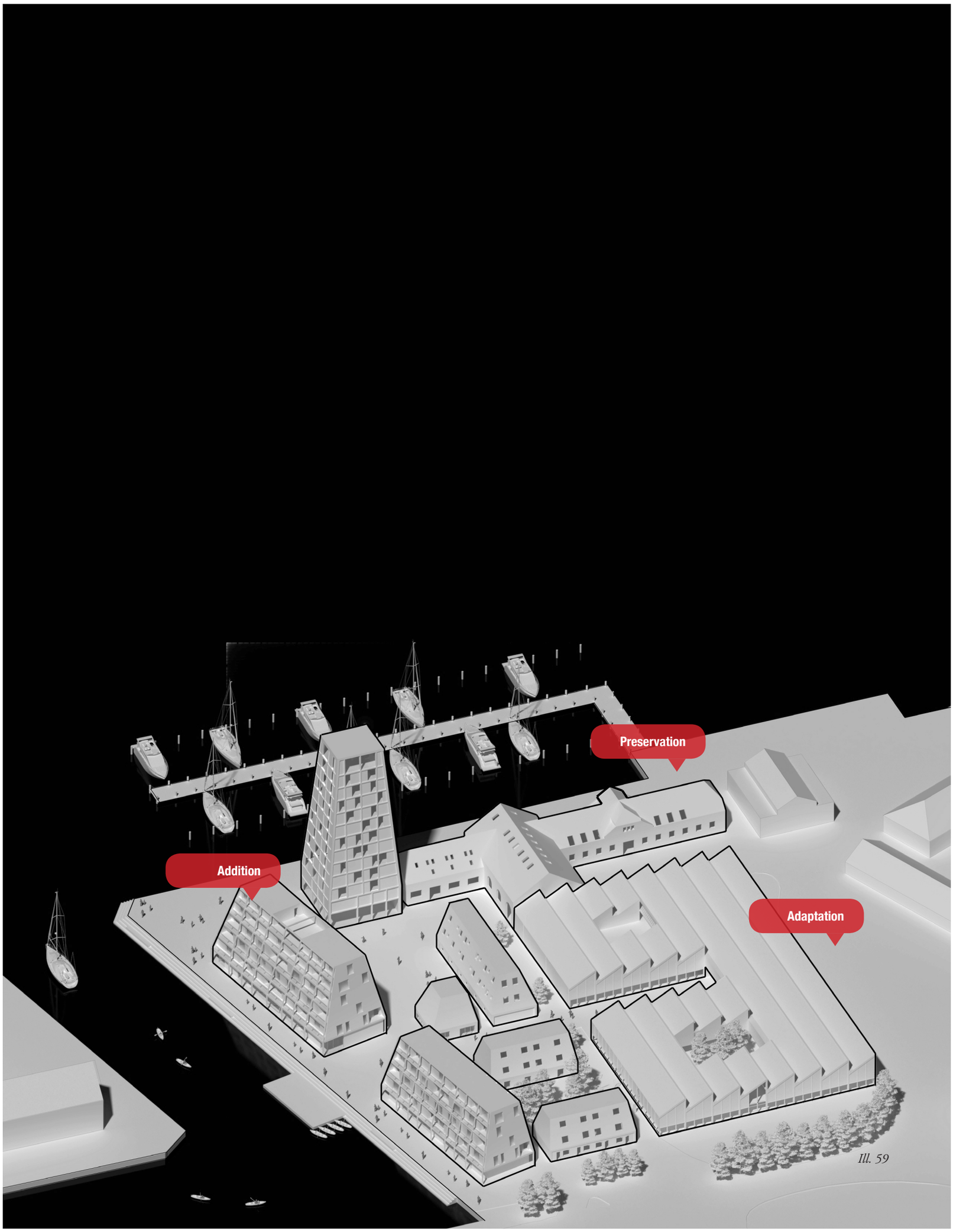


Ill. 59

A new urban quarter

The A-Buildings

The A-volumes have a shared functional organization as a residential typology with open and public ground floors although they differ in height and depth. They are both intended to define and activate the southern harbour front with cafés and shops in the ground floor while providing views through the building to the inner plazas. The gap between the two building volumes are a small but significant node in the area as it serves as a junction between the harbour front, the central plaza and the street running north through the Sawtooth Building.

The Lighthouse

The Lighthouse is the focal point of the new development, rising 13 stories above the ground to create a contemporary and urban gesture towards the Inner Harbour. Although seemingly contrasting in scale, the Lighthouse assimilates to the neighbouring building through materiality but also proportions. Above the public ground and first floor, which holds a restaurant, 11 stories of housing provide additional apartments without compromising the open spaces that are defining to Nyholm.

The Townhouses

Tucked inbetween the A-volumes, the Lighthouse and the existing buildings are a number of samller townhouses that bring the physical environment down to a more human-oriented scale. Above the ground floor, the townhouses have an inclination towards the top in order to open the space in the vertical direction. The townhouse vary slightly in height and materiality to create a differing but complementing expression. The buildings are divided into narrow three-story housing units similar to the infill typology in order to create a spatially interesting and efficient housing typology.

The Sawtooth

The distinct formal language of the Sawtooth makes it ideal for galleries, artist workshop or a similar option more commonly associated with the characteristic diffuse light from north-facing window bands. Instead, the need for housing, particularly smaller affordable units, has produced an original interpretation of the industrial typology as a dormitory with a large number of housing units with certain shared facilities. The dormitory occupies three quarters of the building while the last quarter is designated retail purposes such as a supermarket which is not currently present in the near proximity.

The Harbour House

The red brick building facing the western harbour front is the only decidedly non-residential building in the area - apart from the workshop. Its function is derived from its proximity to the water and the new boat harbour in front of it. The central wing (perpendicular to the harbour front) contain a large two-story restaurant overlooking the harbour front while providing access to the inner plaza of the development.

The Workshop

The final but smallest addition to the new development on Nyholm is the centrally located workshop. The workshop is conceived as a functionally adaptable building which can serve as a workshop or a . As a public, open and active structure in the middle of the development it will activate and enliven the spaces around it.

Preservation

The Harbour House / *The Brick Building*

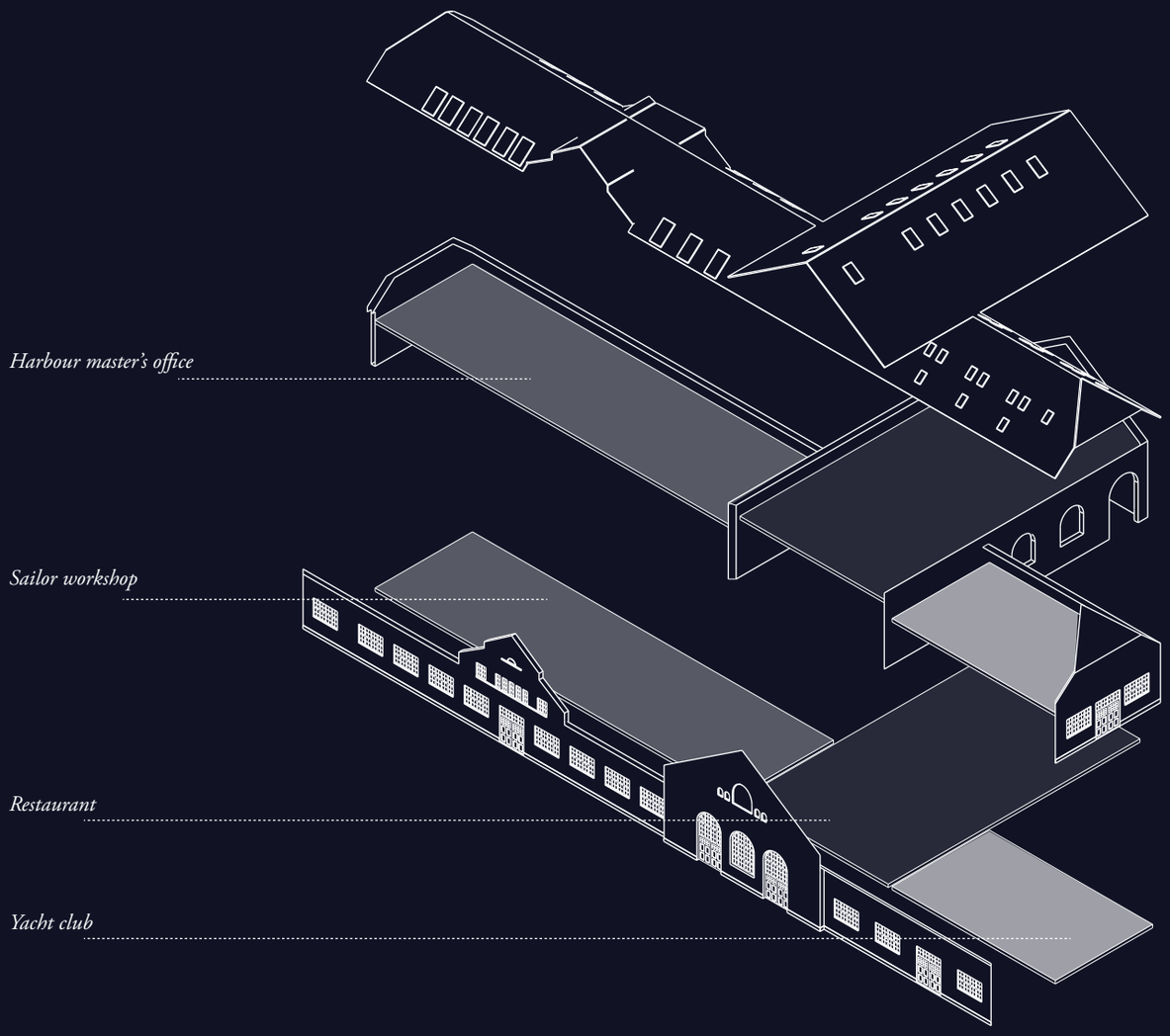
The high preservation-value of the Brick Building can be ascribed to a range of factors, including the aesthetical and functional value of the building as it stands today (appendix 07). As a result, we have chosen to work with a preservation strategy in which new functions are fitted into the existing building volume without further intervention or physical alteration of the building's exterior.

The proximity of the Brick Building to the water has defined the functional proposal for the building. The beautiful facade of the central wing marks the main entrance to the buidling, thus making the space within ideal for a welcoming area related to the boat harbour. In addition, the central wing will accomodate a two-story restaurant open to yachtsmen or other visitors as the well as the residents of the area. The restaurant is ideally located for goods delivery from the north and provides easy access through the Brick Building to the main plaza in the new development. Inside, a centrally located staircase creates a double-height room, providing a great spatial experience upon entering the building.

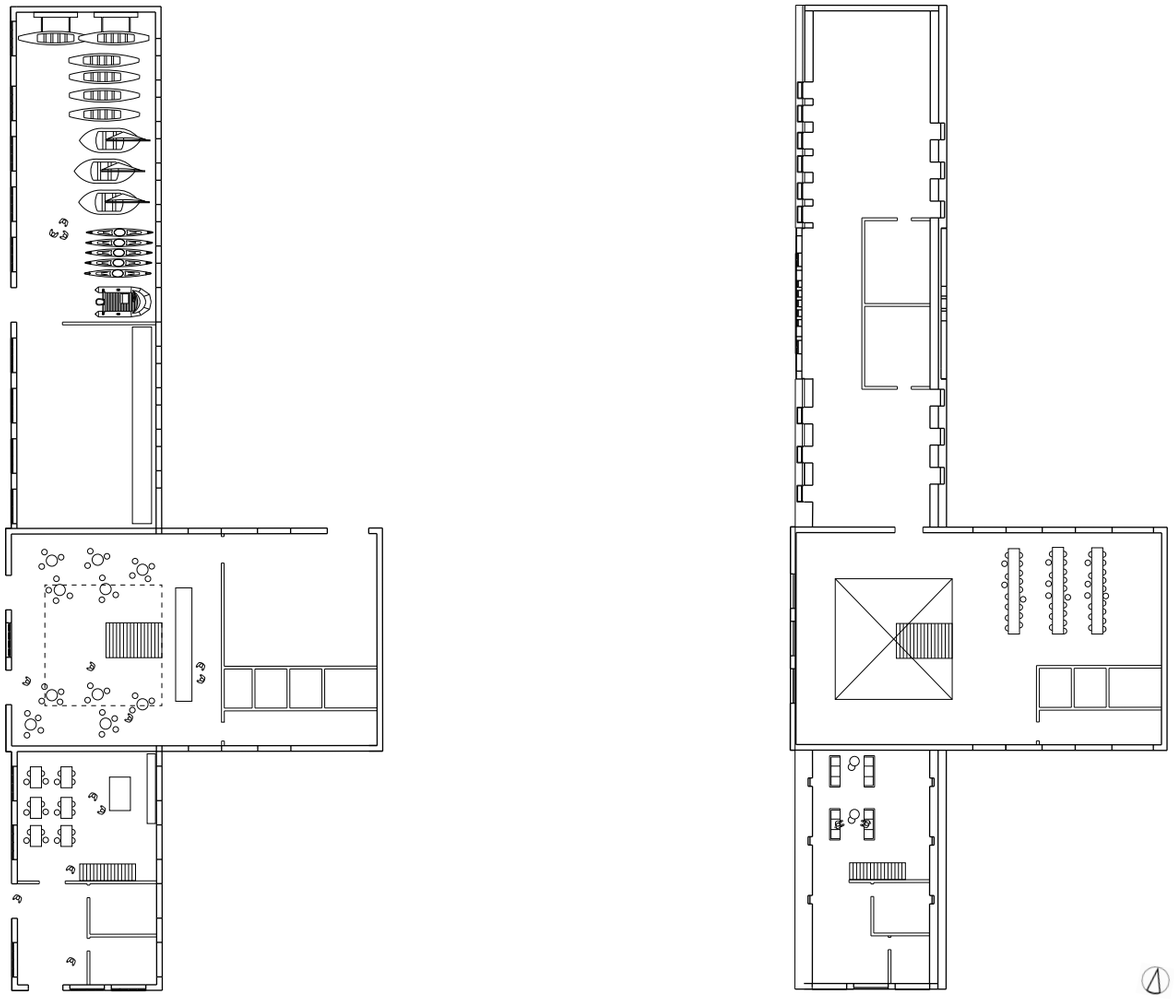
Historically used for storing and building torpedo boats, the original purpose of the Brick Building has been partly restored in the northern end of the building by the reintroduction of shipbuilding facilities and storage. The height of the ground floor makes such as transformation possible. On the upper floor, additional maritime functions can be allocated such as a harbour maseter's office.

