RETHINKING STEELSCAPES

A cross systematic Urban Design approach towards a Sustainable Circular Society for the Metropolitan Region of Linz | AT

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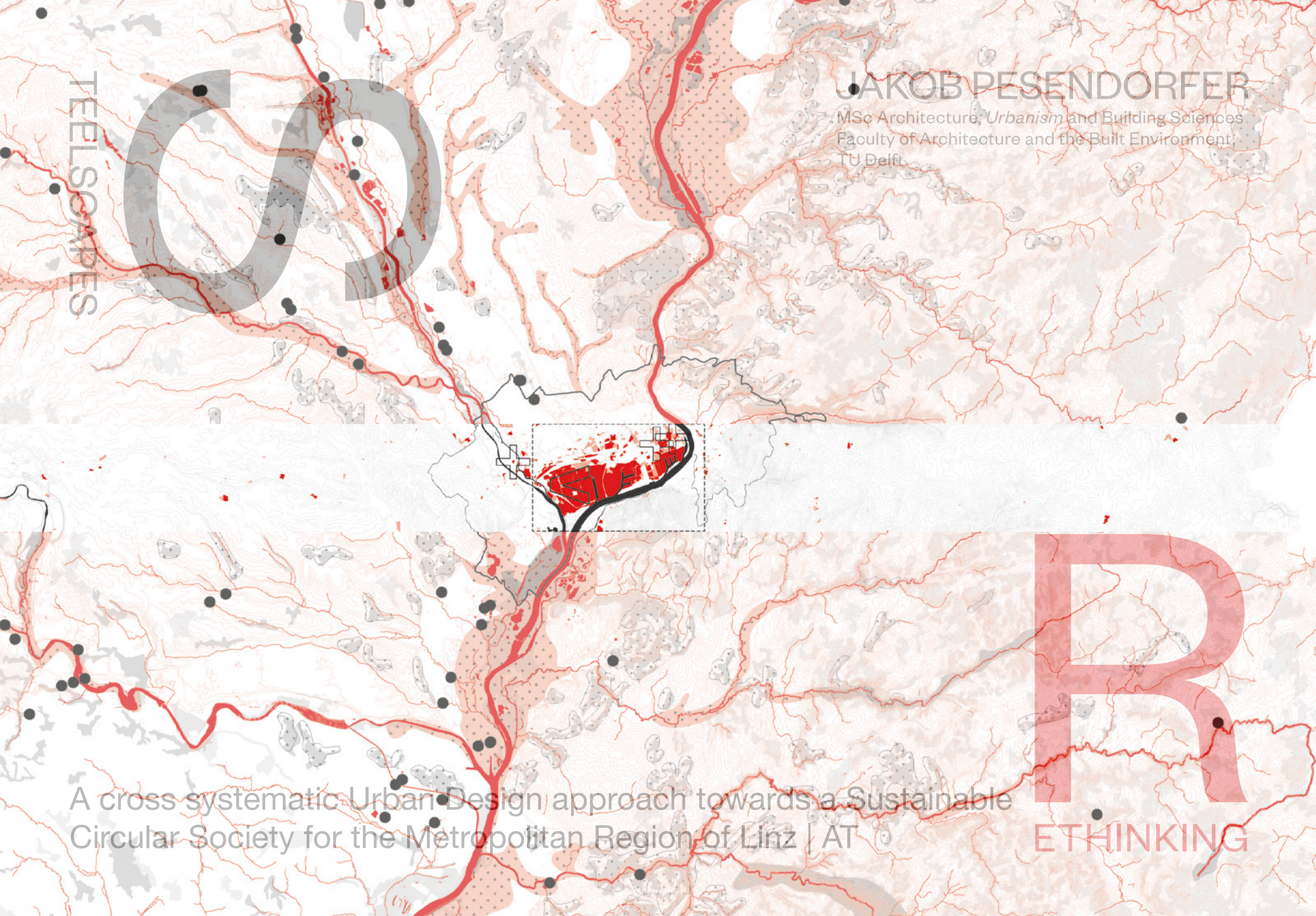

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URBAN DESIGN
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ABSTRACT

The steel industry is a crucial economic sector and a major contributor to the climate crisis. In Linz, located in the Austrian province of Upper Austria, the steel factory of Voestalpine plays a key role in the national, regional, and local economy while being the country's largest single CO_2 emitter. As the company aims to transition to greener production methods by 2050, aligning with the European Green Deal ambitions, this transformation presents future challenges and opportunities for urban and regional development of the Metropolitan Region.

Current research on Circular Economy principles in the steel industry often prioritises technological aspects such as material flows while overlooking societal dynamics and their spatial implications. In Austria, urban sprawl and fragmented development have historically been linked to growth-driven planning models, as seen in the Metropolitan Region of Linz. In the region, peri-urban areas serve multiple functions, including housing, agriculture, and industrial production. These territories face significant pressures such as environmental degradation, land scarcity, and traffic congestion.

This research addresses the gap in Circularity theories by examining how industrial transformations in the steel sector can act as catalysts for shifts towards a Circular Society. It explores the spatial and programmatic organisation of urban and peri-urban areas, emphasising alternative, interdisciplinary planning strategies that integrate economic, environmental, and social needs. By analysing past urban development patterns and projecting future potentials, the research proposes regenerative spatial strategies and urban design methods that promote sustainability and resilience in the Linz Metropolitan Region.

Through a research and design approach, this thesis critically challenges conventional planning paradigms by testing radical alternatives to existing urban and regional development practices. The findings aim to provide professional-level insights and actionable strategies for policymakers, urban planners, and industry stakeholders, fostering a transition towards a more sustainable and inclusive urban future.

TABLE OF CONTENT

ABBREVIATIONS

CE	Circular Economy
CS	Circular Society
UM	Urban Metabolism
UD	Urban Design
SC	Steelscapes
SM	Steelscape Metabolism
SI	Steel Industry
SP	Spatial Planning
EAF	Electric Arc Furnance
DRI	Direct Reduction Iron
BF	Blast Furnance
BOF	Basic Oxygene Furnance
B2B	Business to Business

GLA Greater Linz Area

There is no clear adminsitrative entity of the Metropolitan Region of Linz, compared to e.g. the Amsterdam Metropolitan Area (AMA). GLA defines the "Zentralraum Oberösterreich / Central Area Upper Austria) with it's Cities and Agglomerations of Linz, Wels, Steyer. Also extended mid-sized Cities and Places with spatial and functional connections to the City of Linz are included. More about in Chapter 3 Analysis.

Chapter 1

cont

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1.1 MOTIVATION

American Scholar John M. Culkin once said, “We shape our tools, and thereafter our tools shape us” (Culkin, 1967 as cited in Hurme & Jouhki, 2017). In my view, this reflects how our society has evolved, and role human inventions played in this evolution. Breakthroughs in industrialisation, such as the steam engine, the automobile, and the moon landing, were driven by visionary thinkers to push innovations until today. Yet, many of these developments also brought us to the environmental crisis we face today. Geopolitical tensions, economic shifts, and the exploitation of raw materials from historically disadvantaged areas by wealthy continents like Europe have all contributed to this turning point in history today. These industrial advancements have significantly led to the environmental catastrophe by increasing carbon emissions, a phenomenon humans have known since the 1950s.

Thinking of tomorrow, there are multiple questions ahead, like where Europe will get necessary materials in the future in case the United States, Russia, and China are not dependent anymore on European products and knowledge. Can a European Country like Austria be even economically competitive in a “green market”, if a possible coalition between the populist far-right Party FPÖ and the conservative party ÖVP erases the already by the previous government's planned funding for industrial transformation? And overall, is it ethically acceptable to continue burning fossil fuels in Europe like in the earlier decades? Or is there a need for taking responsibility in the discussion, especially considering the historical emissions Europe produced and the impact on disadvantaged and exploited countries which has societal effects until today? These questions make not only people like managers, politicians, or activists think but also ordinary people in their daily lives, which can be seen in a concerning, antidemocratic political development all over the world.

Born in one of the wealthiest nations in the world, I acknowledge my privilege to discuss these issues in a simplified way and from a Western perspective. As a future Urban Designer, I know I cannot solve all the world’s complex problems. My goal is more to play a small part in the game of pushing for change, fostering critical thinking, and offering alternatives to the current developments in Urban Design (UD) and planning. This is why I chose for my graduation the “Metropolitan Ecologies of Places” studio: to critically identify future challenges in the world and, where possible, tackle those issues through our profession for livable and healthy environments.

Although this may sound like a typical urbanist’s statement, but it is the daily driving force behind my motivation to contribute to the discourse in both academia and practice for liveable, democratic, and inclusive environments. It may seem idealistic, but, returning to Culkin's words, the tools we've created in the past, and the ones we create now will continue to shape us in the future and even beyond impacting generations over generations.

Yet, we still have the chance to modify and rethink them for the benefit of humanity.

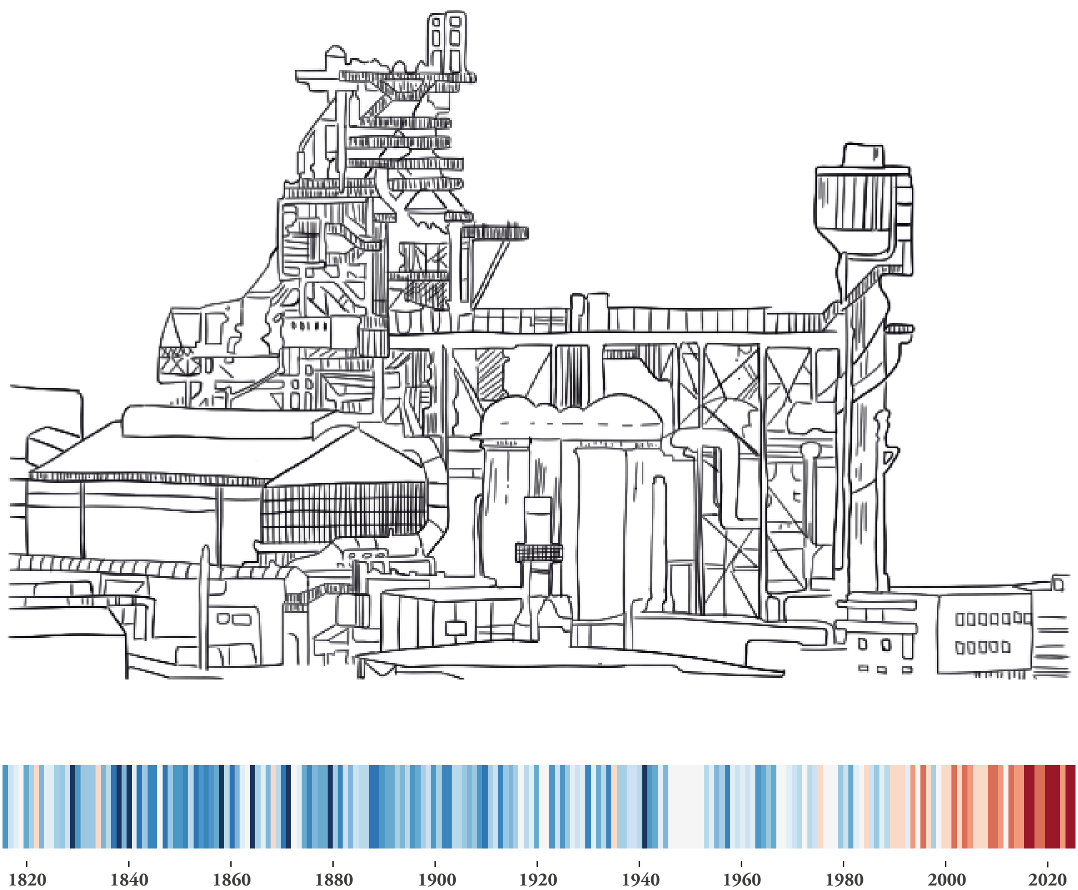


Figure 01 *Basic Oxygen furnance.* Global adapted technology developed in Linz in 1952–1953 by the Austrian steelmaking company VOEST and ÖAMG. Also called LD converter, named after the Austrian towns Linz and Donawitz next to the *Warming stripes of Linz (Brock & Elzinga, 1991; Smil, 2006)*

1.2 RELEVANCE

Societal Relevance

The roots of this project grew from its potential to address pressing challenges that affect not only the environment but also the community and urban development in the Greater Linz Area (GLA). This aligns with urgent global goals to fight climate change and meet net-zero targets, beyond only looking at the steel production sector. Furthermore, there is a recent economic disruption in the automotive sector due to geopolitical developments and national political decisions, which may have effects on the manufacturing-intensive region. In addressing the current efforts of the transition of the Steel Industry (SI) towards a green economy, several ethical considerations arise.

A key concern is inequality at the human level, particularly the potential displacement of workers due to shifts in technology, automation, and green energy adoption. The workforce at the voestalpine steel plant and related industries may face job losses or the need for re-skilling, creating socioeconomic disparities between those who can adapt to new technologies and those left behind. These changes can increase already existing inequalities, especially in a region where the plant and related metal industries are major employers.

Beyond environmental sustainability aiming for circular strategies, this research and design project holds importance for the socio-economic future of the GLA. The SI is a major employer, and by exploring how this transition impacts the workforce, this project aims to ensure that economic changes do not deepen inequality or leave certain groups behind in terms of accessibility and liveability. This work mainly considers, how these shifts affect the urban fabric and spatial organisation of the city and region, using UD strategies to create pathways that integrate sustainable industrial practices without e.g. displacing communities or causing industrial gentrification.

Overall, through this project, I hope to contribute not only to a sustainable future but also to a more inclusive and resilient urban landscape, where economic, social, and environmental goals can coexist and reinforce each other.

Professional Relevance

With the ability to understand complex ideas across different scales, professions, and projects, my aim is to act as a navigator and translator between these interconnected spheres. The goal is to translate complex issues into accessible language to effectively engage decision-makers while ensuring that the voices of weaker players in urban processes are not overlooked.

UD and Urbanism play a crucial role in fostering change, driving innovation, and addressing complex challenges. By combining critical design thinking, scientific evidence, and practical experience, professionals in this field can play a role in guiding projects toward more sustainable solutions.

For example, a tec-company planning to establish a new office in the GLA. Such a development could create jobs, enhance Linz's reputation as an economic and innovative hub, and strengthen its position in global markets. However, greenfield developments and constructing new buildings from scratch would involve significant carbon emissions due to energy-intensive materials like concrete and steel. It would also seal valuable soil, contributing to environmental degradation. Alternatively, a more sustainable approach could involve using existing structures in collaboration with the City of Linz. Many office buildings from the 1970s, 1980s, and 1990s are currently underutilised due to outdated designs and layouts. By working with Architects specialising in retrofitting, these spaces could be transformed to meet modern needs without emitting a high amount of CO2 emissions compared to new construction.

As industrial areas transition to greener operations and adopt Circular Economy (CE) practices, they may attract higher-value land uses or commercial activities, leading to rising property values and the displacement of existing communities or small businesses. As explained in the example above, new businesses may settle on former brownfields within central locations in the region. On the one hand, the development of brownfield areas has a positive effect due to reactivating abandoned land instead of greenfield developments.

However, these transformations also may risks pushing out lower-income residents and reshaping urban areas, rather than fostering inclusive, equitable development. Both inequality and industrial gentrification must be carefully addressed in UD strategies to ensure that sustainability goals do not deepen social and economic divisions but contribute to a just and fair transition for all stakeholders.

In a world full of uncertainties, the main goal is to balance needs, opinions, and interests as effectively as possible, ensuring that development reflects both the values of today and the needs of future generations in the GLA.

Scientific Relevance

This research and design project combines two key theoretical frameworks. The first is a pioneering theory from the 1990s, which lacks consideration of current societal issues, while the second is a contemporary theory that lacks spatial components. A combination of both, from my perspective, creates a more comprehensive, interdisciplinary approach to contemporary UD and planning.

Another central aspect of this thesis is the cutting-edge research currently on the agenda of my second mentor, Arjan van Timmeren, which focuses on the future of former and operational steel factory sites across Europe. These sites, often heavily polluted and located near urban or natural areas, present significant challenges but also unique opportunities for sustainable redevelopment. By addressing economic, environmental, and social considerations, the project aims to explore these industrial hotspots based on Europe's climate and sustainability goals. This thesis may contribute to this broader vision, providing localised insights and exploring innovative strategies for systemic transitions.

While this thesis opens new directions for investigation, it does not have the scope, aim, or even the resources to explore and elaborate all aspects in depth. For example, future research could dive deeper into global supply chains of steel, exploring not only their economic and environmental implications but also their spatial impacts. For example, how they shape the development and transformation of surrounding territories, like settlements or ecologically valuable areas across regions. Further investigations can go into the global dimension exploring the topic in different cultural and political contexts and therefore different planning systems and practices.

1.3 PROBLEM FIELD

This chapter examines the core problem area of the research by addressing three interrelated challenges. It begins by explaining the overarching issue of the climate crisis, followed by analysing current geopolitical dynamics, and concludes with the current processes in spatial planning and design. By addressing these challenges, this chapter aims to identify and contextualise the main problems upon which this research is based.

Climate Crisis. The Umbrella Problem

The world is facing major challenges caused by the climate crisis, disrupting biogeochemical cycles like the carbon cycle (Calisto Friant et al., 2023). "The terrestrial biosphere is a key component of the global carbon cycle and its carbon balance is strongly influenced by climate" (Reichstein et al., 2013, p. 287). A significant driver of climate change is the energy sector, which contributes to 73.2% of global emissions, with 7.2% of these emissions coming from the steel industry, largely because of burning fossil fuels (Ritchie & Roser, 2024). An LCA (Life Cycle Analysis) study conducted by Olmez et al. (2016) revealed that integrated iron and steel products predominantly impact the respiratory inorganics and global warming categories. It is recommended that the steel facilities prioritise these areas during the investment planning stage to mitigate environmental impacts. As part of its broader agenda, the European Green Deal aims to target net-zero greenhouse gas emissions by 2050, with key actions in coordinating industry for a circular and clean economy (Kuci & Fogarassy, 2021). Over the past decades, the concept of "green steel" has emerged, focusing on producing steel with significantly reduced greenhouse gas emissions. This approach not only aims to make steel production more environmentally friendly but also has the potential to lower manufacturing costs and enhance the quality of steel compared to traditional methods (Griffin & Hammond, 2021).

Currently, there is no scientific evidence to suggest that the transition will occur as the SI envisions it, mainly due to interconnected uncertainties, some of which are described in this project.

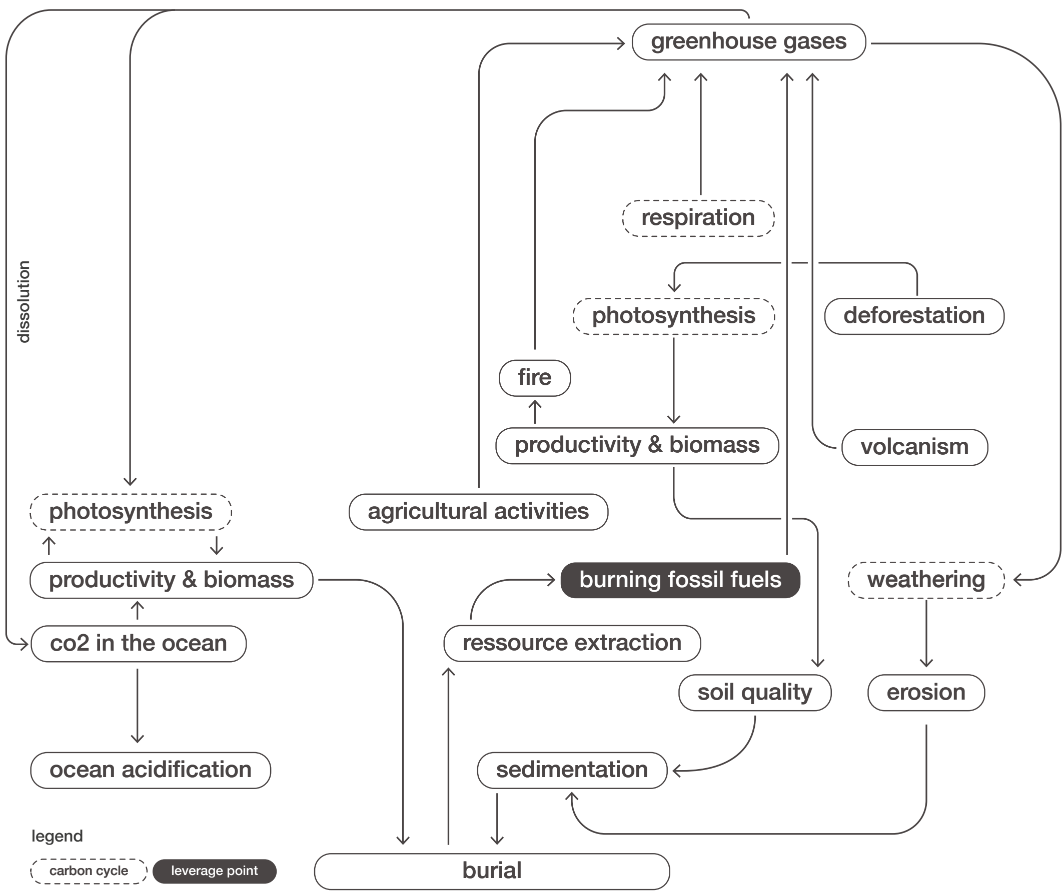


Figure 02: *Carbon Cycle* adapted from the Earth system model about the carbon cycle, University of California Museum of Paleontology.

Geopolitical Dynamics

The SI faces challenges due to geopolitical crises, global economic shifts, changing supply chains, and emerging technologies (Vögele et al., 2020). A contemporary example is the invasion of Russia in Ukraine. The political turmoil had a significant impact on supply chains for essential goods like wheat and energy, reshaping the global business environment. Business-to-business (B2B) companies are adapting by rethinking their sourcing strategies. Many manufacturers are focusing on diversifying their sourcing approaches and developing new products that use alternative ingredients, components, or energy sources to mitigate supply chain disruption (Sheth & Uslay, 2023). Several key commodities exported by Russia and Ukraine, such as coal, steel, and nickel, account for 10-50% of their global market shares. These materials are vital across many industries, and automakers are particularly impacted by increasing prices of 15-25% in materials like aluminum, copper, and steel. This has raised concerns for both manufacturers and consumers, as the higher material costs lead to increased vehicle prices (White et al., 2022).

Regional clusters of coal and steel production can be seen in the figures, localising steel plants, coal mines, and logistic terminals for coal. Most coal in Ukraine is excavated in the Donbass region (Donetsk Coal Basin) in eastern Ukraine in the regions of Donetsk, Luhansk and Dnipropetrovsk (Ukraine Energy Profile, 2021). Between 2013 and 2014, the Donbas region saw a 52% decrease in jobs, losing 136,000 positions. This decline corresponds with estimates that of the 93 coal mines in the region, 12 were destroyed and 55 were not operational, resulting in a 60% drop in average daily coal production (International Bank of Reconstruction and Development / The World Bank et al., 2015).

New York Times global economics correspondent Patricia Cohen points out after the election of Donald Trump, that the outlook for Europe's economy has been disappointing already, but now after the election – it got worse. She mentions Carsten Brzeski, chief economist at the Dutch Bank ING in the article, which states that Europe faces major economic challenges. He warns of a potential "full-blown recession" for the Eurozone next year. Germany and France, exacerbating the crisis at a critical moment. On the same day as Donald Trump's victory announcement, German Chancellor Olaf Scholz disbanded his coalition government due to deep disagreements over spending priorities and deficits (Cohen, 2024).

At the same time, policies in China aim to speed up the transition to a low-carbon economy while positioning the country as a global leader in EV innovation, production, and technology. One opinion is, that this approach has resulted in significant overcapacity, and criticises that Chinese EVs are being exported at low prices, undercutting foreign markets and putting pressure on international EV industries (Gao & Zhou, 2024).

Furthermore, leading European Automotive industries like Volkswagen heavily depend on exports to China, where German manufacturers sold around 4.3 million cars in 2021. However, in recent years, Chinese consumers have shifted to domestically produced electric vehicles, reducing demand for German cars (Eddy, 2024).

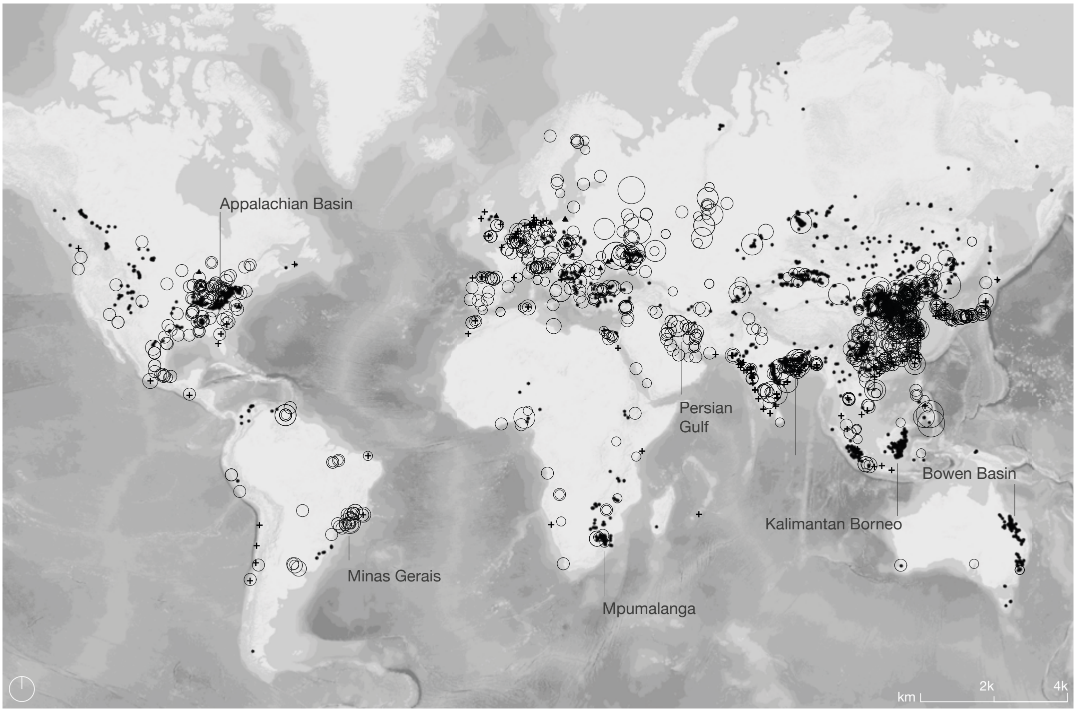


Figure 03 *Global Steel Industry.* Global Steel Factories, Bituminous coal mines, Import- and Export terminals.

○ Steel Factories
● Coal Mines
▲ Coal Import & Export Terminals
✚ Coal Import Terminals
< 1400 workers
1400 - 4400 workers
4400 - 9400 workers
9400 - 20000 workers
< 20k workers

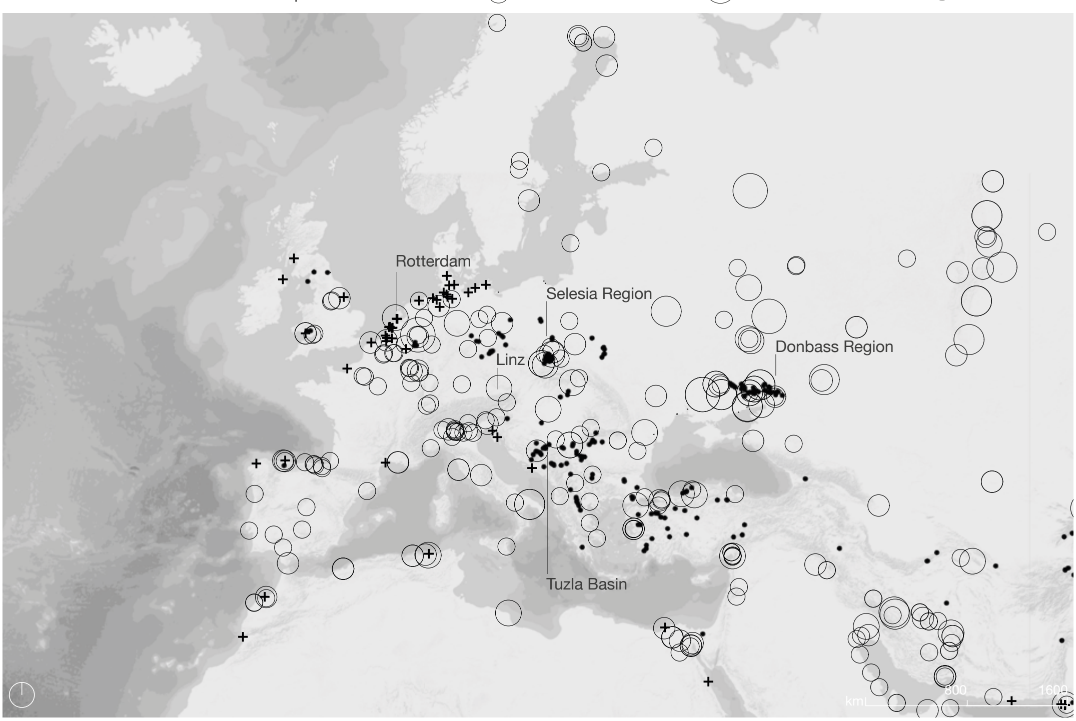


Figure 04 *European Steel Industry.* European Steel Factories, Bituminous coal mines, Import- and Export terminals.

Current Planning Processes

(A. Van Timmeren & L.Henriquez, 2013) describe urban areas worldwide as increasingly interconnected, driven by multiple tangible and intangible relationships through technology, transportation, trade, and a global postmodern metaculture. However, these relationships have drawbacks, primarily involving risks associated with them. These risks are linked to spatial and environmental factors, as well as to the so-called cascading effects (Forgaci & Timmeren, 2014). Planning models have focused until today on growth, aiming to expand built areas by adding new settlements to open, agricultural, and natural lands to support the urban needs of growing economies (Russo & Van Timmeren, 2022, p. 5).

Urry (2014) mentions, as cited in (Hausleitner et al., 2022) that since the 1960s, manufacturing was offshored. The presence of manufacturing in many developed cities has significantly diminished due offshoring, providing pathways for service-oriented and more mono-functional spaces. They argue, that this shift has led to a clear division of production and consumption areas, creating highly linear urban systems that are significantly dependent on their hinterlands.

It is recognised by both planners and the public that urban land use and transportation are deeply interconnected. The basic concept behind transport analysis and forecasting is that the physical separation of human activities leads to the need for travel and transportation of goods. This means, that the suburbanisation of cities is tied to a growing division of labour across space, which in turn drives a continuous rise in mobility (Dieleman & Wegener, 2004).

Sieverts (1997) states, that the modern "city" has expanded into its surroundings worldwide, creating new forms that resemble either an urbanised landscape or a landscaped city. He argues, that we as a society still call these settlement areas "cities", following an ancient tradition. Alternatively, we describe them using abstract terms like "urban agglomeration", "densification area", or "urbanised landscape" because we realise how inadequate the term "city" has become for these settlement areas—a term that evokes entirely different associations. Another term wich is used for these kinds of transitional spaces between urban and rural areas are called peri-urban areas. Territories, which host innovation, globalised enterprises, and multifunctional uses such as housing, transport infrastructure, and agriculture while offering diverse recreation and ecosystem services.

However, with urban development growing up to four times faster than in cities, peri-urban areas face significant pressure, risking urban sprawl and its associated societal and environmental challenges (Piorr et al., 2011).

To illustrate urbanisation patterns, the understanding of settlement patterns connected to infrastructure development in the GLA offers a clear visual. The maps show parts of the municipality of Gallneukirchen in 1965 and today. Located 14 kilometers south-east of Linz, the development of the highway A7 Mühlkreis Autobahn changed the whole territory from an agricultural dominated landscape to a fragmented peri-urban structure. This Highway is part of the TEN (Trans European Network) route “The Rhine - Danube corridor” (European Comission, 2025).

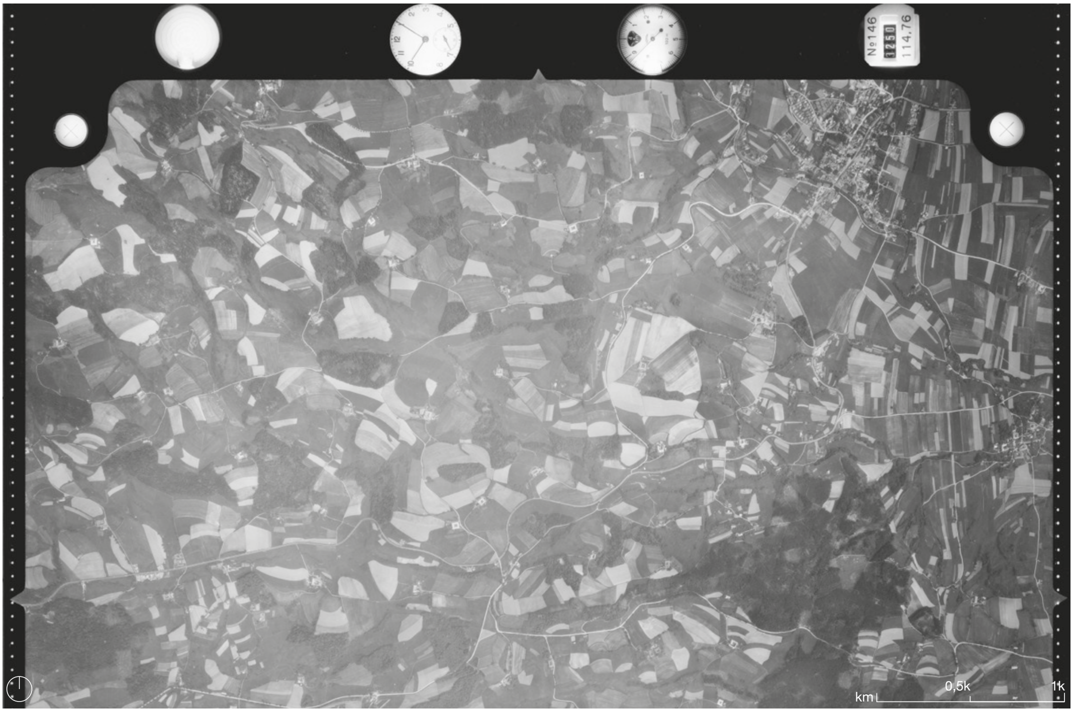


Figure 05 *Arial View Gallneukirchen, Oberösterreich.* Comparison between 1957 and 2024 to highlight the effects of the highway construction on the settlement development.

1.4 LOCATING THE PROBLEM IN A DESTRUCTIVE EUROPE

In this chapter, the focus is on the human and environmental burdens caused by industries like the SI. It begins by explaining the impact of air pollution on both humans and nature, with European case studies from Britain, Austria, and Italy highlighting in the third the role of steel production. The chapter concludes with an analysis of the current air quality in Europe. Following this, the chapter explores the broader effects of the SI has on the climate.

The Matter of Air Pollution

Air pollution is a global threat with significant impacts on human health and ecosystems. While emissions and pollutant concentrations have risen in many parts of the world, Europe continues to face poor air quality in many regions (European Environment Agency. & European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM)., 2018). Globally, air pollution is the fourth leading risk factor for human health, following high blood pressure, dietary risks, and smoking (Rafaj et al., 2018).

While scholars note that air quality is improving, it still presents significant challenges. It impacts vegetation, which are explored through various case studies. The gas-phase effects of primary emissions like sulfur dioxide and nitrogen dioxide are threatening in terms of their impact on organisms in urban environments. The impact of wet and dry deposited acidity from sulfur and nitrogen compounds cause for example forest decline (Stevens et al., 2020).

Cases of Air Pollution from London to Linz

A well-known example of extreme levels air pollution can reach was the Great London smog of December 1952 which lasted for five days and caused up to 12.000 deaths. It was mainly triggered by the widespread use of high-sulphur coal for heating. The smog had both immediate and long-term health impacts, with recent research showing a heightened risk of developing childhood asthma among individuals exposed to it (Polivka, 2018).

An Austrian example was described in an Essay by Philipp citing an article of the Austrian Newspaper Kronenzeitung from 1985, mentioning that the city of Linz had already struggled for decades with the environmental consequences of its heavy industry. By the mid-1980s, environmental problems had worsened dramatically. The article describes the situation as follows: The mild temperatures have turned the Linz basin into an intolerable poison chamber. Since Tuesday, the smog, heavily laden with pollutants, has been suffocating residents in many parts of the city, with pollutant thresholds exceeded by more than 350%. Children and elderly are particularly suffering from the smog. Two students even vomited on the street (Philipp, 2012).

The Role of Steel

A study on Chinese pollutant reduction in the iron and steel industry describes which pollutants emerge in the steel production process. These

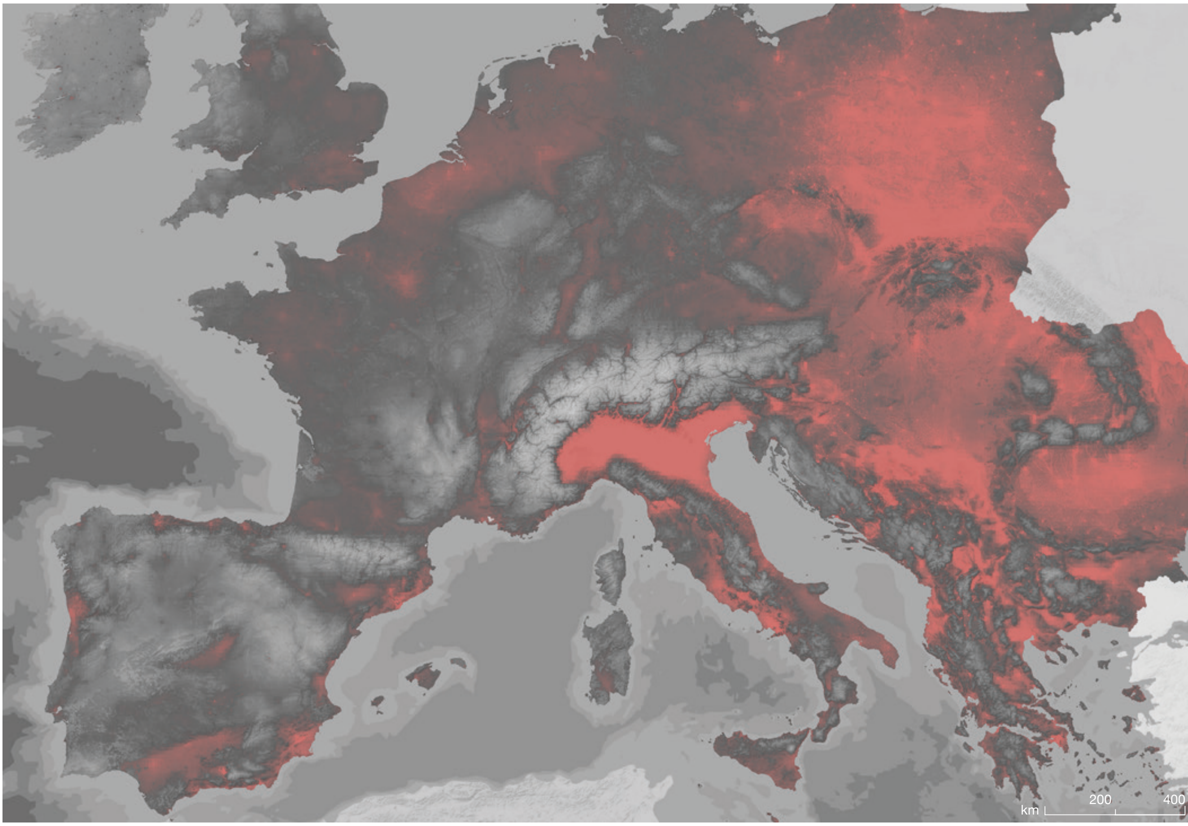


Figure 06 *Air quality in Europe.* Measured based on average concentration levels of fine particulate matter PM2.5 | Linz: 15 ug/m³

range from sulphur dioxide (SO2), nitrogen oxide (NOx), particulate matter (PM), polychlorinated dibenzodioxins (PCDDs) and volatile organic compounds (VOCs) (Wu et al., 2016).

As an European example on the effects of Air Pollution caused by the SI, the case of Taranto in southern Italy can be mentioned. An epidemiological analysis showed, that over a span of 7 years, 11.750 individuals (1.680 annually) died, primarily due to cardiovascular and respiratory diseases, while 26.999 people (3,857 annually) were hospitalised for cardiac, respiratory, and cerebrovascular conditions. In the districts closest to the plant, 637 people (91 annually) died and 4.536 (648 annually) were hospitalised for cardiac and respiratory diseases as a result of elevated PM10 levels in the air (Banini & Palagiano, 2014).

Air Quality in Europe today

Cities are ranked by the European Environmental Agency (EAA) from the cleanest to the most polluted based on the average concentration of fine particulate matter (PM2.5). PM2.5 is considered the most harmful air pollutant in terms of its impact on health, contributing significantly to premature deaths and diseases. This tool emphasizes long-term air quality, as prolonged exposure to air pollution leads to the most severe health outcomes. In 2021, the World Health Organization (WHO) revised its air quality guidelines, recommending a maximum long-term exposure level of 5 µg/m3 for PM2.5 to safeguard public health. In comparison, the European

Union (EU) established an annual limit of 25 µg/m3 for PM2.5 under the Ambient Air Quality Directive 2008/50/EC, introduced as part of its clean air policies. This directive is currently being updated to better align EU standards with WHO recommendations (European Environmental Agency, 2024).

The EEA classifies air quality as follows:

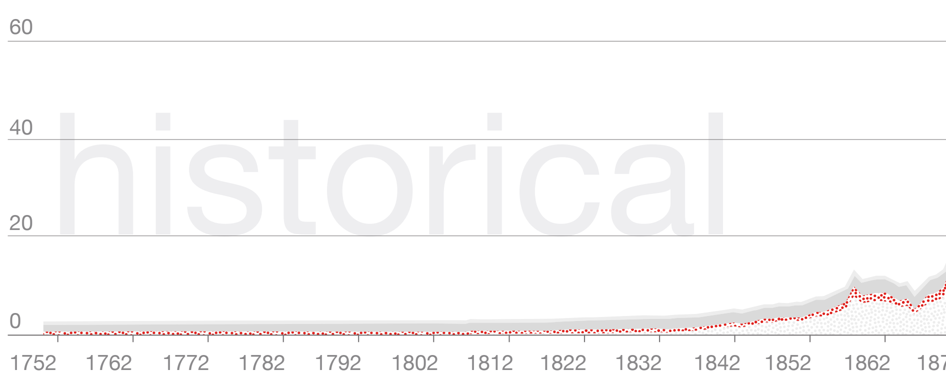
- **Good** for levels of fine particulate matter that do not exceed the annual guideline value of the World Health Organization of 5 µg/m3,
- **Fair** for levels above 5 and not exceeding 10 µg/m3,
- **Moderate** for levels above 10 and not exceeding 15 µg/m3,
- **Poor** for levels above 15 and not exceeding 25 µg/m3, and
- **Very** poor for levels at and above the European Union limit value of 25 µg/m3.

The levels of fine particulate are measured in more than 350 cities across European Environment Agency member countries, assessed from over 500 monitoring stations through data collection with on-the-ground measurements (European Environmental Agency, 2024).

The Matter of Carbon Emissions

The United Nations elaborate, that manufacturing and industrial sectors generate significant emissions, primarily from burning fossil fuels to produce energy for creating products like cement, iron, steel, electronics, plastics, clothing, and other goods. Many manufacturing machines run on energy from coal, oil, or gas, and materials like plastics are produced using chemicals derived from fossil fuels. Globally, the manufacturing industry is one of the largest sources of greenhouse gas emissions (United Nations, 2025).

The main consequences include natural effects like high temperatures, availability of fresh water, and floods; social threats like health issues, vulnerability, and employment challenges; threats to businesses in various sectors e.g., energy, agriculture, and tourism; and e.g., specific territorial threats emerging in different regions like Northern Europe, the Arctic or the



Mediterranean region (European Commission, 2025). The SI plays here a significant role, as explained in Chapter 1.3, Climate Crises – The Umbrella Problem.

Context Austria

According to calculations, greenhouse gas emissions in Austria could fall by around 3.7% in 2024 compared to the previous year, which means a decrease of 2.5 million CO2 equivalents. 2024 is the third year in a row in which emissions will fall significantly. The preliminary data shows emissions of around 65.6 million tonnes. The calculations for the forecast, which will be presented for the first time in 2024, were based on available statistics and data for 2024 (e.g. monthly energy consumption and production figures as well as livestock and fertiliser statistics) and estimates by experts. More detailed calculations for the year 2024 are expected at the beginning of 2025 (Umweltbundesamt, 2024).

However, as shown in the diagram below, Austria is one of the early industrialised countries and has therefore been emitting greenhouse gases for a long time. This means a historic responsibility for the climate crisis, especially for countries in the Global South, which started emitting greenhouse gases late and yet are already suffering massively from the consequences of global warming (klimadashboard.at, 2025).

The Austrian Climate Protection Report 2024 published by the Environment Agency Austria states, that the main sources of greenhouse gas emissions (excluding emissions trading) in 2022 were transport (44.5%), buildings (16.0%), agriculture (17.8%) and energy and industry (13.0%) sectors (Anderl et al., 2024). The largest single CO2 emitter in Austria is the voestalpine steel factory. At 9.4 million tonnes at its headquarters in Linz alone, the steel group emitted more greenhouse gases in 2021 than 900.000 Austrians combined (ORF, 2022).

This chart shows Austria's production-based emissions since 1800, reaching 75 million tons of CO_2 equivalents in 2022. As one of the early industrialised countries, Austria has long contributed to greenhouse gas emissions, bearing historical responsibility for the climate crisis, especially toward Global South countries that started emitting later but are already suffering from climate change impacts. Adapted from klimadashboard.at (2025)

Energy
Industry
Agriculture
Waste
Other

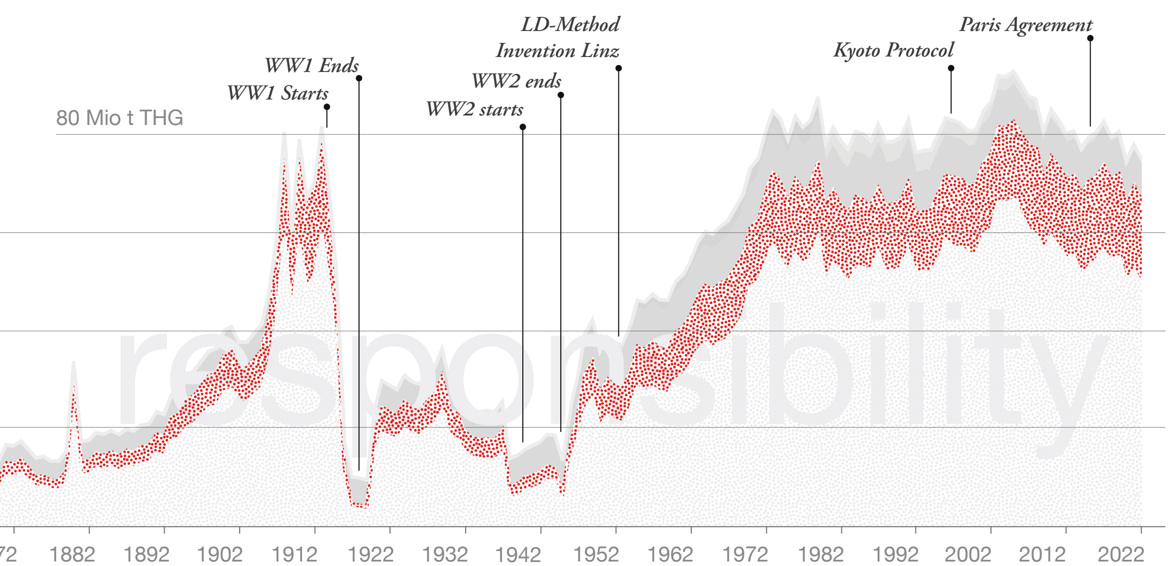


Figure 07 *Austria's historical responsibility to the climate crises.*

1.5 INTRODUCTION TO THE CASESTUDY LINZ | AUSTRIA

This chapter introduces the Metropolitan Region of Linz (GLA) as a case study, describing its transformation from a small rural city to an industrial hub and a modern cultural and innovation center. It explores Linz's spatial development, influenced by suburbanisation, its historical past as a “Führerstadt” to a social democratic working city. Today, the GLA is a leading economic and technological region with cultural institutions like Ars Electronica and the revitalised Tabakfabrik, showcasing the diversity of the region.

Traced from Raith (1990) explaining "Das eine und das andere halbe Linz", wich means "the one half and the other half of Linz"

Spatial Conditions

Erich Raith, Professor Emiruts from TU Vienna, Faculty of Architecture and Urban Planning described in 1990 Linz as follows: One half of Linz is the Linz of churches, townhouses, the castle, the "busy" Landstraße, the town hall, e.g. The other half of Linz is that of the large industries. On the map, they appear almost equal in size. Each half of Linz has streets, traffic systems, and strong architecture. Linz has long been a twin star, politically, economically, and culturally orbiting around a common focus. However, this image must now be corrected. The twin star has become a triple star. The Linz of retail has doubled in a way that is similar to the biological process of cell division. Large shopping centers have emerged on the outskirts of the city, one of which, the "Plus-City," structurally and in its "industry mix", though not architecturally, mirrors the main shopping street of the city (Raith, 1998, p. 51).

Investigating the GLA's bigger picture, the population in the City of Linz decreased between 1965 and 2001 by more than 8 percent. During the same period, residential land in the city increased by almost 40 percent. At the same time, the densely populated Upper Austrian central area between Linz, Wels, and Steyr recorded a population increase of nearly 19 percent (Tötzer et al., 2009). A study by Steinnocher et al. (2004) describes the settlement development of the GLA and shows the strongest increase in population in the smaller municipalities, in particular those located to the north and northeast of Linz (see figure comparison 1.3 Problem field, *Current Planning Processes*). This is partly due to the better connectivity of this region through the construction of the Mühlkreis Autobahn (Highway A7) and also due to the relocation of residents to the popular residential areas above the fog line of Linz as part of suburbanisation. Another area with a very strong population increase is in the center of the study area, particularly along the West and Innkreis Autobahn (Highways). The highest increase is in Asten with over 210%. The municipality with the second-highest growth, Puchenau, is slightly below 170%, which is considerably lower. However, it should be noted that the growth in both municipalities is connected to several large projects in multi-story residential buildings or denser single-story housing (Gartenstadt Puchenau).

Historical Overview

Linz has undergone changes like no other city in Austria. It was rural

Figure 08 *Locating Linz in the European context.*

until the 20th century, had a socialist reorientation in the inter-war period (evident in the buildings of "Rotes Linz"), and was a strategic City during the Nazi Regime (Bina et al., 2012). Adolf Hitler valued Linz, the city where he went to school, more than Vienna. Alongside Berlin, Munich, Hamburg, and Nuremberg, Linz became the fifth "Führerstadt" in the German Reich. Above all, the area around the Danube was to be expanded. On 25 March 1939, the Munich professor of architecture Roderich Fick was commissioned as the "Reich Building Councilor" for Linz with the overall construction plan. He reported directly to Hitler, while in other Gau capitals, the respective Gauleiter was responsible for the redesign. The establishment of large industrial companies caused the population of Linz to skyrocket and made large-scale housing construction necessary. Linz had 112.000 inhabitants in 1938 and 195.000 in 1945 (Dokumentationsarchiv des österreichischen Widerstandes, 2025). A more detailled explanation of the historical development will be described in Chapter 3.1 History.

Linz Today

The province of Upper Austria states, that the Zentralraum Oberösterreich (GLA) where Linz is the capital of the province, still functions as one of the most important economic regions of the whole country. It is renowned for its dynamic economy and technological innovation. Its central European location, robust infrastructure, and high quality of life foster business growth and career opportunities. The region provides a strong research environment, a highly skilled workforce, and an education system aligned with industry needs, ensuring sustainable economic success (Amt der OÖ Landesregierung, Direktion für Landesplanung, wirtschaftliche und ländliche Entwicklung, Abt. Raumordnung / Überörtliche Raumordnung, 2020).

