TALLINN UNIVERSITY OF TECHNOLOGY
SCHOOL OF ENGINEERING
Academy of Architecture and Urban Studies

# URBAN REVITALIZATION: INTEGRATING INDUSTRIAL DEVELOPMENT DRIVEN BY NEW ENERGY SYSTEMS WITH INDUSTRIAL SETTLEMENTS USING KUNDA AS AN EXAMPLE.

# LINNA REVITALISEERIMINE: UUTE ENERGIASÜSTEEMIDE POOLT TINGITUD TÖÖSTUSARENGU INTEGREERIMINE INDUSTRIAALSETE ASULATEGA KUNDA NÄITEL.

Master thesis

Student: Juulia Aliide Salulaid
Student code: 177538 EAUI
Supervisor: Ivan Gavrilov,
Visiting lecturer – Department of Civil Engineering and Architecture
Co-supervisor: Siim Sultson, PhD

Tallinn 2023

Author's Declaration

Hereby I declare that I have written this thesis independently. No academic degree has been applied for based on this material. All works, major viewpoints and data of the other authors used in this thesis have been referenced.

"....." ..... 2023

Author: Juulia Aliide Salulaid

/signature /

Thesis is in accordance with terms and requirements

"....." .....2023

Supervisor: .....

/signature/

Accepted for defense:

"....." .....2023

Chairman of theses defense commission:

.....

/name and signature/

## ABSTRACT

The adoption of new and de-centralized energy systems along with reindustrialization efforts for climate and economic sustainability create a new paradigm of what the city-industry relationship should be, in what has been long considered a post-industrial society. Decades of deindustrialization and offshoring, however, have left several urban centers and particularly monotowns in post-socialist Europe in decay. Although the literature presents a general consensus that integration is the key for modern sustainable industrial development, little emphasis is put on this framework's socioeconomic and cultural utility for the revitalization of these vulnerable settlements, such as the shrinking industrial towns in Estonia. As affordable, reliable energy and manufacture can boost local economies, small urban centers greatly benefit from such infrastructure within their ecosystem.

In this master's thesis, the potential construction of a small nuclear reactor in Kunda is seen as an opportunity to explore an urban model which seeks local revitalization by putting into practice the theoretical principles of new industrial urbanism for the integration of contingent industry within the urban landscape. The work examines the framework of city-industry integration and through a site-specific analysis puts together a set of key concepts and strategies to be applied in the proposal of a design solution for Kunda's revitalization master plan. Via the synthesis of theory and design, this thesis hopes to exemplify an approach to planning for shrinkage and urban decay which embraces the industrial nature and identity of Kunda and other settlements facing similar challenges.



## ANNOTATSIOON

Klimaatilise ja majandusliku jätkusuutlikkuse heaks uute ja detsentraliseeritud energiasüsteemide kasutuselevõtt ning taasindustrialiseerimine loovad linna ja tööstuse vahelise suhte olemuse kohta uudse paradigma ühiskonnas, mida on juba aastaid peetud postindustriaalseks. Aastakümnete pikkune tootmise ja tööstustegevuse ümberpaigutamine on jätnud mitmed asulad ja keskused, eriti post-sotsialistliku Euroopa monolinnad kahanevasse, lagunevasse seisundisse. Asjakohases kirjanduses valitseb üldiselt üksmeel, et kaasaegse jätkusuutliku tööstusarengu võtmeks on integratsioon. Vaatamata sellele, pööratakse vähe tähelepanu linna-tööstuse integratsiooni raamistiku kasutusvõimalusele kahanevate linnade, sealhulgas Eesti tööstuslinnade revitaliseerimiseks. Töökindel ja taskukohane energia ning tootev tööstus saavad elavdada kohalikku majandust, tuues väikeste linnade ökosüsteemidele suurt kasu.

Käesolev magistritöö näeb Kundasse tuumareaktori rajamises võimalust uurida linnamudelit, mille eesmärgiks on kohalik revitaliseerimine, kasutades uue tööstusurbanismi teoreetilisi printsiipe kaasneva tööstusarengu integreerimisel linna maastikuga. Antud töös tehakse ülevaatus linna-tööstuse integratsiooni raamistikust ning asukoha põhisele analüüsile toetudes pannakse kokku põhikontseptsioonid ja strateegiad, mida rakendatakse planeeringu loomisel Kunda taaselustamiseks. Teoreetilise osa ja rakendusliku planeeringu sünteesi kaudu püüab see magistritöö esitada lähenemist kahanevate asulate planeerimisele, mille raames tunnistatakse nii Kunda kui ka sarnaste väljakutsetega asustuskeskuste tööstuslikku olemust ja identiteeti.

# TABLE OF CONTENTS

# PREFACE

The topic for this thesis emerged from an intrigue regarding the role of architecture in energy infrastructure. With the help of Kimmo Sakari Lylykangas, head of the Department of Civil Engineering and Architecture, this initial spark of an idea evolved into the urban planning project it is today.

I want to express my gratitude towards my supervisor Ivan Gavrilov for his unwavering support and guidance throughout this journey, whose insights and constructive feedback helped me refine my ideas.

I am also grateful for my co-supervisor Dr. Siim Sultson, whose valuable input and knowledge were instrumental in completing this work. This project would not have been possible without their mentorship and encouragement.

My family's unconditional support and limitless patience deserve credit of their own.

Keywords: urban revitalization, reindustrialization, industrial urbanism, urban metabolism, master's thesis.

# ABBREVIATIONS

| ABBREVIATION | DEFINITION |
|---|---|
| SMR | Small Nuclear Reactor |
| NPP | Nuclear Power Plant |
| LNG | Liquefied Natural Gas |
| NIU | New Industrial Urbanism |
| UM | Urban Metabolism |
| R&D | Research and Development |

# INTRODUCTION

## Context

The geopolitical scene of 2022 has been an awakening for European nations whose reliance on largely imported natural gas and oil [1] [2] has proven to be unsustainable in the face of a climate crisis [3], growing global demand for electricity [4] and complex international relations. With goals set by the EU to reach carbon neutrality by 2050 [5], the challenge to phase out the use of fossil fuels is on a tight schedule, as coal is filling in the gaps of energy supplies [6], and the expansion of renewables is slow [7]. Concerns over energy security and independence demand a solution which can provide accessible energy in a safe, clean and sustainable way in the long term.

The integration of such energy systems into the urban fabric, alleviating the demand for land and resources in rural or natural areas, in addition to shortening energy transportation distances for its more efficient use, can offset contingent industrial and urban development, which provides a chance for the revitalization of cities experiencing urban decay. In Estonia, not unlike other eastern and central European countries, small single-industry towns are seeing concerning depopulation and problems associated with an aging demographic, lack of diversity of employment and decay [8]. These cities' industrial nature and low environmental quality rarely attract new businesses and fail to retain their youth. Reactivating such settlements must rely on revitalization strategies which include their reindustrialization by the strategic planning of integrated local energy systems, which provide a favorable environment for new industry to form as well as retain their industrial identity through city-industry symbiosis.

Decades of research have proven nuclear power as a promising technology, which - despite controversial media, public fear and political obstacles - has returned to the debate over possible pathways towards carbon neutrality. Small modular reactors (SMRs) allow for the use of nuclear energy at a smaller scale, drastically reducing building time and costs [9], while reimaging energy infrastructure and presenting an opportunity to rethink its role in an urban context for sustainable cities and industrial growth.

## Problem statement

Estonia's energy sector being still largely dependent on fossil fuels (in particular, oil shale, though with declining rates) [10] [11] challenges the country's ability to reach its climate goals, all the while citizens are faced with increasing costs of energy. While public and private actors debate and research the possibility of an eventual SMR being built in Estonia, the small city of Kunda and its vicinity has been highlighted as a possible candidate site. Kunda, an industrial city almost entirely reliant on its cement factory (Kunda Nordic), is faced with an array of problems characteristic to decaying industrial settlements [12], and its revitalization requires the planning of new economic activity that could retain its population and diversify employment. In architectural practice, urban revitalization strategies tend to be understood as renewal, with a focus on commercial and cultural development in addition to the improvement of aesthetic quality [13], however, in the context of industrial monotowns, the loss of industry and therefore the city's most notable identity, results in their slow-paced abandonment [14]. Therefore, a more holistic revitalization approach should be explored, which retains and encourages the industrial identity of such settlements trough a modern approach to urban energy systems, industry and

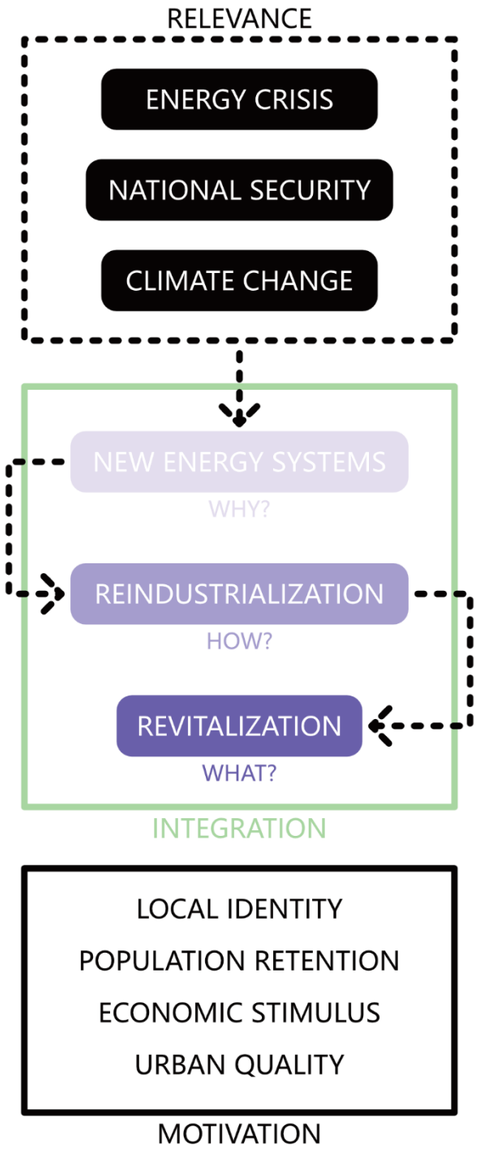



*Figure 1. Thesis structure. Author.*

infrastructure for an integrated and sustainable local economy and high-quality urban space. Planning the SMR in Kunda presents an opportunity to explore these themes for a future functional small industrial city.

### Research aims and objectives

The aim of this thesis is to explore an urban model based on theoretical research, that can be applied to decaying industrial settlements for their revitalization by their integration with new energy systems and potential concurrent reindustrialization, using the planning of an SMR power plant in Kunda as an example. The strategies for urban planning and design shall be focused on livability, sustainability and aesthetic quality, parting from an approach of new industrial urbanism.

The thesis has the following objectives:

1. Understand the relation between urban planning, industry and energy systems.
2. Explore planning methods for the integration of industrial development and infrastructure within the urban fabric.
3. Analyze urban planning and design possibilities within the framework of new industrial urbanism for urban revitalization.
4. Provide a review of the urban challenges faced by Kunda and analyze its spatial quality.
5. Outline a set of strategies and a conceptual framework to propose a design solution for the integration of an SMR and concurrent reindustrialization in Kunda for its revitalization.

### Methodology and structure

This master thesis is the synthesis of predominantly qualitative research and the creative urban planning and design process. The theoretical part is founded on the study and analysis of existing literature and data, field research, recording and documentation, as well as case studies to support the project design.

The research body in the first part focuses on reviewing and analyzing current literature and trends to understand energy systems in the context of urban planning and determine the opportunities for concurrent economic and industrial development. The second part reviews and analyzes the problems and challenges particular to industrial settlements and discusses existing practices for their revitalization, exploring new industrial urbanism as the main framework guiding the project. The theoretical parts 1 and 2 make the case for reindustrialization and integration planning and design strategies to be used in the final project.

Part three comprises site-focused research foundational to the design solution. A brief overview of Kunda's history and formation as well as current development plans will accompany a site analysis, identifying spatial issues to compile a vision for the program to be included in the project brief. A toolbox of planning strategies is developed to inform design decisions.

The final part and primary focus of this thesis presents a project brief and an architectural proposal which encompasses the program presented in the brief, using the strategies and site-specific responses to identified spatial problems concluded from the theoretical part.

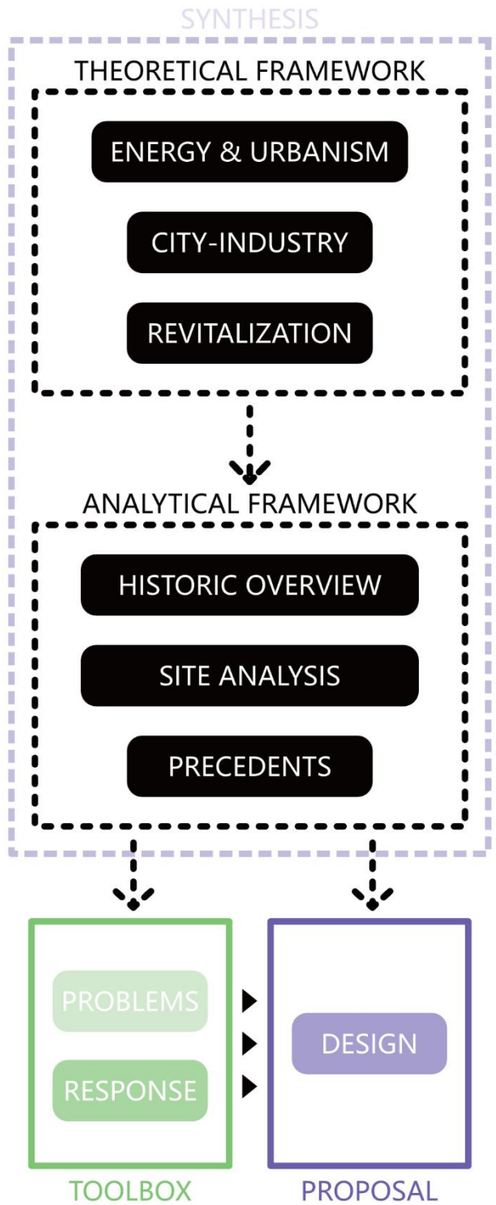



*Figure 2. Methodology. Author.*

## Scope and limitations

The project is limited to a pre-selected scenario in which Kunda (Viru-Nigula) would be the preferred site for a future SMR in Estonia. While it has been discussed in local media and politics as a potential location, it must be acknowledged that actual site selection requires extensive research, investigation, and evaluation of various factors, exceeding the scope of an architectural thesis. This master thesis does not aim to provide a comprehensive analysis of the feasibility of a nuclear power plant in Kunda, but rather focuses on the potential urban revitalization that could result from the integration of reindustrialization driven by its planning.

# PART 1

## ENERGY, URBANISM AND INDUSTRY

### Relevance – a crisis

As part of its commitment to reaching lower carbon emission goals and, eventually, carbon neutrality, the EU has been phasing out its use of fossil fuels, particularly by replacing the use of coal (predominantly in central Europe) with liquefied natural gas (LNG) [15]. Such efforts have been accompanied by the expansion of renewables, however, at a pace that still requires heavy compensation by other energy sources [7]. As we move on from technologies reliant on liquid fuels to electric alternatives such as electric vehicles (EVs), and rapid progress is being made towards automation and digitalization, demand for electricity increases, as well as the pressure to produce it cleanly [16] [17] [18].

Phasing out coal in favor of natural gas had primarily allowed Europe to numerically reduce its carbon emissions [19], with a large proportion of the supply relying on imports [2]. The invasion of Ukraine which significantly reduced the supply of LNG has triggered a global energy crisis with far reaching impact [20], and Europeans in 2022 were seeing to higher emission energy sources to make up for the missing supply, including firing up old coal plants and increasing use of firewood [21]. The 2022 World Energy Outlook report by the IEA estimates that globally, 75 million people will lose recently gained access to electricity, and about 100 million will have to opt for polluting and unhealthy cooking practices [20]. The need for new energy systems and localized solutions is as relevant as ever.

### Energy dependence. Urbanization.

Automation, digitalization, progress in the average living standards, population growth, luxury. The life of the modern human is reliant on energy. Trends since industrialization only show a growing demand for energy per capita [22], and specifically for electricity [7]. Roughly 64% of the current global supply of electricity is generated with fossil fuels, which accounted for nearly 82% of the world's primary energy consumption in 2021, according to the BP Statistical Review of World Energy 2022 [23]. As we seek to provide more people with access to essential commodities such as housing, clean water, nutrition, healthcare, education, etc., emissions resulting from the pressure of urbanization (in the search of such commodities) are continuing to grow – about 72% of primary energy consumption results from urban areas [24]. The use of fossil fuels cannot be simply stopped, their energetic supply must be *replaced*.

The demand for fossil fuels is not solely expressed in the commercial use of energy for lighting homes, cooking, heating or using personal vehicles. Global supply chains are dependent on oil for the transportation of goods (aviation, shipping); agricultural, construction and industrial processes rely on their use, as well as production of daily commodities. One step in the process of replacement is electrification [25] – by minimizing the need for the direct combustion of fuel, decarbonization efforts will necessarily have a greater impact if the supply of electrical energy relies on cleaner technologies over time.

Granted, there are sectors which' machinery and processes cannot yet be replaced with electric substitutes. One of the reasons for this is the extremely high temperatures necessary in industries such as cement and chemical production, glass or steel manufacturing and ceramics, which cannot be efficiently reached with electricity [26], but process heat from nuclear power plants can be used in these industries [27], and there are promises of future technologies of carbon capture and storage to reduce emissions we cannot yet avoid producing. Considering alternative technologies and their byproducts makes a case for the diversification of energy sources and technological exploration to fulfill all our energetic needs. These considerations should also be reflected in the urban planning of modern and future cities.

Currently, demand for large amounts of energetic resources depends overly on valuable natural land and rural areas [28] that impose an additional cost and energetic loss to transportation. A self-reliant urban model that integrates energy production and industry offers an alternative to this. The concepts of circularity, urban intensification, densification and self-sustainability cannot ignore the energetic and industrial needs of modern life – urban planning and development must include the planning of new energy systems and contingent industry to maximize the efficient use of resources.


*Figure 3. Energy and Urbanization. Author.*

## Energy and urban development

*"... the course of history can be seen as the quest for controlling greater stores and flows of more concentrated and more versatile forms of energy and converting them, in more affordable ways at lower costs and with higher efficiencies, into heat, light, and motion."*

*Vaclav Smil. Energy and Civilization: A History.*

The relationship between energy and urban development is well-established. Historically, this was largely determined by geography, as human settlements, dependent mostly on animate energy, would form in the vicinity of natural resources. Early civilizations, for example along the river valleys of the Nile and Tigris-Euphrates, where availability of water for irrigation and transportation allowed for the development of agriculture and urban growth, are a testimony of this [29]. As the diversity of natural resources in demand increased, subsequent industries formed around their supply, and so have human settlements. Industrial cities and mining centers followed a similar pattern, though the use of fossil fuels made long-distance transportation of goods possible and affordable, therefore restraining urban growth not to the availability of *nearby* resources, but rather to the availability of *energy and infrastructure* to supply said resources to the given population [28].

It is obvious to note that energy production requires the planning of land use. Along with the possibility for transportation, Smil points out that the power density of coal and oil played a large role in urbanization, since traditional societies' reliance on mostly biomass was extremely land-intensive: an area about 30-50 times the size of a preindustrial city was needed for its fuel supply [28]. In the current century, Stremke & van den Dobbelsteen expect energy-related land use to be one of the most important planning topics, as it is starting to compete with food production [30], specifically referring to the area needed for renewable energy production due to the low energetic density of current technologies. This leads the authors to consider that conceptually, all landscapes may be regarded as energy landscapes – and the cityscape is not excluded.

As urban development leads to higher energy consumption [31], a sustainable approach to planning should include the provision of clean energy and creation of spatial conditions for the inclusion of infrastructure and its efficient use. Diversifying sources of energy as a form of ensuring higher resilience to systemic failure, climate uncertainty and threats to national security implies the continuation of using established renewable technologies, therefore although modern nuclear solutions require significantly less land than, for example, photovoltaic panels (for an equivalent quantity of energy) [32], designing the urban landscape must consider their inclusion.

As we move to energy production locally, geography and resource availability become relevant again. Not only is there a desire for more productive land-use, but efficient use of energy also requires proximity. Diverse geographic conditions across the globe make for varying success in renewable energy production, so as new urban models can move towards decentralized and integrated energy systems, their growth and development may be determined by available localized technology rather than exclusively by existing resources or the ability to supply them. The circular relationship between energy and urbanization and the cause for sustainability then make the case for urban planning in the proximity of energy systems and vice versa.

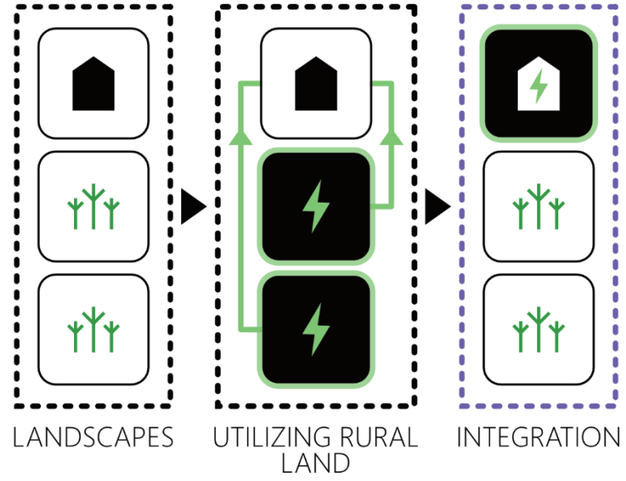



*Figure 4. Energy Landscapes. Author.*

## Urban metabolism

The consideration of energy and resources in planning is not entirely unique. The concept of urban metabolism (UM) draws a parallel between the city and a living organism in its function: cities, through their technical and socioeconomic processes, consume resources and produce waste [33]. Because cities are themselves composed of various systems and organisms who interact with one another, a further expansion of the idea is the view of cities as complex ecosystems; as Kennedy, Pincetl and Bunje assert, natural ecosystems provide a model for the sustainable development of cities, generally being self-sufficient [34]. Urban ecosystems consist of various outputs and inputs, which Decker et al classifies into active and passive [35] – in the context of energy systems, these would be categorized

as active inputs in the energy flow. Although typically, the concept of UM is used as an analytical tool to quantify the sum total of these resource flows [36], in "Netzstadt: Designing the Urban" [37], the authors make use of UM in a design approach to achieve five criteria of urban quality: identity, diversity, flexibility, resource efficiency and a degree of self-sufficiency. These criteria are further discussed in the next part of the thesis.

As ecosystems contain organisms and sub-systems themselves, the UM concept may be scaled to be applied to regional, national, or local developments. In the case of small urban settlements, it is perhaps reasonable to assume that absolute self-sufficiency is too resource and labor intensive to achieve, and collaboration between the metabolic systems within a larger (regional or national) ecosystem is still desirable and, at times, even more sustainable.

Also, although urban metabolism may be used as a framework to make material and energy flow analyses, it is worth noting that while these illustrate the *efficiency* of used resources and waste produced *within* a studied system, they do not accurately represent its overall environmental sustainability, as ecological supply capacity is not accounted for [33]. Therefore, specific input and output processes must be independently sustainable, and collaborative flows within larger systems are, to a degree, inevitable. A sustainable urban model should then maximize its self-sufficiency and local sustainability while also being competitive in its capacity to collaborate on a larger scale. As expressed by Oswald and Baccini:

*"Sustainable development calls for the creation of autonomous regions… [which] recognize that regional development must be based on globally necessitated resource restrictions and a globally influenced exchange of knowledge"* [37].

If we are to regard urban landscapes as energy landscapes, and aim towards such collaborative independence, it follows that not only should energy be produced sustainably and locally, but also consumed efficiently, within the system. The introduction of decentralized energy production put to efficient use sets up the potential for further self-reliance in the form of industrial development, which not only contributes to local socioeconomic processes, but also heightens the competitiveness for collaboration, for example through specialization of industries and academia.

Current discussions observing the possibility of building the first nuclear reactor in Estonia are a matter of policy and lawmaking, but a planning perspective on the issue, with these concepts considered, opens the opportunity for industrial activity in the vicinity of the potential power plant, which could be the basis for urban revitalization. As this would have specific site restraints, it remains to be explored which prospects for development are presented by this endeavor, and how they can be used for the improvement of the local community.

### Reindustrialization

The localization of energy production and the desire to shorten energy supply chains, as well as the concept of urban development as a metabolic system are all directly linked to production and manufacture of resources. While cheap and reliable electricity is a valuable advantage for the average citizen and may be somewhat attractive for larger business operations with higher utility expenses, the industrial sector makes up a large market for its use. Energy as a driver of economic and industrial activity [38] directly impacts local and regional growth, affecting the economic competitiveness of a city or industry. Source proximity and availability of energy drive down the costs of production making for a favorable environment for businesses to operate in, additionally, affordable and available energy makes the wider implementation of innovative technologies possible [39].

Although traditional heavy industries have become a decreasing part of developed nations' GDP for decades [40], critique of the severance in the relationship between manufacturing and the western economy has led to a reevaluation of its role and advocation for re-shoring. This trend has mainly had economic incentives, including cutting the rising costs of shipping (due to higher energy prices), securing supply chains and marketing local production [41], while politically, the move is often attributed solely to employment concerns. The drawbacks of deindustrialization have manifested in lower productivity growth, particularly in Europe [42], which reindustrialization strategies are looking to reverse.

The authors of the book "Producing Prosperity: Why America Needs a Manufacturing Renaissance" highlight that recuperating manufacture is not necessarily a job-

generating goal (as advancement in technological processes and automation usually result in less human resources needed for production), but rather, it has to be seen as an integral part of the overall economic health, which' connection to research and development (R&D) is also a condition for innovation [43]. Localizing manufacturing within a collaborative urban ecosystem along energy production creates a competitive advantage in the physical proximity to varying supply chain participants for faster design and development [44].

Reindustrializing the West requires an understanding of modern industry and industrialization in the 21st century – this practice is not simply reopening the automobile production plants of Detroit. While bringing back production to its prior location can be a part of the process, the digitization and automation of manufacturing, creating new industrial operations play a major role [42] in rethinking industrial growth towards innovative technologies and competitive and sustainable development [45]. Therefore, European policy, supported by the relevant literature, is geared towards creating competitiveness and value built upon efficient, high-tech, low-emission solutions [46] [47] [42]. The modernization of industry is leading manufacturing into becoming a knowledge-based activity, increasing the demand for highly educated and skilled workers [48].

Sustainability

Perhaps one of the main themes of these modern industries and fostering their development in Europe is sustainability. For decades, offshoring was a practice that permitted large manufacturing plants to avoid increasingly more rigorous environmental policies and controls on emissions and waste management [49], while cheaper energy and transportation costs maintained production profitable despite the longer supply chain [50]. Global awareness regarding climate change and international efforts to reduce carbon output have also raised awareness about the sustainability of industrial practices in less regulated nations as well as the ethical implications involved [49]. On one hand, reshoring can offer an oversight of the supply chain, with greater regulatory control over its practices domestically [51], while also reducing the additional costs and emissions of long-distance transportation (to a degree inevitable due to natural resource distribution [51]). Additionally, the adoption of innovative technologies and digital solutions which improve efficiency – a current understanding of reshoring is focused on the capability to develop and apply smart and sustainable practices to production processes, for which local technological readiness and collaboration with R&D is necessary [52].

