Degrowth for Regrowth

– Speculative scenarios in a fossil-free future

Sofia Andersson

Master's Thesis in Architecture 2021
Master of Science in Architecture and Planning Beyond Sustainability
Department of Architecture and Civil Engineering
Chalmers University of Technology

CHALMERS
UNIVERSITY OF TECHNOLOGY

Degrowth for Regrowth
– Speculative scenarios in a fossil-free future

SOFIA ANDERSSON

Master Thesis 2021
Examiner: Nils Björling
Supervisor: Julia Fredriksson
Chalmers University of Technology
Department of Architecture and Civil Engineering
Gothenburg, Sweden

”

While the planet is finite
in its biophysical sense,
infinite growth in human existential values,
such as beauty, love, and kindness,
as well as in ethics,
may be possible.

– European Environmental Agency (2021)

Abstract

Degrowth for Regrowth aims to explore possible scenarios of the future where society is fundamentally restructured, in its values as well as in its built environment. It takes its stance in degrowth theory, which questions the neoliberal market's regard of growing GDP as synonymous with prosperity, abundance and freedom. Rather, it highlights that an approach of infinite economic growth is dependent on increased resource use, production and consumption, and is the cause behind our current social and environmental crises.

Mainstream sustainability efforts rarely question the idea of continual economic growth, they rather promote it as a measure of realizing a sustainable society. Instead of aiming for concepts such as "green growth", which continually allows economic gain to be the main target within sustainable development, the idea of degrowth is to reformulate the definition of success towards socio-ecological values.

This theoretical framework creates the foundation of three future scenario formulations set in 2050: *collaborative economy, local self-sufficiency,* and *automation for quality of life* (Svenfelt et al, 2019). These scenarios, combined with architectural reference projects which have overlapping key ideas, become a base for defining three future design concepts.
These design concepts are followingly implemented on a chosen site, which is an extensive landscape currently hosting an oil refinery. The site becomes relevant to explore as an area in need of transformation in a future which no longer relies on fossil fuels.

The implementations are made with a speculative design approach as a way to shift mind-sets, stir creativity, and focus on desirable outlooks rather than dystopias. Each implementation presents different ideas on spatial qualities, community organisation, and cultural-natural relationships which enhance human and ecological well-being.

As a result of this process, the thesis concludes that visualizing the future in different scenarios can be a powerful method to enable discussion of what we actually aim for in long-term physical planning. It can be an effective pedagogical tool to understand multiple target groups and stakeholders in trans-disciplinary collaborations, as it can transform abstract desires into tangible visual representations. Using future scenarios could thus enable architectural and planning professions to effectively contribute to concrete strategy formulations which reach beyond current sustainability efforts.

Keywords: Degrowth, beyond sustainability, speculative design, future scenarios, post-industrial transformation, fossil-free, societal transition, planning methodology

Table of contents

Introduction

Project background

The required transition

How are the environmental and social crises that the world faces today being dealt with?

According to the European Environmental Agency, EEA (2021), we are already at a pressing state of environmental issues, such as massive biodiversity loss, ecosystem failures, climate change and pollution. The fact that social implications follow e.g. resource scarcity and decreased democratic influence (EEA, 2021) further indicates that the systems currently ruling large parts of human civilizations are failing not only its own species, but the entire planet. The complex and interconnected state of these issues also comes with a high level of unpredictability, as the risk of offsetting tipping points might alter the situation and state of emergency radically (IPPC, 2018). Society as we know it today will undergo a transition in the future – either by lowering the environmental impact from human activity, or by facing the inevitable consequences that a lack of action will lead to.

Change beyond sustainability

In this complex situation, Asara et al (2015) argues that the transition towards a decreased human impact on the planet can no longer be managed by gradual changes. However, current interventions within mainstream sustainable development are still characterized by lengthy and bureaucratic processes which promote "green growth" or sustainability as a marketing strategy. As these approaches continually invest in the systems which make up the core of the problems, they fail to contribute to any significant change, but rather result in increasing the magnitude of the problems (Asara et al, 2015).

According to Andersson et al (2019), this is a behavior deeply rooted in human psychology, explained as loss aversion, which is a reaction coming from a fear of losing any invested time, money, or emotional values, and creates unwillingness towards change.

Continual investments into the existing systems can consequently enforce sustainability as a threat instead of a solution. In order to avoid increasing the problems further, society needs to be fundamentally transformed, even if it could mean short-term sacrifices to some (EEA, 2021).

Impact of building and construction industry

To narrow down the focus and review how the building and construction industry contributes to the environmental state, the IEA report of 2019 proves that it is responsible for a large part of the global environmental impact, both in terms of global emissions and energy use. Our industry constitutes 36% of the final energy use and 39% of energy and process-related carbon dioxide, 11% of which accounts for the manufacturing of steel, cement, and glass products. The impact of the built environment is of a magnitude which urges us as architects and planners to investigate alternative approaches within our practice in order to reduce the industry's environmental impact. This should be done at all scales within which we operate. It includes alternative measures in terms of both buildings and details, but also how cities are planned, built and maintained.

The relationship between rural / urban

In order to highlight one aspect of the planning practice that is lacking today, this thesis broadens the focus of planning to look beyond only the urban. "Planning" as a discipline tends to be generally referred to as "urban planning", indicating that the scope of the profession largely concerns the physical planning of cities, with the aim of expanding and maintaining urban ideals in the built environment. It also implies that the urban periphery and countryside are not included in the planning profession, despite the fact that cities are reliant on external resource flows from said areas. Instead of "rural planning", it is called "rural development" (Swedish: "landsbygdsutveckling"), and it is a discipline related to other professions than architecture and planning. Consequently, today's planning practice fails to acknowledge the bigger picture, and continues to plan urban areas without considering where its construction material comes from, where its waste is transported, how its residents are provided with food, and how to give back to the places which took responsibility for this production. The extraction and manufacturing of resources from rural areas, even other nations, leave a great impact on the local conditions, as they become places where the spatial perception and local values are not prioritized, and development is made entirely for business purposes.

Purpose

With the described background as a stepping stone, this thesis focuses on a break from the current line of action in sustainable development and questions the notion of economic growth as a general target or means to reach social and ecological security. By exploring alternative approaches within planning practice, it provides an investigation into more efficient and powerful tools beyond sustainable development. The aim is to envision alternatives where social and ecological values are the driving forces that shape society.

Research questions

- How could society be shaped if it favored growth mainly in environmental and social values rather than economic growth?
- How could sites and structures that become obsolete in the transition towards a fossil-free future be implemented in a socio-ecological transformation?

Delimitations

What this thesis is about

- Exploring what the future could look like
- Implementing theoretical future scenarios in a predetermined context
- Exploring future use of a fossil industry site
- Speculative and conceptual design
- Exploring planning beyond norms of economic growth
- Using architectural representation to convey narratives of alternative futures
- Relating theoretical concepts of sustainability to architectural design approaches
- Exploring how building typologies, infrastructure, space distribution, materiality and other architectural features can be relevant in different scenarios
- Creating discussion about strategies for a sustainable future

What this thesis is not about

- Proposing what the future should look like
- Creating a general method of implementation on post-industrial sites
- Creating a pragmatic and detailed design proposal
- Exact, technical calculations or measurements of production, consumption, or resource use
- Development of new sustainable techniques
- Developing new theoretical scenario descriptions
- Strategic planning or design

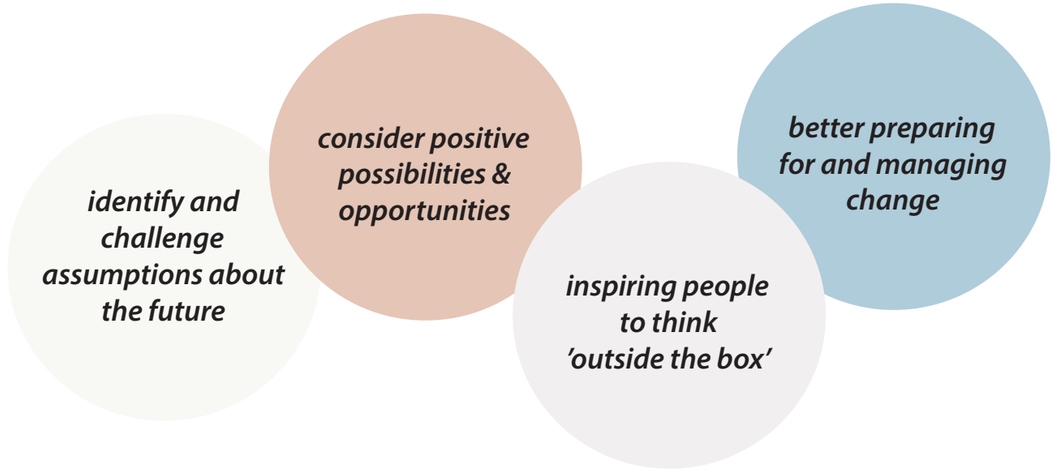


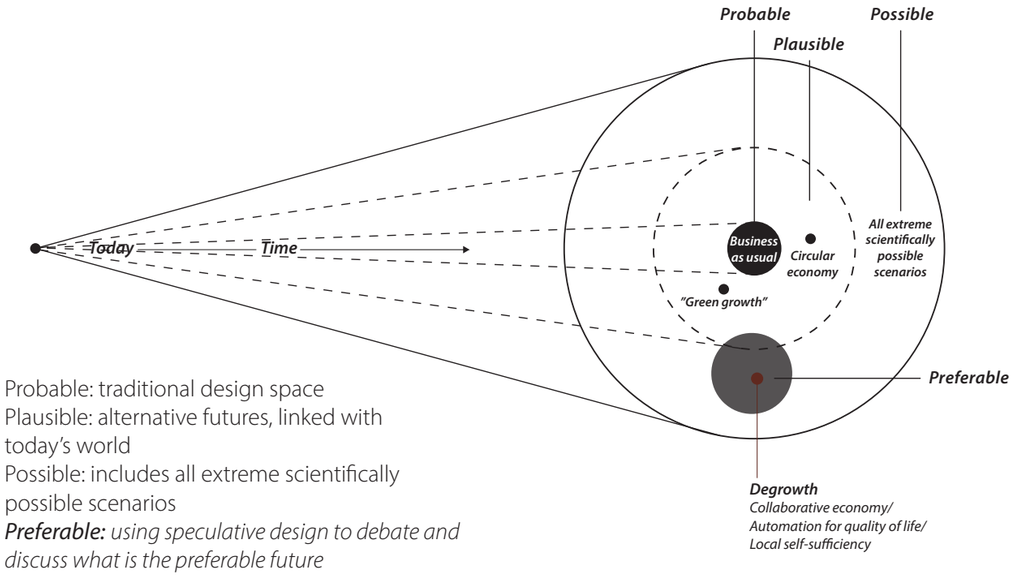
Figure 1. Arguments for using scenarios in design (Stojanovic et al, 2015).

Method

This thesis was conducted with the approaches of "research for design" and "research through design". The framework described both in "Method" and "Theory" in this thesis was defined through literature studies of published scientific articles which were accessed through digital databases available at Chalmers University of Technology's library. One of the findings from this process, which discusses future scenarios beyond GDP growth (Svenfelt et al, 2019), became an important resource when defining the theoretical foundation of the design work. The theoretical research occured in the initial phase of the thesis before continuing with research and analysis of reference projects in relation to each scenario to be used in the design implementation. The conclusions of the reference project analyses became guiding aspects in defining the concepts of the scenario designs and displayed in comparable diagrams. The design process was then conducted with the use of analogue and digital sketching tools, prototypes and iterations. The focus on three different scenarios enabled the opportunity to work with different aspects of design as a way to experiment and showcase a broader variety of possibilities on the site. Another approach could have been to e.g. stay with certain placements of functions on the site in order to highlight how the scenarios differ from each other. However, since the aim of the thesis was to explore alternative approaches in a broader sense, a wider variety of ideas in the implementation answered the research questions to a greater extent. They provided additional elements for comparison and discussion of the future scenarios and gave a broader output of results.

Selecting the site

This choice of site for this thesis, Arendal, is made on the premise that political policies will regulate the usage of fossil fuels in favor of renewable alternatives with less impact on the environment. This transition implies massive transformations for both urban and rural landscapes, as well as changes in how we structure society. Being a part of Göteborg where oil refineries have been active since the 1970s, Arendal is an area which would be greatly affected if the oil industries cease to exist. Vast amounts of industrialized land with great connection to many differentiated communities and their surrounding qualities would be available for new purposes. The reason for exploring the opportunities of Arendal is thus to exemplify how the premises for planning and development practice could be altered when it is to include new types of areas and characteristics.



Probable: traditional design space
Plausible: alternative futures, linked with today's world
Possible: includes all extreme scientifically possible scenarios
Preferable: *using speculative design to debate and discuss what is the preferable future*
Beyond cone: fantasy

Figure 2. *The future cone* (Dunne & Raby, 2013).

Speculative design

In order to look beyond the norm of sustainable development, this thesis is building upon scenarios and speculative design as a manner to reimagine the future. Especially when dealing with complex problems, speculative scenarios enable us to establish distance from the present constructs of society, and instead explore alternatives more holistically (Dunne & Raby, 2013). It presents the opportunity to build hypotheses based on dreams and desires that move beyond current norms and ruling conditions. Broadening the imagination of the future can thereby create discussion, debate, and reflections on which values and desires we prioritize and support. Consequently, speculative scenarios raise questions about the current state of our society, and acknowledge that there in fact are alternatives (Dunne & Raby, 2013). Stojanovic et al (2015) further argues that this method provides an important shift in focus from immediate problems and strategies, which can create action towards not only risk management, but also to significant change.

It is worth clarifying that although speculative design often is occupied with imagining the future, Dunne and Raby (2013) also point out that the purpose is not to specify an exact description of it. This is how speculative design clearly differs from forecasts, which are used for predicting rather than exploring (ibid). The subjectivity of framing the perspective in speculative scenarios towards desirable ends can become more fruitful than factual descriptions as they can help in creating positive action (Svenfelt et al, 2019).
To exemplify in the context of architecture, this can be compared to how the content of a visual concept of a facade differs significantly from a technical detail drawing of an exterior wall. The first is used to communicate one or several ideas, while the latter is used as an exact proposal of how the wall should be built.
This thesis will use speculative design as a method to communicate the ideas of three theoretical descriptions of the future set in 2050. These descriptions will be interpreted into designs in order to provide examples of how they could be visually implemented.