Austria's economic structure is predominantly shaped by small and medium-sized enterprises, with regional economic focuses, where Upper Austria functions as a center for the iron, steel, chemical, and mechanical engineering industries (Advantage Austria, 2025).

There is a clear trend that evolved in the last decades in Upper Austria, especially in and around the capital Linz in innovative digital businesses and creative institutions. International oriented organisations like the Ars Electronica Center, have been analysed the digital revolution since 1979. It develops projects, strategies and competences for the digital transformation.

Together with artists, scientists, technologists, designers, developers, entrepreneurs, and activists from all over the world, the center deals with central questions of the future. The focus lies on innovative technologies and their influence on the way of living and working. Since 1979, the Ars Electronica Festival has been held annually. Over 1,000 innovators and visitors gather for five days to explore key questions about the future (Ars Electronica, 2025).

Figure 09: *Opening show.*
Ars Electronica Solutions curated the opening show at the world's most advanced stainless steel plant, Böhler.
left to right Rupert Huber, Lena Fankhauser, Anna Jantscher. © Ars Electronica / Isabel Schölmbauer.

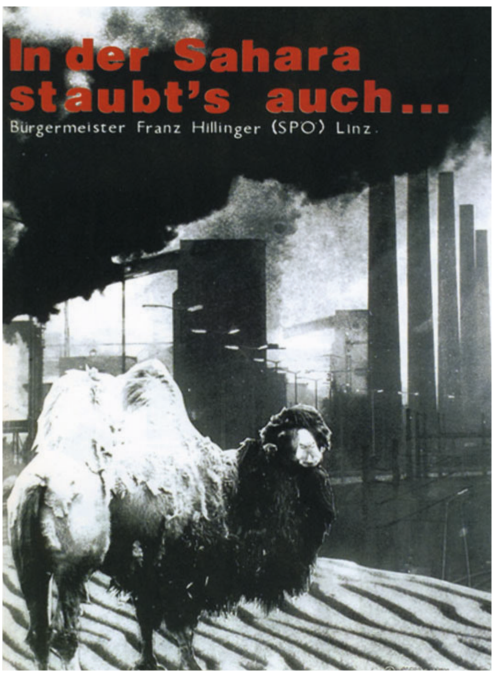
Figure 10: *In the "Lösehalle," the tobacco leaves were separated from the stalk.* Tabakfabrik Linz.

From Industry to Heritage

Another important future-oriented institution in Linz is the Tabakfabrik (Tobacco Factory), in local jargon also called "Tschikbude" which is the colloquial Austrian German word for 'cigarette shack'. It is an industrial complex (heritage site) built between 1929 and 1935, designed by the Architects and Planners Peter Behrens and Alexander Popp. As Austria's first steel-frame construction (Stadt Linz, 2025) in the "Neue Sachlichkeit" style, it holds significant international architectural importance. In 2009, after several changes in ownership, operations at the Tabakfabrik Linz officially stopped. The City of Linz repurchased the 38.148 square meter factory site with the aim of transforming it into a flagship hub for Upper Austria's creative industries. Today, the Tabakfabrik is a key player in the creative economy and Linz's global positioning. It houses around 250 organisations across diverse sectors, providing approximately 2.900 jobs. Artists, start-ups, social initiatives, media agencies, investors, students, and tech developers use the space as offices, studios, co-working areas, workshops, and event venues. The focus is on fostering collaboration, building a vibrant community, and driving innovation through diverse connections (Tabakfabrik, 2025).

The Identity of Linz. "Stahlstadt" or "Innovationshauptstadt"?

„In Linz beginnt's!" (It starts in Linz!) says the country-wide known and famous rhyme slogan for the city, developed in 1973 to attract visitors and simultaneously to polish the dusty image of the industrial city. A large-scale advertising campaign at the end of the 1980s was intended to change the city's image. The starting point was an opinion poll that showed a lack of identification of the people of Dametzstrasse Linz with their place of residence. Although people felt relatively comfortable in the city, but the external image was rated as miserable. This was justified by the poor image as an 'industrial city' and the associated environmental pollution. Back in the early 1970s, there was a spirit of optimism in the city. The establishment of the art academy and the opening of the Nordico City Museum (both in 1973), the construction of the Brucknerhaus in 1974 and the initiation of the Bruckner Festival or the organisation of forum stahl I and II (1971 and 1975), forum metall (1977) and forum design (1980) can be mentioned as important developments. In addition to the founding of the Ars Electronica festival in 1979 together with the Linzer Klangwolke, the first subcultural places such as the Stadtwerkstatt (1979) and the KAPU (see figure 11, Nirvana concert in 1989) (1984) were formed. Numerous public art and cultural institutions and events followed with the founding of initiatives of the independent scene. From an UD perspective, it is interesting that many of these facilities are located along the southern part of the Danube ('Linzer Kulturmeile'). A second axis can be identified along Dametzstrasse. More than half of the art and cultural institutions in Linz can be found along these two lines, and the realization of the European Capital of Culture Linz09 in 2009 marked a temporary peak in the transformation from a dirty industrial city to a modern and clean industrial and cultural city (Philipp, 2012).



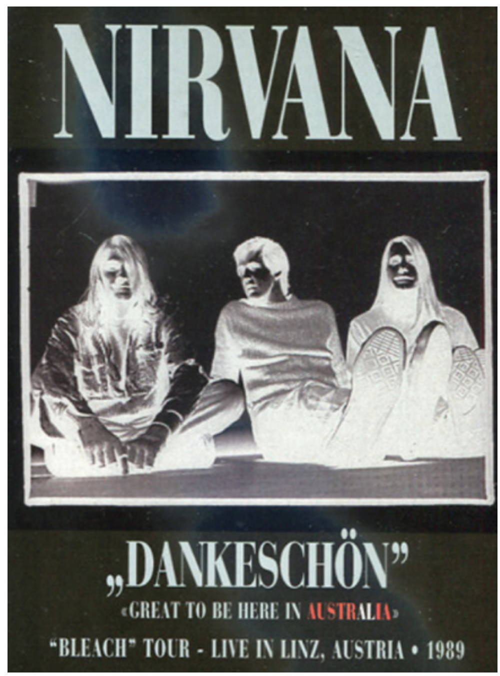


Figure 11: *In der Sahara staubt's auch... In the Sahara it's dusty as well...*
Campaign of the Groupe "s'Kollektiv" 1981 as a parody to Mayor Franz Hillinger who downplayed the Air Pollution Problem

Figure 12: *Nirvana "Dankeschön"* DVD cover of the legendary Nirvana Concert at KAPU 1989

1.6 STAHLSTADT. STAHLREGION?

The company Voestalpine is a major employer and economic powerhouse in Austria. This chapter highlights the company's identity within the workforce and football clubs connected to the factory. It also outlines the organisational structure to provide an understanding of the goods produced, embedding the value chain within the Upper Austrian region for further analysis. Furthermore, it explains the steel production methods and the factory's ambitious plans for transitioning to more sustainable and greener production modes. Finally, the steel production process is explained in a systemic section to understand its spatial dimensions.

Voestalpine – A city within a city

"Voest. Five letters. A magical symbol. A synonym for Linz. For Upper Austria. For the economic upswing after 1945. Nationalised industry. Privatisation. Success. And associated with the name of the third Danube bridge in Linz: Voest Bridge." (Aspetsberger, 2012, p. 169).

The voestalpine corporation today is an internationally operating steel, processing, and service group. The focus lies on high-tech components for the automotive and railway industries. In reference to technological developments in this context, from hard steel to flexible thin steel sheets for automotive manufacturing, broader trends of increased flexibility in employment conditions and the softening of employment contracts can also be observed. Processes of globalisation are driving the deregulation and flexibilisation of labour markets. Stable employment relationships are increasingly shifting to more flexible forms, such as temporary or leased labour (Lydia & Zogholy, 2009).

Employing over 50.000 people worldwide, including more than 23.000 in Austria, the factory plays a crucial role in the global and local economy (voestalpine AG, 2024). People who work or have worked at the company are known locally and even beyond as "Voestler" and share a strong connection to the company's identity and history. This is reflected in many institutions, such as the various soccer clubs that evolved from the company's workforce. This interview with a former player in the SK Voest Linz (today FC Linz) describes the conditions on the field located at the factory site back in the days around 1980.

"And I think, where's the sports field? I drive in there with the car, past the barrier, the porter, and so on. And there was smoke. Green smoke, yellow smoke, black smoke. Then I change in a wooden shack. I thought to myself, well, wow... I had already signed the contract, so okay, I have to give my best. On the factory premises, it stank, it was really unpleasant... Back then, the coach said at the start of the training, 'Take a deep breath.' I said, 'Coach, what should I breathe in? After two breaths I'll drop dead. That won't work. Deep breaths?' 'Alright,' he says, 'you're right, then don't take deep breaths. But the actual games were in the Linz Stadium. The stadium is very beautiful, and playing there during matches was the important thing" (John et al., 2009, p. 61).

Voest is an acronym for Vereinigte Österreichische Eisen- und Stahlwerke which means in english United Austrian Iron- and Steelworks.

Portfolio

Voestalpine, headquartered in Linz is organised in four divisions. The company ranks among the top providers in Europe and worldwide for High-tech steel (Konzern im Überblick - voestalpine, 2025). “As the voestalpine Group's largest unit in terms of revenue, the Steel Division is the quality leader for highest quality steel strip and a global market leader in heavy plate for sophisticated applications and complex casings for large turbines. The division is the first address for major automobile manufacturers and suppliers requiring strategic product development and supporting its customers around the world. It is also a key partner to the European white goods and mechanical engineering industries. Voestalpine produces heavy plate used in the oil and gas industries as well as the renewables sector, for applications in extreme conditions such as deep-sea pipelines or in permafrost regions” (The Steel Division, 2025).

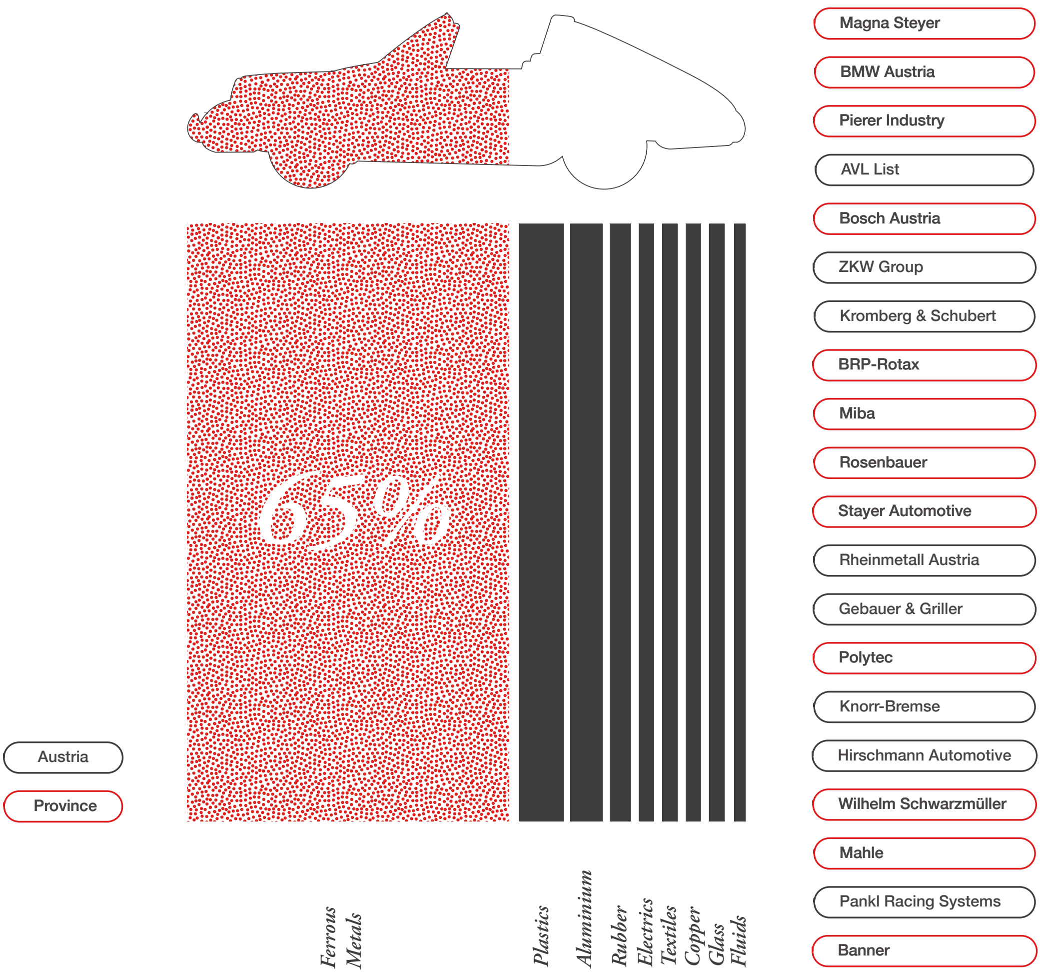


Figure 13: *The materials cars are made of.* Illustration of the materials cars are made off next to the 20 biggest automotive companies in Austria per revenue in 2022. 12 out of them are located in Upper Austria, 9 of them in the GLA.

Region Upper Austria

The province of Upper Austria has a rich industrial history, largely shaped by the SI, which supplies materials for the mechanical engineering, machinery, and transport equipment sectors. The secondary sector continues to play a crucial role, contributing significantly to the gross value added, with its share standing at 41 % (Statistik Austria 2023, cited in Amt der Oö. Landesregierung, 2024), well above the national average (Tödtling et al., 2013).

In addition to voestalpine, which is by far the company with the highest revenue, the automotive industry also plays a crucial role (Arnold, 2024). In 2022, 12 of Austria's 20 biggest automotive suppliers (by revenue) are located in Upper Austria, and nine of them in the case study area of GLA, operating in multiple locations in the region (see Chapter 3 analysis) (Arnold, 2023). Due to ongoing economic disruptions, as well as bankruptcies such as that of Pierer Industries (KTM) (Redaktion ORF OÖ, 2025), the list might differ for an upcoming evaluation.

There might be a coincidence between the locations of the automotive manufacturing industry and high-tech steel production, with the voestalpine Group's Steel and Metal Forming Divisions contributing significantly to the automotive sector. The proximity of steel production to automotive manufacturing may be crucial, as steel makes up to 65% of the average 1.5-ton car shown in figure 13 (explained in detail in chapter 2.3 steelscapes in theory and demonstrated in the analysis chapter).

Transition

The steel factory of voestalpine in Linz uses the conventional method of producing steel, which relies on burning fossil fuels like coke in the Basic Oxygen Furnace (BOF) process, also known as the LD (Linz-Donawitz process). First established at the Linz site between 1949 and 1952, this method remains the most common worldwide, accounting for 75% of global steel production, following a linear production model (Gould & Duschlbauer, 2016).

The voestalpine's greentec steel department states, that technological transitions to greener production methods are facing the entire European SI with major challenges. Voestalpine as Austria's only producer of crude steel and a global pioneer in environmental protection, has drawn up an ambitious plan for green steel production (voestalpine AG, 2025). This new steel product is called „greentec steel" where renewable energy and steel scrap are becoming more important in the supply chain (Gajdzik et al., 2023). Voestalpine further states, that the transition to greentec steel begins with the construction of one Electric Arc Furnace (EAF) at each location (Linz and Donawitz) to achieve a 50% reduction in CO2 emissions. Starting in 2027, these two EAFs will enable Voestalpine to produce approximately 2.5 million tons of CO2-reduced steel annually: 1.6 million tons in Linz and 850.000 tons in Donawitz. Between 2030 and 2035, the plan includes replacing another blast furnace (BF) at both sites. To achieve net zero CO2 emissions in steel production by 2050, research and pilot projects are conducted (voestalpine AG, 2025).

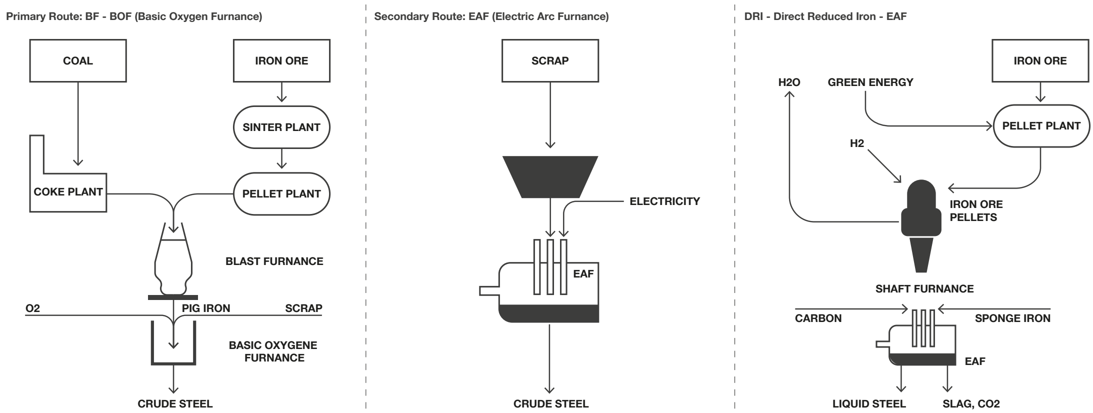


Figure 14: *Steel Production methods* Primary Route (BF-BOF), Secondary route (EAF) and DRI route (EAF).

Scholars argue that hydrogen will play a significant role in achieving decarbonisation goals. To meet the ambitious targets for developing a hydrogen economy (new energy source shown in Figure 14 DRI), rapid infrastructure expansion is essential. Smaller electrolysis projects have already been implemented, crucial projects for hydrogen transport, storage, and large-scale electrolysis are still in the planning phase. The implementation of these projects, along with crucial components such as electricity grids and renewable energy generation, is necessary for the transition towards a sustainable energy system (Strömer et al., 2024, p. 14).

However, other researchers argue that current local energy conditions at steel production sites are often inadequate to support systems with electrolysers, hydrogen storage, and DRI plants. Additionally, since electricity transmission capacity is a limiting factor in many energy systems, a potential alternative for the future is to develop more decentralised value chains, where different processes are located in areas with optimal conditions (Öhman et al., 2022, p. 14).

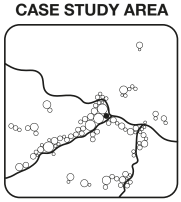
In addition, the European Hydrogen Strategy aims to use an additional 15 million tons of renewable hydrogen by 2030. Of this, 5 million tons will be produced within the EU, and 10 million tons will be imported from third countries (Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie, 2022).

However, considering current developments in the energy sector and dependencies on regimes like Russia, it is important to critically assess the demand for hydrogen.

System Steel

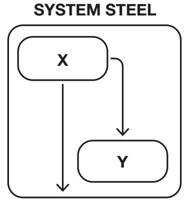
Steel industries are often considered mainly from a material flow perspective, but they are part of a complex system involving many tangible and intangible elements. To get a better understanding of the spatial dimension of the steel industry, it's essential to see it as an interconnected whole. This broader perspective reveals opportunities for more circular and sustainable production methods and also highlights the human relationships within the system. The systemic section presented here highlights the crucial role of the hinterland in supporting both the city of Linz and the steel factory as key players in this industrial landscape.

CASE STUDY AREA

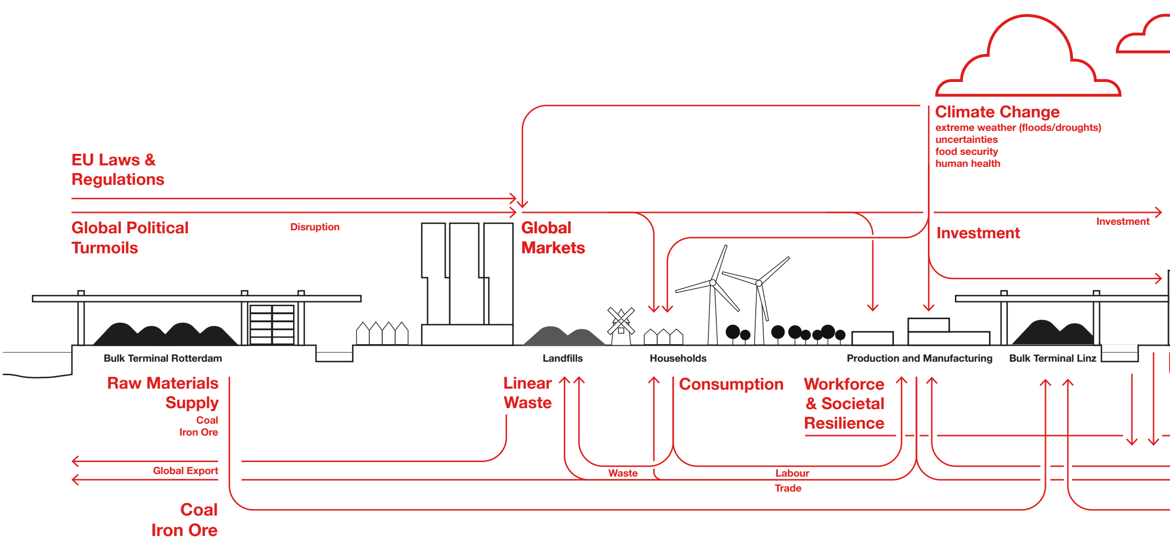


MORPHOLOGY

SYSTEM STEEL



PHYSIOLOGY



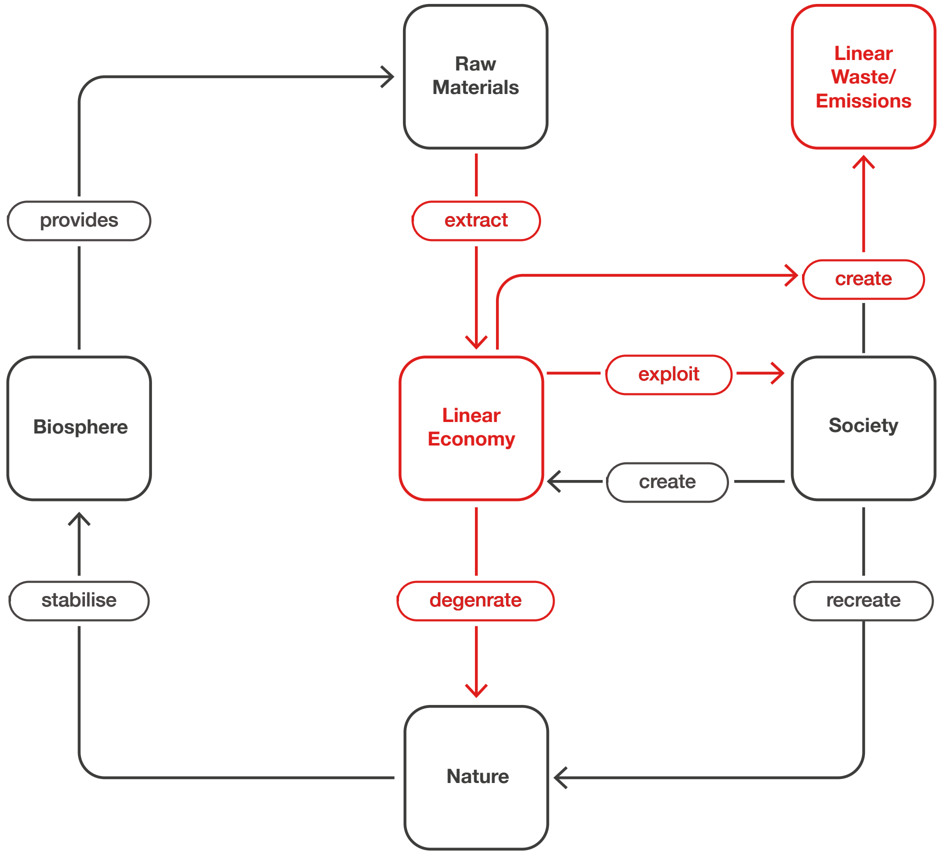
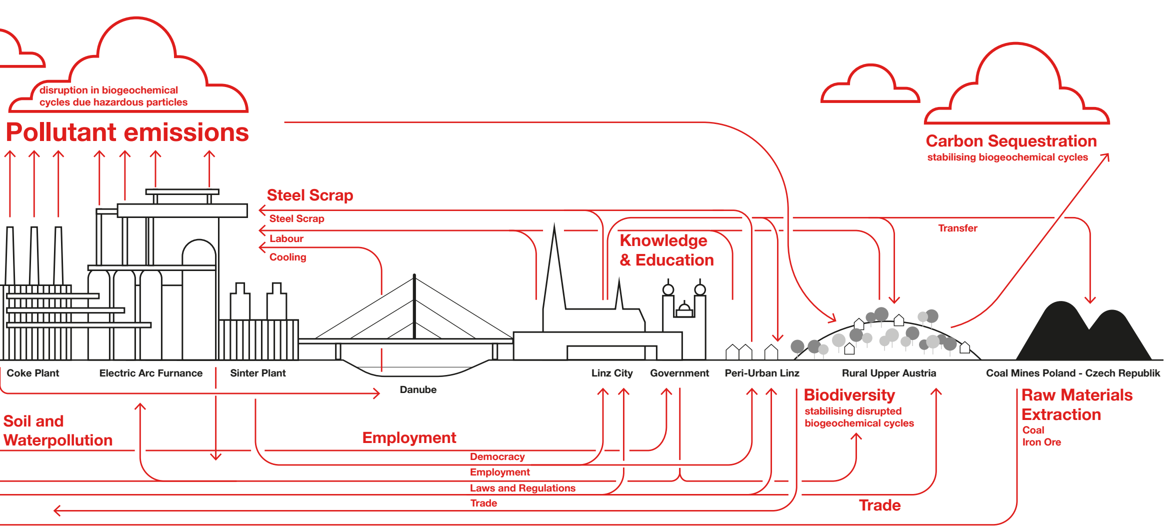


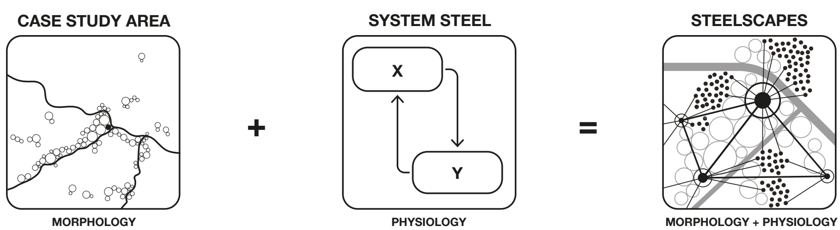
Figure 15: *System Steel Explained*



1.7 STEELSCAPES

Defininition

The concept of Steelscapes (SC) builds on existing definitions, such as Wastescapes (Amenta & Van Timmeren, 2018) or Drosscapes (Berger, 2006), which investigate and define the spatial consequences of unsustainable urban processes. However, no specific term or framework currently addresses the territories and environments shaped by the steel industry, occurring in cities and metropolitan regions with backgrounds in SIs, like Linz. SC are not only the facilities of steel production and the land where steel is processed but also the broader interconnected spatial systems, including natural ecosystems, infrastructural networks, settlement structures, and related manufacturing activities (further explained in Chapter 2.3 Steelscapes in



Theory). These areas reflect the interdependencies between industrial activity, environmental conditions, and the socio-economic fabric of communities. Concentrated in peri-urban areas and industrial zones, SC are often shaped by environmental degradation, underutilisation, or abandonment. Despite these challenges, SC are dynamic environments with significant potential for reorganisation and regeneration. By adopting an integrated spatial perspective, these territories can be reconceptualised as critical nodes for sustainable transformation processes.

Figure 16: *346.000 m2 greenfield surface parking*. Logistic facility connected to the cargo rail and logistic network operated by the european car logistic company Hödlmayr International, Schwertberg.

Steelscapes of Making
- Steel Factory
- Coke Plant
- Scrap Plant

voestalpine Linz

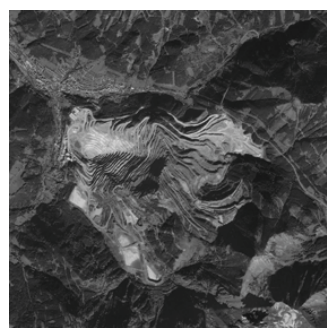
Steel producer

Steelscapes of Manufacturing
- Automotive Industry
- Enegeneering Industry
- Construction Industry

Rosenbauer Leonding

Fire engine producer

Steelscapes of Sourcing
- Coal Mines
- Iron Ore Mines
- Hydrogene Plants



Erzberg Eisenerz

Iron ore mine

Steelscapes of Re-use
- Recycling Facilities
- Scrap yards
- Soil recycling plant

Loacker Götzis

Steel Scrap

Steelscapes of Flows
- Road Infrastrucutre
- Rail Infrstructure
- Waterways

A1 Westautobahn

Highway

Steelscapes of Living
- Workers Settlements
- Urban and Peri-Urban
  Livelyhoods

Bindermichel-Keferfeld

Workers Settlement

Steelscapes of Learning
- Apprenticeship schools
- Higher Education Institutes
- Universities

Berufsschule 3 Linz

Applied Schools

Steelscapes of Regeneration
- Nature Resorts
- Forests

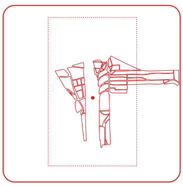
Nature reservoir Traun
Donau Auen

Ecosystems

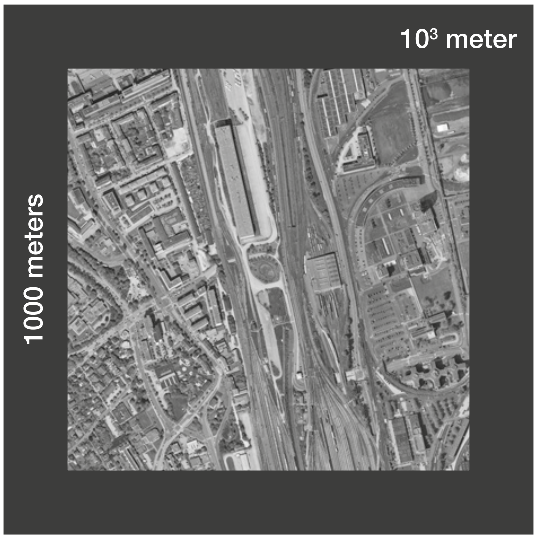
Steel is Multiscalar

To understand the complexity of the steel industry, the investigation has to be made on multiple scales. The film by Charles and Ray Eames Powers of Ten (1977) illustrates multiscalarity clearly. Starting from a picnic scene in Chicago, it zooms out to the edge of the universe, then back into the microscopic level inside a human cell.

This shift in perspective shows how different layers of a system become visible at different scales. Likewise, analysing the steel industry from global dynamics to local impacts, zooming in and out to get an understanding of its dynamics is crucial.

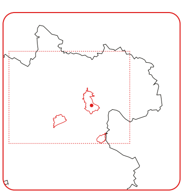


Steelscapes:
Making
Re-use
Flows
Living
Learning
Regeneration

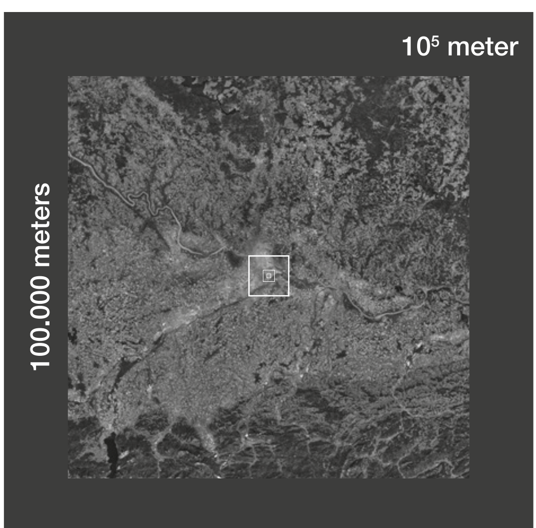


The distance a racing car can travel in 10 seconds

Neigbourhood
District

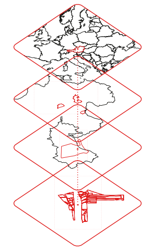


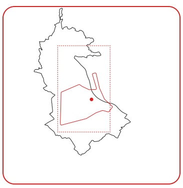
Steelscapes:
Flows
Sourcing
Regeneration



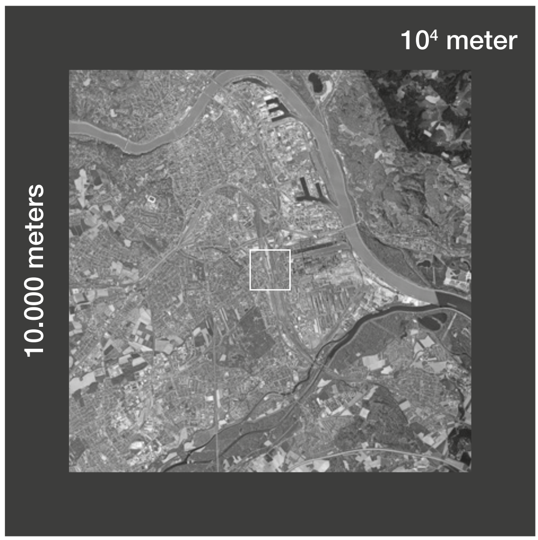
The distance a orbiting satellite covers in 10 seconds

Region
Territory



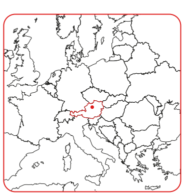


Steelscapes:
Making
Manufacturing
Re-use
Flows
Living
Lerarning
Regeneration

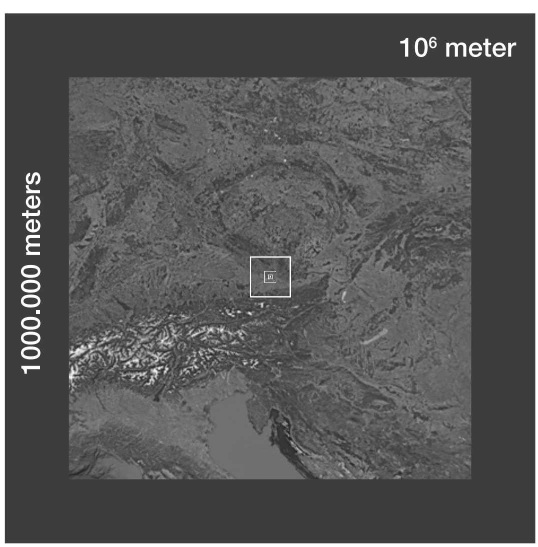


The distance a supersonic air-craft can travel in 10 seconds

City



Steelscapes:
Flows
Sourcing
Regeneration



Soon the earth will show us a solid sphere

Nation
Continent

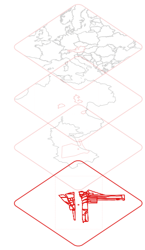
Steel is BIG

Scale comparison between the city centres of Amsterdam, Vienna, Linz and the steel factories' territory. It is interesting to understand, that those artificial environemtns designed by humans have similarities in their inner logic. While citiy centers are organised in blocks and streets, also the layout of factories depends on a strict logic for providing efficient workflows.

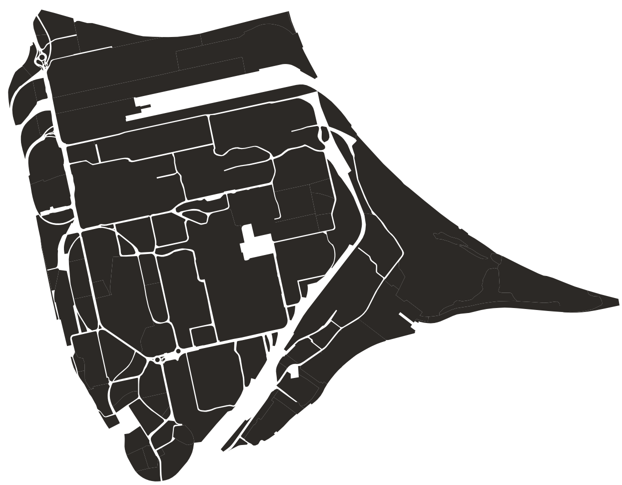
Inner City Amsterdam

Inner City Vienna

*the factories property hosts many other steel related businesses and is not primarily for production. Logistic companies, recycling facilities and heavy industries are also located next to the factory.



Inner City Linz



Steel factory voestalpine Linz*

Chapter 2

resea
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arch
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2.1 RESEARCH APPROACH

Problem Statement

The steel factory of the Austrian-based global steel producer voestalpine in Linz, located in Upper Austria—one of the country's key economic regions—aims to transition from the biggest single CO2 emitter of the country to greener production methods by 2050. Global and local challenges such as geopolitical crises, economic decentralisation, and disruptions in biogeochemical cycles, are rooted in linear and unsustainable practices, including overconsumption, resource extraction, fossil fuel use, and fragmented urban development. As a result, the overarching "wicked problem" of the climate crisis emerges, influencing all these interconnected issues and therefore our whole society. All these complexities have made traditional approaches to Spatial Planning (SP) and UD inadequate.

Planning models in the Austrian context are often based on economic growth and contribute to significant spatial challenges. The offshoring of manufacturing activities in the past has created intense pressure on both industrial and agricultural land, particularly under these convenient linear growth models. As a result, monofunctional spaces, leading to a separation between areas of production and consumption are a common pattern in the GLA. In this context, peri-urban areas play a crucial role as spaces for agriculture, housing, and production. This triple function generates a dynamic and intensive exchange of goods and people between the city, its peri-urban in-between areas, and the broader hinterland. However, this interaction also brings substantial challenges, including heavy traffic congestion, and infrastructural and environmental problems.

Current research has focused on CE principles rather than traditional linear approaches, with efforts being made to explore the territorial dimensions of a CE. However, most studies for now have taken a more technological perspective, concentrating on material flows and waste cycles while overlooking the social dimensions and the effects of societal changes and dynamics. As a response, recent scholarship has shifted toward the concept of Circular Society (CS), a term that incorporates the social layer, acknowledging its relevance, impact, and interconnectedness with circularity.

This research reflects on current planning paradigms and explores design ideas, boosting new pathways and alternative planning strategies, while aiming to address and unfold the complexities of future societal developments.

Research Question

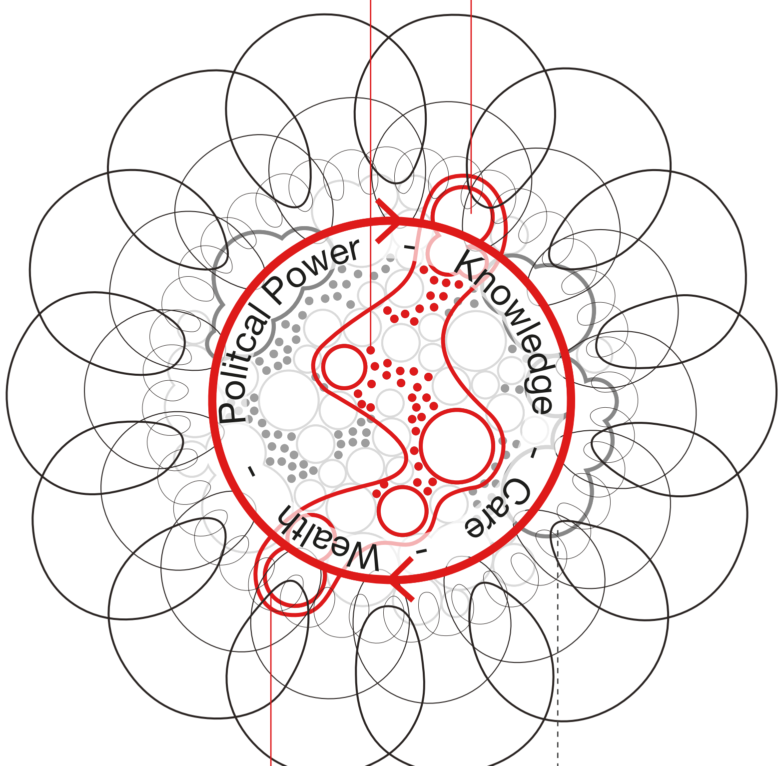
How can transformations in the steel industry of Linz act as a catalyst for the **spatial** and **programmatic organisation** of urban and peri-urban **settlements** and **industrial districts**, fostering the integration of **industrial innovation** and **societal shifts** towards a **Circular Society?**

Figure 17: *Voestalpine coke plant* - View from Pfenningberg

2.2 CONCEPTUAL FRAMEWORK STEELSCAPE METABOLISM

Human Networks
central system to foster
a Circular Society

Emerging Technologies
New economies eneable
new jobs and knowlege-transfer



Circular Steel Production
Re-Use of steel slag, wastewater
steel dust and filter dust
waste heat and flue gases

Biogechemical cycles
Resource cycles
Ecosystem cycles
Human System

Morphological Sphere
Physiological Sphere
Steelscapes
Human Systems in Steelscapes

Coal extraction phase out
Phasing out the coal industry
brings potentials in alternative
energy production modes.
Balancing the disrupted
biogeochemical cycles

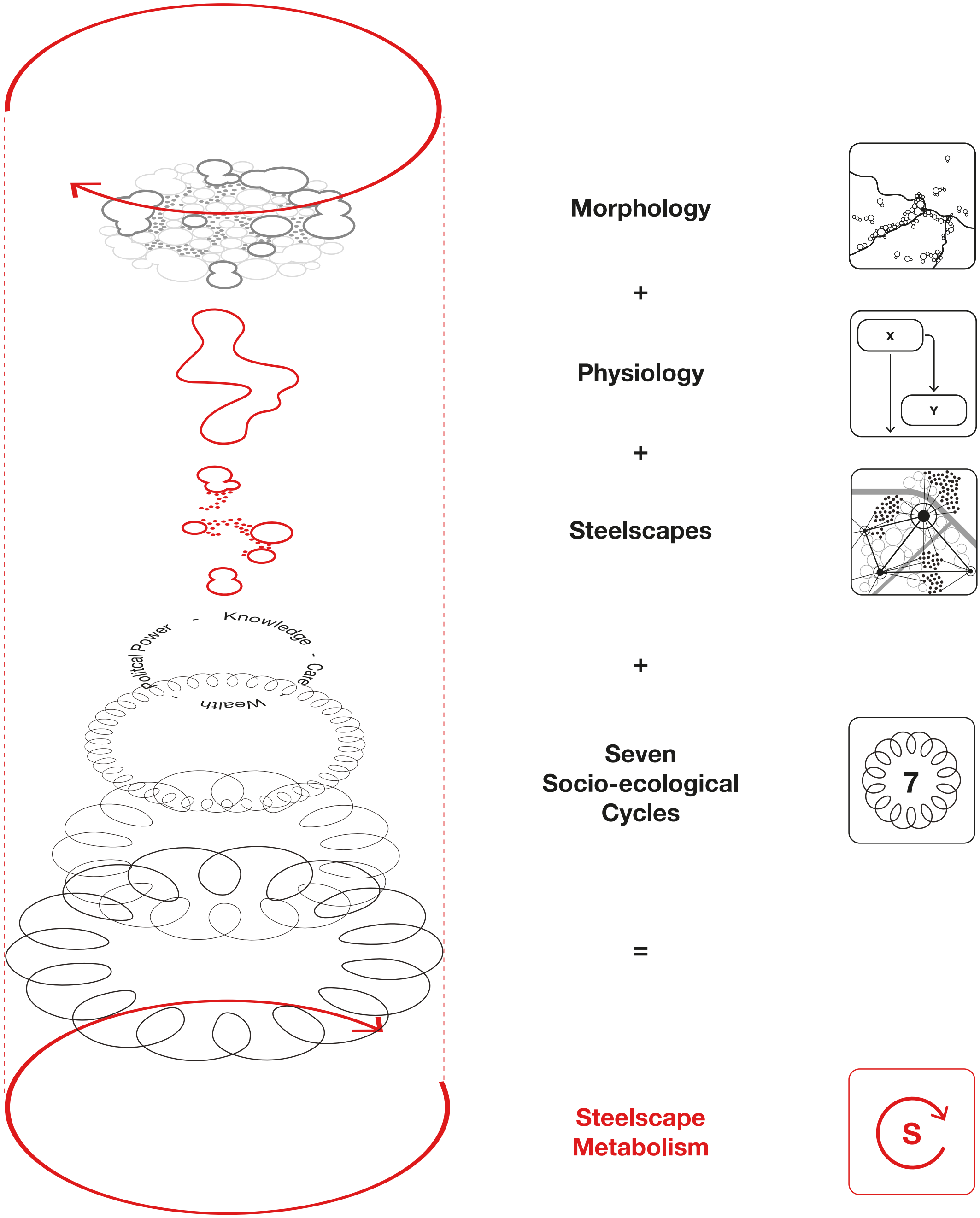


Figure 18: *Conceptual Framework.* Adapted from the Framework of Sven Socio-Ecological Cycles by Calisto Friant et. al (2024)

2.3 STEELSCAPES IN THEORY

The following chapter introduces the main theories and concepts which are used in this research project. First, the “Netzstadt (Network City)” by Swiss scholars Oswald and Baccini (1998) elaborates the importance of combining the physiological and morphological lenses when talking about the spatial dimension of metabolism. The second, more contemporary theory “Transition to a Sustainable Circular Society: More than Just Resource Efficiency” by Calisto Friant et al. (2023) aims to reflect current CE approaches in exploring it from a more holistic and social perspective, describing a Circular Society within 7 socio-ecological cycles.

Theoretical Approach

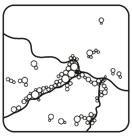
The investigation of SC is based on the theory of Urban Metabolism (UM), “which refers to the collection of complex sociotechnical and socioecological processes by which flows of materials, energy, people, and information shape the city, service the needs its populace, and impact the surrounding hinterland” (Currie & Musango, 2017, p. 1265). Within this frame, a systemic thinking approach based on the definition by Meadows (2008), where systems are defined not simply as a random assortment of things, is used. Meadows describes a system as a connected group of elements that is intentionally organised to accomplish a specific goal. Upon closer investigation of this definition, it becomes clear that a system incorporates three key components: elements, interconnections, and a function or purpose.

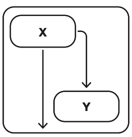
One of the first scholars to combine spatial phenomena (morphology) and systems like networks (physiology) within an interdisciplinary research approach were the Swiss scientists Peter Baccini, Professor Emeritus of Material Management and Waste Technology, and Franz Oswald, Professor Emeritus of Urban Design and Architecture at ETH Zurich. Their research project, known as Netzstadt is a transdisciplinary method, which focuses on junctions and lines and highlights the most important connections in the system of urban environments (Oswald & Baccini, 1998).

However, researchers like Calisto Friant et. al (2023) argue, that the social sphere is often forgotten, and circular strategies primarily focus on material and resource flows. They argue with the concept of seven key socio-ecological cycles, that for example disruptions in social cycles like the wealth cycle, caused by the excessive concentration of capital within fossil fuel corporations, can influence political power cycles. This dynamic leads to societal decisions that tend to align with the interests of that industry. And this can affect again other cycles like the resource cycles, the ecosystem cycles or due to exploitation the biogeochemical cycle.

Overall, Friant’s theory does not fully address the importance of geographical context and the way spatial factors influence the dynamics and outcomes of the processes it tries to explain. In contrast, the theories of Oswald and Baccini incorporate spatial components and programmatic relationships but overlook the social sphere. This opens opportunities to integrate and combine these theories, potentially offering fresh perspectives and new pathways to challenge and question current planning paradigms and processes with their complex and often wicked problems.

Based on these theories, which are always contextualised within the research's geographical location, this project aims to identify the spatial and programmatic conditions of SC (as described in Chapter 1.7). The aim is to guide further investigations into the sustainable organisation of these environments while fostering circular approaches.


MORPHOLOGY



PHYSIOLOGY

Netzstadt – Transdisziplinäre Methoden zum Umbau urbaner Systeme
Network City – Transdisciplinary Methods for the Transformation of Urban Systems by Oswald & Baccini (1998)

The german term Netzstadt can be translated as "Network City", which deals with questions, methods, and transformation scenarios for the urban system as a network. Based on the "Linear City," functions of urban life have been primarily separated or disentangled organisationally. In contrast, the "Netzstadt" aims to highlight the interrelationships of all urban life forms with connecting or intertwining their functions. Unlike the "Linear City," which mainly served as a model for the expansion of the historic city or for new developments, the "Netzstadt" can serve as a model for ongoing transformation processes, ranging from small-scale interventions to larger operations that arise from the conditions, and achievements of the current city (Oswald & Baccini, 1998).

Building on this idea, this research and design project on SC explores urban systems by examining their influences and interconnections, with a focus on systems and spatial patterns that can be traced back to the SI. It is rooted in the antithesis of conventional linear approaches that cities have followed in the past and therefore focuses primarily on transformation and the transition towards circular approaches.

Morphological Lens

From a morphological perspective, Oswald and Baccini when discussing the morphological network, refer to topographies to decode urban systems and reorganise them for transdisciplinary projects. Their conception of networks operates across five organisational levels (scales): dwelling, neighbourhood, community, region, and country. Each of these scales is treated as a network and characterised by a limited number of elements and a selection of components specific to the given scale. These networks are further interconnected with adjacent scales, ensuring a cohesive system (Oswald & Baccini, 1998, p. 11).

A similar categorisation of scales is described within Stadtmorphologie by Raith (1998, p. 12). Rooted in the Italian morphological school of Saverio Muratori (Maretto, 2013), Raith states that there is a parallel relationship between the physical built structure of a certain scale in space and its robustness against changes over time: The larger the spatial extent of the structure, the more robust it is. Typically, four characteristic scale levels are distinguished, which are also associated with the familiar planning levels: "Scale level of the building (architectural design), scale level of the neighbourhood (neighbourhood plan, design of an ensemble), scale level of the city (urban planning), and scale level of the territory (spatial planning).

In the case of Linz and its Metropolitan Region, it can be observed that certain morphological structures changed significantly over time after the construction of the massive steel plant Hermann Göring Werke (now voestalpine) during World War Two, and historical mapping reveals that some urban structures were more resilient to this development than others (long durée explained in chapter 3.1).

For example, there was tremendous development, unlike in any other city in the Third Reich at that time in terms of housing, as there was pressure to accommodate workers for the steel factory. The UD principles of specific districts were influenced by aerial warfare, which affected the design of the space and the urban morphology of these settlements. As a result, based on medieval defensive principles, the idea of a "Wehrstadt" emerged, which can be translated as "Fortress City," designed by Nazi architect Herbert Rimpl (Nordico Stadtmuseum Linz, 2021). Furthermore, in order to make space for the development of the 6 km² steel factory, the entire village of St. Peter Zizlau, home to 4.500 residents, was demolished, and its inhabitants were forced to relocate (Bina et al., 2012, p. 250).

However, the morphological urban form has remained largely intact over the years, across various scales. For example, on the city level, one can mention the Wiener Strasse, which has largely followed the same route since the Habsburg era, connecting historical centers like Ebelsberg with the city center of Linz (see Chapter 3.1). This axis forms a "transition zone" between the heavy industrial steel production sites and the residential areas built because of the steel plant. Regarding Raith's theory, that large and spatially defining structures tend to be more resilient to significant changes, the question arises, how do technological innovations affect these structures? Considering the evolution from horse-drawn carriages to automobiles, one can observe that road construction increased over time, leading to the development of more roads and highways. This changed previously remote areas and altered accessibility (Steinnocher et al., 2004).

However, certain routes, such as the Wiener Straße, remained in its main structure unchanged. This can be explained by the fact that over hundreds of years, settlements, roads, and industries which also incorporate a certain degree of spatial robustness have developed along this axis. From the perspective of this phenomenon, the morphological development potential of the present-day steel factory site suggests that the fundamental structure defined by the Danube, the Traun River, and logistical infrastructures would likely remain constant. Nevertheless, the internal organisation and urban layout could change due to technological innovations, potentially generating spillover effects on adjacent land uses. On a larger scale, these innovations can also have a morphological influence on the entire GLA, especially considering the demand for labor and the associated mobility behaviors.