Integration

In summary and reference to the prior discussion, the search for sustainable and efficient energy and resource use leads to the inclusion of production and manufacture into urban landscapes. From one perspective, there is a desire to preserve rural landscapes and spare them from bearing the load of supplying cities energetically (and industrially). Furthermore, striving for a balanced urban ecosystem, in which the ideal use of resources is circular, requires heightening the self-sufficiency of the system in question, in which production would have to take place. In addition, general principles of sustainability, like shortening the supply chain and reducing unnecessary emissions of, for example, shipping, also favor the integration of production with urban landscapes within a collaborative environment along research and development. The economic benefits of western reindustrialization and current policy geared towards reshoring production create an opportunity to explore urban models in which energy production and industry are integrated to establish a more circular economy and regenerative flows of intellectual resources. New decentralized energy systems, as would be the case with an SMR, offer potential for industrial development, becoming a catalyst for the implementation of these concepts into urban planning, which' benefits could become a model for the revitalization of decaying settlements such as Kunda. Pending is the understanding of the role of urban planning in industrialization and its successful integration into the urban ecosystem.

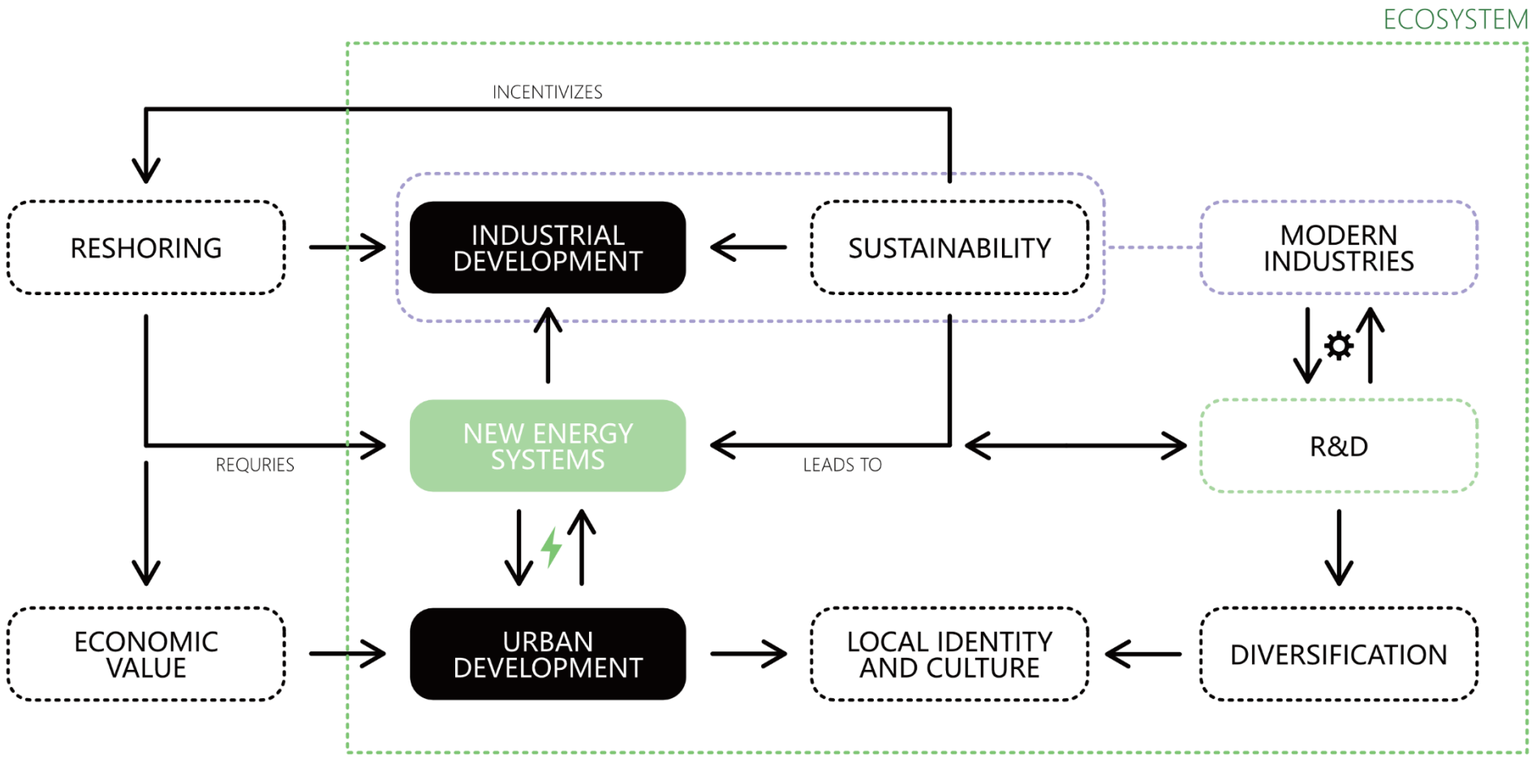



*Figure 5. Diagram of relations. Author.*

# PART 2

## INDUSTRIAL SETTLEMENTS

### Planning industry

Although industrial development can be considered overall an economic net positive, concerns over environmental impacts have made the planning of industry a matter of discussion that requires further exploration. Reindustrialization in the post-industrial society of developed nations may be subjected to skepticism, as the idea of industrial activity can evoke associations with noise, pollution, large and unsightly building masses, heavy traffic, unpleasant smells, etc. To reconcile the economic benefits of production and manufacturing with efficient land and energy use, self-sufficiency and resilience, and ultimately better environmental policy, the integration of urban and industrial development becomes paramount. It is therefore the planner's challenge to integrate industry into the cityscape in a way that promotes sustainable growth and maintains urban quality.

The relationship between cities and industry has been a close one since the first industrial revolution, often evolving side by side, resulting in many of the spatial challenges characteristic to the 20th century urban planning [53], and attempts to solve these issues like zoning [54] and the garden city and company town concepts [55]. Though as previously discussed, economic incentives played a major role in the eventual deindustrialization of nations in Europe and North America, the effect of a growing scale of production demand resulting in larger, noisier, more polluting factories which' presence was deemed undesirable, already preceded the trend in the separation of manufacture and production from the urban landscape [56] [55].

### Post-industrial society

Globalization and offshoring of industry to countries with lower wages and more lax regulations on emissions consolidated the shift into a service economy in western developed nations [43]. The consequences of this shift can be ardently felt in the built environment in regions which were largely dependent on industry for their economic activity, most notably cities and settlements that relied on a single sector of production, a common pattern in post-soviet countries [57]. Such settlements are facing typical aspects of urban decay [58], usually as a result of rapid job loss [59], but also due to larger trends causing structural changes in western society [48].

Even as industry has become a diminishing sector in the European economy, the existence of industrial infrastructure is still necessary, but typically reserved to remote locations or large industrial parks, creating a need for commuting and incentivizing sprawl [56]. The segregation of production and manufacture from city life was in part a response to the concerns regarding factories' pollution and low aesthetic quality, wanting to keep real estate valuable and prioritizing commerce, resulting in strict zoning and the present city-industry relationship also referred to as the piecemeal city [60]. The literature differentiates between three contemporary spatial types of industry, based on their level of separation or integration with the city: the integrated, adjacent and autonomous [55].

### City-industry

The late 20th century deindustrialization process that has left western societies with various economic and environmental concerns, is being followed by a growing interest in reindustrialization in the form of city-industry symbiosis. While historically industrial activity has been concentrated in urban areas (partly due to urban development having taken place around industry), the noise, pollution, traffic, generally low urban quality, zoning restrictions and regulation have made industrial sites unpopular for residential and commercial activity, segregating manufacturing and production into industrial parks, which, in part, leads to extra-urban and suburban sprawl [56]. City-industry symbiosis or city-industry integration seeks to reconcile the relationship between industry and the urban in pursuit of sustainable urban growth.

### New Industrial Urbanism

New industrial urbanism, a framework proposed in the book of the same title by authors Hatuka and Ben-Joseph, ties together several aforementioned concepts, exploring from a focal urban planning and design perspective the unification of economic, sociopolitical and spatial aspects of cities in pursuit of city-industry integration [55]. Though not a rigid handbook for industrial planning, the framework offers strategies of interest, which will be taken into consideration going forward in the project design solution. As the concept is rather recent in the literature, the framework relies on the book "New Industrial Urbanism: Designing Places for Production" and supporting works by Hatuka in collaboration with other authors [53] [56] [44] [55].

Described as a "socio-spatial concept which views manufacturing as part of city life", the main argument

presented by New Industrial Urbanism is in the emphasis in localism, empowering small and medium-sized firms as well as individuals by recognizing the competitive advantages of urban locations and shaping the practices of planning industry through this understanding, in which manufacture and production are an integral part of urban structures [55].

The authors present four key planning concepts for the realization towards integration:

Scalar strategies:

The concept is similar to urban metabolism, as the idea is to understand the ecosystems created on a local, regional and urban scale. Regarding these systems as those of production and innovation, depending on the scale of the intervention, different applications are appropriate, such as mixed-use building typologies or flexible land zoning. An emphasis is placed on the triple helix model, based on a balanced relationship between government, academia and industry, ceding academia a leading role.

Integrative approaches:

Using urban planning and design tools which foster and encourage the integration of city and industry, like efficient transportation between neighborhoods, creating new typologies that can house diverse uses and displaying character and forming identity in manufacture.

Coding complexity:

While in practice a regulatory aspect of urban planning, this refers to the flexibility of zoning and integrating varying compatible functions like housing and retail with research and academia as well as non-disruptive light manufacture and food production. It requires the evaluation of the negative impacts and nuisances industrial functions may present in urban spaces while looking to create adjacency and a balance of activities with hybrid land uses. This touches on the subject of protecting both rural and industrial lands, as the authors see it as a certainty that industrial development will happen, planning its location will be a major aspect of developing urban structures.

Synchronic typologies:

Perhaps more apt on a local architectural scale, the concept refers to the operative coexistence of different uses in a building space for the optimal consumption and management of resources. By integrating different non-interfering functions into shared spaces, some positive outcomes are optimizing land use and lowering the need for commuting. The shared space does not necessarily need to be a building but may also refer to land or parcel. The authors go further into dividing synchronic typologies into centralized and decentralized, differentiated mainly by the degree of integration of uses.

Overall, new industrial urbanism recognizes the need for including and integrating production into cities of the future. Building upon the concepts of urban metabolism and city-industry integration, it is clear that urban planning must be done through measures that create a collaborative ecosystem to transfer knowledge, encourage innovation, strengthen local communities, foster competitiveness and use and manage resources efficiently and aim towards sustainability in the creation of mixed-use economic clusters [55].

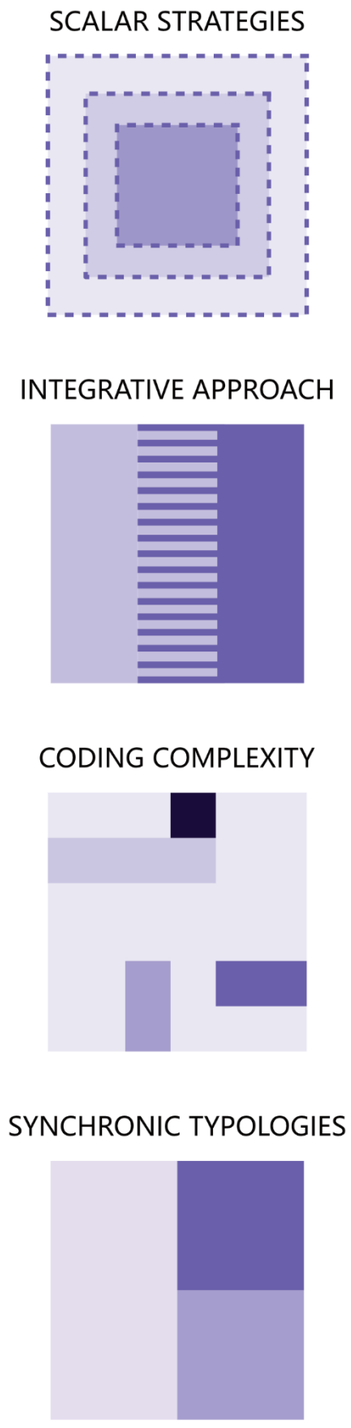



*Figure 6. NIU key concepts. Author's interpretation.*

# REVITALIZATION

## Urban decline

Urban decline as a phenomenon is already established as a topic of concern in the development of cities in western nations across the EU and North America. According to Martinez-Fernandez, Cristina, et al., the concentration of resources and infrastructure into cities partaking in a global economic order has led to the outflow of human and economic capital from smaller towns, specially impacting those dependent upon a single sector or industry [61]. The most notable aspect of urban decline is depopulation; lower fertility rates and out-migration to larger cities and suburban areas lead to the marginalization and land abandonment in rural regions [62], creating a vicious cycle of shrinkage in cities where a lack of human resources and business operations are followed by lesser job opportunities, followed by more out-migration, etc. The need for revitalization of urban settlements experiencing decline stems from the problems experienced by these areas as it pertains to their environmental and life quality, as well as the desire for more sustainable urban models.

## Shrinkage and the future of cities

Evidenced by the European Commission's aspirations towards sustainable cities and the Joint Research Centre's policy recommendations [24] [63], understanding urban shrinkage and its linked problems is crucial in the search for modern urban planning strategies. In the doctoral thesis "Urban Regeneration Strategies for Shrinking Post-Soviet European Communities: A Case Study of Valga, Estonia", Tintera provides an overview of the relevant literature associated with shrinkage and planning responses, a focus on post-socialist Europe and the implications this phenomenon has on public space [57]. The main takeaway as it relates to planning, according to the literature, is that urban development needs to be geared towards the improvement of life quality within the reality of ongoing shrinkage, rather than aiming for growth or repopulation.

Some of the planning responses to shrinkage, reported by the European Commission's Joint Research Centre (JRC) are as follows [63]:

Urban renewal – repurposing or renovating abandoned buildings.

City branding – creating or strengthening a positive image of a city for a wider audience.

Economic diversification – reconfiguring the local economic makeup towards new and innovative sectors, include emerging businesses, creative industries, tourism, etc.

Rightsizing – as the word implies, resizing shrinking settlements to their declining populations' decreasing demand for space; incentivizing densification by moving services into central areas, buying and demolishing abandoned buildings and repurposing land.

As policy and urban planning reconcile with the reality of shrinkage, no revitalization efforts should be aimed at the significant increase of the local population [57], but rather seeking to slow down shrinkage by the retention and diversification of demographic groups. Diversification may also imply exchange or replacement of the inhabitant profile, as out-migration may continue, but new incentives are created for local settlement from other regions.

## Urban revitalization

Various concepts (renewal, conservation, rehabilitation, restoration, etc.) are often synonymously used to refer to processes of varying kind of urban improvement, but revitalization implies accounting for physical, economic, social and cultural aspects, encompassing a greater realm of topics related to urban life and its overall quality [64]. This means that urban revitalization strategies should respond to multidisciplinary problems that improve qualities in these criteria, specifically as they relate to creating opportunities for betterment through urban design and planning.

In order to provide solutions for the challenges presented by decay, a measure for understanding urban quality is needed both to evaluate present problems and to offer appropriate measures for their resolve. The principles of urban quality must be considered when making a site analysis to identify site-specific restraints and opportunities.

As urban metabolism is one of the main concepts regarding the theoretical framework in search of city-industry integration, the relevant qualities in spatial design noted by Oswald and Baccini are as follows [65] [37]:

Identity – an assessment of the unity and cohesion of the city's architectural expression, joint activities between inhabitants and visitors (commuters), cultural and social participation in the town's wholeness, recognizing and maximizing local potential for economic, touristic, creative activities.

Flexibility – an understanding of structure and accessibility as it pertains to movement, existing infrastructure and how this influences transportation and mobility.

Resource efficiency – an evaluation of building structure, land use and service infrastructure from an angle of efficient use of material and energy flows.

Degree of self-sufficiency – an observation of the creation of added value by local production and lowering the degree

of dependence on outside infrastructure.

Diversity – an assessment of the variation of activities that can take place in the local territory, spatial opportunities, contrasts and architectural enrichment.

Urban planning strategies aimed towards a heightened urban quality must aim to provide, encourage or facilitate these facets of urban life. While maintaining the aesthetic of the overall environment is also compelling and perhaps an aspect that falls under the category of "identity", easing mobility and access and providing spaces for creative and diverse functions while encouraging self-sufficiency and sustainability is at the core of revitalization efforts, making the building program, land use and zoning a priority among the key concepts in setting out a site-specific strategy.

## Integrated reindustrialization as revitalization

Parting from the aforementioned criteria, it becomes apparent already that there is an overlap in the addressed challenges which city-industry integration desires to improve upon and the aspects prioritized in the judgement of urban quality from the perspective of urban metabolism, but there is also a close relation with the processes resulting from urban shrinkage and decay. A common pattern emerging from the literature in reference to these concepts is the core principle of sustainability referring to both land use and multidisciplinary collaboration, aiming for efficient resource management and diverse employment opportunities for the variation of local demographics – attracting and retaining high-skilled workers. Additionally, a running theme for sustainable urban development is the existence or creation of an identity and culture, fostering communal relations, creating a positive local image and encouraging social and cultural activity.

The revitalization of industrial settlements like Kunda must then focus on the preservation of their industrial identity, not rejecting their heritage but promoting its further development within the forward-looking framework of new industrial urbanism, in which higher urban quality can be achieved while still accounting for shrinkage. Urban planning and design in this direction is therefore not ordered towards the commercial growth of these towns, but a radical intensification with production and manufacture in a more independent ecosystem that serves its inhabitants interests and offers new spaces for their needs.

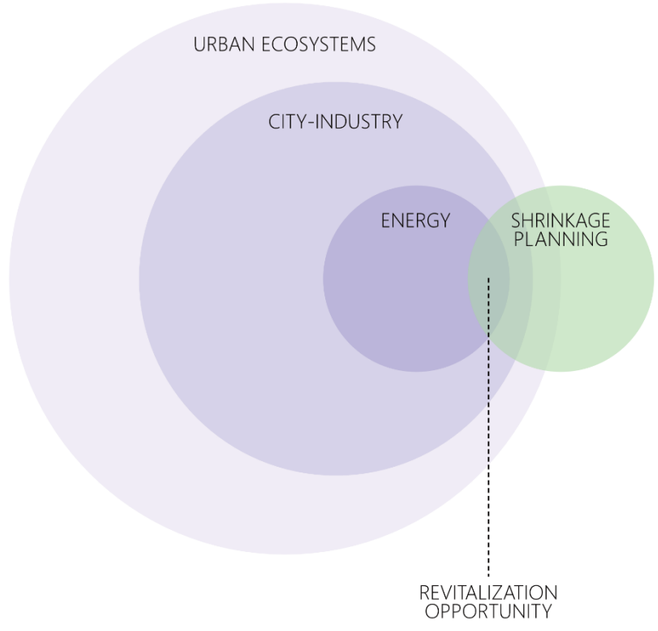



*Figure 7. Conceptual overlap. Author*

# REFERENCE CASES

The reference studies aim to inform project decisions. The chosen cases have been selected to offer a range of approaches that may be combined for a creative project in the revitalization of Kunda. The highlighted qualities sought in these cases refer mostly to the structure and mixed-use integration, criteria based on those outlined in "New Industrial Urbanism".

Selection

Jiading Mini-Block, Jiading, China
Architects: Atelier FCJZ
Area: 7 ha

A low-rise, high density urban high-tech office park with mixed-use functions including commercial and public facilities, rentals and hotels [66]. Selected for its hybrid functionality and block typology, this reference can inform massing and spatial decisions.

Bremerhaven Werftquartier, Bremerhaven, Denmark
Architects: ADEPT
Area: 140 ha

The competition proposal reimagines an industrial harbor into a district with added residential and creative functions, seeking to preserve the identity and heritage of the port [67]. Selected for its scalar variety, mixed-use functionality and community building.

The Open City, Hamburg, Germany
Architects: Karres en Brands
Area: 50 ha

A proposal located in the industrial city of Hamburg; the project seeks to promote interaction with the industrial port area and other urban uses [68]. Selected for its exploration for integration, hybridity and public space.

Jiading Mini-Block

Description:

The primary exploration sought through this project is a human-scale appropriate block size. The project, an R&D park or an "industry 4.0 demonstration base" is a low-rise high density quarter with mostly offices and research facilities, but it includes residential functions on its top floors to the capacity allowed by local regulation. The 10 meter wide streets are meant to encourage workers to use its public space and walk without intimidating scales typical of high-rise and industrial buildings [66].

Reference utility:

As the development function is directly tied to modern industries, the building typology and massing configuration are relevant examples to the planning project at hand. Human scale is an integral part of planning in a settlement as small as Kunda, and functions as a "pacifier" of the otherwise imposing scale of industrial warehouses, factories and office buildings. In this project, the scale reduction is achieved by treating each building as a block, ensuring public space mobility between each of the masses introduces walkability and human oriented transit into the overall configuration.

A level of complexity is achieved by the mixture of functional typologies within a single building organized by storey, fitting into the leveled synchronic architectural typology established by "New Industrial Urbanism" [55]. The industrial functions of the building are directly connected to public space on the street level while residential hotels and rentals have a degree of privacy on the superior levels.

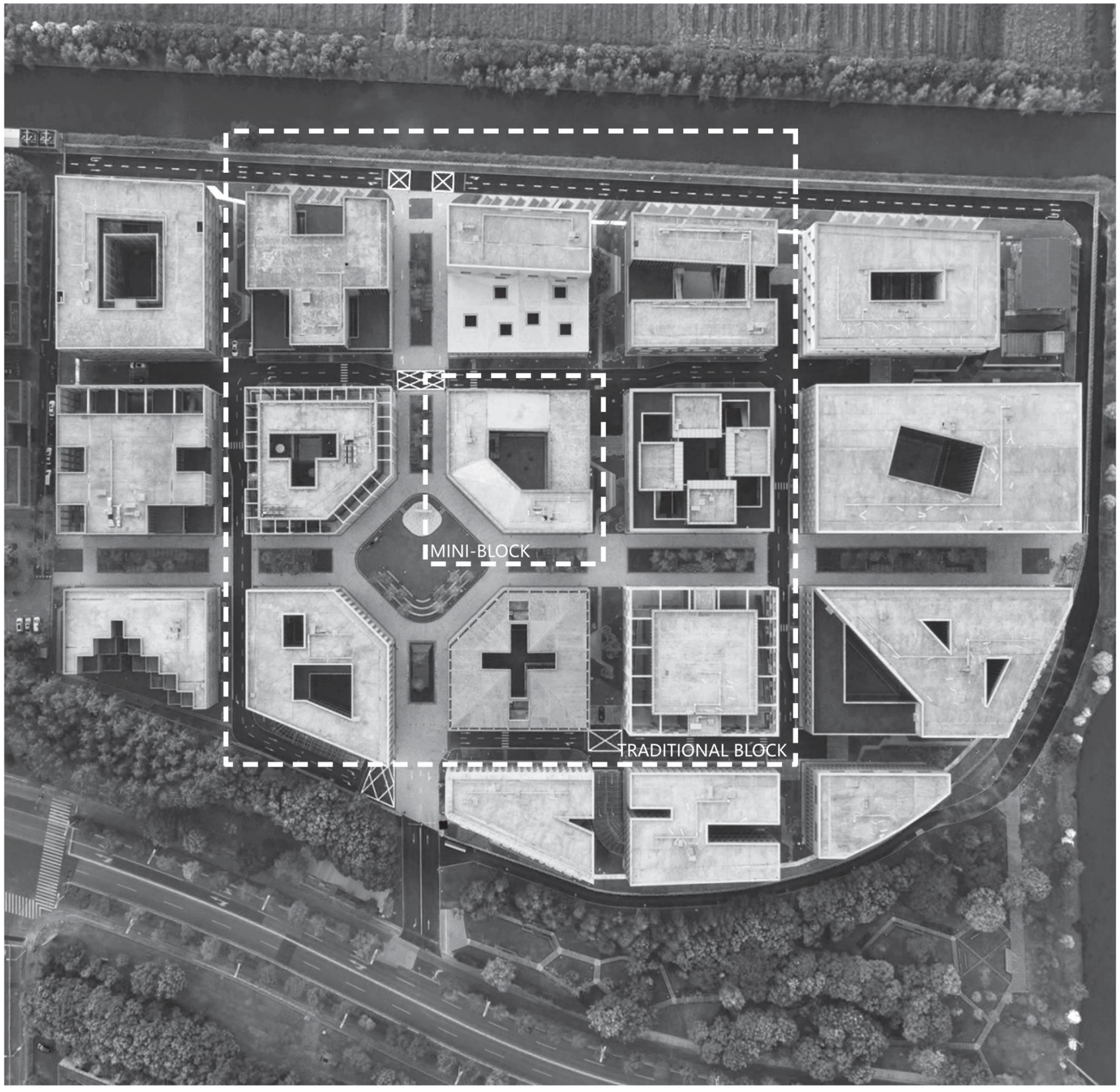



*Figure 8. Jiading Mini-Block. Image source: Atelier FCJZ. Annotations by author.*

Bremerhaven Werftquartier

Description:

The proposal is aimed at the transformation and revitalization of the Bremerhaven industrial harbor. Combining functions, preserving industrial infrastructure and identity and introducing shared public spaces are some of the strategies used to connect various activities, conserve industrial nature and implement a human scale [67].

Reference utility:

Though revitalization and mixed-use are also relevant to the thesis project, a notable aspect of ADEPT's proposal is the organic integration of this new hybrid quarter into the existing urban fabric. The entire intervention seamlessly continues and connects existing pathways, as well as introduces an axis and circular pathway which integrates both the varying functions within the development and the development itself with existing areas of the city.

The planners have decided to keep offices and industrial typologies towards the center, where they share a large public space, and they use a juxtaposition of residential blocks around and across, so the typologies aren't strictly mixed, but share the public space axis. Though synchronic typologies are not present in this project, a clear integrative approach is taken through the establishment of connectivity, achieving a diverse use neighborhood and maintaining industrial infrastructure and function as central to the proposal.