The future cone

The future cone is a diagram created by Dunne and Raby (2013) to explain different categorizations of future scenarios: probable, plausible, possible, and preferable ones. The purpose of the diagram is to estimate the scenario's probability of realization, how it connects to the situation of today, but also to clearly visualize that the future is not fixed (ibid).
The scenarios that are explored in this thesis are placed within the "preferable" zone of the diagram. This is both due to that they in fact focus on desires and preferable ideas rather than the opposite, but also because they highly contrast to today's reality. However, despite being radical, they are not extreme to the extent that they become unrealistic. Thereby they intersect both the "possible" and "plausible" categories.
Furthermore, the diagram helps to state the scope of the thesis, as it will not focus on scenarios aside from the mentioned preferred ones.

Theory

> *"'Degrowth' [...],*
> *"la décroissance" in French*
> *or "la decrescita" in Italian*
> *refers to a river going back to its normal flow*
> *after a disastrous flood.'"*
>
> – degrowth.org

This chapter describes the theoretical framework that has been used as a foundation for the development of design concepts. After a brief description of degrowth as an overall concept, the three scenarios which the continued work is based upon will be described. The descriptions addressed in this chapter are based on published research and articles according to the cited references and is a collection of external facts, research and inspiration upon which the continued work is based.

Degrowth

A critical response to capitalism

According to Asara et al (2015), the perspective "degrowth" was coined out of a critique on economic growth's relationship to sustainability. They describe the promotion of economic growth as a threat for development of social and environmental aspects, which does not correspond with the idea of sustainability. The neoliberal market sees growing GDP as synonymous with prosperity, abundance and freedom; it reformulates people's desires into needs, and reduces needs to desires that can be met through consumption (Asara et al, 2015). In contrast to this definition,

Furthermore, the basis of degrowth to builds upon the so-called "threshold hypothesis",which argues that economic growth does not improve people's quality of life after a certain degree of economic stability has been achieved. Rather than arguing that a deregulated market enables freedom and prosperity, the degrowth movement highlights that its pursuit of growth is closely linked to the increasing use of resources and energy. Consequently, the social, ecological and economic crises threatening the world today are derived from the capitalist obsession of endless growth, exceeding the limitations of both humans and the planet.

Criticism of degrowth has been that, contrary to its purpose, even the title of the theory centers the discussion around economic growth rather than altering the focus (Asara et al, 2015). Therefore, an alternative concept of "post-growth" has been brought up as a response to the term "degrowth". However, according to EEA (2021), post-growth and degrowth also differ in their primary definition of economic growth's role in relation to societal and environmental problems. Degrowth acknowledges the goal of continual growth of the economy as destructive to society and environment, whereas post-growth is agnostic towards the role economic growth plays in responding to the challenges of today (EEA, 2021).

Aims of the degrowth movement

Instead of allowing economics and material resources to be the leading framework for discussions and decision-making regarding sustainable development, Lehtinen (2018) describes the degrowth movement as a desire to reformulate the definition of success so that it is anchored in social and ecological values instead. Consumption and production should be reduced and decentralized so that society's turnover decreases (ibid), the norm of striving for efficiency should be replaced by a striving for sufficiency (Svenfelt et al, 2019), and values such as resourcefulness, autonomy and quality of life should be promoted (Asara et al, 2015).

This would mean practical adjustments to society, but also changes in relationships, work life, leisure time and resource use, which could increase the well-being of both people and the environment (Svenfelt et al, 2019). A downscaling of material production does not equal a downscaling in life quality or degree of sophistication in a society. Rather, Lehtinen (2018) highlights health and education as high-priority aspects within the degrowth movement, and Asara et al (2015) also emphasize care for democracy, justice and the meaning of life as key focuses.

Degrowth and urban planning

Linking degrowth to urban planning, architecture and the focus of this thesis brings the topic onto the critique of how distribution of functions, labor, and development between different areas are organized. Van Timmeren et al (2002) highlight the problem how urban planners design cities in a way that the responsibility for production of carrying functions such as water management, food production, energy production and waste management, etc. is placed outside urban areas, even outside national borders. This centralized approach creates an extensive need for infrastructure to be able to transport these flows to and from the users. This not only means extensive transport losses (e.g. the energy efficiency factor is often below 10%), it also means further land exploitation and serious consequences for the environment, especially on a local scale where production and management is performed. Based on this description, van Timmeren et al (2002) argue that the built environment should be integrating local, circular systems in the built structure with adjacency to its users, and be based on passive and natural systems.

Future scenarios beyond GDP growth

Figure 3. The targets set for the scenarios according to the four themes (Svenfelt et al, 2019).

The upcoming descriptions of "collaborative economy", "local self-sufficiency", and "high automation for quality of life" are taken from the scientific publication "Scenarios for sustainable futures beyond GDP growth 2050" which was published by Svenfelt et al (2019) in a collaboration between KTH Royal Institute of Technology, Södertörn University (School of Social Science and School of Natural Science), VTI Swedish National Road and Transport Research Institute, and IVL Swedish Environmental Research Institute, along with participation with external stakeholders and municipalities.

The article begins by discussing different perspectives on how economic growth and sustainable development relate to each other, before highlighting the fact that *visions and strategies* are needed in addition to the criticism directed at economic growth. The focus is thus on examining alternatives to today's approaches by using multi-target backcasting. This is described as a method where a number of desirable goals for the future are defined and used as a framework for formulating normative future scenarios where the goals have already been met. In this way, a long-term perspective on contemporary problems is built which shifts focus from the short-term, unwanted sacrifices that some may need to make to maintain a desirable holistic perspective. As previously mentioned, these can then be used to build clear strategies for achieving the stated goal picture and/or for discovering what future is actually desirable (Svenfelt et al, 2019).

The objectives used to formulate the scenarios in the above mentioned article address four themes: climate, land use, distribution of power, and resource security (figure 3). Furthermore, a Swedish context was set as a prerequisite, where Sweden continues to exist as a nation with the same territorial borders and national legislation system. The scenarios are described as parallel realities in 2050 and are based on different organizations of society. However, all of them assume that economic growth will slow down or cease entirely and is no longer the main driving force in society.

Collaborative economy

In this scenario Svenfelt et al (2019) describes the economy of 2050 to have transformed into a sharing economy with less usage of money in favor of trading, borrowing, and sharing. The available resources of the community are collectively managed and consumed, organized in people-led networks and associations which both produce and distribute goods and services, and ownership is collective rather than individual. People contribute to different types of associations by active participation, and time put into efforts or initiatives is what builds up the community functions and availability of resources. Citizens change from being consumers to "prosumers", with a high influence on the governing of society through continual co-creation. People live in clusters, rather densely, to be able to form the networks the communities are built upon. Digital networks and information- and communication technology enable remote connections and arenas of exchange on a virtual level.

Summary

- Sharing, borrowing, trading
- Networks and associations
- Collective ownership, not individual
- High democratic influence
- Community co-creation
- Remote networks and digital arenas

Local self-sufficiency

Moving to the next scenario, Svenfelt et al (2019) assume that society's organization is based on smaller communities that have a high degree of self-sufficiency. The import, export and overall global market has decreased and instead societies produce their own necessities based on the conditions of their local ecosystems and resources. Great focus lies on living in balance with the surrounding nature since the community's needs depend on a functioning local environment. Large cities have undergone large-scale emigration and been transformed into more sparsely populated areas. Instead, people live in the countryside or in smaller cities since agricultural land is highly sought after. People live simpler lives with less consumption and focus on material things, and spend their working time producing food and other important products which are then shared by the community. Political power has shifted from national to local level and is ruled by the local community to a high extent.

Summary

- Self-sufficient, smaller communities
- Resources based on local availability
- Simplicity and sufficiency
- Political power is locally anchored
- Minimal import and export
- Population is relocated to rural areas

Automation for quality of life

The last theoretical scenario description from Svenfelt et al (2019) portrays a future society where the development of technology and automated processes has enabled a drastic decrease in working hours for the population. People work around 10h/week, and the performed labour is no longer related to administrative or routine tasks but about extending human qualities like care, empathy, and creativity, and to interpret and evaluate data or input generated from technology. As people have significantly more free time, they are more involved in meaningful activities such as socializing with friends and family, spending time with sick and elderly, and performing recreational activities. There is a political majority to ensure less consumption and focus on sufficiency to exist within planetary boundaries. Produced goods and resources are distributed across the country with the aim of fairness, but this is also the biggest challenge of society. However, smarter systems have made it easier to have direct influence on politics. In order to avert inequality of income or influence in society, the technological resources which are responsible for productivity are distributed evenly across the country to decentralize their management.

Summary

- Automated production
- Reduced working hours for people
- Respect for nature, less consumption
- Manual work replaced by technology
- Increased focus on meaningful lives, recreation and human qualities
- Decentralized control

Reference projects

After presenting the theoretical descriptions of the future scenarios from the article by Svenfelt et al (2019), the following part will list a number of reference projects which present concepts that link to certain aspects of the scenarios. The content of the projects will be shortly presented, followed by a summary of which aspects are brought further in the thesis work, and how they relate to aspects of the future scenarios. The references are thus part of creating a theoretical framework for the upcoming designs, as they relate both to architectural concepts as well as to concepts that move beyond the aim of economic growth. Lastly, two projects of transformed oil cisterns will be presented as examples linking to the site context.

"ECOBOX" by Atelier d'Architecture Autogérée (2001-)

Ecobox is a project in the La Chapelle area, Paris, where the aaa created a garden in a left-over space, constructed by reused materials. Additional structures such as a cooking station, media station, and a workshop station were also set up and left to be activated by local residents. Aside from the initiating architects, the project was driven by a collaborative network of people with different trades, researchers, universities, artists, and of course the residents.

- Transdisciplinary collaboration network
- Active participation by citizens
- A venue for diverse activities to grow
- Mainly user shaped
- Grass-root governing
- Minimal resource use
- Social, cultural, environmental focus
- Enabling small businesses

"Rental house tower" by Sou Fujimoto Architects (2016)

This project shifts the way space is distributed in a residential rental house. The private space is minimized to bedrooms while the rest of the space is shared, containing kitchens, baths, library, movie theater room, gardens, terraces, etc. The building volume can therefore be designed in a more dynamic and creative way which also adds quality to the living situation.

- Residential building with high degree of shared space
- A mix of intimate/social atmospheres
- Creative building shape furthering the concept of space distribution
- Opportunity for added functions
- Integration of informal meeting spaces

"Stockholm 1-minute city" by ArkDes/Vinnova (2020)

This initiative acts as a toolkit to transform the public into a social space, being climate friendly as cars are not dominating the space, and democratic as the modules are supposed to be altered, moved, and adapted by the communities that use them. The intention is to enable a diverse outcome depending on the context; experiments, large-scale solutions, seasonal, etc. It is not about providing every base function in the community, but a way to develop and activate the existing public space that invites engagement beyond a car-dominated streetscape.

- Adaptability to context, such as adjacent flows or building functions
- Co-design between designers/citizens
- Alternative measure for designing public space
- Imagines a future streetscape of less cars

Figure 4. From aaa (2001-). ECOBOX [photo collage]. http://www.urbantactics.org/projects/ecobox/ecobox.html

Figure 5. From Sou Fujimoto Architects (2016). Rental house tower [photography]. https://archeyes.com/rental-space-tower-sou-fujimoto/

Figure 6. Utopia Architects (2020). Modules acting as plant beds and parking [illustration]. https://www.bloomberg.com/news/features/2021-01-05/a-tiny-twist-on-street-design-the-one-minute-city?cmpid=BBD010521_CITYLAB&utm_medium=email&utm_source=newsletter&utm_term=210105&utm_campaign=citylabdaily

Figure 7. Utopia Architects (2020). Modules acting as green structure with shadowed seatings and parking [illustration]. https://www.bloomberg.com/news/features/2021-01-05/a-tiny-twist-on-street-design-the-one-minute-city?cmpid=BBD010521_CITYLAB&utm_medium=email&utm_source=newsletter&utm_term=210105&utm_campaign=citylabdaily

"Jintai Village Reconstruction" by Rural Urban Framework (2017)

After a disastrous earthquake in 2008, the Jintai village in the Sichuan province, China, was new-built to provide new homes and a community for the people affected by the disaster. The project is interesting as it is an example of "investigation into modern rural livelihood" (Divisare, 2015) with emphasis on achieving symbiosis with the local ecology, planned circular systems and measures for higher degree of self-sufficiency.

- Community center
- Local materials
- Green stepped-roofs
- Biogas technology
- Animal keeping
- Natural ventilation
- Rainwater collection
- Biological waste-water treatment

"House farm" by Spark (2015)

"House Farm" presents the idea of combining a retirement home with production of food. The building design is mixing apartment housing with a hydroponic system, soil-based farming, an organic supermarket and a roof garden.

- Combines health-related benefits of greenery in everyday spaces with food production
- Closed nutrient-cycle through ecological waste-management and bio fuel
- Lively and vibrant meeting spaces for elderly
- A sense of purpose integrated in community activity and environment
- Self-sufficient

"Reimagining the workforce in the age of AI" by Niamh Reed (2019)

An article discussing the future needs within human workforce.

"AI's continued growth in scope and ability will lead to greater emphasis on human-unique workforce skills. These include soft skills such as empathy and flexibility, as well as creativity and strategy formation. This will translate into a shift in the type of work that humans do. While technology takes over the 'grunt work', the human workforce will be thinking more about the outcomes of a project or action. They'll be able to spend more time interacting with customers. And, crucially, the human workforce will be free to explore more new, innovative avenues.

Artificial intelligence will also assist the future workforce in ways unique to the technology. By conducting more advanced analytics, it will enable humans to make use of more data. So, humans will need the skills to apply the insight AI generates in the most productive and effective way."

- Discusses future needs within workforce
- How humans may adapt ther skill sets
- Supports the anticipated need of creativity, empathy, and flexibility in future work
- People will need different education and training focusing on strategy, analysis, and application of data

"Slime mold is master network engineer" by Laura Sanders (2010)

This article presents the research performed by Hokkaido University in Sapporo, Japan, which studied the capacity of the single-cell organism *Physarum polycephalum* known as slime mold to create highly efficient networks between certain nodes. The research team placed oat flakes in a pattern mimicking the metro stations of Tokyo and presented it to the slime mold, which started to grow a network in between the nodes. The organism's expansion in between its sources of nutrition grew organically to become more and more refined and optimized, until it held striking resemblence to the existing metro network. Tokyo's metro system was carefully designed by engineers and deemed to be one of the most efficient in the world.