Physiological Lens

From a physiological perspective, in contrast to the morphological analysis, the scholars argue that the geographical location of the processes (nodes) is irrelevant. The entire physiological network is a physical system whose properties can be mathematically calculated. Physiological networks also allow internal "material cycles" (Oswald & Baccini, 1998, p. 210).

Meadows (2008) describes systems as interconnected tangible and intangible elements, organised into sub-elements and even sub-sub-elements. The interconnections between these components create relationships that bind the system together. She explains that in such a system, behaviours within the sub-elements can unexpectedly influence the overall system's behavior, even when these effects are not intentionally designed or foreseen. She uses the example of drug addiction and crime in society, issues that no one explicitly wants or designs. However, because of a combination of various actors and their actions, these problems have become prevalent in society.

Connecting these theories back to the SI, conventional systems rely on extracting fossil fuels like coal, which is transformed into coke. Coke is then used to process iron ore through several industrial steps, ultimately producing raw steel, a process that results in CO2 emissions (Yin, 2011), making it, except for emerging circular approaches, a linear system. However, there are already numerous pathways to shift this system towards a more sustainable and circular model to lower these high amounts of emissions (Vögele et al., 2020). These include utilising steel scrap, reusing by-products for example in the cement industry, and adopting alternative energy sources to reduce the high levels of CO2 emissions (Griffin & Hammond, 2021).

Related to CE theories in UM, territorial perspectives on circularity are essential, making the use of appropriate representation a central tool for highlighting dynamics and achieving integration. A method called Activity-based Spatial Material Flow Analysis (AS-MFA) (Furlan et al., 2020) shows three key levels of reflection: framing the object of analysis appropriately, translating flows into spatial terms, and activating the roles of cartography (Furlean et al., 2022, p. 39). The example focuses on wood waste flows which are cartographically mapped in the Amsterdam metropolitan Area.

In the Austrian case, the majority of the automobile sector is concentrated in the states of Upper Austria (mainly GLA) and Styria, which together account for nearly 75% of the industry's turnover and employ over two-thirds of the sector's approximately 37.500 workers. The industry primarily focuses on producing passenger cars and motorcycles, with smaller volumes of trucks and agricultural vehicles. Although car manufacturing in Austria is largely dominated by foreign companies, mainly from Germany (Carlier, 2024). This plays a key role in the GLA. Not only the automotive assembling and manufacturing sector is located in this area, but also the Steel Division (41% Automotive) and the Metal Forming Division (55% Automotive) of the voestalpine Group, as already mentioned in 1.6 (voestalpine AG, 2024, p. 48).

Concluding, According to Mavropoulos & Nilsen (2020, as cited in, Corvellec et al., 2022) there is no single commonly accepted definition of the term circular economy. But different definitions share the basic concept of decoupling of natural resource extraction and use from economic output, having increased resource efficiency as a major outcome.

7

7 SOCIO-ECO LOGICAL CYCLES

Transition to a Sustainable Circular Society: More than Just Resource Efficiency by Calisto Friant et al., (2023)

The Circular Economy theories have gained prominence in sustainability debates, but the modern understanding still is in development. This theory addresses gaps by exploring the meanings of cycles, loops, and flows in economies and societies, identifying seven key socio-ecological cycles that are crucial for sustainability. Biogeochemical, ecosystem, resource, power, wealth, knowledge, and care cycles. It critiques current discourses on CE principles for insufficiently addressing these cycles and proposes the concept of a Circular Society (CS) to integrate the ecological, social, and political spheres (Calisto Friant et al., 2023).

Biogeochemical Cycles of the Earth

"The Earth relies on complex biogeochemical cycles such as water, carbon, nitrogen, and phosphorus cycles that facilitate the circulation of matter and energy through various natural processes" (Steffen W et al., 2015, as cited in Calisto Friant et al., 2023). This relates to the case study in Linz, due to burning fossil fuels within the steel production process (Vögele et al., 2020).

When discussing global climate change and its regional impacts, the focus is usually on rising temperatures and their consequences. However, changes in precipitation patterns such as the amount, frequency, and intensity are at least as important as temperature. In the Austrian Alpine region, vegetation depends on adequate water availability during the growing season, and changes in the amount or intensity of precipitation directly affect the runoff behavior of rivers, resulting in flood risks (Formayer & Kromp-Kolb, 2009).

An incident in Austria can be mentioned, which is relevant to this research project. On September 11, 2024, a cold front carrying polar air swept across Austria, causing a sharp drop in temperatures. At the same time, a storm over northern Italy pulled in moist air from the warm Mediterranean, leading to heavy and persistent rain in some areas. This caused heavy, ongoing rainfall in provinces like Upper Austria, but mainly in Lower Austria, where more than 5.5 times the long-term average monthly rainfall for September fell within just five days (Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft, 2025).

Ecosystem Cycles

"Ecosystem cycles provide vital functions and services that enable the existence and reproduction of life and human societies, such as plant pollination, flood regulation, water purification, soil formation, disaster risk reduction, climate adaptation, and carbon sequestration" (Folke C et al., 2021 and Buchmann-Duck J, Beazley KF 2020, as cited in Calisto Friant et al., 2023).

Using again water as an indicator highlights the interconnectedness of human activity and environmental change. For instance, deforestation in upland areas can have a similar impact on flooding as the filling of estuarine marshes, disrupting natural water flow and storage. Groundwater pollution can cascade into surface water systems, creating a cycle of degradation, and vice versa. Urbanisation has an impact on these effects by increasing runoff, erosion, and sedimentation, leading to turbid waters, loss of aquatic life, and a decline in the natural purification of water. These changes result in tangible consequences, including higher costs for channel dredging and water treatment, as well as potential flood damage and drought-related expenses (Ian L. McHarg, 1971).

In the Austrian context, research on 10,885 watersheds in the Eastern Alps provided evidence that forests help mitigate natural hazards. In detail, a 25 percentage point increase in forest cover was found to reduce the likelihood of torrential hazards by 8.7% ± 1.2% (Sebald et al., 2019). This contextualisation is important, because compared to other countries, Austria's population is more exposed to flood risks than most OECD countries (OECD, 2024a).

Resource Cycles of Materials and Energy

"Resource cycles bring materials and energy into human economies. After being extracted, processed, and consumed, resources are cycled through various recovery loops such as repair, reuse, remanufacture, and recycle" (Antikainen et al., 2018 & Ghisellini P et al., 2016, as cited in Calisto Friant et al., 2023).

Other scholars add, that at their end-of-use, resources are cycled back to nature either by being burnt and dissipated into the atmosphere, by being placed into landfills, or by being thrown into the environment (Krausmann F et al., 2018 & Rammelt C, 2020, as cited in Calisto Friant et al., 2023).

In 2019, Austria was a global leader in recycling, thanks to four decades of focused policies and efforts. As a result, 58% of all municipal waste in the country was recycled (de Wit et al., 2019).

A promising approach to improving sustainability and energy efficiency on an industrial scale is through energy cooperation or industrial symbiosis. Researchers, together with the park management and companies of Ennshafen (a Port located on the Danube 15 kilometers south-east of Linz in the GLA), potential synergies within conducted research were identified. A total of 24 companies were interviewed, two workshops with companies and external experts were held, an energy working group was formed and an energy roadmap was developed. Based on the findings, the researchers conclude that the primary barriers are a lack of knowledge and communication regarding potential synergies (Rodin & Moser, 2022).

Researchers focusing on industrial symbiosis refer to the collaboration between traditionally separate industries to gain a competitive advantage by exchanging materials, energy, water, and by-products. The keys to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity (Chertow, 2000, p. 313).

Political Cycles of Power

"Unsustainable cycles of power can arise when citizens lose the ability to democratically control their state due to the power of wealthy economic "elites" or of entrenched political elites (or a mixture of both, as political and economic elites, are often hard to distinguish from one another due to the many "revolving doors" between high level public and private institutions)"

(Stiglitz JE, 2012 & Frankel B, 2018, as cited in Calisto Friant et al., 2023).

Current developments in the political landscape in Austria may reflect these issues. Since autumn 2022, the previous Austrian government (Green Party and conservative ÖVP) has allocated nearly three billion euros to support industrial businesses in making green investments. This funding, called the "Transformation of Industry" fund, aims to help companies tackle the costs of sustainable projects, which are crucial for future business and international competition. The fund is widely supported, including by both green and business associations. However, the future of this fund is uncertain. Reports indicate that the conservative ÖVP party proposed its cancellation during recent failed government negotiations, citing cost-saving concerns. With three billion euros set aside for the fund by 2030, its potential removal is being reconsidered in ongoing talks with the far right FPÖ (Gepp, 2025).

Next to these developments, the government's targets and voestalpine's goals could be more effectively aligned, considering that the country's net-zero ambition is set for 2040, while the company aims for 2050 (OECD, 2024b).

Economic Cycles of Wealth, Capital, and Money

"When monetary wealth accumulates too much in certain hands, it can generate unsustainable inequalities that prevent the economy from running for the benefit of society as a whole" (Stiglitz JE, 2012 & Piketty T 2019 & Piketty T, 2019, cited in Calisto Friant et al., 2023). The same principle applies to wealth in the form of private property, particularly ownership of the means of production (such as companies, technologies, tools, and natural resources), as well as private ownership of land and housing (Calisto Friant et al., 2023).

Vögele et.al. (2023) states, that several European countries are planning to phase out coal-fired power plants in an effort to achieve greenhouse gas reduction targets. This transition is expected to result in various secondary benefits.

In 2021/22, voestalpine introduced its net-zero initiative called "greentec steel." The plan includes a short-term goal of reducing emissions by 10% through optimising input materials and reducing agents and a longer-term goal of achieving a 30% reduction by 2030 with the installation of two EAFs. This would result in a 5% reduction in Austria's national greenhouse gas emissions (voestalpine 2023, cited in Maier et al., 2024).

Within a cluster analysis, Vögele et al. (2023) argue that sectors such as coal mining, which are closely linked to the steel industry, face significant challenges. From a governmental perspective, a decline in coal demand leads to reduced tax revenues, royalties, or dividends. Moreover, these effects can directly affect specific groups within the population in coal regions.

A more detailed finding on the case of the German administrative labor market shows, that displaced workers from high carbon-intensity sectors experience greater earning losses on average and more significant challenges in finding new employment and restoring earnings. This is caused by the specificity of their human capital, the regional concentration of carbon-intensive industries, and the higher wages typically offered by carbon-intensive companies. These workers tend to be older, operate in more concentrated local labor markets, and have fewer alternative opportunities for jobs that match their skill sets (Barreto et al., 2023).

Knowledge Flows of Technology, Information, and Education

"Transdisciplinary teaching and research approaches such as participatory action research can also help democratise knowledge flows by empowering marginalised and vulnerable people in the creation, ownership, and dissemination of knowledge" (Frankel B, 2018 & Papanek V, 1972 & Zizek S et al., cited in Calisto Friant et al., 2023).

Researchers argue that digital technology has become deeply integrated into education in ways that were unimaginable, shaping nowadays almost every aspect of modern learning. While this is a widespread phenomenon in developed countries like the UK and Australia, it's important to acknowledge that about half of the world's population still lacks direct access to the internet. Although mobile telephony is expanding globally, unequal access to the internet remains a significant challenge, limiting the ability to fully benefit from its potential (Selwyn & Facer, 2014).

In the GLA case, software developers and individuals with strong programming skills are in high demand, making recruitment challenging for companies. Basic programming knowledge is also becoming increasingly important across various industries due to digitalisation. In 2018, Coders Bay, located in Tabakfabrik Linz, was established as a coding school and part of a unique program in Austria to address the lack of programming education in schools and universities, with a focus on providing easy access for all (Coders Bay, 2024).

Social Cycles of Care

"Care is a fundamental cornerstone of human civilisation that ensures the health and reproduction of life Care cycles are responsible for the well-being and education of children, the feeding and nourishing of most of humanity, the regeneration of vital ecosystems, the protection of biodiversity, the maintenance of people's physical and mental health, etc."(Pla-Julián I, Guevara S, 2019 & Morrow O, Davies A, 2021 & Rogers HA et al., 2021, as cited in Calisto Friant et al., 2023).

Research from 2018 (before COVID-19) reveals, that Austria's residents experience the lowest levels of unmet medical care needs in the EU. Almost the entire population is covered by social health insurance and benefits from a comprehensive range of services.

However, Bachner et al. (2018) argues that growing disparities between the number of contracted and non-contracted physicians could lead to social and regional inequalities in access to care.

The legal health insurance system in Austria offers protection in case of illness for insured individuals and their dependents. It provides benefits, including medical treatment, medications, dental care, and hospital services, with most of these services being provided without additional costs to the insured. Key benefits include health check-ups, sick pay, and maternity leave, along with professional guidance from health insurance providers (Bundesministerium für Soziales, Gesundheit, Pflege und Konsumentenschutz, 2023).

However, the care professions in Austria are undergoing structural changes due to demographic, technological, and economic developments. Additionally, health policies bring challenges and COVID-19 measures have increased pressure on the social and healthcare systems. As a result, paid care work is evolving. The majority of these jobs are still practiced by women (Fritsch et al., 2023).

Conclusion

From a CE perspective Calisto Friant et al., (2023) argue, that there is a significant potential for innovation and contribution to the sustainability debate. They state, that this can be achieved by going beyond a biophysical viewpoint. By integrating the full range of relevant cycles and flows, a combination of these concepts can develop an understanding of interconnected social, material, energy, and biological systems. These systems influence human and planetary well-being and result in the spatial organisation of territories.

Finally, in the case of this research and design project on the GLA, the conceptual approach of combining these theories and methods can help to provide a base to overcome conventional planning processes for a reorganisation of current planning systems, towards a more sustainable direction. A first aggregation of these theories, applied in a test case, will be assessed by unfolding the dimensions of SC.

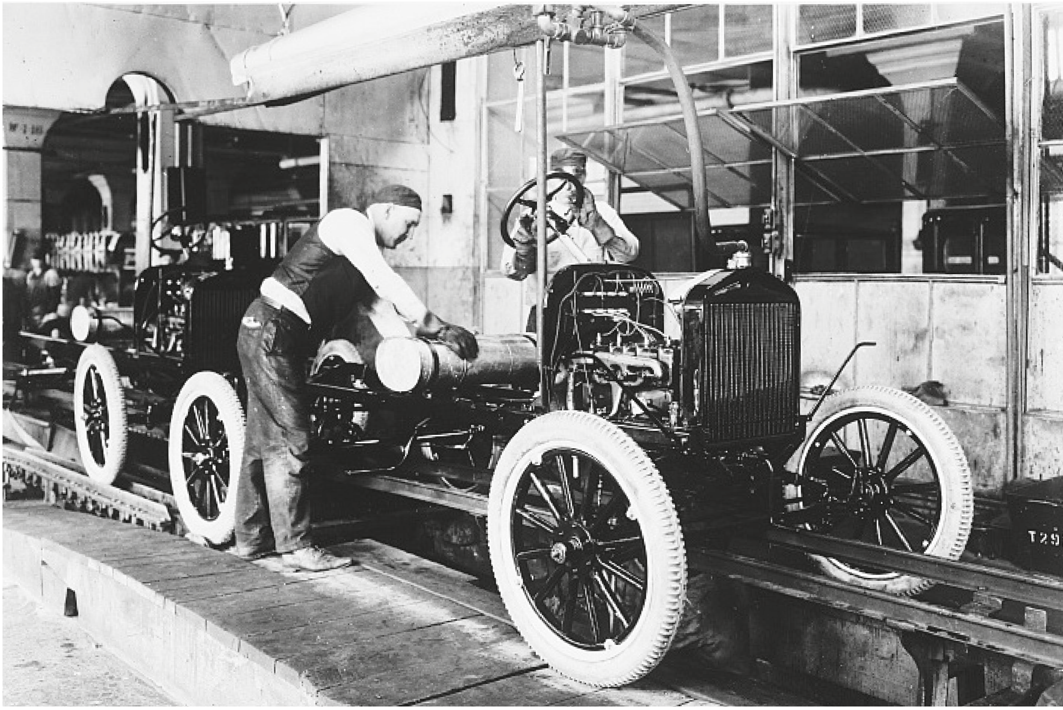


Figure 19 Top: *Car assembly line Ford 1923.* Ford factory in Detroit photographed in 1923.
Figure 20 Bottom: *Semi-automatic car assembly*. Hyundai Motor Group in Singapur, 100 years later in 2023.

2.4 URGENCIES IN THE GLA

This chapter outlines the main urgencies facing the region, which have been shaped by current global developments and translated into the local context of the GLA. These urgencies are defined by the framing of key issues, the underlying theoretical concepts, and the specific local conditions. The three central urgencies are: Global Dynamics – Local Impacts, Shifting Industries, and Learning, Re-learning, or Unlearning. Throughout this thesis, not only have the urgencies themselves evolved, but the mechanisms driving them have also been influenced by recent developments such as shifts in the global order, trade wars, and emerging defense strategies.

Global Dynamics – Local Impacts

“Perhaps you've heard the cliché that the economy is a pie we must grow rather than slice. It is hard to know where to begin with what this image gets wrong, because it gets almost nothing right. If you somehow grew a blueberry pie, you'd get more blueberry pie. But economic growth is not an addition of sameness. The difference between an economy that grows and an economy that stagnates is change. When you grow an economy, you hasten a future that is different. The more growth there is, the more radically the future diverges from the past. We have settled on a metaphor for growth that erases its most important characteristic.” (Klein & Thompson, 2025).

This is a quote from the Book “Abundance” written by the U.S. journalists Ezra Klein and Derek Thompson, exploring the political, economic, and cultural dynamics shaping the world. Rather than maintaining the status quo, they strive for bold action that fosters growth and possibility. Covering key areas like healthcare, housing, infrastructure, and innovation, they present a roadmap to a future driven by abundance instead of fear.

However, other scholars argue with the concept of degrowth, highlighting the necessity of reducing resource and energy consumption through radical political and economic restructuring. They examine, that economic growth was the primary objective in historical, social, cultural, and political spheres in the past and argue that degrowth is necessary and feasible (Kallis et al., 2018). The main idea is that continuous economic growth is unsustainable, and that progress is achievable without it. Advocates of degrowth criticise GDP-centric development and market globalisation, and instead promote social and ecological well-being, stronger democratic systems, and fairer wealth distribution (Schneider et al., 2010).

While the urgency of the climate crisis makes it clear that current economic systems built on endless growth are unsustainable, recent geopolitical developments complicate this conversation. It is evident that we must rethink economic models to prioritise ecological sustainability, and reduce material and energy consumption.

However, with the war in Ukraine, the European Union originally built around free trade and known as a "peace project" is now shifting its focus toward defense as a reaction to President Trump’s cancellation of financial support to Ukraine. The EU plans to grow its defense industry and make military spending more efficient and cooperative across member states (Smialek & Erlanger, 2025).

Therefore, the *White paper for European defence - Readiness 2030* was developed, where EU member states maintain control over their national defense policies while also benefiting from the collective strength and coordination that the EU framework provides. It encourages member states to increase defense investment, procure essential military equipment, and help foster sustainable industrial growth. The document identifies three core areas for action, addressing capability gaps, advancing a more integrated single defense market and accelerating technological transformation and increasing Europe's overall readiness for high-risk scenarios (European Union, 2025).

This doesn't mean the climate argument is less urgent, but it means that navigating the path forward requires balancing ecological limits with the political and strategic realities of a changing world.

Shifting Industries

In Chapter 1.6, this research highlights the shift from a fossil fuel-based steel industry to a more sustainable and renewable one, within the broader goal of the European energy transition. Recently, as already discussed in the paragraphs above, a new world order is emerging driven in part by Donald Trump's "America First" strategy.

Traditional industries like the automotive, steel, aluminum, and chemical industries can be revitalised by integrating into an expanding European defense industrial base. At the same time, emerging advanced technologies such as artificial intelligence and next-generation electronics offer dual-use potential, serving both civilian and military needs (European Union, 2025).

Figure 20: *Global dynamics - Local impacts.* Playground at Bindermichl Linz.

This would mean that steel factories like voestalpine in Linz could become strategic players in the current development, additionally highlighting the entire supply chain behind it and the regional focus of the GLA on the metal and automotive sectors.

Austria's defense industry operates within a multi-layered regulatory environment shaped by European Union legislation, national laws, and international agreements, including arms embargoes. The Foreign Trade Act 2011 governs the export of military equipment, requiring official approval for transfers both within the EU and to third countries. Authorisation is denied if the export poses a risk of fuelling armed conflict or worsening existing instability in the receiving state (Barabas et al., 2025).

Therefore, the whole concept around CE translated into the current developments could mean, rather than focusing on resource efficiency from an eco-centric and environmentally friendly perspective, that self-sufficiency and resourcing of raw materials could be based on defense strategies.

Scholars argue that fluctuations in defense research and development spending across industries and countries are influenced by external shocks that are largely independent of private-sector research and development dynamics. These shocks include events such as wars, acts of terrorism, major geopolitical shifts such as the end of the Cold War, as well as the ideological orientations of political leadership (Moretti et al., 2025). Other scholars argue for example, that public investments of the U.S. Office of Scientific Research and Development (OSRD) had a significant impact on technological innovation in the United States. With analysing OSRD contract data, they demonstrate that these investments not only influenced the direction of the invention but also contributed to the emergence of high-tech industrial employment clusters, laying the groundwork for the major technology hubs of the postwar period (Gross & Sampat, 2020).

Voestalpine has experienced a significant decline in profitability. In the first three quarters of the 2024/25 fiscal year, the company's profit after taxes dropped by 50% compared to the same period in the previous year. As a result, the earnings outlook for the year has been adjusted downward. The economic challenges can also be seen in employment figures. Since the start of the current fiscal year, Voestalpine's workforce has declined by 1.8%, from 51,589 to 50,670 employees. However, when compared to the level recorded on December 31, 2023 (50,712 employees), the number of employees has remained relatively stable (Fabry, 2025).

Learning, Re-learning, Unlearning?

The need to move away from fossil-based energy systems due to the climate crisis will lead to major transformations in the manufacturing and production sectors. These shifts will also impact labor markets. Skills and competencies will change or lose relevance. If these transformation processes are to be managed in a socially just way, they will require specific political effort. A guiding framework for this is the concept of a "Just Transition." This concept highlights the importance of fairness during structural change: distributive justice, procedural justice, and recognition justice (Eichmann et al., 2024).

Figure 21: ***Learning, Re-learning, Unlearning?*** **Municipality Steyregg facing the steel industry.**

In Austria, doing an apprenticeship is a common and well-established path into the job market. Over the last few decades, as shown in the chart on the right, there has been a clear trend towards academic education pathways, while the share of people whose highest qualification is only compulsory education has significantly declined and continues to do so. Apprenticeships, while still representing the largest group at around 30% in 2022, have decreased by about 7% over the past decade. Meanwhile, the proportion of people choosing secondary or higher academic education has remained stable during the same period. At this point, their share is nearly equal to that of those doing apprenticeships.

Another way to complete the Austrian A-levels (Matura) to enter higher education is a combined apprenticeship. The vocational Matura consists of four partial exams: german, mathematics, a foreign language, and a specialised subject (based on the field of apprenticeship). For companies, the "apprenticeship and Matura" model offers the opportunity to train talented young people to become highly qualified skilled workers within their own businesses (WKO, 2025).

Upper Austria has the highest share of apprentices nationwide, with around 21%. As shown in the pie chart, 43% of them work in trades and crafts, 16% in industry, and 13% in the commercial trade sector.

On the supply side, economic conditions impact the availability of apprenticeships. In times of economic uncertainty, companies often become more cautious about hiring new staff. In addition, the number of companies offering apprenticeships has declined in recent years, and apprenticeship training is increasingly shifting away from small and medium-sized enterprises toward larger firms (Arbeitsmarktservice Österreich, 2025).

There are clear trends visible in the education landscape, both in the higher education sector and the applied jobs sector which show a shift towards innovative and future-oriented education facilities in the GLA. In the higher educational sector, a pioneering project was the development of the *Software park Hagenberg* located in the hinterland of Linz, in the rural municipality Hagenberg.

A former medieval castle in the municipality of Hagenberg became a center for a high-tech success story. The castle was transformed in the 1990s into a hub for advanced research. With the relocation of RISC (Research Institute for Symbolic Computation) from Johannes Kepler University Linz, the foundation was laid for the software park Hagenberg which hosts today more than 1000 students and researchers (Land Oberösterreich, 2019).

Another, more contemporary development is the establishment of a new University in Linz called the IT:U, the Interdisciplinary Transformation University Austria. A key element is the newly designed PhD program "Digital Transformation in Learning." This innovative PhD program will launch in the winter semester of 2024 and is led by Assoc. Prof. Sebastian Dennerlein recently appointed to IT:U and Univ. Prof. Markus Hohenwarter, a professor at the JKU Linz School of Education also known as the creator of the dynamic geometry software GeoGebra. Dennerlein is regarded as one of Europe's leading experts in New Learning and the digital transformation of education (JKU - Johannes Kepler Universität Linz, 2024).

In the applied educational landscape, there is also a trend offering new job perspectives for Apprentices. New vocational training profiles are defined through new regulations and examination standards and are structured according to learning outcomes. They are divided into subject-specific and cross-disciplinary competence areas. In addition to the specialised skills required for each profession (e.g., Application Development – Coding or Information Technology), every new apprenticeship also includes a general competence area titled "Digital Work" (Bundesministerium für Arbeit und Wirtschaft, 2023).

The recent "Lehrberufspaket 2/2024" a regulatory package of the Austrian Federal Ministry of Economy, Energy and Tourism includes seven new Apprenticeships. This regulatory package aims to implement the newly defined competencies in dual vocational training developed according to the latest technological standards, in collaboration with industry experts, social partners, and supported by scientific guidance. To mention a few forward-looking developments: the Electronics Apprenticeship has been expanded to include satellite reception technology and broadband cable networks. New apprenticeship programs have also been introduced such as District Heating Technician, now recognised as a standalone profession, and Climate Gardener, which includes essential skills in design-oriented landscaping, green space maintenance, green building facades, and urban greening solutions (Bundesministerium für Wirtschaft, Energie und Tourismus, 2024).

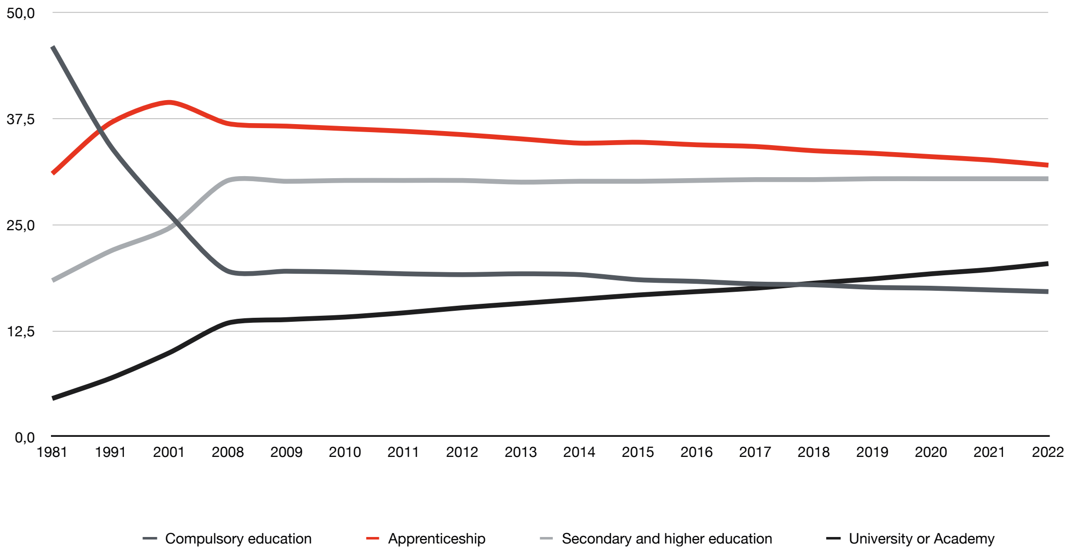


Figure 22: *Development of the educational attainment of the population aged 25 to 64 in Austria between 1981 and 2022*

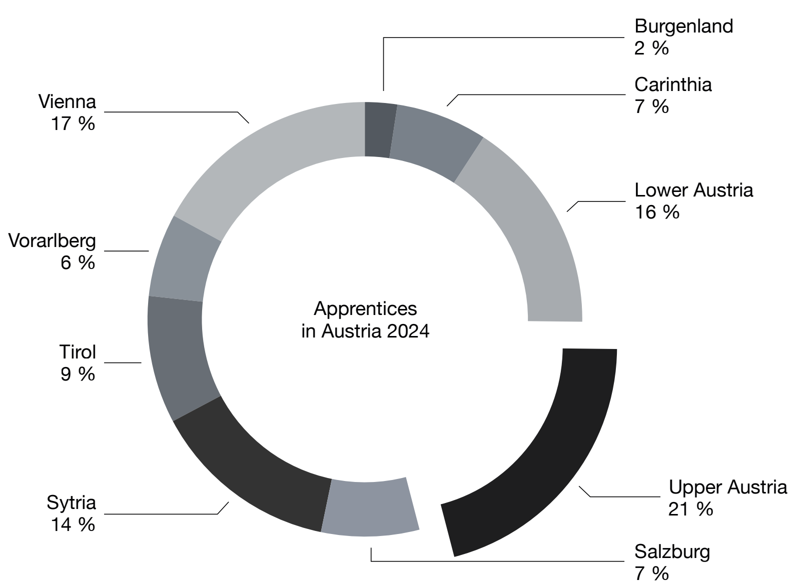


Figure 23: *Share of Apprentices in Austria per Province*

Figure 24: *New ways of learnig?*

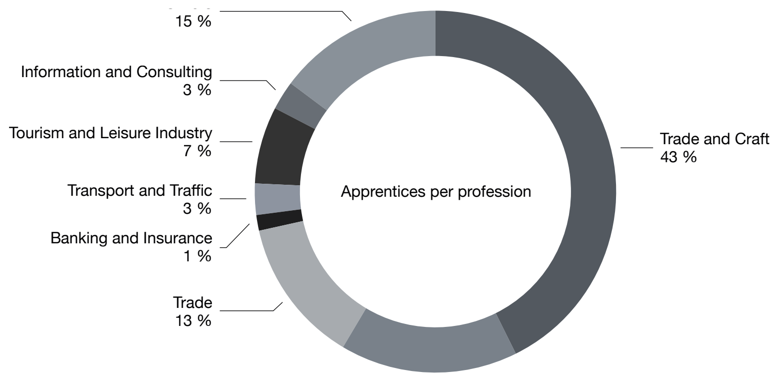


Figure 25

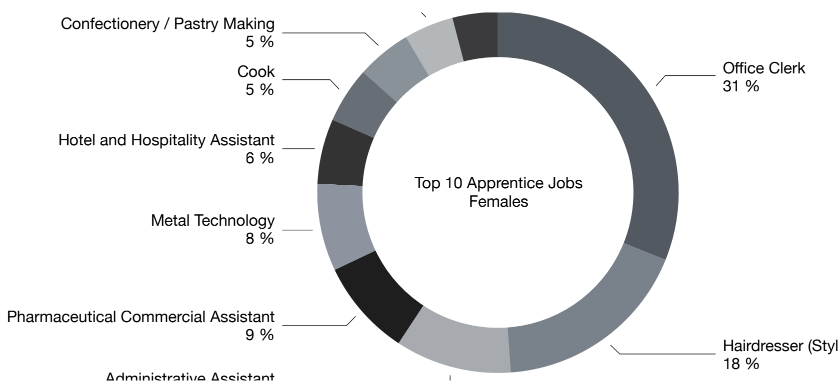


Figure 26

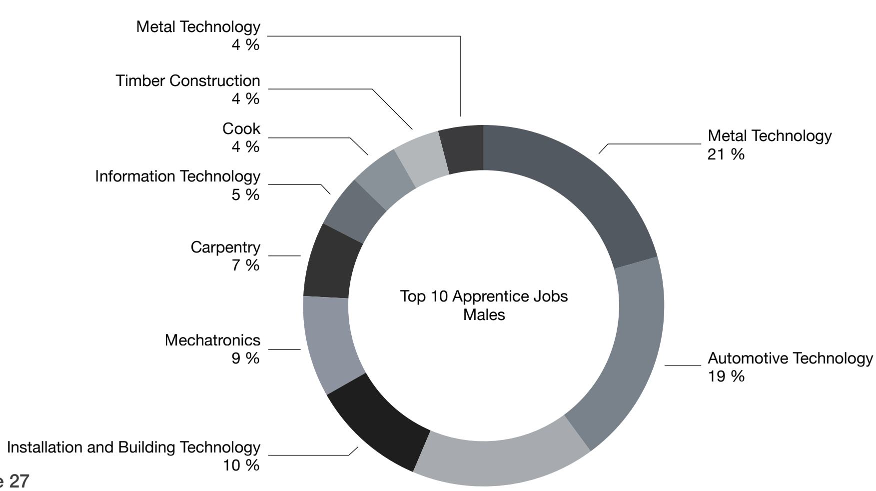


Figure 27

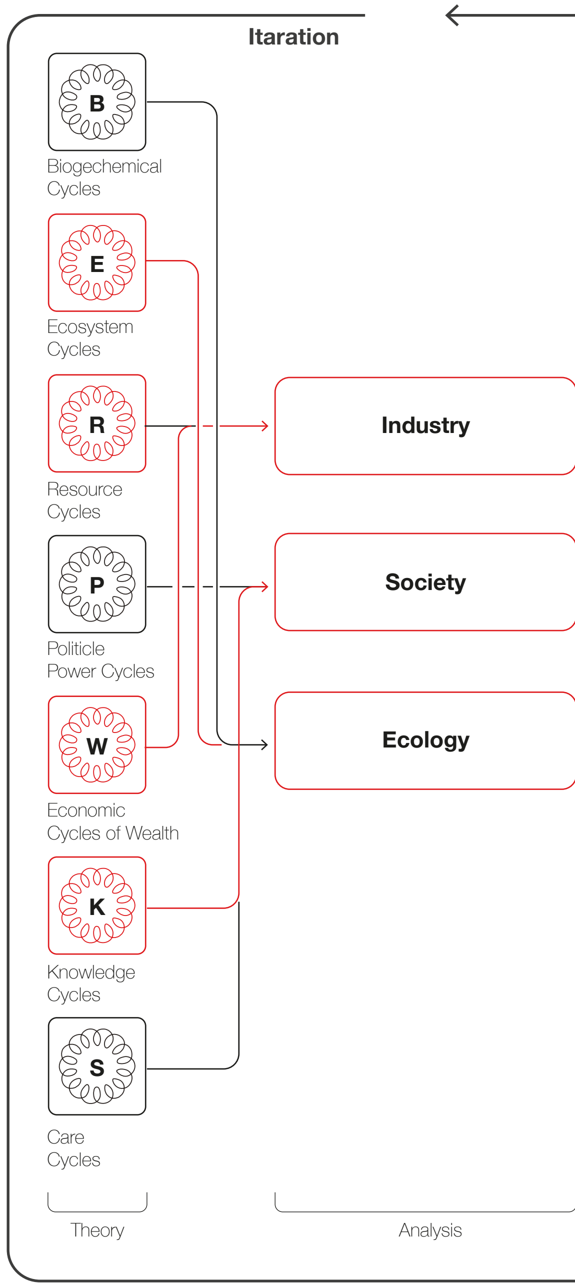
2.5 OPERATIONAL FRAME

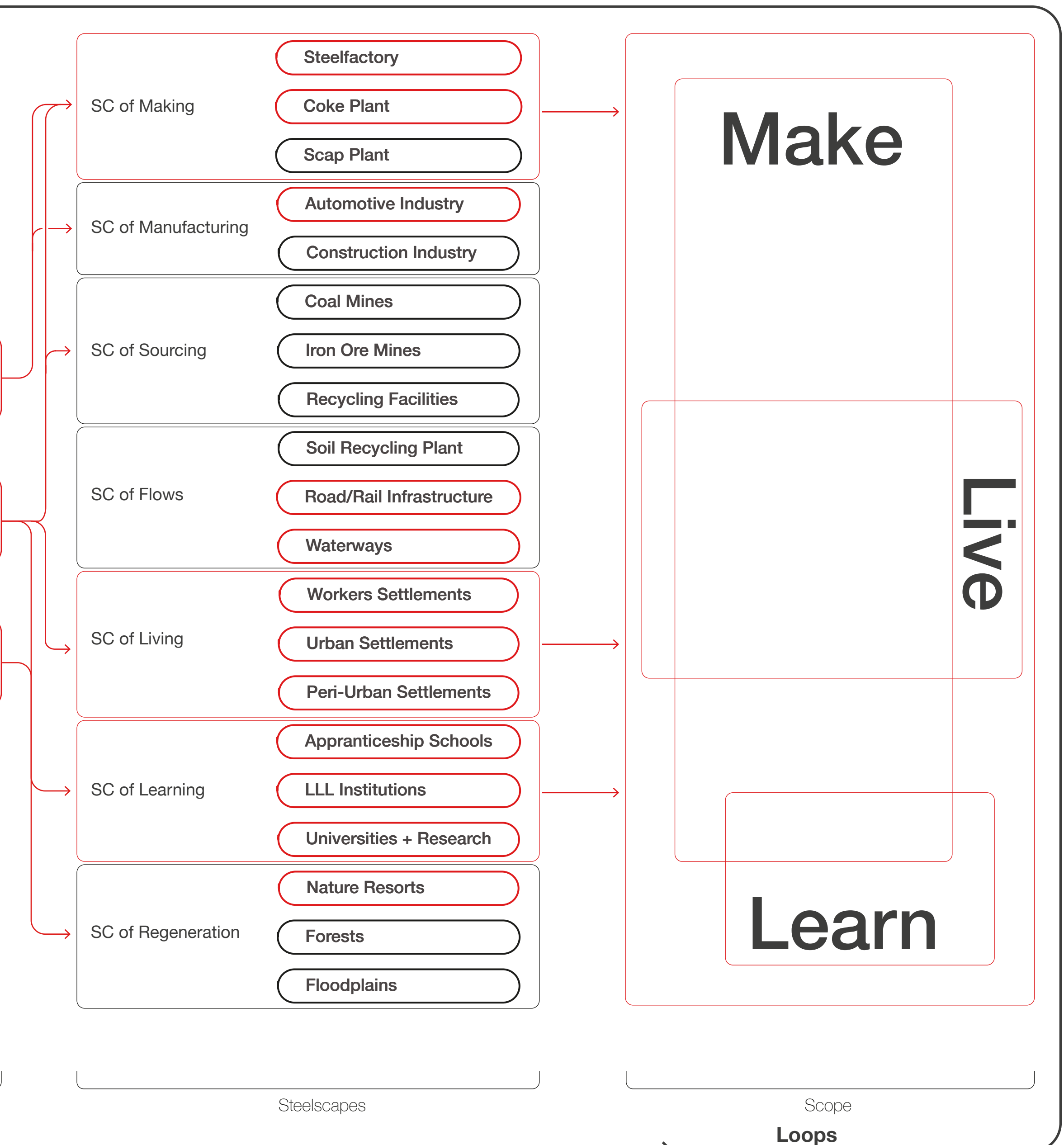
This chapter narrows the conceptual framework, focusing on key findings from the analysis, the fieldwork, the current urgencies, and the problematisation. This operational framework serves as a guiding method to maintain focus and to identify the scope (Make, Live, Learn) for further analysis in the following chapter. It also highlights the complexity of the topic itself, revealing its many facets that can be explored in greater depth through future research.

Method

Based on the main urgencies identified in the GLA, four out of the seven socio-ecological cycles were selected to reduce complexity. This selection does not mean that the remaining cycles are irrelevant to the concept. As elaborated in Chapter 2.2, these theoretical constructs are interrelated, and no cycle exists in isolation. However, focusing on the Resource Cycles, Economic Cycles of Wealth, Knowledge Cycles, and Ecosystem Cycles allowed for a more precise analysis of the core topics. Additionally, the definition of SC supported identifying specific spatial conditions, helping to further define the key themes and spaces in the analysis. At the top of the diagram, the three overarching scopes *Make, Live, Learn* emerge, serving as guiding themes throughout the process. It is important to note that the scenario-building during this phase also influenced the development of the operational framework. This iterative approach enabled a balance between exploration and analysis.

Overall, the key focus lies in spatialising the selected cycles according to the main scope to explore the spatial dimension of a CS. This will be further examined through the analysis, the scenario building, and the final conclusions.





SC of Making
Steelfactory
Coke Plant
Scap Plant
SC of Manufacturing
Automotive Industry
Construction Industry
SC of Sourcing
Coal Mines
Iron Ore Mines
Recycling Facilities
SC of Flows
Soil Recycling Plant
Road/Rail Infrastructure
Waterways
SC of Living
Workers Settlements
Urban Settlements
Peri-Urban Settlements
SC of Learning
Appranticeship Schools
LLL Institutions
Universities + Research
SC of Regeneration
Nature Resorts
Forests
Floodplains
Make
Live
Learn
Steelscapes
Scope
Loops

Chapter 3

analy

ysis

3.1 HISTORY

This chapter provides an overview of the historical development of the City of Linz, with a particular focus on the period before, during, and after the construction of the Steel factory of voestalpine. Special attention is given to the city's morphological transformation, the impacts on both Linz and the surrounding region, and the shift in the city's identity brought about by the establishment of the factory and its Nazi History.

Linz rhymes to Province

"People always smile in Austria when someone mentions this city's name; it rhymes so inevitably with **'province.'** A bourgeois population of rural origin, shipyard workers, craftsmen, mostly poor people, with just a few houses belonging to the old-established Austrian rural nobility." This is a quote from the famous Austrian writer Stefan Zweig, talking about Linz in 1920 in the Book *Joseph Fouché. Bildnis eines politischen Menschen* (Zweig, 2023 cited in Bina et al., 2012, p. 178).

Somehow, this character is still embedded in the identity of Linz, with its provincial and rural qualities still shaping parts of the city today. The strong connection to its agricultural hinterland, the Mühlviertel, plays a central role in this identity. This is evident not only in the high number of daily commuters from the surrounding region but also in the visual relationship between the city and its specific landscape. From the central Hauptplatz, one can see the green, rolling hills to the north, just across the Danube.

Figure 28: *Historical Map from 1676.* The Danube and the Traun river defining the territory.

According to historical records from the City of Linz, industrialisation began in the second half of the 19th century, including shipbuilding, locomotive manufacturing, the textile industry, and the food and luxury goods industries. This took place far from the city center. The growing population was addressed through the incorporation of surrounding areas (Lustenau and Waldegg in 1873; St. Peter in 1915; Urfahr and Pöstlingberg in 1919; Kleinmünchen in 1923) and the development of the Neustadtviertel, designed in the architectural style of the Gründerzeit period. The former western suburb gained an urban landmark with the construction of a new cathedral (Cathedral of the Immaculate Conception). In 1880, a horse-drawn tramway was introduced (electrified in 1897), and in 1898, the steepest railway in the world was opened, connecting the city to the Pöstlingberg with its pilgrimage church (Stadt Linz, 2025b).

A New Paradigm – The Nazis and the Hermann Göring Werke

Adolf Hitler had a particular passion for Linz, the city where he went to school, valuing it more than Vienna. Alongside Berlin, Munich, Hamburg, and Nuremberg, Linz was designated as the fifth "Führer City" (Führerstadt) in the German Reich. The area around the Danube was of special interest for expansion and redevelopment. On March 25, 1939, Munich-based architecture professor Roderich Fick was appointed as "Reich Building Commissioner" (Reichsbaurat) for Linz to develop a masterplan for Linz. In contrast to other regional capitals, where local Gauleiter were responsible for urban redesign, Fick reported directly to Hitler. He was regarded as a specialist in the transformation of Linz's historic city center (Dokumentationsarchiv des österreichischen Widerstandes, 2025).

On May 13th in 1938, the groundbreaking ceremony of the HWG (Hermann Göhring Werke) for the so-called "Bastion of German Labor in the Ostmark" became a prime example of a propaganda National Socialist event. It reached grotesque proportions, describing Hermann Göring "like a god" as he stepped off a special train at Linz's main station. He stated that iron and coal were more important than gold, calling them "the fundamental materials of the world." He proclaimed that Linz, once a modest city, would become a central hub of energy in the labour cycle of Greater Germany. After the speech, Göring descended from the platform and entered the engine room of a waiting excavator, symbolically performing the first groundbreaking by moving earth three times (Carrington et al., 2012).

Architecture has always played am important role in the history of the steel factory. However, its beginnings were marked by destruction. After Austria's annexation by Nazi Germany, the demolition of the Linz suburb of St. Peter/Zizlau began in early summer 1938, along with the forced relocation of its 4,500 residents to enable the development of the steel factory. From an architectural perspective, the project gained significance through the involvement of Alexander Popp and his team of architects. Popp, who also held a professorship at the Vienna Academy of Fine Arts during the Nazi period, had gained recognition for his collaboration with Peter Behrens on the Linz Tobacco Factory (Tabakfabrik) between 1928 and

Long Durée.
Morphological development of the settelement patterns, infrstructures and waterways over time.

1830 - Linz is dancing alone

Back than, the City of Linz was oriented towards the Danube, functioning as twin City with Urfahr on the other shore. The Wienerstraße was an important connection between Salzburg and Vienna, defined by the direction of the Danube in the west. Attached to this, independent farms villages conencted Linz with its hinterland.

1926 - Industries join

Linz was already industrialised earlier, which allowed settlement development and expanded the city center away from the Danube. New infrastructures allowed new settlements and industries along those, and besides this the Danube was regulated. Slowly, villages grew together.

1945 - Steel defines the rhythm

After the establishment of the Hermann Göhring Werke in the Second World War, the City nearly doubled the size which was remarkable back in he days for Austrian Cities, especially in times of war and destruction. Big scale greenfield developments where accomplished to facilitate the growth of the City. The City expanded more towards west.

1935 (Aspetsberger, 2012).

The Eisenwerke Oberdonau GmbH began producing tank components in 1940/41. The company dictated the demand for steel production and later became the largest German tank manufacturing plant. Operations at the Linz industrial complex took off slowly from 1941 onward. The first two blast furnaces were ignited, and the power plant of the Linz steelworks was brought online. Due to the war, the full development of the originally planned integrated steel and ironworks was delayed. However, as an armament facility, the construction of the Eisenwerke Oberdonau was given the highest priority (voestalpine AG, 2025a).

During this time, Linz also had become known as a "barracks city." Although official records from 1937 cited a housing shortage of only 504 units, this figure ignored the thousands living in makeshift settlements that dated back to the First World War. This provisional situation conflicted with the National Socialist vision. While propaganda promised to quickly transform Linz into a "finished city," big architectural plans remained unrealised. Instead of removing the barracks as promised, the regime responded by expanding them first through company-owned housing, and later through camps for foreign labourers, forced labourers, and prisoners of war (Carrington et al., 2012).

The industrial complex could not have been built or operated without foreign labor, as the required workforce was unavailable in Austria and Germany. The immense scale of the project and wartime labor shortages made external labor essential. The first civilian foreign workers arrived in the summer of 1938. From 1940/41, forced laborers, prisoners of war, and, by late 1942, male concentration camp inmates were deployed. The latter were held in two satellite camps of Mauthausen located on-site and forced to work at Hütte Linz, Eisenwerke Oberdonau GmbH, and Stahlbau GmbH. Unequal treatment and food rations, based on Nazi racial beliefs, made it clear how forced and unfair the labour system was. By 1944, the Linz plants reached peak employment. Foreign workers made up around two-thirds of the workforce and over 90% in some areas. Over 10% of the foreign laborers were women (voestalpine AG, 2025a).

In the book *Hitlerbauten – Beobachtungen einer Stadtfremden* (Necker, 2012) there is a critical perspective on the emerging housing projects that were developed all over the city during the war period, known colloquially as "Hitlerbauten" (Hitlerbuildings). It states, that these buildings, located in neighbourhoods such as Spallerhof, Bindermichl, Kleinmünchen, Neue Heimat, Harbach, and Keferfeld, are still widely referred to by that name. Their design often mimics the regional Vierkanthof (four-sided farmhouse), and their varied typologies are explored both architecturally and socially. This Research extends into the postwar period, addressing how these buildings were perceived, inhabited, and dealt with over time. Built in part by forced labourers under harsh conditions with materials like granite from the Mauthausen concentration camp quarry, these structures are not only architectural artifacts but also markers of a dark history.

Figure 29: *Typical Austrian Vierkanthof.* Farm "Käfergut" of Josef Reisetbauer around 1930 on the site of todays main entrance to the "Chemiepark Linz". ©Lentia-Verlag

Figure 30: *Adolf Hitler visiting the Eisenwerke Oberdonau on a tour of the factory grounds on June 20 1942.* ©Lentia-Verlag

Figure 31: *View from Spallerhof across Muldenstraße toward Hanuschstraße.* On the left are the buildings "Am Bindermichl" and "Werndlstraße", with the barracks of the local workers' home in front ©Lentia-Verlag

New Order – New Owner – New Identity?

"We have the longest bridge in the world. It begins in Washington and ends in Siberia" was a legendary statement by Governor Heinrich Gleißner during the occupation time of Linz by the Soviets and the Americans (Nordico Stadtmuseum, 2015).

Historical records reveal that the advancing war developments prevented most of the ambitious plans by the Nazis from being realised. The construction of industrial facilities and mass housing was finalised, while the planned monumental development of the Danube riverbank and the grand boulevard largely failed. As a centre of important industrial facilities, Linz experienced 22 air raids in 1944/45, resulting in extensive destruction (Stadt Linz, 2025c).

The book Geteilte Stadt (divided City), explains that the Danube River became a demarcation line, dividing the city into two zones: the northern sector under Soviet control and the southern under American administration. The postwar period was marked by a rapid and often chaotic process of denazification. Trips to the countryside became a necessity, as the city faced several shortages. Amid these challenging conditions, the residents of Urfahr and Linz, alongside thousands of returning soldiers, displaced persons, and refugees, struggled to survive in a city whose infrastructure and resources were pushed to the brink. Nonetheless, signs of recovery and renewal began to emerge. The American presence brought care packages, chewing gum, and the sounds of jazz, while Austria's first self-service grocery store opened in Linz. Industrial innovation, such as the development of the LD (Linz-Donawitz) steelmaking process, and cultural milestones, including the founding of the New Gallery, marked the city's gradual transformation (Kreslehner & Thiel, 2015).

At this time, the industry in Linz underwent a profound transformation, centered around the restructuring and revival of its steelworks. On July 18 and October 1, 1945, the Linz plants were seized by the U.S. military government as "German property" and re-established as the "Vereinigte Österreichische Eisen- und Stahlwerke AG" VÖEST – which means "The United Austrian Iron and Steelwork Corporation", placed under public administration. A turning point came with the handover of the VÖEST to Austrian trusteeship on July 16, 1946, followed by nationalisation under the first Nationalisation Act. The plant's revival was supported by the 1948 Iron and Steel Plan, which was aligned with the Marshall Plan's funding mechanisms, positioning Linz as a key site for commercial steel production. At this time, the already mentioned "LD process" (Linz-Donawitz oxygen steelmaking process), a technological breakthrough that brought Austrian steel into international competitiveness, was developed. By 1955, VÖEST had expanded its operations. With its industrial growth, VÖEST launched extensive social initiatives, including employee housing projects, healthcare services, and in-house childcare, shaping not only the economic but also the social fabric of postwar Linz (voestalpine AG, 2025b).

The dark history, its dusty industrial character, and the interventions during the European Capital of Culture in 2009 make Linz the city it is today. In Austria, especially outside the province of Upper Austria, Linz is often treated as the unloved child compared to its shiny neighbours, Salzburg or Vienna, with their rich histories starting with Mozart and ending with Sissi. However, the complex history and its lingering spirit of rurality, mixed with a dynamic makers' culture, have brought it to where it is today: an innovative and future-oriented place with renowned universities, museums, and a vibrant alternative scene.