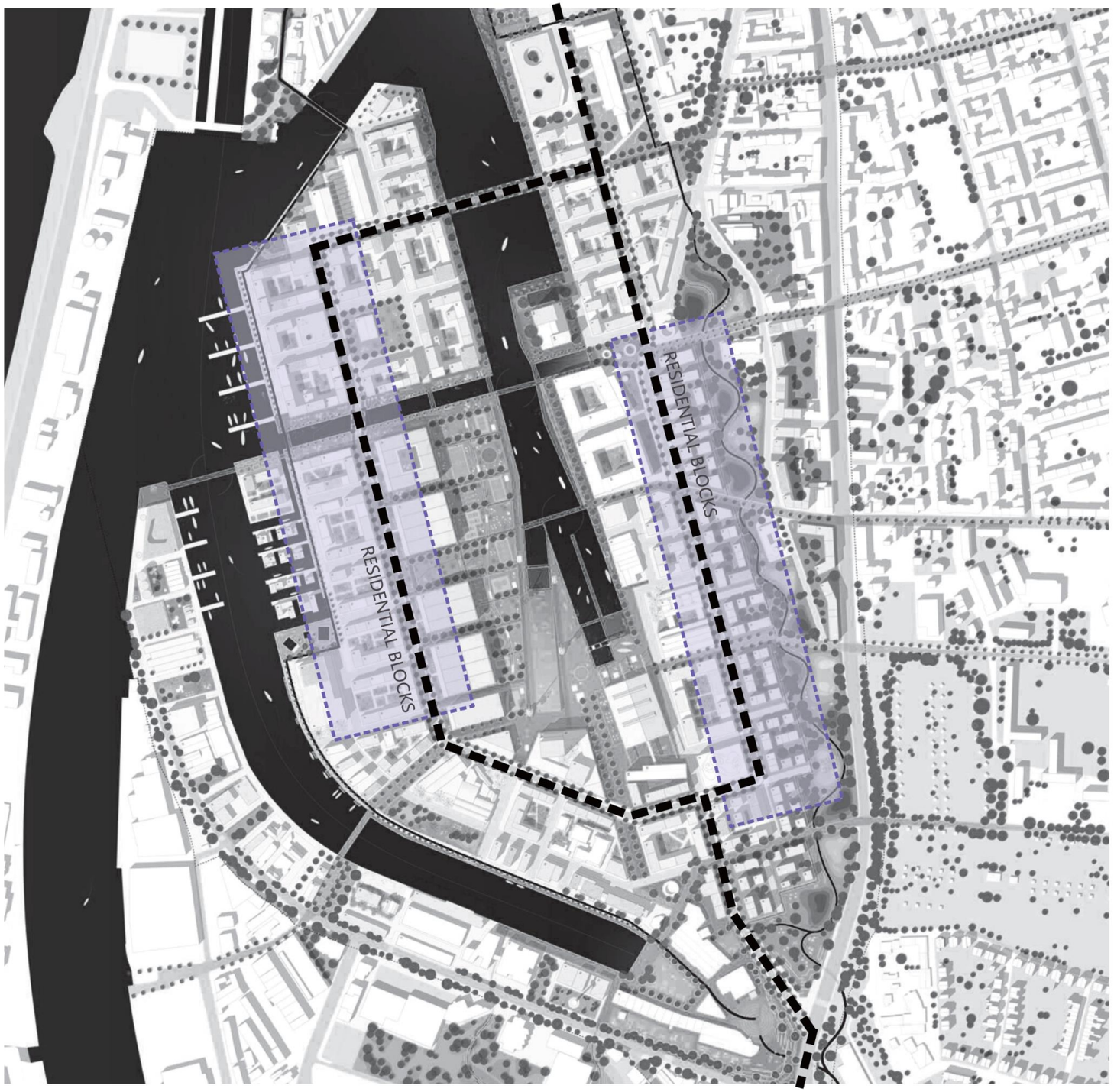



*Figure 9. Bremerhaven Werftquartier. Image source: ADEPT. Annotations by author.*

The Open City

Description:

The Open City is a mixed-use district which' goal is to establish a connection between the city and harbor. Aiming to encourage interaction with an innovation district, the project proposal uses public space as the central organization of functions and typologies. The quarter overall is geared towards creativity and outdoor activities, mixing industrial infrastructure with a city square, promenade and park as a unit [68].

Reference utility:

This development exhibits the "character" integrative approach, through which industrial nature and identity is addressed and reflected in the public space [55]. Using a central element – a covered linear park/boulevard – the interaction between functions is established by a multifunctional public space with a diverse user profile, and which acts as a compositional node around which the rest of the functions, massing and mobility are organized. This central element encourages movement between the areas within the project and also works as an attractive landmark for visitors and local branding.

Although the proposal makes use of other integration strategies such as hybridization, the case emphasizes a densification of the area for the approximation to human scale. Converting large, empty lots of land into a vibrant locality makes the connection between city and industry possible without sacrificing industrial land and a reduction in empty space scales the built environment to a size palatable for pedestrians.

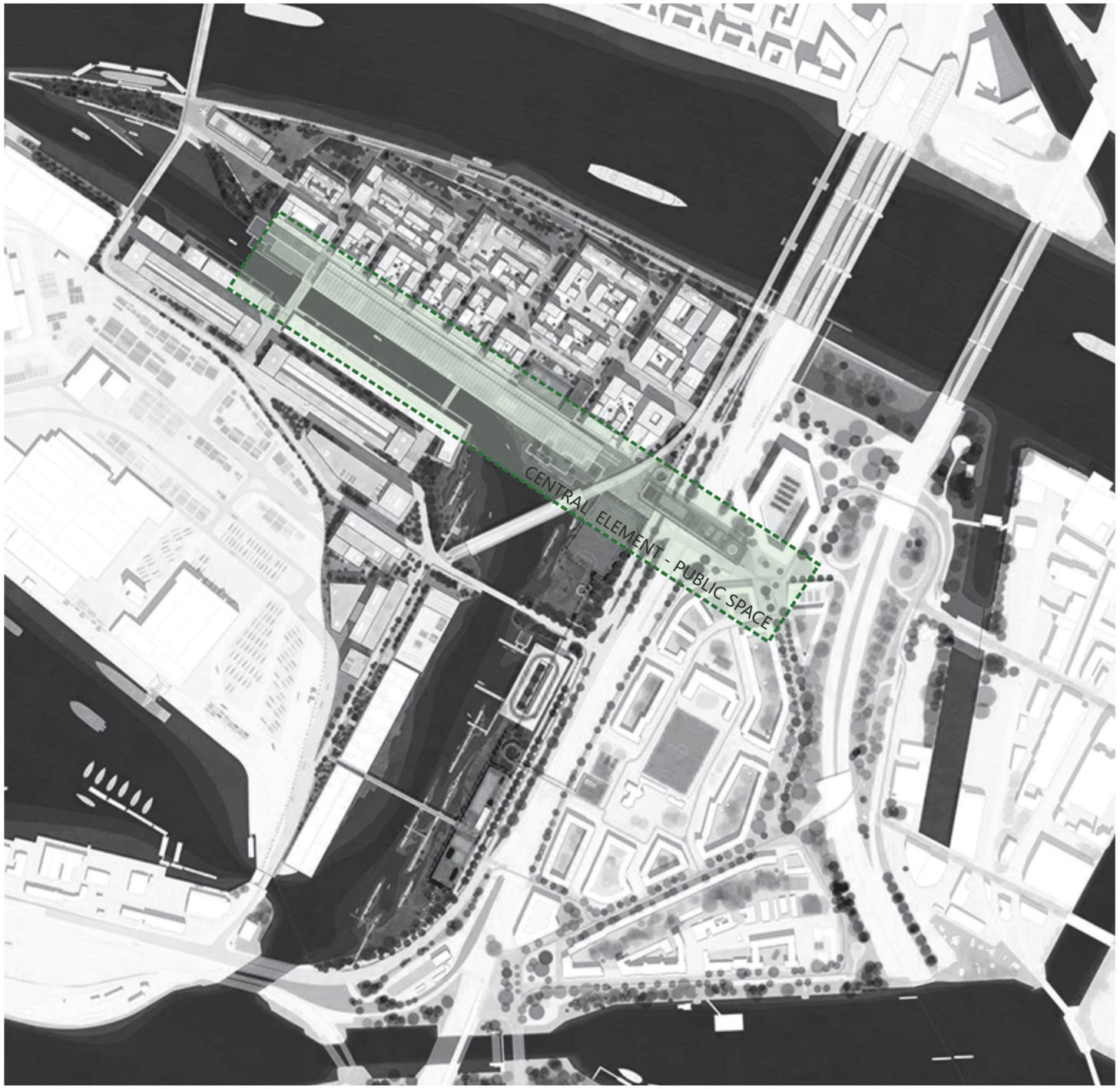



*Figure 10. The Open City. Image source: Karres en Brands. Annotations by author.*

# PART 3

## KUNDA

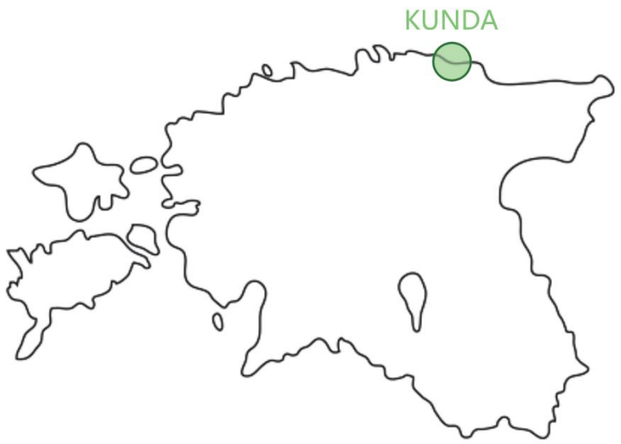



*Figure 11. Kunda. Schematic position. Author.*

As stated, the aim of this thesis is not to propose a viable location for a future SMR in Estonia. Public and private actors have suggested Kunda and its surroundings as a potential site, the local municipality has expressed interest in its development, and an interim report by the Estonian Ministry of the Environment in April 2023 confirmed Kunda along with Loksa, Toila and Varbla as favorable options. The selection for this project is predicated on the fundamental goal of revitalization of industrial settlements. Kunda with its history rooted in industry and a connection with eastern counties facing similar challenges, with a strong situation along the Tallinn-Narva highway, makes for a candidate worth exploring.

### Overview and background

#### General information

Kunda is an industrial seaport town, taking up 10.1 $km^2$ in the municipality of Viru-Nigula in Lääne-Virumaa county, Estonia. With an approximate population of 2900 [69], the town's development can be attributed to its strong industrial base, that has had a significant role in the shaping of its local economy, demographic and urban fabric.

Various small and mid-scale industries operate in the region, but the most notable is Kunda Nordic Cement, a cement production company with inseparable historic ties to the formation of the town and its spatial development. Estonian Cell, the only aspen pulp mill in the country is also based here and the town is still served by the Port of Kunda for cargo shipping.

The most significant portion of the economic activity in the region is centered around industry. According to statistics provided by the Estonian Tax and Customs Board, in 2023 companies in processing industries make up the largest proportion of operational companies with employees in Viru-Nigula at 18% – a reported 34% of registered workers are employed in this sector, contributing to roughly 76% of the total revenue generated in the first quarter by all companies in the municipality [70].

The distance to Tallinn from Kunda nears 110 km, but the populous city closest to the town at 25 km is Rakvere, connected to Kunda via regional buses and an existing railway initially constructed for cargo, that serviced commercial trains in the past, non-operational to date.

#### Formation – early history

The historical overview of Kunda will focus on its development after industrialization, as it is most relevant to the topic at hand.

Commercial activity in the area was offset by the construction of Port-Kunda in 1805, which a decade later began its use as a customs point for various imports and exports [71]. Initially a settlement that comprised Lontova village and the Kunda manor properties, the town formed with the creation of the first cement factory by then manor owner John Girard de Soucanton in the 1860s [72].

The next few decades saw rapid industrial development as Kunda formed around the factory and its needs – as the factory grew, energy supply ranged from steam engines used for raw material mining to a hydroelectric power station which was the first of its kind in Estonia [73]. By the turn of the century, a private cargo railway was built, expanding the existing line from the port to the cement factory, connecting the industrial site to the Tallinn – St. Petersburg line passing through Rakvere and soon a commercial train began operating between the two settlements.

Before the factory's nationalization in 1940, energy production had switched to the use of oil-shale. The spatial development of Kunda was intertwined to the growing success of the cement factory [74]. To illustrate the speed of progress in these first decades of operation, production grew from 20000 barrels of cement a year (about 3400 tons) in 1875 to 113000 barrels a year by 1890, making up 10% of Russia's cement production of the time [75] – a 465% increase in 15 years.

The book "Punane Kunda: 1870" gives an overview of the cement factory's history, which, characteristic to its publication period, focused mostly on the perspective of the

worker's conditions. However, some hints about Kunda's urban development can be deducted from the narrative. According to the book, existing buildings in Lontova were initially used to house factory officials, but it quickly became apparent that housing workers would require new builds. A mixture of stationary and seasonal laborers flowing in prompted the construction of housing facilities and basic barracks.

Evidenced in historic maps and written accounts, the settlement surrounding Kunda's cement factory was expanding eastward at first, across the river. Additional barracks were built in a north-south direction towards the manor's territories. By the beginning of the 20th century though, locals had general complaints about the lack of amenities and space for entertainment, commercial and cultural activity, often commuting to Rakvere even for groceries [75]. The population count in 1922 was 2310, mostly made up of male workers in the (already) third expansion of the cement factory [75]. These expansions were due to rapid modernization of production technology and increase in product demand and they led to the southwestern direction of the factory's growth. Along those changes and demands, Kunda saw additional construction westward in the 1930s, with the addition of a proper school and a community house [76].

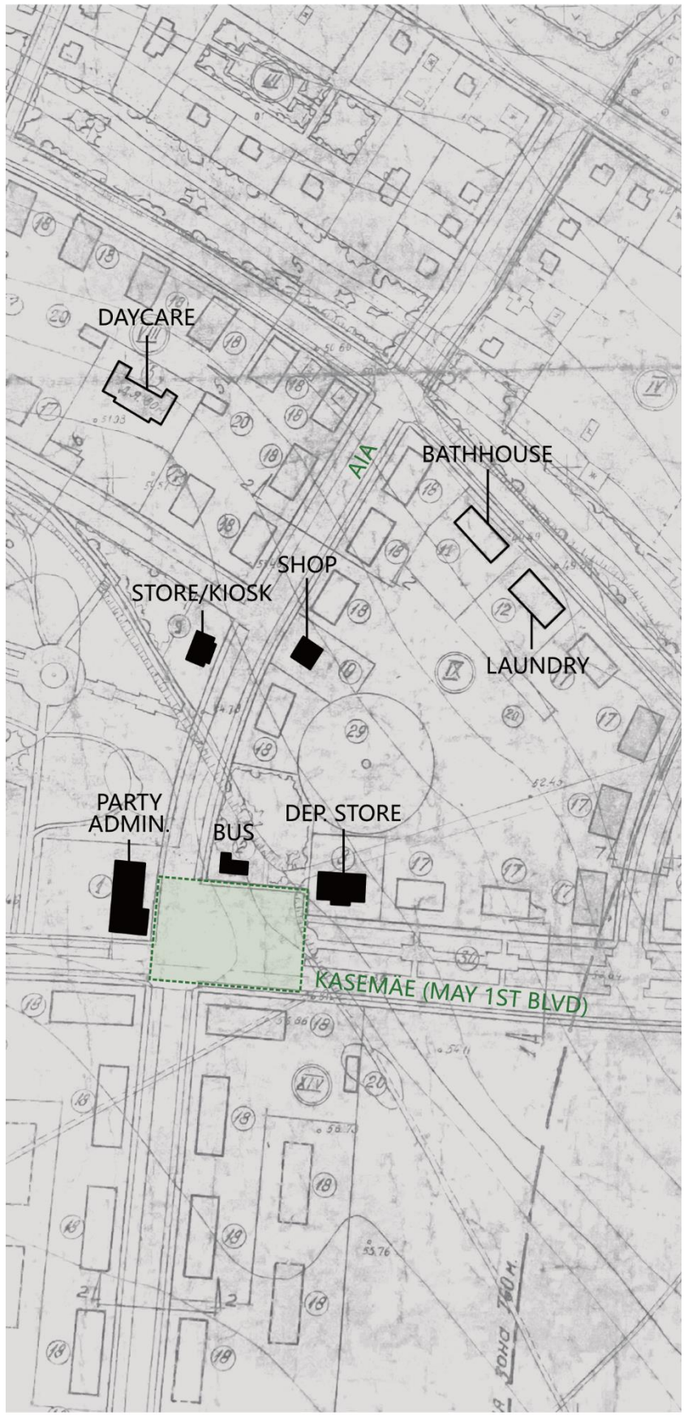

*Figure 12. Kunda maps, 1940s-1960s. Before cement factory expansion (above), after expansion (below). Map source: X-GIS2, Estonian Land Board.*

Urban fabric - structure

The structure of Kunda as it is today, was mostly formed after the nationalization of Kunda's cement factory during the soviet occupation of the country. The world war and regime change ended much of the international commerce, which resulted in the closure of the port until the 1990s [71]. The war and economy took a toll on the town's population and work force, reducing the number of inhabitants to near 1600 [75], but focus on improving living conditions for local workers and new plans for industrial growth led various urban developments which began in the late 1940s by providing new housing units for construction workers tasked with the cement factory's fourth expansion.

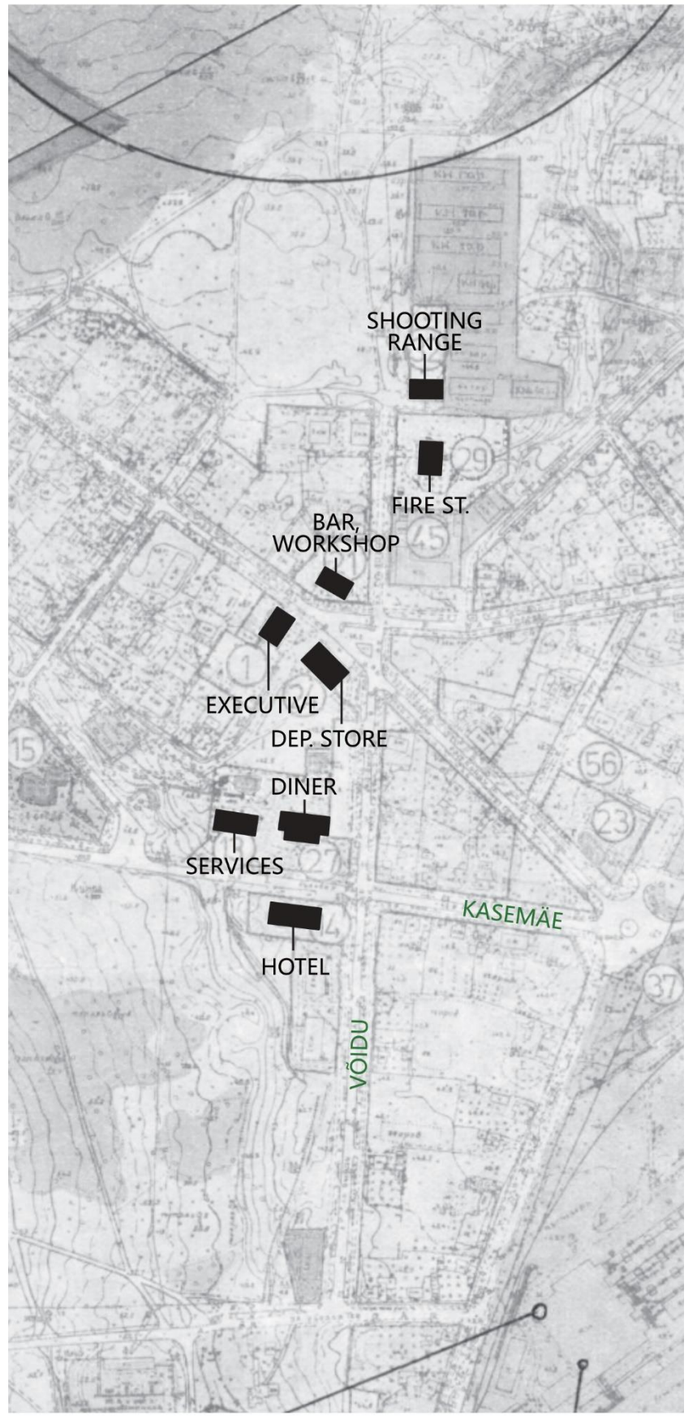
Expansion

A study of available maps and project plans of the time period reveals that one of the reasons Kunda expanded towards the northwest was due to the then-established worker's quarter being downwind from the expanding factory, significantly affecting living quality with dust pollution resulting from predominantly southwestern winds. The unique arch-shaped development, built throughout the soviet period, can be explained by observing the local topography, which shaped initially Pargi and Mäe streets, along which apartment buildings were planned. It is clear from archived texts, that the dust pollution being a concern left the immediate vicinity of the cement factory, between the stadium and the 4th factory expansion, somewhat underdeveloped. "Punane Kunda. 1870" makes reference to the general plan of 1961, claiming the foreseen number of inhabitants to be 7300 by 1980 [75] – explaining ambitious plans of expansion. Even though that number was not reached, latter plans from 1982 and 1993 were both projected for population growth [77]. The 1993 Kunda's




Map source: RA, ERA.T-14.4-6.8688, 1961
unscaled excerpt

*Figure 14. 1961 General plan. City center.*




Map source: RA, ERA.T-14.4-6.896, 1982
unscaled excerpt

*Figure 13. 1982 General plan. City center.*

general plan project explanation was put together with the projected thorough renovation and modernization of the cement factory – the sanitary protection zone for KNC was expected to be at least half its size [77], opening up the area southward and eastward from the stadium for development – at the time for a park which would offer some protection and a transition from the industrial area (marked HS in figure 16) and an expansion for 3-storey apartment buildings (3E in figure 16). However, buildings along Rakvere mnt, Jaama and Võidu street were deemed unsuitable for permanent residence (AE in figure 16), and commercial and public activity, which had already been established by the building typology, was planned to remain in what had developed as the city center.

City center

The formation of a clear city center most likely took place in the late 1960s, not adhering to the general plan of 1961. In those documents, a central square was drafted in front of an administrative building for the party (Figure 14) at the end of the main boulevard, today Kasemäe street (Figure 15). The plan included buildings for a school and daycare, but not any of the public amenities later constructed along Võidu street, which are, however, already visible in maps from the mid-to-late 1960s (Figure 12), instead, an open marketplace was envisioned there (Figure 15). The eventual public buildings, which included commercial uses, a sauna-bathhouse, a diner-cafeteria, a service center, and a hotel among others (Figure 13), have configured the city center for Kunda, as even current general development plans regard the area as such, also containing the central bus station.

However, an observation of current occupancy and functionality would lead to quickly dismiss this area as central at all, given that the buildings meant for public use along Võidu, surrounding the station, are empty and in decay. There is also no clear usable public space that could constitute a city square, and all intersections are fully oriented for car traffic. Currently, the formation of an important functional node surrounding the school is observable, as the local municipality holds its office in the same complex along with the sports center. The surrounding public space is however also lacking in terms of usability, and while a place for schooling and employment, no commercial activity is hosted there, but it contributes to the westward shift of the town.

The current city-industry integration of Kunda most accurately fits the adjacent typology. Heavy industry is a part of the urban fabric but is situated on a segregated strip of development in the southeastern side of the town. Further growth will likely follow a similar expansion pattern, as evidenced by development plans and available space.

Demographic changes and decay

Shrinkage and urban decay are quite apparent in both the physical and demographic makeup of Kunda. Although once a thriving small industrial town, technological changes in the cement production led to some people having to look for alternative job opportunities, but while modernizing Kunda Nordic Cement in the 1990s was likely one catalyst for its decay, general changes in the nation's politics, economy and society at large would also play a role. The symptoms can be observed in the demographic changes that have occurred in these last few decades. While the general plans for Kunda all counted with a growing population, those ambitions did not come to fruition and demographic changes can be noticed retrospectively already by the time the 1993 general plan was accepted. The 1989 census sets the local population at 5037 [78], but the document in 1993 claims the population count in 1992 to have been 4979, which, although not a significant drop, would further approach four thousand by the year 2000 [79], dropping to 3246 by 2015, and currently to 2997 [69].

The consequences of population decline can be noted in the built environment, as evidenced by abandonment and decay of local buildings and infrastructure, but also certain trends in housing inhabitance. A study of these trends points out that while a decreasing population is leading to overall higher dwelling vacancy in Viru-Nigula, the inhabitance rate of single family homes has increased by 20% between 2013-2020 [80], attributed in part to the fact that a large proportion of available homes have been constructed during the soviet period as factory workers' dwellings and subsequently inhabited by the industrial labor market, eventually aging out – certainly plausible in the case of Kunda.

A closer look into the town's vacancy by apartment building (see Appendix B) reveals that the western housing development maintains an 80-100% occupancy rate, with some exceptions, but the data on the apartment buildings in central and eastern Kunda sets occupancy below 60%, with several buildings being inhabited at only a 0-40% rate. The old workers barracks across the river from the first factory were probably falling out of favor already during the soviet time, when the city began developing structurally towards the west, while buildings in closer proximity to the operational factory were most likely heavily affected by dust pollution, as eventually the areas were declared unfavorable for residence. Today though, Kunda's air quality has significantly improved since its monitoring from 2008, with no current problems recorded, and ceasing the burning of clinker since 2020 further enforces reduction in dust pollution [81].

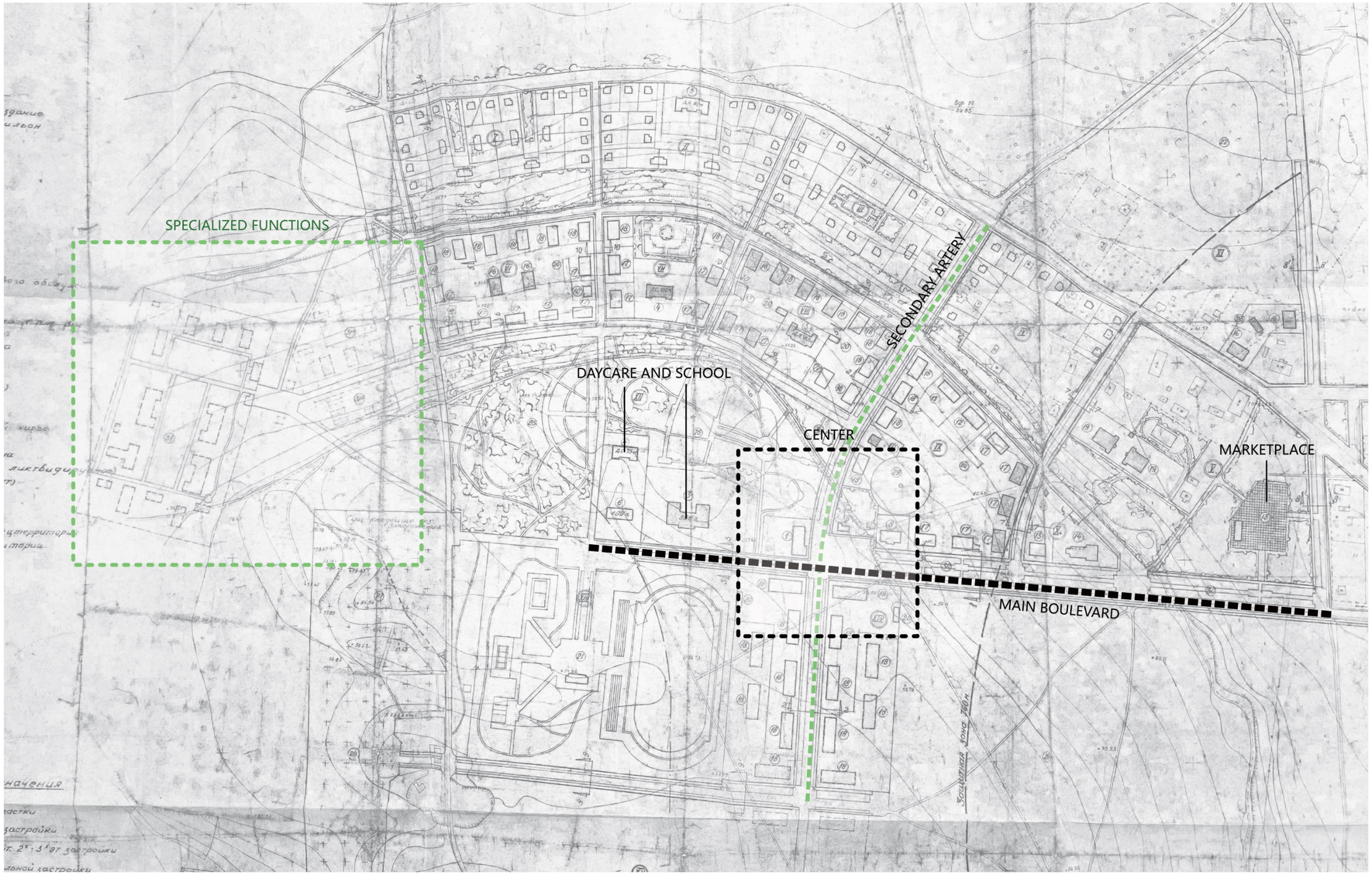
Population decline is also leading to a greater proportionality of elderly people and men in the local demographics, as the largest employers in the region are of industrial nature (including the aspen pulp mill and port besides the cement factory) and the lack of diversity in employment is expressed by a steady decline in the population of working age and youth migration [12].