Creating a new harbour environment requires common areas for yachting enthusiasts, a communal kitchen, bathrooms, washroom, workshop areas, storage and so on. These functions are all provided in the wings of the Brick Building that run perpendicular to the harbour front.

he proposed design of the Brick Building is a conceptual idea meant to support the presentation of the southern development area. A detailed design requires a further exploration of the functional, structural and technical constraints of the building.


Harbour master's office
Sailor workshop
Restaurant
Yacht club

Ill. 59



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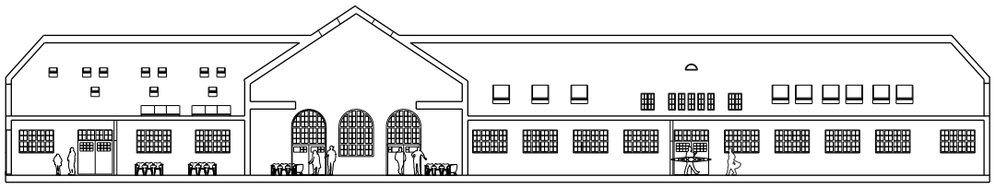

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Ill. 61

Adaptation

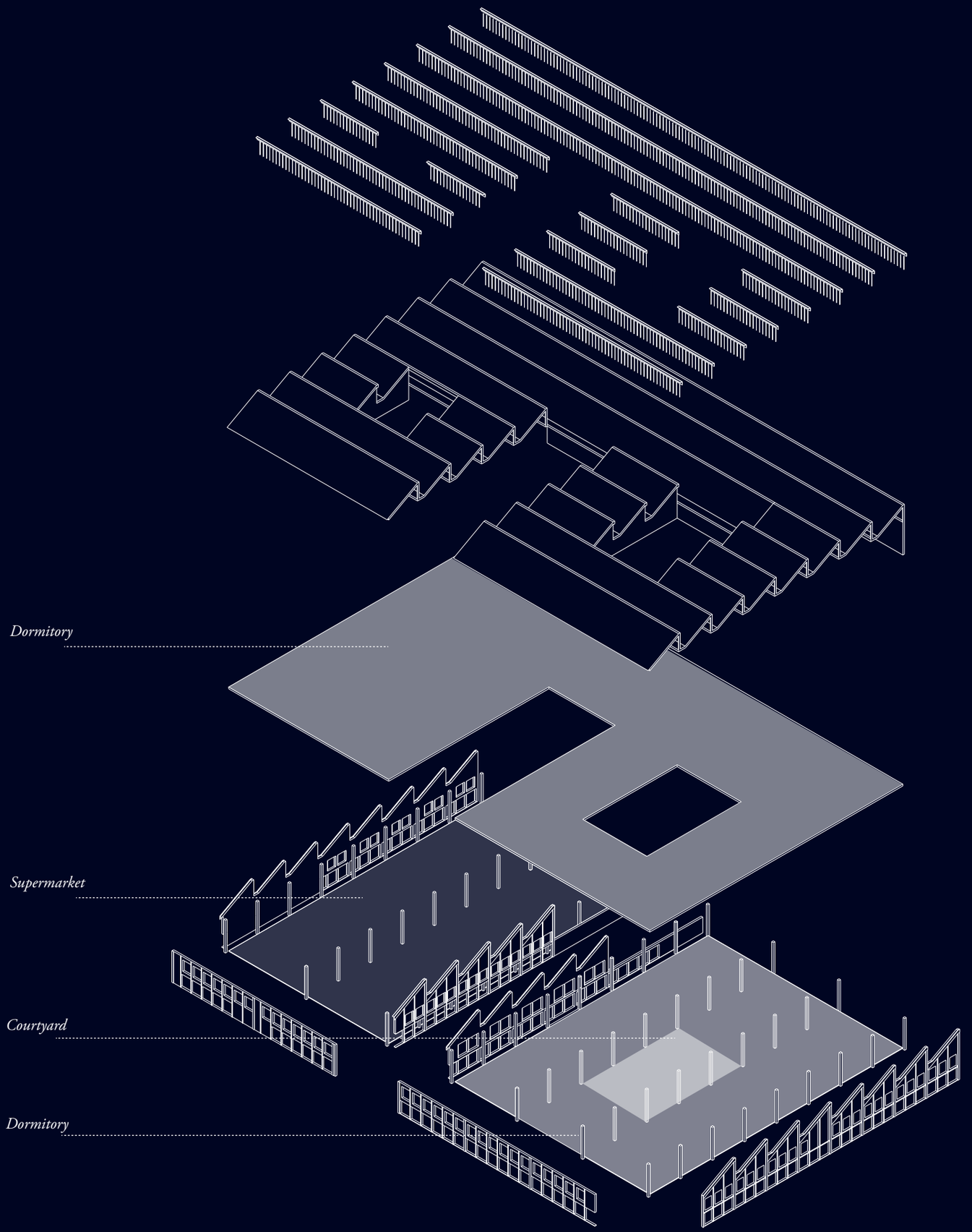
The Sawtooth Building

One of the most significant characteristics of Nyholm is the history of development which is manifested in the building heritage. Although not an architecturally significant contribution to the area, the Sawtooth is a distinct and important part of the history of Nyholm as a place of maritime history and progress (appendix 07). The industrial typology is commonly transformed into larger spaces such as exhibition halls or galleries. The aim of creating a socially diverse quarter has however formed a different concept for the transformation of the Sawtooth; a mixed-use building that functions as a dormitory with common spaces, a café and a supermarket. The conflict between the demands of living spaces and the proportions of the industrial building has necessitated a different approach to this building, thus introducing the second strategy, adaptation.

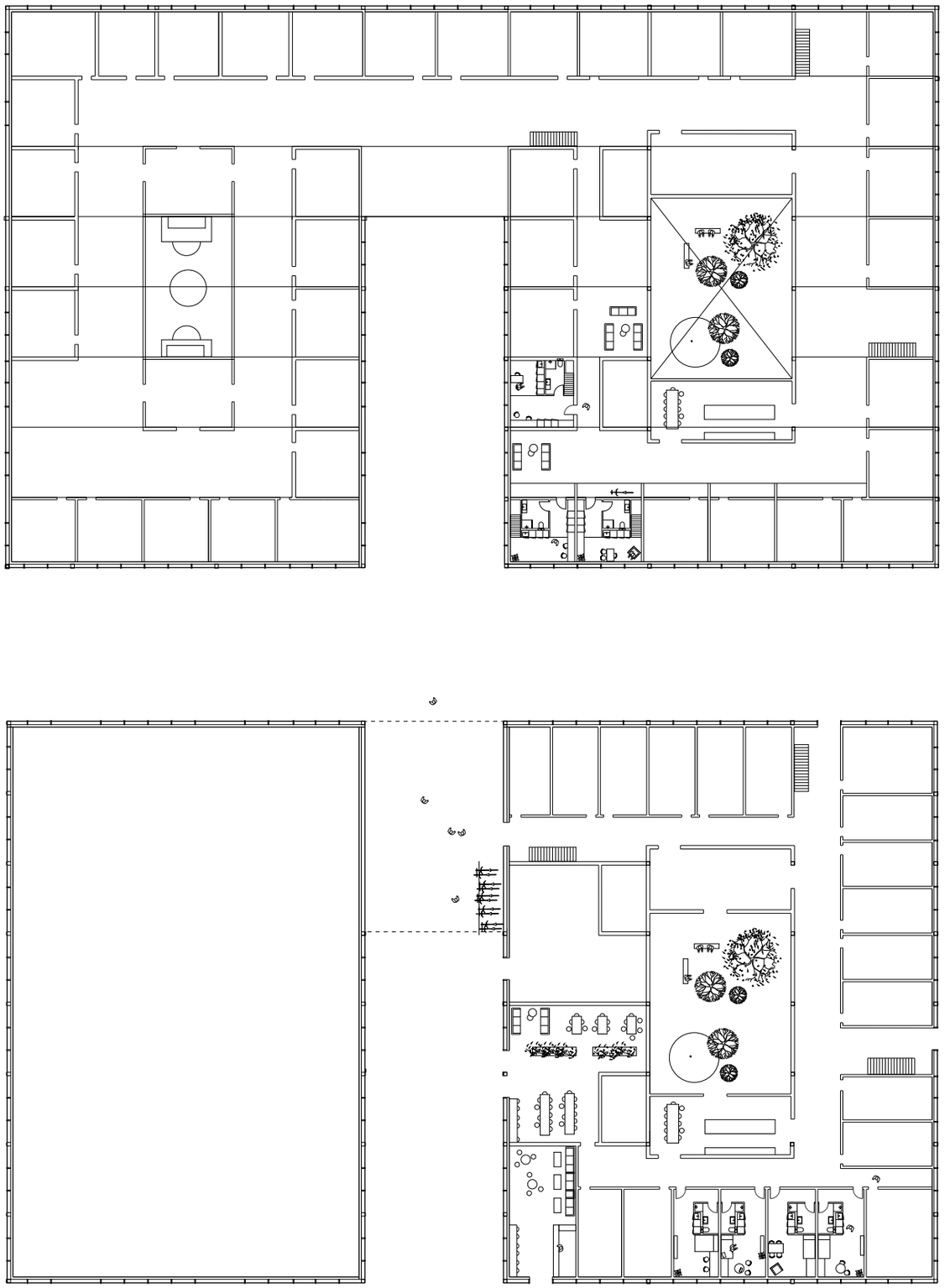
The Sawtooth is adapted to a residential typology through the subtraction of volume in the deepest parts of the building. Introducing a courtyard to the eastern half of the building allows daylight to enter the building from within and improve the living conditions of the residents. Furthermore, it provides an ecnlosed courtyard with outdoor spaces shaltered by the building itself, thus providing the residents with a private and tranquil outdoor space. Organized around the courtyard on both levels are several common areas such as kitchens, a worspaces, recreational areas and a workshop. Storage space and a laundry is also provided within the building volume. The housing cells are adapted to the existing structure; they take advantage of the unique height and spatial qualities of the industrial typology to make small but spacious apartments. More than 60 apartments have been fit into the building.

The depth of the Sawtooth makes the ground floor ideal for functions that do not have a particular demand for daylight. For this reason, the western half of the ground floor has been turned into a supermarket, thus providing residents in the area with easily accessible shopping facilities. The supermarket entrance is located in the gap in the middle of the building. In order to activate this space and enhance its quality, both facades facing it have been opened up with a glass facade in the ground floor. In addition, the common functions of the dormitory have been placed towards this space to create interaction between the residents and the surroundings.

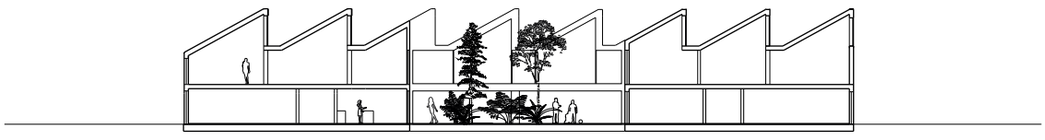
Similar to the Brick Building, the proposal for the Sawtooth is a conceptual proposal intended to support the ideas presented in the urban masterplan and place the final strategy, addition, in a specific context.