After many different slogans already mentioned in chapter 1.5, from "in Linz da stinkts" (its stinky in Linz) to famous slogans like "in Linz beginnts" (it starts in Linz) the recently announced slogan of the tourism agency is the following, this time in English: "Take a risk, visit Linz", which brings the unidentifiable character of the city to the point.

An Invitation to Discover.
Every new experience holds a bit of risk. You never quite know what will happen – but that's exactly where the chance lies: in being surprised. Linz doesn't expect anything, nor does it impose itself on anyone. But those who open up to it will feel a city full of energy, movement, and transformation. Not a fixed image, but an open space for personal discoveries. Perhaps it's just the moment when something special begins.

Figure 32: *The new city branding and strategy* "*Take a risk, visit Linz*"*.* It reflects the many faces Linz has.
© Fredmansky, Martin Stöbich, Tourismusverband Linz.

3.2 MAKE

The following chapter reveals the spatial, infrastructural, and environmental dimensions of the voestalpine steel factory and its context within Linz. It explores the site's strategic position within European transport networks, the industrial landscape of the GLA and its logistics dependencies, and the interplay between private and public spaces. The chapter also highlights areas of transformation, including the coke plant and emerging "wastescapes," and presents findings from spatial analyses that can inform future planning strategies.

Linz lies on the trans-European rail corridor between Munich and Vienna, intersecting a key north-south route linking Berlin, Prague, and Trieste. It also hosts Austria's largest logistics hub and a high-capacity train infrastructure for long freight trains, making it a prime location for logistics-focused enterprises. The GLA benefits from good road connectivity situated at the intersection of major highways A1, A7, and A8. These corridors link Eastern and Western Europe, as well as the North and Southern parts of Europe (Stadt Linz, 2025a).

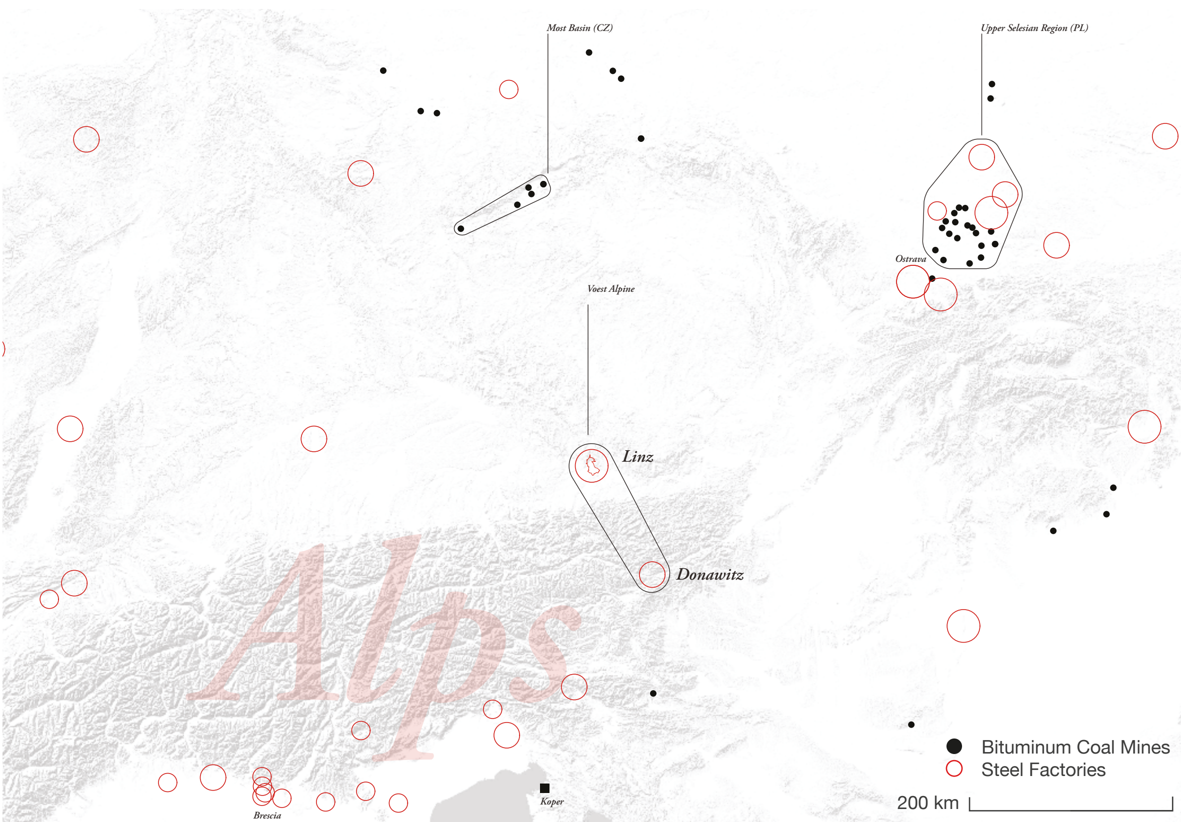
The Port of Linz is equipped with efficient cargo handling facilities spanning an area of around 150 hectares. The transport and transshipment of mineral raw materials, which are particularly sensitive to moisture and contamination due to their hygroscopic nature, are handled by the Linz AG authorities. One transport chain, for example, the Rotterdam Linz one, begins with seaborn in the Port of Rotterdam through the Rhine, Main, and Main-Danube Canal to reach Linz (REWWay, 2025).

Another transport chain is the connection downstream to the Black Sea. Since the outbreak of the war in Ukraine and the insecurity in the Black Sea, the Danube has gained importance as an alternative transport route. Despite its logistical challenges and dependency on weather, the waterway offers a cost-efficient, energy-saving option for moving large volumes of goods compared to road or rail (ARTEde, 2024). However, the differing political and consequently budgetary prioritisation of this mode of transport among the individual Danube states, as well as the modernisation needs of many Danube ports and parts of the Danube fleet makes it also a more complex mode of logistics (REWWay, 2020).

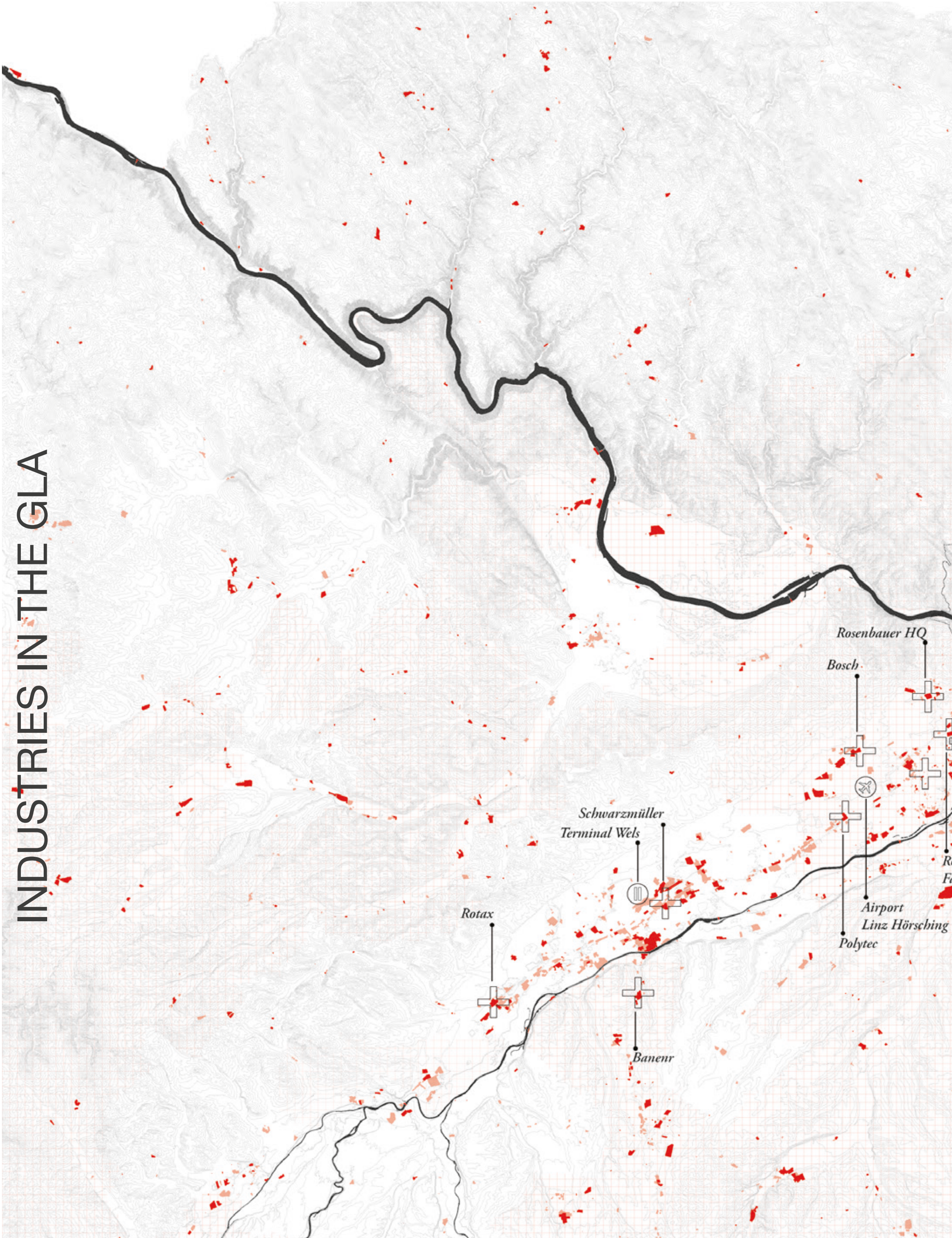
Overall, Upper Austria can be seen as a logistics centre with central supply functions by freight forwarders. Alongside Vienna and Graz, Upper Austria is the third most important logistics centre in Austria. Within Upper Austria, the GLA is the most important industrial region. This area is also home to most of the state's logistics centres. Due to the location of the transport routes and the density of industrial settlements, the greatest pressure on land is also expected here in the future (Schildorfer et al., 2022).

*Current regional trends related to this topic are already elaborated in "Chapter 2.4 Urgencies in the GLA".

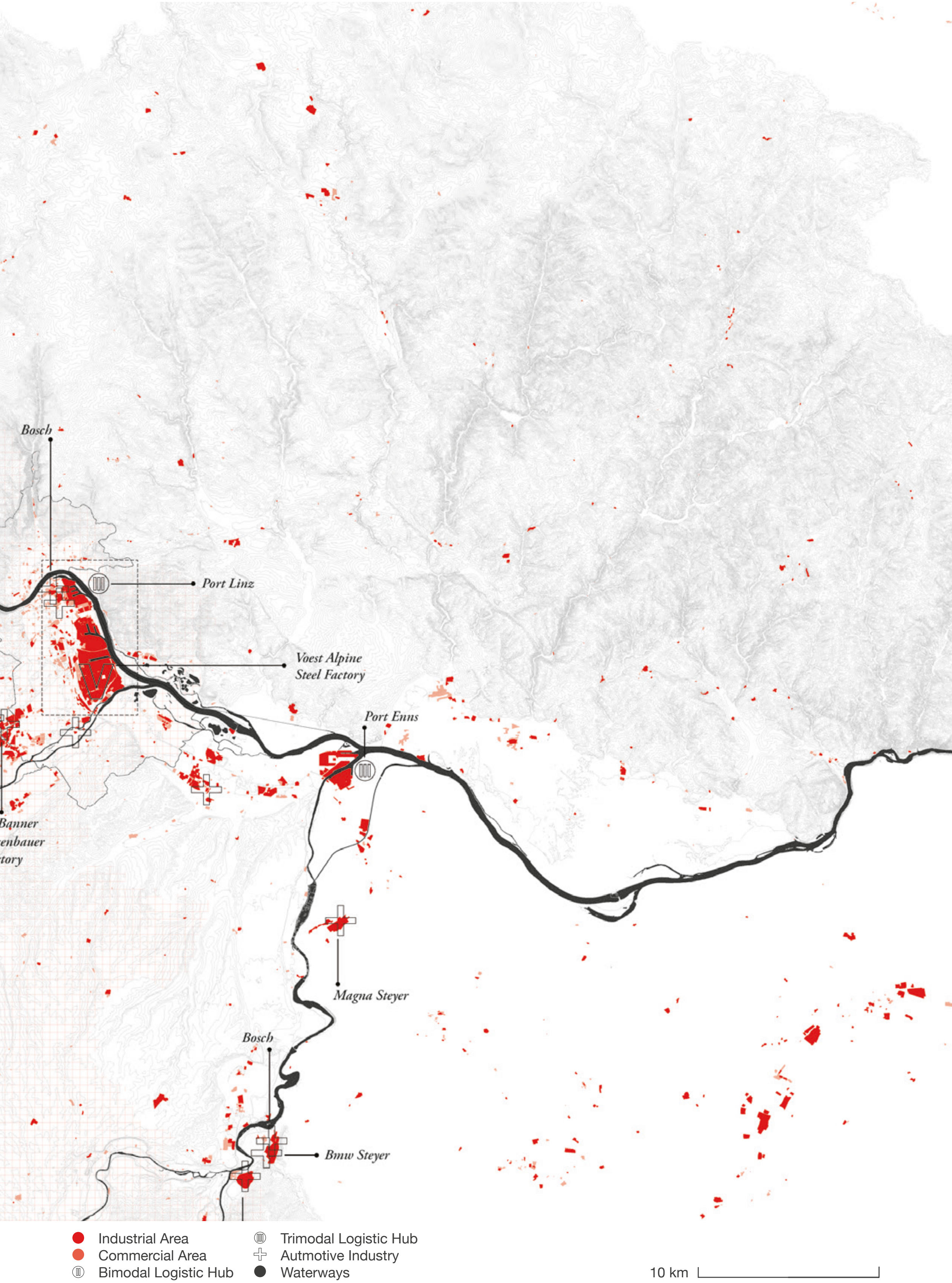

Amsterdam
Rotterdam
Antwerp
NL
BEL
Frankfurt
Berlin
Leipzig
DE
POL
Warsaw
Praha
Ostrava
Katowice
CZ
Brno
Kosice
Rhine - Danube
Nuremberg
Paris
Karlsruhe
Stuttgard
Strassbourg
Inglodstadt
Passau
Linz
Vienna
Bratislava
Budapest
FR
Munich
Salzburg
Innsbruck
Graz
Lienz
Klagenfurt
CH
Udine
Triest
Lubljana
Zagreb
Milan
Verona
Western Balkans
Belgrade
ROU
IT
Bologna
Florence
BIH
SRB
Sarajevo
Danube
Sofia
Rome


Most Basin (CZ)
Upper Selesian Region (PL)
Ostrava
Voest Alpine
Linz
Donawitz
Alps
Brescia
Koper
Bituminum Coal Mines
Steel Factories
200 km

INDUSTRIES IN THE GLA



This map shows the industrial and commercial areas in the GLA with a focus on the biggest Automotive Industries in Austria by value in 2022 and the spatial relationship between the steel factory, logistic hubs and manufacturing enterprises.


Bosch
Port Linz
Voest Alpine
Steel Factory
Port Enns
Banner
enbauer
tory
Magna Steyer
Bosch
Bmw Steyer
Industrial Area
Commercial Area
Bimodal Logistic Hub
Trimodal Logistic Hub
Autmotive Industry
Waterways
10 km

The steel factory and its neighbours

Further investigations focus on the area in spatial proximity to the factory of voestalpine itself, including selected “Steelscapes” like the steel factory itself with its facilities, settlements, transportation infrastructures, public spaces, education facilities, and green infrastructures. The Industrial area of Linz, including the steel factory in the south and the Winterhafen (port) in the north, has a size of approximately 1.200 hectares, which makes 1/8 of the total size of the city’s territory. The industrial zone shows a gradient of increasing functional intensity and a decrease in accessibility from north to south. The area is defined by the Danube in the north and east and by the river Traun in the south, which ends in the northern point of voestalpines’ steel factory into the Danube. It can be seen that there is a clear vertical transition area hosting the highway A7 between the Industrial Area and the city, defined by more commercial and office functions along Industrie Zeile and at voestalpine along the Stahlstraße. To better understand the potential for collaboration, various companies are mapped and preliminarily clustered based on similarities in their production profiles.

Figure 33 - 36: *Types of Making.* The fieldwork revealed within sketching and photographic documentation small-scale, big scale, digital and re purposed manufacturing activities.

Industrial Area
Business Park

1 km

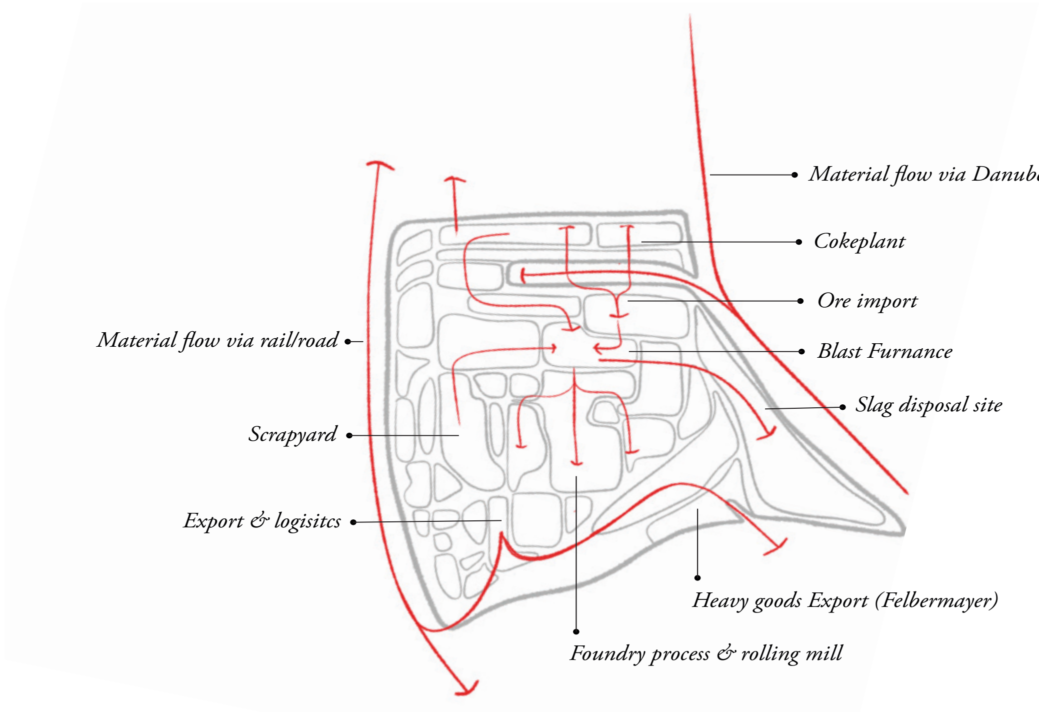
Neigbhbours

small in the north
big in the south

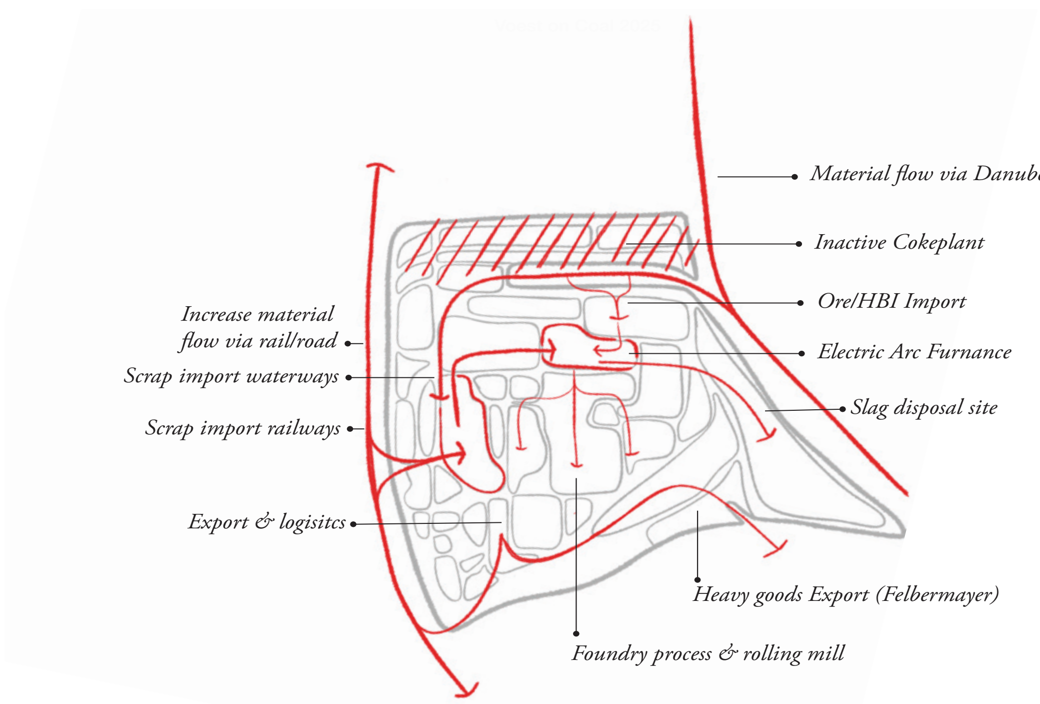
relaxed and intense
industries

- Industrial Area
- Commercial Area
- Area of commercial use more than 1500 GFA

1 km



Voest on coal 2025



Voest on H2 2040

The Potentials of Change
The transition to Greentec Steel implies that certain existing facilities will shift their current purposes. In this context, the 57-hectare coke plant has been identified in this project as a key area of change, representing spatial opportunities within the broader transformation process.

Figure 34: *Gas power plant.* Located on the shores of the Danube on the site of the coke plant.

Figure 35: *Steam as a landmark.* Shaping the skyline of Linz from nearly every angle in the city.

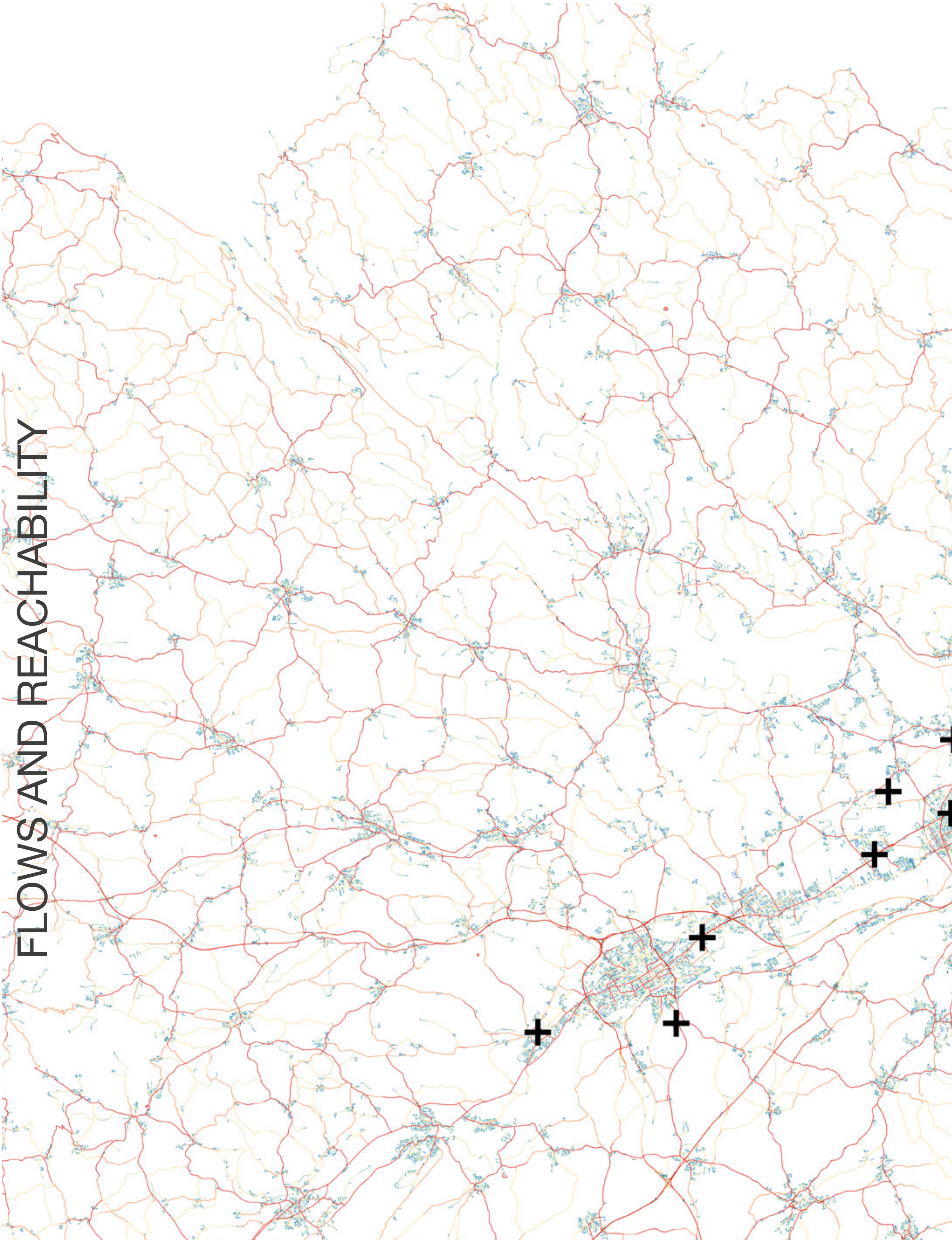
Figure 36: *The steel factory as part of Linz'a idendity.*

Figure 38: *Clash of scales.* New Dynatrace Campus in the Digital Mile next to Livelyhoods.

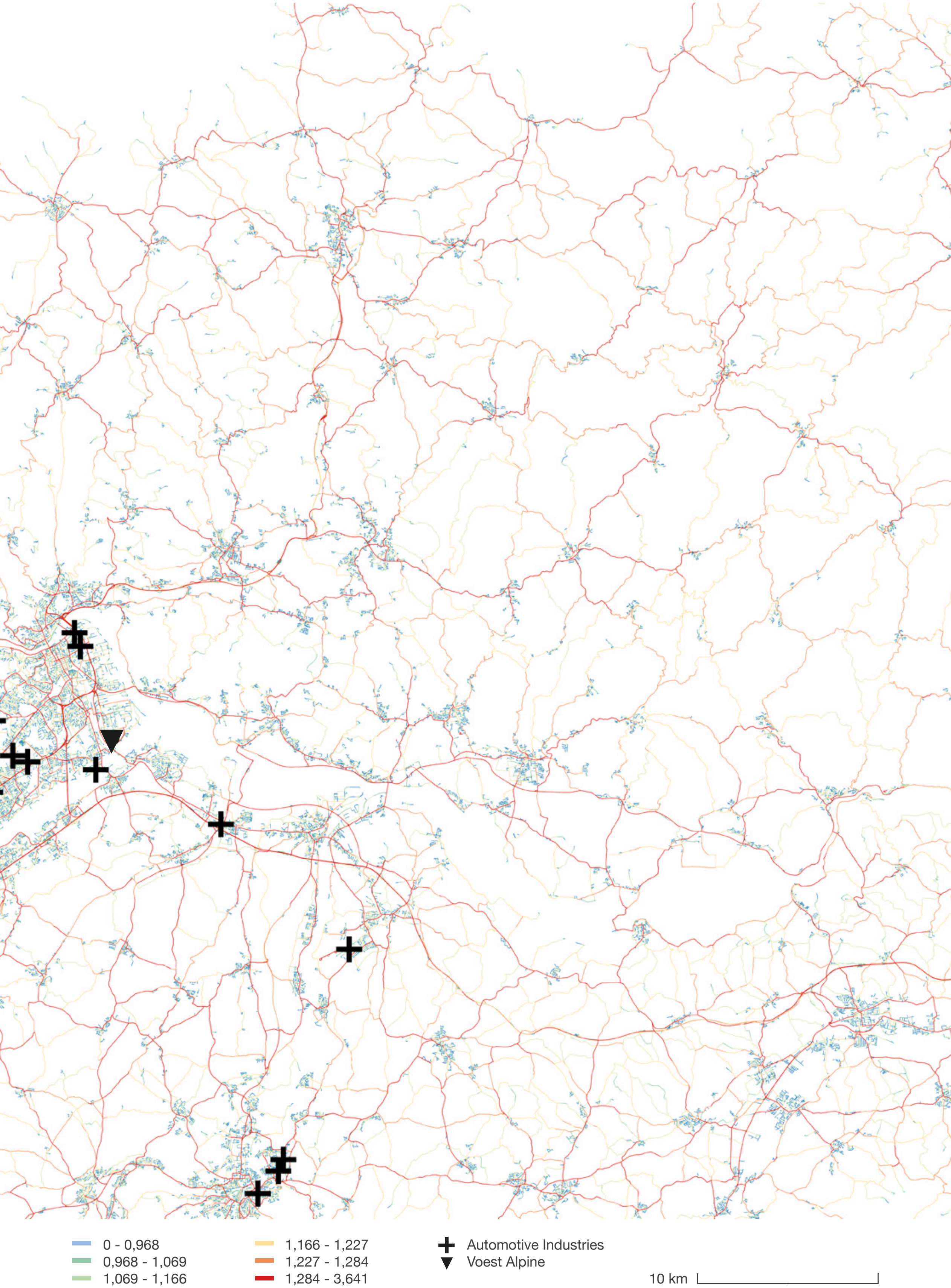
Figure 37: *Steelrelated logisitcs in the GLA.*

Figure 39: *Old warehouses.* Function as cultural spaces for arts and subcultural movements. The grafitti says "Zukunft ist Jetzt" translated "Future is now" in front of the new development in the digital mile "Hafenportal".

FLOWS AND REACHABILITY



This map shows the calculation with a Space Syntax Angular Choice 10k in the GLA with the biggest Automotive Industries in Austria by value in 2022 and the spatial realationship between the steel factory and the polycentric Hinterland.


0 - 0,968
0,968 - 1,069
1,069 - 1,166
1,166 - 1,227
1,227 - 1,284
1,284 - 3,641
Automotive Industries
Voest Alpine
10 km

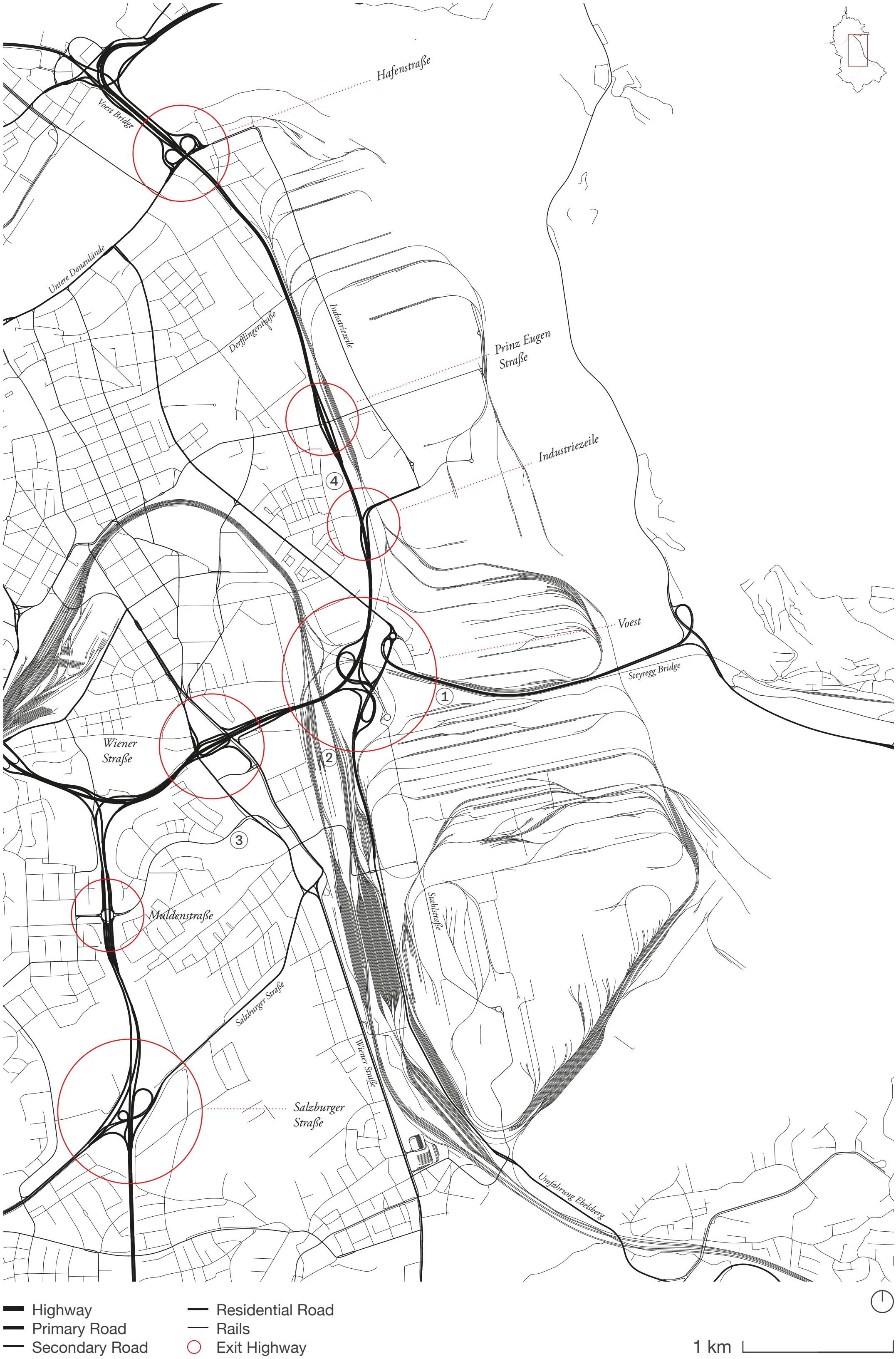
Flows

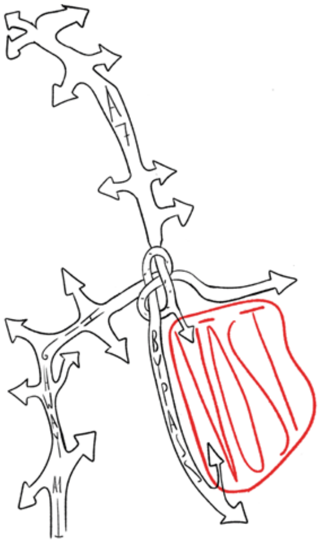
Linz is deeply interconnected with a robust infrastructure network, most notably the A7 motorway, which crosses the city. With seven direct exits serving the area, the A7 provides essential connectivity to the European highway system, enabling the efficient movement of goods and materials across borders.

“Logistics infrastructure often plays a crucial role in a business’ location. This kind of infrastructure can include the national highway network, a canal, a port, an airport, a connection to a logistics hub, a material supplier or a manufacturing cluster” (Vickery Hill et al., 2020, p. 144).

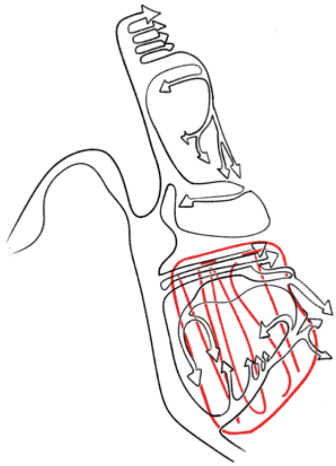
At the local level, these networks often act as physical barriers, fragmenting the urban fabric as experienced during the fieldwork. Highways and rail corridors can hinder slow mobility, such as walking and cycling, and divide neighbourhoods, limiting permeability and access between different parts of the city.

Figure 40 - 44: *Types of infrastructures.* The fieldwork revealed many different infrastructures, which are connecting but disconnecting as well.

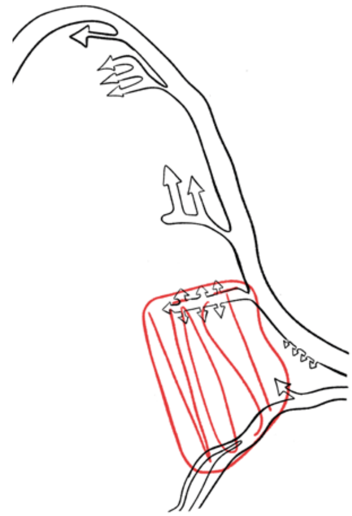

Hafenstraße
Voest Bridge
Untere Donaulände
Derfflingerstraße
Industriezeile
Prinz Eugen Straße
Industriezeile
4
Voest
Steyregg Bridge
1
Wiener Straße
2
3
Muldenstraße
Stahlstraße
Salzburger Straße
Wiener Straße
Salzburger Straße
Umfahrung Ebelsberg
Highway
Primary Road
Secondary Road
Residential Road
Rails
Exit Highway
1 km



Attached
Roadnetwork



Interwoven
Railnetwork



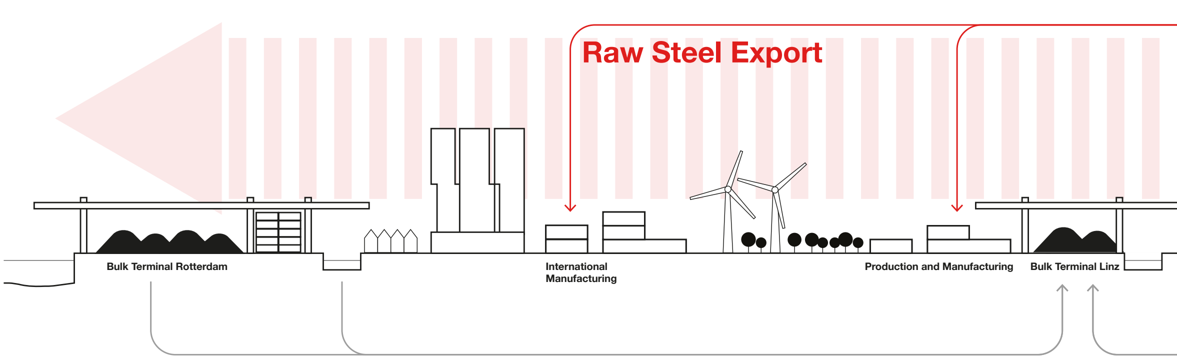
Input - Output
via Danube

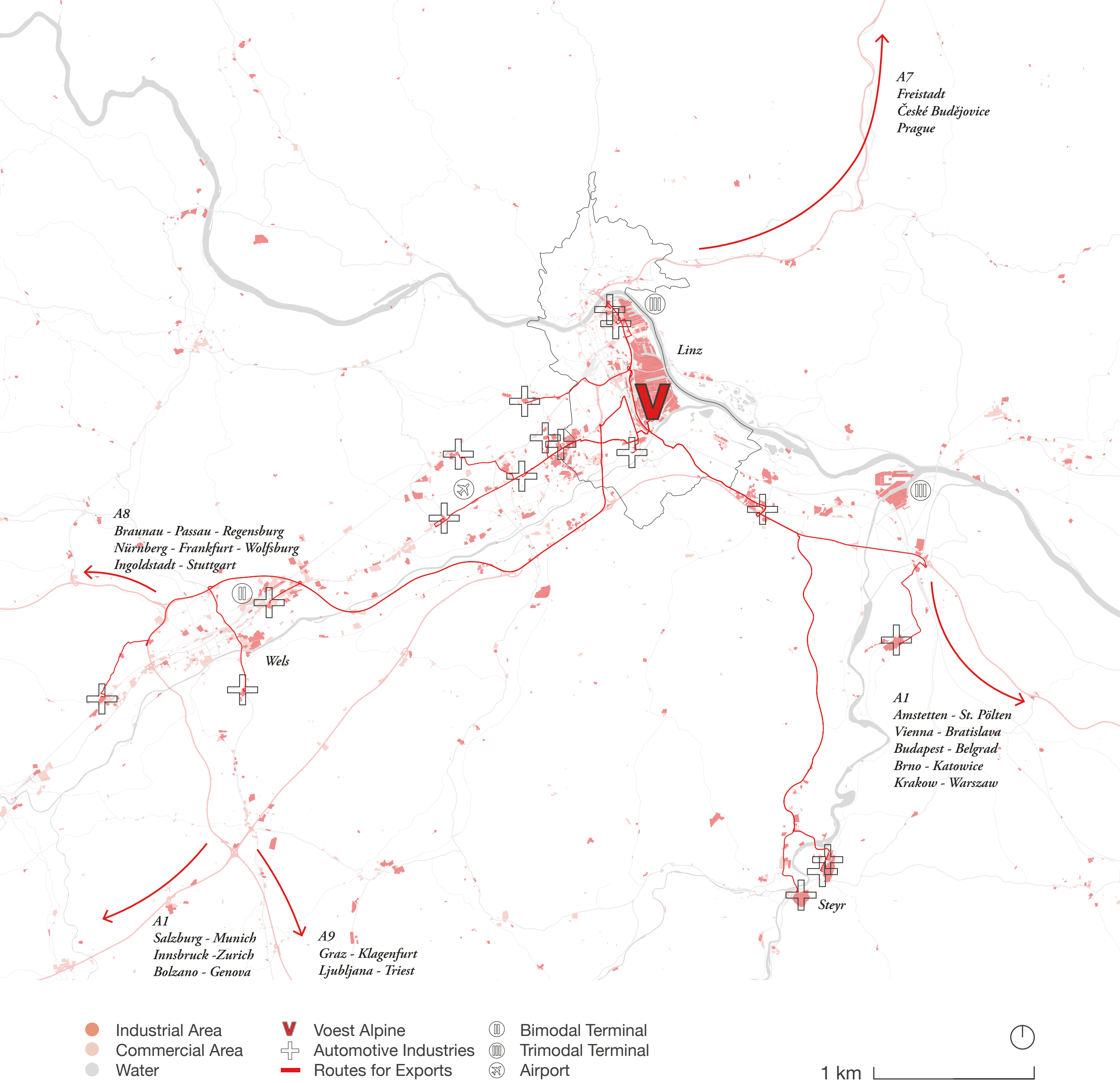
4-14389
14389-18612
18612 - 21711
2171 - 24709
24709 - 28270
28270 - 33290
33290-62087

1 km

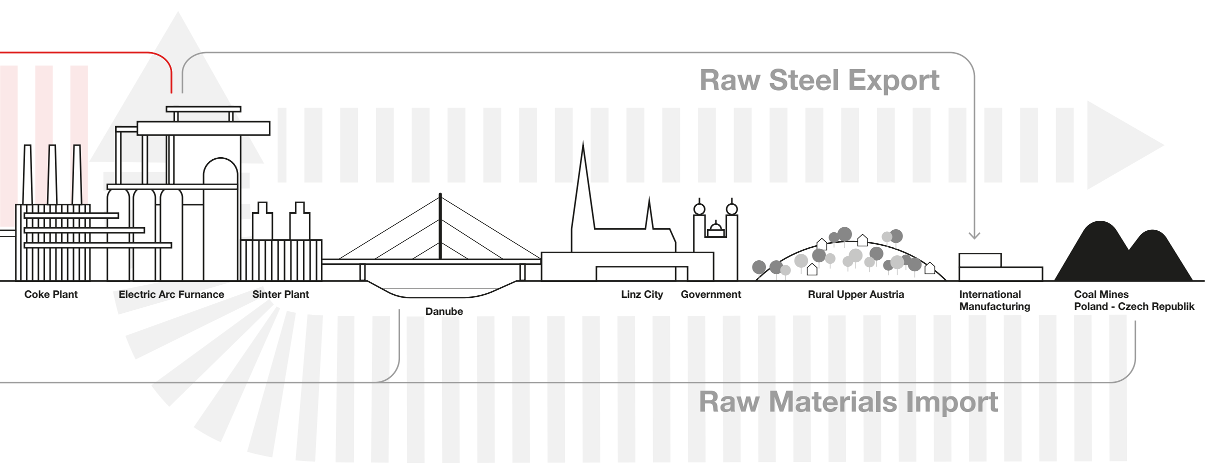
Dependencies in the Region

The majority of goods and materials used in the steel production process are imported primarily via rail and waterways. A significant portion of the output, however, is exported by road, affecting the local transportation network. It is estimated, that a large share of these road-based exports is destined for nearby manufacturers as well as manufacturers located within the range of freight transport by truck abroad. This reveals the annual report of voestalpine (voestalpine AG, 2024).

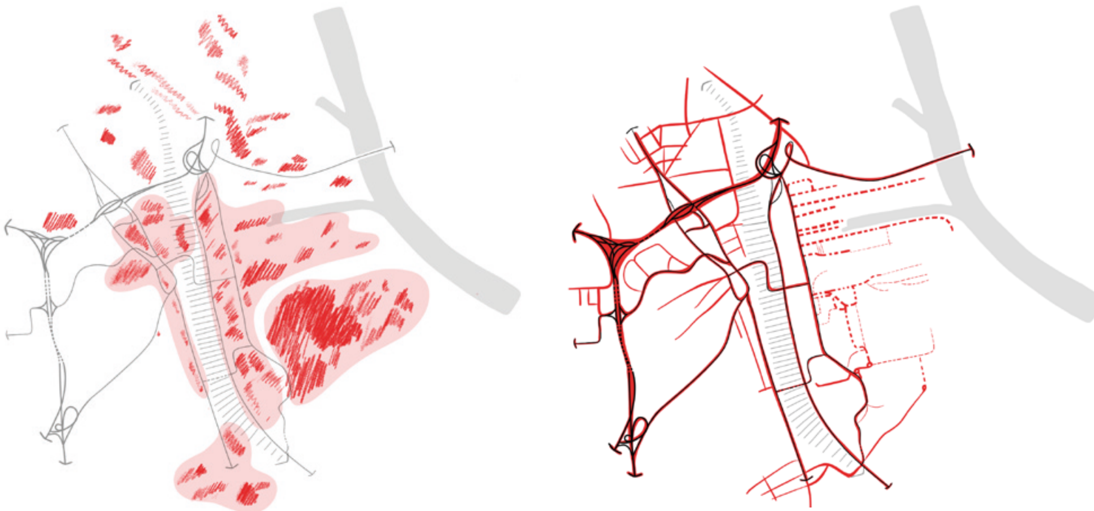




A7
Freistadt
České Budějovice
Prague
Linz
A8
Braunau - Passau - Regensburg
Nürnberg - Frankfurt - Wolfsburg
Ingoldstadt - Stuttgart
Wels
A1
Amstetten - St. Pölten
Vienna - Bratislava
Budapest - Belgrad
Brno - Katowice
Krakow - Warszaw
Steyr
A1
Salzburg - Munich
Innsbruck -Zurich
Bolzano - Genova
A9
Graz - Klagenfurt
Ljubljana - Triest
Industrial Area
Commercial Area
Water
Voest Alpine
Automotive Industries
Routes for Exports
Bimodal Terminal
Trimodal Terminal
Airport
1 km



Raw Steel Export
Coke Plant
Electric Arc Furnance
Sinter Plant
Danube
Linz City
Government
Rural Upper Austria
International Manufacturing
Coal Mines Poland - Czech Republik
Raw Materials Import

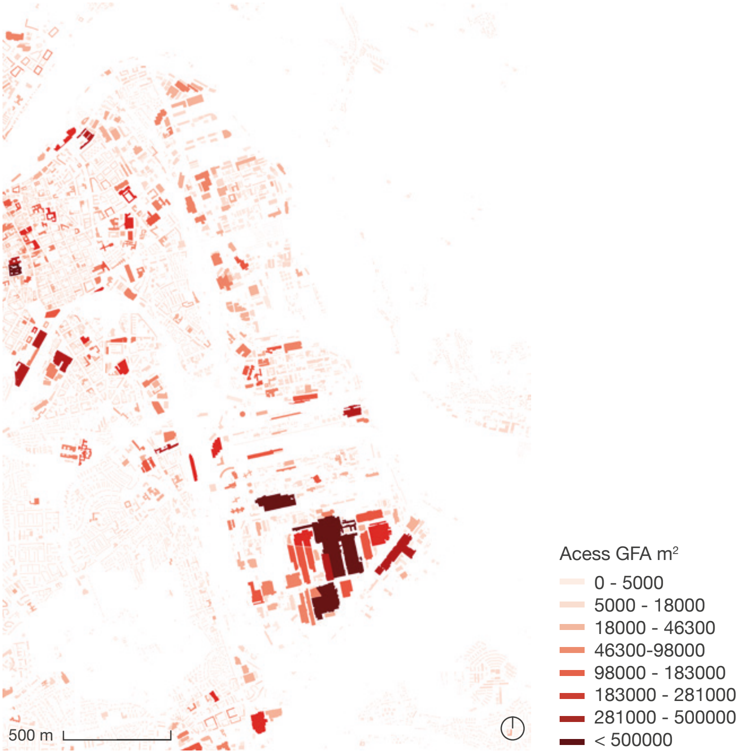


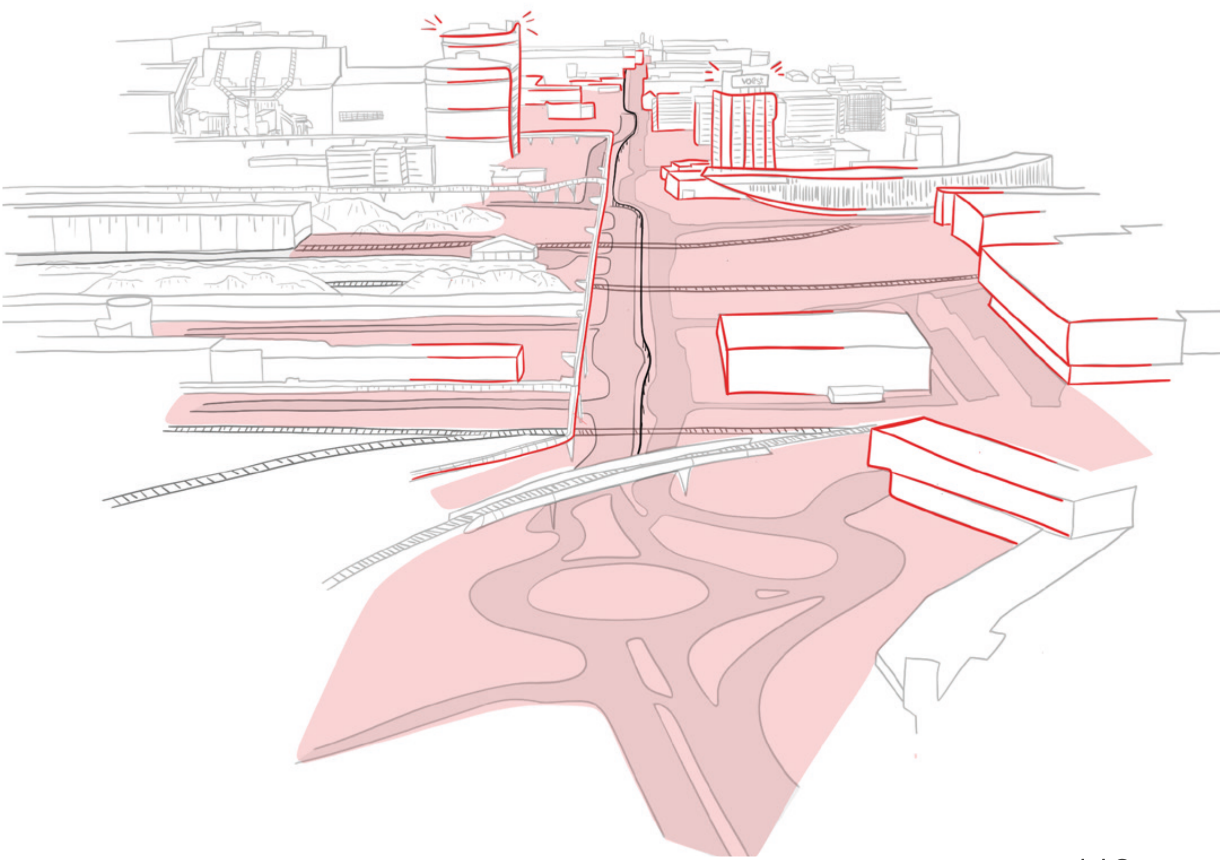
Network analysis

To gain an understanding of the street network, space syntax was used to analyse accessibility and centralities within the urban fabric. Within a metric radius of 10 km, an Angular Integration was calculated to understand the accessibility for vehicular traffic, freight movement, or regional flow (Vaughan et al., 2025). The darker the lines in the map (page 109), the higher the centrality of the place is.