Development opportunities.

Despite a seemingly negative outlook, with proper investment and policymaking, Kunda's potential could be exploited following the introduction of an SMR. The transition towards nuclear power alone would have a proportionally large local impact, according to a socioeconomic impact analysis, as the construction period (5-6 years) would require the temporary employment of between 300 to 400 workers and an operational power plant would employ approximately 200 people, the majority of which will be earning above the average income [82]. The report estimates that with an average family comprised of 2,6 people, the municipality would invest in the construction of 150 residential units and along local tourism attracted by a visitor center for the power plant, there will be an increase in demand for local services, mainly entertainment, food, accommodation (including temporary).

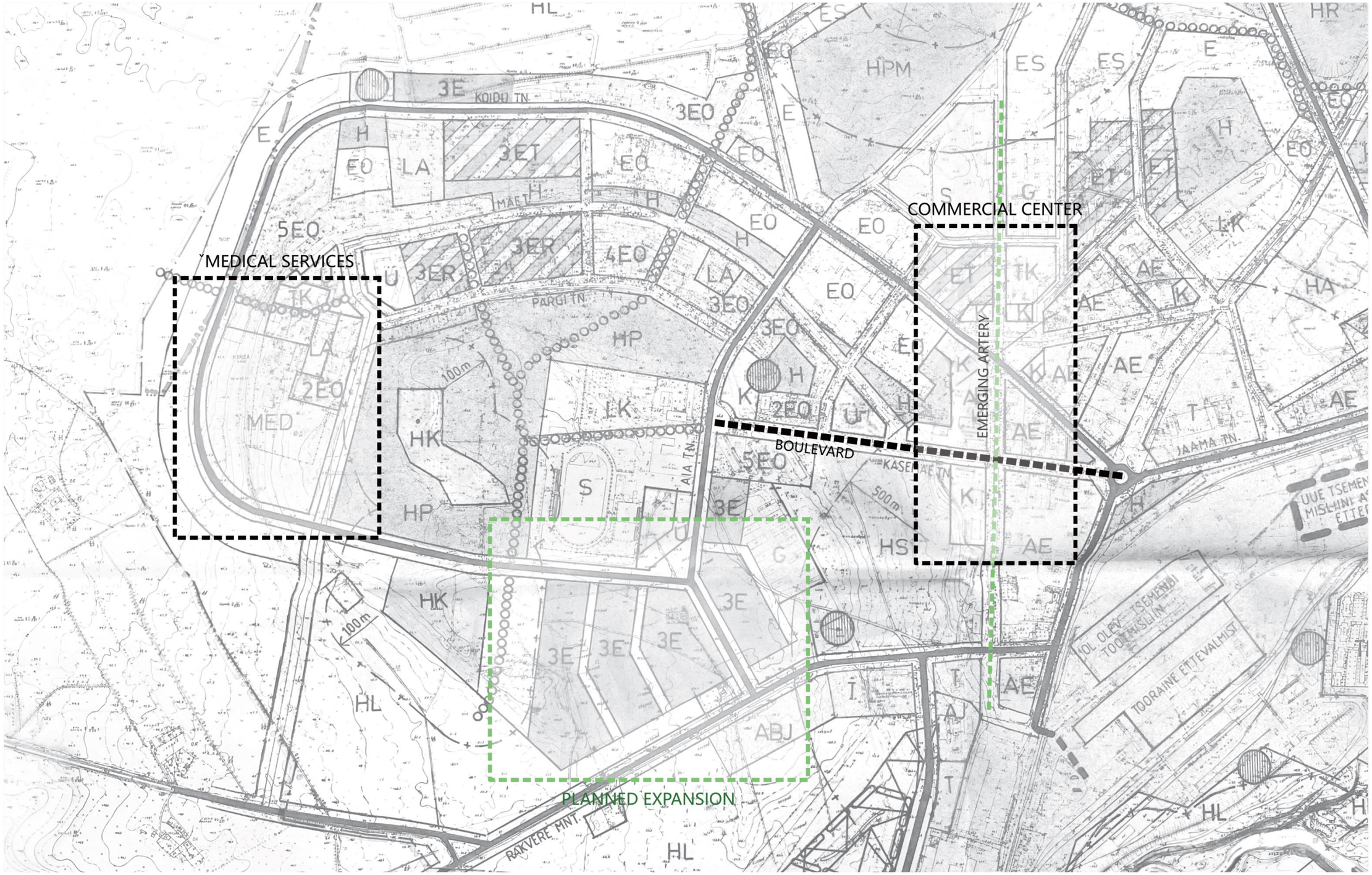
The municipality of Viru-Nigula in its development plans additionally highlights the potential for port logistics and establishing a commercial ferry connection with Finland; becoming one of the main ports in the nation is among their ambitions [12]. Also, branding and collaboration could be used to incentivize repopulation of rural areas, facilitated by the possibility of remote work.

Local development assumes a degree of industrial growth regardless of the implementation of nuclear power, however, access to residual heat and affordable and reliable electricity is likely to cause contingent industrialization, not only offering favorable utility contracts, but also as a way to maximize the efficient use of energy and creating the possibility for future production and research of synthetic fuels [83].




Map source: RA, ERA.T-14.4-6.8688, Väljavõte Kunda linna generaalplaanist (Excerpt from Kunda's general plan), 1961
unscaled excerpt. notes and references from author.

*Figure 15. 1961 General plan.*




Map source: RA, ERA.T-14.4-6.33834, Seletuskiri ja graafiline materjal (Project explanation and graphic material), 1993
unscaled excerpt. notes and references from author.

*Figure 16. 1993 General plan.*

## Physical analysis


*Figure 17. Observation route. Author.*

Kunda's development today is outlined by the municipality of Viru-Nigula's general plan and development plan [84]. Because these documents do not count with a potential nuclear power plant, they will be informing but not determining this thesis' planning decisions.

### Observations

To further inform the planning process, a non-intrusive observation of the site was carried out during which the private and public space, functionality and opportunities for users of the space, and spatial practices developed in the researched area were observed. For the analysis of the results, notes and comments recorded during the observation, as well as supporting images will be used. Remarks are made on the architectural and urban impression of the site regarding quality of the space, as well as brief descriptions of the activities carried out by users of the space in the observed area. The observations were carried out on a Tuesday 07.03.2023 in the time period 10:00 – 12:30 and Friday 24.03.2023 at 14:00 – 16:00.

### Access and networks

Entry to Kunda from both the east and west is through Põdruse-Kunda-Pada, a detour of Tallinn-Narva highway. The western entry is immediately met with industrial typologies and the road flows into Rakvere mnt, directly into the cement factory frontside. Entering from the east, the city structure begins with old riverside worker's barracks and the ruins of the first cement factory, the so-called "old town".

There are 5 bus stops in total and a central bus station. All operating bus lines (8) are regional or intermunicipal, connections existing with Tallinn, Rakvere and Narva, buses to Rakvere being the most frequent – passing 11 times a day. No other type of commercial transportation currently operates in Kunda. Two bus stops are located along the western entrance to the city, two in the center along Võidu street, one by the school and another at the western end of Pargi street.

### Urban space assessment

- Built environment:

Kunda's built environment is undoubtedly the result of soviet time development. With the exception of the first cement factory along with the eastern riverside barracks and a few more recent family houses, Kunda's prefabricated panel housing, school and other public buildings are either recognizable standard projects or style products of the era. The majority of buildings seem to have had little upkeep, noticeable are different window frames per apartment (probably an effort from selective owners for home improvement) and damaged facades. Exposed concrete block buildings, such as garages, as particularly in bad shape, with aspects of abandonment. Notably, Kunda's school, sports center and municipal government building (all

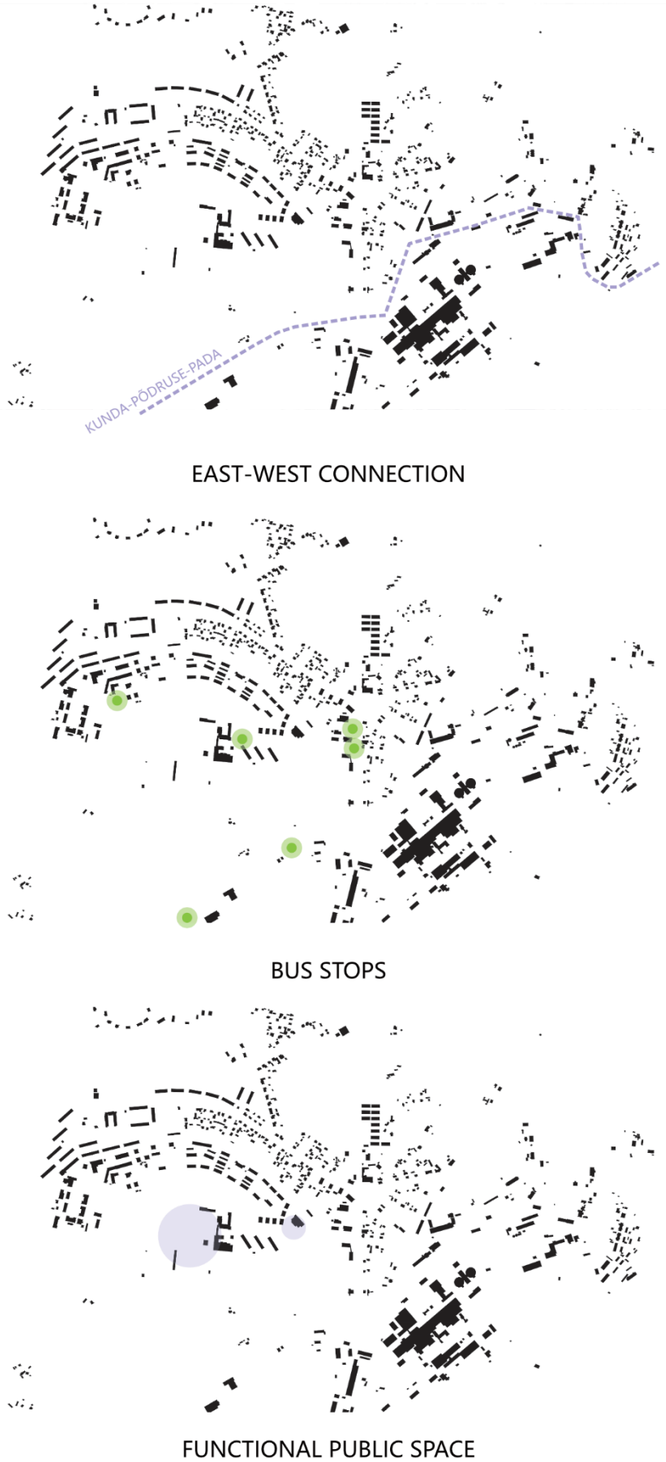



*Figure 18. Schematic analysis. Author.*

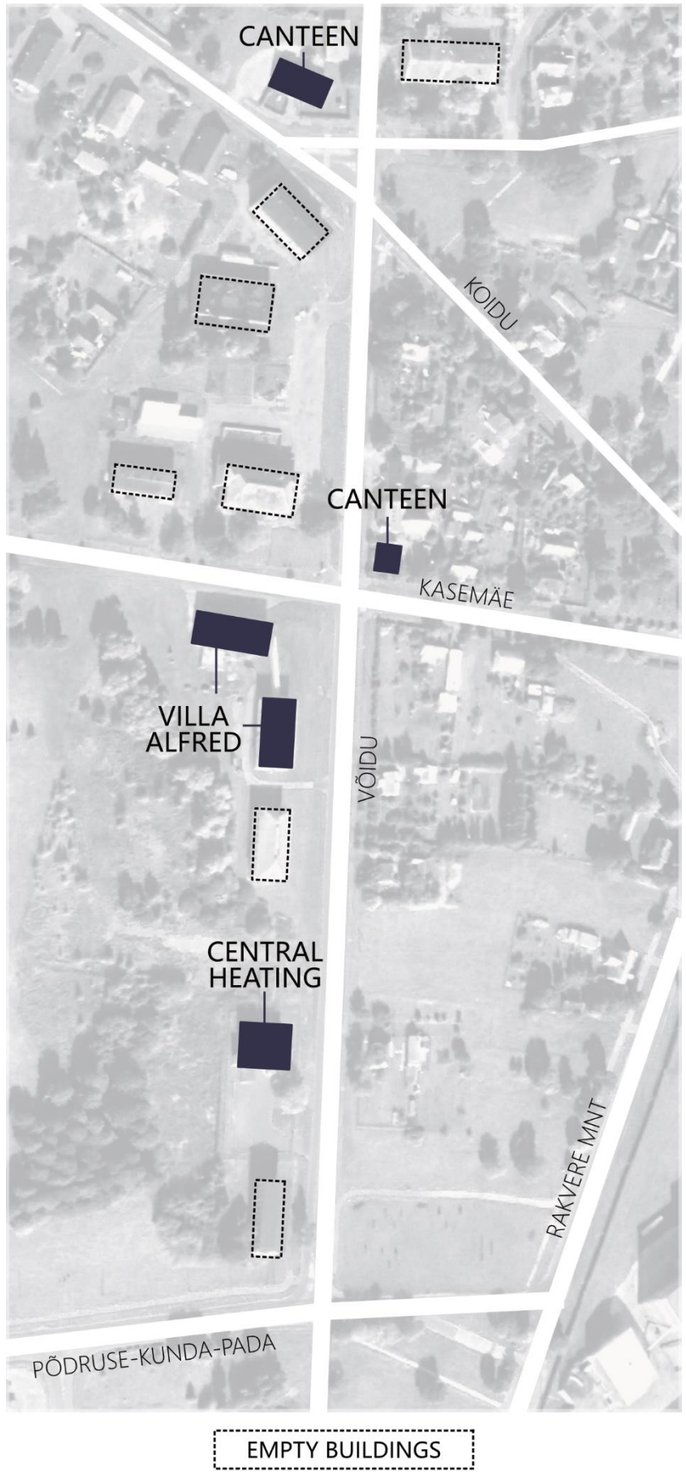



*Figure 19. Empty buildings on Võidu street. Author. Map source: Google Earth Satellite Map.*

of which are in one large complex) have a cleaner appearance, as well as Villa Alfred, an elderly home positioned in the intersection of Kasemäe and Võidu.

Although the panel housing is at least somewhat inhabited (granted, local trends see depopulation of panel housing in favor of single-family homes [80]), what once was meant to be the city center of Kunda along Võidu is desolated. Only two small canteens service the commercial street, the rest of the public buildings being abandoned. Two prefabricated apartment homes, one 2-storey and one 3-storey, are also abandoned, probably due to their direct proximity to the cement factory and previous dust pollution. The eastern side of Kunda, towards the first factory line, is uninviting and in decay. Although there is value in the heritage of the late 19th and early 20th century structures, this area is positioned directly in front of the now run-down 2nd and 3rd factory lines. Some of these buildings are well kept, like the now museum and city club, but this area is completely disconnected from the city due to the characteristic of Kunda's westward development.

Regardless of the building typology or functionality, the city has mostly impermeable facades, a singular exception being Kasemäe 13, which has its street level floor reserved for commercial use, although it is not oriented towards the street. Even though for a decaying town it would be ambitious to expect vibrant street-level commerce, there is little to no interaction between public areas and commercial uses and services, as these lie behind imposing walls.

In general, a 2-3 storey building height seems appropriate for the scale of the overall city and for creating a more human-oriented urban space. Contrasting with this, is the intimidating size of the cement factory, for which there is no structural transition, offering an organic integration of the industry into the city. It's also obvious that industrial activity is completely segregated from all other functions of the urban life, even though the tall infrastructure of the cement factory lines the views from central Kunda. The separation of industry-oriented functions leaves those zones into urban decay, with little attention put on spatial quality. The scalar transitions are sudden, and segregation is mostly achieved with empty swaths of land as buffer areas, contributing to low urban density and disproportionality.

- Public spaces:

The lack of functional public space is probably the most noticeable aspect of Kunda's urban structure. As previously mentioned, there is no obvious public square, and spaces where one could be expected are oriented towards car traffic, taken up by intersections or car parks. Large areas of empty grassland are common, again creating a sensation of massive scale and lacking functionality for different user groups.

By the school, the stadium and a skate park make a public space unit with the forested park, on the southern side of Pargi street. It has an unstructured network of pine trees and small playground, but otherwise lacks landscaping design, and the transition from the park hillside and Pargi street is abrupt. The skate park is in good shape, but being inside the gated stadium complex, it lacks connection with street networks and any other public functions.

In Kasemäe street, Grossi Toidukaubad, one of the two supermarkets in the city, counts with a large, empty, paved area surrounding it. Its position and function have the potential of creating a central public space, but currently it is used predominantly for parking, and an urban design intervention would be needed to make it a welcoming and

functional pedestrian space. The space is sometimes used as a marketplace, improvised stalls from the backs of vans can be seen there, selling local produce and miscellaneous items.

- Street networks:

Despite being a small city, traffic (although generally very low) seems to be dominated by cars. Sidewalks are present in all of the observed areas, however, disproportionately wide streets with often lacking green "barriers" between pedestrian and car lanes make some of the main streets uninviting, especially as they host industry-oriented heavy traffic. Pedestrian lanes are comparatively narrow, giving a hierarchal priority to cars and minimal urban design is applied to landscaping. Noticeable is also the decay of pavement both in car lanes and pedestrian streets.

- Commerce and services:

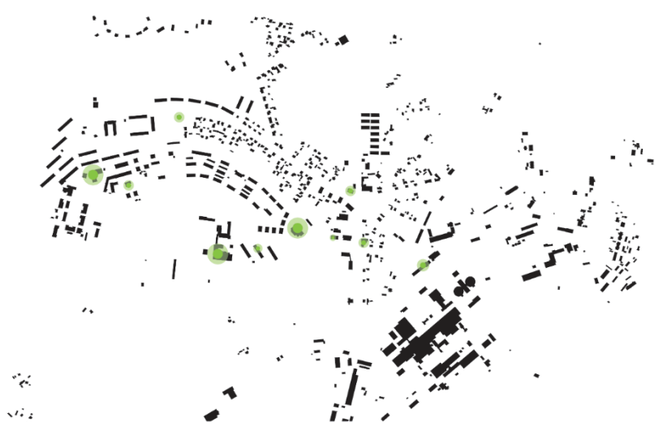


*Figure 20. Existing commercial services. Author.*

Although some essential amenities exist, there is no distinct commercial center for Kunda's services, as they are few and dispersed. Even though there are some facilities in the city, they are insufficient to establish a thriving town center. Additionally, it may be challenging for visitors to locate the services they require due to their dispersed distribution (Figure 20), often located in buildings with very low permeability or connection with public space. Kunda is likely not a town where people from the region would travel to shop or spend time as a result.

Considering the aging population, accessibility should be reflected in further planning and investment into Kunda's services.

Kunda counts with the following (physical) services:

Grocery stores (2)

Grossi and Coop, two small grocery stores offer some basic goods. Seemingly well-stocked, the variety of products is limited, but sufficient for most daily needs. Out of all available services, these are the ones with most customers.

Eateries (4)

Two canteens (Saarepiiga, Maria), a small kiosk (Parkla pood) and the factory cafeteria/diner. The food selection is similar for all, except for the kiosk.

Pharmacies (2)

Family doctor (1)

Flower shops (2)

Museum (1)

Kunda's Cement Museum, open for preregistered visitors for 6 months, the rest of the year open on a schedule. The museum is focused on the history of cement production in Kunda and its factory. Visitors to this museum are usually excursion groups from schools and corporations or national tourists, rather than the populace of Kunda itself.

Retail (2)

A small boutique of rocks and crystals and a secondhand store.

Retirement homes (3)

These facilities might be a symptom of the fact that the local community is aging, a frequent tendency in many small towns in Europe. However, it's also conceivable that residents of other areas bring their older relatives to these retirement communities, which would account for the high proportion of senior living facilities.

Beauty salon (1)

Sports center (1)

Part of the high school complex, the sports center is equipped with a swimming pool, basketball court, gym, mat hall and the outdoor stadium.

- Green networks:

For a settlement with high industrial capacity, more intentional green networks and landscaping should be part of the urban fabric, to alleviate the effect of harsh and imposing masses of heavy industry related typologies. Although a review of previous master plans and historic texts reveals that greenery was high in the list of priorities, the overall sensation in Kunda's urban space is dominated by concrete. The town counts with a large forest-park, but rather than being integrated with the city structure, its position, size and lack of landscaping dilute its role, as the park remains to an edge of the city's core. The existence of greenery has been maintained by private gardens in lots occupied by single family homes, but public and semi-private spaces are mostly covered by plain grass and pavement. The main exception to this is Kasemäe street,

intended as a boulevard, various species of trees line the wide lane. Young trees, seemingly recently planted, also decorate both sides of Võidu street. Considering the recurring disproportion of streets and the low density of the existing built environment, it appears that although intentions for green networks probably existed on a planning scale, these were not fully executed.

### Socio-physical assessment

On both observation dates, the number of users in public space were very low. Although temperatures were low, both days were sunny and generally pleasant for outdoor activities with low wind and no precipitations. Despite this, it was rare to encounter pedestrians on the streets. Both on Tuesday and Friday, the two grocery stores had clients walking in and out, the majority of them into cars parked outside.

Most of Kunda's public space consists of its street networks; as pointed out, functional spaces are lacking, therefore the opportunities for outdoor interactions are minimal. The stadium, likely only used for school lessons and sporting events, was empty on both days, and so was the skatepark. March 7th still had a thick layer of snow on the ground, and a few children with their caregiver were sledging down the sloped terrain of the forested park. Tracks on the snow suggested that this was probably a common activity. Other than a small playground in the park itself, the public space generally isn't particularly family oriented. Kunda's shrinking and aging population might be part of the reason why incentives to make it such are missing.

In general, the people present at the time seemed to be locals, mostly elderly. The Friday observation seemingly coincided with the end of school classes and several students were seen boarding intermunicipal buses. This presents some options for speculation; on one hand, children from smaller settlements within Viru-Nigula or surrounding rural areas probably attend Kunda's high school; on the other hand, it's also possible that students would be heading to a larger center like Rakvere for leisure and entertainment entering the weekend.

*Figure 21. Aia street. Sledging in the park. Image source: author.*

### Identifying spatial problems

In accordance with the results of the observation and site analysis, a revised list of perceived spatial problems that contribute to lower urban quality and livability in the intervention area is made, to be addressed by the project proposal with corresponding planning and design objectives and strategies.

1. Lack of functional public space
2. Disproportionate scale, low density
3. Monofunctionality
4. Fragmented urban fabric
5. Limited cohesion of green networks
6. Loss of place identity
7. Propensity for sprawl
8. Decaying infrastructure

While typical for similar settlements, the specific responses to these issues must be directly tied to the site in question, which can only be achieved by a planning project made to address the analyzed location's shortcomings. The spatial problems summarize the nature of the challenges, but don't adequately describe the unique instances and ways in which they are exhibited, therefore they guide the set of objectives for revitalization, but a project proposal requires a more specific toolbox and design solution which will be expressed in the final part of this thesis.

VÕIDU 2. ABANDONED PUBLIC BUILDING.
DISPROPORTIONATE, PLAIN PUBLIC SPACE & BUILDING FRONTS.

KASEMÄE 13. DIFFERENT WINDOW FRAMES.
EMPTY GROUND FLOOR COMMERCIAL SPACE.

KASEMÄE 11, 13, 15. CLASHING SCALES.
AMPLE EMPTY LANDSCAPES, HIGH CONTRAST.

*Figure 22. Image source: author.*

KASEMÄE 12. SUPERMARKET FRONT - LARGE PUBLIC SPACE USED FOR PARKING AND CIRCULATION.

KASEMÄE 8. ABANDONED PUBLIC BUILDING. IMPERMEABLE FACADES WITH UNINVITING SERVICES INSIDE.

KOIDU 9. ABANDONED COMMERCIAL BUILDING..

*Figure 23. Image source: author.*

# PLANNING AND DESIGN STRATEGIES

## Theoretical-analytical synthesis

To develop a set of urban planning and design strategies to inform project decisions, theoretical knowledge and site-specific analyses are combined into key concepts leading the development proposal. Responding to the identified challenges in Kunda and socioeconomic aspects of urban decay, a list of revitalization objectives and corresponding design tools is formed.

## Key concepts

Drawn from the theoretical framework, planning and design objectives stem from the concepts previously expanded. An ecosystem as a sustainable urban model - multifunctionality, the efficient use of resources and the integration of various urban systems. Planning for shrinkage - focus on rightsizing while adapting to changing demographic and economic trends. These concepts are intertwined with the principles of self-sufficiency, new industrial urbanism, and urban revitalization, providing a framework for sustainable and resilient development in Kunda in the context of a potential nuclear plant.

## General objectives

### 1. Create a collaborative urban environment

In accordance with new industrial urbanism, an integrated ecosystem that fosters collaboration between industry, academia, manufacture, entrepreneurship and government for sustainable growth should be aimed for.

### 2. Conserve identity and heritage

Kunda's foundation as an industrial town has formed an identity which should be upheld moving forward to create a local culture and an engaged community. Reputation and identity also contribute to recognition on a larger scale.

### 3. Stimulate innovation and the local economy

Revitalization should aim to stimulate local commerce, educational and business activity to retain and diversify the population, as a prerequisite for investment and spatial improvement while planning for shrinkage.

### 4. Maximize self-sufficiency and sustainability

With the introduction of the SMR, the new urban model of a sustainable small industrial town should be viewed as a metabolic system and an energy landscape, functioning independently to the highest realistically possible degree.

## Planning objectives

As a response to the previously identified spatial problems:

1. Integrate multiple functions.
2. Connect fragmented local areas.
3. Maintain human scale.
4. Follow existing structural paths.
5. Promote walkability.
6. Create space for community.
7. Introduce green networks.
8. Avoid sprawl.

## Toolbox

In response to the identified spatial problems in Kunda and the set list of objectives, a planning and design toolbox is put together which will guide the structural and spatial design of the project proposal. The toolbox is aimed ultimately at the urban revitalization of Kunda in a long-term perspective scenario with an operational local NPP, in which policy and investments would be directed towards reindustrialization for economic strength while building resilience, sustainability and self-sufficiency by fostering an ecosystem of integrated city-industry within the framework of new industrial urbanism.

### Hybrid program:

To create a collaborative ecosystem and foster self-sufficiency and integration, a hybrid program of functions is needed to diversify local economic, commercial, social, educational and cultural activities. Attracting an inclusive and diverse population to form a new local culture.

### Pathway extensions:

As a way to maintain the existing structure while attempting to connect segregated areas in the town and improving walkability and transit, existing pathways should be extended and connected where necessary.

### Densification:

Densification through rightsizing can introduce an urban scale more apt to the human experience while also concentrating different areas of the local economy into better connected and integrated infrastructure and also addresses shrinkage and sprawl, while aiming to reduce the dependence on motorized transport.

Public square:

As a direct response to the current shortcomings of the urban fabric in Kunda, the reconfiguration or creation of a functional and clear public square should be included for markets, events, outdoor activities, etc.

Communal functions:

Using public communal services, spaces and functions to foster positive community relations, further consolidating the local culture and identity while contributing to social integration of various user groups.

Permeability:

Permeable facades can be effective in creating inviting public and commercial uses while integrating interior and public spaces.

Parks and landscaping:

Maintain a priority in landscaping, improving the local spatial and environmental quality and the overall aesthetic quality of the settlement, contributing to the population's wellbeing.

Landmark objects:

Introduce landmark objects to reinforce local identity, attract visitors and create a brand image.

Multi-user public space:

Assess and respond to the needs of a diverse user base for the urban design of public spaces.