Ill. 62



Ill. 63



1:500

Ill. 64

Addition

The A-Building

The A-type is defined by its uniquely contextual yet contemporary formal expression. It is a residential typology adapted to site-specific climatic conditions in order to optimize the energy performance and indoor climate of the building.

The ground floor is a partially transparent public space that can accomodate a number of functions. It is divided into three multifunctional zones that is intended to house cafés, boutiques or a small public workspace. The glass facades create a strong connection from the interior spaces to the exterior, thus enriching and stimulating the urban environment on all sides of the building.

The spatially dividing element in the ground floor is the enclosed staircase that provide access to the upper floor apartments. The staircase is accessed from the northern side of the building - within the plaza. A welcoming space precedes the actual staircase, providing a functional space for the residents before progressing to the apartments. The sustainable aspirations of the project is visually expressed in the material choice as soon as the residents enter the building; surfaces, structural walls and stairs are all constructed in cross-laminated timber to reduce the environmental impact of the building, The aesthetical and sensory qualities are also important contributions to the perception of the building.

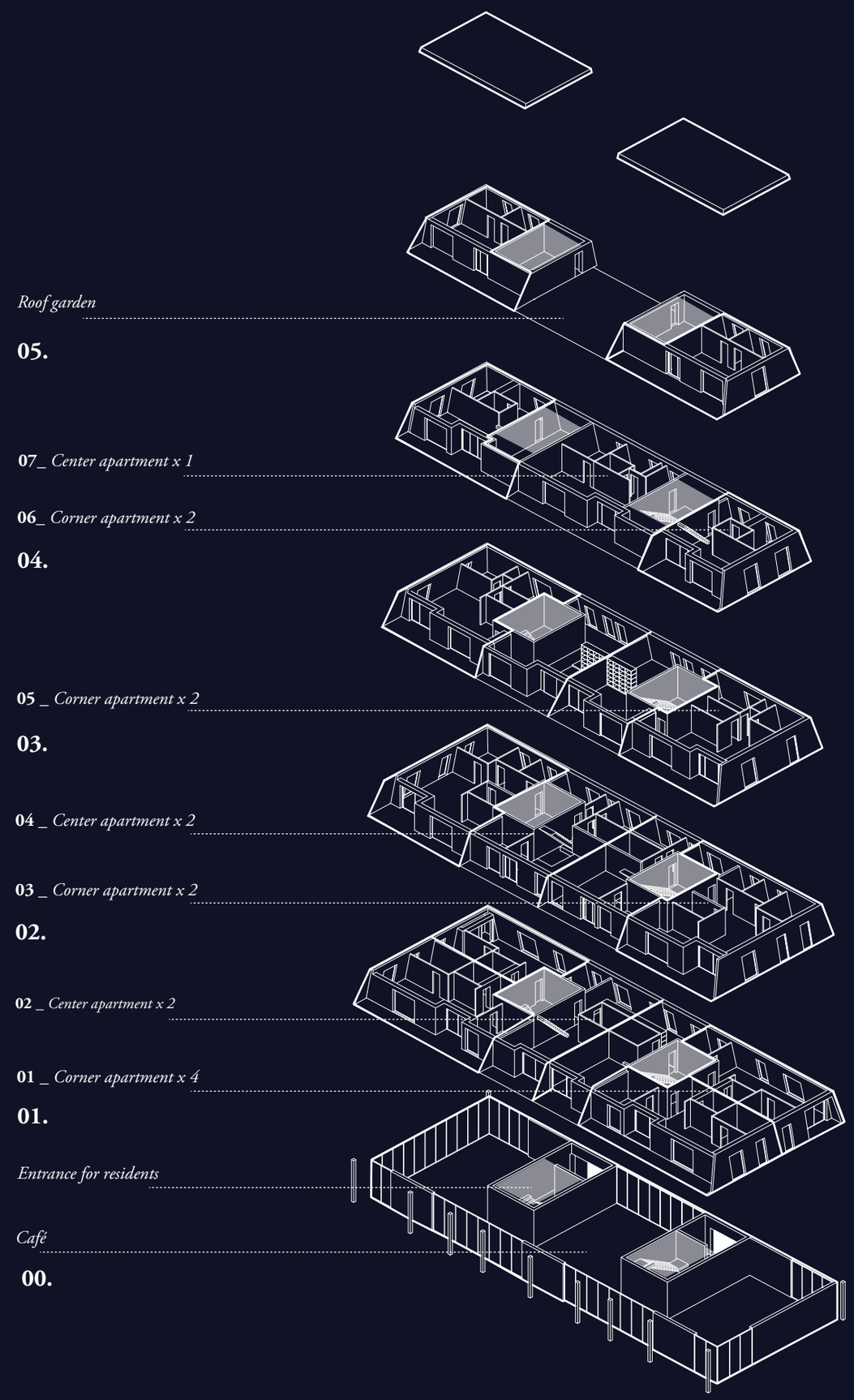
The first floor of the building provide access to a total of six apartments. Four apartments are placed in the corners of the building, each with a balcony facing east, south or west. These apartments are similar in organization and therefore constitute the first of seven apartment types in the building. The second type, of which there are two apartments on the first floor, is located in the center of the building. The spaces of the second apartment type are distributed over two floors which gives the apartments a high spatial quality while remaining its functionality.

The second floor of the building provides access to four apartments, divided into two types. The first type is the outer apartments which have facades to three sides. The second type is another duplex apartment but with a distinctly different layout. All apartments on this floor, as on the floors above, have south-facing balconies.

Apart from the spaces of the duplex apartment on the subjacent floor, the third floor has two apartments in either end of the building. Although these apartments are of a different type, they have a somewhat similar layout to the outer apartments on the floor below.

The fourth floor is the final access floor to any of the apartments. From here the final two apartment types can be entered. Two apartments of similar type are located at the eastern and western end of the building. These apartments are duplexes, have three rooms and views to north, south and east or west. The final apartment is located in the center of the building with views to both north and south.

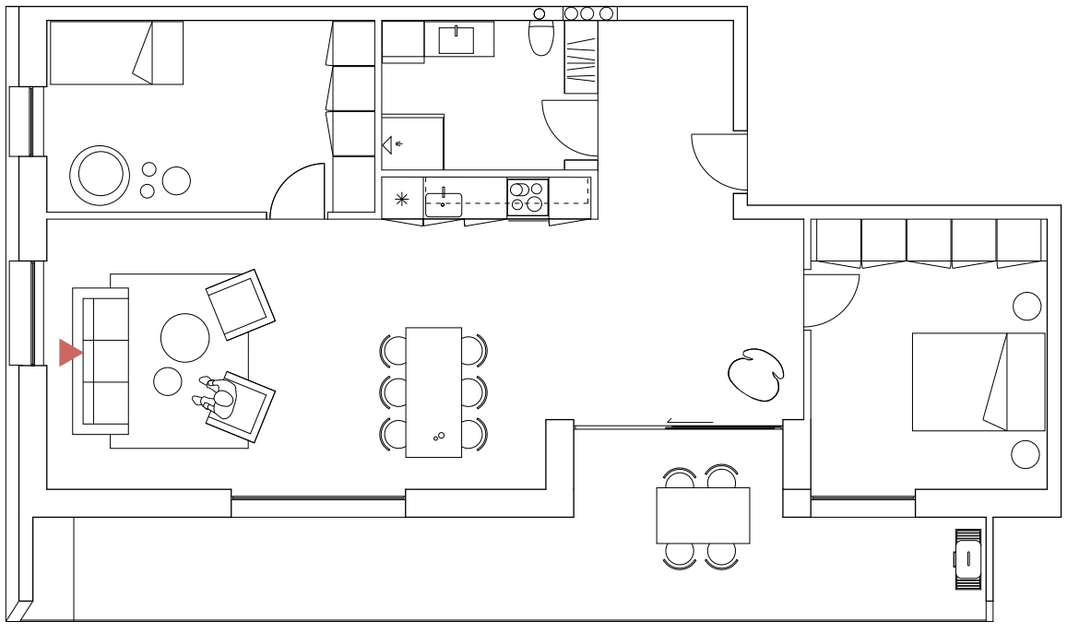
All apartmens have a large balcony with views over the inner harbour of Copenhagen. In addition, the residents of the A-type share an attractive roof terrace with space for social events or other activities. The following chapter will dive into the functional, spatial, aesthetical, structural and technical aspects of the A-type.


Roof garden
05.
07_ *Center apartment x 1*
06_ *Corner apartment x 2*
04.
05 _ *Corner apartment x 2*
03.
04 _ *Center apartment x 2*
03 _ *Corner apartment x 2*
02.
02 _ *Center apartment x 2*
01 _ *Corner apartment x 4*
01.
Entrance for residents
Café
00.