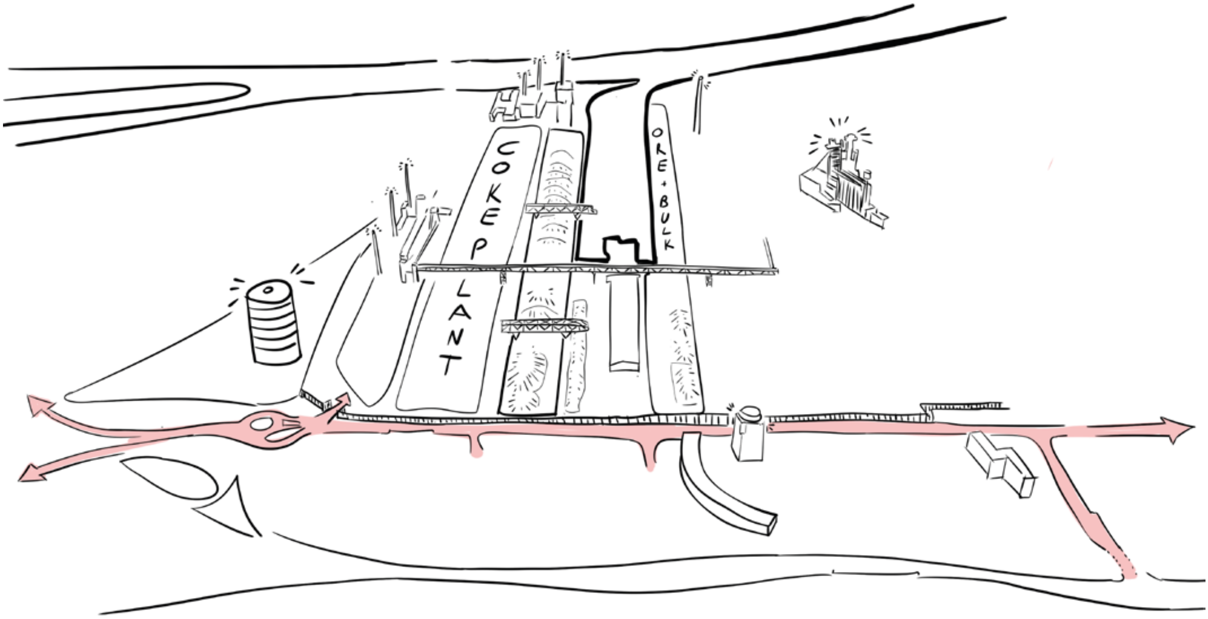
Furthermore, the Gross Floor Area (GFA) of buildings was calculated and interpolated with the results of the space syntax PST Reach analysis (KTH School of Architecture et al., 2019) to assess spatial accessibility within a 10 km radius. The resulting map visualises buildings in varying shades, where darker shades indicate higher reachability of a high amount of Cross Floor Area.

The Stahlstraße functions as the central backbone of the publicly accessible space of the steel factory hosting its main entrance. “Loading docks accessed directly from the street generally require buildings to be set at some distance back from the front boundary. This makes the public street space appear oversized, messy, and sometimes dangerous” (Vickery Hill et al., 2020, p. 75).


Acess GFA m²
0 - 5000
5000 - 18000
18000 - 46300
46300-98000
98000 - 183000
183000 - 281000
281000 - 500000
< 500000
500 m



Public or Private?
The factory of voestalpine is private property, and most parts of the site are not accessible to the public. However, the public face of the voestalpine steel factory, an area where administrative buildings like the headquarters, the museum, the human resources office, the apprentice workshop, and various other industries connected to steel production are located, is publicly accessible. Described in the Pattern Language of Foundries of the Future, "Public façades and street related spaces allow both clients and the general public to have an insight into what is being produced on the site" (Vickery Hill et al., 2020, p. 178). In this case, this does not mean, that they are public spaces like other open accessible spaces in the city. During the fieldwork and photographic documentation, security staff stated that photography was not permitted due to the site's regulations. To make accessibility easier for workers, there is the possibility to enter the fenced area at gate C, where they can enter directly by car.


COKE PLANT
ORE + BULK

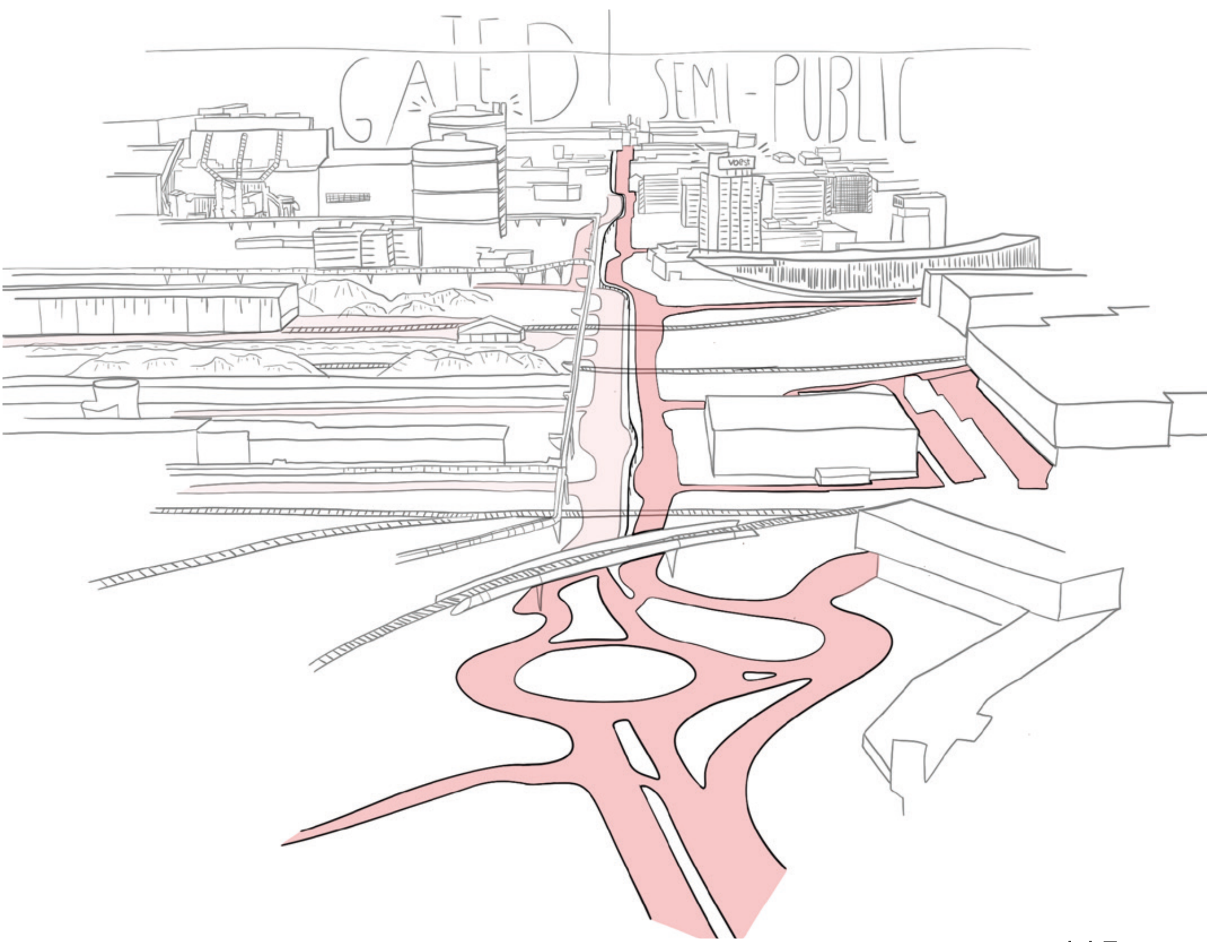

GATED
SEMI-PUBLIC

Figure 45: *Main character voestalpine.* The steel factory also reffered as "Stahlwelt" (steel world) functions like a district.


Figure 46: *Transition spaces between industries, allotment houses and highway nodes.*

Figure 47: *Infrastructure acting as a seperator between settlements, factories and cultural uses.*

Figure 48: *Undergoes for slow traffic to overcome massive infrasturctures next to piplines.*

Figure 49: *Exit Bindermichl towards Spallerhof.* One of the workers settlements developed by the Nazis for the Hermann Göhring Werke. Today a green and attractive neighbourhood.

Figure 50: *Liminal spaces*. Environments underneath the highway node *Knoten Voest*.

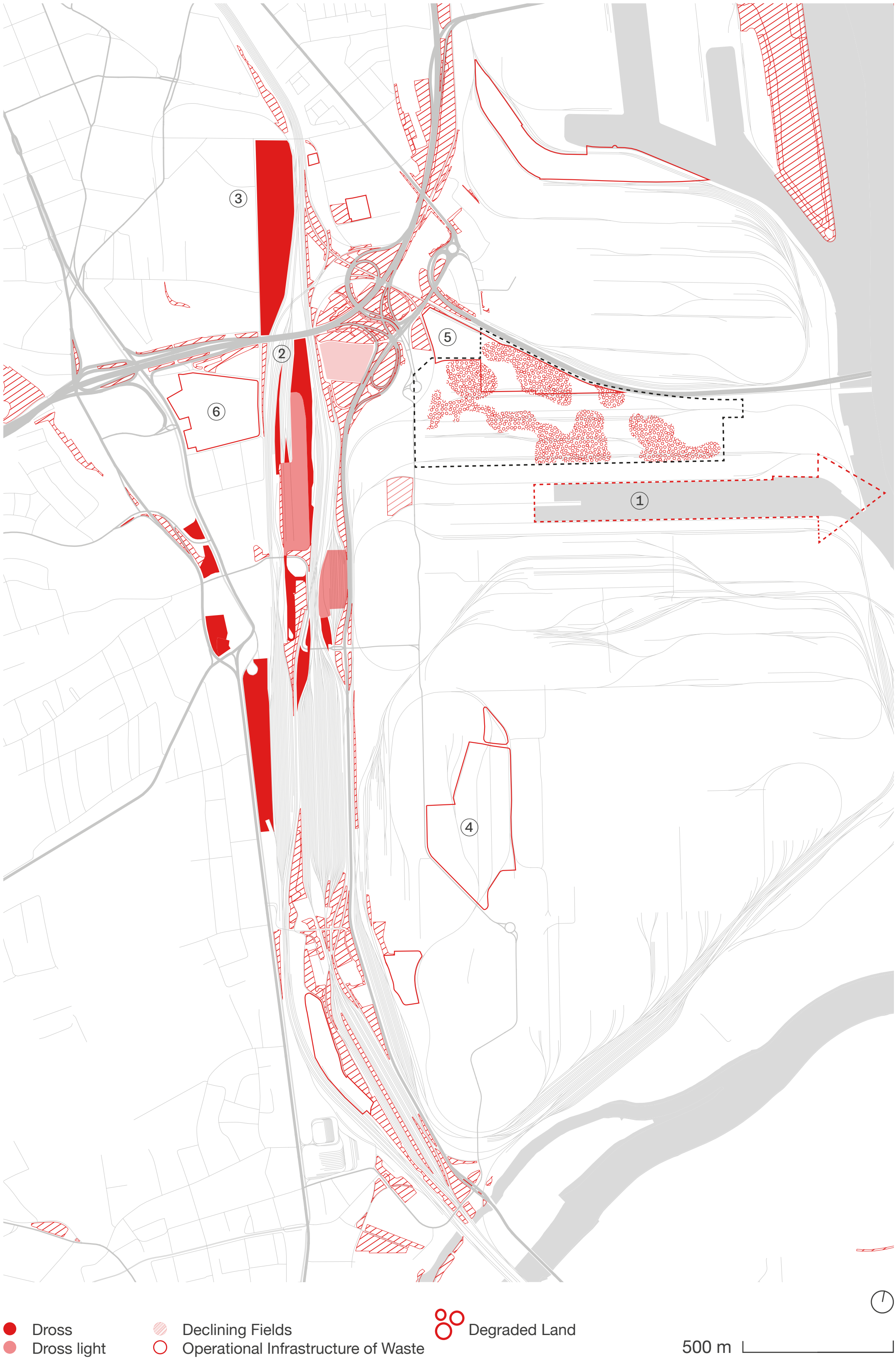
Wastescapes

Due to the extensive infrastructure required to support the steel factory and other industrial facilities in Linz, fragmented spaces have emerged between these large-scale areas. One way to define those spaces in terms of environmental conditions and impacts is through the concept of Wastescapes, areas that emerge as a consequence of unsustainable, linear growth patterns and their spatial impacts within the framework of urban metabolic flows and related infrastructure (Amenta & Van Timmeren, 2018, p. 1). These areas are often underutilised or abandoned, as their current condition describes them as unusable. Revitalising them typically requires often costly interventions to restore their value and functionality.

The concept of wastescape regeneration embraces the landscape's opportunities and territorial conditions, and can be clustered in six different categories (Amenta & Van Timmeren, 2018; Geldermans et al., 2017)

- **Degraded Land** – Soils that lost fertility due to human activity.
- **Degraded Water** – Polluted water bodies or areas under hydraulic pressure.
- **Declining Fields** – Abandoned/vacant parcels and vulnerable soils.
- **Settlements and Buildings in Crisis** – Obsolescent, neglected, or illegally built structures
- **"Dross" of Facilities and Infrastructures** – Disused infrastructures like old factories or train yards
- **Operational Infrastructure of Waste** – Active waste management facilities such as landfills, incinerators, and transfer stations. (Amenta & Van Timmeren, 2018, p. 8)

The focus lies in this research on SC on Degraded Lands, like the area of the coking plant (1); Degraded Water, like the canal in the material port (2) for the coking plant; Declining Fields, like the vacant parcels between the railyards (3); Dross, like the abandond trainyard north of the highway bridge (4); and Operational waste infrastructure, like the scrapyard (5), the soil recycling or soil treatment plant ground unit (5), a recycling cluster, and the headquarters of the public utilities company Linz AG (6).



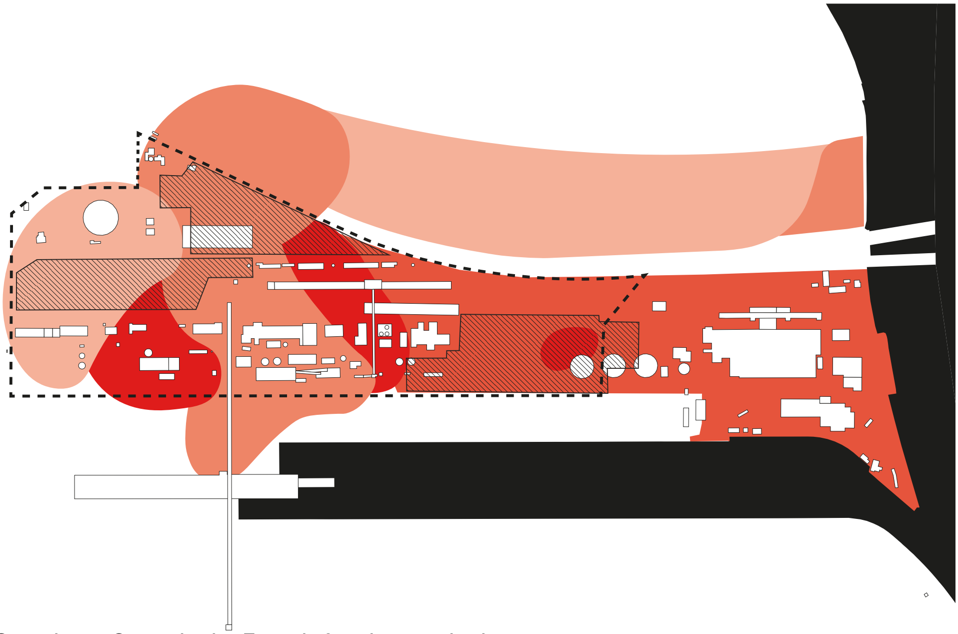
3
2
5
6
1
4
Dross
Dross light
Declining Fields
Operational Infrastructure of Waste
Degraded Land
500 m

Degraded Land – The coke plant

A report from the Environment Agency Austria from 2023 reveals the decontamination efforts in 2015 of the heavily polluted site of the coke plant as part of the voestalpine steel factory. It covers around 350,000 m² and has been in operation since 1942. There is a history of contamination events, including bomb damage during World War II and various operational incidents in the decades after. These events led to widespread soil and groundwater pollution, primarily from coal tar, polycyclic aromatic hydrocarbons (PAHs), and aromatic hydrocarbons such as BTEX compounds (benzene, toluene, ethylbenzene, and xylenes).

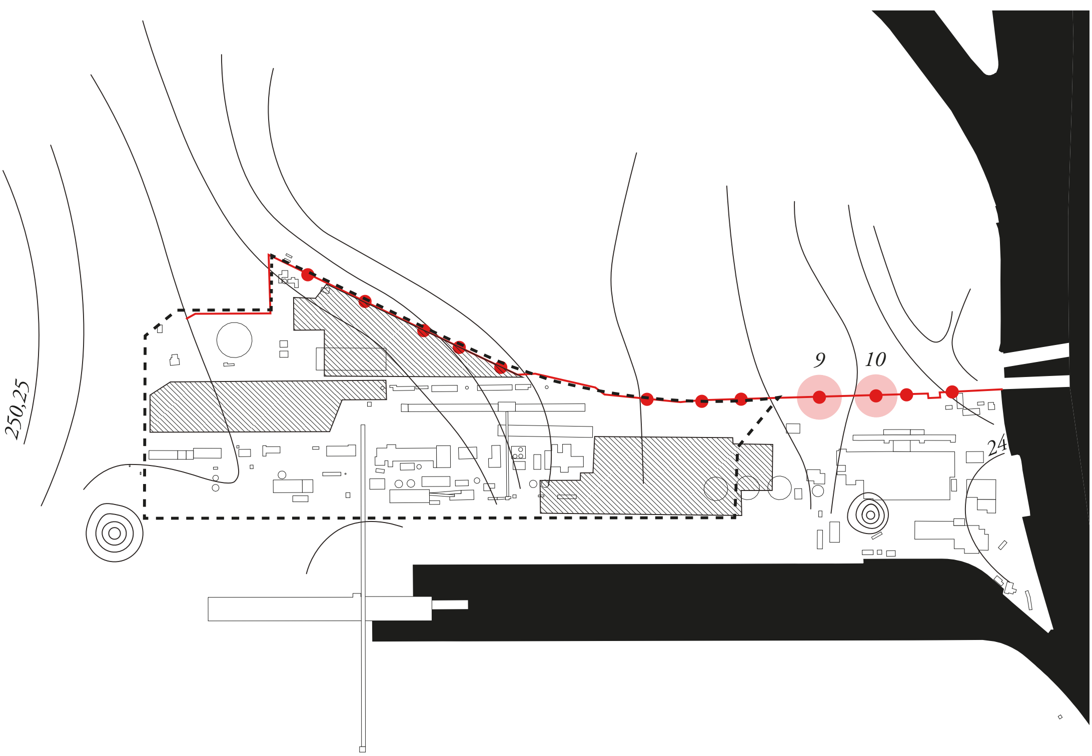
Investigations revealed contamination in the subsurface, with an estimated 1,000 to 2,000 tons of PAH-15 in heavily impacted areas. Affected zones included the benzene refining plant, the former tar distillation area, and the coal by-product recovery facility. The contamination resulted in a groundwater pollution extending over 700 meters, with daily pollutant fluxes of around 1 kg of PAHs and up to 200 g of benzene, levels far exceeding threshold values for environmental concern.

In 2011, remediation and containment measures were implemented. These included excavation and treatment of "hot spot" zones (see Figures on the right) with highly contaminated soil, soil vapor extraction (SVE) to remove volatile BTEX compounds, and phase separation to extract floating and dense non-aqueous phase liquids (e.g., coal tar). In 2015, a "funnel-and-gate" system was implemented to hydraulically contain and treat contaminated groundwater. This system features a 1,650 m long impermeable wall with activated carbon filter sections (gates) that clean the groundwater as it flows through. The objective of the remediation efforts was not full restoration of pre-conditions, which is considered unfeasible due to the extent and depth of the contamination. Rather a substantial reduction in emissions, control of contaminant spread, and preservation of the site's industrial usability. Despite the impossibility of complete cleanup, the measures are considered effective and essential for mitigating long-term environmental and human health risks. However, recent measurements fluctuated. Some gates showed temporary increases in pollution, but most were not consistent. Gate 4 needed maintenance, and Gates 9 and 10 showed rises later. In conclusion, any future use or structural modifications at the site must carefully consider potential risks related to existing contamination. Changes such as removing surface coverings could increase exposure hazards (Umweltbundesamt, 2023).



Summary of Groundwater Contamination Zones before decontamination

Low pollution
High pollution
Vey high pollution
Massive pollution
Areas of soil excavation
Area of investigation



Gate and Funnel System

Groundwater level
Gates
Water
Areas of soil excavation

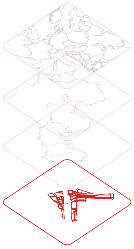
350m

Figure 51: *In-between leftover space.* Neglected and often degraded spaces between infrastructures.

Figure 52: *Down-under.* Undefined spaces between large scale infrastructures, ecosystems and manufacturing.

Figure 53: *Declining fields.* Between the steel factory, rail yards, and a logistic center large wastescapes appear.

Figure 54: *Productive stripes.* Empty spaces, spaces for logistics, and space for creativity creating the atmosphere.



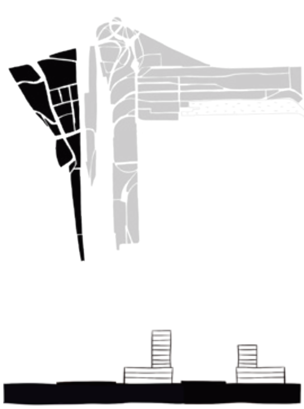
Conclusion

Findings from a making perspective are that big-scale industries, besides their big footprint, require a massive spatial amount of additional infrastructure like road networks, rail networks for input and output, waterways for cooling and transportation purposes, or recycling facilities to process residues. Based on the local condition of being directly attached to the City of Linz makes the steel factory part of the city's urban system and therefore functions like a district. This comes with challenges like sharing road infrastructures or the impact of uncertainties, like floods, due to the location along the Danube.

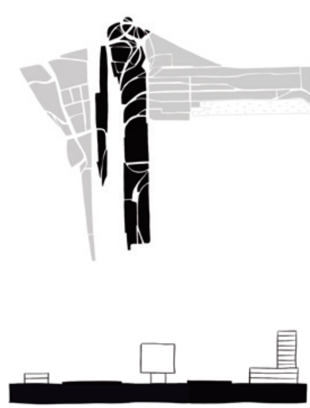
Areas along the main road infrastructures of the factory are well connected and contain underutilised plots and areas with low built density, showing potential for new spatial strategies. Existing clusters of businesses with similar product ranges are already present, indicating a foundation for industrial symbiosis. As trends toward circular economies and the shared use of goods and materials continue to grow, these practices will demand significantly more space than is currently designated. Therefore, these plots could serve as flexible zones for collaboration, storage, exchange, and other city-wide circular functions enabling a more adaptive and resource-efficient urban fabric.

In the light of the energy transition shifting towards a non-coal-driven steel economy, the factory's coke plant was identified as a key location for developing alternative spatial perspectives due to its massive coal storage areas and its bulk cargo port connected to the Danube.

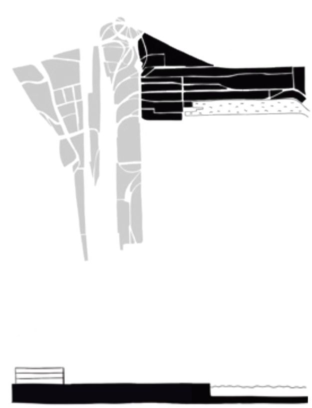
To understand the spatial dimension of the steel factory and the scope of this research better, three key areas emerge on the district/neigbourhood scale.



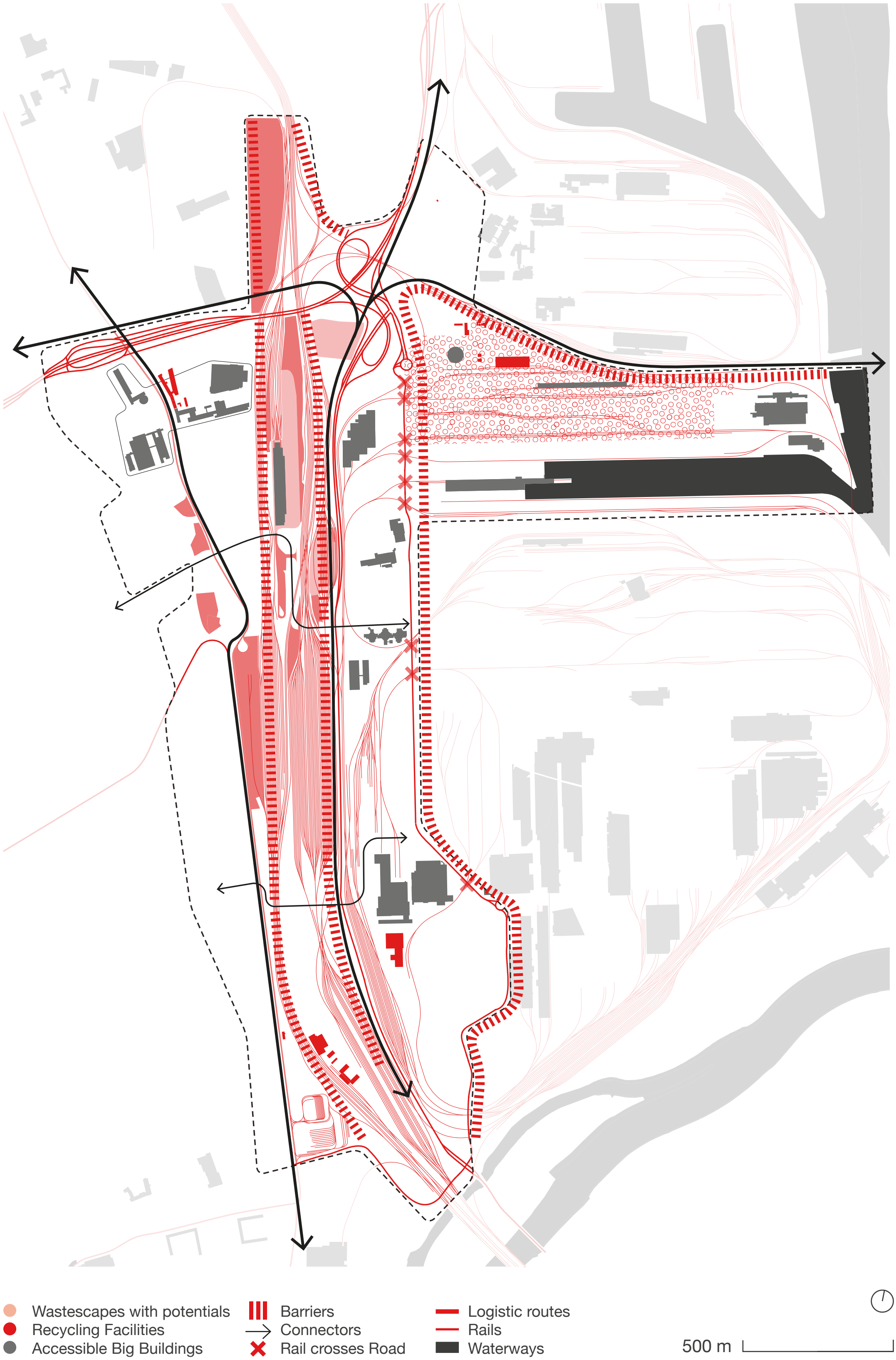
Wiener Straße x Turmstraße



In Between



Coke Plant


Wastescapes with potentials
Recycling Facilities
Accessible Big Buildings
Barriers
Connectors
Rail crosses Road
Logistic routes
Rails
Waterways
500 m

3.3 LIVE

This chapter describes the dynamics of Linz as a “Drive-in City” (Novotny, 2025), highlighting its role as a regional employment hub shaped by commuter flows from the surrounding hinterland. It investigates the tension between regional connectivity and local fragmentation caused by car-centric infrastructure, diverse settlement structures, and spatial qualities around the steel factory and its neighbors. Furthermore, accessibility, environmental challenges such as noise, air pollution, and urban heat will be analysed. Additionally, it addresses the disconnection of ecological habitats.

Drive-in City

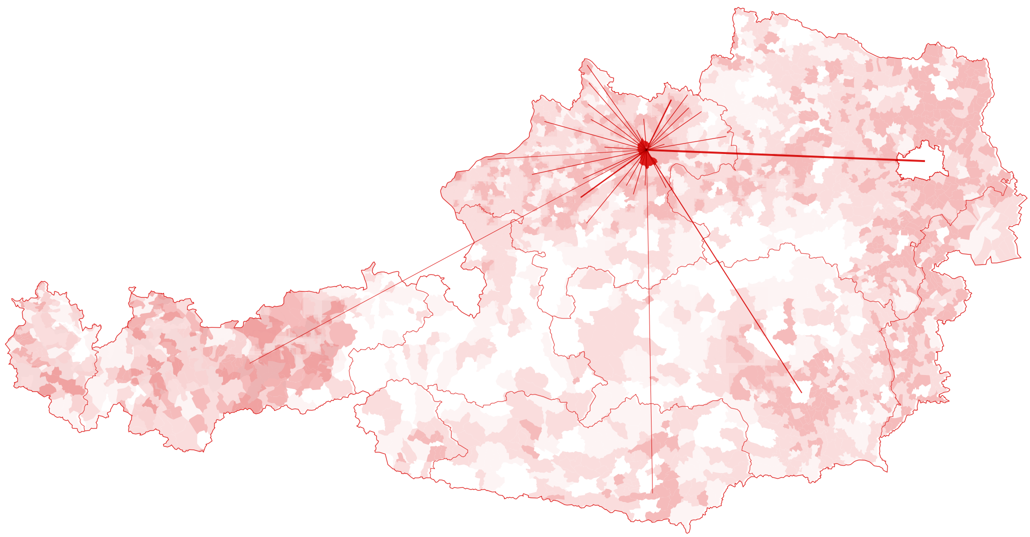
Linz serves as an economic center for the province of Upper Austria, with approximately 210,000 jobs. It is a key employment hub, not only for the city itself but also for the surrounding hinterland with more than 109.000 daily commuters according to Statistics Austria. This means that every 6th worker is not from Linz (Stadt Linz, 2024).

In 2022, a report by the province of Upper Austria reveals that in total, approximately 201.700 trips lead into the city of Linz daily. The majority is operated by the automobile with a share of 69.3 %. Only 20,9 % of the trips are facilitated by public transport (Gesamtverkehrsplanung und öffentlicher Verkehr, 2022). This underlines the importance of the hinterland’s role in the urban systems of Linz, affecting main corridors like highways, roads and the public transport system.

Infrastructure projects

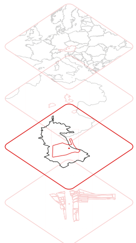
To overcome these massive numbers of commuters, the City of Linz and the Province of Upper Austria developed the idea of a bypass project called Westring. Based on a car-centric 1970s planning model, the Westring project has faced strong opposition, including over 23 citizen initiatives. Delayed for decades due to public resistance, legal issues, and rising costs, the project was approved in 2011. Critics warn that the project will increase car traffic by 30.000 cars daily, ignoring climate targets that call for 150.000 fewer car trips in Linz (ORF.at, 2023). Another major project is the development of a new light rail line S6, which will connect Linz’s main station with the Mühlkreisbahnhof. In addition, the new S7 line will branch off toward Auhof, with future expansion planned toward Gallneukirchen/Pregarten, improving access to educational institutions in the region. At the heart of this network is the new Urfahr-Ost transit hub, designed to accommodate up to 20.000 daily transfers. This hub will serve as an interchange between regional trains, trams, and the new trolleybus line (Schiene OÖ GmbH, 2025).

*Current regional trends related to this topic are already elaborated in “Chapter 2.4 Urgencies in the GLA”.



Share of out-commuters (in % of the employed population at place of residence)

"In Linz, thinking and doing go hand in hand. It's not a city that erects social barriers or marks territories. Newcomers from the Innviertel, Hausruckviertel, Mühlviertel, and Traunviertel (Hinterland) don't first have to learn refined urban manners or decode hidden social codes to get involved. It's the opposite: a city where pragmatic people from rural areas roll up their sleeves and get to work without fuss. Assembling, producing, realising. However, most of them return to the countryside afterward. This means that Linz rarely gets a break from the constant, nerve-wracking presence of car traffic. A drive-in city for the surrounding region" (Novotny, 2025).

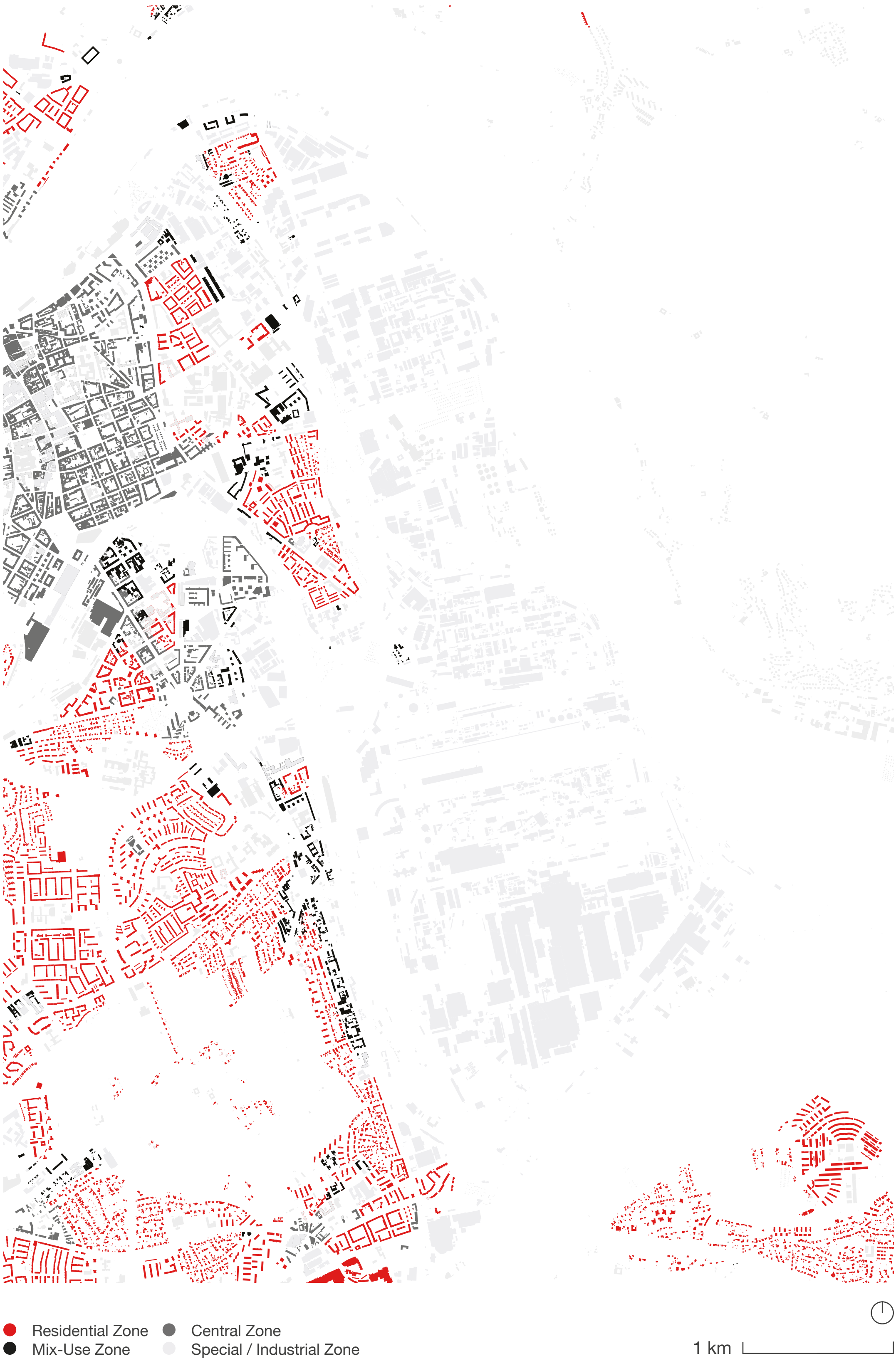


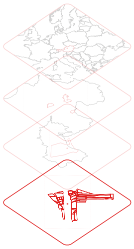
Settlements

Linz functions as an important place for commuters to work. Still, there is a significant amount of housing in the city. The map on the right shows the built environment in relation to its land use. The "Kernzone," shown in dark grey, represents centrally located mixed-use areas, which can mostly be seen as the oldest parts of the city, like the historic city center in the north. Red areas indicate residential zoning, which aligns with major settlement developments in the north during and after World War II, driven by the growth of the steel industry and many other industrial enterprises. An important and historically relevant connection is the highstreet Wiener Straße (see smal drawing right)w, which has linked Linz with Salzburg and Vienna since the Habsburg era. This axis still functions as a key corridor along which the city expanded in the past.

Looking more closely at the area around the steel factory, different types of settlement structures can be identified. First, Wiener Straße functions as a high street, connecting the city center with the hinterland and supporting multiple mixed-use functions but also functions as a transition area (Vickery Hill et al., 2020) to the inustiral zone. Second, the "Arbeitersiedlungen" workers' settlements were established by the Hermann Göring Werke as housing for workers, designed with holistic planning principles and forming cohesive ensembles. Third, between these two types, lie the backyard settlements, mostly low-density single-family homes with private gardens.

Wiener Straße as important corridor for the morphological development of Linz


Residential Zone
Central Zone
Mix-Use Zone
Special / Industrial Zone
1 km



Accessibility

To gain an understanding of the human networks, the space syntax method was used already described in Chapter 3.2 Make , but with different parameters. Within a metric radius of 800 meter, an Angular Choice Space Syntax was calculated to understand the 'trough movement'. "When applying various metric radii for the angular choice analysis, the following results are obtained. For a small metric radius, the local main routes of local centres of a city are highlighted. This applies, for example, for radii of 400, 800, or 1,200 m" (Nes & Yamu, 2021, p. 66). In this example, it means that the darker the line is (see map on the right) the higher the probability is that the route is chosen by a pedestrian. It also shows a clear concentration around the Wiener Straße and highlights the railyard between the city and the steel factory.

The map below (left) shows the quality of public transport access, reffered to as the "Public Transport Quality Class Model" (ÖROK, 2025). It is clear that Wiener Straße, with its major tram and bus lines, functions as an efficient transportation corridor, while the industrial area in the east is clearly disadvantaged. Patterns of low accessibility also appear in the areas of the backyard settlements.

To better understand the density at the plot level, the Floor Area Ratio (FAR) was calculated (map below right). It can be seen that the main corridor along Wiener Straße has a higher density compared to the areas in the second row. However, fragments of low-density plots remain long on this axis, indicating a potential for re-densification. The lowest densities are found in the backyard settlements with values below 1.

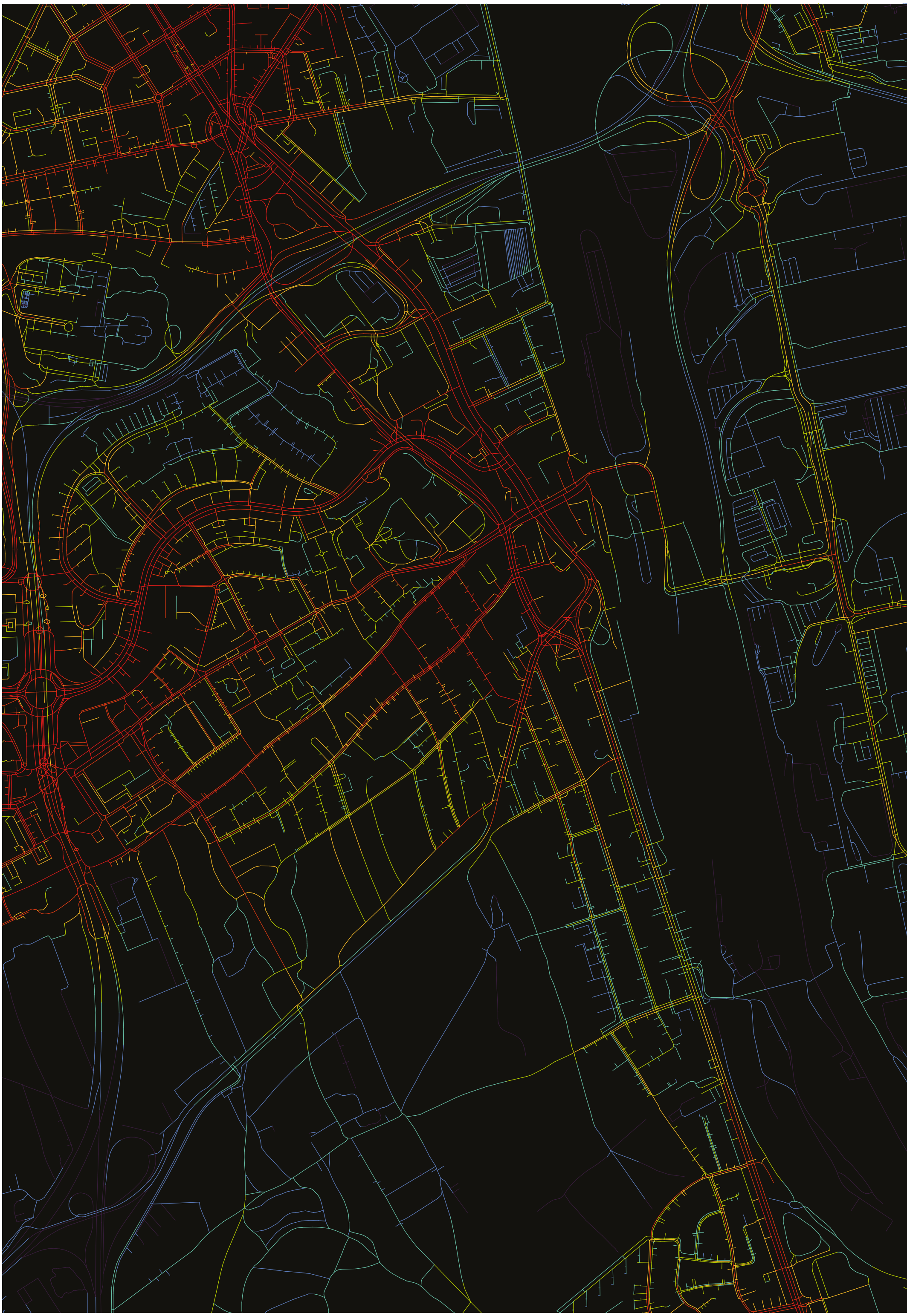
Public Transport Access (A highest level - G basic access)

A (urban) — B (urban) — C urban/rural — D urban/rural — E rural

Floor Area Ratio (FAR) per Plot

0 - 1 — 1 - 3 — 3 - 5 — 5 - 10 — 10 +

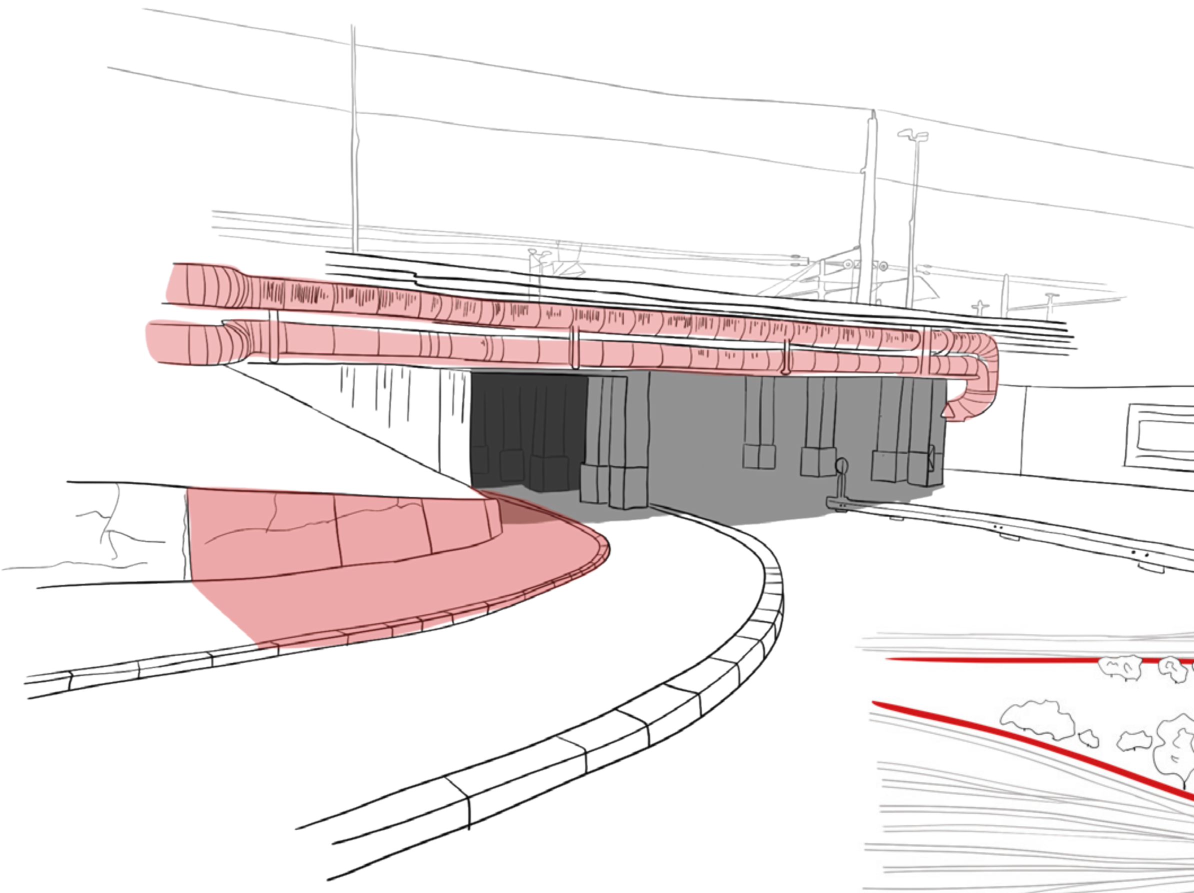
500 m

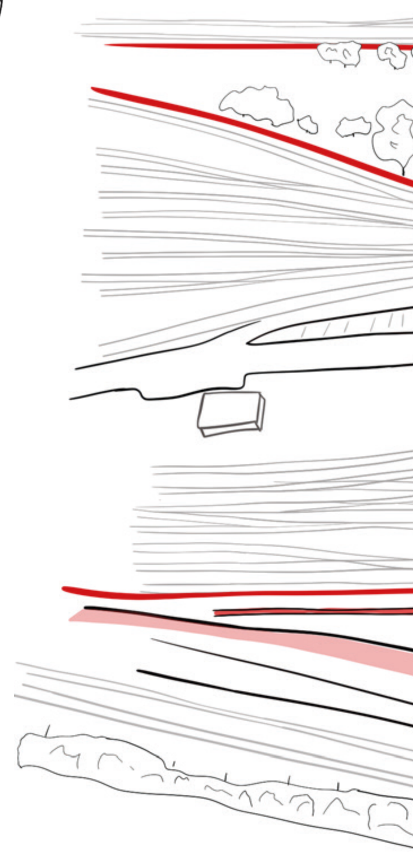


Space Syntax - Angular Choice 800

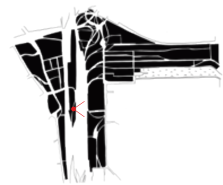
0,919 - 1,049
1,049 - 1,132
1,132 - 1,206
1,206 - 1,286
1,286 - 4,057

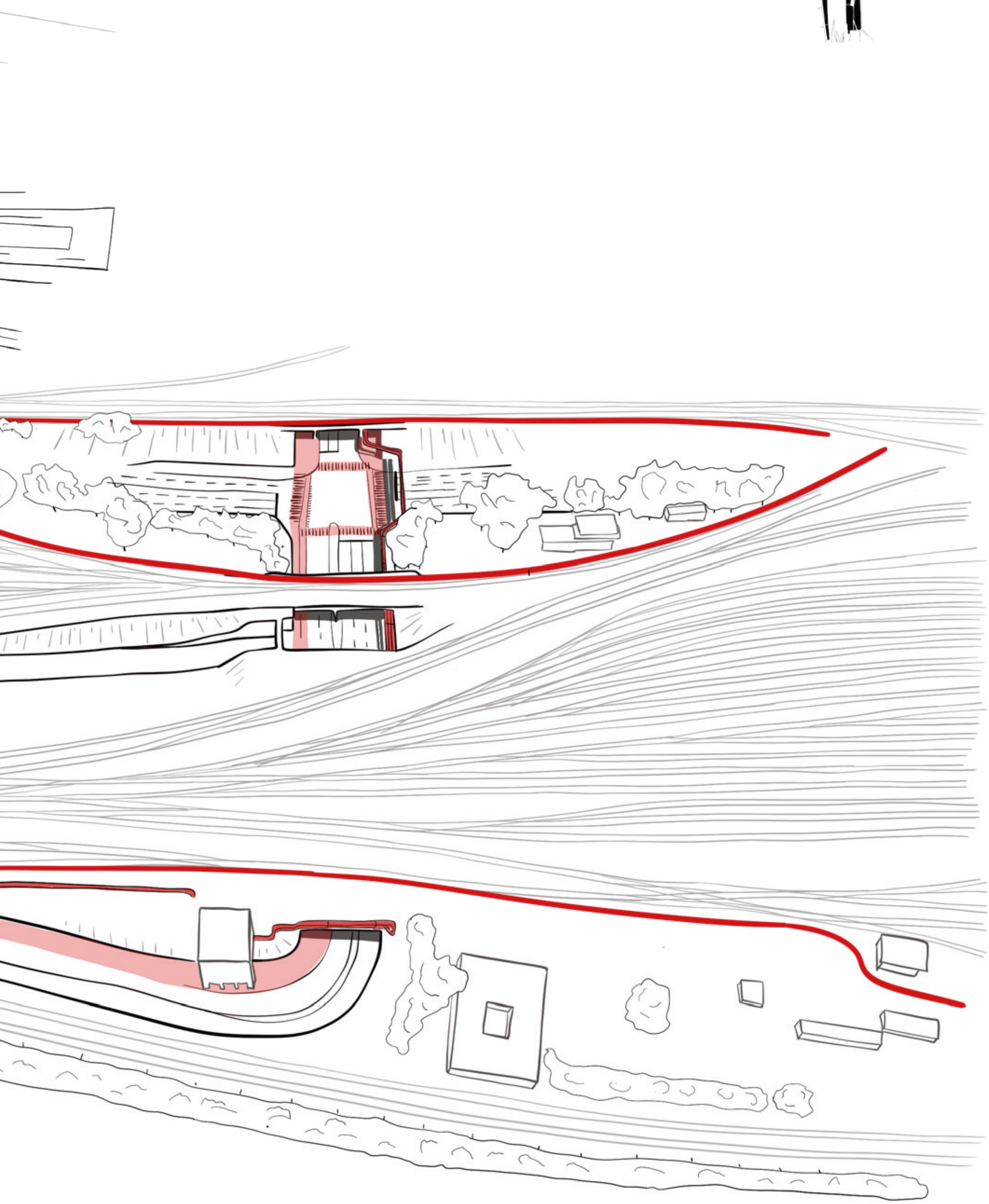
500 m

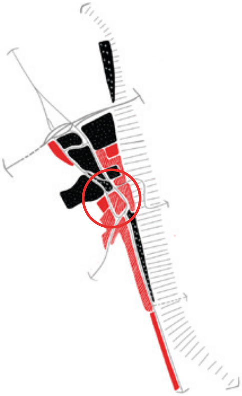




“There must be eyes upon the street, eyes belonging to those we might call the natural proprietors of the street. The buildings on a street equipped to handle strangers and to ensure the safety of both residents and strangers must be oriented to the street. They cannot turn their backs or blank sides on it and leave it blind.”
(Jacobs, 1961, p. 35)







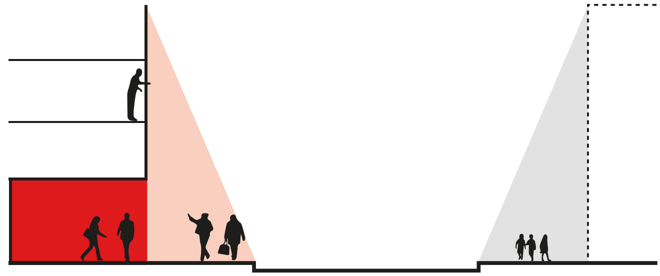
Public space

As a well-known landmark in the district, the “Spinatbunker” (spinach bunker) is a multi-story modernist residential tower built in the seventies, named after its former green façade. It is located at the intersection of Turmstraße and Wiener Straße and was previously inhabited by workers and soccer players from the VOEST soccer club (Schedlberger, 2014).