- Finding biological behaviors with potential to inspire smarter and resourceful methods of design
- How research within natural science can benefit design and planning
- The potential of biomimicry design

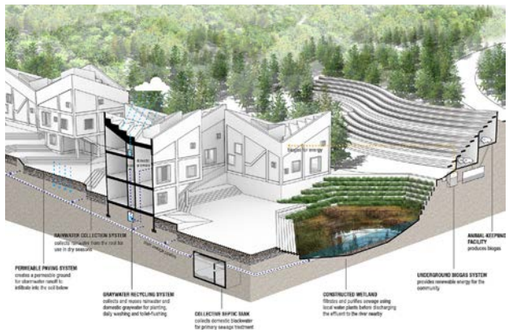


Figure 8. From RUF (2017). Water and nutrient systems [illustration]. https://divisare.com/projects/301565-rural-urban-framework-jintai-village-recostruction

Figure 9. From RUF (2017). Residential houses and garden in Jintai Village [photography]. https://divisare.com/projects/301565-rural-urban-framework-jintai-village-recostruction

Figure 10. From Spark (2015). House farm with vertical gardens [illustration]. https://www.dezeen.com/2015/11/17/home-farm-spark-model-asian-retirement-housing-communities-city-farms/

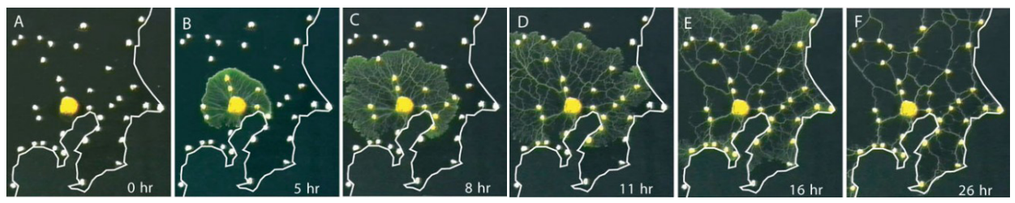


Figure 11. From Marwan, W (2010). The expansion of the physarum polycephalum and its nutrient network. [photography].https://www.sciencenews.org/article/slime-mold-master-network-engineer

"Robot developers hub" by 3XN Architects (2021)

This to-be-built facility in Odense, Denmark, will provide space for two technology developers working with "cobots" ("collaborative" + "robots") which are robots that collaborate with humans. The workspace of the hub will be shared by both robots and humans with varied space functions. aimed at further development. (Maganga, 2021)

- Post-human architectural design, considering robots as a target group
- Expanding the notion of collaboration in workspaces to include meetings and space for non-human participants
- Aiming for qualities in the design which highlight sensory qualities for humans such as tactile materials and natural light

"The hospitals of the future" by OMA/Reiner de Graaf (2021)

A manifesto by OMA & Reiner de Graaf (2021) of what the future of health-care could look like, laying out the historical traces of how diseases were fought with the help architecture (walls to keep out infected with plague in medieval times; light and air to prevent cholera and yellow fever in industrial cities) until the architecture of hospitals became too massive and time-consuming to construct that they became obsolete. They recognize only one remaining unit: the bed.

Furthermore, the manifesto portrays the future hospital to be self-sufficient to a certain degree; facilities will be 3D printed and possible to recycle and reproduce according to pressing needs; logistics will be automated; high-precision operations will be self-managed by robots; other self-operating and automated technology will free medical staff from routine work and focus on human-centered care.

- Automation and technology enable qualitative and empathy-centered work for e.g nurses and doctors
- Advanced building technology could create high adaptability of health facilities to meet the needs of the patients better
- Digitalization will cease the need for centralized care and located in closer proximity to patients

"Silo 468" by Lighting Design Collective (2012)

An old oil silo was transformed into a piece of light art and public venue in Helsinki, Finland. The walls were perforated in a selected pattern with additional armatures placed on the inside to create a play with light to be seen from both interior and exterior. (ArchDaily, 2012)

- Showcases the possibility of reforming former objects from the oil industry into well-designed habitable space for people

"Oil tank culture park" by Heo Seogoo & RoA architects (2017)

This culture park in Seoul, South Korea, represents a complete transformation of use and typology while still preserving structural och geometrical features of the past. Formerly used as a site for storage of oil, the site was redesigned into a cultural center where each of the six tanks remaining from the past was re-appropriated for various uses; performance spaces, exhibition circle, memorial circle, etc. (WorldArchitecture.org, 2019)

- Holds interesting design features as the tanks have undergone various degrees of alterations and combination with contrasting materials
- Creates new and generating purpose in a post-industrial space while preserving the memory of the site

Figure 12. From 3XN Architects (2021). Robot developers hub [illustration]. https://www.archdaily.com/956516/3xn-unveils-design-for-new-robot-developers-hub?ad_source=search&ad_medium=search_result_all

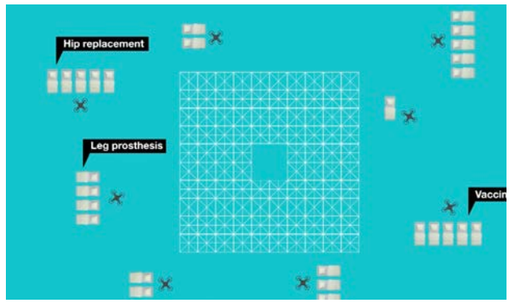


Figure 13. OMA & de Graaf, R. (1 mars 2021). Drones delivering medicines [video]. https://vimeo.com/495716066?utm_medium=website&utm_source=archdaily.com

Figure 14. Lighting Design Collective (2012). Silo 468 [photography]. https://www.archdaily.com/298912/silo-468-lighting-design-collective> ISSN 0719-8884

Figure 15. Seogoo, H. & RoA architects (2017). Oil tank culture park [photography]. https://worldarchitecture.org/architecture-projects/hccev/oil_tank_culture_park-project-pages.html

Figure 16. Seogoo, H. & RoA architects (2017). Oil tank culture park [photography]. https://worldarchitecture.org/architecture-projects/hccev/oil_tank_culture_park-project-pages.html

Implementation

The following implementation chapter is divided into two parts. The first part provides an introduction to the chosen site and its surrounding context. Then comes the design concepts that have been developed as part of this thesis work, which relates to each of the three discussed scenarios: collaborative economy, local self-sufficiency, and high automation for quality of life. Each design concept is then synthesized with the site to provide exemplification of how they might take shape in a given context. Therefore, this chapter consists of subjective interpretations which are created from the site analysis and described theories in order further their connection to urban planning and architecture.

Site

Figure 17. Hisingen's communities and zonings in relation to Arendal.

Arendal

As mentioned in the method, the chosen site of this thesis is Arendal, an almost purely industrial area located on the southern coast of Hisingen. It is part of the industrial fringe that follows the riverbank from West side of Älvsborgsbron until it reaches a Natura 2000 area in Torslandaviken. Road 155 runs parallelly to the coast, through the industries, and provides a connection between central Göteborg and the rest of Hisingen's southern communities all the way to the ferry between Öckerö and mainland. The site is presently occupied by oil refineries.

Historic land use

1960: The land was used for agricultural purposes with farms and single-family houses scattered across the landscape. An airport was located here before it moved to Landvetter. The coast line was natural.

1975: The oil industry settled with new infrastructure, artificial expansion of the coast line and landfills. An oil port was built with a road running through Torslanda bay and across the small islands.

2021: The industry has continued to expand. The landfill completely encloses the Torslanda bay, altering the habitats in its brackish water.
The cluttered landscape alternates between industrial, rural, suburban, and recreational areas.

Figure 18. Timeline of land use in Arendal.

Figure 19. Building footprints in the landscape.

Figure 20. Green structures.

Figure 21. Infrastructure.

Figure 22. Industrial land-use.

Connections

As can be seen in the diagrams displaying different layers of the site area and its surroundings, there is clear industrial dominance along the coastline, which has resulted in extensive infrastructure and a sprawl of development based upon the needs of the businesses. The green structures along route 155 are mainly fringes in between roads, buildings and pavings without further proof of thought for biological connectivity.
The industrial area lies in between the more rural communities of Torslanda and the urban residential areas in Eriksberg, Kyrkbystaden and Biskopsgården. It thus has great connection to several parts of Göteborg, but presently it also acts as a barrier in between them.

The urban areas are organized in smaller, denser neighborhoods with apartment blocks, single houses, or attached houses. The typologies in Torslanda are similar to the urban ones, but also have additional typologies related to the close agricultural history. Some of these rural qualities are displayed in points on the opposite page, and represent the more spontaneous and user shaped areas which give a comprehension of the patchwork this landscape is today, with its many contrasting features.

Surrounding area

Figure 23. Rural characteristics surrounding Arendal.

Photographs of the landscape

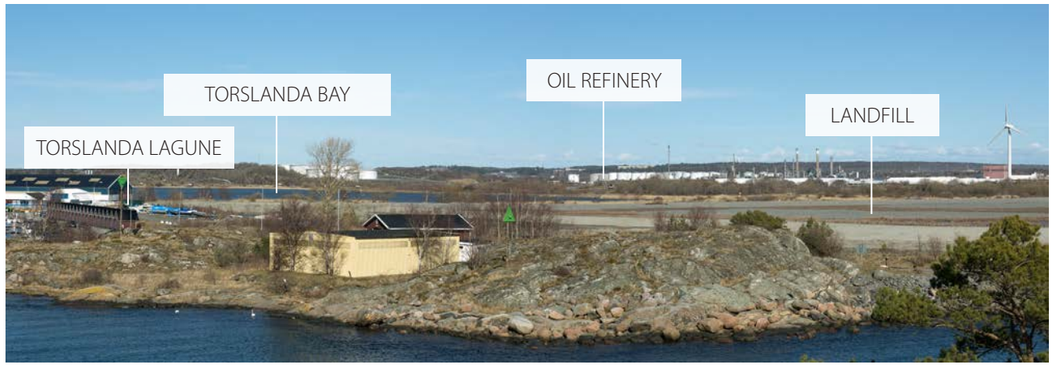


Figure 24. A photo from the West side of the oil refinery where the vast landfill that closes Torslanda bay is visible.

Figure 25. An adult and a child play by the water on Skeppstadsholmen.

Figure 26. Outside Skeppsholmen there is an oil port where oil ships anchor.

Figure 31. Oysters and mussels in the shallow water by Skeppstadsholmen.

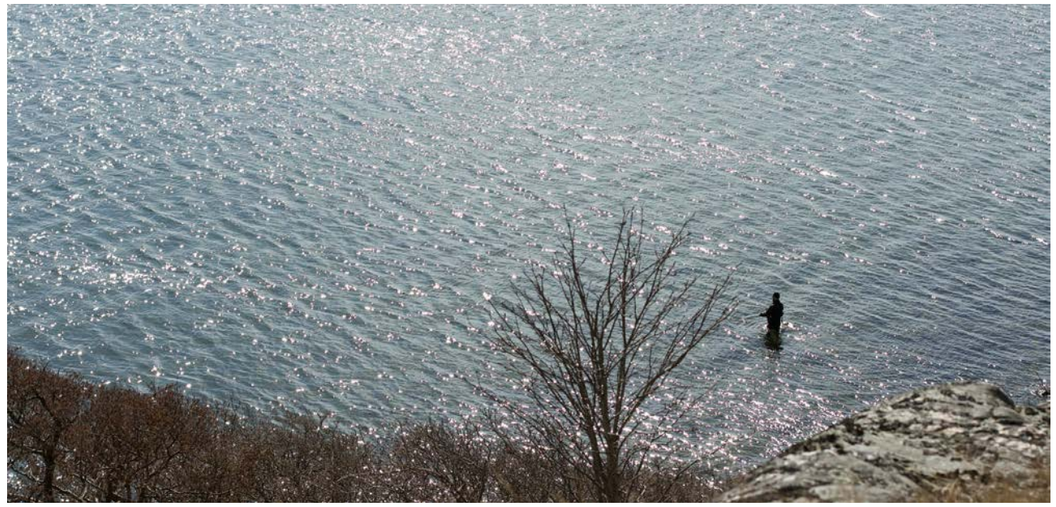


Figure 27. A fisher in waders going into the water from one of the coastal villas during lunch hour.

Figure 28. The building for Amhult-Lyse local history society (hembygdsförening).

Figure 29. A small exhibition of land dividers and vehicle for road maintenance in the early 1900.

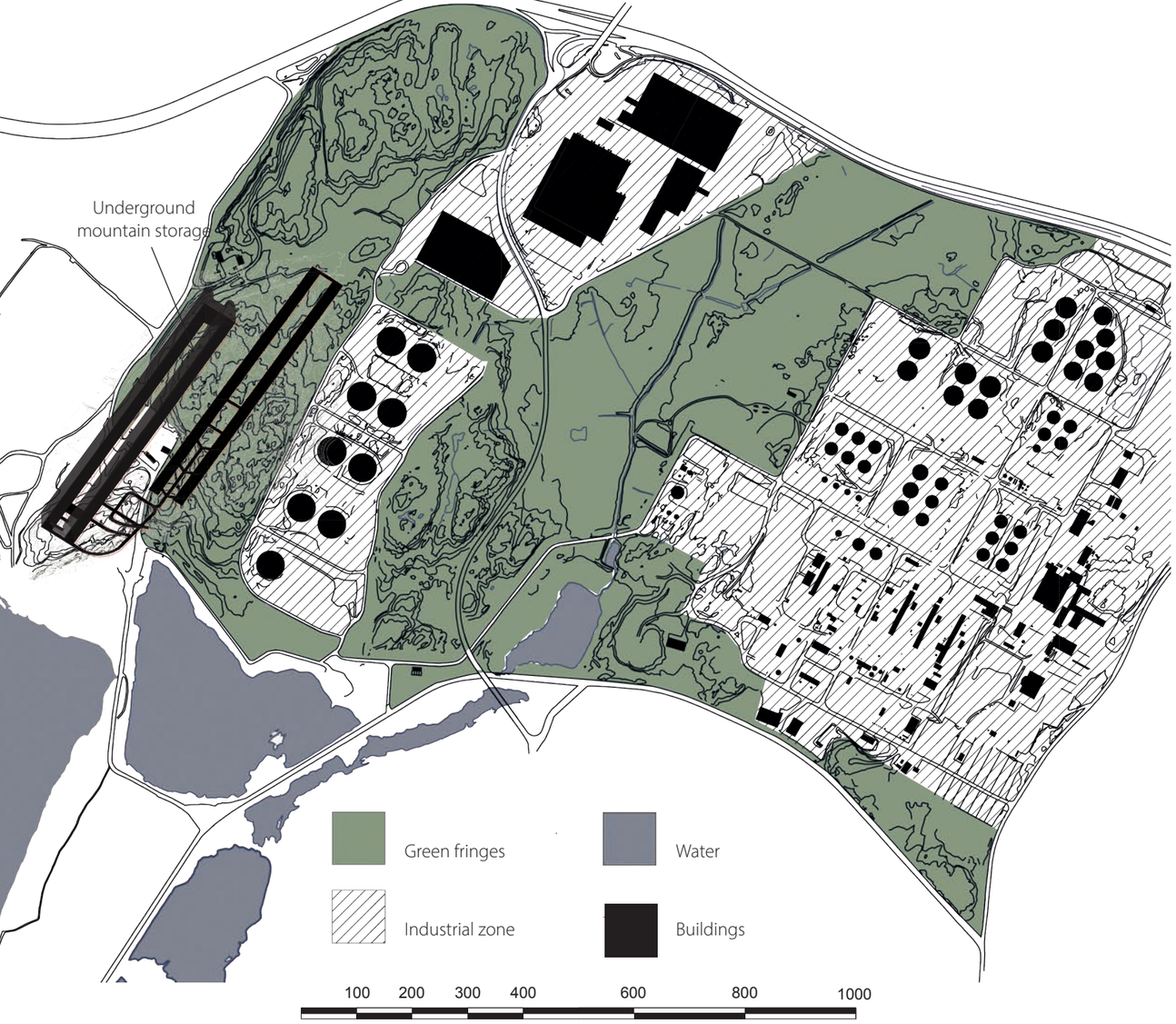


Figure 30. Oil refinery area. Scale 1:10 000.