Setbacks:

Setbacks can diversify the built environment and create semi-private spaces as well as guide flow of movement in a desired direction.

Waste management:

Including modern waste management and repurposing options are important for the creation of a sustainable ecosystem for the more efficient use of resources.

Commercial area:

Offer a variety of spaces for commercial pursuits such as eateries, retail and services to the diversifying local population including visitors.

Intensification:

Repurposing existing space and infrastructure, creating an environment for collaborative integration. With densification and hybridization, this is aimed at reaching overall sustainability in the urban ecosystem.

Work/live environment:

With a multifunctional program, planning functions into a close-knitted and well-connected structure is essential to creating an environment that sustains its inhabitants' professional and residential needs.

Integrated typologies:

A step further from hybridization of the general program, architectural synchronization includes diverse functions within one building typology fortifies the integration of activities and users.

Public gardens:

Expanding from general public spaces and communal functions, public gardens invite public participation into the creation of green networks and culture of local food supply.

Step-backs:

A way to achieve higher permeability as well as approach a human scale, step-backs in buildings of larger footprints or massing can make their perception more inviting.

2..3 storey heights:

Maintaining the human scale and appropriate scale for a small settlement like Kunda, building heights should follow existing patterns and remain low-rise.

Gradation of function:

Creating a gradient in building functionality is a way in which industry and city can be integrated without planning residential functions near heavy industrial plants, connecting the now segregated zones with an intermediate buffer, coding complexity while maintaining compatible adjacency.

Multifunctional corridor:

Create a central corridor in which various functions are unified for facilitated transit and collaboration between users with shared public spaces between them.

Public services:

Include essential public services for a higher degree of self-sufficiency within the urban ecosystem, becoming a fully functional town within which life can thrive.

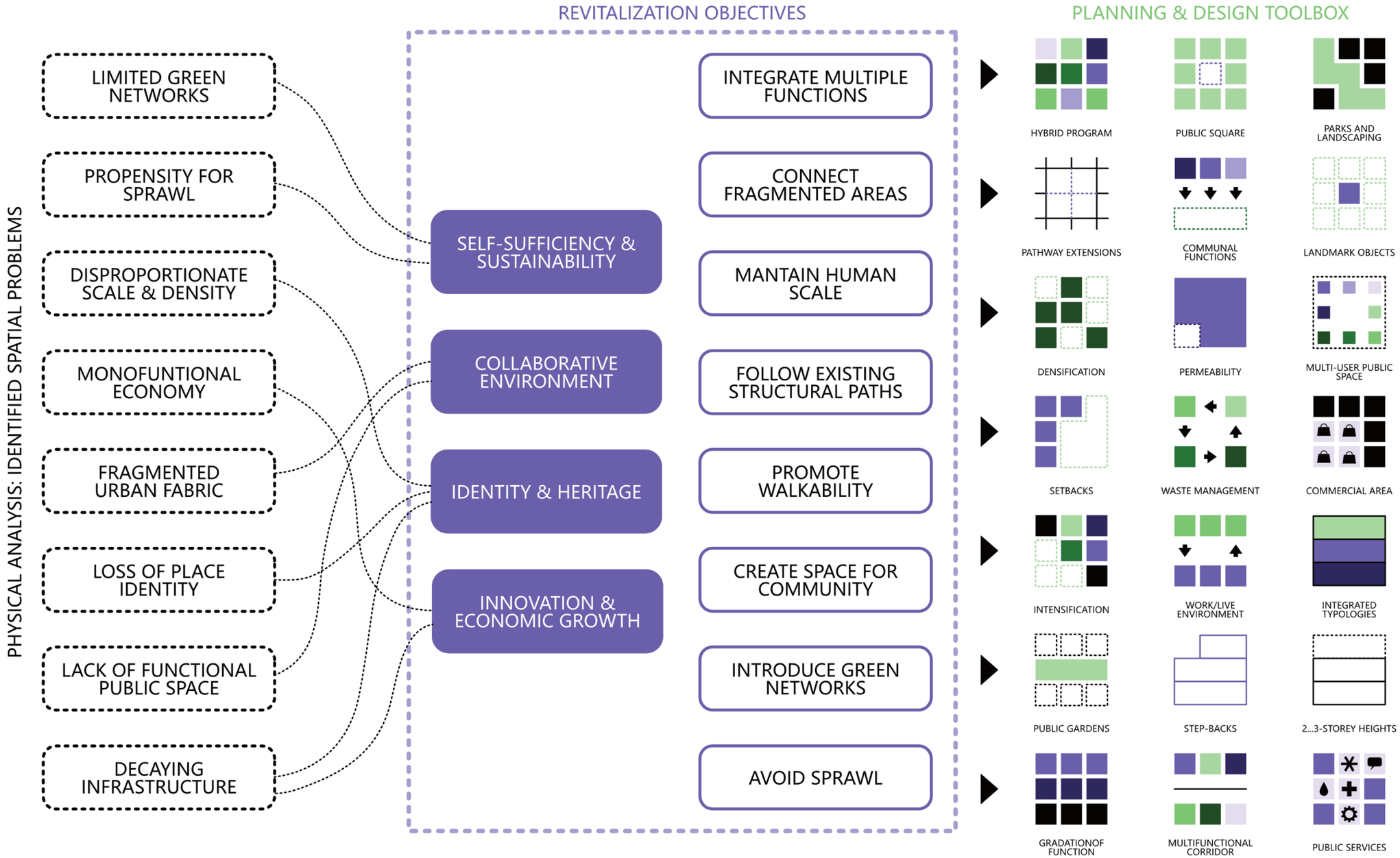



*Figure 24. Synthesis. Planning and design toolbox. Author.*

# Summary

The overall aim of this thesis is to explore an urban model based on theoretical research, that can be applied to decaying industrial settlements for their revitalization by their integration with new energy systems and potential concurrent reindustrialization, with a site-specific application on Kunda, led by the potential construction of an SMR in the area. Urban settlements facing shrinkage and decay are a common phenomenon, and industrial monotowns in Estonia, as in many post-socialist countries, are a prime example of this issue. At the same time, new trends for reshoring and reindustrialization have emerged as a response to concerns over sustainability and economic value, accompanied by efforts of decarbonization and development of clean energy systems.

The main argument of this thesis is that the process of reindustrialization, catalyzed by the adoption of new energy systems, has utility in its economic benefits for the revitalization of depopulating industrial areas, and city-industry integration, from the perspective of creating and fostering sustainable urban ecosystems, is the appropriate framework for its planning, based on the literature. A review of the typical spatial, social, cultural and economic problems present in decaying monotowns, and the principles proposed by new industrial urbanism – a modern, revised framework for city-industry integration developed by authors Hatuka and Ben-Joseph – reveals an overlap in which key integratory strategies are aimed towards outcomes desired in revitalization planning.

Kunda, as an example of an industrial settlement in the process of shrinkage, is a candidate site for the construction of the first nuclear reactor in Estonia. Introducing an energy system which provides not only clean, affordable and reliable electricity, but also residual heat, can serve as the impetus for industrial development in the vicinity. A desire for sustainable ecosystems and conservation of rural land, in addition to the benefits brought by the creation of a collaborative integrated ecosystem, favor the development of such infrastructure in proximity to the cityscape. The results of a site-specific analysis are synthesized with a strategic planning approach, resulting in a toolbox which summarizes the course of action appropriate for the development of a project in Kunda.

The findings based on the literature and analysis conclude that any urban model aimed at the revitalization of a shrinking industrial town must be concerned with the diversification and retention of the local populace rather than expecting its growth. This can be achieved mainly by heightening the general and spatial urban quality, diversifying the job market, maintaining and strengthening local culture and identity (emphasis added on the industrial nature of these settlements), fostering collaboration across sectors and aiming for sustainability and self-sufficiency. An urban planning intervention in Kunda can achieve this by providing a hybrid program of functions, mixed-use development on a scalar variety, flexible land use, rightsizing and densifying the urban fabric and introducing an improvement of public space, green networks and communal functions.

It must be noted though, that the realization of such large scale intervention (as is often the case with urban planning and even architectural projects) is largely dependent on policy and economic investment. It would remain to make a further in-depth market analysis for determining specific business opportunities and industries which would benefit from developing in the area; additionally, local participation in the planning process would also be crucial for the improvement of urban conditions, which can specifically target local needs.

Though this project is tied to a real life location and specifically a nuclear power source, follow-up theoretical research could be dedicated to the exploration of future urban modalities, a shift from populous, centralized cities and forms of production to small ecosystems of technologically advanced sustainable industrial hubs, powered by other forms of decentralized energy, to which urban life and local production are integrated.


*Figure 25. Problem to solution. Author.*

# PART 4

## PROJECT BRIEF

The potential planning of an SMR in Kunda presents an opportunity to attract industry and businesses - a chance to utilize industrial growth for the revitalization of the city, exploring a model that integrates energy production and industry into the urban fabric for a more sustainable urban ecosystem. The purpose of this project is to address various aspects of urban and social decay present in an industrial monotown like Kunda, implementing planning strategies based on the framework of new industrial urbanism through a site-specific multifunctional program deducted from potential local economic benefits a nuclear power plant could offer.

The practical part of this thesis will be exploring an urban model based on the planning and design objectives, strategies and toolbox discussed in Part 3. The proposal is comprised of three tiers, each with a distinct level of detail and focus:

1. A structural analysis of Kunda, encompassing connections between the NPP, main streets and flows of movement, city center and future intervention and expansion areas.
2. The main intervention area, to which the most detailed planning work will be dedicated, serving as the city-industry integration multifunctional quarter.
3. Non-detailed interventions in specific nodes and areas of the city, outside of the main intervention area, which would require future development.

### Project task

In order to illustrate the goal and objectives of the planning project, a base scenario must be set up as a parting point, which is justified by the themes reviewed in the theoretical discussion.

In a scenario in which Kunda will be selected as the location for the NPP, given the utility of reindustrialization as a revitalization initiative, this planning project envisions the spatial potential and organization of such development efforts; catalyzed by a new energy system, industrial growth and R&D initiatives would be offsetting the need for an urban plan. Though necessary premises would realistically depend on political, regulatory and economic factors, this project offers a proposal to showcase an integratory urban model applying the relevant strategies adjusted for shrinkage as an exploratory exercise of the creation of an urban ecosystem through NIU for the preservation and revitalization of industrial monotowns like Kunda.

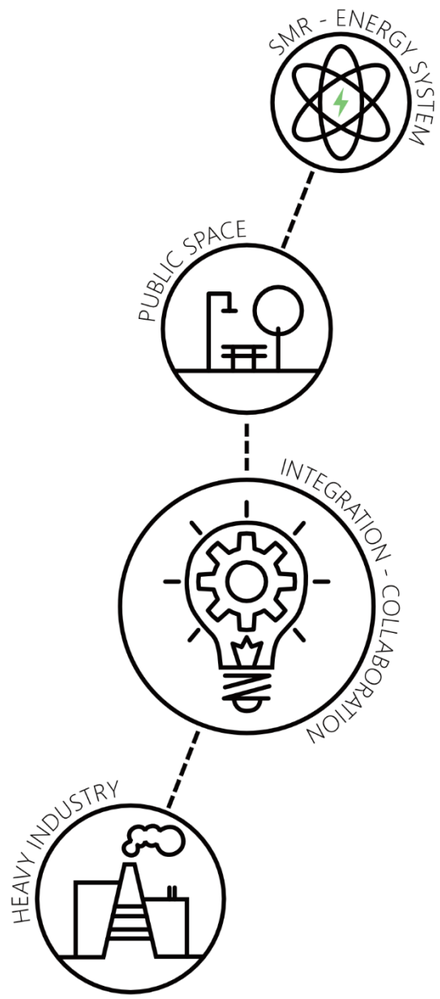



*Figure 26. Intervention structural scheme. Author.*

## Structural analysis

The historic development and current state of Kunda's urban fabric was discussed in Part 3 of this thesis. The following is a proposal and vision for the overall structure and connections made within the settlement at large, including its main points of interest and development.

### General development

Striving towards a functional, attractive and sustainable ecosystem, it is important to understand Kunda's local potential as a point of interest for population retention, heritage preservation and creation of culture and identity. As the economic investments and developments in industry and academic functions would diversify the population to include a larger proportion of high-skilled workers, educated professionals and experts, one of the purposes of planning as an ecosystem is to incentivize long-term stay with possibilities for local recreational activities as well as attraction points for branding and tourism.

Kunda counts with existing potential that allows for further progress.

#### Existing potential

- Sandy beach
- Lontova adventure park
- Kunda manor
- Lontova manor
- Lammasmägi – archeological site
- Old factory ruins

#### Development prospects

- Leisure and commercial port
- Camping and hiking spots/trails
- Innovation initiatives and facilities
- Local tourism routes

### Industrial expansion

As envisioned in current development plans and previously discussed, Kunda is expected to see industrial growth, as of now comprised of mostly heavy industries, characterized by large factories, noise and low aesthetic quality. Adhering to the NIU principle of compatibility, it is necessary to plan the expansion of heavy industry in a way which does not interfere with other functions. At present, this expansion is envisioned towards the southwest, continuing the trend of the cement factory, with some areas for industry closer to Kunda's port.

For the existing urban structure, this expansion is coherent with the adjacent nature of local industry, development further from the city would contribute to a sprawling effect, which is undesirable for the case. Available land which has fallen out of use from the decommissioned parts of the cement production complex could be reutilized for this purpose, avoiding additional land being occupied by heavy industry.

Given the emphasis on rightsizing in the process of planning for shrinkage, low-density areas suitable for development are identified.

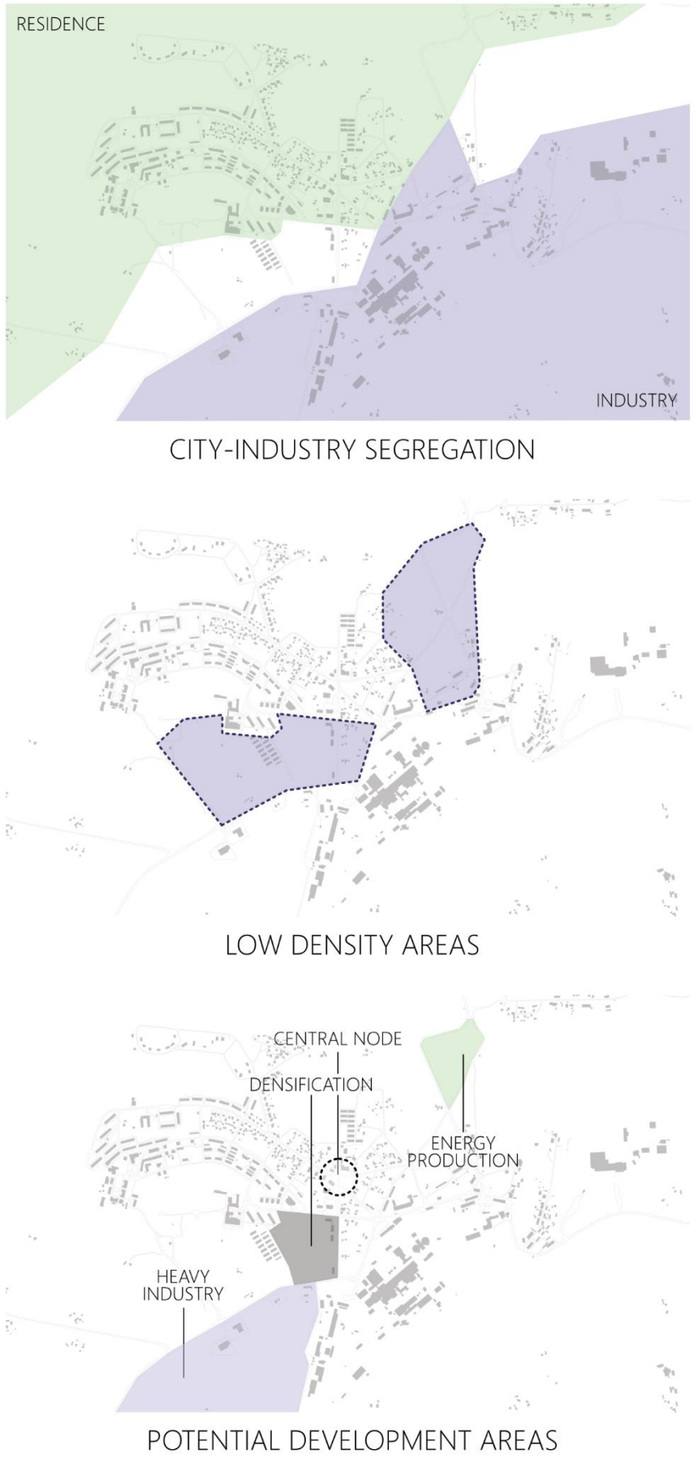



*Figure 27. Schematic analysis. Author. Scale 1:30000.*

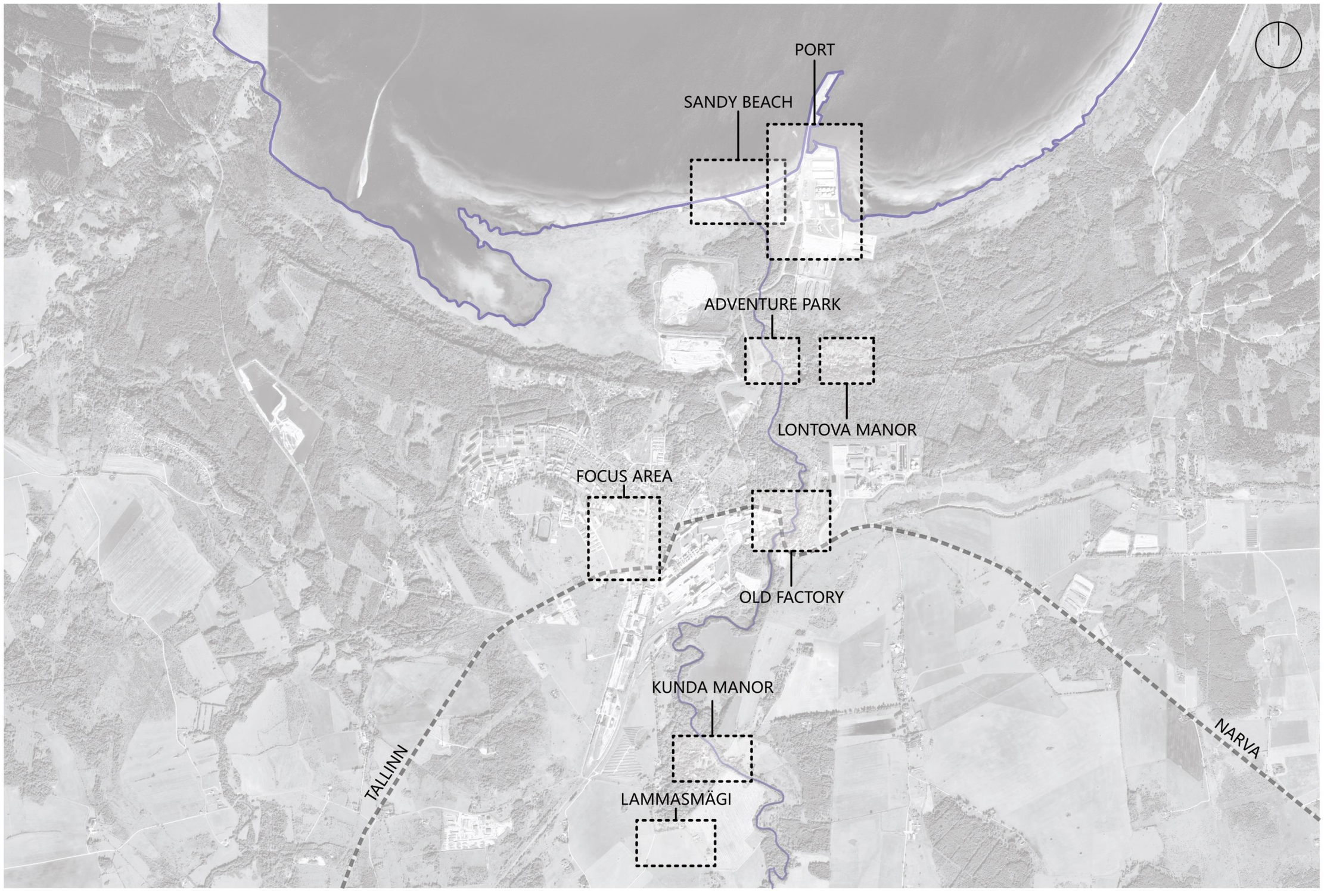



*Figure 28. Kunda's potential. Unscaled. Map source: Google Earth Satellite Map. Annotations by author.*

SMR complex

The foreseen complex hosts two SMR reactor buildings and contingent facilities. Spatial need estimated – roughly 10 ha.

Innovative SMR technology implies changes to safety regulations and precautions pertaining the spatial planning and site selection of nuclear power plants with small reactors. Recently approved methods for determining emergency planning zones (EPZ) based on NuScale's SMR allow for the EPZ to be limited within the plant's site boundary [85], which in turn makes planning in their proximity more accessible. Still, to consider proximity to a water source, a hypothetical site has been chosen near the river, also ensuring the efficient distribution of energy (and perhaps synthetic fuel production) to heavy industries as well as the port area, ensuring a 5 km radius within which service charges aren't added to utility costs.

The NPP location is also a symbolic joint, which bridges the village of Lontova with Kunda's main urban area as well as the port and beach. The selected parcel strengthens the landmark quality of the complex both thanks to its connective location, but also a slight elevation in its topography.

The new power plant would create a linear connection between itself and Kunda's southwestern entry point, forming an axis for future development. Densification, infills, and other growth would ideally concentrate around this formation, as the edges give way to the reclamation of natural and rural landscapes. In this project, the focal intervention will be planned on the marked densification area (Figure 30).

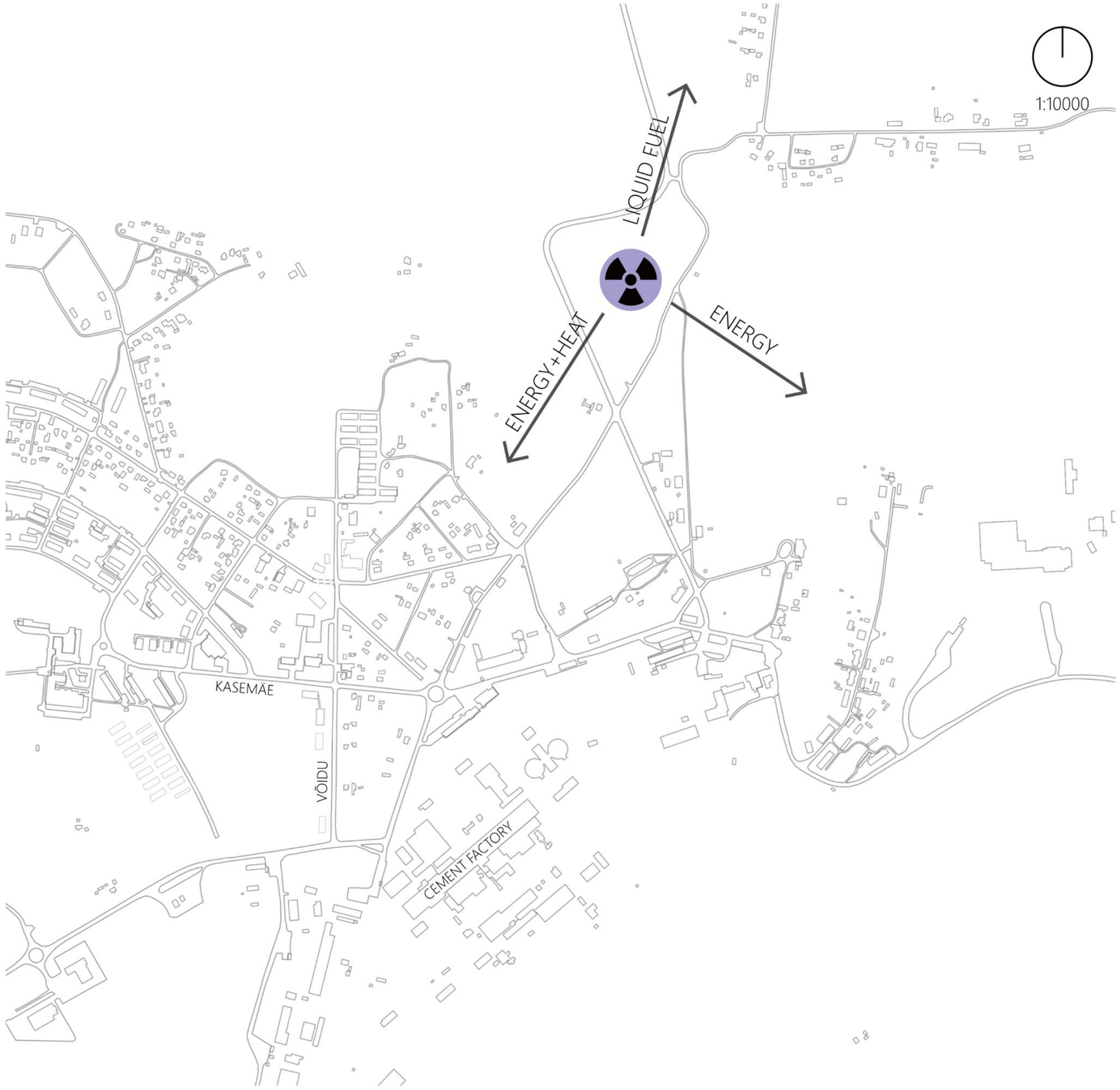



*Figure 29. SMR complex location. Author.*

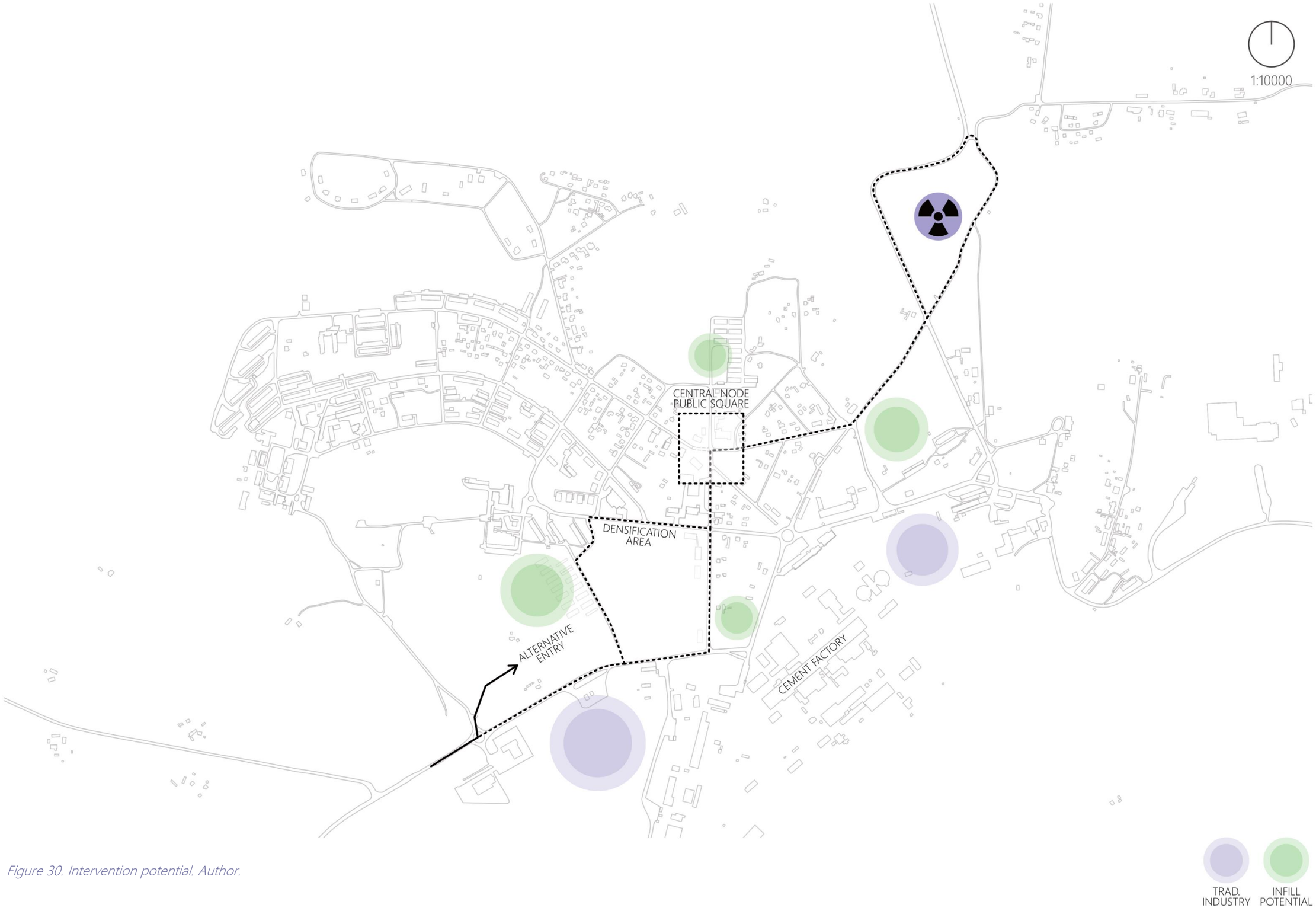



*Figure 30. Intervention potential. Author.*

Main intervention site

The greater focus area which will be observed is located in the southwestern part of Kunda, an area between the streets of Kasemäe and Põdruse-Kunda-Pada on the north and south, limited by the local school and stadium on the west and Kunda Nordic Cement on the east. The main interventions will be planned in what is currently a mostly empty lot limited by Võidu on the east and Kasemäe põik on the west, an area of about 11.3 hectares.