Today, its location and the public space around it have a negative image due to multiple criminal incidents such as drug trafficking and robberies. Regional newspapers have reported on this topic, reflecting ongoing discussions in local politics about possible measures, such as the installation of video cameras, to enhance security in the area. A challenge

is the heavy traffic combined with a vacant plot, which contributes to an uncomfortable atmosphere, especially for vulnerable groups such as young people or women. The crossing also hosts the tram and bus stop “Turmstraße”, the main station for the surrounding schools located in the area.

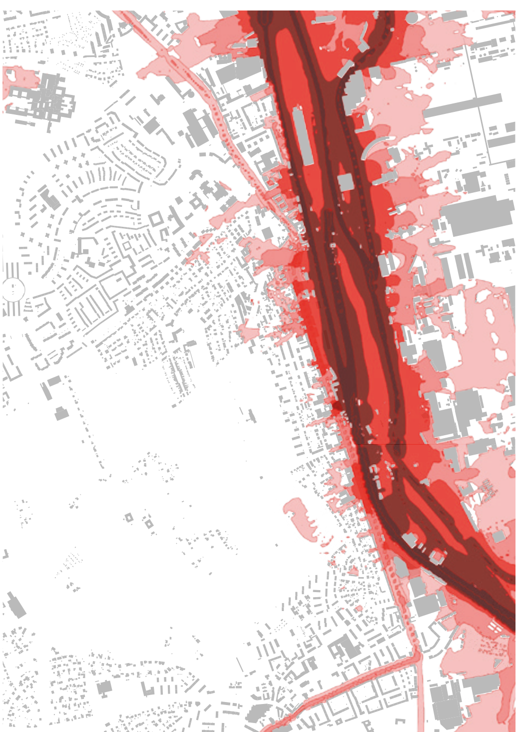
Jane Jacobs was a pioneer in revealing the unseen. Vacant and empty spaces in the city make people feel unsafe and unconformable



“We cannot understand the effects of high and low densities if we assume that the relationship between concentrations of people and production of diversity is a simple, straight mathematical affair.” (Jacobs, 1961, p. 205)

Noise Emissions

Due to both road and rail traffic, certain areas along Wiener Straße experience high noise levels, which can pose a risk to human health (see maps below). These elevated noise levels are concentrated near major intersections, underlining the need for effective mitigation strategies. The diagrammatic Maps on the right show the distribution of different age groups across the area. Along Wiener Straße, the population is mostly made up of working-age individuals. In contrast, the backyard settlements are more populated by elderly residents. Children and teenagers are more evenly distributed, living across both main corridors and side areas without a strong clustering pattern.



Noise emissions rail (2022 - 24h average)

> 75 db
70 - 75 db
65 - 70 db
60 - 65 db
55 - 60 dB

Noise emissions road (2022 - 24h average)

> 75 db
70 - 75 db
65 - 70 db
60 - 65 db
55 - 60 dB

5 - 7 %
more than 10 %
Share of Children (0 - 5 y)

7 - 10 %
more than 10 %
Share of Children (4- 16 y)

55 - 61 %
65 - 75 %
Share of Workers

25 - 33%
33 % and more
Share of Elderly

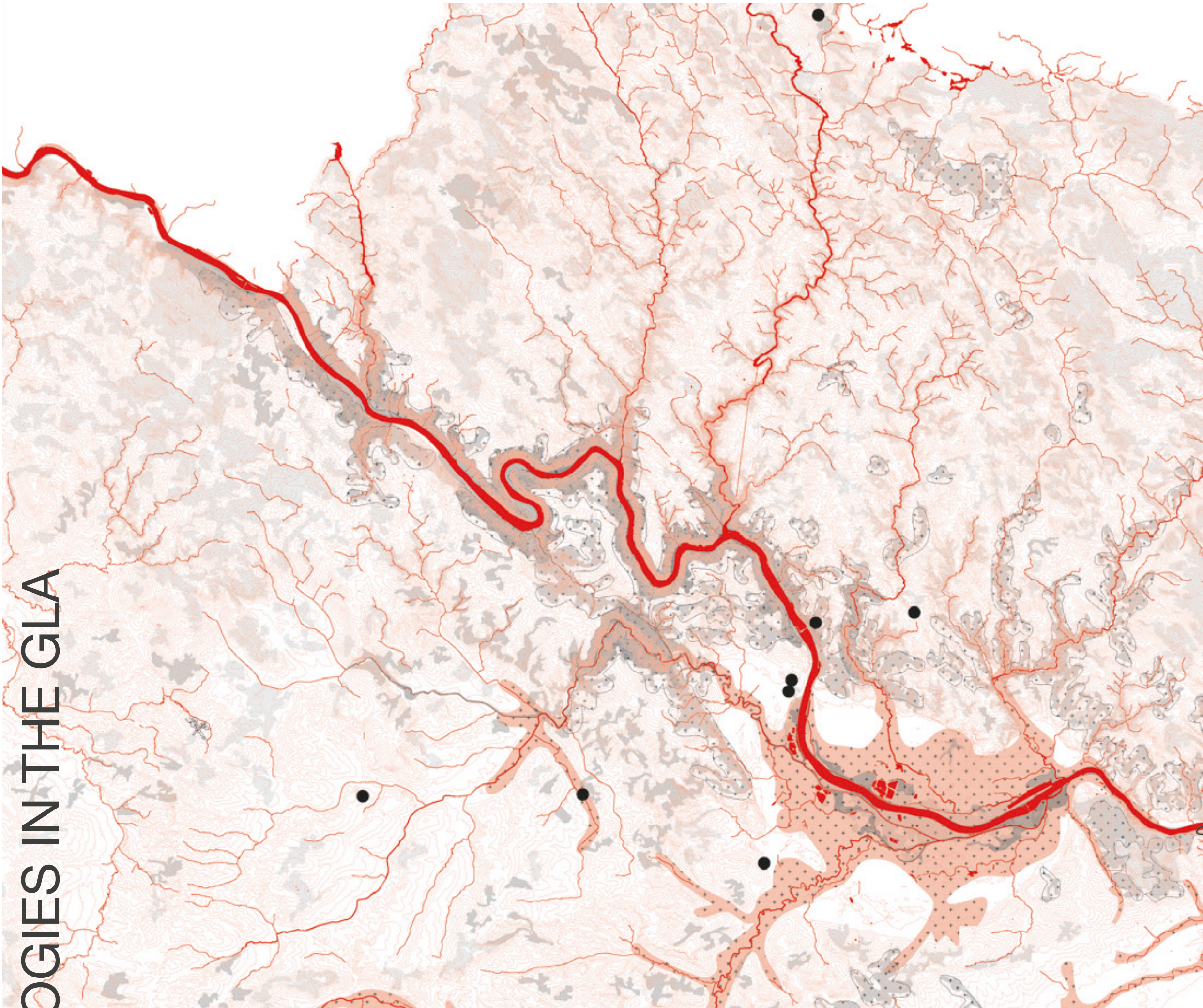
Urban Heat Islands
The crossing Turmstraße – Wiener- Straße is also an urban heat island, due to its big sealed surface. The City of Linz also decided to define the whole area as a future target zone for attention regarding climate adaptation due to the age of the building stock and the public space.

Infrastructures
The high number of streets and intersections cause multiple challenges for livelyhoods along these infrastructures. Next to noise and particulate matter emissions, these built structures are often directly in front of residential buildings.

Safety
The crossing Turmstraße – Wiener Straße is highlighted by the Province Upper Austria as a major high accident location. The high amount of traffic and the low quality of pedestrian and cycling infrastructure make the public space unattractive and dangerous to experience.

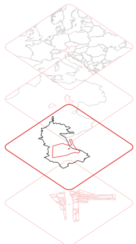
Figure 55: *Graffiti "Linz bleibt Blau"*.
Which means "Linz stays blue" which can be related to the local soccer club "Blau-Weiss Linz".

ECOLOGIES IN THE GLA



The map shows the ecological territories and industrial polluters. The urban core of Linz disrupts the ecosystem of the Danube. The most pollutants are located in the industrial Area of Linz, directly attached to the shore of the Danube.

Waterbody
HQ 30+ Flood Area
Natura 2000
Coniferous Forest
Broad Leaf Forest
Mixed Forest
Polluters
10 km



Ecological habitats

In the regional context, the urban fabric of Linz cuts through the so-called "Auen landscape" a natural floodplain zone. The Danube has been regulated multiple times, both to better manage flood risks and to enable the development of the voestalpine's industrial site. The earliest developments were along the Traun River, where mills for the textile industry and other water-dependent industries were established. Also, today, most of the pollutants connected to industrial purposes are along these sensitive environments.

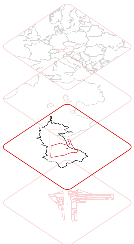
On the local level, there are large green and recreational spaces (Wasserwald, Traun-Donau Auen), but these are often disconnected from other green spaces and livelihoods. For example, most parts of the Danube are accessible only from the eastern shore, where a diverse ecological habitat exists (See Figure 56). In the north, near the Traun River, there is also access and a natural reserve. However, the entire riverbank along the Voest area and the adjacent industrial zones is completely artificial and offers no access to the waterfront.

In terms of flood risk, parts of the industrial area remain vulnerable and might be affected during extreme weather events. Looking forward, a key question is how to address these uncertainties and how to reconnect ecologically valuable areas to enhance biodiversity while also improving access for the residents of Linz and the GLA.

Recreation areas
Water
Green Corridors

1000 y flood happening
Water

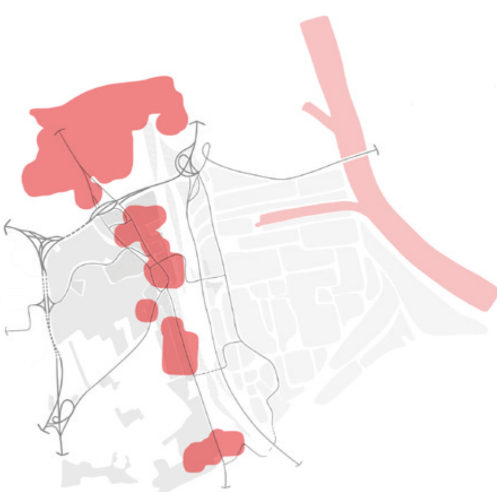
Figure 56: *Green within the grey*. The factory is surrounded by important ecosystems which support the city with fresh air.



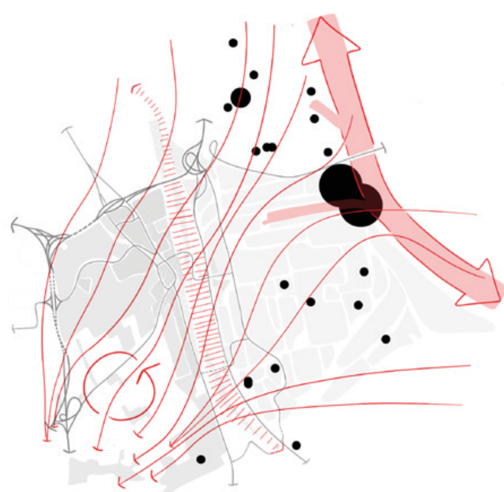
Air and temperature

Air pollution is significantly influenced by the topographical situation of the area within Linz. Due to the presence of the Pfenningberg on the eastern shore of the Danube and the hills to the north, prevailing wind patterns tend to follow the course of the river. However, these winds often curve over the industrial zones, carrying emissions from the factories toward the nearby settlement areas. This airflow can also lead to wind erosion, especially of coal and ore stored in open-air facilities, contributing to dust and particulate pollution.

In addition, the city has identified several future areas of concern regarding urban heat islands and areas for redevelopment to enhance livability and mitigate climate stress. Densely built-up zones along Wiener Straße have been highlighted. Large, sealed surfaces, minimal tree coverage, and limited green infrastructure, especially in the areas near the railyard, intensify heat retention. These factors create significant urban heat stress, especially during summer months, and show the urgent need for cooling strategies like greening, shading, and surface unsealing.

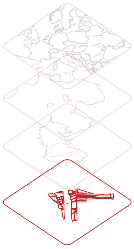


Critical Zones for climate adaptation



Wind directions
Pollutors


Forest
Trees
Water
Historical Waterflow
Floodrisk Area (300 - 1000 y)
Pollutors
1 km



Conclusion

The steel factory functions as a major employer in the region, with many dependent businesses and enterprises linked to its operations. Most people commute from the Hinterland of Linz into the city, making it what is often referred to as a “drive-in city.” These commuter flows are primarily car-based, which means Linz is well-connected on a regional scale. However, on the local level, the same infrastructure often cuts off nearby neighbourhoods from places of employment. This creates several challenges, including high traffic volumes, unsafe public spaces, and the need to share infrastructure with industrial transportation flows.

From a planning perspective, areas along main high streets close to the factory are well connected via public transport and include underutilised plots and low-density zones that present opportunities for rethinking urban form. However, these areas also suffer from low spatial quality due to high traffic, noise pollution, and emissions. Additionally, the proximity to the factory exposes nearby neighbourhoods to environmental risks. Linz also discusses some spaces in this area as “challenging,” reflecting social inequality and urban stress.

On an ecological level, the area has fragmented green spaces that interrupt connections between larger green zones. Vacant plots could play a key role in ecological functions such as water retention, microclimate regulation, and enhancing biodiversity. Meanwhile, the combination of dense infrastructure and low vegetation cover has led to the emergence of heat islands, further increasing environmental pressures in these already vulnerable neighbourhoods. The north–south axis, defined by the railyard and the nearby highway, currently functions as an important fresh-air corridor for the city. However, the effectiveness of this corridor is challenged by local topography and prevailing wind patterns, which often carry industrial emissions toward residential areas, intensifying pollution exposure and reducing air quality in adjacent neighbourhoods.

Residential area
Mixed-use areas
Eco spaces
Low-dense areas
Trees
Wiener Straße
Flood Risk area
500 m

Figure 57: *Re-imagined infrastructures.* Bindermichl is a good example for an transformation from an separating highway into a deck park, connecting now two neighbourhoods and hosting many community spaces for all age groups.

Figure 58: *High frequency.* The Wiener Straße as a main traffic corridor effecting adjacent livelihoods.

Figure 59: *Deep messages.* "Wenn du täglichst dankbar bist, dass keine Bomben fallen, spielt es keine Rolle ob die Sonne scheint." "If you're deeply grateful every day that no bombs are falling, it doesn't matter whether the sun is shining."

Figure 60: *Preserved Heritage Arbeitersiedlung Franckstraße.* Retrofitted working class settlements from 1928 by City planner and Architect Curt Kühne.

3.4 LEARN

This chapter investigates, how industrial transformations in Upper Austria are influencing educational landscapes. It discusses which role strategic sites, such as new Universities, educational facilities near industrial zones, and innovation hubs like the Hagenberg campus in the GLA, can play a role in the shift toward sustainable practices.

Transformations and the effects on Education

The province of Upper Austria developed a strategy called Workplace Upper Austria 2030, a regional labor market and skills strategy developed to ensure a sustainable and socially just economic transformation in Upper Austria. In response to significant shifts such as digitalisation, demographic changes, climate goals, and industrial transformation the strategy aims to secure the region's skilled labor supply through a future-oriented, inclusive, and education-driven approach. It functions as a key pillar of the umbrella strategy "#upperVISION2030". The central objective is to maintain full employment and ensure the availability of qualified workers across all sectors. It aims to enable broad participation in the labor market and strengthen social cohesion during a time of structural change (Pamminger, 2019).

Three main strategic goals related to education are explained in this concept.

- Needs-Based qualification
- Activation of Labor Force Potential
- Attraction and Retention of Talent

A critical reflection on this strategy is crucial, especially regarding those who are left behind or who drop out of the conventional educational and employment systems in Austria. To understand the complexity of the energy transition, it is essential to untangle the interrelated systems it affects. For example, workforce reductions in major industries may generate spillover effects on small-scale enterprises such as bakeries, restaurants, and other locally rooted businesses located near large employers. These broader social and spatial impacts highlight the need for more inclusive and systemic approaches to transformation.

*Current regional trends related to this topic are already elaborated in chapter "2.4 Urgencies in the GLA".

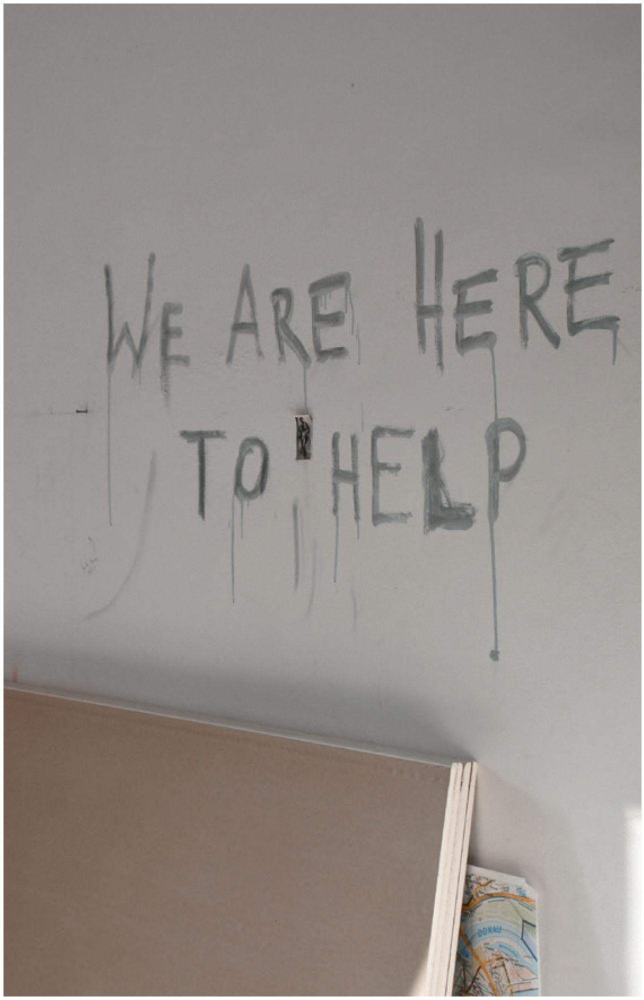
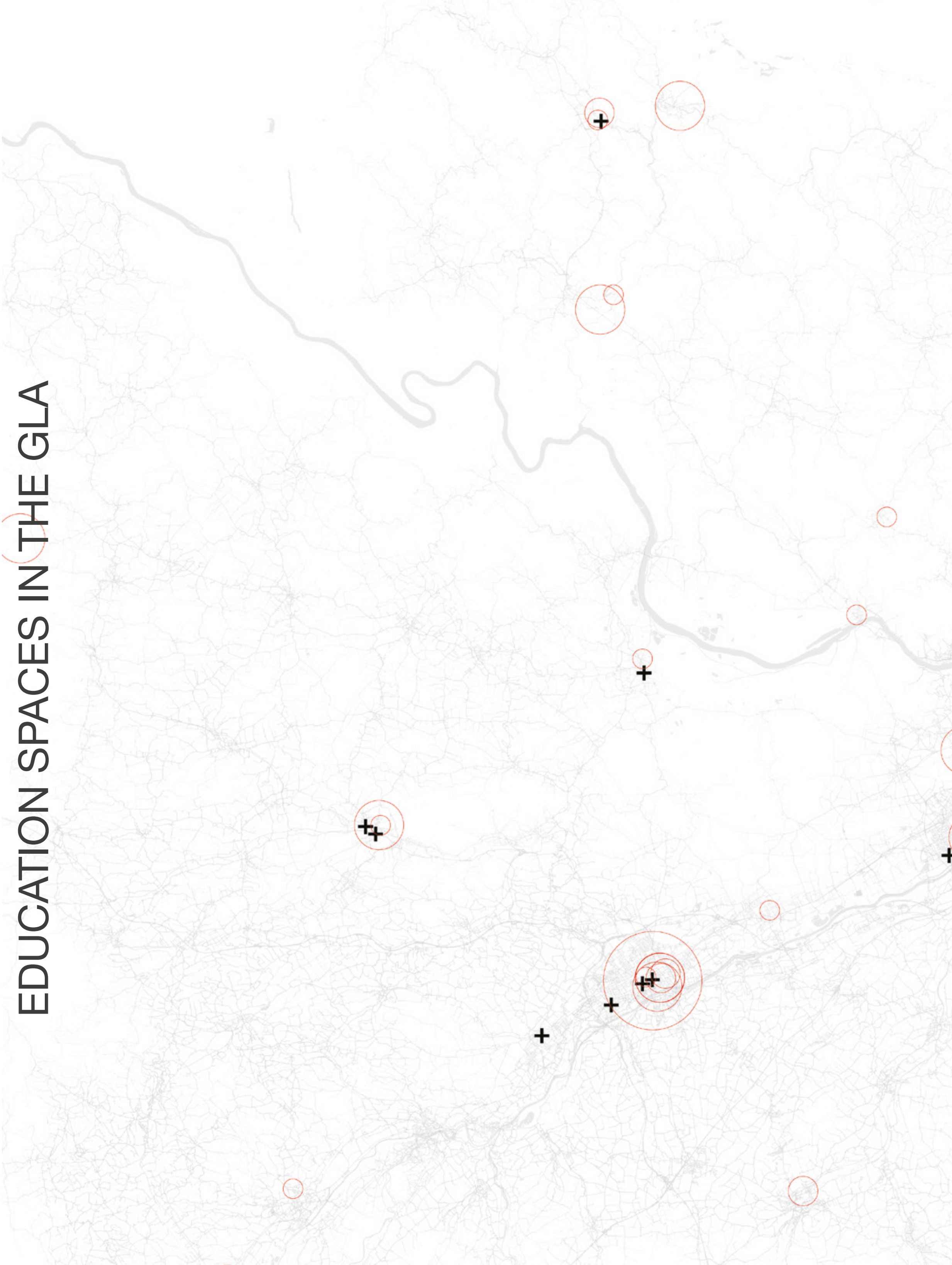
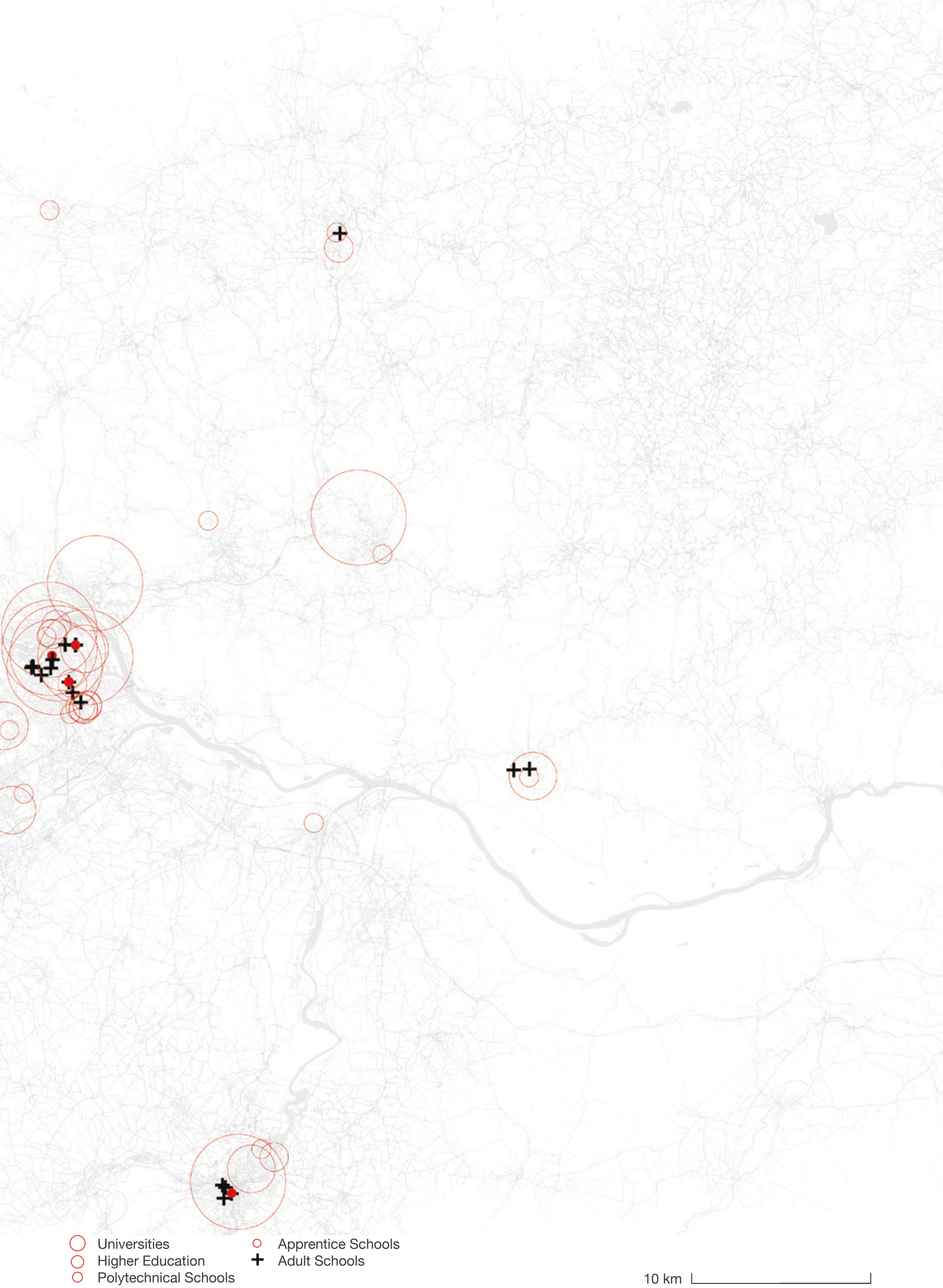


Figure 61: "*We are here to help*" and "*Why are we so afraid of Peace?*", written on walls at the University of Arts in Linz, interpereted as critical refelctions on knowlege, education and awareness in society.

EDUCATION SPACES IN THE GLA



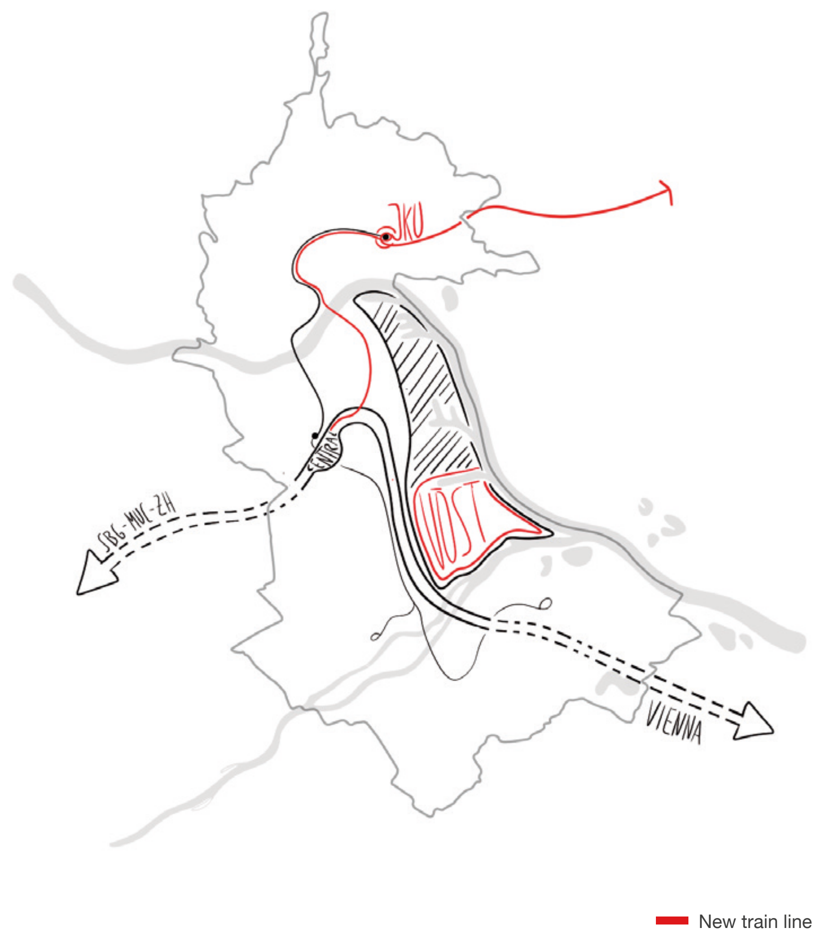
This map shows educational landscape of the GLA


Universities
Higher Education
Polytechnical Schools
Apprentice Schools
Adult Schools
10 km

From the Digital Mile in the North to Apprentice Workshops in the South

Signs of industrial gentrification signal that a transformation is underway, as the formerly monofunctional industrial area begins to shift from north to south. The evolving “Digital Mile”, a linear cluster of tech-based enterprises signals a shift in education, industry, and urban development.
Research facilities like the new JKU campus and the I:TU university’s northern satellite marks a strong academic presence in the region. A new regional rail line, as explained in Chapter 3.3, will soon connect the central train station with the JKU campus, improving accessibility and mobility.

However, the heart for applied jobs lies in the south, closer to Linz’s industrial core. Here, adult training centers and job-oriented facilities are next to each other, especially along Wiener Straße, a linear urban axis interpreted as a key corridor for practical, skill-based education and employment.




JKU University Linz
I:TU Linz
(University Campus)
BS1
Tec-Harbor
Digital Mile
Dynatrace
BS6, BS7
Tec-Harbor
Tabakfabrik
(Start-up / Innovation HUB)
Teacher Training cluster
Apprenticeworkshop
Plasser+Theurer
HTL 2 - Paul Hahn
KU Linz
Catholic Private University
FH Oberösterreich
Campus Linz
Teacher Training school
HTL 1 Bau und Design
(Build and Design)
Vis.com
School for Social Care Professions
Adult Education Cluster
(Care, BFI, Foreman School, BS3)
Apprenticeworkshop
ÖBB (federal railway)
Adult Education BFI
Adult Education Cluster
(WIFI, BS2, BS 5, BS3, BS9, BS10
Boarding School for Apprentices)
Polytechnial School
Apprenticeworkshop
Voest Alpine
Wiener Straße
Special Zoning
Other Use
Adult Education
Education Cluster
Apprentice School
Adult Education Steel related
500 m

Figure 61: *Kunstuniversität Linz.* University of Arts Linz.

Figure 62: *Sports and industry.* The Vocational High School for Engineering's sport facilities next to the industrial area.

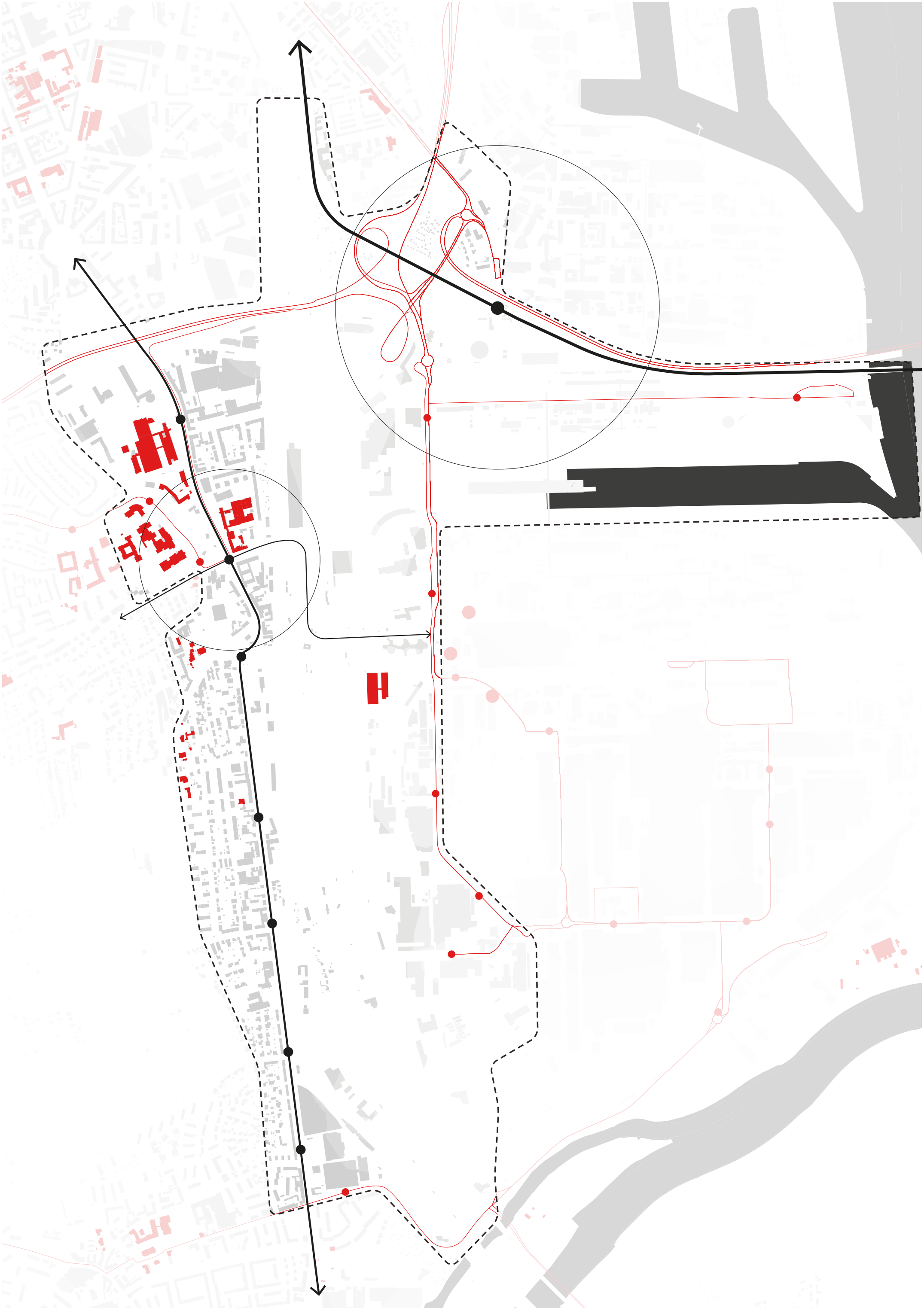
Figure 63: *WIFI Linz.* Provincial headquarter of WIFI – Adult Vocational Training.

Figure 64: *Apprentice School cluster.*

Conclusion

Industrial transformation comes with innovation, and innovation requires change in education. In recent years, Linz has been trying to position itself as a digital city. This is evident through the establishment of a new technology- and digitally focused university, the presence of headquarters of internationally operating companies in IT, and the internationally renowned campus Hagenberg located in the GLA, an international key hub for research and information services. These developments are also reflected in applied job training programs that aim to prepare the next generation of workers. From a spatial perspective, the proximity to industrial areas and the clustering of institutions for adult education reveal strong potential. Regional strategies around a just transition and the involvement of various organisations suggest opportunities to support structural change. By integrating lifelong learning and retraining into educational curricula, especially in response to shifts in production and manufacturing, these places of education can become critical facilitators of transformation.

Providing a just transition for those left behind remains a significant challenge. This calls for critical reflection and action to improve access to education, a need that reflects deeper structural and programmatic issues essential to addressing future transitions.



Educational Insitutions
Wiener Straße
Tram Stop
Buslines connecting voest with Hinteland
Train / Tram

500 m

Figure 65: *Apprentice School I + II.* Behind one can see the greentec steel banner of voestalpine.

Figure 66: *Fighter jets in the garden.* Vocational High School Paul Hahn Straße.

Chapter 4


JKU University Linz
I:TU Linz
(University Campus)
Tec-Harbor
Dynatrace
Tec-Harbor
Tabakfabrik
(Start-up / Innovation HUB)
Teacher Training cluster
Apprenticeworkshop
Plasser+Theurer
HTL 2 - Paul Hahn
KU Linz
Catholic Private University
FH Oberösterreich
Campus Linz
Teacher Training school
HTL 1 Bau und Design
(Build and Design)
Vis.com
School for Social Care Professions
Adult Education Cluster
Digital Mile
BS1
BS6, BS7


(Care, BFI, Foreman School, BS3)
Apprenticeworkshop
ÖBB (federal railway)
Adult Education BFI
Adult Education Cluster
(WIFI, BS2, BS 5, BS3, BS9, BS10
Boarding School for Apprentices)
Polytechnial School
Apprenticeworkshop
Voest Alpine
Wiener Straße

4.1 MAKING, LIVING & LEARNING

In this chapter, the findings and results of the spatial analysis are synthesised, intersecting the themes of make, live, and learn. To outline important aspects of the current situation, challenges, and opportunities are defined across four categories. **Morphology** focuses on the physical built environment, **Circularity and Environment** addresses sustainable practices, **Processes** covers the programmatic and systemic aspects, **Governance and Collaboration** highlights the communal dimensions of the analysis. As a result, specific key areas emerge forming the foundation for testing in explorative scenarios.

Morphology. Connecting or blocking?

Challenges

The spatial configuration of the area is historically influenced by the urban morphological layout defined by infrastructures. The city has developed along infrastructures (Wiener Straße, Railyard, Highway A7), which influenced other spatial conditions and contributed to the formation of leftover spaces or 'wastescape'. These areas often feel disconnected or out of scale, due to the dominance of highly efficient large-scale industry-oriented infrastructure. The Wiener Straße, serving as a main corridor to the Hinterland, functions simultaneously as a high street with mixed-use functions. Residential zones adjacent to these infrastructures are affected by multiple forms of pollution, particularly noise and poor air quality. Furthermore, unsafe public spaces for pedestrians occur due to missing social control. Green spaces are fragmented and poorly connected, which exacerbates the problem of urban heat islands.

Opportunities

Low-density areas and vacant plots in well-connected locations near the campus (WIFI, BS) present potential for future inner-city development. These areas can support the concept of a 15-minute city, where living, working, and learning are integrated within proximity and can happen together. The shift in industrial processes at Voest Alpine can also open opportunities in enabling new uses in restricted zones, e.g. the potential redensification of the company's public face. Rethinking traffic flows, strengthening public transport, improving cycling infrastructure, and enhancing walkability can support a shift in mobility behaviour. Especially small-scale interventions regarding walkability, such as the transformation of public spaces, can positively influence the well-being of residents and the habits of individual commuting patterns.

Circularity and Environment. But where?

Challenges

Large industrial areas create a demand for facilitating material flows such as raw materials, products or waste. These flows are often still linear. There are already recycling facilities and businesses in the area linked to the steel industry that can make use of by-products, such as concrete plants using steel process residues. Drivers for these shifts are European Green Deal targets or the Climate Strategy of Linz (Measure No. 45 Investigation of potential on all levels of the circular economy) (Schrot et al., 2024). The City of Linz will need strategies and allocate space to manage significantly higher local waste streams in the future. Households also play an important role, especially through their awareness and efforts to reduce waste to meet future goals. In terms of pollution, the soil contamination at the coke plant remains problematic, as well as the open yard storage which results in wind erosion. Despite decontamination efforts, pollution levels in some areas are still high and must be considered in future planning.

Opportunities

Companies already engaged in circular practices can learn from each other and exchange to build up a cooperation, due to the fact that these processes often start from **Bottom-Up** initiatives and through exchange like in the example of Kalundborg in Denmark (Chertow, 2000).

The close connection between households, schools and innovative businesses presents an opportunity to build interconnected places of learning that support adaptation to change. Polluted Areas, such as the coke plant site, can be repurposed for other uses like regenerating territories with a focus on remediation practices or as a space for facilitating large-scale recycling.

Processes. Flexible enough?

Challenges

The shift in production methods and innovation processes can have a direct impact on jobs and ways of working. As mentioned in Chapter 2.4, economic uncertainties are accelerating this driver of change and challenging current learning and education practices to meet future needs. There is already awareness within the GLA of the need to adapt curricula to future trends. A remaining challenge is to identify the spatial requirements of these environments, especially in terms of digital ways of working and environmental challenges.

Opportunities

The strong local identity in craftsmanship and entrepreneurship can act as a driver in connecting the different spheres already discussed. The large number of people employed in applied jobs, along with the upcoming generation of workers, can be educated but also re-trained across existing learning facilities. Digitalisation can play an important role in making learning more accessible and less dependent on fixed physical environments. Moreover, the changing climate can also act as a driver for shifting employment towards green jobs, addressing future needs such as food security, climate resilience, and biodiversity.

Governance and Collaboration. But how?

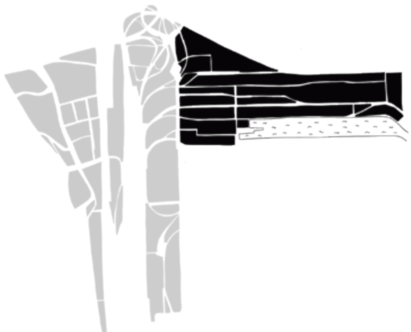
Challenges

Increasing complexity can push rigid and traditional practices in governance and policymaking, especially in spatial planning, to their limits. For example, the challenges of implementing circular practices often lie in the involvement of a wide range of stakeholders and departments within city governments, which can complicate collaboration across different so-called "silos."

Opportunities

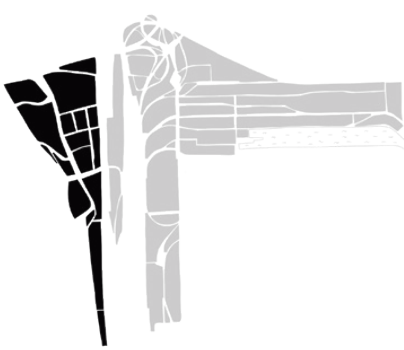
The innovative environment of Linz and its medium size can make the city more agile in navigating upcoming challenges. Initiatives like "Innovationshauptplatz Linz," facilitated by the Innovation Department, are early stepping stones toward co-creation and participative bottom-up approaches.

4.2 STRATEGIC SPACES

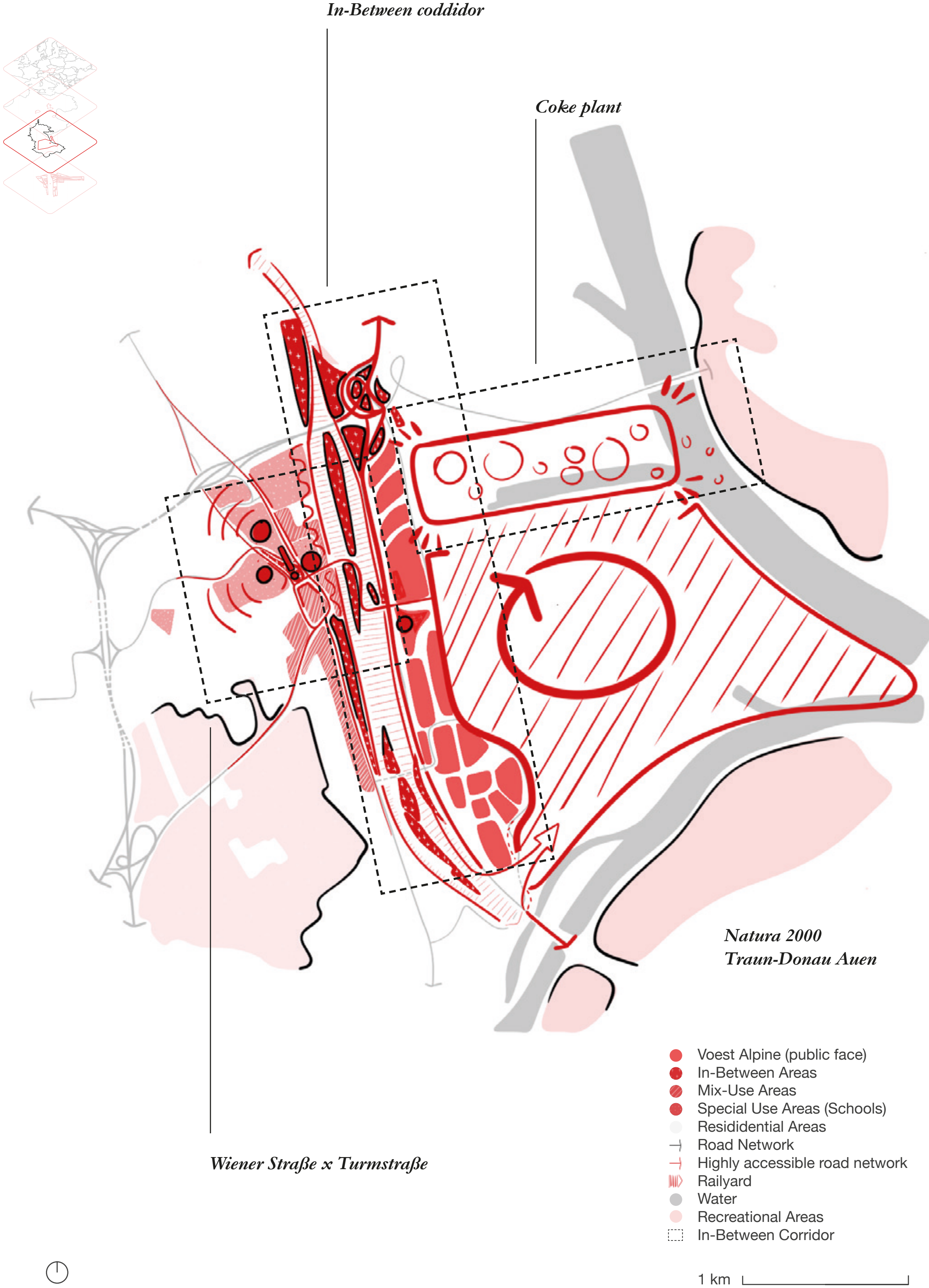


Coke plant
The main challenge lies in the polluted soil and groundwater, which are also located in a flood risk area and positioned between the chemical plant and the steel factory. Currently, an operational coke plant occupies the site, along with several associated facilities such as a gas power plant, a coke gas gasometer, and coke storage and loading areas spanning approximately 56 hectares (excluding the port canal).

In-between corridor
The railyard, essential for the logistics of the steel plant and other industrial facilities in Linz, hosts a large logistics center, situated next to various types of wastescapes. The eastern bypass (Umfahrung Ebelsberg) and the Stahlstraße in the public areas of voestalpine serve as key north–south corridors, but also act as barriers that separate spaces from one another. Only the A7 highway bridge, Turmstraße, and Währingerstraße provide connections to the western part of the city. The railyards and parts of the public-facing areas of the factory cover an area of approximately 90 hectares.

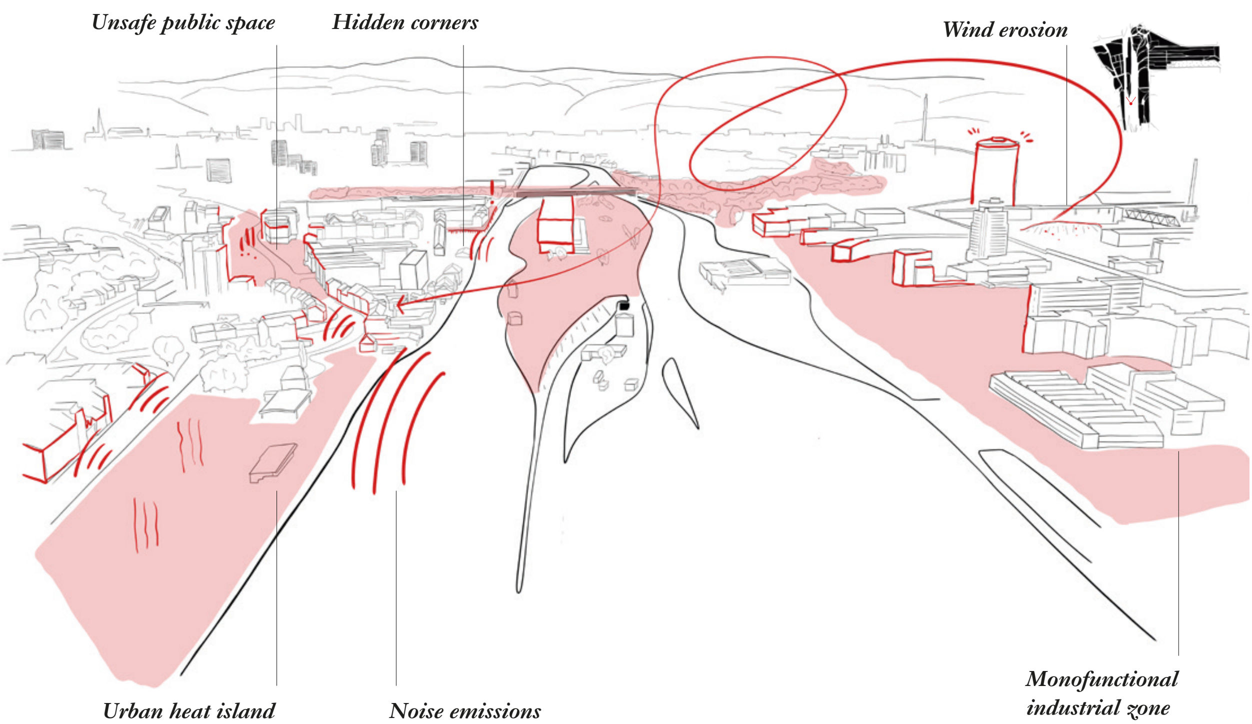


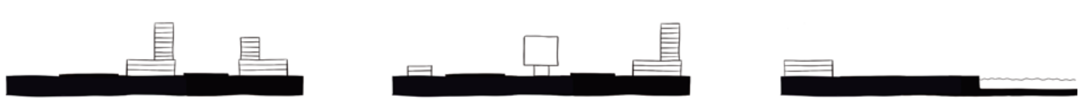
Wiener Straße x Turmstraße
The neighborhood around the intersection of Wiener Straße and Turmstraße (which connects to voestalpine) is characterised by heavy traffic, unsafe spaces, and nearby educational facilities. The eastern part, toward the railway tracks, has undergone partial redevelopment but still faces challenges such as a lack of social control caused by dead ends and shielded public areas. At the center of the area stands a local landmark, the "Spinatbunker," a multi-story modernist tower from the 1970s, situated in front of a vacant plot. This location is frequently featured in the media due to incidents of crime and public insecurity, contributing to its negative image.