Industrial inventory

As the historical maps conveyed, large areas along the coast line have been used by the oil industry for more than half a century, reshaping the landscape according to their business needs. The interventions are massive, robust, and disconnected to the human scale. Steel and concrete dominate the materials of the built environment and the form language is aside from the linearity of the car roads made up of cylinders in different shapes and sizes; oil tanks, endless amounts of piping, and chimneys.

Aside from the physical implications of infrastructure and buildings, the fact that the industry centers around processing toxic substances also impacts the area chemically. According to Länsstyrelsen's (2021) analysis of land pollutants, there is a "very high risk" of existing pollutants in the area of the oil refinery and oil depots. Furthermore, according to research done by Livsmedelsverket (2021), there is a higher risk that old soil pollutants remaining in industrial areas will move around and pollute groundwater flows as landslides, water level rise, and heavy downfalls will increase with climate change. The land consequently will need to undergo sanitation when the oil refinery is no longer active.

Figure 31. From Göteborg Hamn (2011). Mountain vault for raw oil storage. [photography]. https://www.mynewsdesk.com/se/goteborgs_hamn/pressreleases/historiskt-oegonblick-raaolja-lastas-ut-fraan-goeteborgs-hamn-629841

Oil storages

Figure 31 is a photograph taken in the underground storage marked out on the site map on the opposite page. The space consists of an aisle which is 500 m long, 20 m wide, and 30 m tall, and was carved out in the late 1970s to store raw oil in the mountain in case of another oil crisis. The masses that were dug out from the mountain were used as landfill to build the roads and expansions between the small islands outside the coast, and fill the bays along the shore. The boat in the picture gives a sense of how huge these spaces are. There are eight aisles in total, but only two are used today. There is another example of a mountain storage for raw oil in Hudiksvall, which was decontaminated in order to enable new uses (SVT, 2015).

Aside from this storage for raw oil, there are presently 50 additional oil tanks in varied dimensions on the site, as can be seen in figure 32. The scale figures next to the tanks in the drawing, which are only visible as dots, help to convey their massive scale.

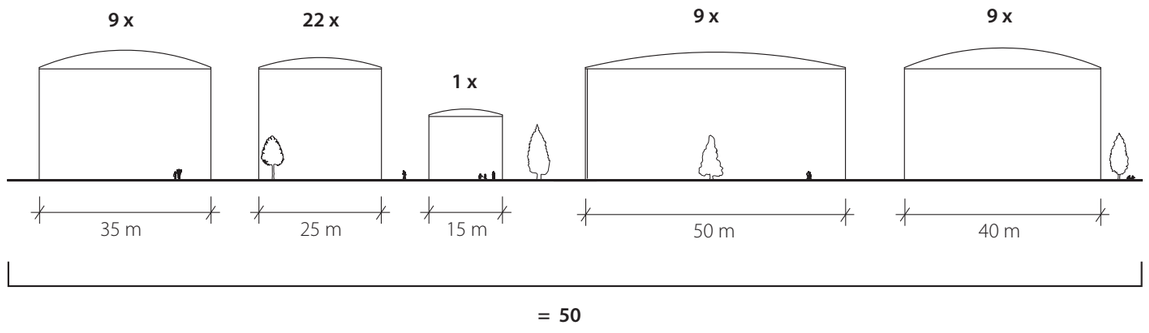


Figure 32. The quantity of the different dimensions of oil tanks on site.

SWOT-analysis

Strengths

- Coastal connection
- Closeness to urban & rural communities
- Windy
- Historic traces
- Nearby bottom-up communities
- Leisure activities
- Beautiful views towards archipelago
- Rugged landscape

Opportunities

- Interesting geometries
- Objects suitable for re-appropriation
- Expanding green and blue structures
- Large amounts of land
- Unusually shapes/space dimensions
- Renewable energy
- Strengthening sightlines in landscape

Weaknesses

- Soil contamination and pollution
- Car dependency
- Barriers created by highways
- Industry dominated
- Noisy
- Polluted
- Weak ecosystem
- Inhabitable environment

Threats

- Sea level rise (climate change)
- Landslides
- Spread of toxins/pollutants

Site summary

The area taken into account for the following implementations is a big landscape with many contrasting elements, from heavy industry to countryside communities. Today, the industrial fringe along the coast acts as a physical barrier between central Göteborg and the communities in Torslanda. It holds great room for improvement considering its proximity to many surrounding locations.

There are many valuable qualities both regarding recreational activities and ecology in the landscape, but the industrial presence has decreased their values, for example through inaccessibility and by locking in Torslanda bay so its brackish marshland is ruined.

The industrial structures that exist in the oil refinery area have geometries and dimensions in their constructions that could be interesting in transformative design work. However, both within the industrial and surrounding landscape, the infrastructure carries heavy traffic which cuts off pedestrian and bike mobility and overlook the location's potential for connectivity. The bus traffic along route 155 which connects Amhult and Torslanda to Göteborg is relatively frequent, but public transport between Torslanda's smaller communities is sparse and further promotes car dependency.

Some of the values found in the area inventory that will be brought into the design implementations are some of the cultural and social aspects of the local communities, as well as expanding the ecology of the natural landscape. Patches of natural habitats such as the Natura 2000 reserve shows the potential for biodiversity along the coast, and the previous agricultural tradition proves potential for productive land.

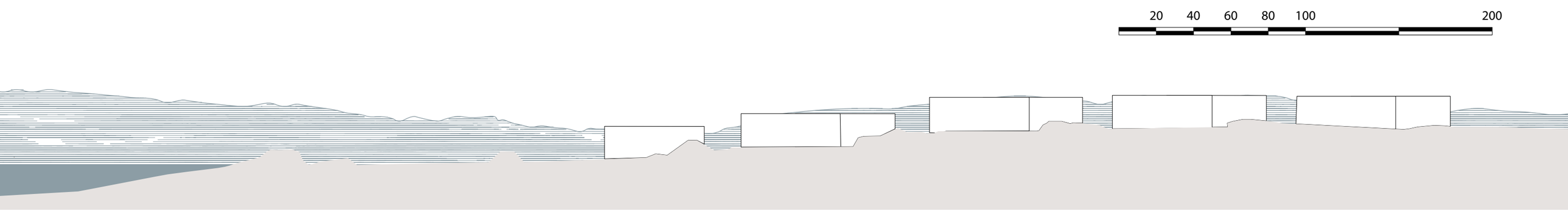


Figure 32. Cross section (A) of the terraced landscape descending into the water.

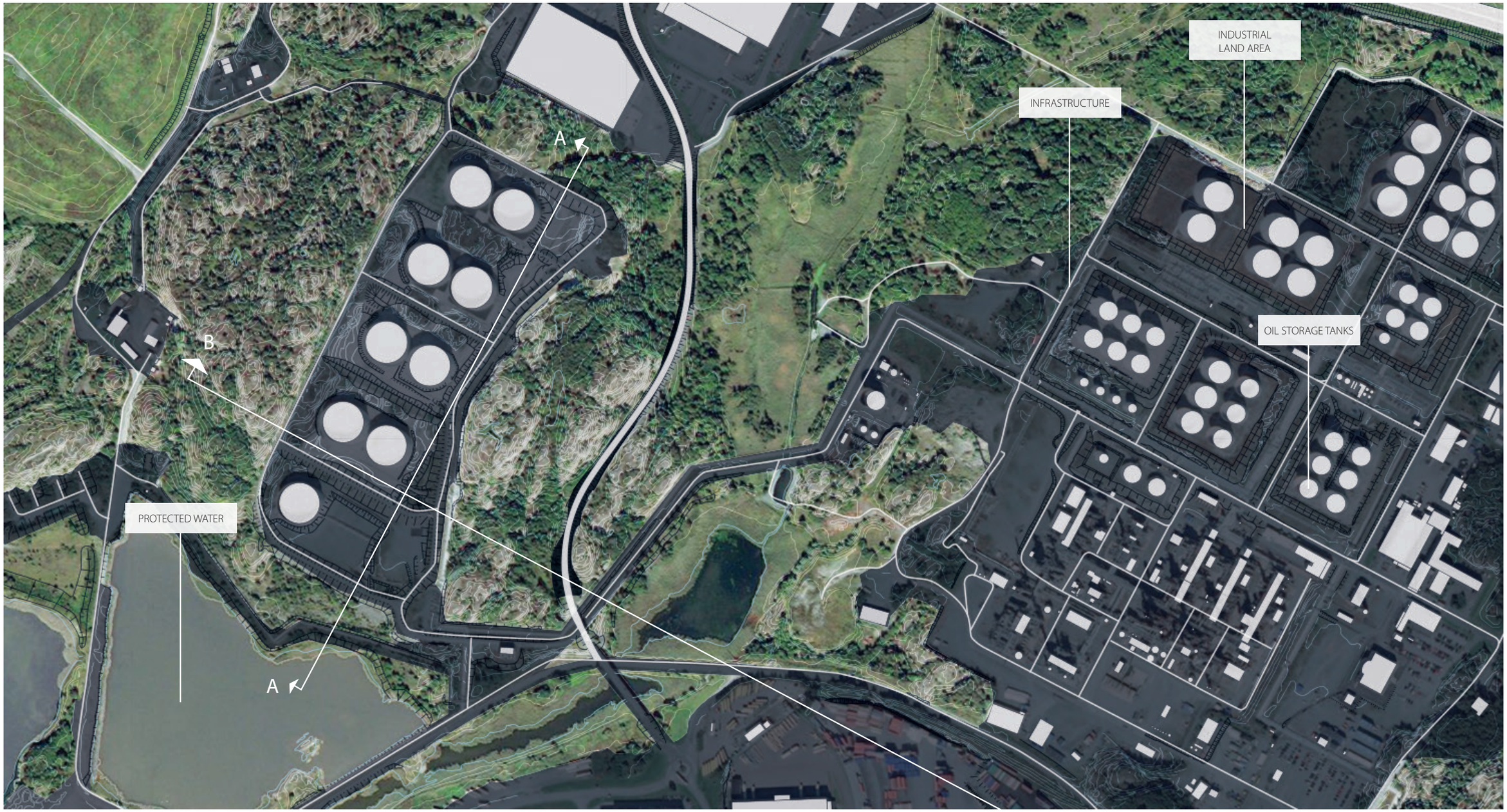


Figure 33. The oil refinery area with a summary of site inventory.

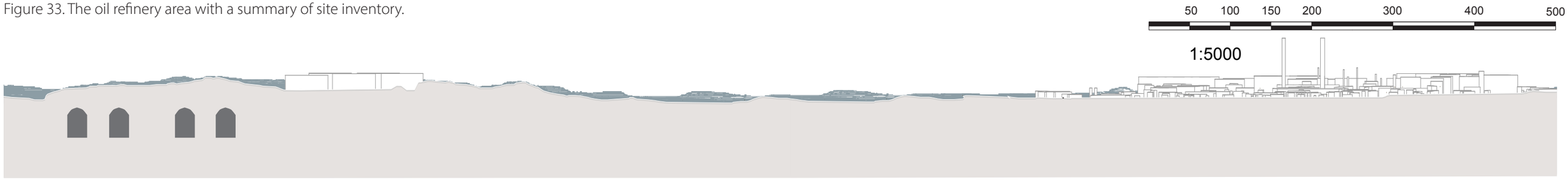


Figure 34. Long section (B) of the landscape topography, including the mountain storage in the mountain.

As a result of studying references and theories, the following design concepts, diagrams and illustrations are subjective interpretations and ideas derived from the earlier thesis process.

Arendal 2050: Collaborative economy

Narrative

The landscape where the old oil refineries once held their activity had an excellent location for living a qualitative life. Its position next to the sea made it easy to have sustainable exchanges between wide-ranging destinations. The possibility to collaborate, trade, and to travel, as well as the diverse and active atmosphere of the community, made the place highly attractive.

The closeness to the sea provided so many opportunities, it now seemed absurd it had been used for polluting industries in the past (then again, so many aspects of the industrial age seemed absurd in hindsight). The coast gave too much to be damaged like that. It made up a complex biological system which depended on its habitats, and it gave so much to the people, both for practical but also purely enjoyable reasons.

People wanted to live close to the sea, close to the water, but there were dangers to this as no one had known how the water levels might fluctuate in the future. The most vital functions of the community were therefore placed higher up, and it provided panoramic views of Göteborg's archipelago right outside of people's homes and workplaces.

There were other things that could be placed near the water. Cultural and leisure activities were built here, as well as a new harbour, which gave a vibrant welcome to tourists and trades-people who arrived by waterway.
The good things the industries had left behind were infrastructures and constructions. Some of the materials had to be eliminated from stable constructions due to withering, but they were creatively used for artistic and sculptural purposes. The oil tank constructions that remained in good conditions served as the skeletons for new buildings, sometimes the plate cladding as well.
Since large areas within the district had been contaminated with pollutants, these places were used for temporal activities; work places, production space, and recreational halls. There had been extensive decontamination of the land when the industry closed, and vegetation suitable for phytoremediation were planted to regenerate the soil. The idea had been to be able to use the land for food production, but eventually this business hub had become such a vibrant and expressive area, it continued to be so. The park-like, mixed spaces, with its old industrial elements intertwined with greenery, made the hub a unique architectural and cultural value in the district.

Then there were the four massive mountain caves. One had been cleaned from the rest product of the raw oil and used as a museum of the oil industry. There were also flexible spaces for temporary exhibitions and events and used occasionally in there. One or two of the other caves had been used to dispose contaminated landmasses, and remove some of the landfill enclosing Torslanda bay to restore the brackish water quality of the bay.