This site has been selected with several considerations pertaining to both the current structure of Kunda and the objective of city-industry integration. The lot is conveniently located in close proximity to the cement factory and the areas projected to be developed for industrial use in the southern region, as per current development plans, serving as a buffer zone between heavier industrial activity and the residential functions which have developed westward. Observing the lopsided L-shape structure of the city, this area is located at a central joint that functionally could serve to connect and integrate, as well as to fulfill the purpose of densification and intensification of the city center, avoiding further sprawl.

It is also selected with the purpose of reactivating the center of Kunda by fortifying Võidu and Kasemäe streets as main arteries to bring back originally intended activity to currently abandoned infrastructure. Reviving this terrain could bring more cohesion to the overall urban fabric and improving green infrastructure in this area addresses the overall lack of intentional landscaping and green networks.

The primary aim of this project is revitalization – despite the fact that the base scenario is that of a future operational NPP with two reactors and concurrent industry, it is important to note that population decline in Viru-Nigula is fast enough that any new future inhabitants will likely not surpass the rate of depopulation, meaning that the overall number of people in Kunda in the most positive projected outcome by 2040 will either stay the same or slightly decrease. Therefore, revitalization efforts are mainly focused on population retention and urban quality improvement.

However, higher tax revenue from skilled workers, professionals and industrial activity (as well as potential reactivation of the port) can contribute to a better urban environment; a planned visiting center for the power plant and collaboration with academia for research and development can additionally attract local tourism and temporary residents, who also require available services and amenities. This project envisions a long-term scenario of development that can realistically come to fruition through strategic investments and collaborative policy concerned with new industrial urbanism to make a decaying monotown such as Kunda an example of a revitalized modern resilient small industrial settlement.

Being a city with a small population, outward sprawl is hardly justified, therefore new development should focus on the densification of the center, providing an attractive livable environment that could be favored by a potential new workforce, discouraging opting for long commutes from nearby towns. Part of making sustainable lifestyles possible is in the provision of quality infrastructure that promotes sustainable choices and behaviors while maintaining a resilient ecosystem, not only in terms of resources, but also in all human activities and city life.

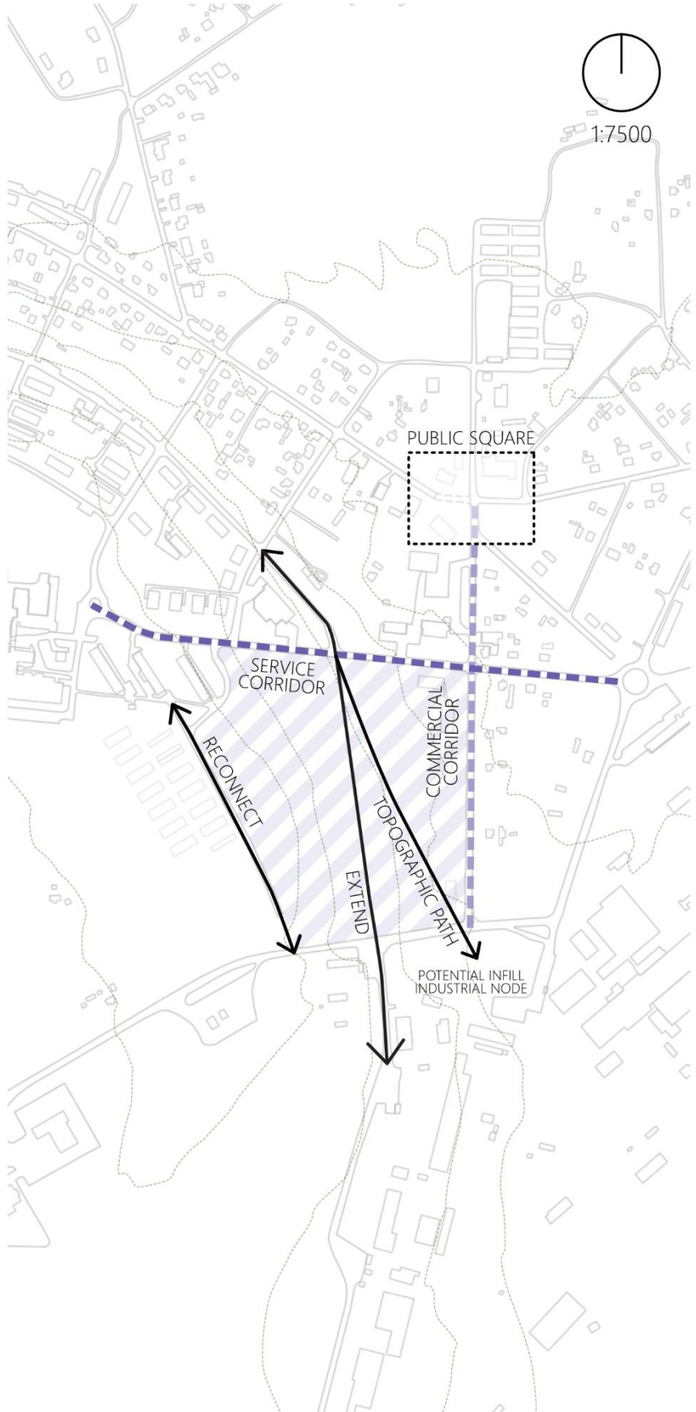



*Figure 31. Focus area connections and premises.*

## The vision

The proposed development offers residential, business and mixed-use accommodation geared towards economic activity integrated with the industrial nature of the city. A variety of spaces for light industry and manufacturing along with workshops, educational laboratories and offices provide a transition from heavy industry while avoiding sprawl and function segregation. The goal is to create a diverse and high-quality neighborhood that retains the industrial backbone of Kunda's local economy with added value from the densification and modernization of its infrastructure and access to public services, while providing an enjoyable environment to retain local population from emigrating and attract a varied new workforce.

As Kunda is defined by its industry, the purpose is to maintain industrial development as the main economic driver of its population in the long term, using integration strategies for an attractive and revitalized city.

In the design, various aspects are considered in addition to planning strategies concerned with revitalization and integration discussed in the theoretical part of this thesis. These considerations refer to the aesthetic and spatial quality of the projected intervention.

## Building program

To guide the spatial planning in this project, a function-based program has been outlined with specific spatial requirements for each category of use. The requirements are derived from the expected number of employees in the operational NPP with an additional margin, counting with contingent industrial growth while considering current residents may be among those employed, not necessarily causing immigration.

As mentioned in the theoretical part, the estimate for an operational NPP in Viru-Nigula sees the need for new residential units to be at about 520. Counting with 200 new employees with an average family unit of 2.6 people. As housing inhabitance trends showed that soviet time apartments are vacated at a higher rate, modern units with larger flats are envisioned. Additional to the potential incoming workforce, as an effort to incentivize densification and rightsizing as well as a diverse pool of residents, some apartments should be allotted for affordable housing,

### Industry and manufacturing (HI/LM)

The projected industrial development in Kunda includes both heavy industry, which requires larger scale buildings and land use, as well as light industry and manufacturing, which provide a transition in scale, noise and functionality between residential, public and industrial space. Both types of industry can benefit from the proximity of an electric power source for lower energy costs and residual heat.

Light industry can include furniture manufacturing, food processing, digital printing and publishing, textile and clothing industries, recycling facilities, ceramics, alcohol production, warehousing, etc. This would also include modern high-tech industries such as indoor farming, e-commerce and distribution, software development, consumer electronics, cloud computing and servers, pharmaceutical production, etc. Additionally, urban manufacturing in the form of independent production by artisans, small business entrepreneurs also occupy this category.

As industry and manufacture is the most important part of this development and integration of this function is integral, an approximate 40% of the developed area is allotted for light industry.

### Research and development (R&D)

Also an inseparable part of a well-integrated hybrid program is R&D. Creating spaces for laboratory research, training, conferences and specialized learning facilities will be an opportunity for diversification as well as introduce landmark objects to the built environment, differentiated from residential and production blocks.

### Business and commerce (C/O)

In addition to space for industrial activity, accommodation for business and commerce is needed for administrative functions as well as local retail and entertainment, which are currently lacking. This would vary depending on the nature of incoming industry, but overall make up a smaller proportion of the intervention, as a commercial boom is unlikely in Kunda. Some office spaces are also reserved for administrative functions of industry and manufacturing.

### Public spaces and services (PUB/S)

Additionally some spaces will be projected for public services and amenities. This could include a small yet proper health clinic with available doctors and essential bloodwork labs, a dental clinic and physiotherapy as well as counselling,

all essential functions which service newcomers and the aging population alike. More services can be a veterinary, a small public tech-library (with public computers containing specialized programs and tech equipment for individual use or workshops), and public/cultural/recreational spaces. Kunda used to have a cinema and while a traditional film theatre might be out of scale, the town could do with a film streaming hall which could double as an event/conference space.

### Residential block (RES)

250 new living units will be planned for the entire intervention, averaging in size 60-75 $m^2$. The residential block is planned in a dense, low-rise modality. Additionally, temporary housing for non-resident specialists, researchers and other guests or tourists visiting the facilities will be included. From the focus area, future infills could densify the central urban fabric with additional single family homes where current typologies permit for it.

As an initiative to ensure diversification and avoid segregation of old/new inhabitants or classification by profession or income, local investments should allocate apartments for social interest, also a part of the rightsizing strategy. Offering low-cost affordable living for residents to relocate to in an effort to vacate outdated soviet blocks for their replacement with natural and rural landscapes.

*Figure 32. Social housing for rightsizing. Author.*

### Program suggestion

Parting from the aforementioned program and distribution ratio based on housing rate, an approximate functionality distribution can be suggested for the focus area intervention.

| OBJECT | FUNCTION | AREA |
|---|---|---|
| SMR | INF | 10 ha lot |
| Chemical production | HI | |
| Housing | RES | 18000 |
| Indoor farming | LM | 1000 |
| Manufacturing (gen) | LM | 4500 |
| Storage | LM | 2500 |
| Offices | O | 1200 |
| Publisher/Printer | LM | 200 |
| Studio/atelier | LM | 1000 |
| Culture/Leisure | PUB | 450 |
| Research lab | R&D | 500 |
| Innovation center | R&D | 1750 |
| Retail | C | 1000 |
| Eateries/café/kiosk | C | 1000 |
| Health services | S | 750 |
| Development area: | mixed-use | 33850 |

Total available accommodation: ca 525

Total available employment: ca 265 + SMR 200

### Circulation and public space

Though this project is not centered around urban design, the formation of functional public spaces and connections as well as inner nodes and joints of circulation make part of the revitalization efforts as well as creating a cohesive, well-integrated urban fabric.

### Public spaces – main plaza

One of the most notable spatial problems identified in Kunda was the lack of functional public space. To remedy this, a new spatial organization should create the prerequisites for the formation and eventual design of such spaces, varying in type such as public and semi-private.

In order to fortify the axis along Võidu street and to envision a renewal of the current city center, the main public square would be projected in the currently five-way intersection where Võidu street meets Kalevi, Koidu and Staadioni streets. A reorganization of the surrounding buildings as well as the junction can create the extents for outdoor functions and act as a joint between the linearity towards the NPP.

Other spaces are created in the focus area with the specific block organization, forming semi-private areas for residential clusters and multi-user spaces for hybrid-academic clusters as well as a mini campus.

The concept for block organization per typology parts mainly from scale and surrounding structures. As a way to blend into the existing built environment somewhat organically, building sizes and heights are maintained to the appropriate extent, introducing some irregularities for further architectural exploration. The concept parts from creating clusters of functions which plays into the human scale, creating a gradient with some hybrid typologies – as

the extents of the intervention area and building scales are rather reduced, creating a decentralized, integrated architectural type (NIU – synchronic typologies) which varies in layout at the parcel or block level [55], makes more sense than entwined typologies within the building level. In this way, the intervention area has several blocks of distinct character and public space, which are still interconnected by close proximity and collaborative flows between activities.

## Parks

Landscaping and parks are an integral part of urban renewal as well, and Kunda's industrial character could be vastly improved with the introduction of designed green networks, on one hand, landscaping helps alleviate some concerns regarding air, dust or noise pollution (though these have dramatically reduced in Kunda), but also create a feeling of higher density, filling in currently sterile grasslands, alleviating the appearance of infrastructure, creating buffer zones for transitions, etc.

As Kunda already has a forested park, south from the soviet time residential development, west from the stadium, the intervention and project are focused on the connection and integration of the new hybrid intervention and the SMR complex, passing through several instances of public spaces, creating a connected network as a linear park which flows into Kalevi, an amicably landscaped quiet street, with a pedestrian/bike lane conducing to the visitor's center, which from its elevated position would overlook the SMR complex. This linearity is also purposed with the strengthening of the connection between Kunda and its port and seaside as well as Lontova, as both roads surrounding the hypothetical NPP lead to the piers and the village.

## Circulation

As per the size and population of the town, introducing traditional internal public transportation methods, such as bus or tram lines is excessive and not foreseen in this planification. However, non-traditional modes of transport, like shared bicycle and scooter applications, self-driving shuttle routes and other sustainable and futuristic solutions are more likely, to create a connection between the hybrid quarter with the SMR as well as with the rest of Kunda. Incentivizing the reduction of car use by providing alternatives is why the linear connection is important. It is also not completely excluded that some people would choose to walk, as the distance by foot between the new intervention area and the NPP would be 12-15 minutes.

## Design solution

The design proposal is centered around a spatial solution for the focus area. To maintain an appropriate scale and contextual fit, the concept seeks to create blocks and small clusters where functions can be integrated, maintaining the feeling of a smaller town with ample pedestrian circulation while creating the opportunity for semiprivate spaces of differing character. The smaller block sizes allow for the organic blending of the new intervention with the rest of the urban fabric, also favoring the mixture of functions within the parcel or block rather than on the building level. The massing facade lines and orientations follow the surrounding built environment, ensuring that transitions are seamless.

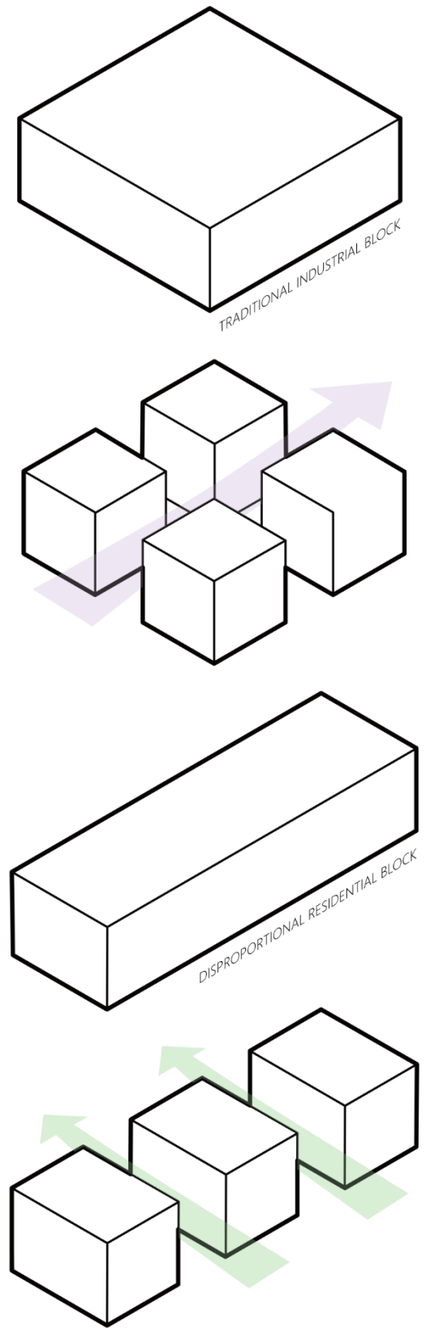
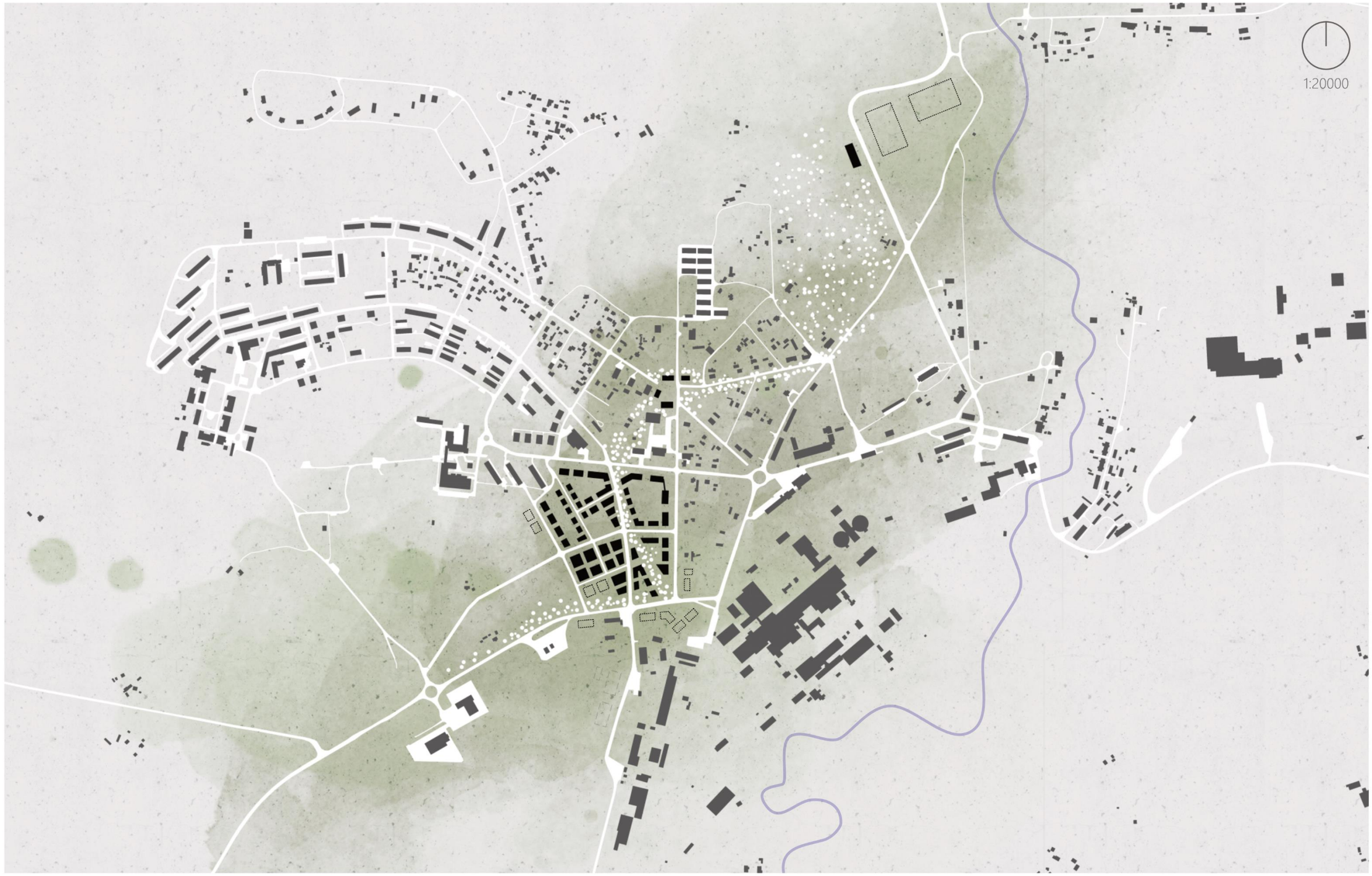



*Figure 33. Scaling and circulation. Author.*




EXISTING NEW INFILLS RIVER

FULL SITE PLAN


1:5000
PEDESTRIAN PATHWAY
ALTERNATIVE ENTRY POINT
INFILLS
NEW

Functions and connections

In order to create a well-integrated quarter while conserving the smaller scale appropriate for Kunda, the synchronic mixture would remain on the parcel level, simultaneously creating a gradation of functions which bridge the gap between the residential wing and heavy industries.

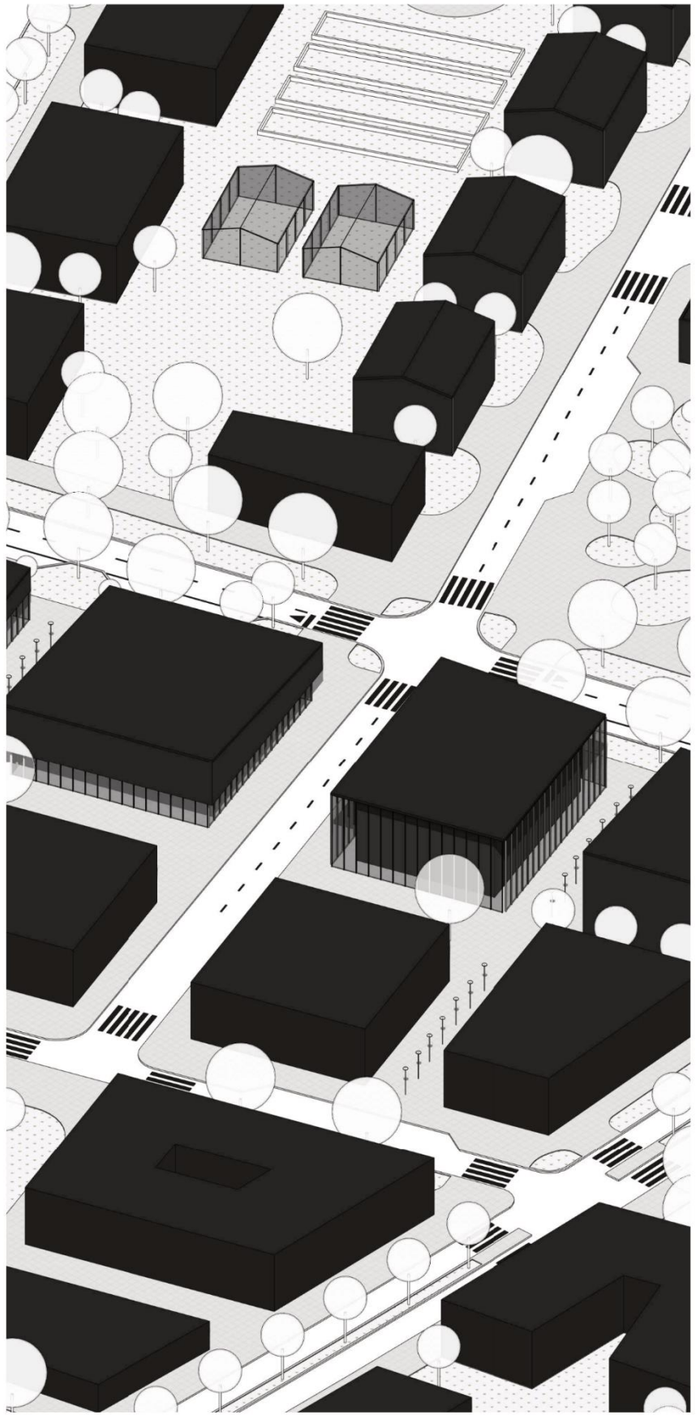
This also facilitates the creation of a work/live environment where essential activities and services can interact and collaborate in a diverse environment.