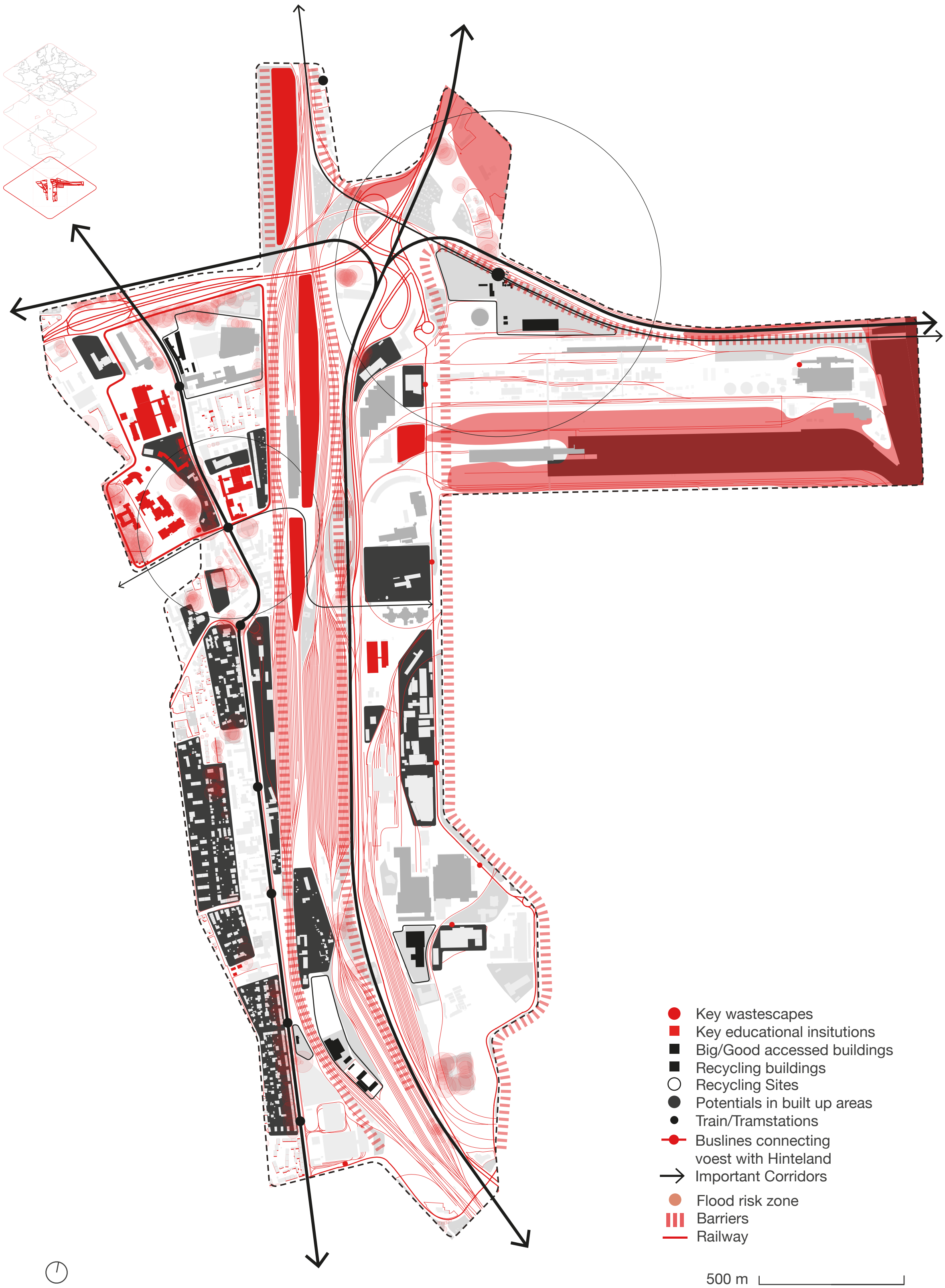
In-Between coddidor
Coke plant
Natura 2000
Traun-Donau Auen
Wiener Straße x Turmstraße
Voest Alpine (public face)
In-Between Areas
Mix-Use Areas
Special Use Areas (Schools)
Resididential Areas
Road Network
Highly accessible road network
Railyard
Water
Recreational Areas
In-Between Corridor
1 km

The investigated area holds strong potential for a sustainable urban transformation, particularly through its morphological opportunities. The city's low-density and vacant yet well-connected areas offer conditions for redevelopment aligned with the 15-minute city concept bringing living, working, and learning into closer proximity. However, challenges persist in the form of a disconnected urban fabric shaped by large-scale infrastructure, underutilised wastescapes, pollution near residential zones, and fragmented green spaces contributing to disconnected ecosystems. Addressing these spatial issues is crucial for enabling broader circular and social programs across governance, sustainability, and economic processes.

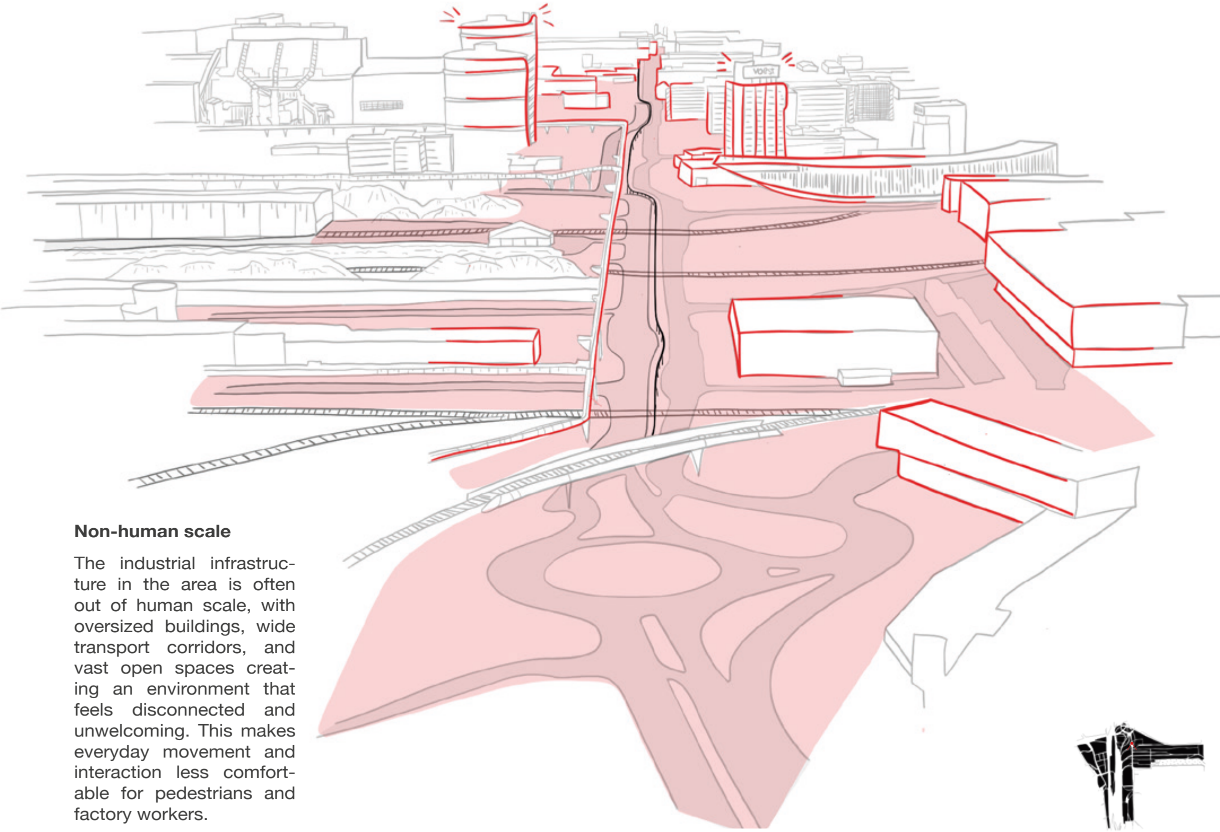




Wiener Straße x Turmstraße *In Between* *Coke Plant*


Key wastescapes
Key educational insitutions
Big/Good accessed buildings
Recycling buildings
Recycling Sites
Potentials in built up areas
Train/Tramstations
Buslines connecting voest with Hinteland
Important Corridors
Flood risk zone
Barriers
Railway
500 m

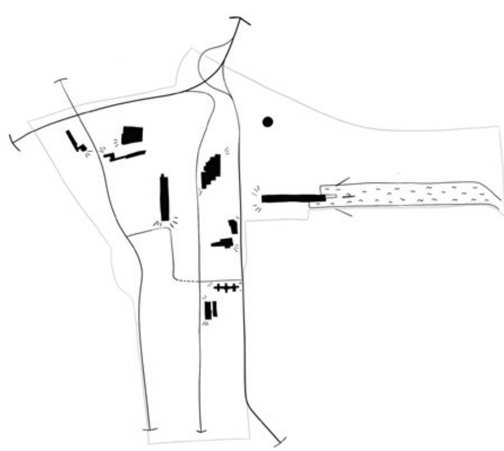
4.3 SPATIAL QUALITIES



Non-human scale

The industrial infrastructure in the area is often out of human scale, with oversized buildings, wide transport corridors, and vast open spaces creating an environment that feels disconnected and unwelcoming. This makes everyday movement and interaction less comfortable for pedestrians and factory workers.

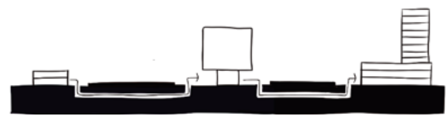
Defined and undefined spaces



Access to key locations of making

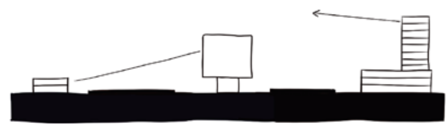
Connectivity

The area features unattractive and often dangerous options for pedestrian permeability connecting places of living and working. Many barriers cut the public spaces into pieces.



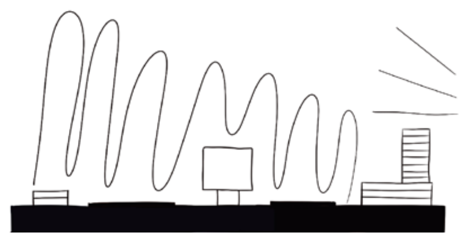
Orientation

Big industrial infrastructures help to navigate in the city, functioning as landmarks like back in the days churches did. However, places of living closest to the steel factory are confronted with views on large walls.



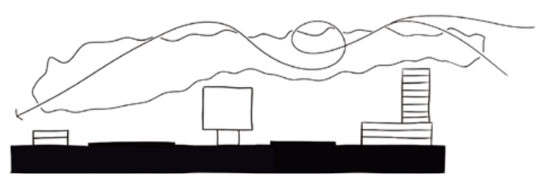
Noise pollution

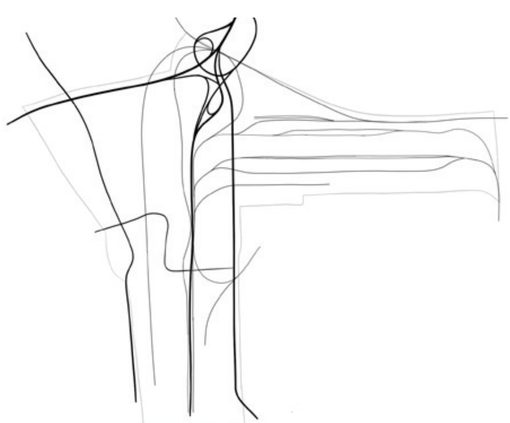
The proximity to the steel factory also brings with it the presence of related infrastructure such as roads and railways. As a result, noise pollution from both industrial activity and transport routes significantly affects the quality of life for those living along these corridors.



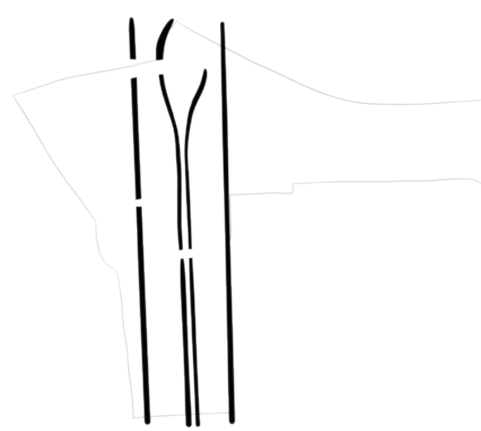
Air pollution

Air quality in the surrounding areas is impacted by multiple factors, including wind erosion from the coke plant's open coal and ore storage, as well as emissions from the factory itself. Prevailing wind directions can carry fine particles and pollutants into nearby residential zones and cause environmental and health challenges for local communities.

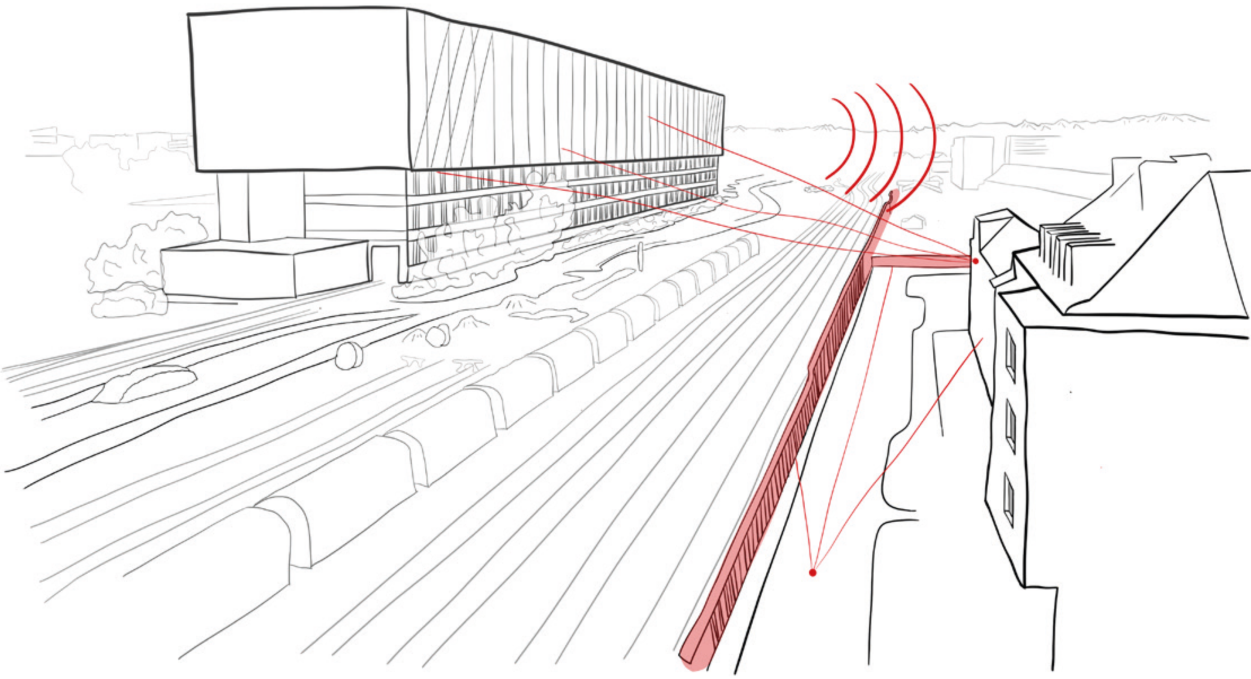


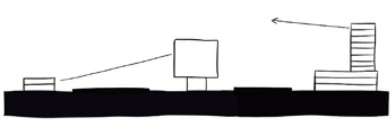


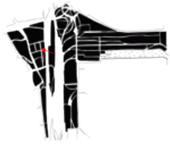
Regional connectors

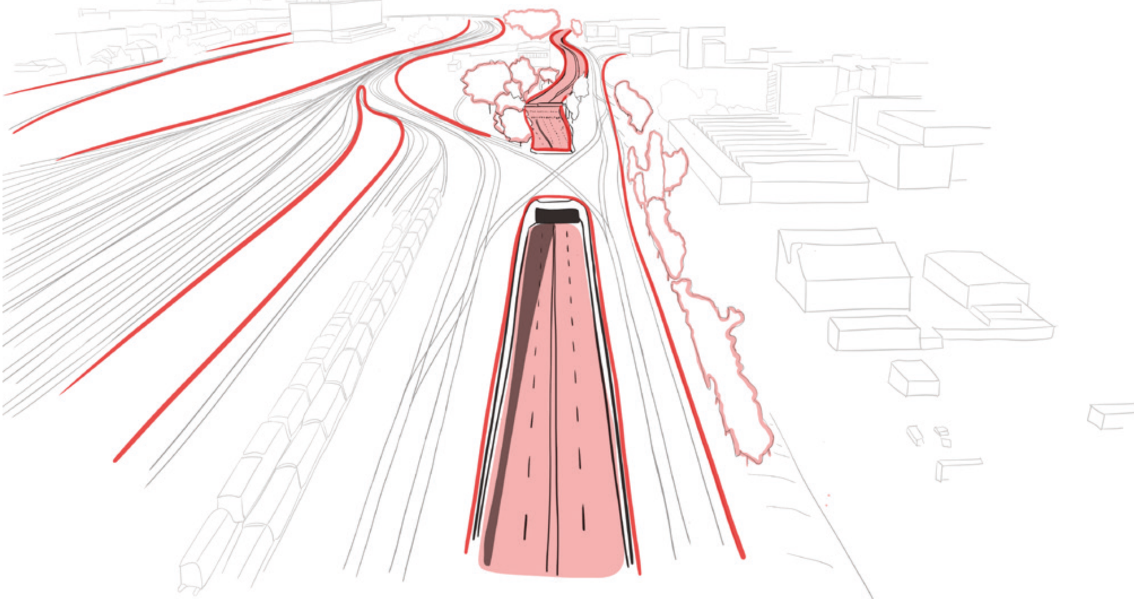


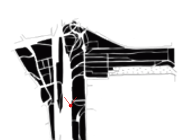
Local barriers

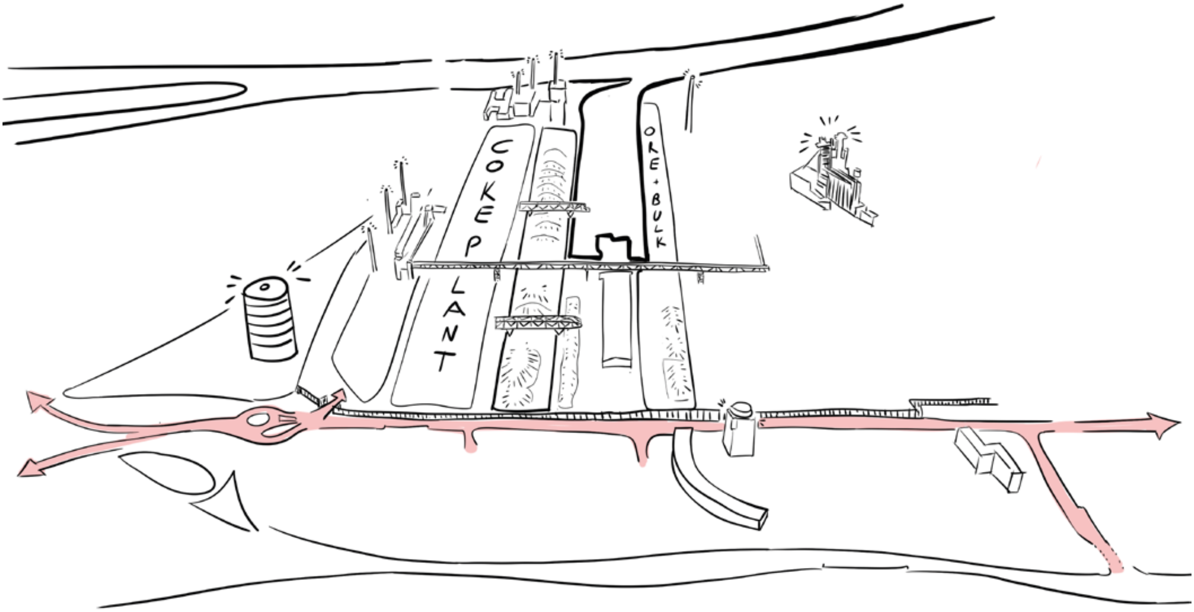


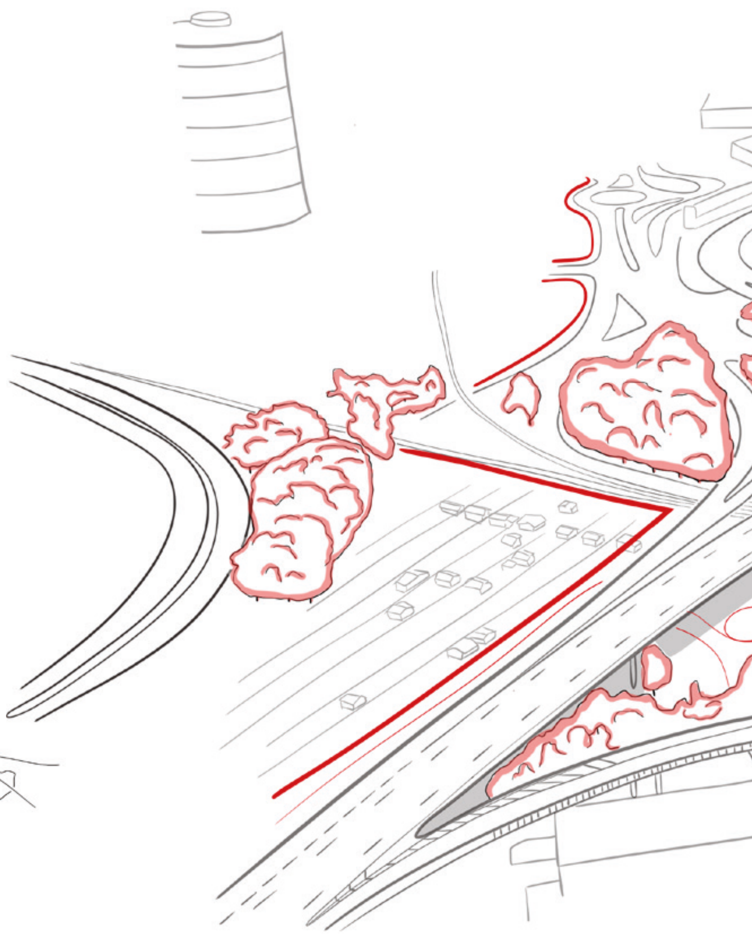


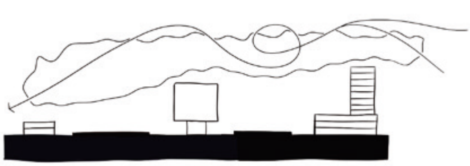


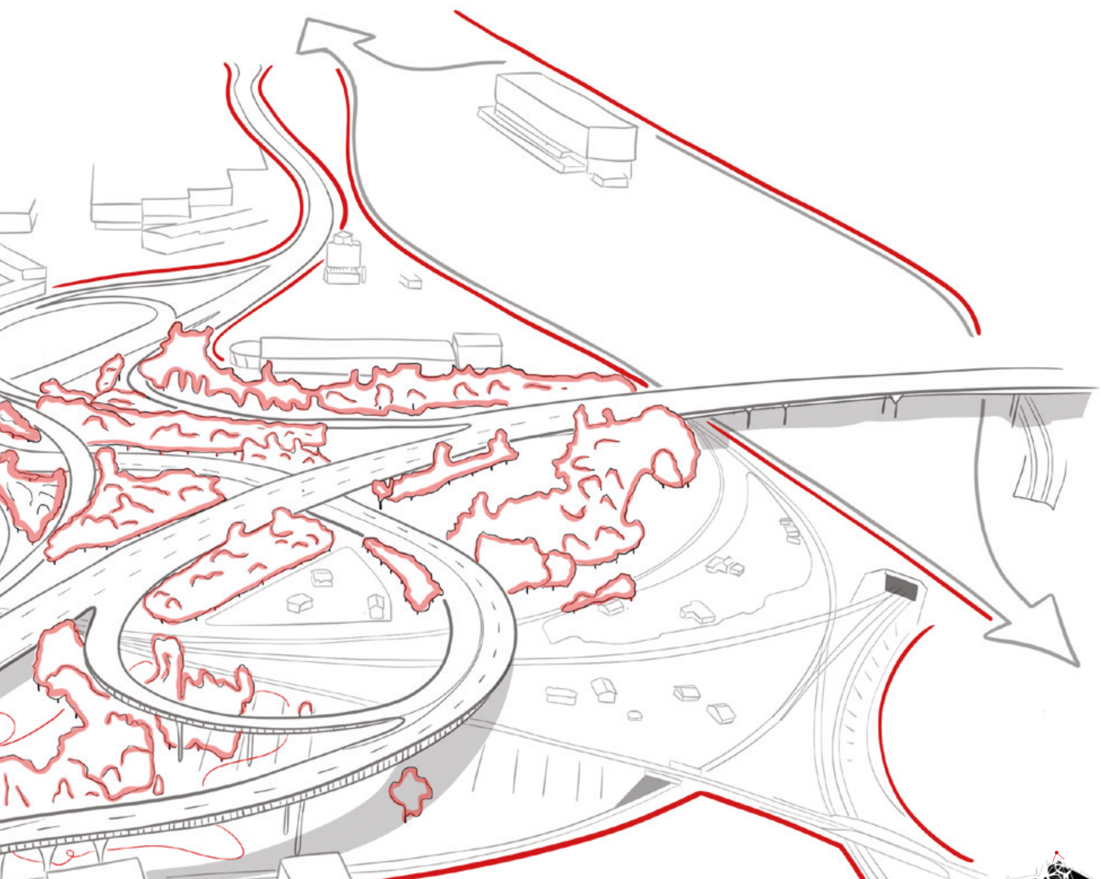





COKE PLANT
ORE + BULK







Chapter 5

scen

arios

5.1 THE THINKBRIDGE

This chapter outlines potential future scenarios to inform the strategic planning of Linz and the GLA. Two scenarios are developed based on the conceptual framework Steelscape Metabolism (Chapter 2.2), the current urgencies in the GLA, which emerge from the problem field and current developments (Chapter 2.4), and the findings and conclusions of the spatial analysis (Chapter 4.1). In an explorative way, the Scenarios highlight two diverging pathways, one which is more oriented towards economic growth and one which is more based on degrowth models to simulate different futures.

Hyperlinked Horizons - Perspectives on Digital Futures

This scenario is based on global trends and developments toward a digital and tech-driven way of making, living, and learning. A podcast from Austrian prodcaster Ö1 Radiokolleg: *Wie Algorithmen unser Leben formen (1),* discusses how algorithms shape the daily lives of humans. From search engines to social systems, algorithms follow structured rules and logic. While their roots lie in ancient methods of problem-solving, today's algorithms, especially those powered by artificial intelligence, can learn and adapt, increasingly influencing our decisions and potentially becoming mechanisms of control. This raises a pressing question: how much power do these invisible systems have over our lives? Scientists like Max Weber and Frederick Winslow Taylor recognised the power of structured processes. Taylor's method of scientific management, called Taylorism, aimed to automate work routines by breaking tasks down into small units for the most efficient way to act. Workers were then expected to execute these optimised sequences precisely, an early form of algorithmic control in the industrial world (ORF, 2025).

A contemporary example of how algorithms shape human lives is the breakthrough of Artificial Intelligence with the launch of Chat GPT in 2022. But artificial intelligence has also found its way into governmental structures and organisations, which can be interpreted as a contemporary reincarnation of Max Weber's ideas on bureaucracy.

The BBC explains in April 2025 U.S. President Donald Trump's new "Department of Government Efficiency" (Doge), which aims to cut federal spending and streamline services, resulting in agency closures, layoffs, and bans on DEI (diversity, equity and inclusion) initiatives (Clarke, 2025; Ngo & Schleifer, 2025).

The main takeaway for the scenario design is how citizens, enterprises, and governments can navigate a digital world dominated by digital tools and capitalised markets. Linz and the GLA play a significant role in the digital industry, hosting global tech companies and leading educational institutions specialising in digital and information services.

Resilient Roots - Perspectives on eco-driven futures

This scenario is influenced by Eco-driven and local based Urbanism principles for making, living, and learning. Based on concepts like Design with Nature by Landscape Architect Ian McHarg (1971), this scenario aims to look at ecosystems as a primary guide and as a base for planning and design. McHarg sees the designer as a steward rather than an invasive guide who decides in a top-down manner over territories.

Contemporary examples of how nature influences territories and cities are recent disasters caused by the climate crisis, like recent floods in September 2024, where record amounts of 300 to over 400 mm of rainfall in 5 days were recorded in an area between Lower Austria and Vienna. As mentioned in Chapter 2.3 Steelscapes in Theory, vegetation, and ecosystems play an important role and influence the runoff behavior of rivers, resulting in flood risks (Formayer & Kromp-Kolb, 2009). Linz and the GLA play a key role within the Danube's trans-territorial ecosystem, which is shaped by upstream events in the Alps, but at the same time impacts regions further downstream. This has significant importance because Austria is more exposed to flood risk than other OECD countries (OECD, 2024).

The main takeaway for the scenario design is how citizens, enterprises, and governments can navigate through an ecologically driven, resilient world organised in self-sufficiency. Do humans still have individual lifestyles, or do they have to change their lifestyles for the common good?

Linking Circularity

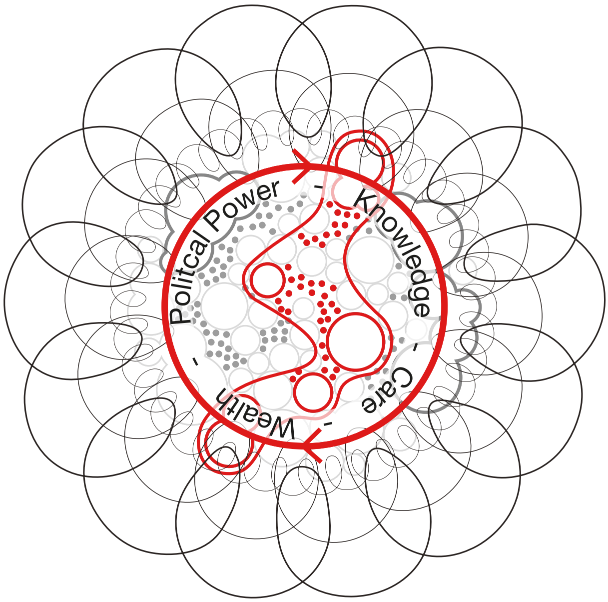
In both scenarios, one constant remains. The challenge of scarcity. Whether it concerns resources, space, or security, scarcity has a high demand for adaptability, flexibility, and resourcing. These topics are not new and were already discussed in the 60s and 70s by architects and designers within the metabolism movement, first discussed at the CIAM (Congrès Internationaux d'Architecture Moderne) in 1959 (Korokawa, 1977). Early pioners were Architects like Kenzo Tange with his plan for the Tokyo Bay (Kuan et al., 2012), Alison and Peter Smithson as part of the Collective Team 10 talking about 'holes in the cities' in their book *The charged void – urbanism* (Smithson & Smithson, 2005) or Cedric Price's systemic approach with projects like Fun Palace or his work for McAppy (Herdt, 2017).

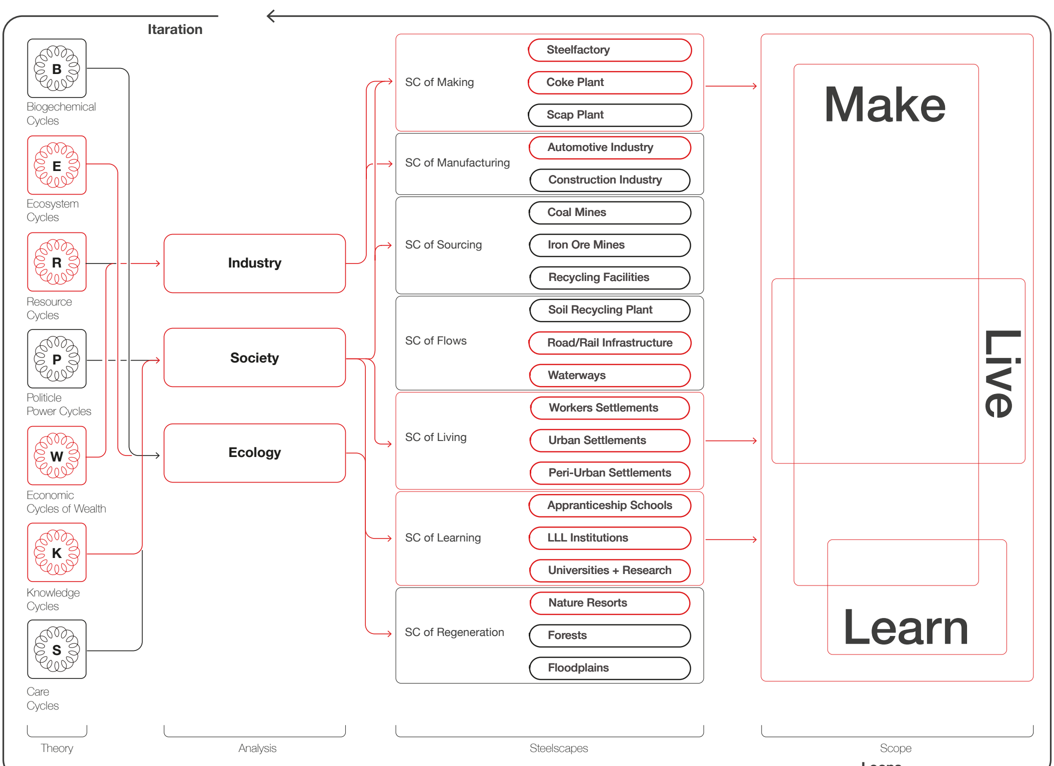
The main inspiration for the scenario design is rooted in Cedric Price's vision *of Potteries Thinkbelt*, a territorial strategy for the declining region of North Staffordshire in the United Kingdom. His Idea was to challenge traditional university models like campuses, using existing transport infrastructure and the unemployment situation in the region to create a dynamic, flexible educational ecosystem where living, working, and learning are thought holistically. By integrating education directly into the social and spatial fabric of a post-industrial territory, Potteries Thinkbelt became a provocative example of adaptive and metabolistic learning environments rooted in real-world conditions (Price et al., 2016).

To merge the pioneering design ideas of the metabolism movement with contemporary principles on circularity, the Butterfly Diagram by the Ellen McArthur Foundation functions as a guiding principle. On one side, the diagram maps out the **biological cycle**, where organic materials are returned to the environment through processes like composting and anaerobic digestion. On the other side, it outlines the **technical cycle**, in which products and materials such as metals and plastics are re-used through refurbishment, maintenance, reuse, remanufacturing, and recycling (Ellen MacArthur Foundation, 2021). This is the pathway for positioning the two scenarios, **Resilient Roots** and **Hyperlinked Horizons.**

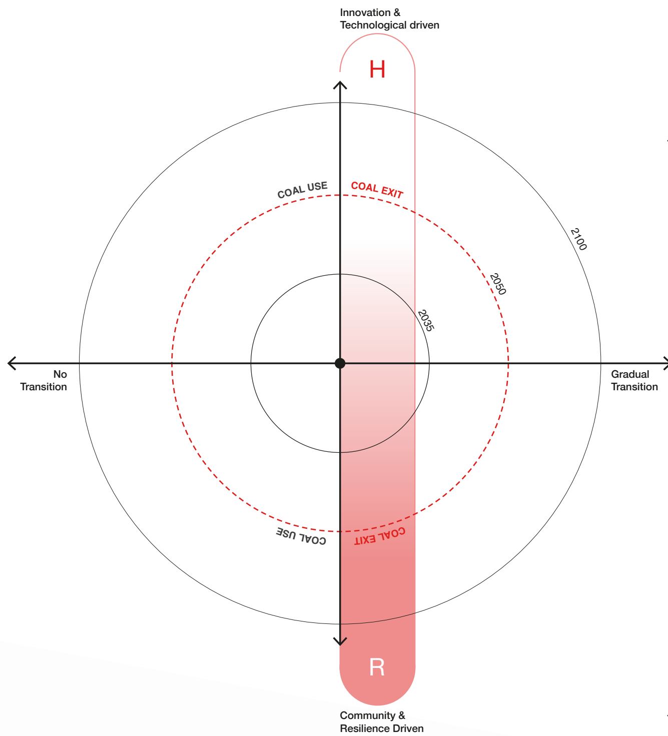
Steelscape Metabolism

Findings





Operational Frame


Innovation &
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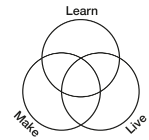
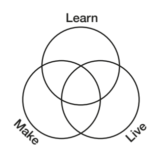
Community &
Resilience Driven


Learn
Make
Live


Learn
Make
Live

Synthesis

5.2 SCENARIO FRAMEWORK

This chapter elaborates the scenario framework inspired by a long-term spatial strategy for the Dutch IJssel-Vechtdelta (HNS et al., 2012). It explores two contrasting scenarios, each exploring spatial pathways influenced primarily by the phased coal exit of the voestalpine factory. A set of enablers, grounded in the area's spatial and programmatic conditions are developed and tested within a flexible framework for both scenarios, focusing on the scopes make, live, and learn.

Scenario Design

The scenario framework shown on the right, outlines the configurations of two contrasting explorative design scenarios (as described in Chapter 5.1), the role of time, and the scenario conditions. The main driver of the future pathways is the planned energy transition, in which the steel factory voestalpine gradually phases out the use of coal and coke and transitions to hydrogen- and electricity-based steel production using EAF and alternative methods.

Building on this, the spatial and programmatic development of the area evolves in response to the two different scenarios Hyperlinked Horizons and Resilient Roots.

On the x-axis, the state of the transition, based on the coal phase-out, is illustrated along two diverging paths, highlighting the critical milestone of 2050, by which voestalpine aims to fully transition to green tec steel. On the y-axis, two different paradigms are described: community-driven and technology-driven directions. The two aligned scenarios are developed and located based on these paradigms.

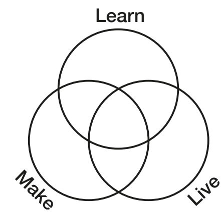
Time component

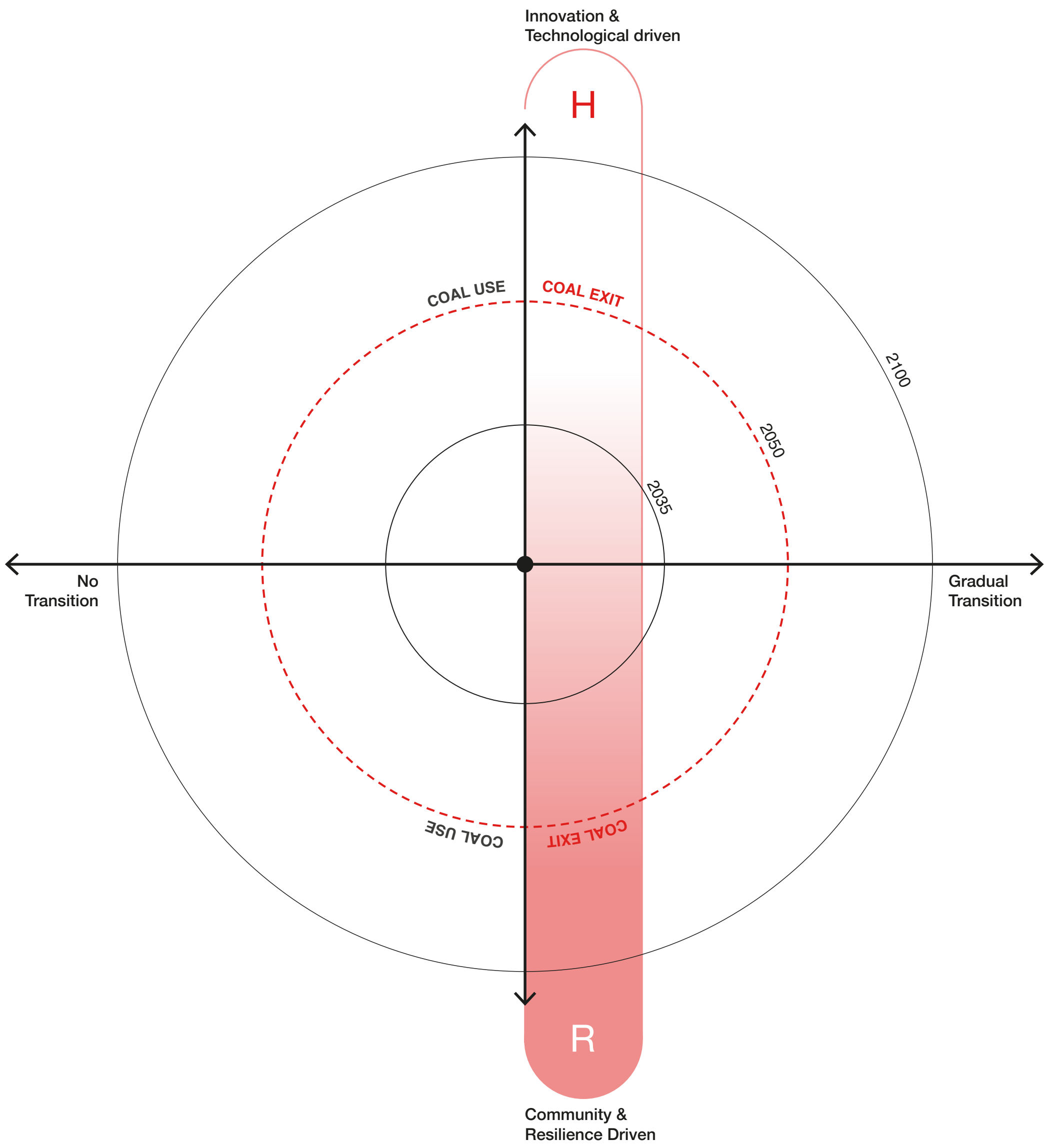
The phasing is based on the main driver, and the shift in the energy demand by the steel factory (described in Chapter 1.6).

Phase 1: Initial phase	**2025 – 2035**
Phase 2: Acceleration phase	**2035 - 2050**
Phase 3: Post-transition phase	**2050 - 2100**

Enablers

To understand the spatial and programmatic dimension of the transition, 24 enablers based on the conceptual- and operational framework (Make, Live, Learn) the analysis and the local challenges and opportunities are developed. To understand the integration and comparability of those, the enablers are located in a triple helix (see page 186).
Based on this, the 12 most integrated enablers in both scenarios (highlighted in red in Chapter 5.3 and 5.4) emerge and are further explored in the scenario development. Based on the phasing, the enablers deal with a flexibility component helping to adapt to fast and changing conditions. In the framework design of each scenario, the main focus lies on the most diverging enablers based on flexibility "C1 Circular Infrastructure" and "M1 Beyond Wastescapes" (see next page, red dots).


Learn
Make
Live


Innovation &
Technological driven
H
COAL USE
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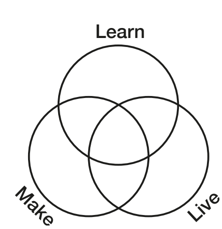
2100
2050
2035
No
Transition
Gradual
Transition
COAL USE
COAL EXIT
R
Community &
Resilience Driven

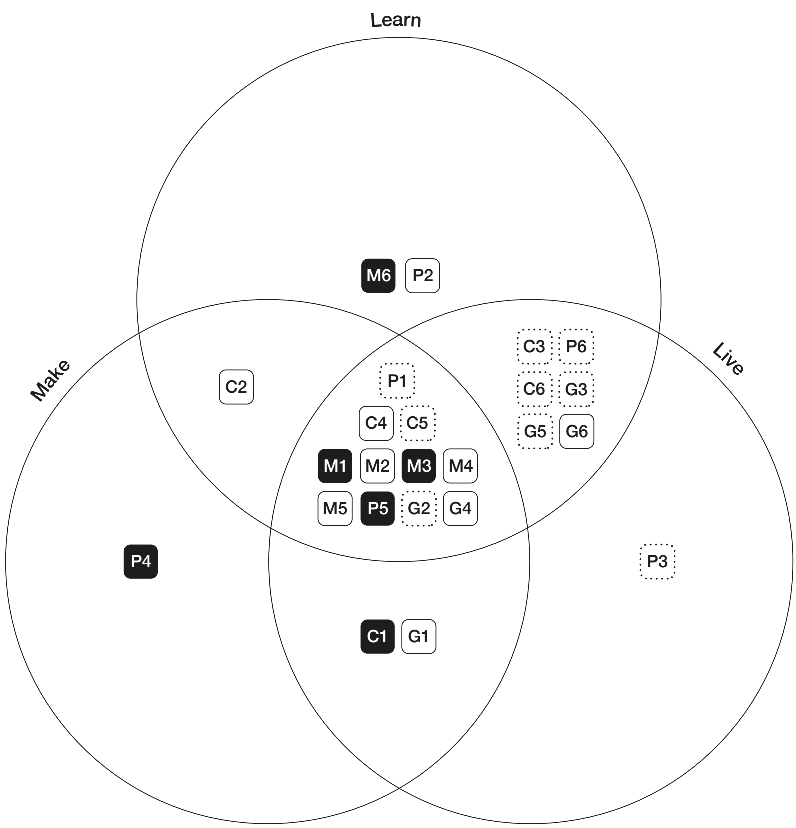

Learn
Make
Live

ENABLERS

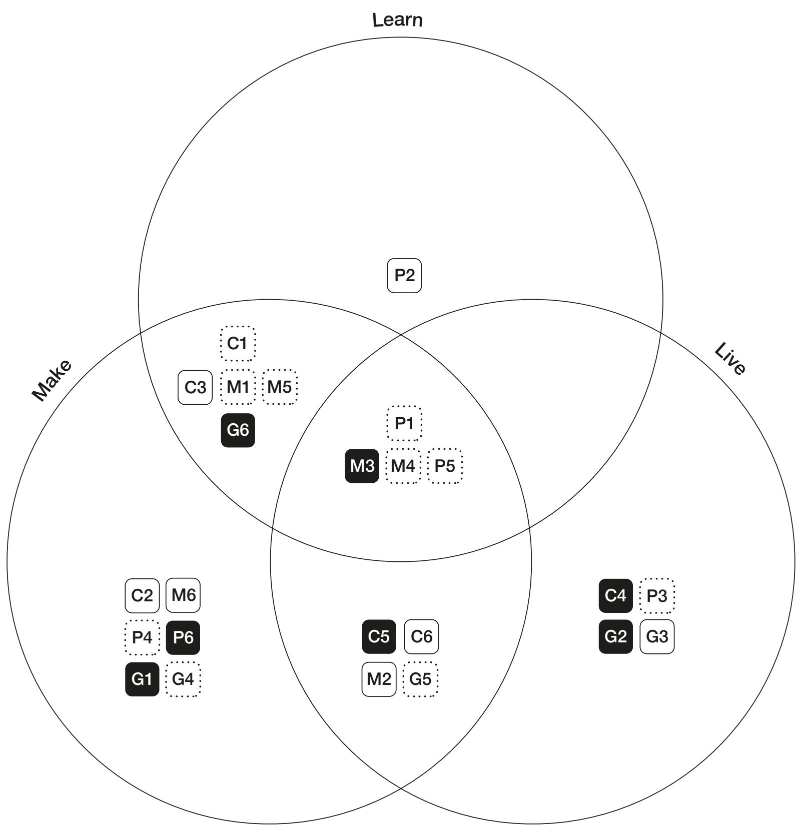
Enablers	Resilient Roots	Hyperlinked Horizons	M + L + L (RR)
C1 Circular Infrastructure	Small scale, decentralised and local defined areas for re-use and sharing	Large + centralised areas for material storage and remanufacturing	Live + Make
C2 Transformation of coke plant	Remidiation of Polluted Soil + Repurposing the site for regeneration	High-Tec HUB for recycling and distribution beyond regions	Learn + Make
C3 Waste Flow Management	Focus on organic ways of making, compostable biosbased materials	AI, real time wasteflow management estimate flows beyond regions	Live + Learn
C4 Construction Sector	Retrofit buildings, new programms, repurpose + adaptable buildings	Demolish buildings, recycle materials in proximity, new buildings	Live + Learn + Make
C5 Societal Behavior Patterns	Scarcity. people have to re-use and adapt what they have. Communal	Abundance. Everything is available at all time. Outsourced supply	Live + Learn + Make
C6 Circular Learning Patterns	Relearning practices from indigenous - living with nature	Adapting to new ways of digital learning. Tech driven	Live + Learn
M1 Beyond Wastescapes	Adaptive landuse zones make space for circular practices (food, energy,...)	Space for new development, eco-nomic driven learning and making	Live + Learn + Make
M2 Places for living	Repurpose + redensified exisiting built environment in mixed use areas	New development with re-used ma-terials, high rise in central locations	Live + Learn + Make
M3 Remote outposts	Mobile + nature related outposts for food production + self sufficiency	Mobile + digital nomadic connection to information infrastructure	Live + Learn + Make
M4 New train station	New train station connects the area with the main station.	New international high-speed HUB connects European destinations	Live + Learn + Make
M5 New connecting bridge	Bridge overcomes barriers for pedes-trians and connects green spaces	Train station connects the west/east campus districts	Live + Learn + Make
M6 Focus on Green space	Nature defines design. Reservoirs connect city within a green network.	Design defines nature. Green spaces function as technological solutions	Learn
P1 Defining a new Campus	New Eco-Campus of life sciences Curricula with environmental focus	New Digital IT-Campus Curricula with AI + IT focus	Live + Learn + Make
P2 Future ways of Learning	Schools focus on environmental edu-cation to prepare for climate crisis	Schools focus on digital technologies to prepare for shift in job market	Learn
P3 Future ways of Living	Community based and supported by strong state run organisations.	Individual oriented with focus on and private investment.	Live
P4 Future ways of Making	Locally produced goods with re-sourced materials (degrowth)	Globally produced goods with re-sourced materials (abundance)	Make
P5 Future ways of Planning	Framework thinking + public driven investment in existing structures	Masterplan thinking + private driven investments in new developments	Live + Learn + Make
P6 Perspectives on change	Open minded and local based per-spective on common practices	Open minded global based perspec-tives on individual lifestyles	Live + Learn
G1 New Zoning methods	Flexible + adaptive landscapes as experimental zones	AI zoning on demand for smart solutions	Live + Make
G2 Bottom Up practices	Initiatives foster collective decision making + grass root movements	Top down accepts bottom up ap-proaches for informative issues	Live + Learn + Make
G3 Emergency prevention strategies	Awareness building with strategies to overcome environmental shocks	Awareness building to overcome economic shocks with analogue tools	Live + Learn
G4 Intercommunal cooperations	Strong interaction with communities in the hinterland sharing resources.	Strong interaction with municipalities based on economic development	Live + Learn + Make
G5 Investment in Infrastructures	Public driven with focus on public transport and slow traffic	Public Private driven with focus on material flow optimisation	Live + Learn
G6 Politics of Change	Citizen voices are represented in local governments - co-design	Industry and Economy voices define pathways to increase competitiveness	Live + Learn

Flexibility (RR)	M + L + L (HH)	Flexibility (HH)	Repair assesment	
●●●	Learn + Make	●○○	5.3 Functional (BE)	●
●●○	Make	●●○	5.2 Physical (BE)	
●○○	Learn + Make	●●○	3.1 Flows	
●●○	Live	●●●	3.2 Stocks	
●○○	Live + Make	●●●	2.3 Ordinary Life Practices	
●○○	Live + Make	●●○	2.3 Ordinary Life Practices	
●●●	Learn + Make	●○○	5.1 Wastescapes	●
●●○	Live +Learn + Make	●●○	5.3 Functional (BE)	
●●●	Live + Learn + Make	●●●	5.2 Physical (BE)	
●●○	Live + Learn + Make	●○○	5.2 Physical (BE)	
●●○	Learn + Make	●○○	5.2 Physical (BE)	
●●●	Make	●●○	1.3 Experiments/Eco-Innovative Solutions	
●○○	Live + Learn + Make	●○○	1.2 Agendas	
●●○	Learn	●●○	1.1 Arenas (long-term strategies)	
●●○	Live	●○○	1.1 Arenas (long-term strategies)	
●●●	Make	●○○	1.1 Arenas (long-term strategies)	
●●●	Live + Learn + Make	●○○	5.3 Functional (BE)	
●○○	Make	●●●	1.2 Agendas	
●●○	Make	●●●	1.3 Experiments/Eco-Innovative Solutions	
●○○	Live	●●●	3.3 Co-creation	
●○○	Live	●●○	3.3 Co-creation	
●●○	Make	●○○	3.3 Co-creation	
●○○	Live + Make	●○○	2.2 Policy Implementation	
●●○	Learn + Make	●●○	1.1 Arenas (long-term strategies)	

INTEGRATION OF ENABELERS TRIPLE-HELIX



RR


Learn
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C3
M1
M5
G6
P1
M3
M4
P5
C2
M6
P4
P6
G1
G4
C5
C6
M2
G5
C4
P3
G2
G3

HH

5.3 RESILIENT ROOTS

Scenario Condition

Keywords: Degrowth, Localised Economies, Nature based, Soft Edges, Mixed and open, Public Investment

The core principles in this explorative scenario are based on theories and perspectives towards degrowth (D'Alisa et al., 2014) highlighting the necessity of a more localised economy with a strong focus on communing practices and actions towards a Just transition (Wang & Lo, 2021) regarding to alternative economies and the emerging uncertainties caused by the climate crisis. "Resilient Roots" imagines a place-based Urbanism approach rooted in the spheres of the described and conceptually implemented *Ecosystem Cycle* and *Knowledge Cycle* elaborated by Calisto Friant et al. (2023). Acknowledging that none of these interrelated cycles can be seen separately, but due to the exploration of extremes in the design scenarios, directions are taken to simulate contrasting futures.