Design concept

People live in neighborhoods that provide for basic needs: housing, welfare, and leisure activities combined with a variety of meeting places.
Energy production, maker spaces, workshops, gardens, recreational halls, etc. run by local associations are placed more freely around the area, not necessarily tied to residential buildings. Additional initiatives, depending on the needs and desires of the inhabitants, take form and are part of shaping identity, additional functions, and character of the neighborhood. The neighborhoods are connected through networks with an exchange of knowledge, goods, services, etc. that creates a certain level of self-sufficiency, a high degree of influence, diversity, and vibrant culture.
Due to the mentality of sharing, trading, and borrowing, space distribution becomes less privatized. This could manifest in the way buildings are zoned, for example residential buildings which increase semi-private and community space, as maintenance and management of the neighborhood is done collectively.
Since society isn't focused on defining citizens as consumers, public space is shaped inherently different from present commercial intentions. Instead, it represents the social exchange that dominates life, while also providing more intimate atmospheres, spaces for recreation, and other necessary traits/ functions for the wide range of human needs and desires. Additionally, there is a greater care for the environment as a means to maintain local resilience and the accompanying human health benefits that come with a high-functioning, biodiverse environment.

Key design approaches
- Shared space
- Expansion of public landscape
- Diversity in public spaces (social,
- contemplative, restorative, recreational)
- Meeting spaces
- Creative spatiality
- Multi-user space (accessibility, inclusion)
- Social networks
- Community space

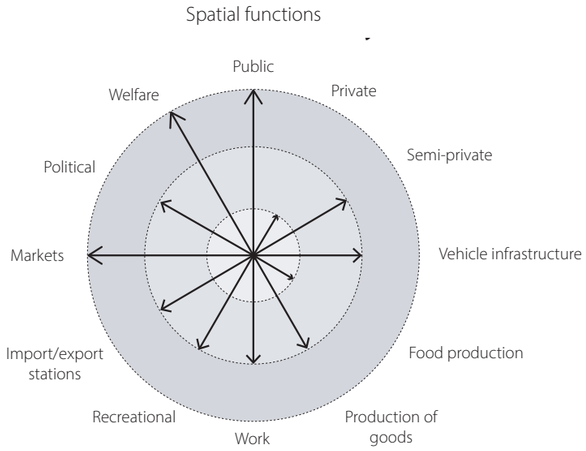


Figure 35. Diagram showing estimated importance of a number of spatial functions.

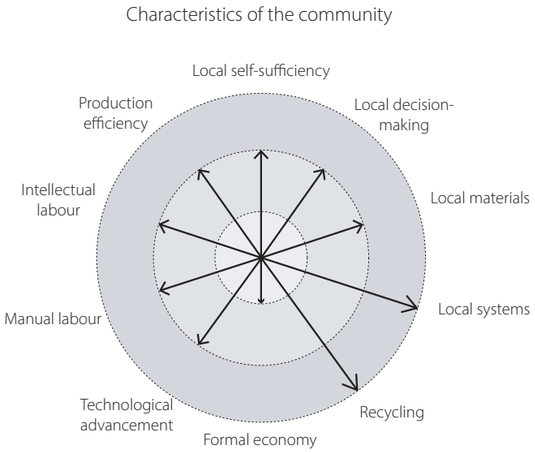


Figure 36. Diagram of general characteristics which influence the community's design.

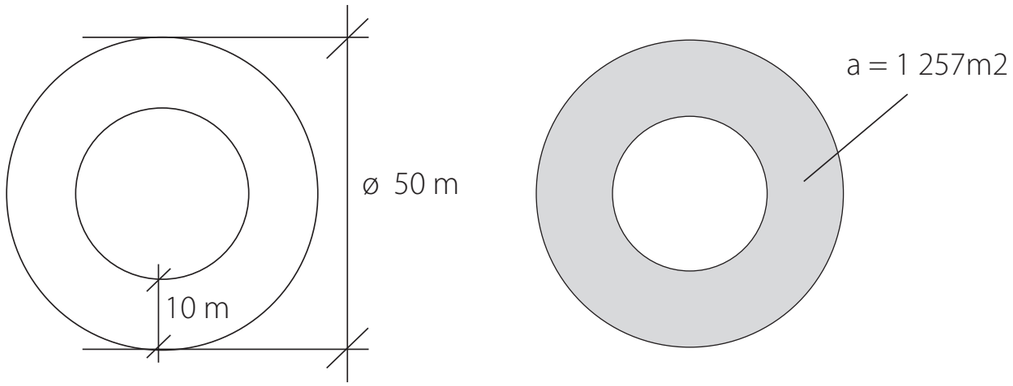


Figure 37. The measurement of the 50 m wide oil tanks gives a floor area of 1 257 m2 if it is transformed to have an internal courtyard and a building width of 10 m.

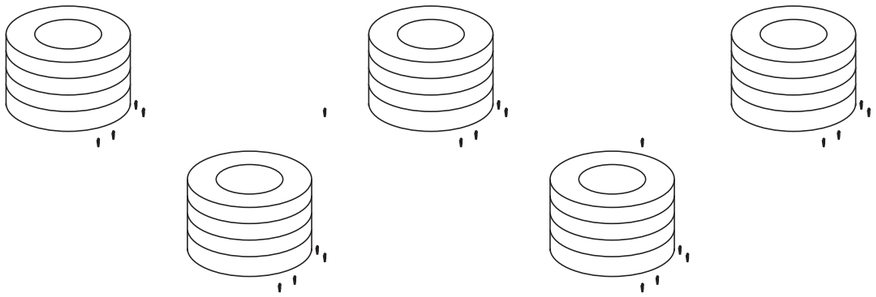


Figure 38. If the tanks also were redesigned to have four floor levels, the total floor area would be more than 25 000 m2.

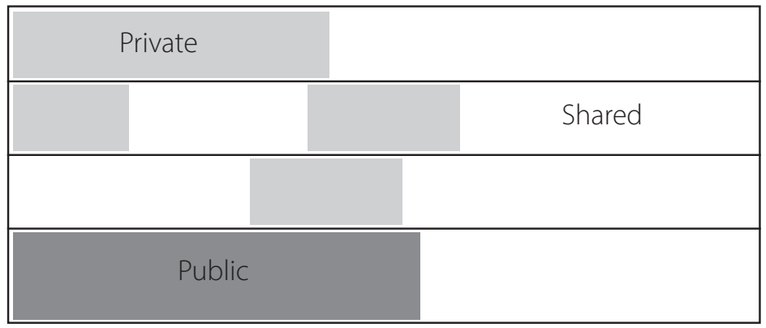


Figure 39. The space distribution of private, shared and public space could be designed in favor of shared spaces and present the opportunity to fit more room functions than a standard residential building have.

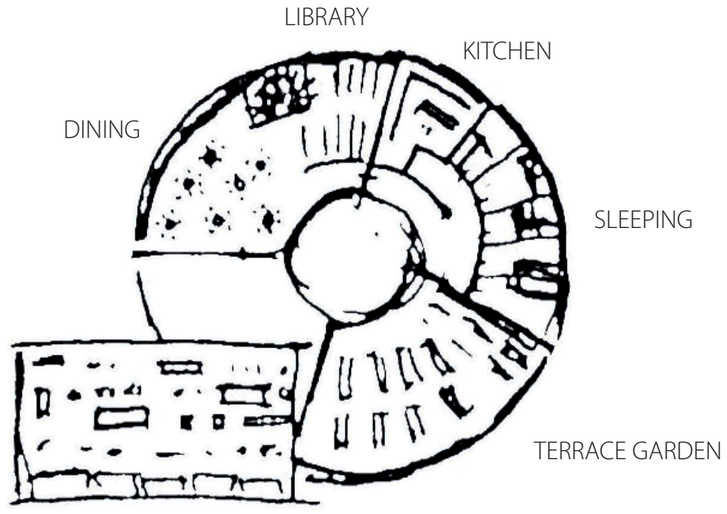


Figure 40. This plan diagram examplifies how a floor plan could be divided, with small private bedrooms and a shared kitchen, dining space, terrace, and library.

Figure 41. Master plan of Arendal in 2050 as a collaborative economy. The community is built around three main hubs: the residential area, the industry park, and the port. The lines connecting the different hubs symbolises the high exchange between people and associations which makes up the local network. The port provides external connection the community by waterway.
The constructions and infrastructure of the past industry has been preserved to a high extent and repurposed for new activity as an "industry park". It consists of a mix of productive and recreational facilities with green structures intertwined into the area, both for spatial and phytoremediation purposes. Some of the past constructions from the oil refinery have been preserved as sculptural monuments of the fossil era.

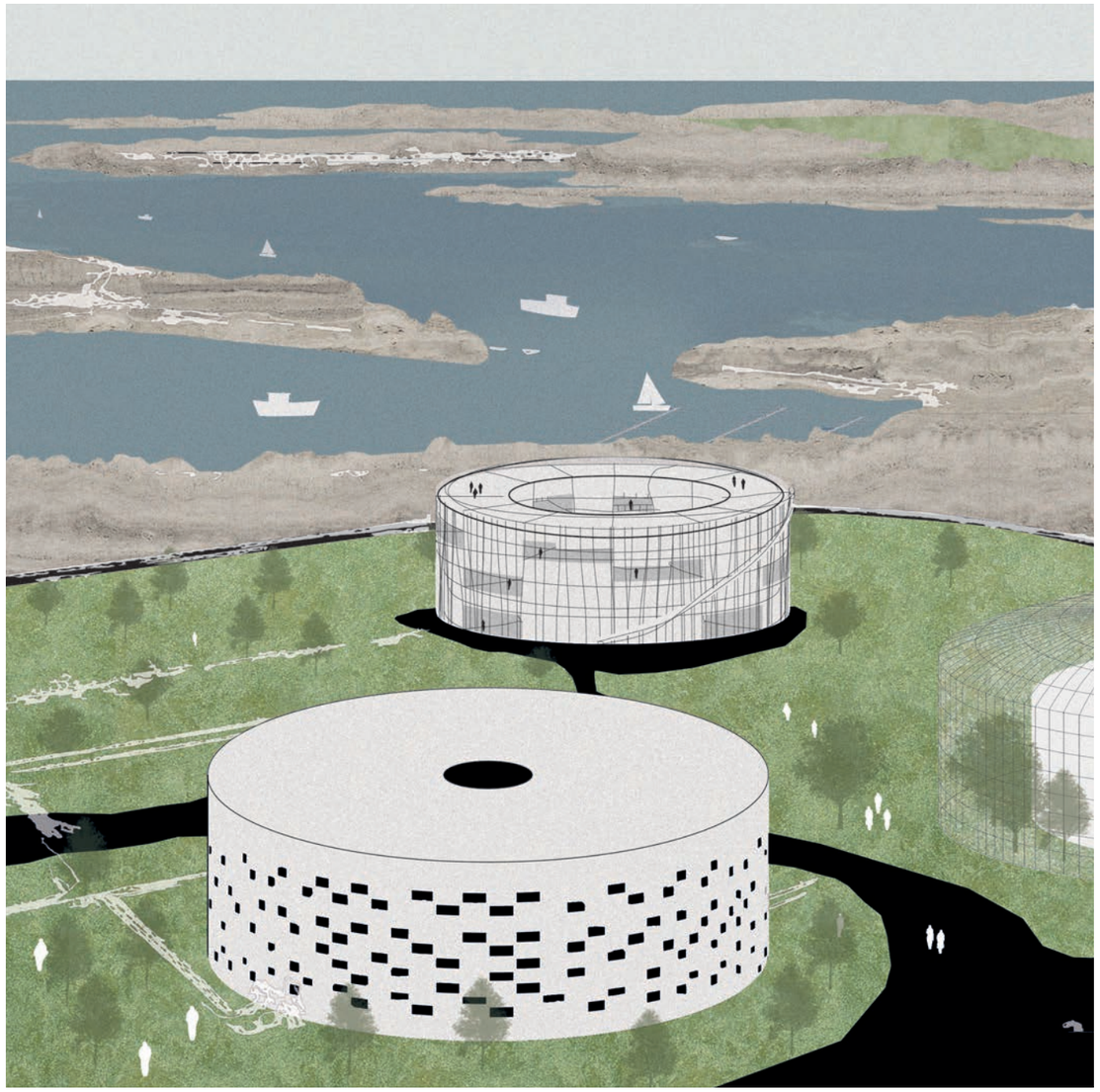


Figure 42. Perspective of residential and recreational area, showing the port in the background with both trade and leisure boats approaching it. The residential houses holds views over the archipelago.

Figure 43. Perspective of the industry park, with a mix of recreational buildings (e.g. culture halls), productive facilities, and pedestrian pathways connecting the area. Old industrial objects such as the chimneys framing the walkway are preserved as monuments over the fossil era.

Arendal 2050: Local Self-Sufficiency

Narrative

The seaside community of Arendal grew organically over a long period of time after the oil industry stopped. When they left and sold the area to the community's initiators, the price was cheap due to the many problems affiliated with the previous activity. The land was sold on the premise that the new owners would be responsible for the sanitation of the site's hazardous waste.

This was a condition that the new owners of the land happily accepted. They were a group made up by a wide ranging mix of people who had come together based on immediate needs, desires, and long-term visions for the industrial area of Arendal. Some had been long-term residents of adjacent coastal districts of Göteborg who wished to phase out the imposed industrialism and work restoratively for the area's future. Some people were new-comers to Sweden who wished to be part of shaping a new community where they could settle down and live in peace from conflicts or environmental crises. Some were environmental enthusiasts within different professions who saw the potential of the site. As the community grew, it attracted more people who would like to physically reconnect to nature in their everyday life and be part of a resilient and safe community.

As soon as possible, a biological sanitation of the soil began and the leftover structures were cleaned up.
The first few residential buildings settled near Härröd Hill. The production of vegetables, foods, water and sanitation systems, and energy was integrated into the neighborhood. It was relatively small as the rest of the area was cleaned-up, which took years due to the sensitivity of spreading pollutants as the soil was shifted. Eventually, new soil, green structures, and animal pens were gradually implemented in the area to enrich the land again. Finally it was safe to move freely in the area, even for children, and to use the land for growing crops.

The initiative of this community attracted a lot of people who shared the values of resilience, self-sufficiency, and simplicity in nature. The way of living and regenerative will-power that existed here awoke inspiration and new initiatives in the surrounding areas. People traded their everyday work-life to be part of producing the necessary means for their community's welfare, joy, and survival.

Some rest materials and construction parts were saved and reused or re-appropriated in the community's built structures. Some were sold to be recycled or used in other places that had better need of them. Instead of the steel and concrete, local materials were used for new constructions, such as wood, clay, and stone.