Ill. 65

Apartment_01

Two-bedroom apartment
Net area 80 m²

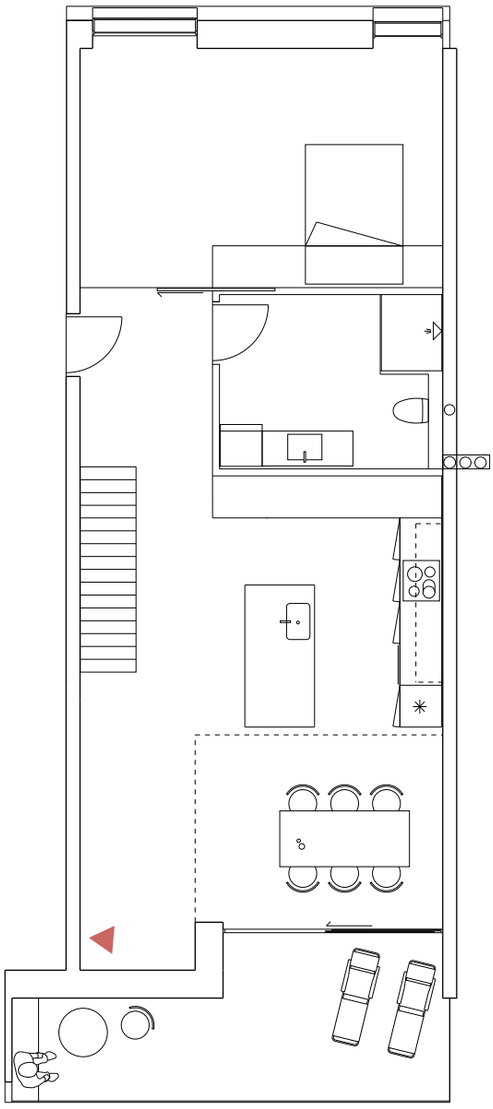


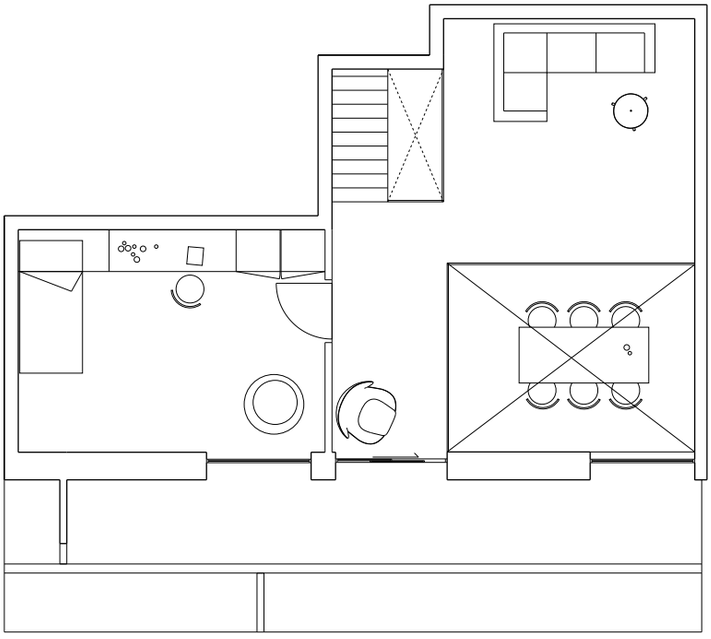
Ill. 66
1:100

Ill. 67

Apartment_02

Two-bedroom apartment
Net area 99 m²



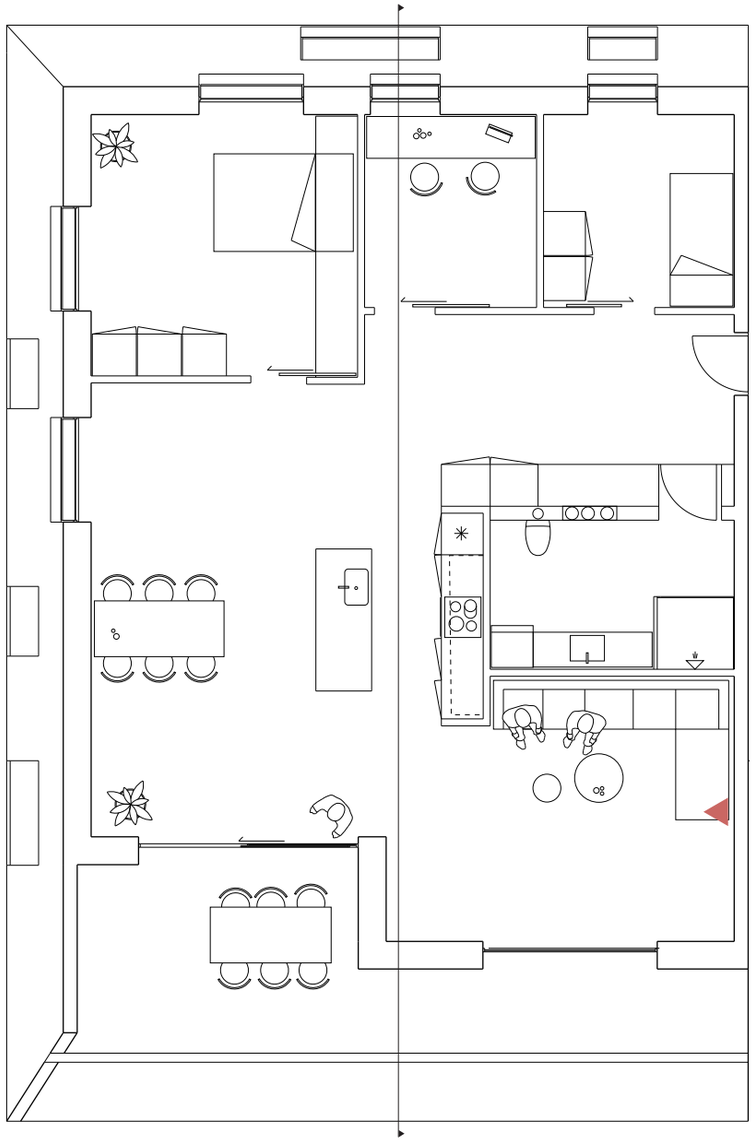


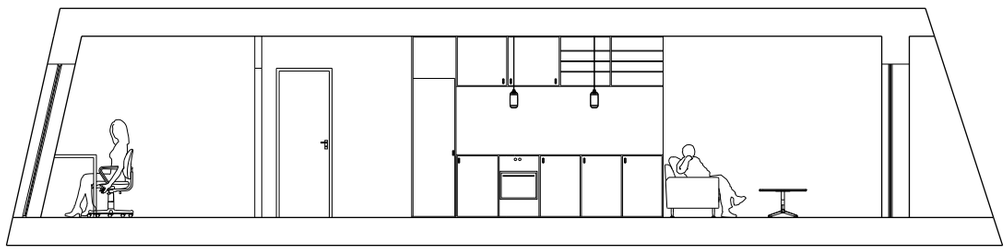
Ill. 68
1:100

Ill. 69

Apartment_03

Three-bedroom apartment
Net area 95 m²

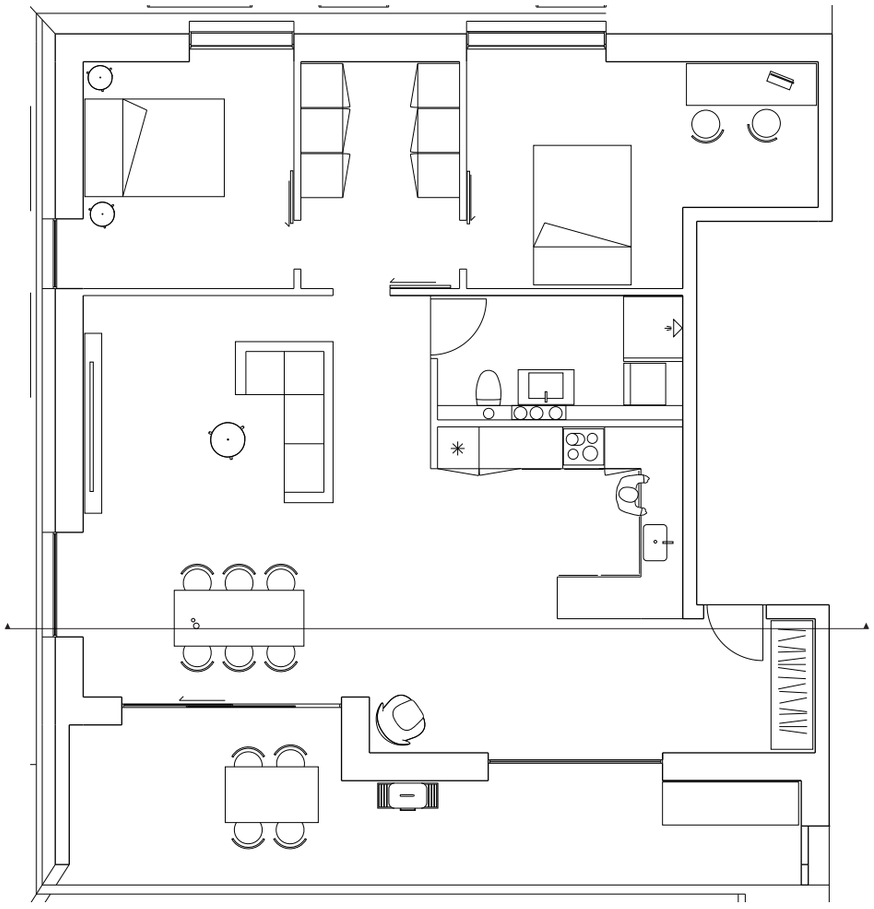


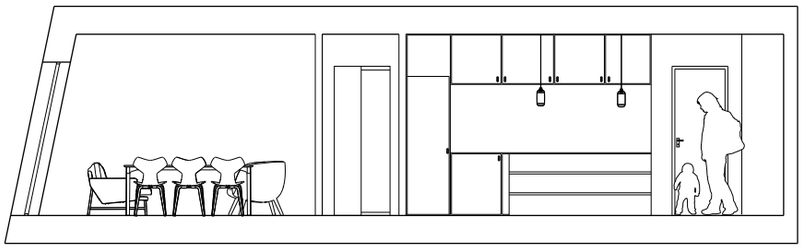


Ill. 70
1:100

Apartment_04

Two-bedroom apartment
Net area 92 m²





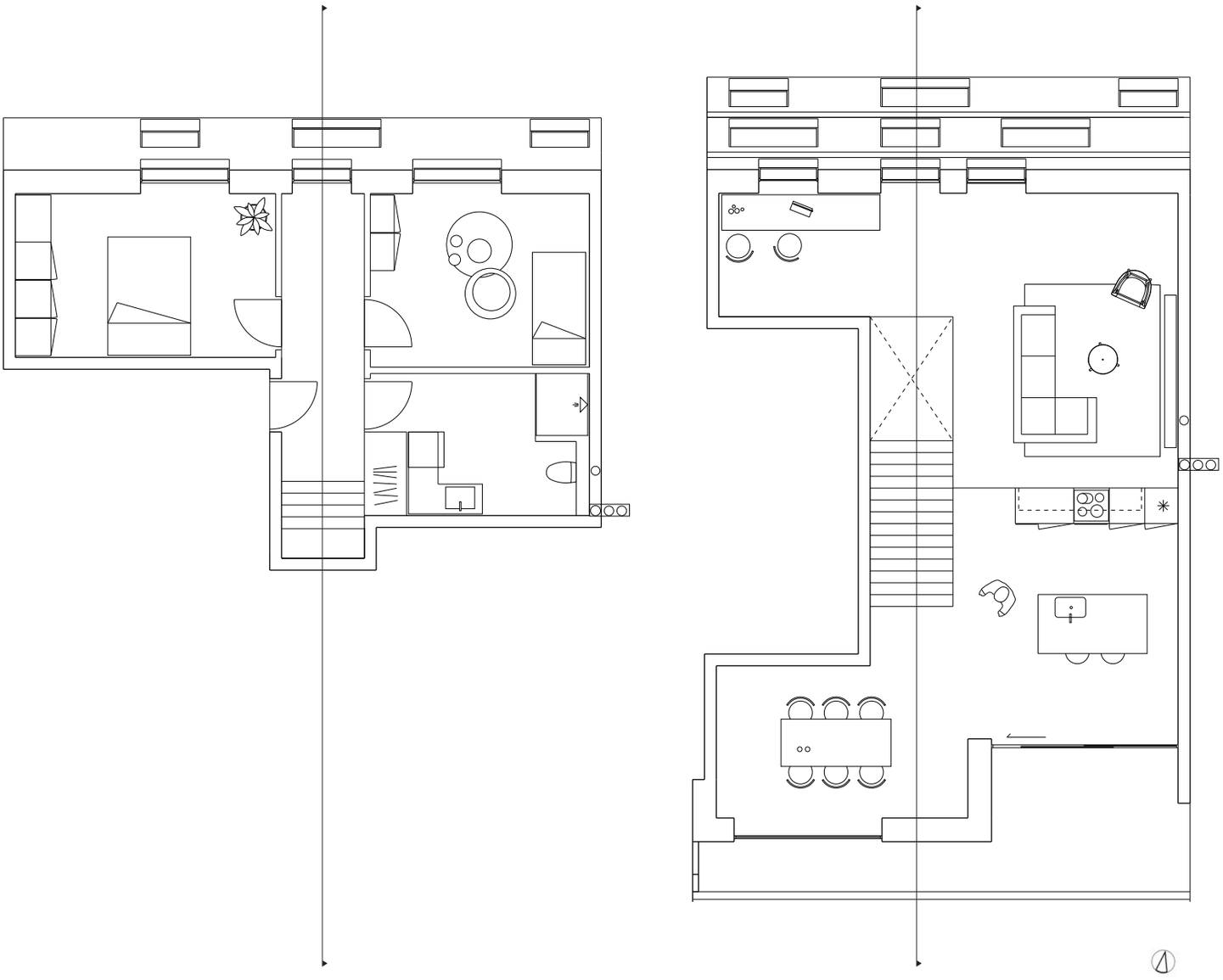
Ill. 71
1:100

Apartment_03
View from living room

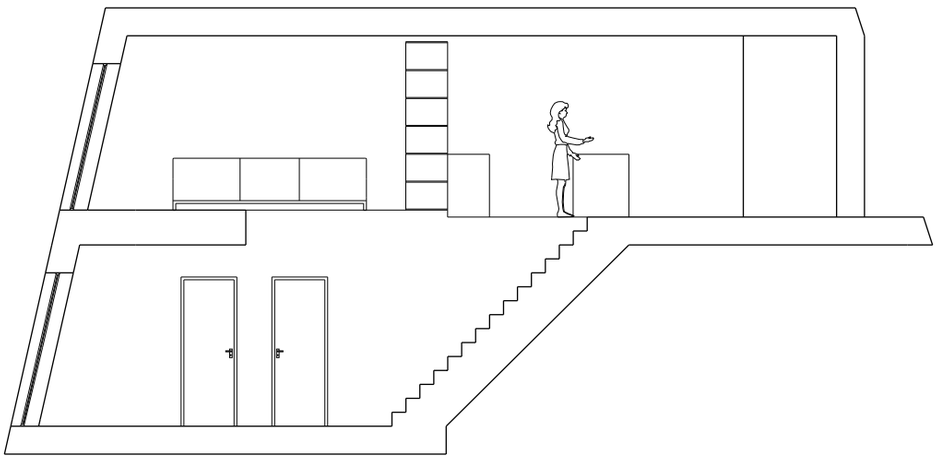
Ill. 72

Apartment_05

Two-bedroom apartment
Net area 93 m²



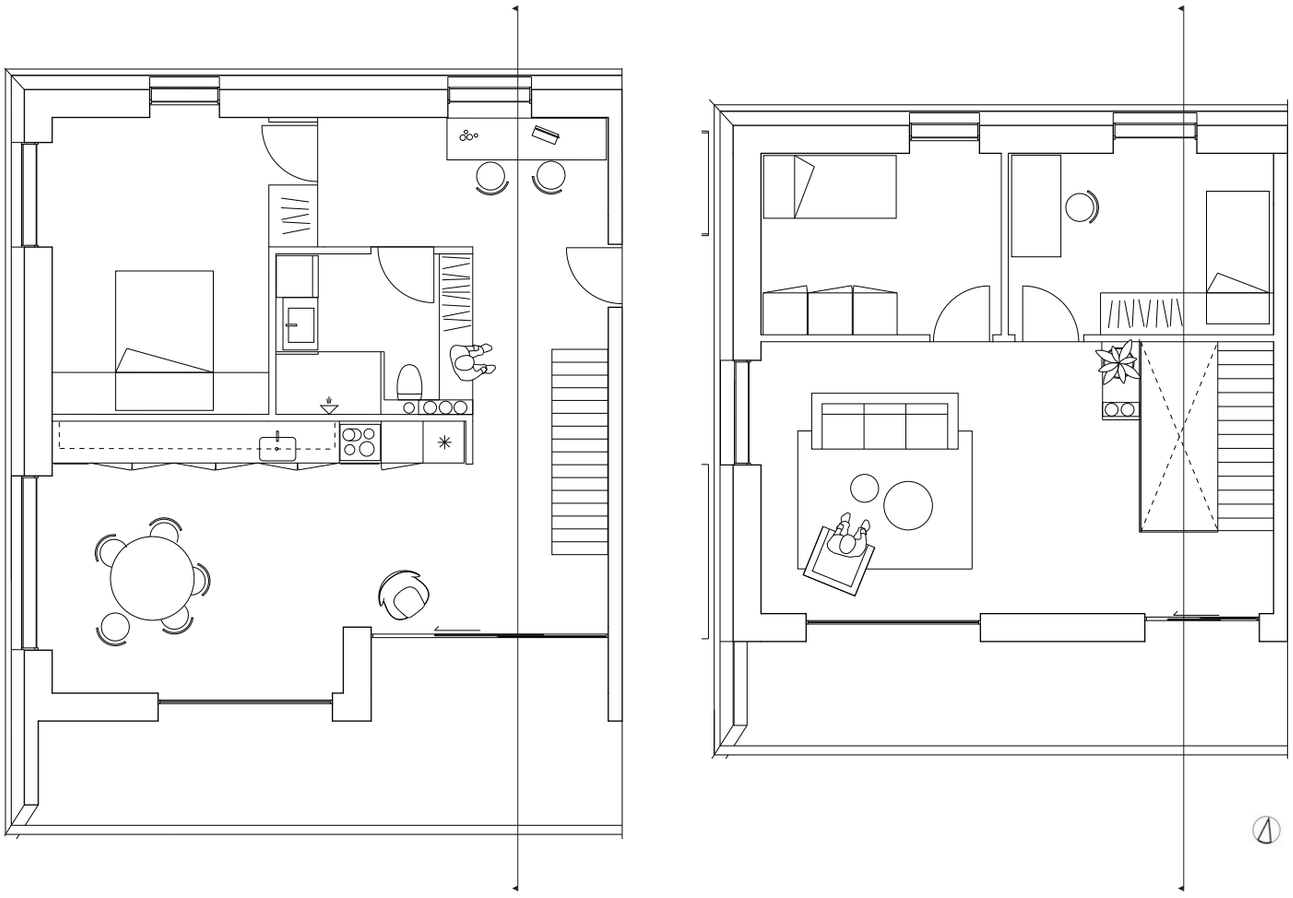
Ill. 73
1:100



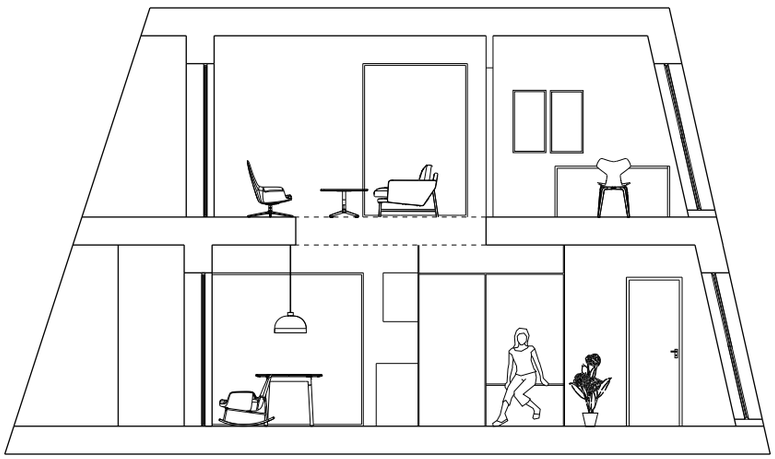
Ill. 74
1:100

Apartment_06

Three-bedroom apartment
Net area 104 m²



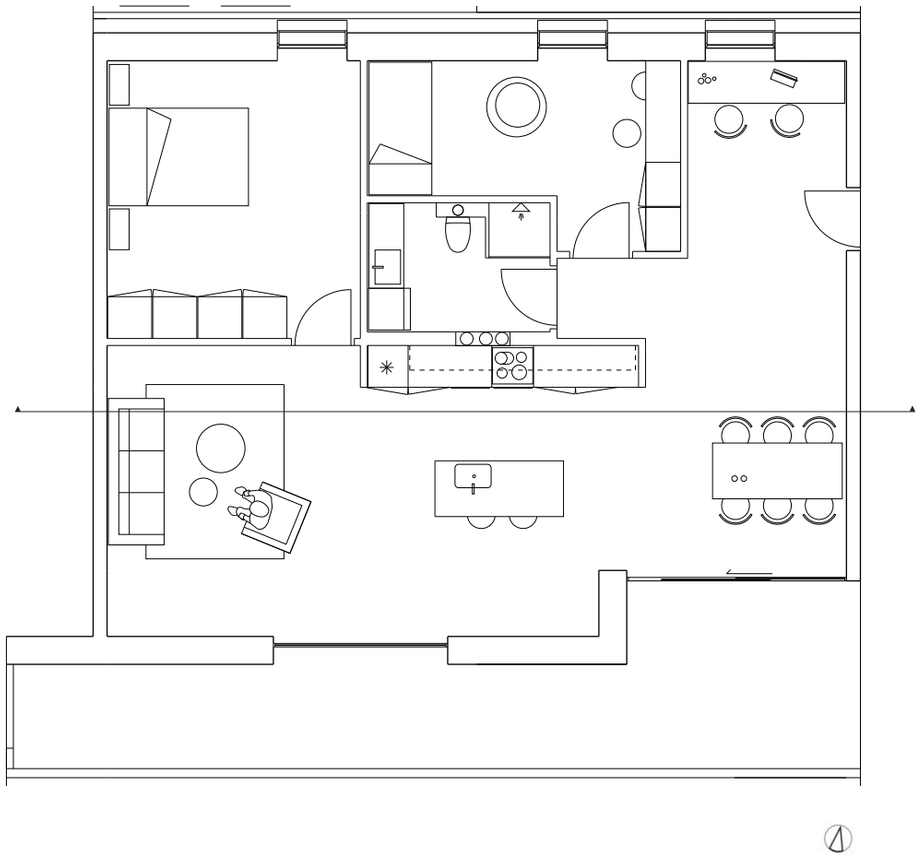
Ill. 75
1:100



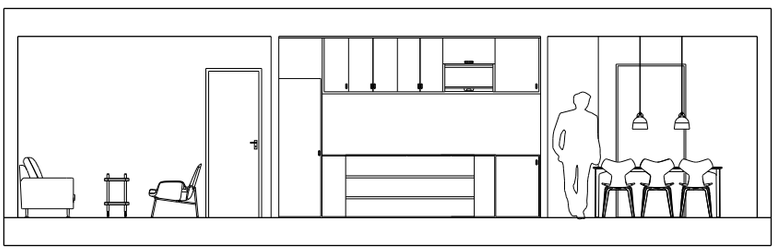
Ill. 76
1:100

Apartment_07

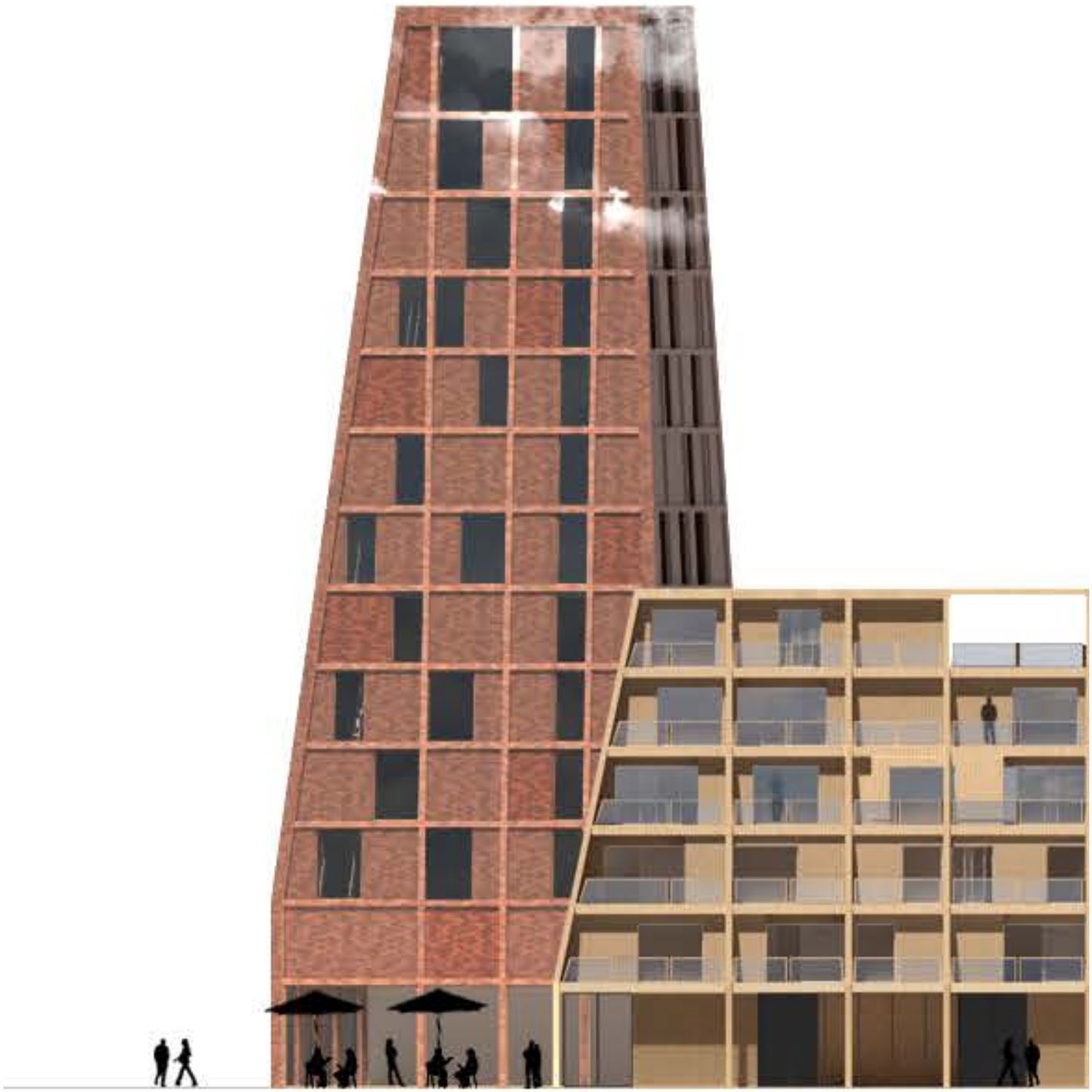
Two-bedroom apartment