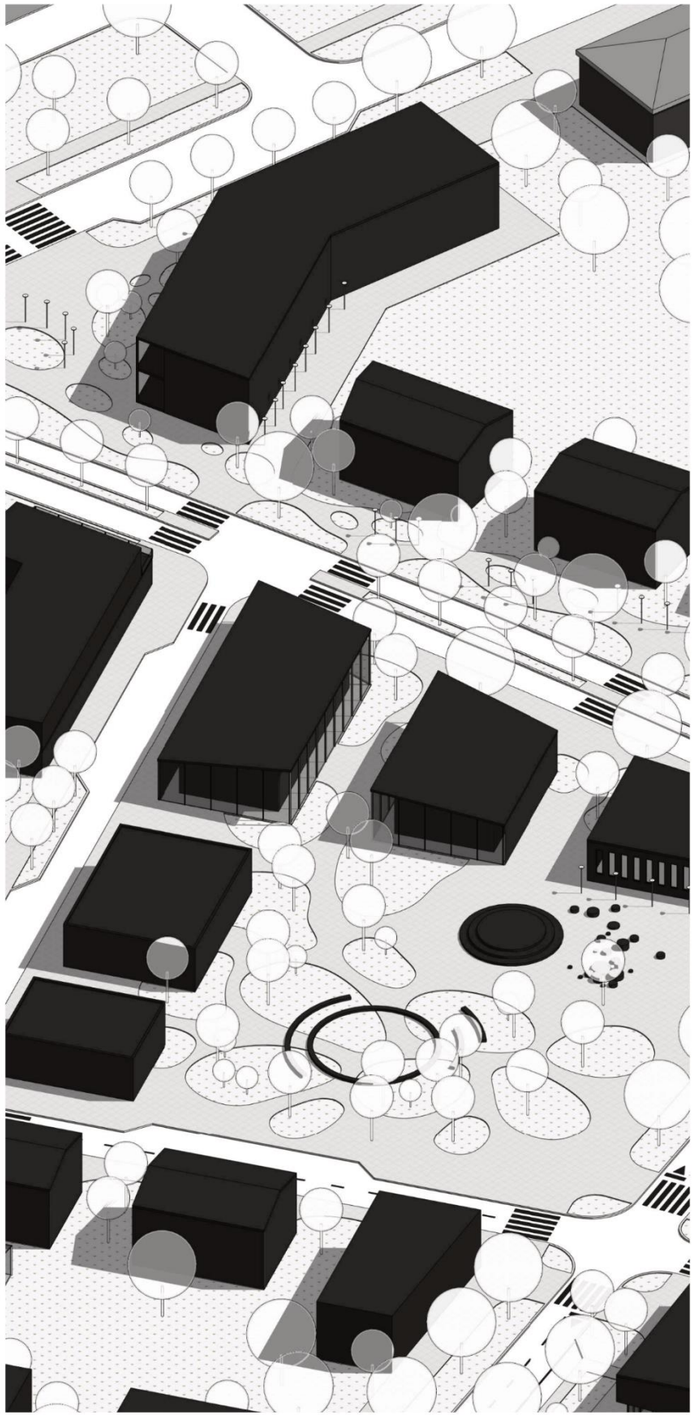
INTENSIFICATION - WORK/LIVE ENVIRONMENT


BLOCK FORMATION

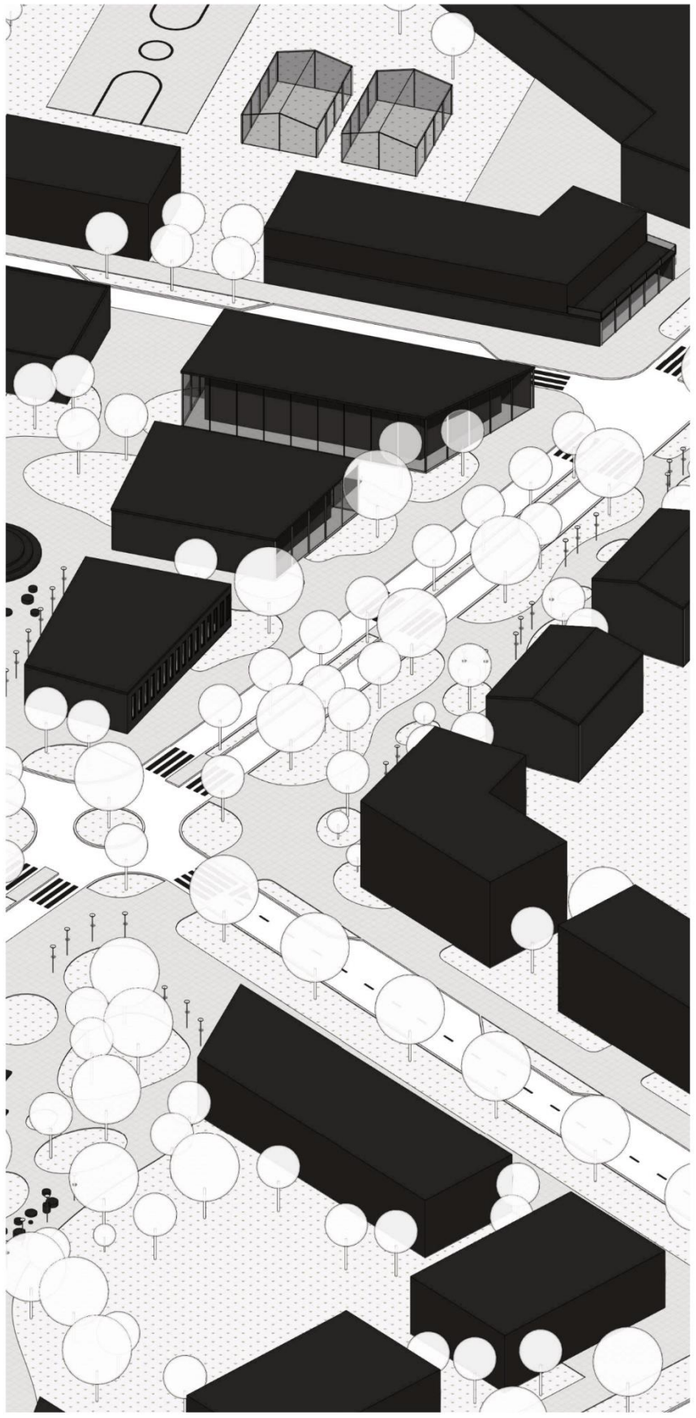

FOCUS AREA - SITE PLAN



SOUTHEASTERN VIEW - MANUFACTURE BLOCK

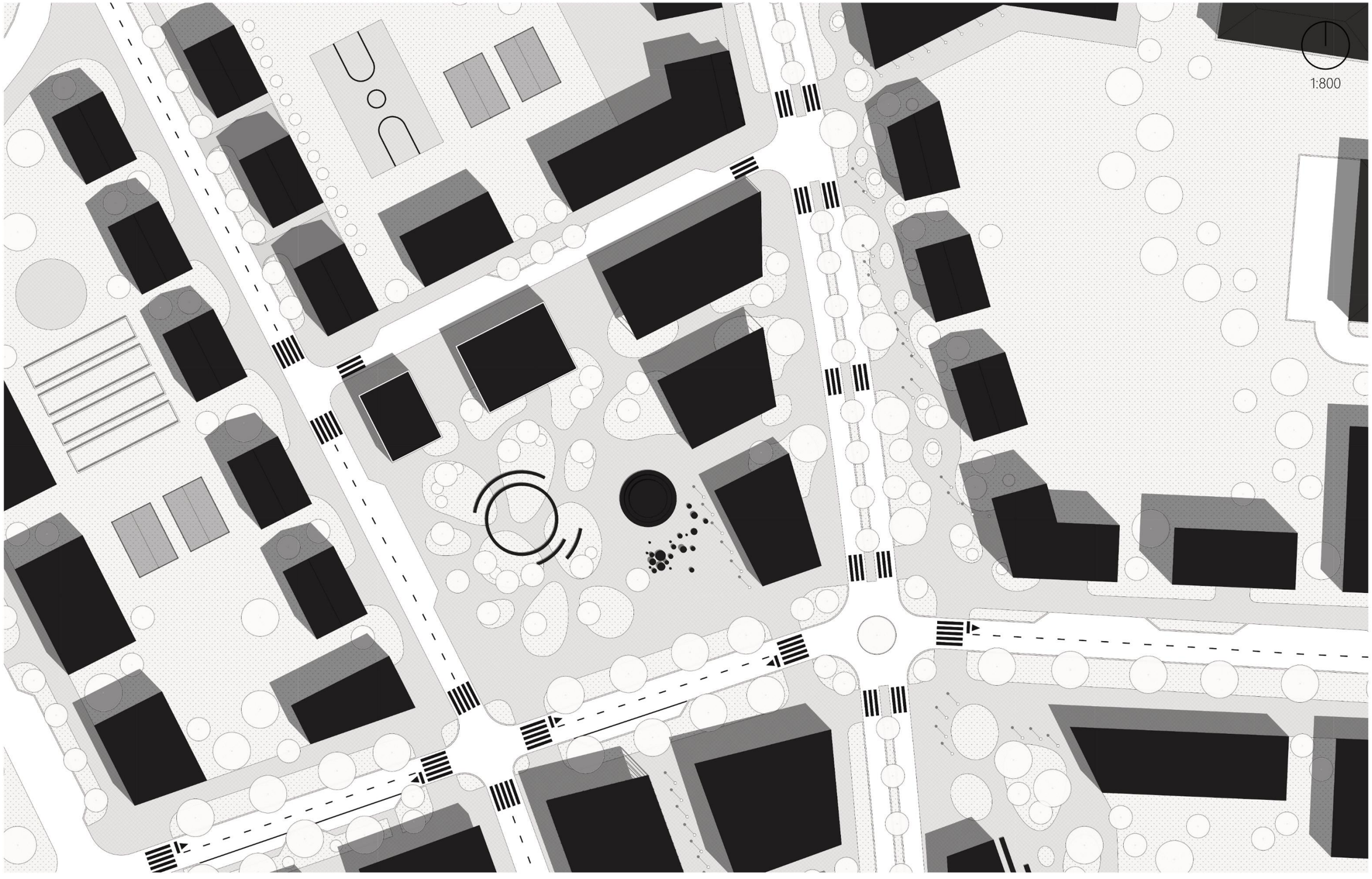


WESTERN VIEW - CAMPUS AREA PUBLIC SPACE



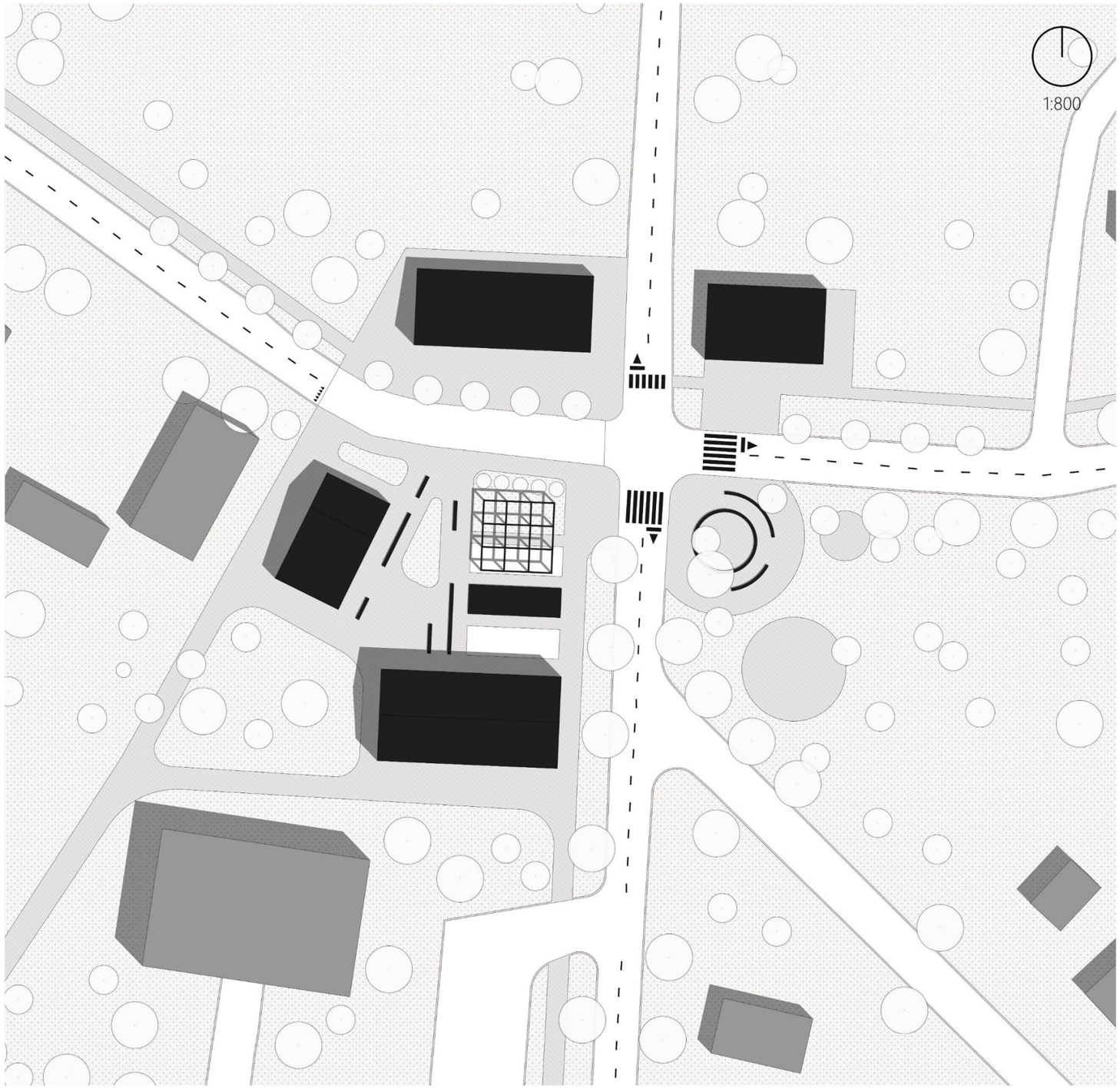
EASTERN VIEW - CROSSING LINEAR PARK

INTERVENTION SITE ILLUSTRATION

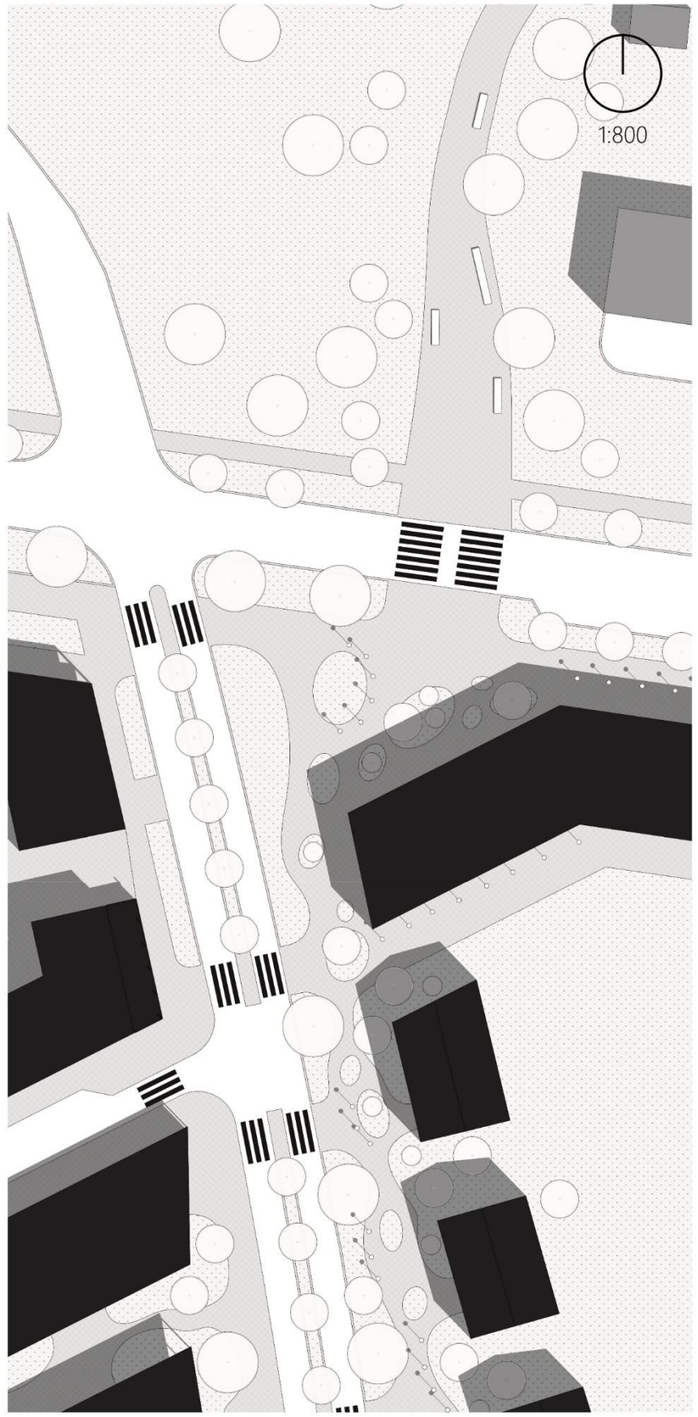



DETAIL PLAN INTO INTERVANTION AREA

INTERVENTION SITE ILLUSTRATION




PUBLIC SQUARE - INTERSECTION REORGANIZATION

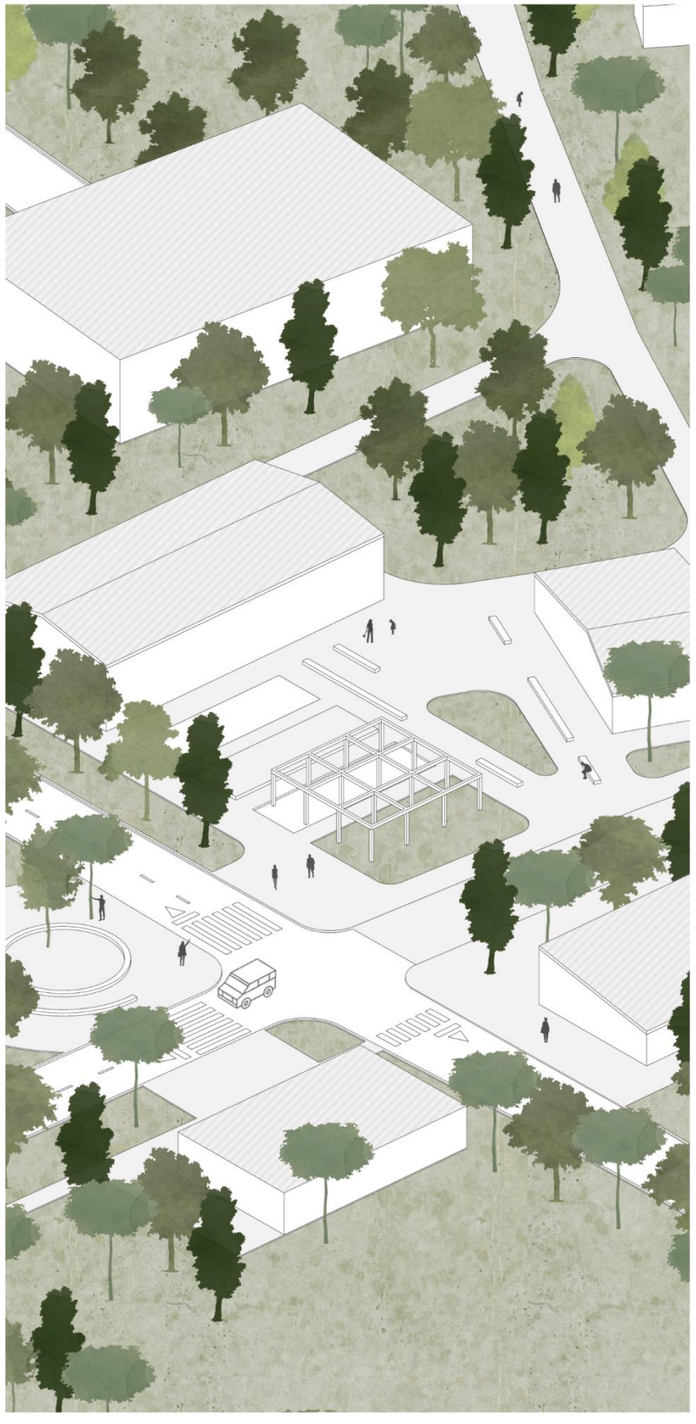



LINEAR PARK - CROSSING TRANSITION

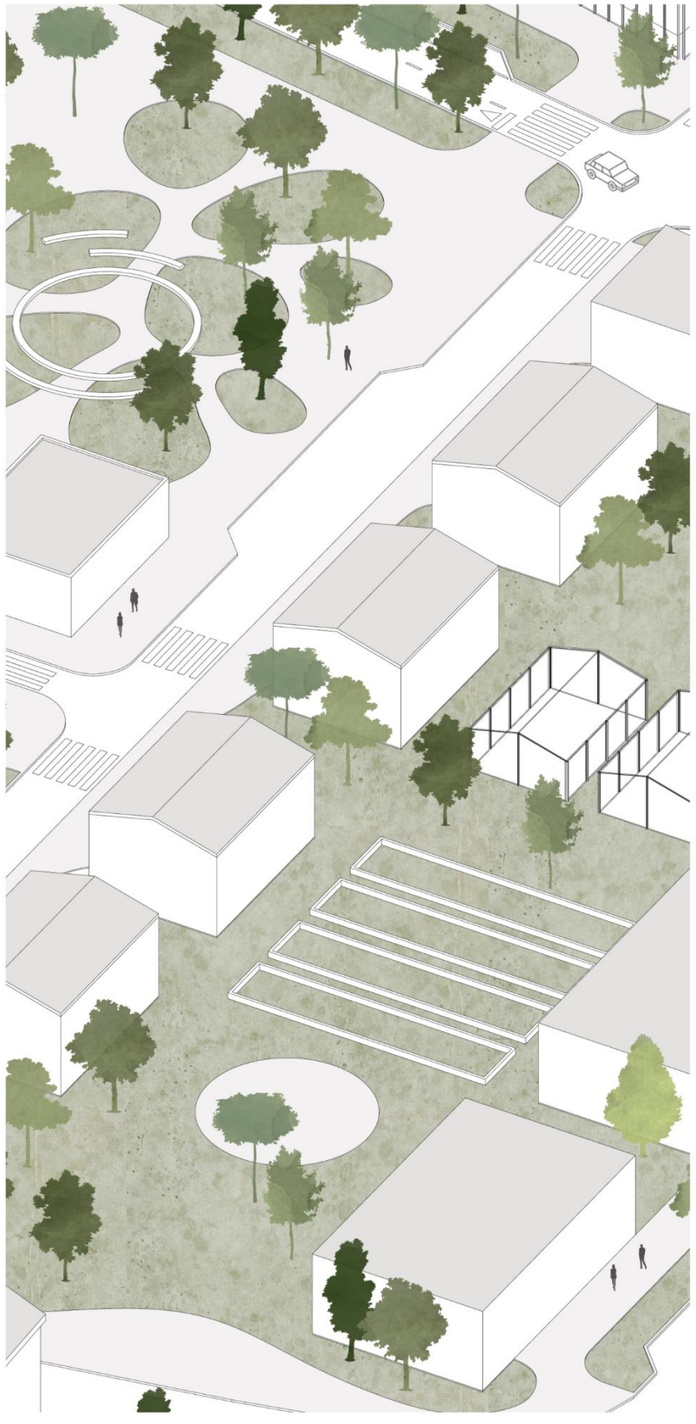
INTERVENTION SITE ILLUSTRATION


1:10000

LINEAR PARK AND CAMPUS AREA



PUBLIC SQUARE



RESIDENTIAL SEMIPRIVATE SPACE

# Conclusions

In this master's thesis, the overarching key concept is integration in the exploration of how new energy systems and contingent industrial development could be utilized for the revitalization of industrial settlements in decay. The analytical work and design project are based on the example of Kunda, a shrinking industrial town and candidate site for the first SMR in Estonia. The themes then concern various fronts related to urban planning; decay and shrinkage, energy and urbanism, reindustrialization, land use and ecosystems, revitalization.

Based on the literature and relevant policy, the efforts towards revitalization of shrinking cities need to shift from a growth-oriented strategy to a high quality and retention-oriented one. An argument is to be made that high quality urban space is that which exists as a well-functioning urban ecosystem, for which sustainability and a degree of self-sufficiency are paramount. The conclusion from this point of view is therefore that energy infrastructure and reindustrialization must be part of the cityscape. The challenge with the industrial towns in question then becomes planning in a way that accounts for shrinkage and revitalization while integrating industry into its urban environment.

As a result, a framework that integrates industrial development with the city – new industrial urbanism – needs to be synthesized with a site-specific analysis in order to create a set of strategies and tools to guide a project proposal. Although these settlements face similar issues in terms of spatial and social problems, the scale, location, local heritage and built environment play a major role in the realization of any intervention. However, a general understanding can be drawn from the overlapping strategies in new industrial urbanism and general revitalization responses and planning for shrinkage. This is what integration, as a key concept, summarizes. Integration requires diversification. Collaboration. Sustainability. Intensification. Densification. Identity.

Although any project proposal must be tied to its location to accurately respond to site-specific needs, a few attributes of an integrated industrial urban space for revitalizing shrinking towns can probably be applied more broadly. For instance, orienting development towards human scale and densification hints that low-rise high density environments are favorable for application in these cases. Hybrid programs and flexibility in zoning and typologies are also an integral part of planning a well interconnected neighborhood or city. This also furthers the intention of rightsizing depopulating settlements, ceding unnecessary sprawl to the conservation or reclamation of rural and natural landscapes.

A project solution in Kunda is directly tied to its unique formation, with a riverside factory that expanded westward, and a soviet time residential arc which formed following local topography, further to the west, spreading the town and separating the industrial area from the rest of the settlement, also resulting in a shift from the original city center, leaving much of its infrastructure and space abandoned. This results in a perfect opportunity to focus on the central area of Kunda, intervening by creating an integratory quarter which forms a transition, connection and relationship between the distinct fragments of functions, both bridging their relationship while also encouraging densification and pulling in the extents of Kunda's urban structure. The projected intervention does not just formally amend the scattered urban fabric of the town, but it also works as the area of intensification by a diverse hybrid program, introducing manufacture, modern industry and academic functions as well as essential amenities and additional services which promote self-sufficiency and local employment.

All of this could be made possible with the construction of an SMR, which would already radically change the population's demographic by employing 200 highly skilled workers and experts, creating an opportunity for additional sustainable industrial development in the vicinity of clean, affordable and reliable energy and residual heat. Although such investments will ultimately be up to political and economic decisions, the availability of this energy source in concordance with strategic branding and collaboration with R&D could set a standard for future sustainable decentralized urbanities. While the project proposal features an intervention at a proportionally large scale for Kunda's context, the sight is set at decades long development, as even the possibility of an operational NPP is 10-15 years away. The purpose is directed towards showing that this kind of intervention should evolve inward, and even at the small scale of this settlement, its spatial conditions can appropriately supply the need for local production and proper city-industry integration.

To conclude, the way in which we conceptualize urban life in the practice and study of urban planning will be predicated upon progress in either a centralized direction towards large complex populous cities at the cost of shrinking towns or clustering of smaller independent collaborative ecosystems, which energy infrastructure and industry will be an essential part of.

# REFERENCES


[1] Eurostat, "Simplified Energy Balances," NRG_BAL_S dataset, last data update 14.04.2020.

[2] European Commission, "Liquefied natural gas," Available: https://energy.ec.europa.eu/topics/oil-gas-and-coal/liquefied-natural-gas_en, Accessed: 28.10.2022 [Online].

[3] United Nations Environment Programme, "Emissions Gap Report 2022: The Closing Window — Climate crisis calls," UNEP, Nairobi, kenya, 2022.

[4] U.S. Energy Information Administration, "International Energy Outlook 2021 Narrative," EIA, Washington D.C., U.S.A., 2021.

[5] European Commission, "The European Green Deal," EC, Brussels, Belgium, COM(2019) 640, 2019.

[6] International Energy Agency, "Global Energy Review: CO2 Emissions in 2021," IEA, 2021.

[7] International Energy Agency, "Electricity Market Report – July 2021," IEA, 2021.

[8] Stuvøy, K., & Shirobokova, I, "Multiscalar entanglements in the post-socialist city: monotown restructuring, spatial re-ordering and urban inequality in Russia," Eurasian Geography and Economics, vol 63(5), pp 625-652, 2022.

[9] Lloyd, C., Roulstone, A., & Middleton, C., "The impact of modularisation strategies on small modular reactor cost," Proceedings of the 2018 International Congress on Advances in Nuclear Power Plants, ICAPP 2018, 1042-1049, 2018.

[10] Statistikaamet, "Eesti elektritootmine liigub keskkonnasõbralikus suunas," Available: https://www.stat.ee/et/uudised/eesti-elektritootmine-liigub-keskkonnasobralikus-suunas, Accessed: 02.02.2023 [Online].

[11] Eesti Energia, "Eesti Energia aastaaruanne 2022," Available: https://www.energia.ee/-/doc/8644186/ettevottest/aastaaruanne/pdf/EE-aastaaruanne-2022-EST.pdf, Accessed: 29.03.2023 [Online].

[12] Viru-Nigula Vallavalitsus, "Viru-Nigula valla arengukava 2019–2026," Available: https://www.riigiteataja.ee/aktilisa/4081/2202/0041/VM_26112020_nr_86_Lisa.pdf, Accessed: 12.03.2023 [Online].

[13] Fernandez Agueda, B., "Urban Planning in Industrial Cities: The Reversibility of Decay. In: "City Futures in a Globalising World. An international conference on globalism and urban change"," Madrid, 2009.

[14] Crawford, C. E. , "Monotown: urban dreams brutal imperatives," Journal of Urban Design, vol 26(1), pp 133-135, 2021.

[15] Grigoryev, L., & Medzhidova, D., "Energy transition in the Baltic Sea region: A controversial role of LNG?," he Future of Energy Consumption, Security and Natural Gas: LNG in the Baltic Sea region, pp 61-91, 2022.