Design concepts

The idea of this scenario is that a large portion of the spatial planning in the community revolves around producing and managing what is necessary in order to secure the survival of the community. That means food production (vegetables, grains, animal keeping) which demands space and circular water- and nutrient systems; producing/refining materials; energy production, maintenance and construction of buildings, local political facilities, facilities for storage, places for community gatherings and meeting spaces, carbon neutral and energy efficient processes and life-styles, and seasonal adaptation of life.

The aesthetic of the community becomes small-scaled, shaped by individual preferences, and constructed with local materials. It reflects the simplicity and resourcefulness along with the organic structure of the community as it evolves over time with many different people involved. Most of the facilities are for practical purposes but as a large portion of the day is spent in these places, there are also "resting islands" integrated into the landscape, with attention to sensory qualities. Due to shift towards increased usage and dependency of productive land compared to urban landscapes, the atmosphere of the self-sufficient community is relating to the nature in the surroundings.

Key design approaches
- Solar-passive design
- Storage spaces
- Local materials
- Circular systems
- Vertical food production
- Context-based design
- Rural community functions
- Low-tech

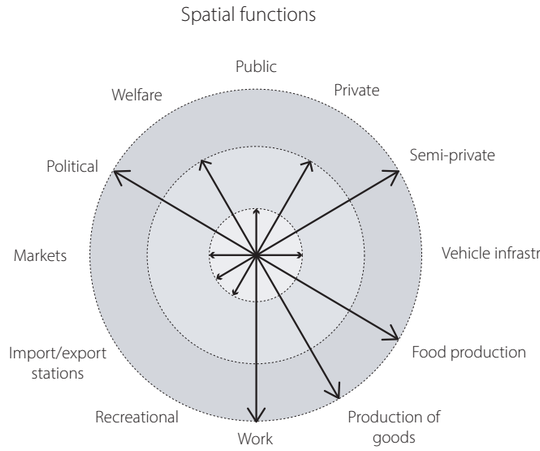


Figure 44. Diagram showing estimated importance of a number of spatial functions.

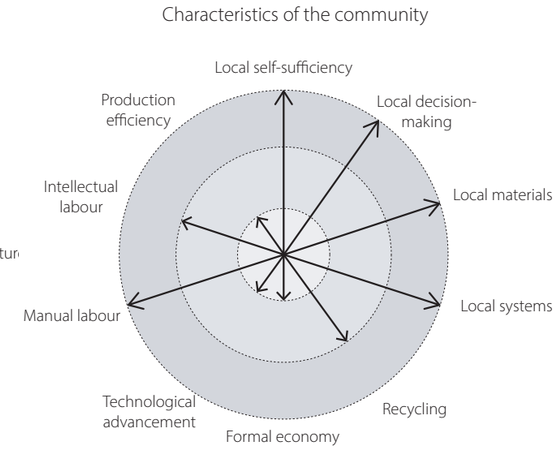


Figure 45. Diagram of general characteristics which influence the community's design.

Figure 46. Master plan of Arendal in 2050 as a locally self-sufficient community. Arendal has been thoroughly sanitated and renewed in order to use the land for food production. Buildings are sparsely placed in small clusters on high points in the landscape with nearby community centers acting as a meeting spaces. Fields are divided into narrow plots to promote polyculture in the crops.

The old oil tanks have been altered and reused for storage of water, nutrients, food, and necessary tools. Some acts as shelters for animals or pavillions which people can rest in during their work days. The old structures from the oil refinery has been removed, sold or recycled. A facility for political meetings and decisions is centrally placed in the community.

- Preserved structure
- Productive facility
- Residential building
- Trade space

Figure 47. Residential houses are built on the rocky patches of the landscape, leaving productive land free for use, while still being in close proximity to their work areas. The yield of each harvest is shared and distributed among the community members. Aside from the plots of their dwellings, individuals do not privately own land; the land and productive facilities are seen as common resources of the community.

Figure 48. There is a community center in each residential cluster for social gatherings and cultural events. The main community building for the entire area lies on the Western end and here is also where political gatherings are held as well as occasional markets.

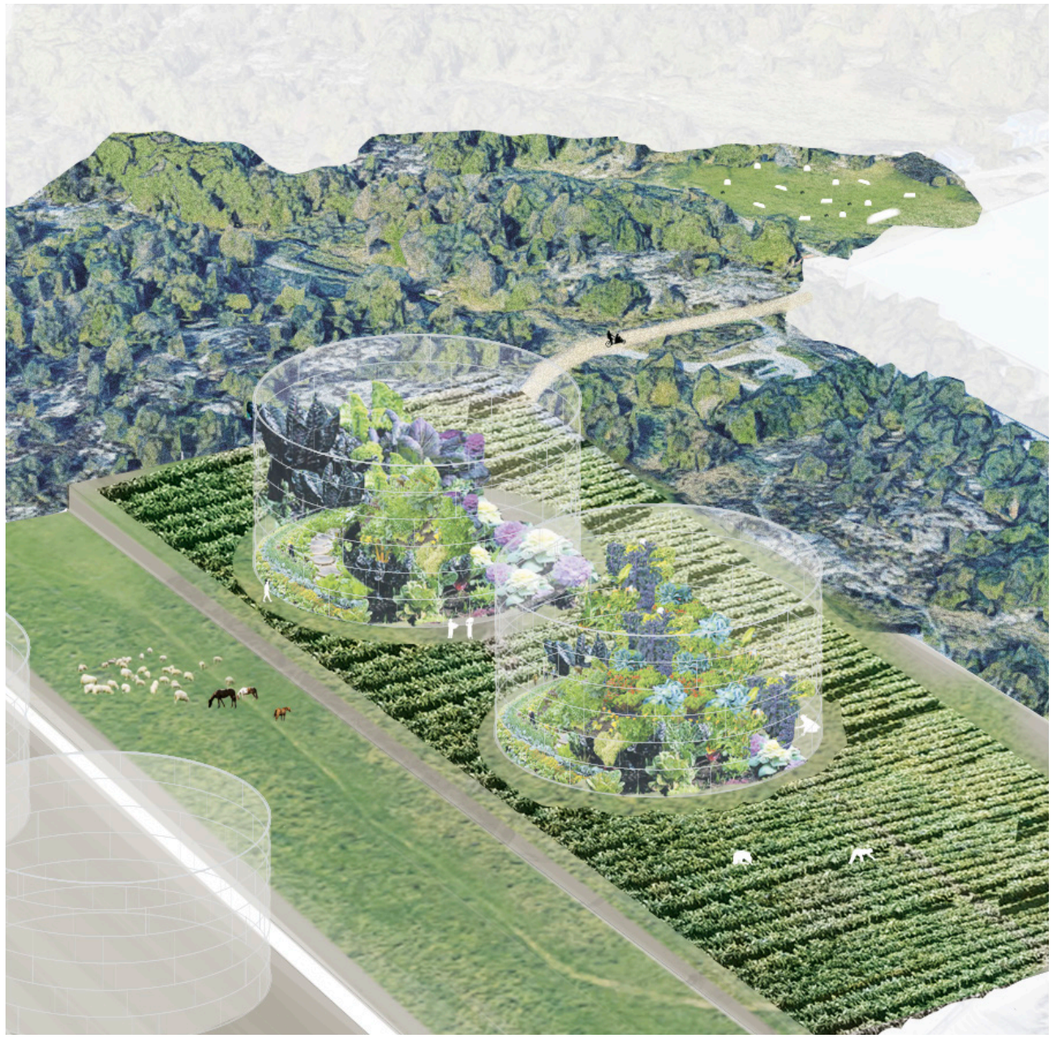


Figure 49. Collage displaying old oil tanks tranks transformed into green-houses for vertical vegetable production. The terraced topography is enhanced to create different levels of farming landscape intended for horizontal soil beds or animal pens. In the background, one of the clusters of residential buildings can be sighted.

Figure 50. Collage of a section in the landscape which shows the productive farmland between the productive facilities in the East and a residential cluster on top of the cliffs.

Arendal 2050: Automation for quality of life

Narrative

In the automated society there are many concepts from different fields of sustainability design that are woven together, such as reuse, low-energy building design, biophilia, bio-mimicry, regenerative design, etc.
The technological advancement which enabled a liberation from administrative and routine work has made science, technology, engineering, and mathematics (STEM) important in education and skill development to facilitate society which is reflected in its central placement of the community.

As a consequence of the environmental crises in the beginning of the 21st century, a profound respect for nature is embedded into society, strengthened by the scientific evidence of its vitality.

In general, people have similar desires and needs in 2050 as they always had. These require safety of the physical environment, social venues, recreational spaces, and possibilities to have adventures.

Since Arendal was one of the areas with obsolete fossil activity, it became a focus for transformation early on. Initially, the industrial areas were supposed to just adapt their facilities to new production systems, but Arendal was not included in this concept as it was considered to hold high potential for other uses. Its proximity to both the qualities related to the countryside, and the culturally vibrant urban areas of Göteborg, Arendal was decided to strengthen the regenerative aspects of its surroundings.
Extensions of habitats for wildlife and nature and human reconnection to nature became the main focus, as well as creating a new, dense neighborhood to provide more housing.

The area used for refining raw oil consisted of rock, patches of soil, and dense infrastructure, and became a suitable location to construct the new neighborhood upon. Now, the infrastructure is no longer occupied by cars and heavy trucks, but has a self-operating public transport system connecting the area both internally and to the high-speed train located on route 155. The streetscape is less linear and more park-like as a consequence.

Aside from this urban core, the landscape is fundamentally changed. The total foot-print required for both community functions and infrastructure has shrunk significantly and has enabled a removal of the labyrinthic highways cutting through the landscape as massive barriers. Non-organic and polluted substances had been removed and diverse habitats in the eco-system re-established, becoming an extension of the nature reserve in Torslandaviken. Now, it is possible to hike along a beautiful coastal landscape from central Göteborg all the way to Öckerö. Along the hiking paths there are small design interventions of shelters and sculptures.

Design concepts

In the future scenario of high automation beyond GDP growth, the life-standard has become simpler, less ruled by consumption, and the technological devices needed are highly optimized and aimed at functional tasks, in order to free humans from labor. Just as Hans Rosling (2010) explained how the invention of the washing machine enabled his mother to improve her life through education and more leisure time, the advancement of technology in the future would similarly mean more time for research, education, culture, and recreation. Human activities and interests would be able to become more developed and flourish.

Since all basic tasks of society and life are performed by robots, the design structure of the built environment needs to be structured intelligently to enable automation. Biomimicry becomes a dominating design approach in practice as it refers to the most ancient and optimized systems there are on our planet. The study of nature greatly inspires architecture and community planning to enable expressive, smart, perhaps even self-healing design systems.

The well-being of the environment is an obvious factor to consider in every aspect of society. Along with the increased use of nature-inspired design approaches, architecture as a discipline became oriented towards making the built environment an active contributor to local ecosystems, and inflict as little damage on nature as possible.

Key design approaches
- Biomimicry
- Baubotanik
- Evidence-based design
- Self-operating vehicles
- Respect for nature
- Health and recreation spaces
- Humanity-centered

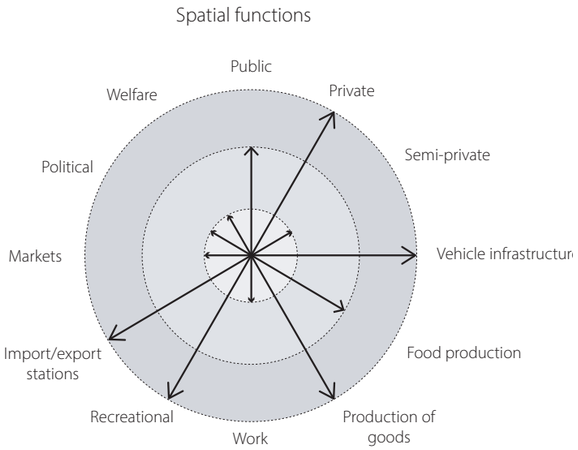


Figure 51. Diagram showing estimated importance of a number of spatial functions.

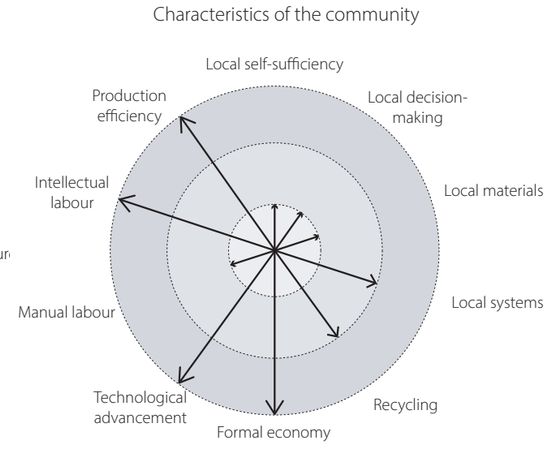


Figure 52. Diagram of general characteristics which influence the community's design.