Net area 80 m²



Ill. 77
1:100

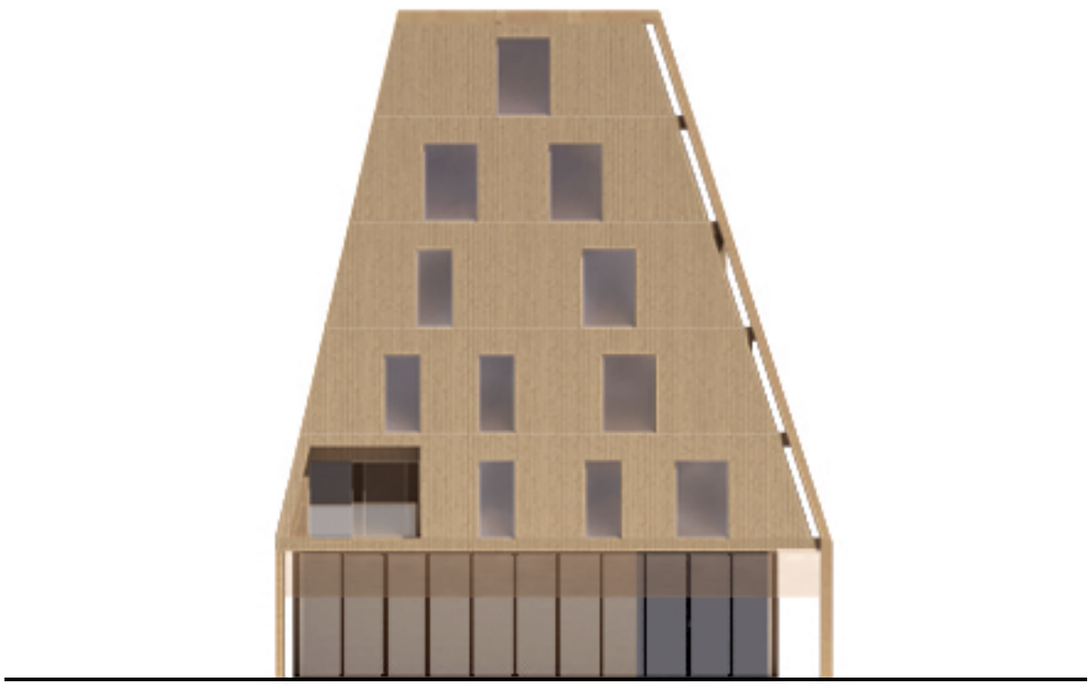


Ill. 78
1:100

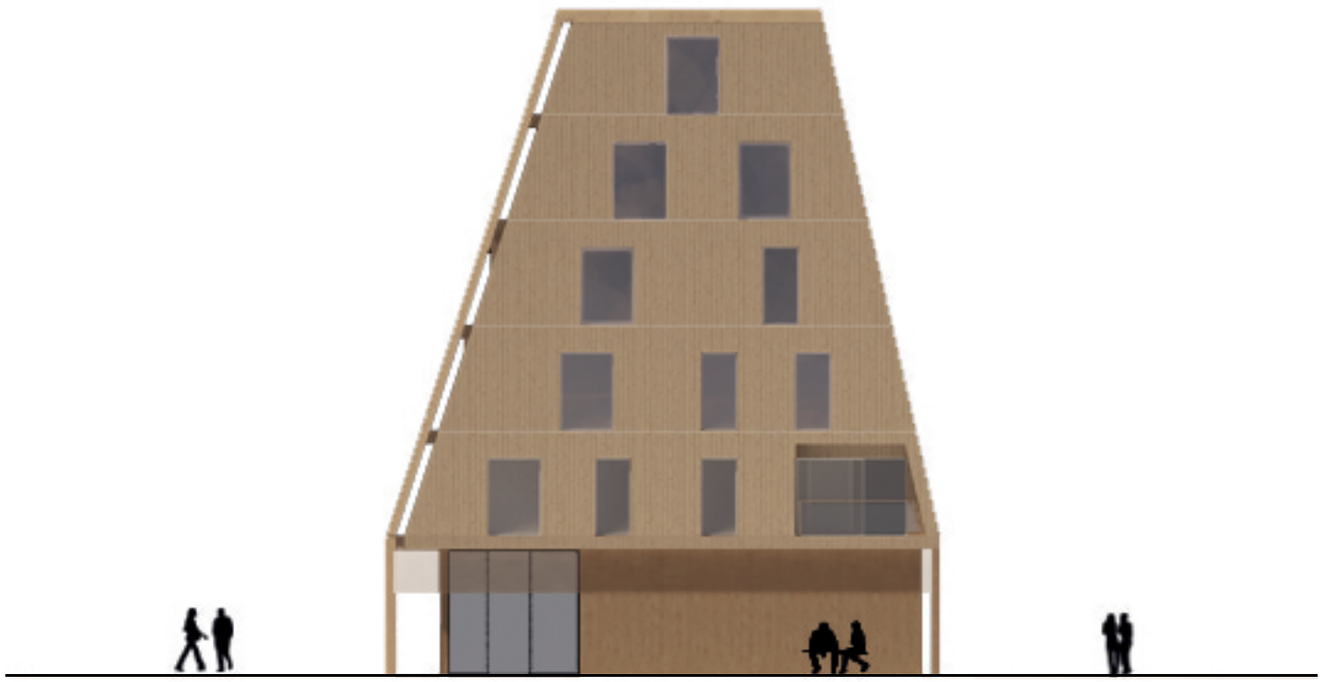


Ill. 801:200

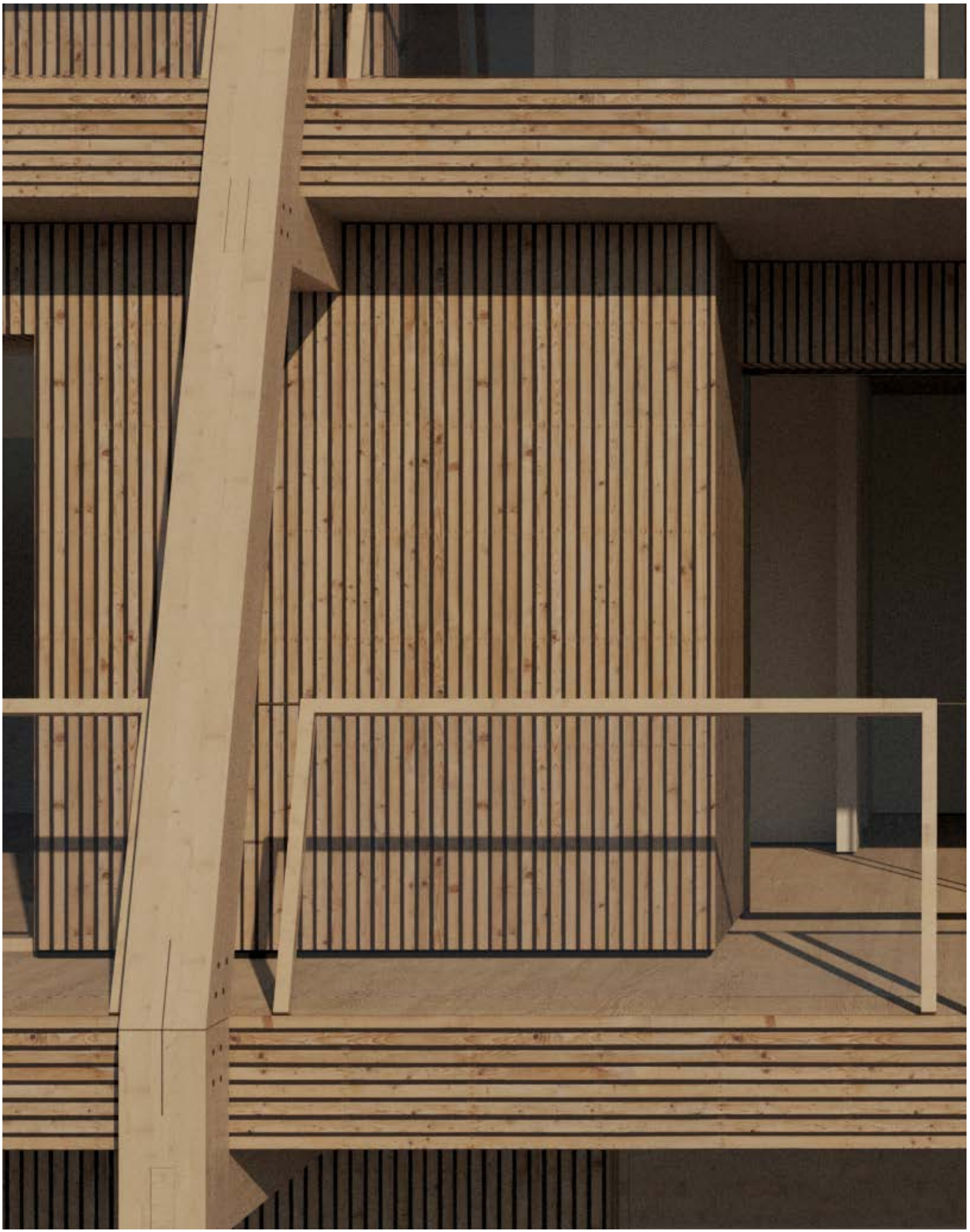
Ill. 81_Facade north
1:200

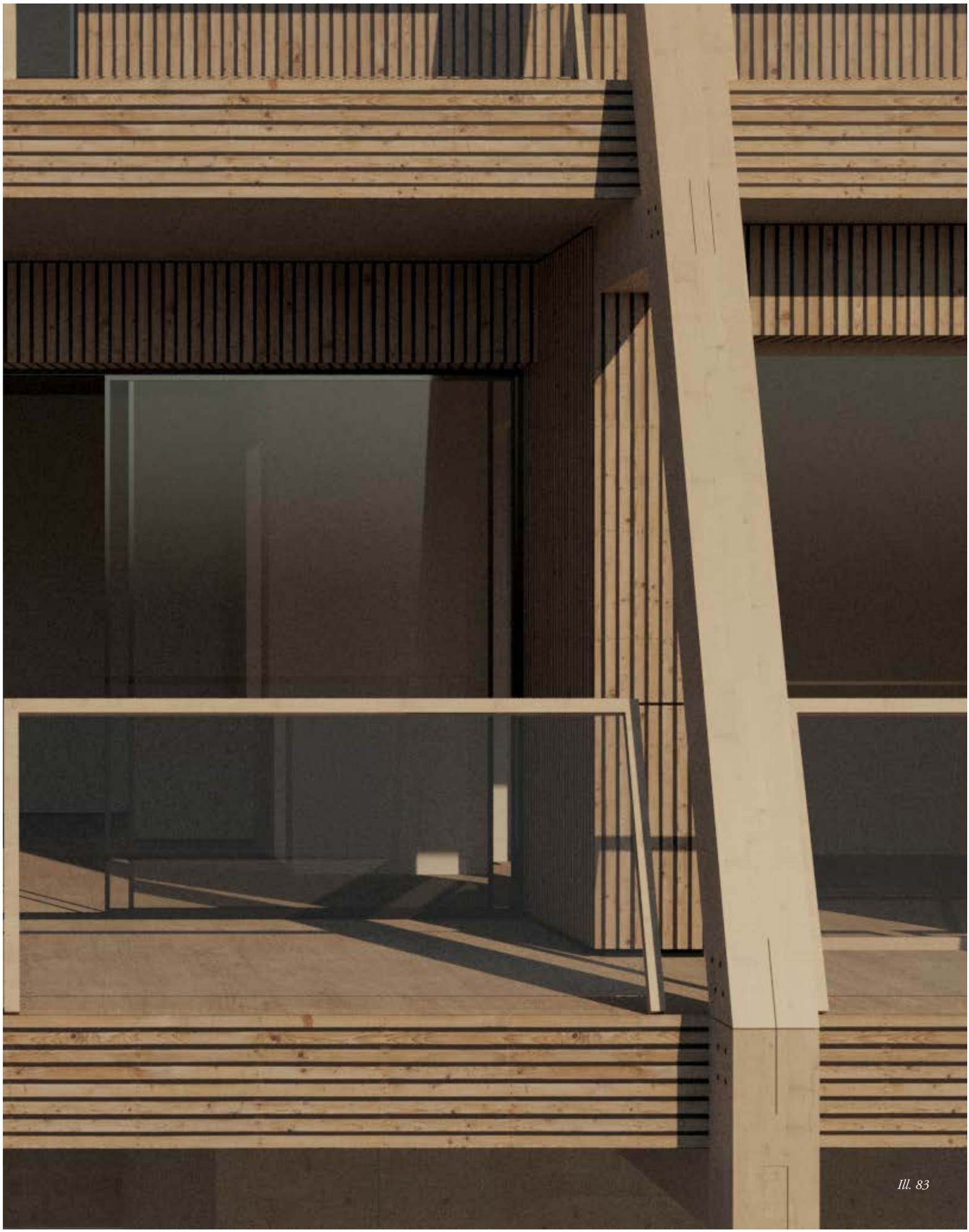


Ill. 79_Facade west
1:200



Ill. 82_Facade east
1:200





Ill. 83

Construction
A-type

Due to its considerable advantages over other structural materials, the entire construction of the A-type is conceived as cross-laminated timber panels. Cross-laminated timber is a multifunctional building material; it has great structural properties due to the cross-lamination of the glued pieces of wood which enables it to take up force in two directions. Consequently, cross-laminated timber have both a bearing and stabilizing function within the structural system. In addition, the moisture accumulation capacity, which has been documented in previous studies, has a positive effect on the indoor climate. The multifunctionality of cross-laminated timber can also be acsribed to its airtightness which eliminates the need for a vapour barrier in the building envelope. It is a relatively light material which makes it easier to transport and the simplicity of the construction makes it easy to assemble. Both aspects weight into the environmental profile of the material which, compared to other structural materials, is very good. Finally, cross-laminated timber is valued for its aesthetical values which can be expressed by exposing the panels on the interior surface of a building.

The Danish building industry have started experimenting with the use of cross-laminated timber but many still think that timber products are prone to cathc on fire, thus making tall timber structures unsafe. Danish fire requirements on solid timber products are, by our estimation, somewhat outdated, since they haven't fully accepted the use of it unlike many of the surrounding countries where multi-storey residential buildings in wooden constructions are becoming more common. The desire for this project has been to keep as many construction elements in cross-laminated timber since we know it has a low environmental footprint compared to other structural elements.