[16] European Commission, "REPowerEU actions," Available: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en, Accessed: 26.04.2023 [Online].

[17] National Renewable Energy Laboratory, "Electrification Futures Study: Operational Analysis of U.S. Power Systems with Increased Electrification and Demand-Side Flexibility," NREL/TP-6A20-79094, 2021.

[18] Resources for the Future, "Electrificaiton 101," Available: https://www.rff.org/publications/explainers/electrification-101/, Accessed: 10.01.2023 [Online].

[19] Ernst & Young Global Limited, "The role of carbon neutral LNG in the energy transition," Available: https://www.ey.com/en_pl/law/the-role-of-carbon-neutral-lng-in-the-energy-transition, Accessed: 20.12.2022 [Online].

[20] International Energy Agency, "World Energy Outlook 2022," IEA, 2022.

[21] United Nations Economic Commission for Europe, "Wood energy on the rise in Europe," Available: https://unece.org/climate-change/press/wood-energy-rise-europe, Accessed: 09.12.2022 [Online].

[22] Csereklyei, Z., Rubio-Varas, M. D. M., & Stern, D. I., "Energy and economic growth: the stylized facts. The Energy Journal, 37(2).," The Energy Journal, vol 37(2), pp 223-255, 2016.

[23] BP, "bp Statistical Review of World Energy 2022," Available: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf, Accessed: 27.12.2022 [Online].

[24] European Commission, " The Future of Cities – Opportunities, challenges and the way forward," EUR 29752 EN, Publications Office, JRC116711, Luxembourg, 2019.

[25] Sun, Y., Jadun, P., Nelson, B., Muratori, M., Murphy, C., Logan, J., Mai, T., "Electrification Futures Study: Methodological Approaches for Assessing Long-Term Power System Impacts of End-Use Electrification," Golden, CO: NREL, NAU. NREL/TP-6A20-73336, 2020.

[26] Gross, S., "The challenge of decarbonizing heavy industry.," Foreign Policy, The Brookings Institution, 2021.

[27] World Nuclear Association, "Nuclear Process Heat for Industry," Available: https://world-nuclear.org/information-library/non-power-nuclear-applications/industry/nuclear-process-heat-for-industry.aspx, Accessed: 07.02.2023 [Online].

[28] Smil, V., "Energy and Civilization : A History," MIT, Cambridge, MA, 2017.

[29] Leick, G., "Mesopotamia: The invention of the city.," Penguin UK, 2002.

[30] Stremke, S., & van den Dobbelsteen, A. (Eds.), "Sustainable energy landscapes: designing, planning, and development", CRC Press, 2012.

[31] Bakirtas, T., & Akpolat, A. G., "The relationship between energy consumption, urbanization, and economic growth in new emerging-market countries," Energy, vol 147, pp 110-121, 2018.

[32] Rashad, S. M., & Hammad, F. H., "Nuclear power and the environment: comparative assessment of environmental and health impacts of electricity-generating systems," Applied Energy, vol 65(1-4), pp 211-229, 2000.

[33] Zhang, Y., "Urban metabolism: A review of research methodologies," Environmental Pollution, vol 178, pp 463-473, 2013.

[34] Kennedy, C., Pincetl, S., & Bunje, P., "The study of urban metabolism and its applications to urban planning and design.," Environmental pollution, vol 159(8-9), pp 1965-1973, UEP2010, Boston, USA, 2011.

[35] Decker, H., Elliott, S., Smith, F.A., Blake, D.R., Sherwood Rowland, F., "Energy and Material Flow Through the Urban Ecosystem," Annual Review of Energy and the Environment, vol. 25, pp 685-740, 2000.

[36] Lucertini, G., & Musco, F., "Circular urban metabolism framework.," One Earth 2.2, pp 138-142., Venice,, 2020.

[37] Oswald, F., Baccini, P., & Michaeli, M. , "Netzstadt - Designing the Urban," Birkhäuser (Springer Science & Business Media), Basel, 2003.

[38] Stern, D.I., "The Role of Energy in Economic Growth, CCEP working paper 3.10," Centre for Climate Economics & Policy, Crawford School of Economics and Government, ANU, Canberra, 2010.

[39] Stern, D. I. , "Energy and economic growth in the USA: a multivariate approach.," Energy economics, vol 15(2), pp 137-150, 1993.

[40] Tregenna, F., "Deindustrialization and Reindustrialization. In: Pathways to Industrialization in the Twenty-First Century: New Challenges," Oxford University Press, 2013.

[41] Saki, Z., "Disruptive Innovations in Manufacturing - An Alternative for Re-Shoring Strategy," Journal of Textile and Apparel, Technology and Management, vol 10(2), 2016.

[42] Capello, R., Cerisola, S., "Regional reindustrialization patterns and productivity growth in Europe," Regional Studies, vol 57(1), pp 1-12, 2023.

[43] Pisano, G. P., Shih, W. C., "Producing Prosperity: Why America Needs a Manufacturing Renaissance," Harvard Business Press, Boston, MA, 2012.

[44] Hatuka, T., Ben-Joseph, E., Peterson, S. M., "Facing Forward: Trends and Challenges in the Development of Industry in Cities," Built environment, vol 43(1), pp 145-155, 2017.

[45] Westkämper, E., "Visions of Future Manufacturing in Europe. In: Towards the Re-Industrialization of Europe," Springer, 2014.

[46] European Economic and Social Committee, "Reshoring of EU industries in the framework of reindustrialisation," Available: https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/reshoring-eu-industries-framework-reindustrialisation, Accessed: 18.03.2023 [Online].

[47] European Commission, "European industrial strategy," Available: https://single-market-economy.ec.europa.eu/industry/strategy_en, Accessed: 20.03.2023 [Online].

[48] Westkämper, E., "Global "Megatrend's" Grand Societal Challenges. In: Towards the Re-Industrialization of Europe," Springer, 2014.

[49] Orzes, G., & Sarkis, J., "Reshoring and environmental sustainability: An unexplored relationship?," Resources, Conservation and Recycling, VOL 141, pp 481-482, 2019.

[50] Ashby, A., "From global to local: reshoring for sustainability.," Operations Management Research, vol 9, pp 75-88, 2016.

[51] Choudhary, N. A., Ramkumar, M., Schoenherr, T., Rana, N. P., & Dwivedi, Y. K., "Does Reshoring Affect the Resilience and Sustainability of Supply Chain Networks? The Cases of Apple and Jaguar Land Rover," British Journal of Management, 2022.

[52] Cosimato, S., & Vona, R., "Digital innovation for the sustainability of reshoring strategies: A literature review.," Sustainability, vol 13(14), pp 7601, 2021.

[53] Hatuka, T., "Industrial urbanism: Exploring the city-production dynamic.," Built Environment (1978-), vol 43(1), pp 5-9, 2017.

[54] Shertzer, A., Twinam, T., & Walsh, R. P., "Zoning and the economic geography of cities," Journal of Urban Economics, vol 105, pp 20-39, 2018.

[55] Hatuka, T., Ben-Joseph, E., "New Industrial Urbanism: Designing Places for Production.," Routledge, New York, NY, 2022.

[56] Hatuka, T., & Ben-Joseph, E., "Industrial urbanism: Typologies, concepts and prospects.," Built Environment, vol 43(1), pp 10-24, 2017.

[57] Tintěra, J., "Urban Regeneration Strategies for Shrinking Post-Soviet European Communities: A Case Study of Valga, Estonia," Tallinn University of Technology, Doctoral thesis, 2019.

[58] Caterino, B., "Deindustrialization, the Welfare State and Urban Decay. In: The Failure of the Neo-Liberal Approach to Poverty: The Rochester Monroe Anti-Poverty Initiative," Cham: Springer International Publishing, 2022.

[59] Russo, J., & Linkon, S. L., "The social costs of deindustrialization," Manufacturing a better future for America, pp 183-216, 2009.

[60] Hatuka, T., Ben-Joseph, E., "Prototypes," Available: https://www.industrialurbanism.com/prototypes, Accessed: 03.02.2023 [Online].

[61] Martinez-Fernandez, C., Audirac, I., Fol, S., & Cunningham-Sabot, E., "Shrinking cities: Urban challenges of globalization.," International journal of urban and regional research, vol 36(2), pp 213-225, 2012.

[62] Kroll, F., Haase, D., "Does demographic change affect land use patterns? A case study from Germany," Land use policy, vol 27(3), pp 726-737, 2010.

[63] Aurambout, J.P., Schiavina, M., Melchiori, M., Fioretti, C., Guzzo, F., Vandecasteele, I., Proietti, P., Kavalov, B., Panella, F. and Koukoufikis, G., "Shrinking Cities," European Commission, JRC126011, 2021.

[64] Ramlee, M., Omar, D., Yunus, R. M., & Samadi, Z. , "Revitalization of urban public spaces: An overview.," Procedia-Social and Behavioral Sciences, vol 201, pp 360-367, 2015.

[65] Baccini, P., & Oswald, F. , Designing the urban: Linking physiology and morphology., Handbook of transdisciplinary research, pp 79-88, 2008.

[66] Atelier FCJZ, "Jiading Mini-Block," Available: https://www.fcjz.com/archive/p/5e143ba89a88e3001f4a0bd5, Accessed: 22.04.2023 [Online].

[67] ADEPT, "Bremerhaven Werftquartier," Available: https://adept.dk/project/bremerhaven, Accessed: 16.04.2023 [Online].

[68] Karren en Brands, "The Open City," Available: https://www.karresenbrands.com/en/project/the-open-city, Accessed: 20.04.2023 [Online].

[69] Statistikaamet, "RV0240: RAHVASTIK 2017. AASTA HALDUSREFORMI JÄRGSELT, 1. JAANUAR | Sugu, Elukoht, Aasta ning Vanus," Available: https://andmed.stat.ee/et/stat/rahvastik__rahvastikunaitajad-ja-koosseis__rahvaarv-ja-rahvastiku-koosseis/RV0240, Accessed: 15.04.2023 [Online].

[70] Estonian Tax and Customs Board, "Ettevõtluse statistika 2023," MTA, 2023.

[71] Kunda sadam, "Kunda sadamast," Available: https://www.kundasadam.ee/, Accessed: 15.03.2023 [Online].

[72] Kunda Nordic Cement, "Esimene tehas," Available: https://www.knc.ee/et/esimenetehas, Accessed: 12.02.2023 [Online].

[73] Kunda Nordic Cement, "History," Available: https://www.knc.ee/en/history-0, Accessed: 10.02.2023 [Online].

[74] "Ordeniga "Austuse märk" tsementitehas "Punane Kunda" 1871-1971 : [ülevaade]," Valgus, Tallinn, 1971.

[75] Rakvere Koduloomuuseum, Koostaja: Karma, O., "Punane Kunda 1870: [ajaloost ja tänapäevast]," Eesti NSV Teaduste Akadeemia Ajaloo Instituut, Eesti Raamat, Tallinn, 1968.

[76] Veski, K., "Kunda hariduselu algus," Available: https://www.kundakool.ee/kunda-koolist/uldkontakt/asukoht/22-ajalugu, Accessed: 17.03.2023 [Online].

[77] Rahvusarhiiv (National Archive), "ERA.T-14.4-6.33834, Seletuskiri ja graafiline materjal," 1993.

[78] Statistikaamet, "Rahvastik rajoonides ja linnades, 1989," Available: https://www.stat.ee/et/rahvastik-rajoonides-ja-linnades-1989, Accessed: 25.04.2023 [Online].

[79] Statistikaamet, "Eesti maakondade rahvastik. Hinnatud ja loendatud.," Ofset OÜ, Tallinn, 2015.

[80] Majandus-ja Kommunikatsiooniministeerium, "Üleriigiline uuring elamute kasutusest väljalangevusest ja tühjenemise mustritest," Available: https://eehitus.ee/timeline-post/elamute-tyhjenemise-uuring/, Accessed: 18.02.2023 [Online].

[81] Skepast&Puhkim OÜ, "Viru-Nigula valla üldplaneeringu keskkonnamõju strateegiline hindamine (KSH)," 2022.

[82] Cumulus Consulting, "Väikeste moodulreaktoritega tuumajaama asukohtade alternatiivide sotsiaalmajandusliku mõju analüüs," Fermi Energia, 2021.

[83] Fermi Energia, "Vesiniku, ammoniaagi ja sünteetiliste kütuste tootmine tuumaenergia abil," Available: https://fermi.ee/wp-content/uploads/2021/03/h2-raport-fermi-energiale-pdf.pdf, 2020.

[84] Skepast&Puhkim OÜ, "Viru-Nigula Valla Üldplaneering," Viru-Nigula Vallavalitsus, 2022.

[85] World Nuclear News, "US regulator approves methodology for SMR emergency planning," Available: https://www.world-nuclear-news.org/Articles/US-regulator-approves-methodology-for-SMR-emergenc, Accessed: 12.01.2023 [Online].

[86] Tractebel, Steiger OÜ, "Väikse Moodulreaktori Asukoha Eeluuring," 2020.

[87] Rahvusarhiiv (National Archive), "ERA.T-14.4-6.8688, Väljavõte Kunda linna generaalplaanist," 1961.

[88] Rahvusarhiiv (National Archive), "ERA.T-14.4-6.896, Kunda linna genplaani eskiis ja korrektuur," 1982.

# LIST OF FIGURES

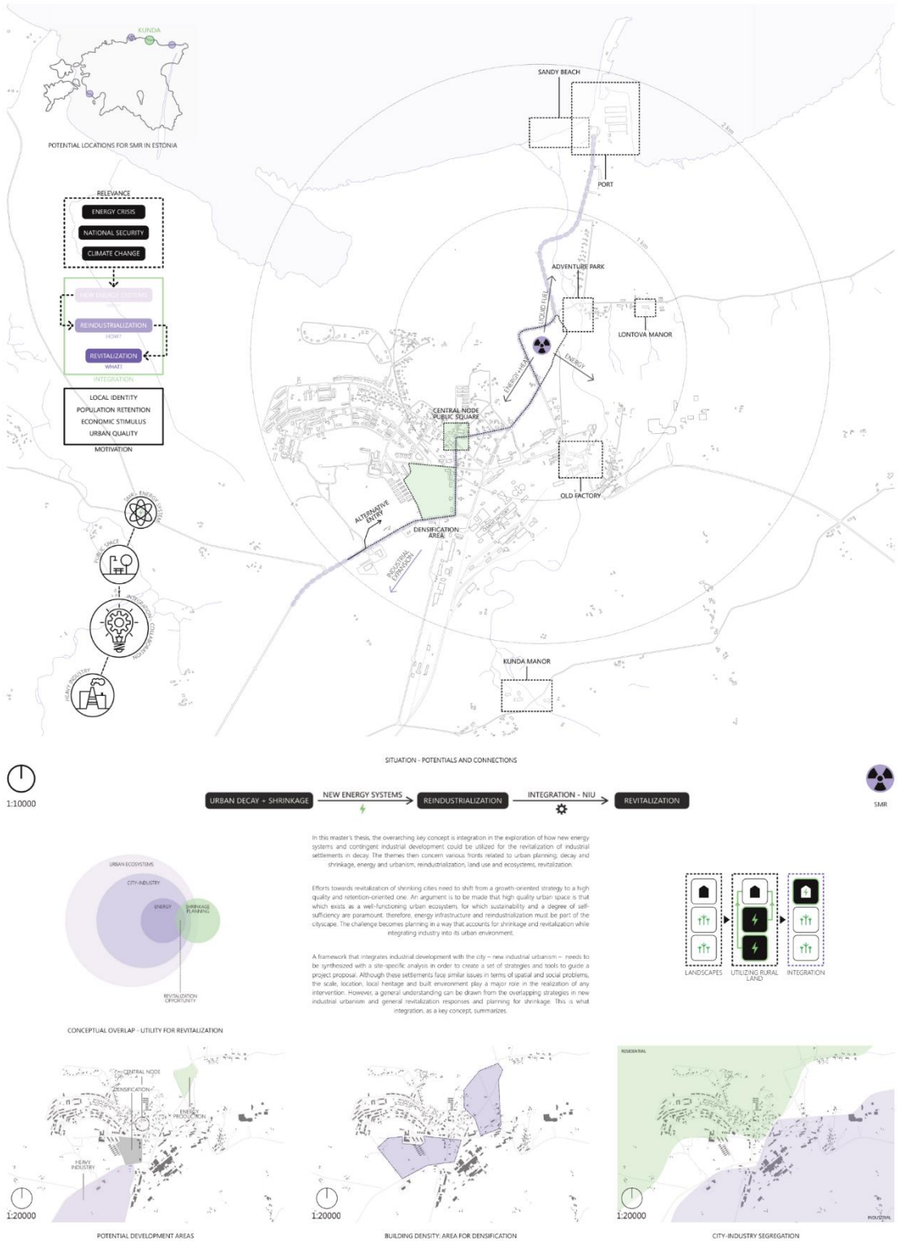
# LIST OF APPENDICES


REINDUSTRIALIZED POST-SMR KUNDA

**URBAN REVITALIZATION:** INTEGRATING INDUSTRIAL DEVELOPMENT DRIVEN BY NEW ENERGY SYSTEMS WITH INDUSTRIAL SETTLEMENTS

JUULIA ALIIDE SALULAID
2023

SUPERVISORS: IVAN GAVRILOV, SIIM SULTSON




**THEORETICAL FRAMEWORK AND ANALYSIS:** PLANNING STRATEGIES AND INTEGRATION

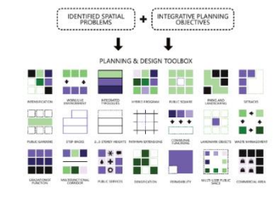
JUULIA ALIIDE SALULAID
2023

SUPERVISORS: IVAN GAVRILOV, SIIM SULTSON


FOCUS AREA INTERVENTION SITE PLAN

1:1000

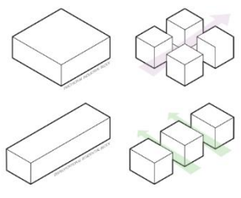
EXISTING NEW



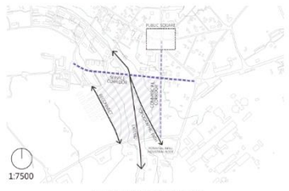

SYNTHESIS OF THEORY AND ANALYSIS

This site has been selected with several considerations pertaining to both the current structure of Kunda and the objective of city-industry integration. The lot is conveniently located in close proximity to the cement factory and the areas projected to be developed for industrial use in the southern region, as per current development plans, serving as a buffer zone between heavier industrial activity and the residential functions which have developed westward. Observing the structure of the city, this area is located at a central joint that functionally could serve to connect and integrate, as well as to fulfill the purpose of densification and intensification of the city centre, avoiding further sprawl.

The proposed development offers residential, business and mixed-use accommodation geared towards economic activity integrated with the industrial nature of the city. A variety of spaces for light industry and manufacturing along with workshops, educational laboratories and offices provide a transition from heavy industry while avoiding sprawl and function segregation. The goal is to create a diverse and high-quality neighborhood that retains the industrial backbone of Kunda's local economy with added value from the densification and modernization of its infrastructure and access to public services, while providing an enjoyable environment to retain local population from emigrating and attract a varied new workforce. As Kunda is defined by its industry, the purpose is to maintain industrial development as the main economic driver of its population in the long term, using integration strategies for an attractive and revitalized city.



SCALAR MODIFICATIONS - CIRCULATION




1:7500

CREATING CONNECTIONS - PATHWAYS

1:5000

INTENSIFICATION - WORK/LIVE ENVIRONMENT

1:5000

GRADATION OF FUNCTIONS - HYBRIDITY

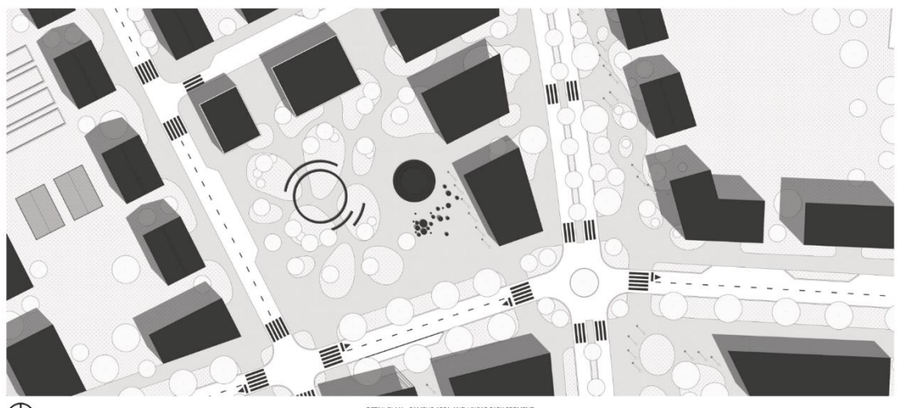
R&D - LOCAL MANUFACTURE - OFFICE → PUBLIC SERVICE - COMMERCE - RESIDENCE

## FOCUS AREA - INTEGRATIVE HYBRID QUARTER

JULIA ALIIDE SALULAID
2023

SUPERVISORS: IVAN GAVRILOV, SIIM SULTSON

ISOMETRIC VIEW INTO FOCUS AREA INTERVENTION



DETAIL PLAN - CAMPUS AREA AND LINEAR PARK SEGMENT

1:400

## SITE VIEWS - PUBLIC SPACE AND BUILT ENVIRONMENT EXCERPT

JULIA ALIIDE SALULAID
2023

SUPERVISORS: IVAN GAVRILOV, SIIM SULTSON

LINEAR PARK - GREEN NETWORK CONNECTIONS

1:5000

F1 - VIEW INTO THE LINEAR PARK AND CAMPUS AREA

F2 - VIEW INTO THE PUBLIC SQUARE

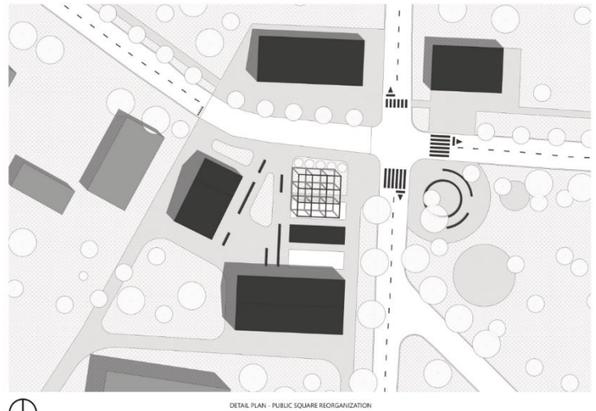
F3 - VIEW INTO THE RESIDENTIAL SEMIPRIVATE SPACE

GREEN NETWORKS - LINEAR CONNECTION - PLACE MAKING

JULIA ALIIDE SALULAID
2023

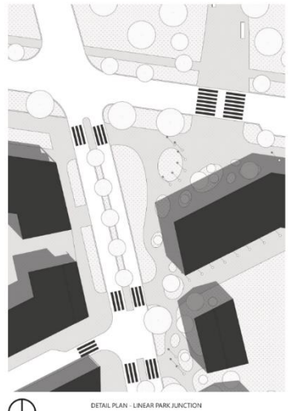
SUPERVISORS: IVAN GAVRILOV, SIIM SULTSON

VIEW INTO FULL SITE INTERVENTION



DETAIL PLAN - PUBLIC SQUARE REORGANIZATION

1:400



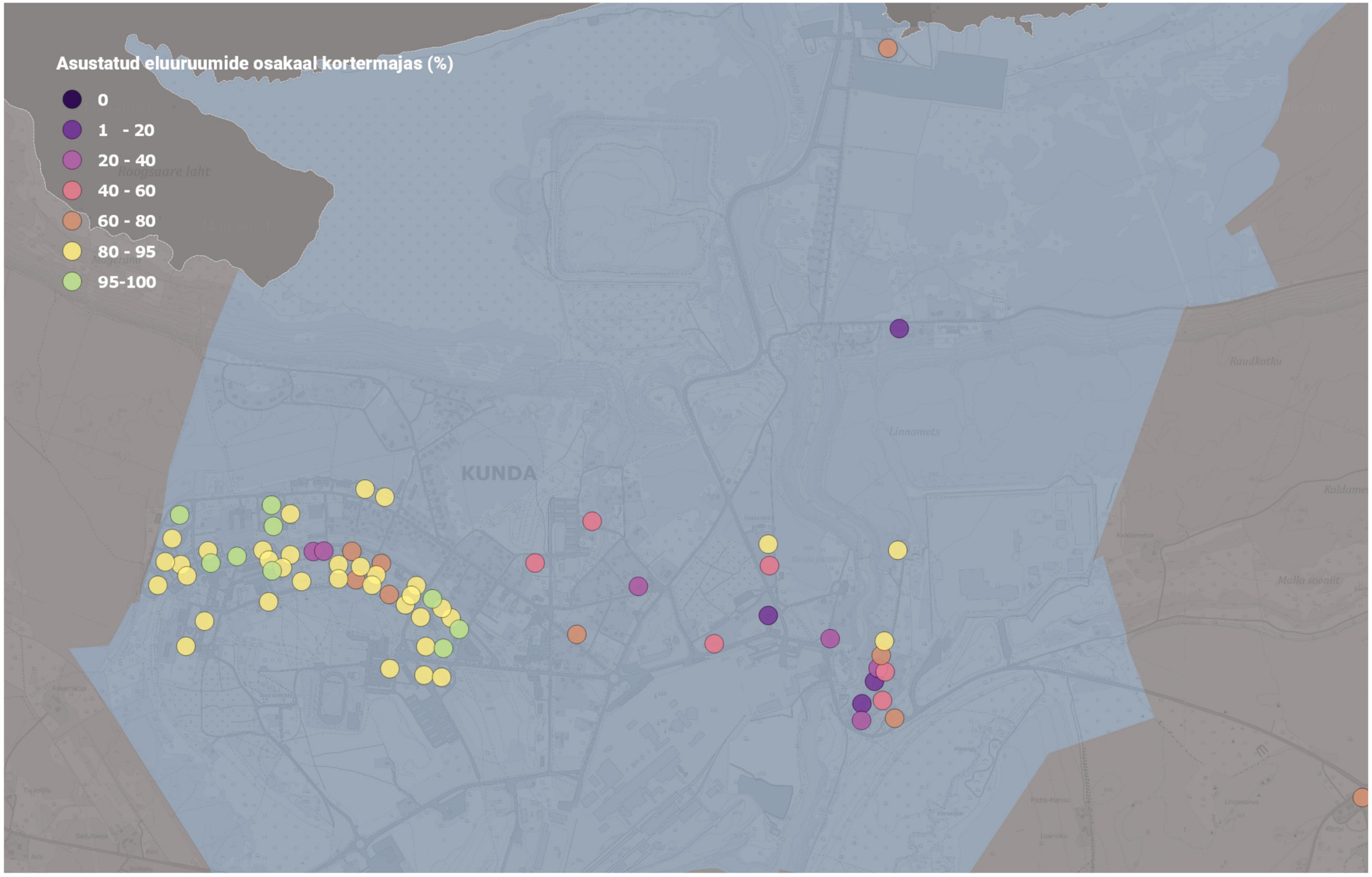
DETAIL PLAN - LINEAR PARK JUNCTION

1:400

SITE VIEWS - PUBLIC SPACE AND FITTING INTO THE CONTEXT

JULIA ALIIDE SALULAID
2023

SUPERVISORS: IVAN GAVRILOV, SIIM SULTSON




Map source: MKM, "Üleriigiline uuring elamute kasutusest väljalangevusest ja tühjenemise mustritest", 2022.

Inhabitance rate of apartment buildings in Kunda. Unscaled.