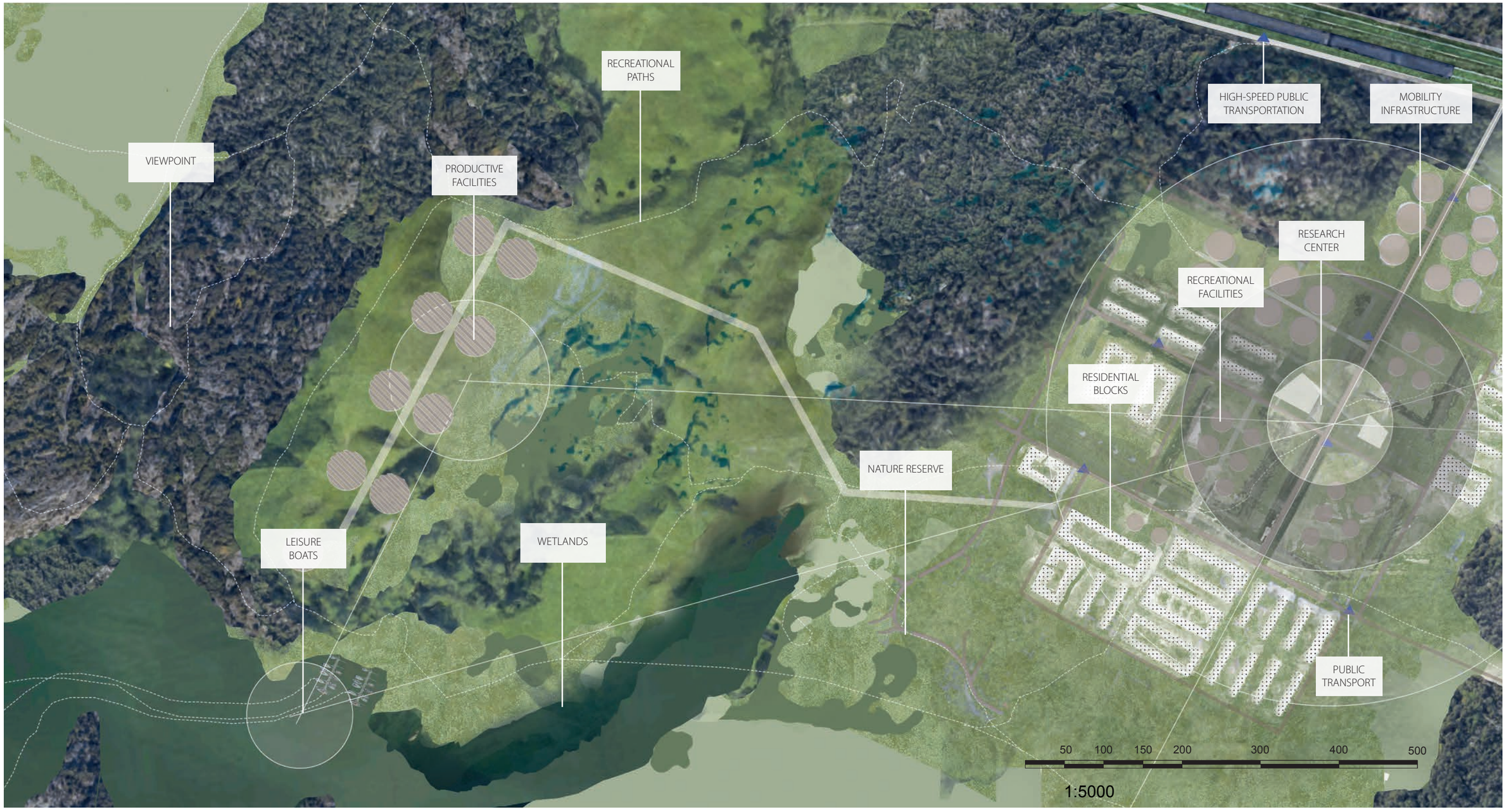


Figure 53. Master plan of Arendal in 2050 based on a highly automated society scenario. The human footprint has withdrawn to center around a research center, reusing the old infrastructure of the oil refinery. A majority of the land has been restored to a natural landscape with enhanced biodiversity through ecosystem services embedded in the landscape (e.g. wetland reconstruction). Most of the land has become an extension of the nature reserve in Torslandaviken, bridging over the old barriers for the green structures and wildlife. There is little infrastructure running through the landscape except recreational path with minimal footprints, running continuously along the coast and connecting to other communities and nature areas.

People are residing in efficient and sustainable apartment blocks with integrated welfare, service, and social functions into the buildings' ground floor level which provides a lively streetscape. Cars are barely used, instead people travel with a self-operating public transport system which circulates the area and connects to the high-speed trainstation which runs where route 155 once did. Streets can be designed more creatively with less space reserved for vehicles, and the negative space in between buildings hold greater resemblance to park qualities, as they become less linear and hold more diverse functions.

Preserved structure | Productive facility | Residential building | Trade space

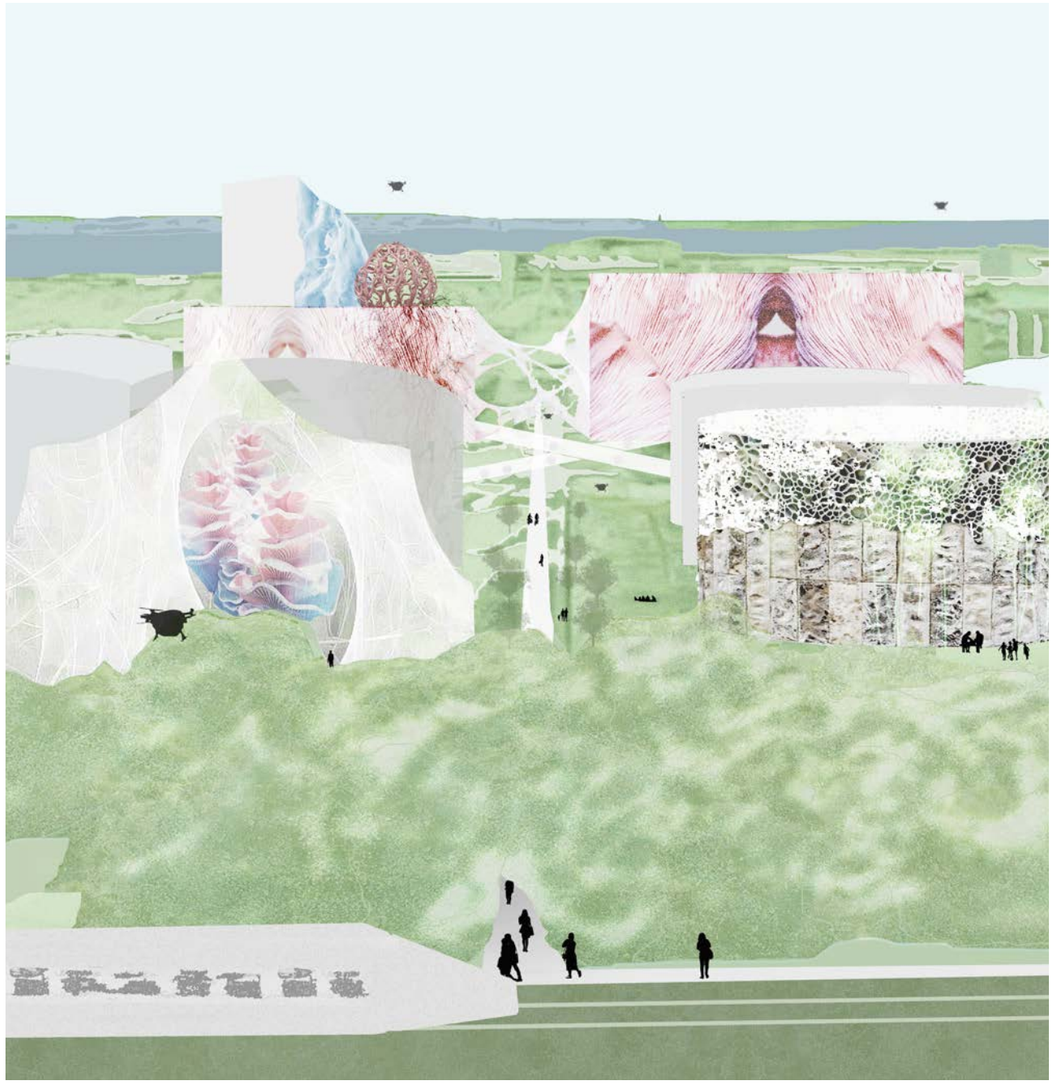


Figure 54. Collage which shows a perspective of the valley between the urban core and productive facilities, including diverse nature and wetland habitat. Small drones are passing in the air

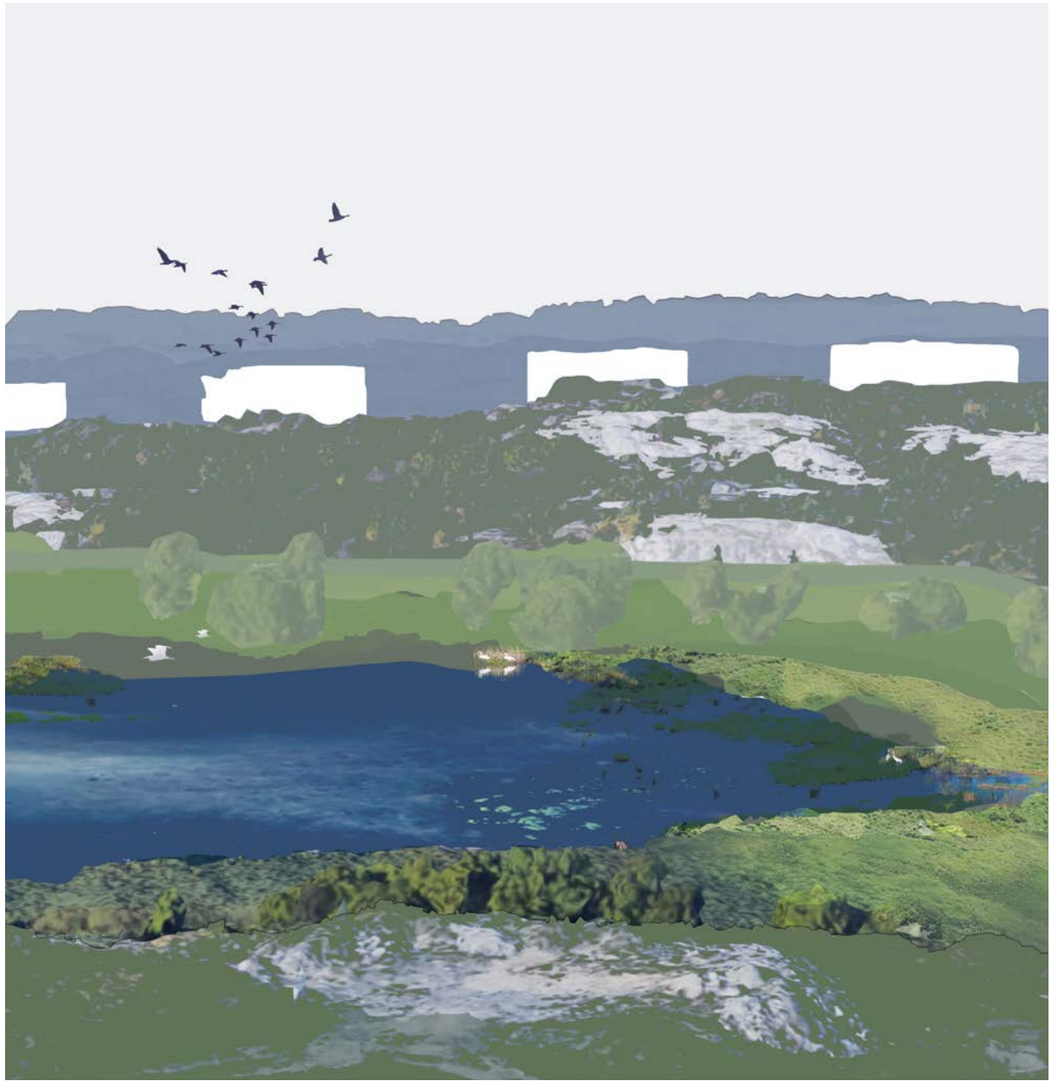


Figure 55. Collage of recreational activities, form language of the buildings, and building elements within the ”urban core”, including self-operating public transport.

Figure 56. There is a lively atmosphere in the human-center with many places for socializing, games, sports, and relaxing. The environment has an urban characteristic to it with organized streets, active bottom floors, and density.

Discussion

Summary

The purpose of this thesis was to explore alternatives beyond sustainable development with decreased focus on economic growth in order to explor socio-ecological aspects further. With the use of future scenarios beyond GDP growth and speculative design, the thesis created conceptual visualizations of each scenario by implementing them on a site with architectural design tools. The site was chosen because it contains an industrial landscape which will grow obsolete in a future which has diminished its use of fossil fuels, thus becoming an area of potential transformation.

Comparison and analysis

The scenarios presented in this work share many features, but they also differ from each other. Some main approaches in the design implementations was applied in all three scenarios:

Shared approaches:

- Nature's role in society is held in higher regard
- Community resilience in response to rising sea levels
- A degree of production of necessary goods
- A degree of preservation of the industrial structures
- Re-establishing Torslandavikens connection to Göta Älv
- Decontamination of the polluted land masses

These approaches were established as a manner to showcase the heightened awareness of nature's and ecosystems vitality in order for communities to survive.
The scenario implementations include nature as a self-evident member of the affected parties by the activity within the area. Whether it is through the act of withdrawing the human footprint to be compact and less sprawled, to live more modestly according to the available resources in the immediate surrounding, or to reuse already existing structures, these implementations acknowledge the importance of considering the natural environment and wildlife as an crucial part of planning.
Aside from these overarching similarities, the design process was aimed at creating clear distinction between the implemented scenarios in order to communicate their key messages and get a wider variety of ideas, as opposed to merging the future concepts into one scenario. This was a surprisingly challenging process, especially considering that the theoretical scenario descriptions were so clearly seperated. However, when processing the options for the implementations, certain decisions proved to have greater impact on many additional factors of the community design depending on to which extent they where implemented. These themes were used to create clear distinction between each scenario.

The first one is related to how the local economy is organized, i.e. which degree of trade or degree of self-sufficiency there is in the community.

Degree of trade vs. self-sufficiency:

- how much land is necessary for production of food and goods
- the amount of working hours, productive facilities, and consequently also amount of recreational traits
- the extent of external and internal infrastructure needed for transportation

Furthermore, with regards to urban planning terminology, these categories and points were used to further separate the scenario implementations from each other:

Figure 57. Collaborative economy.

Figure 58. Local self-sufficiency.

Figure 59. Automation for quality of life.

Preserved structure Productive facility Residential building Trade space

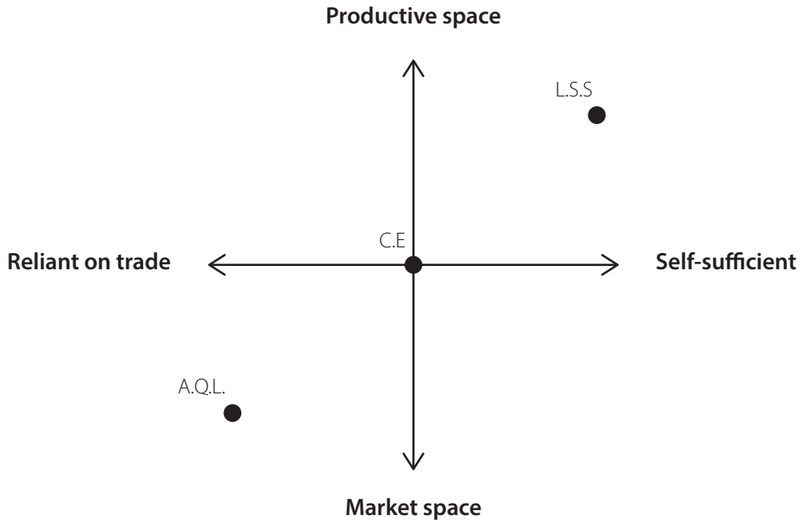


Figure 60. Diagram of how the degree of trade vs. self-sufficiency relates to demand for productive vs. market space in each scenario.