According to the fire requirements, we must comply with REI60. Fire regulation for Danish housing complexes is categorized as risk class 3, and the building has to fulfill the fire resistance class 2. (Trafik- Bygge- og Boligstyrelsen, 2018) There are no legal restrictions for building wooden houses that are more than four floors. If, as in our case, you want to build higher than four floors, instructions can be used, cf. the Building Regulations. In the building regulations there are no specific requirements on how to fire-proof a given building; instead there are stated functional requirements, which are the client's responsibility to present the technical documentation for a building's fire safety - in practice it will be the design consultants who ensure fire safety. (Innobyg, 2017) As part of the fire-resistant building, two stairwells are placed that comply with the dimensions of escape routes and further there is the possibility of rescue opening at terraces. (Trafik- Bygge- og Boligstyrelsen, 2018) An automatic sprinkler system is used to limit the development of fire. In Denmark, it is not yet legal to include the effect of the sprinkler system in the design of load-bearing structures. In other countries such as the UK, the sprinkler system can be included in the dimensioning of the construction, the same principles you use abroad as fire ventilation, sprinkling, fire protection during the construction period, etc. can be used in a Danish context, but it requires a comprehensive documentation to ensure the building regulations function fire requirements. (Innobyg, 2017)

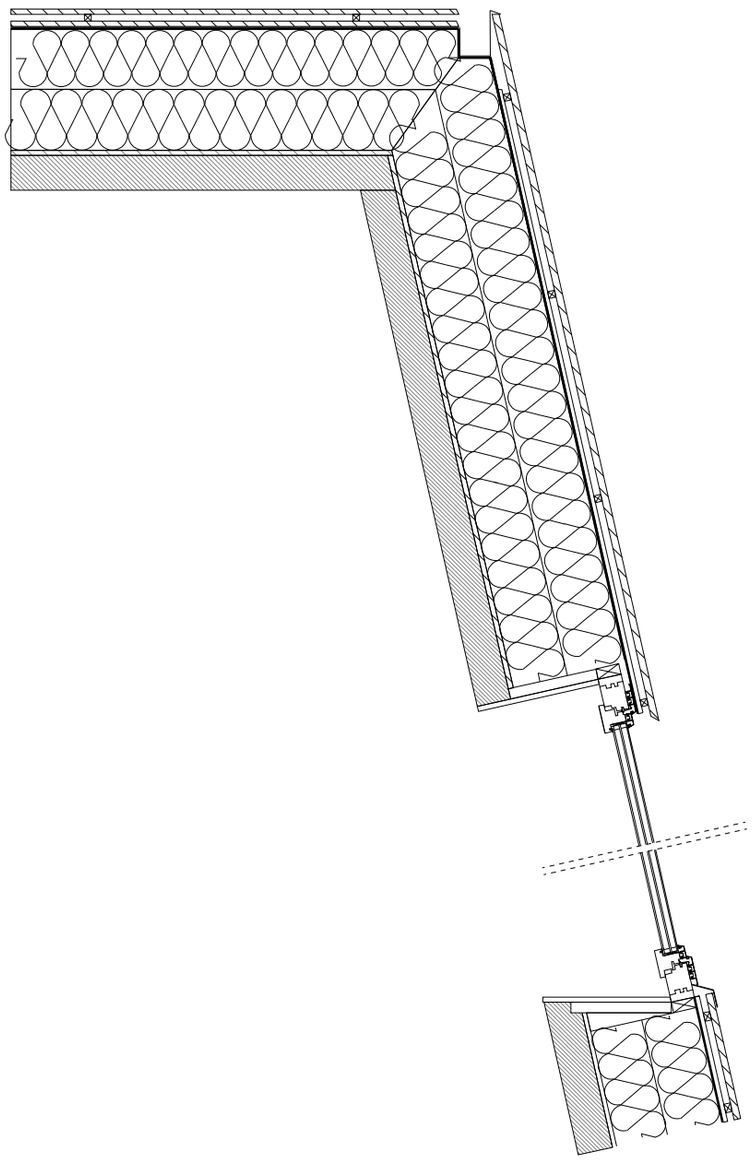
Structural principle
Structural CLT panels in all walls and core is supported by a concrete base and a steel piling foundation

Ill. 84

Detail drawings
A-type

Roof/

Accoya wood cladding, 19/110 mm
Ventilated air gap, 25 mm
Horizontal distance strips, 25/50 mm
Roofing felt
Concealed gutter, ø150 mm
Wood fibre insulation, 350 mm
Oriented strand board, 15 mm
Cross-laminated timber, 100 mm



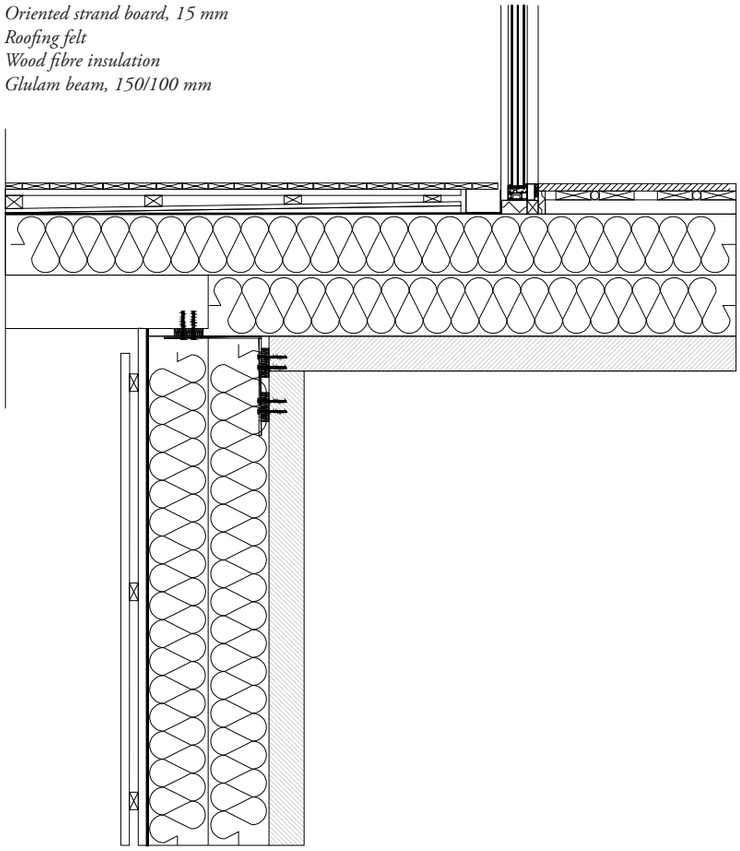
Ill. 85

Exterior wall

Accoya wood cladding, 19x110 mm
Ventilated air gap, 25 mm
Horizontal distance strips, 25x50 mm
Wind barrier
Wood fibre insulation, 350 mm
Oriented strand board, 15 mm
Cross-laminated timber, 100 mm

Balcony deck

Accoya wood cladding, 19/120 mm
Wood battens, 25/50 mm
Wood counterbattens
Oriented strand board, 15 mm
Roofing felt
Wood fibre insulation
Glulam beam, 150/100 mm



Floor deck

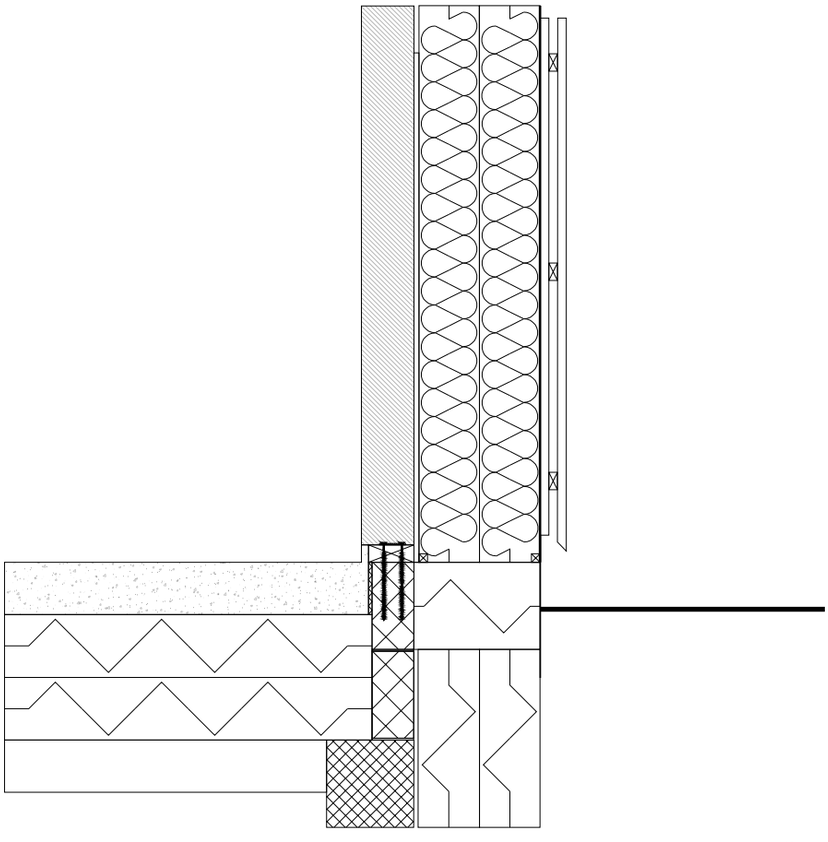
Oak parquet flooring, 19 mm
Wood battens, 25/100 mm, with underfloor heating
Wood counterbattens, 45/100 mm
Wood fibre insulation, 350 mm
Cross-laminated timber, 100 mm

Exterior wall

Accoya wood cladding, 19x110 mm
Ventilated air gap, 25 mm
Horizontal distance strips, 25x50 mm
Wind barrier
Wood fibre insulation, 350 mm
Oriented strand board, 15 mm
Cross-laminated timber, 140 mm

Foundation

Concrete flooring, 150 mm
Polystyrene insulation, 400 mm
Gravel
Lighweight aggregrate concete block, 100 mm
In-situ concrete foundation, 200 mm



Ill. 86

Energy & indoor climate

A-type

Part of the vision of the project was to create a sustainable housing development that fulfills the standards of a sustainable building and the resources of energy use. Designing a zero-energy building is achieved through an iterative process around both indoor climate, energy performance and embodied energy. By applying passive and active strategies to the building, energy consumption is reduced. The building was verified in Be18 to meet the requirements of a zero energy building, where the total energy demand per year is 23.6 kWh / m^2. By further supplementing with photovoltaic panels located on the roof of the Sawtooth building the energy consumption can be brought down to -1,4 kWh/m^2 year. The area for the photovoltaic panels on the Sawtooth building is roughly 470 m2 (appendix 08)

Natural ventilation and mechanical ventilation are designed to meet the need for air supply and exhaust. The venting system is analogously controlled by the residents, so it is their individual experience that determines the quality of the indoor climate, and they must open the windows to activate the system advantageously during the summer period and during the winter period mechanical ventilation is used, which are described on the following pages. Finally, to control the indoor climate, external shading in the building volume has been created to prevent overheating. Since this shading solution is sufficient in relation to the overtemperatures, where there is only 7 hours above 27 degrees, a flexible exterior shading system is not used, but curtains in the apartment cover the need for shade, if needed. In the winter period when the sun is low, the solar heat gain will minimize the energy consumption for heat. For seeing the heat balance result see appendix 02.