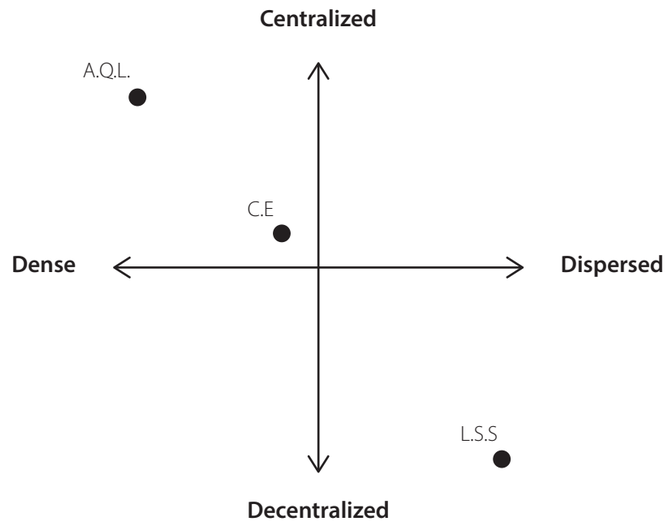


Figure 61. Diagram of the scenarios' level of centralization and density.

Figure 62. Each scenario is implemented with different approaches on preservation vs. transformation of the industrial landscape as demonstrated on the axis.

Organization of functions:

- C.E: three hubs created through adaptation to the existing structures; the least polluted area for residential buildings, the immediate oil refinery area for new economic activities, and the bay as a port for import, export and travel
- L.S.S: food production dominates the area and people live on the unproductive patches in the landscape in single house units close to the productive land
- A.Q.L: one dense, central neighborhood containing all necessary functions and traits in most industrialized part of the area to re-establish connectivity between green structures

Degree of centralization:

- CE: decentralized in its production of some foods, goods, and services, but also relies on external exchange and internal exchange between the hubs
- LSS: the most decentralized scenario with small self-sufficient units locally providing all necessary resources
- AQL: the most centralized scenario both internally and in regards to the rest of Sweden. It has efficient transportation systems which enables easy connections to other communities or cities, but is densely built to minimize the human foot-print and have close proximity to necessary units in the immediate, physical community

Adaptation to existing structures:

- C.E: preserves the existing elements of the industry, integrates new purposes and regenerative elements, and adapts placement of functions to the most suitable location according to the current situation
- L.S.S: preserves some functional elements, e.g. tanks for storage and terraces for farming, but holistically transforms the land to be eligible for agriculture use again
- A.Q.L: uses the most dense existing infrastructure to center the community around and repurposes some oil tanks, but generally withdraws the human footprint in the landscape as much as possible to restore its natural qualities again

Aside from these listed similarities and differences which are easily separated, it is worth mentioning that it is possible to overlap many concepts between the scenarios. For example, the community could be both highly self-sufficient and highly automated; these aspects do not cancel out each other.
However, in order to communicate their key ideas, each implementation goes to the limit of each idea. Since the automated society holds great ability for efficient transport, it is assumed to use this system for export and import, dispersing production to different locations in Sweden, and thus not designed to be self-sufficient.

Concluding discussion

Architectural design and planning is always based upon norms, assumptions, and subjectivity, and current practice within our industry have a great impact both on the built environment and the use of global resources. This fact is important to acknowledge especially in times that call for change. Only by addressing and understanding what or where the current problems are derived from, we can assess the methods and strategies that have caused them, and discuss other ways to operate.
But the chronology of this analytical process does not need to follow that particular order in order to be most effective. This is why this thesis chose an approach of backcasting and portrayal of sustainable societies, as the definition of future targets that are wished to be obtained can become more effective if they are made before formulating strategies that are aimed at reaching those targets.
Moreover, the work investigated how an established connection between backcasting and physical planning could take shape with an applied perspective of degrowth. Since degrowth presents an interlinked discourse of both critical and visionary perspectives that relates to the topic of sustainability, it contributes with a suggestive narrative of alternative approaches that evokes creativity.

During the design process, the transition of going from theoretical research for design to an implementation of the logical framework proved to be more difficult than initially thought. Despite having these three "manifestos" of seemingly clear and separated goals, the work with the implementations still held great room for subjective interpretation and decision-making. One decision about i.e. building typology, productivity level, or density created significant variations in the design results.
This observation led to two conclusions about the scenario implementations. The first is that policy making doesn't guarantee that the policy's aims are carried out as they were intended. In this case, the theoretical scenario formulations, which can be equable as policies for the implementation, were made in a group of several well-educated people within different fields, and tested on a broad group of stakeholders, including different levels of governmental, non-governmental, private and non-profit organizations. But as the implementations were carried out by an individual architecture student, the designs are still the result of one person's interpretations of the scenarios/manifestos/policies, and probably lack many of the aspects that the scenario authors or involved stakeholder would consider as crucial.
This leads to the second conclusion. Images, narratives, and visualizations in general are inherently evocative. They can be reactive, seductive, provocative, and persuasive. It is difficult for architects and planners to ensure that all important knowledge and experiences are applied in their design work. However, by using their professional tools, design implementations of future scenarios could enforce the scenarios' position as dynamic and valuable tools for discussion. Architects and planners could contribute to the discussion by providing tangible representation of what the scenarios could entail. If recurring exchange between said disciplines and affected target groups were to be included in the process of understanding desirable futures, this could enable a mediating and goal-oriented discussion even between stakeholders that might have short-term conflicts of aim, while still gaining their diverse perspectives through their thoughts on the scenarios. Thereby, the implementations can be seen as an effective tool to convey future possibilities for different stakeholders involved in planning processes, which could help discussions about sustainability efforts reach farther than they currently do. The site which was used for the implementations provided one example of how the future scenarios could raise questions for discussion.
Approaching the site as a possible area of regeneration shed light on the many problems and challenges that would arise when dealing with land that would become brownfield areas left from the fossil industry. Although the project scope did not include in-depth research about the technical aspects of, for example, remaining pollutants, it still created ground for discussion about what these areas could become. The fossil era only makes up a small portion of the landscape's history, and as the industry grows obsolete, it becomes relevant to discuss entirely new purposes of the site in the future. Does this area have to remain a polluted industry site forever, or are there alternatives, perhaps even assets, to find here?
This question is somewhat dependent on practical aspects if a deeper understanding of the possibilities are wanted. For example, knowing the exact condition of the land influences the ability for interventions which renew it as e.g. an agricultural or residential area. But as for most of the other aspects that the implementations regard, they do not depend on practical conditions, but ideological ones. This, for example, applies to the question of using fossil fuels or not. The impact that fossil fuels have on the natural environment and human health is factual; the standpoint of whether or not to use them is political and depends on which interests are valued.
The decision of land use is also ideological. This aspect is connected to the way land is valued depending on its proximity to urban areas and prospects of financial gain. When the land and its inherent resources are only valued according to how much profit it could generate, its cultural, social, and ecological values are entirely neglected. The project site for this thesis clearly states this case, especially when putting its industrial aspects and the surrounding landscape qualities in comparison.

Some examples are:

- a Natura 2000 area with protected waterlife borders onto an oil refinery site which deals with hazardous products and processes
- an entire bay with unique ecosystem values is closed in completely, severely damaging the habitat's qualities, because the oil industry excavated oil storages in the mountains and needed to deposit the land-masses somewhere
- a sea bathing allotment area has a port for oil ships outside the cliffy shores where children bathes

When the economic aspects are taken out of the evaluation of these places and the focus lies only on social and ecological ones, it is difficult to find logic behind how the land has been exploited, if the end goal is for people and nature to prosper.

Lastly, the organization of our society, and decisions to plan communities with higher degree of centralization, self-sufficiency, fair resource distribution, less consumption and changed working conditions are also ideological. They are shaped by priorities of interests. Today's economic system which aims for increasing private property, production, and trade could be changed into a different system which regards natural resources and human welfare as common, with consideration to local ecosystem capacity. The built environment could create preconditions which enable this contrasting reality, such as the implementations represent, but it also depends on ideological conviction.
When trying to accomplish actual transitions within our society in response to the crises we face, the question is not if we have the practical means to do it, it comes down to if we are willing to change or not. We do not lack technical innovations in order to create change; we lack collective willpower to realize the change. Anchoring back to one of the previous conclusions, here is why it is relevant to find tools for open dialogue and deeper understanding between different stakeholders of what different changes could entail. By using scenarios to illustrate alternatives where both people and nature can flourish, we could start building collective understanding of a broader perspective which moves beyond economic catches that prevent the discussion from moving farther.

Bibliography

Andersson, K., Hylander, F., Nylén, K. (2019). Klimatpsykologi. Natur & Kultur.

Asara, V., Otero, I., Demaria, F., & Corbera, E. (2015). Socially sustainable degrowth as a social–ecological transformation: repoliticizing sustainability. Sustainability Science, 11(3), pp. 375-384.
Article: https://link.springer.com/journal/11625/topicalCollection/AC_a1328cab4383ac9fedf4bd2cf5df943e

Dunne, A., & Raby, F. (2013). Speculative everything: Design, fiction, and social dreaming. MIT Press. pp. 2-9, 33-45.
Retrieved from http://ebookcentral.proquest.com

European Environmental Agency (2021). Growth without economic growth.
Article: https://www.eea.europa.eu/acl_users/credentials_cookie_auth/login_form?came_from=https%3A//www.eea.europa.eu/themes/sustainability-transitions/drivers-of-change/growth-without-economic-growth

International Energy Agency (2019). Global status report for buildings and constructions. UN Environment Programme.
Report: https://www.iea.org/reports/global-status-report-for-buildings-and-construction-2019

Lehtinen, A. A. (2018). Degrowth in city planning. Fennia - International Journal of Geography, 196(1), pp. 43-57.
Article: https://doi.org/10.11143/fennia.65443

Sharmin, T. (2011) A comparative study of sustainable urban forms: Compact city and short cycle strategy. AIUB Journal of Science and Engineering,10(1), pp. 1-9.
Article: http://hdl.handle.net/2086/16629

Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.) (2018). Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. IPCC.
Report: https://www.ipcc.ch/sr15/

Reed, N. (March 20, 2019). "Reimagining the workforce in the age of AI". Datafloq.
Article: https://datafloq.com/read/reimagnning-workforce-age-of-ai/6179

Stojanovic, M., Mitković, P., & Mitković, M. (2014). The scenario method in urban planning. Facta universitatis - series Architecture and Civil Engineering, 12(1), pp. 81-95.
Article: https://www.researchgate.net/publication/276321581_The_scenario_method_in_urban_planning

Svenfelt, Å., Alfredsson, C. E., Bradley, K., Fauré, E., Finnveden, G., Fuehrer, P., Gunnarsson-Östling, U., Isaksson, K., Malmaeus, M., Malmqvist, T., Skånberg, K., Stigson, P., Aretun, Å., Buhr, K., Hagbert, P., & Öhlund, E. (2019). Scenarios for sustainable futures beyond GDP growth 2050. Futures, 111(1), pp. 1-14.
Article: https://www.sciencedirect.com/science/article/pii/S0016328718302477?via%3Dihub

van Timmeren, A., Roling, LCLW., & Kristinsson, J. (2002). The scale of Autarky: self sufficiency through integrated design of decentralised natural technologies in citydistricts and building-clusters. Sustainable Building 2002, pp. 1-9.

Yavuz, I., & Tümtürk, O. (2017). Envisioning Future Forms of Urban Spaces Through Speculative Design Explorations: An Urban Design Studio Experience. Middle East Technical University, Research Assistant, TED University. pp. 80-93
Article: https://www.researchgate.net/publication/335975657_Envisioning_Future_Forms_of_Urban_Spaces_Through_Speculative_Design_Explorations_An_Urban_Design_Studio_Experience

Figures:

Figure 4. aaa (2001-2006). Eco-Urban Network / Ecobox [photo collage].
Website: http://www.urbantactics.org/projects/ecobox/ecobox.html

Figure 5. Sou Fujimoto Architects (2016). Rental house tower [photography].
Article: https://archeyes.com/rental-space-tower-sou-fujimoto/

Figure 6. Utopia Architects (2020). Modules acting as plant beds and parking [illustration].
Article: https://www.bloomberg.com/news/features/2021-01-05/a-tiny-twist-on-street-design-the-one-minute-city?cmpid=BBD010521_CITYLAB&utm_medium=email&utm_source=newsletter&utm_term=210105&utm_campaign=citylabdaily

Figure 7. Utopia Architects (2020). Modules acting as green structure with shadowed seatings and parking [illustration].
Article: https://www.bloomberg.com/news/features/2021-01-05/a-tiny-twist-on-street-design-the-one-minute-city?cmpid=BBD010521_CITYLAB&utm_medium=email&utm_source=newsletter&utm_term=210105&utm_campaign=citylabdaily

Figure 8. RUF (2017). Water and nutrient systems [illustration].
Article: https://divisare.com/projects/301565-rural-urban-framework-jintai-village-recostruction

Figure 9. RUF (2017). Residential houses and garden in Jintai Village [photography].
Article: https://divisare.com/projects/301565-rural-urban-framework-jintai-village-recostruction

Figure 10. Spark (2015). House farm with vertical gardens [illustration].
Article: https://www.dezeen.com/2015/11/17/home-farm-spark-model-asian-retirement-housing-communities-city-farms/

Figure 11. Marwan, W (2010). The expansion of the physarum polycephalum and its nutrient network. [photography].
Article: https://www.sciencenews.org/article/slime-mold-master-network-engineer

Figure 12 & 13. 3XN Architects (2021). Robot developers hub [illustration].
Article: https://www.archdaily.com/956516/3xn-unveils-design-for-new-robot-developers-hub?ad_source=search&ad_medium=search_result_all

Figure 13. OMA & de Graaf, R. (1 mars 2021). 3D printing interior walls [video].
Video: https://vimeo.com/495716066?utm_medium=website&utm_source=archdaily.com

Figure 14. Lighting Design Collective (2012). Silo 468 [photography]. https://www.archdaily.com/298912/silo-468-lighting-design-collective> ISSN 0719-8884

Figure 15. Seogoo, H. & RoA architects (2017). Oil tank culture park [photography]. https://worldarchitecture.org/architecture-projects/hccev/oil_tank_culture_park-project-pages.html

Figure 16. Seogoo, H. & RoA architects (2017). Oil tank culture park [photography]. https://worldarchitecture.org/architecture-projects/hccev/oil_tank_culture_park-project-pages.html

Figure 31. Göteborg Hamn (2011). Mountain vault for raw oil storage. [photography]. Article: https://www.mynewsdesk.com/se/goteborgs_hamn/pressreleases/historiskt-oegonblick-raaolja-lastas-ut-fraan-goeteborgs-hamn-629841