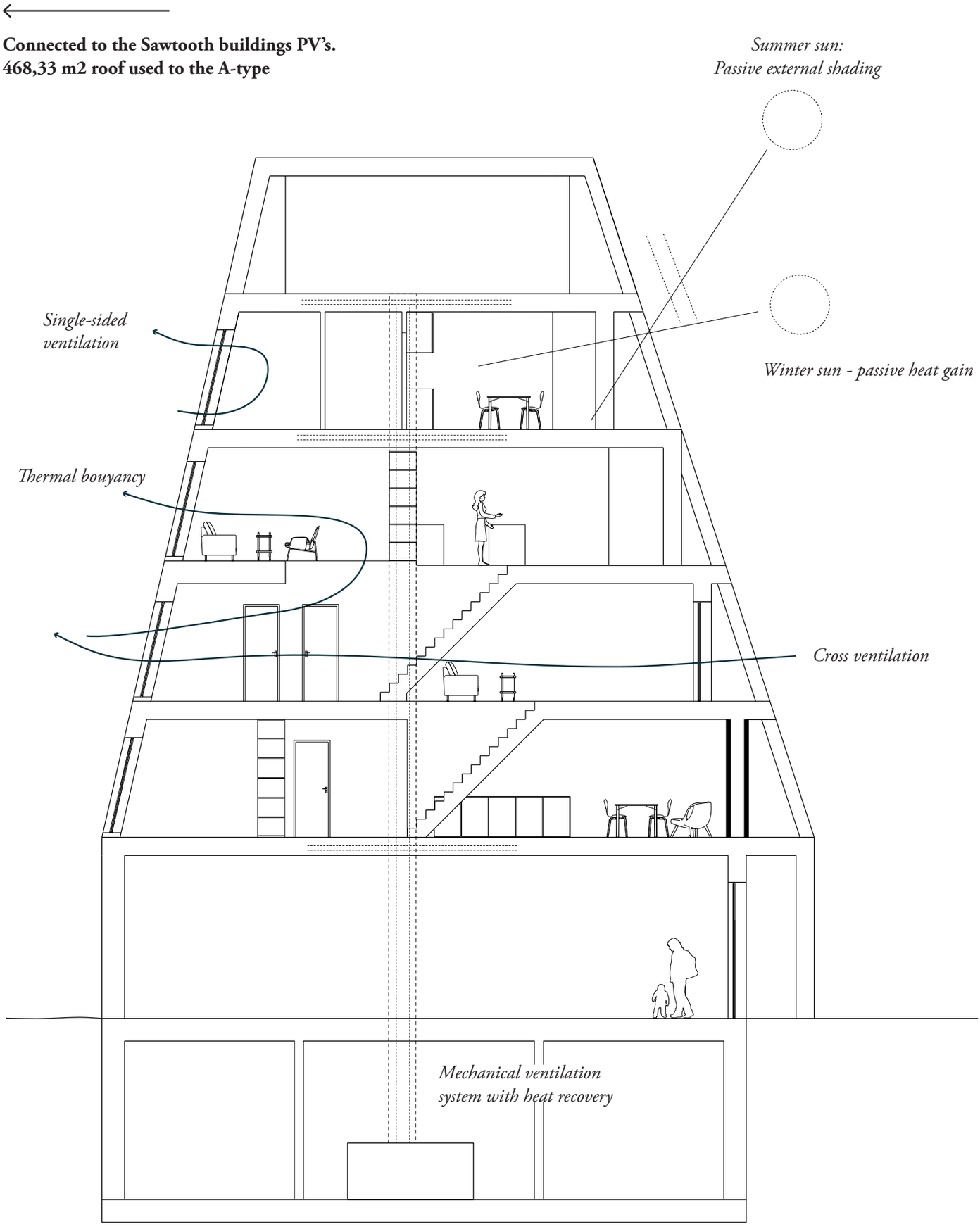
23,6 kWh/m2 per year

Energy frame 2020: 27 kWh/m2 per year (low-energy class)

With photovoltaic panels

-1,4 kWh/m2 per year

Connected to the Sawtooth buildings PV's.
468,33 m2 roof used to the A-type



Ill. 88

Energy & indoor climate
A-type

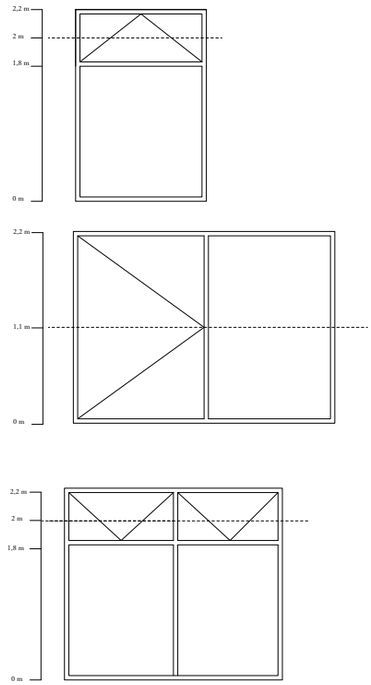
When designing an optimal ventilation system, it is important to achive balance between good air quality and energy efficiency. The type and use of the ventilation strategy will affect the electricity demand and furthermore utilizing the system with a heat recovery system during the winter period, thus the energy demand is lowered. To obtain a sufficient strategy it is preferable to use hybrid ventilation combining natural ventilation in the summer period and mechanical in the winter period and all year around in the bathroom and kitchen. The mechanical ventilation unit is centralized in a service room in the basement and branch out to the different apartments. Inlet is placed in the façade towards north and the outlet is placed on the roof.

Throughout the apartments a ventilation shaft has been included to avoid long ducts. In all apartments, the ventilations shaft is place near the kitchen and bathroom. The ducts are hidden in the deck and in the walls. The supply inlet and exhaust fan is placed in the walls and the ceiling. It has been important to avoid intersection of the ducts, to create unnecessary problems and further to avoid pressure loss.

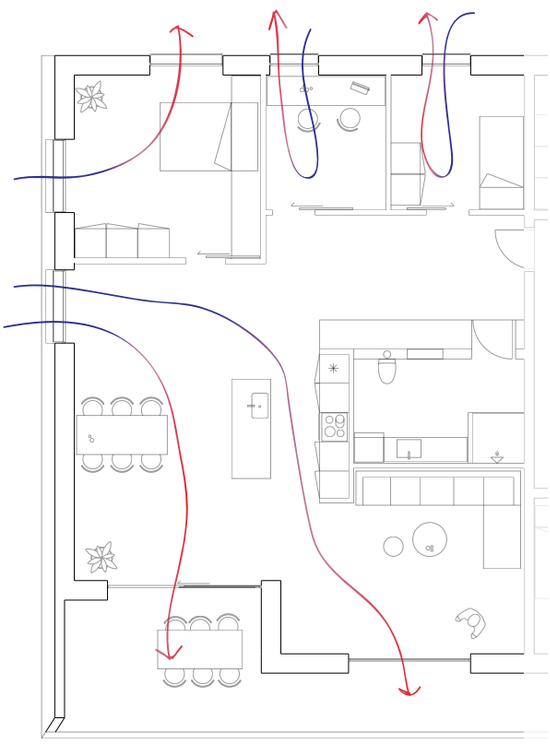
As part of the design of the apartments, natural ventilation strategies are enabled, mainly as cross and thermal buoyancy ventilation. In most of the bedrooms single sided ventilation is used.

In the summer period the prevailing wind direction is southwest. The wind rose from Copenhagen is the reference for windspeeds and percentage. To investigate the calculation of ventialtion rates and natural ventilation see appendix 06. Two scenarios are investigated, for a “normal” day in the summer period with a windspeed of average 6,5 m/s. The worst scenario for the wind is a velocity of 1 m/s and a one-degree temperature difference between inside and outside. This scenario is tested to identify the strength of the natural venting and to ensure that atmospheric comfort in the apartment is obtained.

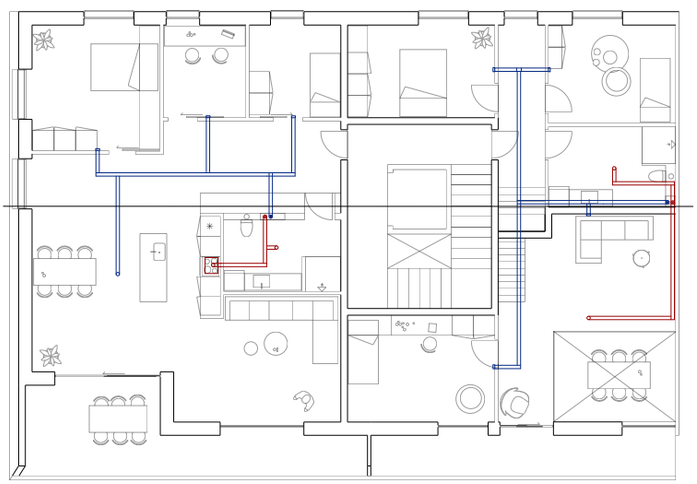
Since the window is a large floor to ceiling window only some of the part of the window needs to be opened, therefore the detail of the window is also carried out in this venting process, as illustration 89 shows. The venting is compared with the calculation of the ventilation rate from the olfaction to ensure that the venting system is enabled. The results shows that in the worst scenario that the venting is approved with 100% open windows, the air change is 1,2 h-1 and the need of air change from the calculation of olfaction is 1,18 h-1. For a normal day with an average windspeed the result of air change with a minimum opening of 20 % the air change is 1,7 h-1. The cross ventilation moves from south west to south. Furthermore, the calculation shows that the thermal buoyancy works against the cross ventilation, it caused by the south window openings are bigger than the window in the living room, but it is a minimum extent, thus does not have a great influence of the result.

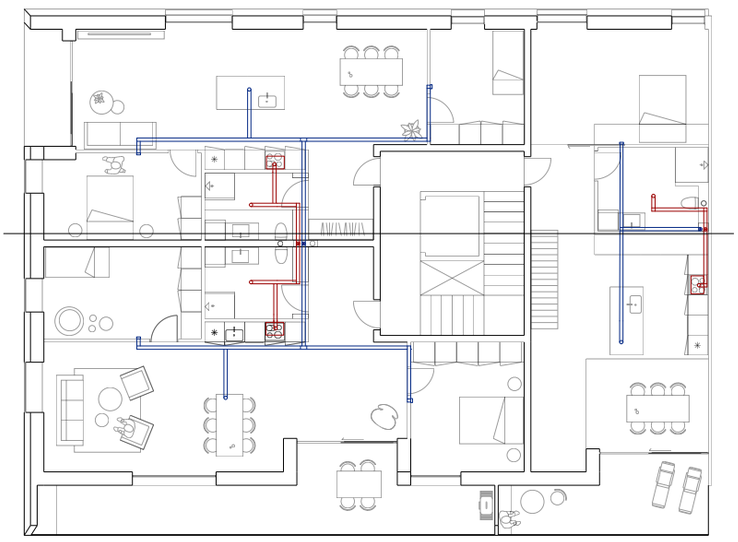


Ill. 89



Ill. 90





Inlet *Exhaust*

Ill. 91

006.

Epilogue

Ill. 92

Conclusion

Nyholm Naval Quarters is a distinctly contemporary, contextual and sustainable mixed-use urban development in the Inner Harbor of Copenhagen. It is a response to the complex interplay of environmental and social issues from a global to a local scale as well as a progressive way to preserve a part of the common Danish cultural heritage through the transformation of Nyholm.

The design proposal is based on an original interpretation of a classical approach to architectural quality; through the adaptation of the Vitruvian virtues, a coherent design framework has been developed and applied to the specific design task. Given the specific conditions of the site - the presence of two culture-historically significant buildings - a coherent design approach based off the strategies of preservation, adaptation and addition has governed the development of the design in order to build on the pre-existing narrative of Nyholm.

The architecture of Nyholm Naval Quarters is one of authenticity and tactility. The current formal and material identity of Nyholm has been translated into a new contemporary building typology. Provided with high urban and living qualities, the new residential typologies act as catalysts of an urban renewal of the southwestern area and the island of Nyholm as a whole.

Reflection

The debate over the future of Nyholm will likely continue for the years to come with the selling-off of the majority of buildings on the island. The conceptual masterplan proposal presented in the beginning chapters of this thesis includes many of the proposed functional additions to Nyholm, although the main focus of this thesis, a new housing development, is opposed by many of the parties who have an interest in the future of Nyholm. Given the insights and experience gained from the development of this thesis, we fully acknowledge the concern over the prospect of housing on Nyholm due to the inevitable effect it will have on the urban qualities and identity of the island. This particular project was premised on the addition of a residential development in the southwestern corner of Nyholm. It could however be argued that the culture-historical environment of Nyholm would be better preserved by transforming the entire island into a public, maritime experience center with museums, exhibits, visitor centres, new dockyards, workshops etc. While the outcome of this thesis might serve as inspiration for the discussion, a process dedicated to the development of a coherent masterplan for the entire island must take place in order to determine the future of Nyholm.

If the premise of housing on Nyholm is accepted, this thesis presents a viable proposal for the transformation of the southwestern corner of the island. The proposal includes a detailed design of one residential typology, the A-type, while addressing the remaining buildings of the masterplan on a conceptual level. In order to determine the potential of the final design proposal, a secondary design phase dedicated to the further development of certain building volumes and urban spaces would be relevant. This could also include a broader perspective on the transformation of other areas on Nyholm such as the ones identified in the site analysis.

A critical perspective on the underlying assumptions of the final design of this thesis could also be used to evaluate the proposal. One particularly interesting consideration relates to the contextual approach that has been central to the development of the project. The approach was defined by a subjective interpretation of contextualism in architecture thus begging the question if the interpretation was correct. In addition, the specific application of contextual references can be discussed; is the final design proposal contextual? Which design effect is most important to achieving contextualism? And, how could the design have been adapted to be more or less contextual?

Litterature

Allmannsattlerwappner.de. (2019). Postareal Leonberg - Projects - Postareal Leonberg. [online] Available at: http://www.allmannsattlerwappner.de/en/projekte/2755/postareal-leonberg [Accessed 16 May 2019].
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Illustrations

All illustrations and photos without any reference are own production.

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