K

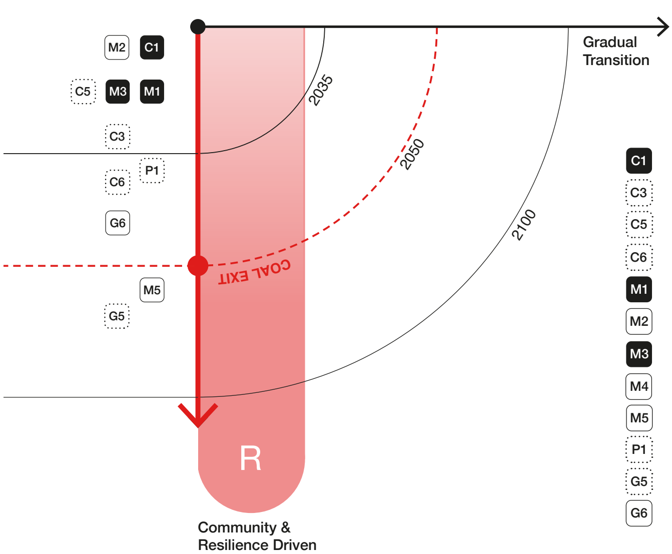
Knowledge Cycle

The educational landscape in this scenario focuses on regenerative learning practices via eco-campuses, green job programs, and lifelong learning. Campuses are integrated within the territory, and farmers become mentors for re-learning indigenous practices. Students can share living practices in cross-generational homes, exchanging knowledge and experiences in proximity to their places of learning. Education is not just local but also rooted in ecology and resilience curricula.

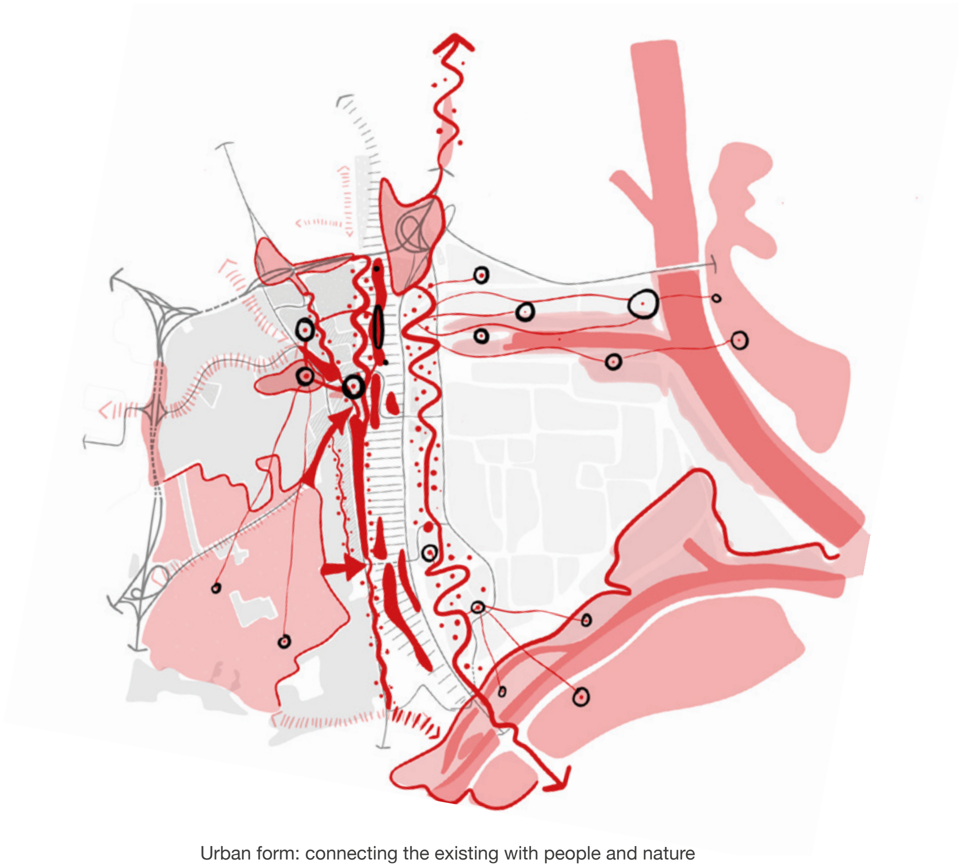
E

Ecosystem Cycle

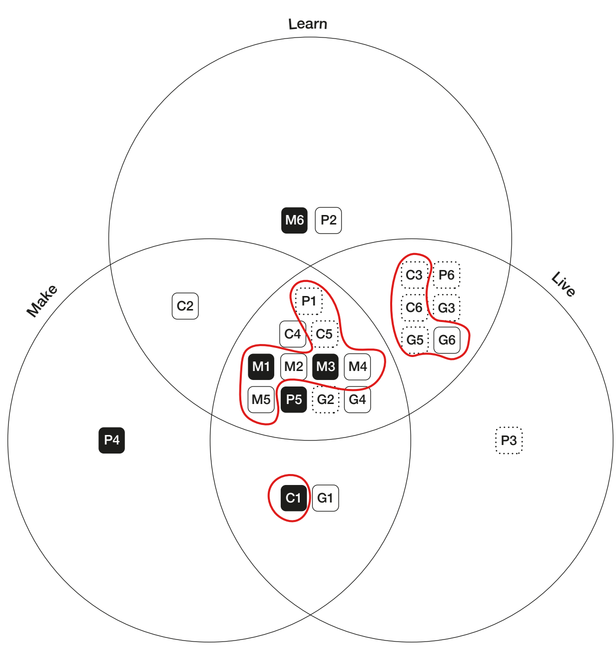
Living labs with practices in composting, renewable energy self-sufficiency, and shared resources emerge. Repair culture is a mainstream movement, and material banks and repair cafes are spaces of change and exchange. The steel industry's shift enables new biophilic ecosystems, where filtered soils and renewable-powered food hubs take root.



- C1 Space for circular infrastructure
- C3 Waste flow management
- C5 Societal behaviour patterns
- C6 Circular learning patterns
- M1 Beyond Wastescapes
- M2 Places for living
- M3 Remote outposts
- M4 New train station
- M5 New bridge
- P1 Defining a campus
- G5 Investment in infrastructure
- G6 Politics of change



Urban form: connecting the existing with people and nature



5.4 HYPERLINKED HORIZONS

Scenario Condition
Keywords: Growth, Tech-optimism, Artificial Intelligence, Hard Edges, Concentrated and Efficient, Private Investment

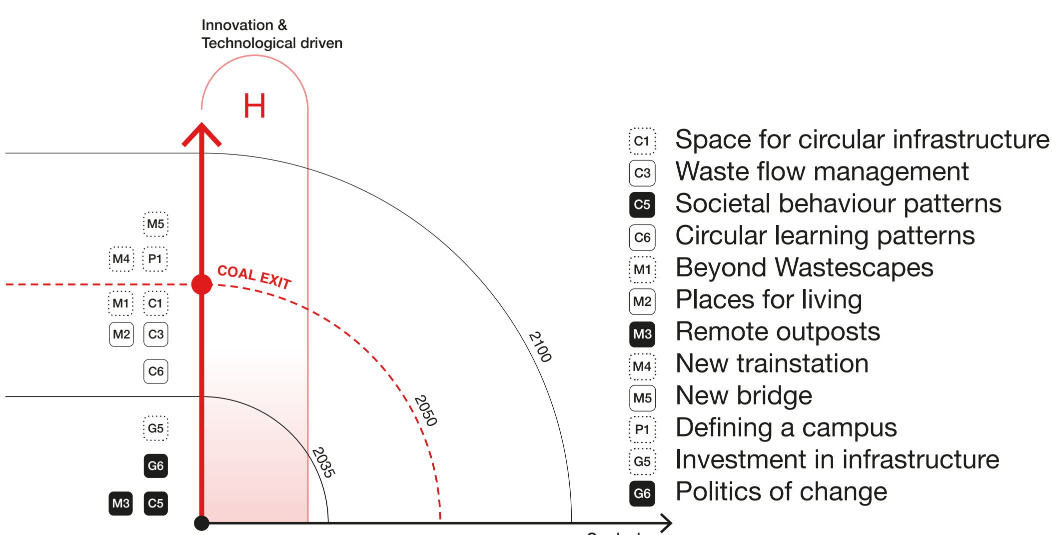
The core principles in this explorative scenario emerge from narratives around technological abundance and hyper-connectivity, where global market integration drives responses to climate disruption and new business opportunities. "Hyperlinked Horizons" imagines AI-driven decision-making connected with transnational infrastructures, rooted in the Economic Cycle of Wealth and Resource Cycle defined by Calisto Friant et al. (2023) (Acknowledging that the other interrelated cycles cannot be thought separated). Efficiency, adaptability, and resilience are achieved through smart systems. By scaling innovation and expanding digital networks, society can overcome major challenges like trade wars and turmoils, but not without risks to equity, governance, and ecological limits.

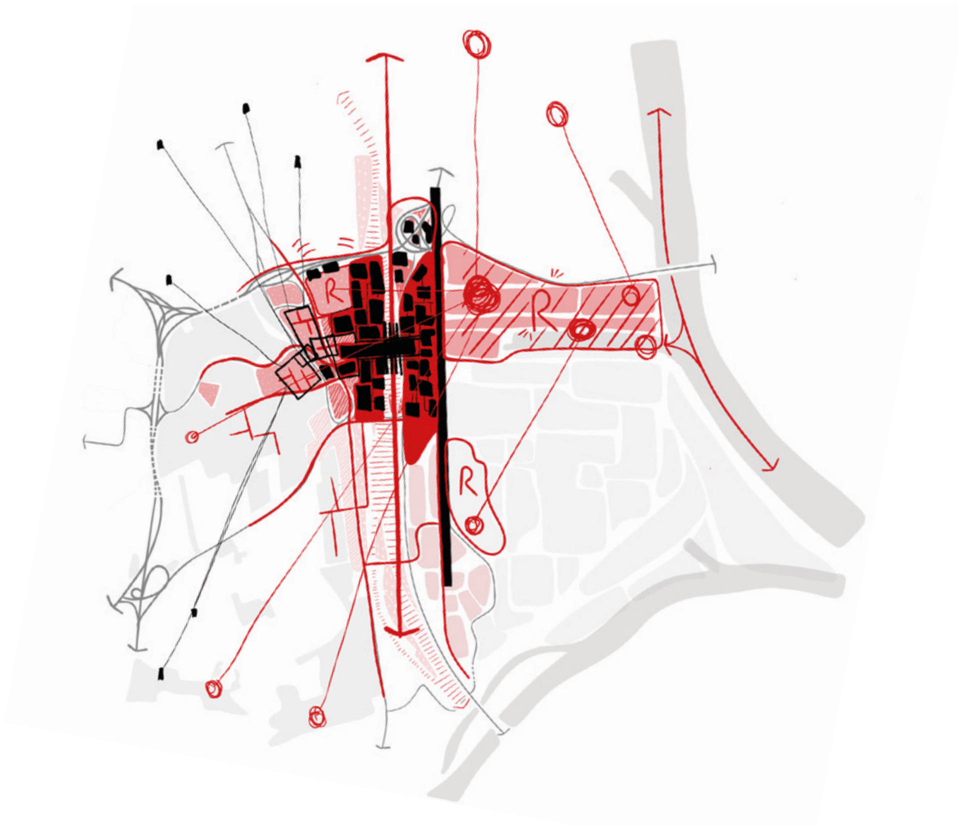
W

Economic Cycle of Wealth
The education environment focuses on innovation, digital job programs, and deep integration with industries. Campuses like Hagenberg become key hubs, connected through high-efficiency business and mobility infrastructure, grounded in transit-oriented development. European innovation centers like Paris, Zurich, Munich, or Vienna are linked via high-speed rail.

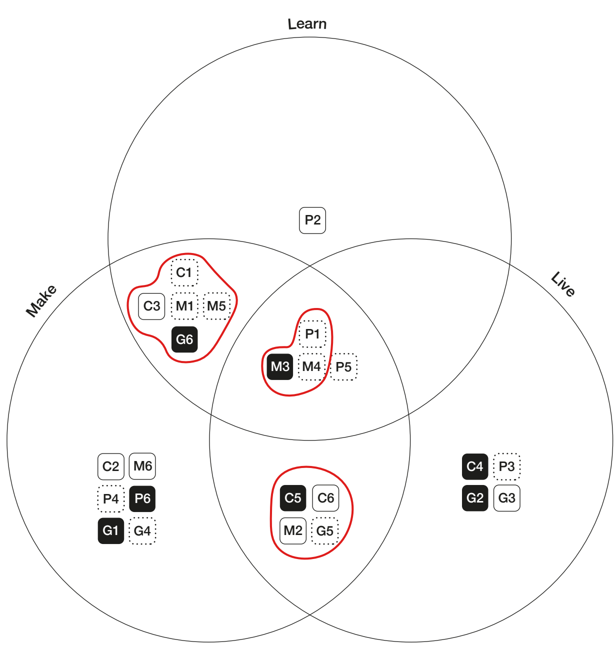
R

Resource Cycle
A European Hub for recycling and resource security develops on the 56-hectare former coke plant, optimised through AI-driven and real-time material flow analysis. This supports achieving European Green Deal targets, aligning with the European Critical Raw Materials Act (European Parliament, 2023). This can optimise and establish an infrastructure for a European self-sufficient network in cases of global turmoil like trade wars or emerging geopolitical conflicts.



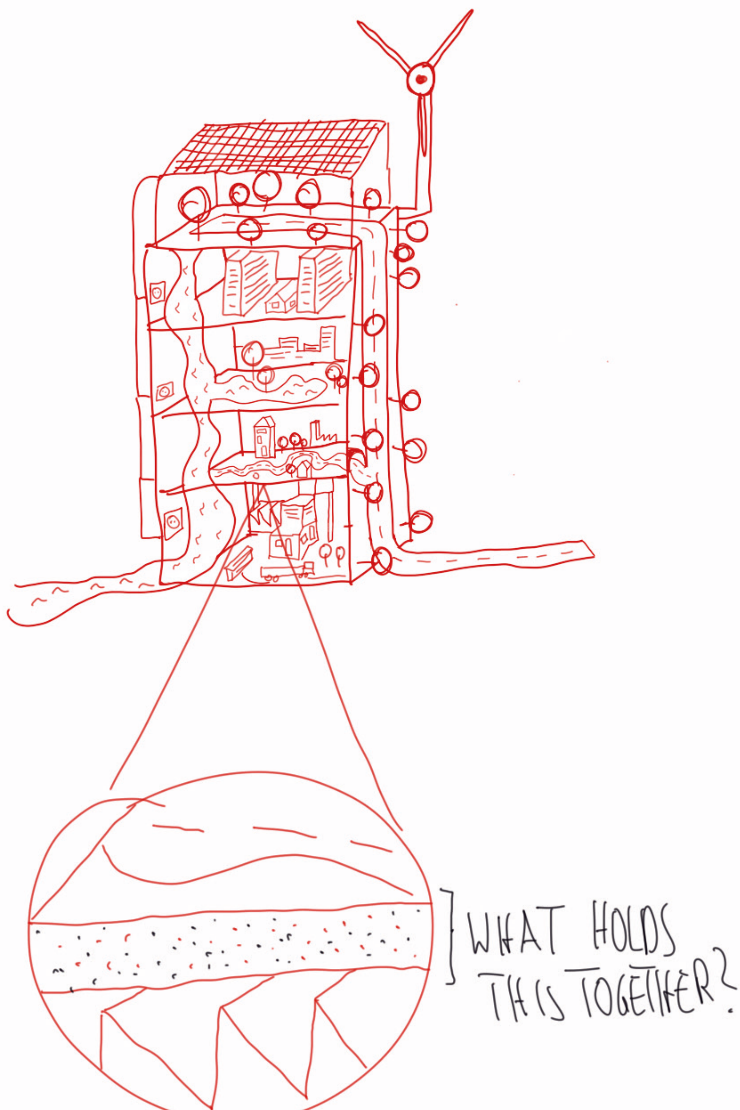


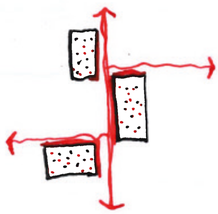
Urban form: connecting the new with innovation and businesses



5.5 ~~MASTERPLAN~~ FLEXIBLE FRAMEWORK

Re-imagining the bookshelf of Raith
To avoid a continuation of using the linear and stiff components of a masterplan, but working with its valuable components, this imaginary helps to define a grid as a backbone, which can function like a bookshelf as Raith describes in Stadtmorphologien (1998). He compares the qualities of future-proof concepts and city architectures with the qualities of bookshelves. They are structurally resilient to evolving demands but are capable of being filled in many different ways and flexible enough to allow an ongoing reconfiguration.



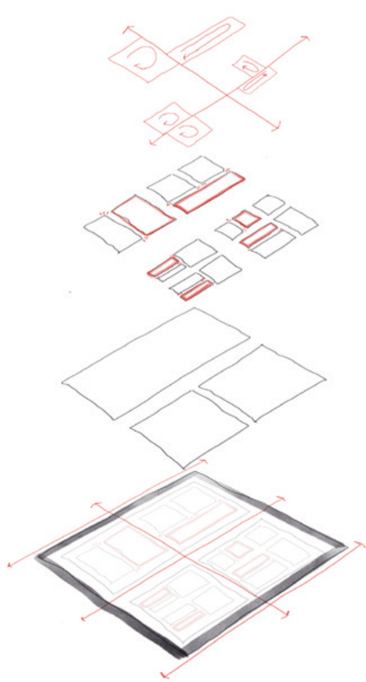


Spatialising circularity

The term circularity has as already mentioned, multiple different definitions and scopes. In this case, the integrated approach to understanding the spatial dimension of circularity under the lenses of make, live, and learn aggregated within the research to two main enablers **"C1 Circular Infrastructure"** and **"M1 Beyond Wastescapes".** These enablers are two of the 12 most integrated ones in both scenarios (see page 184 enablers) and the most diverging in terms of flexibility per scenario. The focus in the framework lies on those two enablers and their spatial and programmatic dimensions. Therefore, the elaborated Wastescapes and underutilised low-dense areas are seen as the connecting element between different places of making, living and learning.

Wastescapes as circular spaces

Left over spaces or in-between areas along infrastructures, manufacturing areas are often left behind overlooked, degraded and complex due to the lack of accessibility or nearby emissions. However, those areas are most of the time seen simply as infills when it comes to developments. To avoid simplification and primarily economic-driven masterplan thinking, these spaces can function as flexible and shared areas for its adjacent users. They stay flexible and evolve over time depending on the demand and the conditions in the ongoing transition. This allows beyond conventional zoning, flexibility in demand regarding economic developments or environmental shocks. If there is no actual program or demand for those, these areas often host already valuable species and complex ecosystems and can stay like this to enhance biodiversity.



Circular space logic

An inner logic connecting these circular spaces generates a network for its users to navigate trough the space. Flexible circular spaces can change be switched on and of on demand.

Block

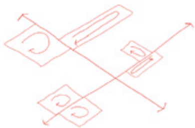
Blocks function as an ongoing changing entity, with a focus on circular spaces with a maximal grade on flexibility.

Maxi Block

Maxi Blocks keep the flexibility within the quarter structure to adapt to continues changes.

Quarter

Characterised quarters enable a definition of core strengths of the area as more robust structure.

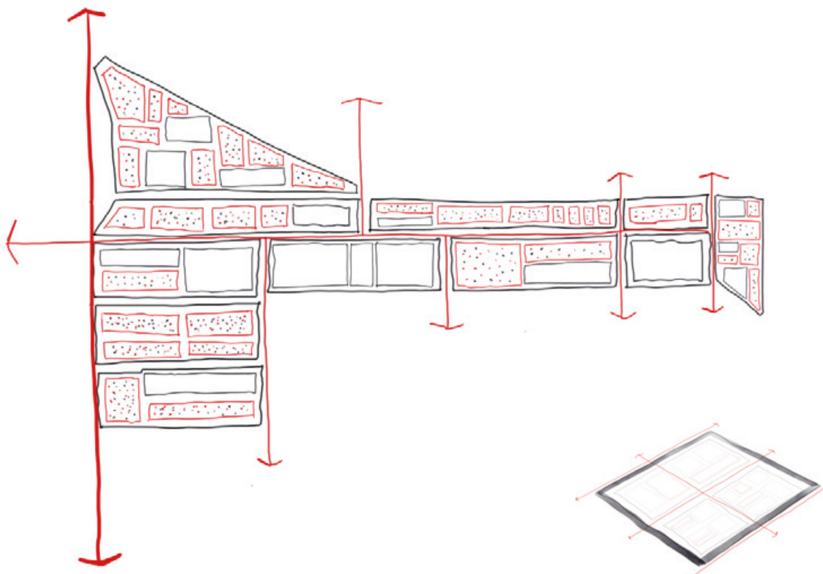


Circular space logic: spatial organisation

Based on urban grid principles, the spatial organisation of circular spaces is in both scenarios flexible, but with different logics based on the conditions. While the grid in Hyperlinked Horizons is flow based and standardised, the logic in Resilient Roots follows a more heterogenic order.

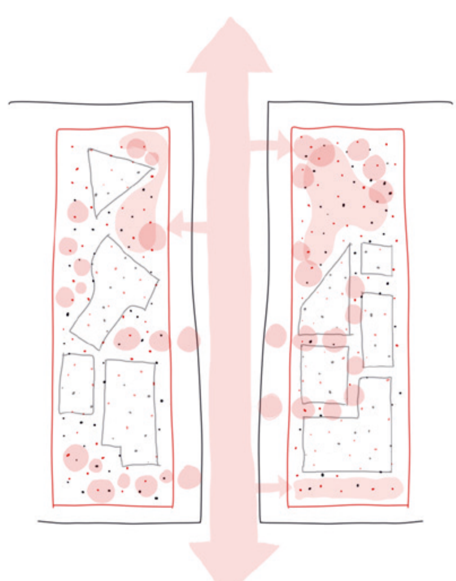
Heterogeneous order

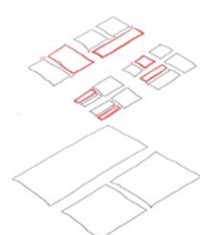
This organisation on the quarter level allows cooperation between maxi blocks and blocks. The structure follows more an inner logic and allows due to diverse sizes of maxi blocks a variety of block sizes and circular space dimensions.



Ecosystem based arrangement

The circular spaces play a crucial role in soil re mediation and micro climate enhancement. Therefore, the main structure is defined by ecosystems to build a cross block network. Within, a flexible arrangement it allows to connect communities and ecosystems. A **messy order** within the block structure is possible.



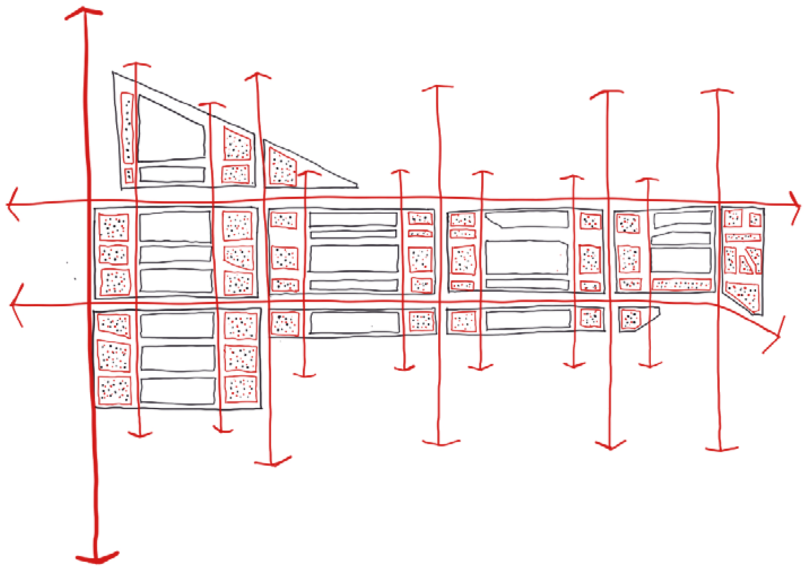


RR

Flow optimised order

This organisation on the quarter level allows a trough-put between quarters, maxi blocks and blocks. Existing infrastructures like rail and road networks build the backbone to align circular spaces along these infrastructures to grantee a maximal flexibility for material flow optimisation

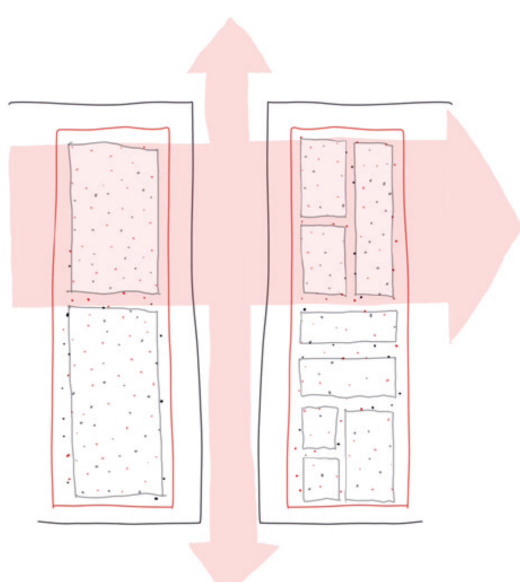
Circular spaces
Blocks
Quarters
Main Connections



Cross-block plug-in on demand

Enterprises on maxi block or block level have the opportunity to share circular spaces with others across blocks, or add circular spaces on demand if necessary to their blocks. A **clear order** within the block structure is required.

Circular spaces
Blocks
Quarters
Main Connections



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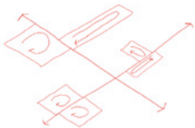


Circular space logic: programmatic organisation

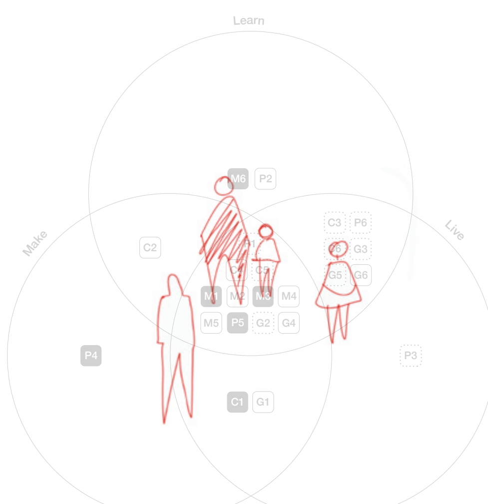
The programmatic configuration is based on the two main enablers “C1 Circular Infrastructure” and “W1 Beyond Wastescapes”. Under this umbrella, a combination of a variety of other enablers is possible. However, the focus lies more on the identification of core qualities of circular spaces to understand the demand, distribution and stewardship.

Hardware

To understand the physical conditions of the defined circular spaces, an investigation of the qualities is necessary. Within a database, this can function as helpful tool to **connect e.g. communities** with spaces and to understand the **ecological valu**e of those. The **public sector** functions as facilitator for monitoring the circular spaces in the GLA.

Qualities to investigate can be:

- Tree cover
- Species
- Groundwater level
- Pollutants
- Soil condition
- Size/Dimensions
- Neigbour Block
- Technical Infrastructure



Software

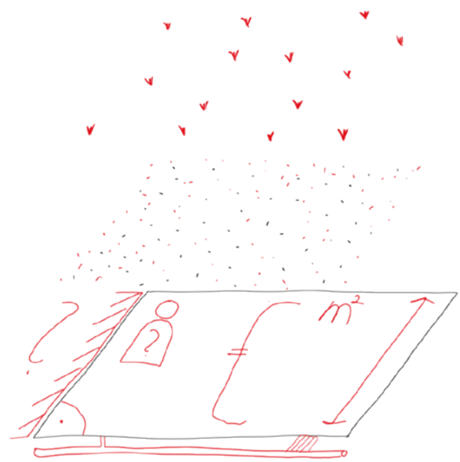
To find the right fit for the user group of those spaces, the triple helix with the enablers can help to understand the programming of the circular space. Therefore, a circular space can host multiple combinations of enablers based on its conditions and needs. In this scenario the program mainly focuses on **community driven practices.**

Hardware

To understand the physical conditions of the defined circular spaces, an investigation of the qualities is necessary. Within a database, this can function as helpful tool to **connect e.g. businesses** with spaces and to understand the **economic value** of those. The **private sector** functions as facilitator for monitoring the circular spaces in the GLA.

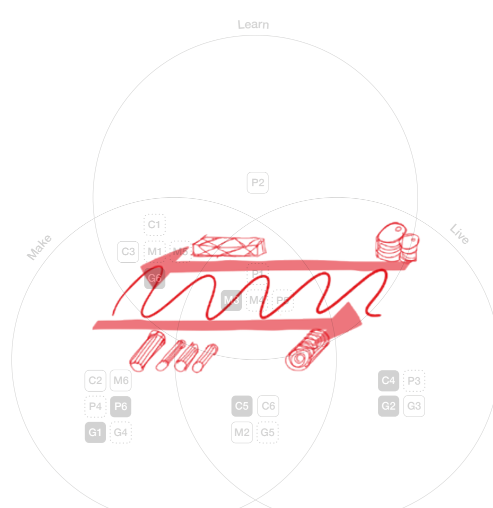
Qualities to investigate can be:

- Ownership
- Size/Dimensions
- Price per square meter
- Neighbour Block
- Rail access
- Road access
- Technical Infrastructure
- Soil (Load-bearing capacity)



Software

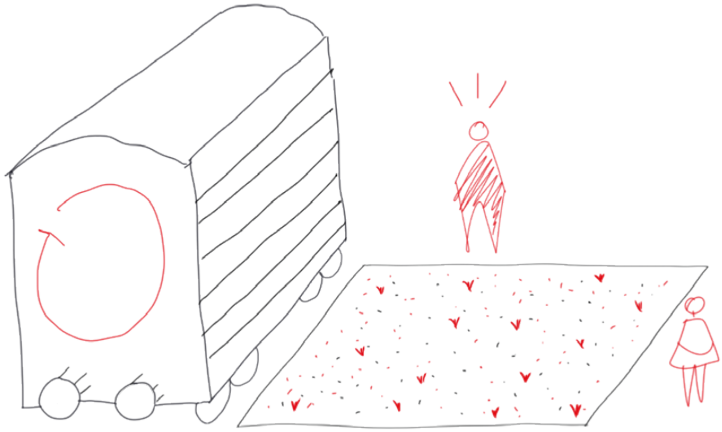
To find the right fit for the user group of those spaces, the triple helix with the enablers can help to understand the programming of the circular space. Therefore, a circular space can host multiple combinations of enablers based on its conditions and needs. In this scenario the program mainly focuses on **technology driven practices.**



MAKE RE-USE WORK

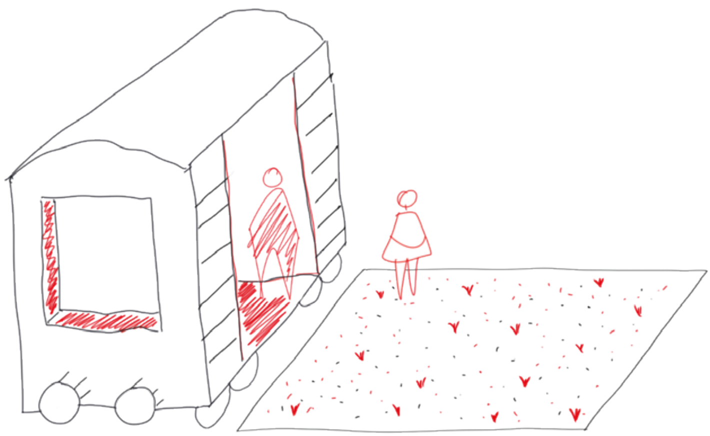
1. Find opportunities

In the energy transtition, many infrastructures and objects may change value or purpuse. Knowing where they are can be a potential for re-purposing the existing.



2. Use the exisiting

Activating vacant buildings or mobile infrastructures can function as a base for community driven places for repair.



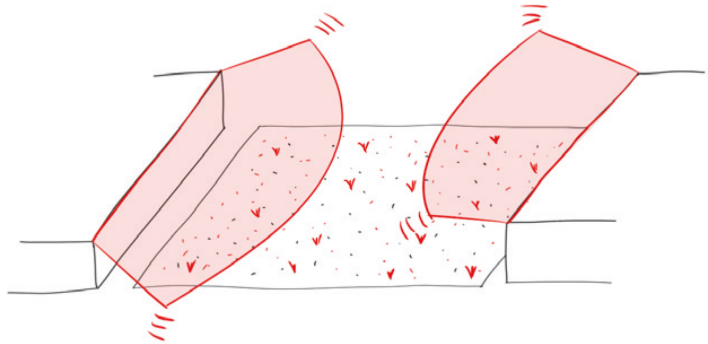
3.Claiming space together

More hands - more pos-sibilities. Common prac-tices enable with low cost interventions a resource efficient and sustainable way of making.

RR

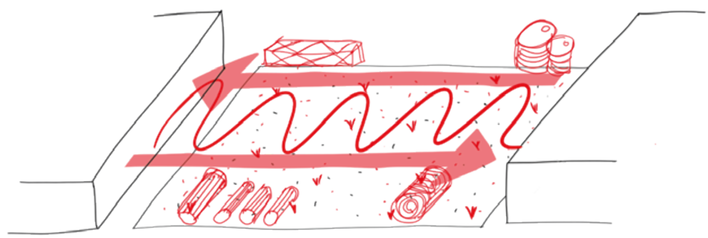
1. Find partners to share

New technologies mean also new ways of making and new possibilities to do it together. Knowing who is doing what and where helps to understand future purposes of circular spaces.



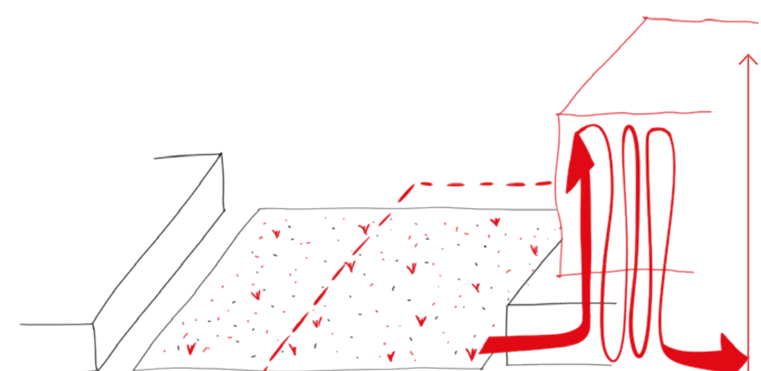
2. Benefit from the other

To optimise work flows, proximity plays a crucial role in material flows. Local exchange is more cost efficient and allows fast and independent exchange between partners.



3. Changing demands

Changing technologies mean changing demands of space and built environments. Therefore, flexibility is crucial to give those who need the space at the moment the right amount. Development is only happening vertically, which shifts again the surrounding conditions for circular spaces.



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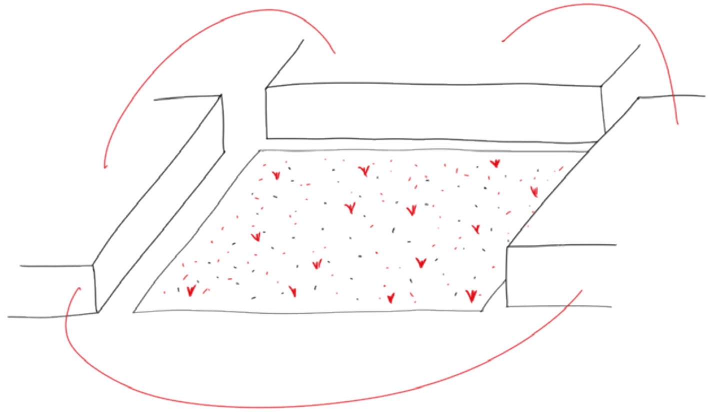
LIVE LAUGH LOVE

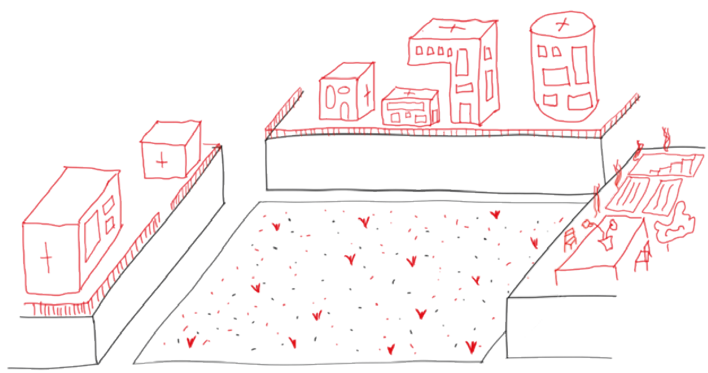
1. Get to know the others

Often neighbours across the courtyard don't know each other for a whole life. In a future where helping each other gets more crucial, having a support network around can help.



2. Share future plans

Changing demand on living require a more flexible and adaptable built environment. Sharing common plans for changing situations can help to understand the others better and generates common space for negotiation.



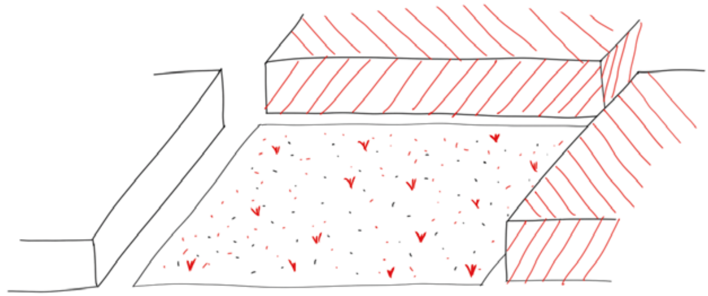
3. Celebrate togetherness

This common negotiation space can be today the garden party, tomorrow the outdoor pilates studio and in 5 years the playground for the next generation.

RR

1. Identify potentials

Some buildings don't meet today's standards for renovation and have to be demolished to meet future needs of living.

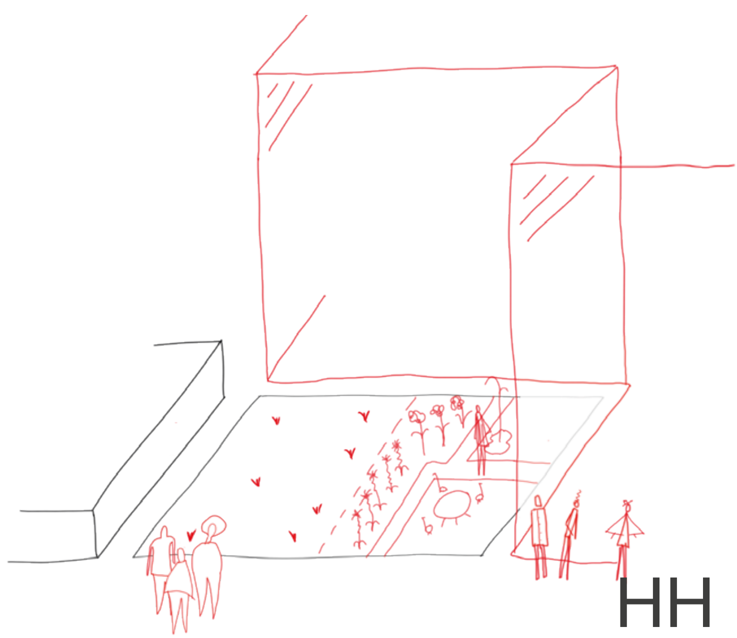


2. Demolish but re-use

To avoid an increase in CO^2 emissions, it is crucial to re-use as much as possible of the deconstructed built environment. Therefore, a material bank can help to separate usable from non-usable materials to keep usable material in the loop.

3. Aim for density

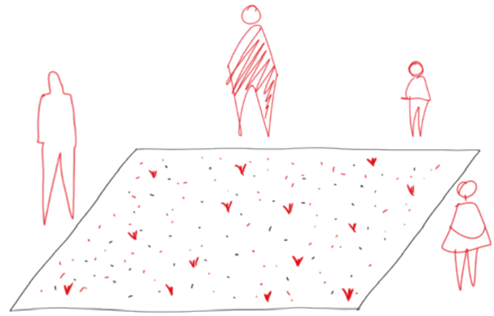
When it comes to new developments, it is crucial to avoid greenfield developments at all costs. Furthermore, new developments have to be align with future needs in terms of material re-use. The space in between the existing and the new can be re-interpreted on demand for commercial or private use.



LEARN TO RE-LEARN

1. Find an interest group

Resilient futures require local methods. Not all people have the knowledge for those, often forgotten and unlearned practices. Therefore, finding a peer-group to learn together helps to navigate trough uncertain futures.

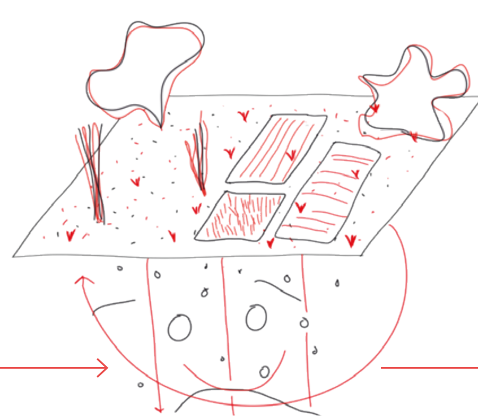


2. Learn new-old things

Making food is nothing new. But interdependencies from food markets in a more self sufficient future requires knowledge in terms of how, where, when and what. Exchange between educational facilities, indigenous, old and young people is crucial to learn healthy ways of doing.

3. Regenerate

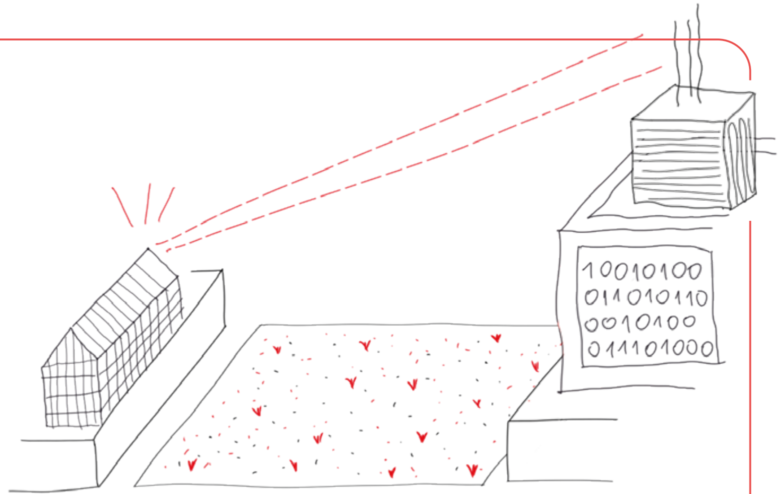
After a period of human interaction with ecosystems, the soil can regenerate because of the previous restoration and preparation. This allows flora and fauna to claim back the space needed.



RR

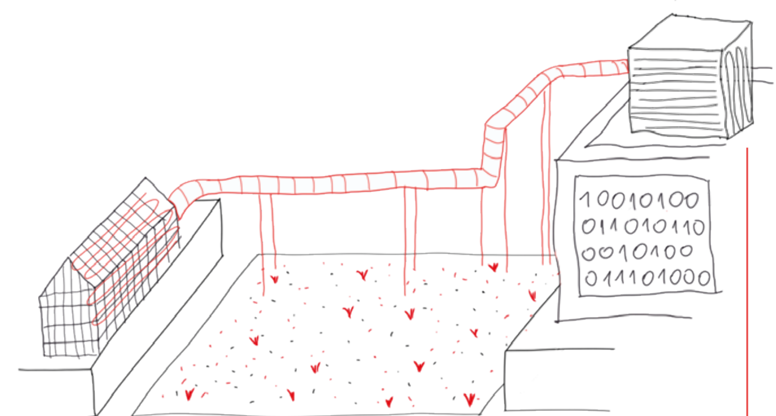
1. See the unseen

Often innovate and ground breaking solutions are just developed around the corner without any notice. Knowing who is doing what where helps to learn from each other.



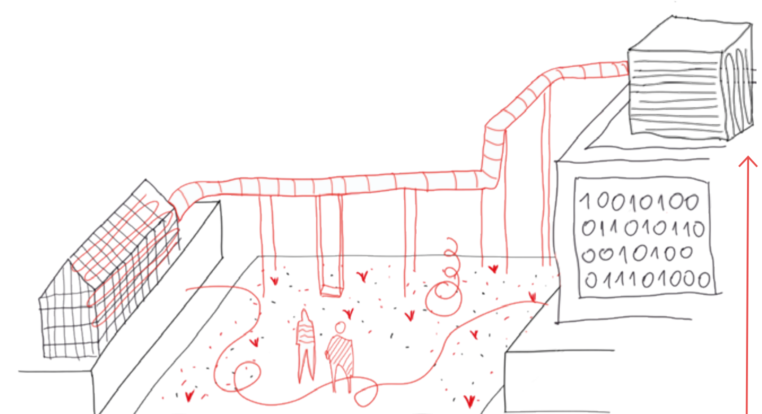
2. Learn how to use it

To join forces, a certain infrastructure is required to make things work. Circular spaces can host adaptable technologies.



3. Learn togetherness

Working with the knowl-edge and infrastructure from other disciplines can help to join forces for new findings and smarter ways of making.



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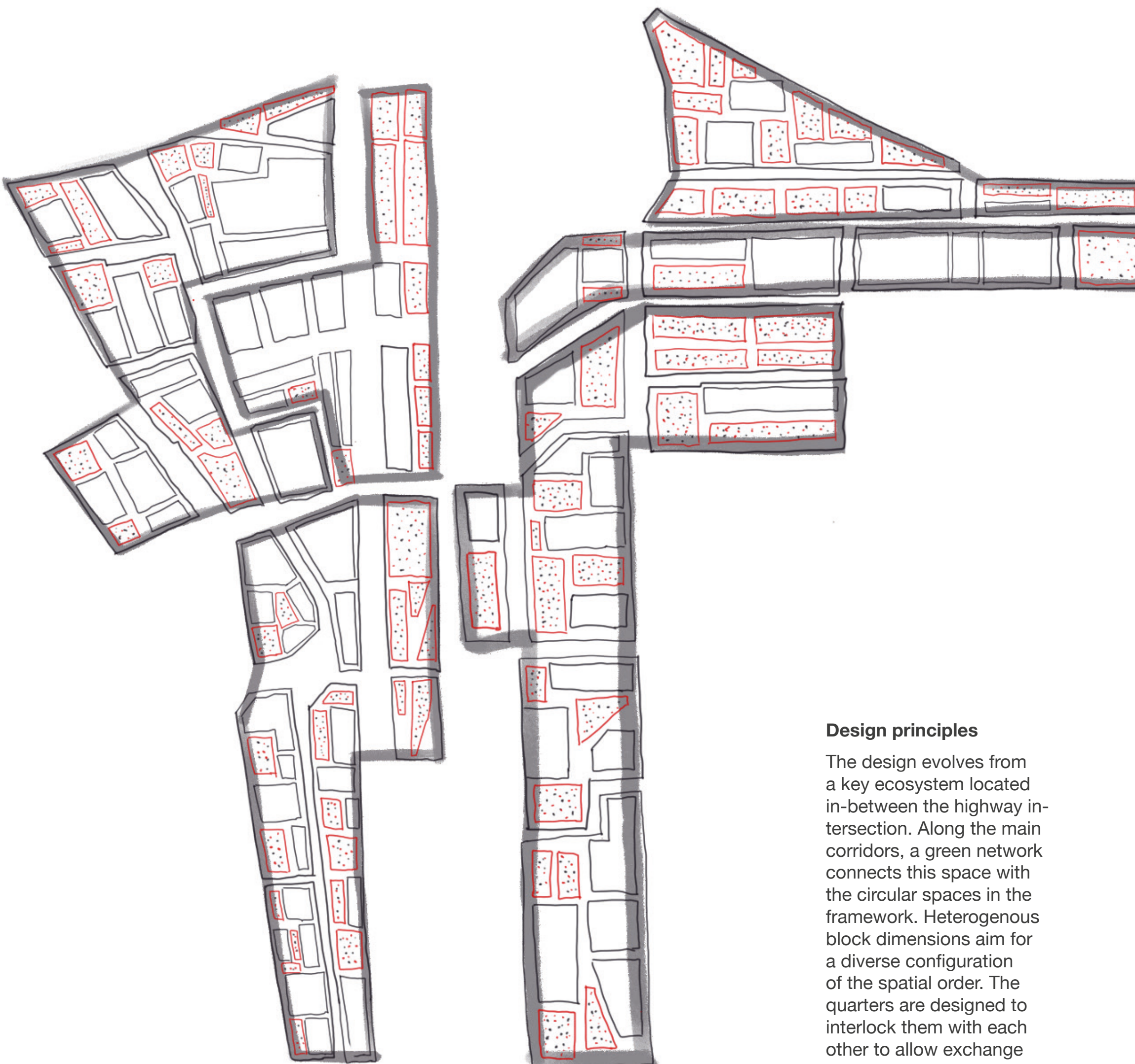
5.6 RESILIENT ROOTS FRAMEWORK



Design principles

The design evolves from a key ecosystem located in-between the highway intersection. Along the main corridors, a green network connects this space with the circular spaces in the framework. Heterogenous block dimensions aim for a diverse configuration of the spatial order. The quarters are designed to interlock them with each other to allow exchange between them.

Circular spaces

Blocks

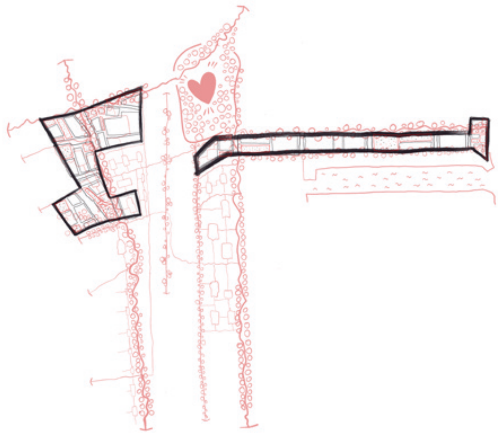
Quarters

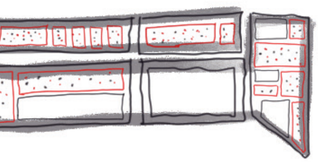
Main connections

200m

Eco-Campus as connector

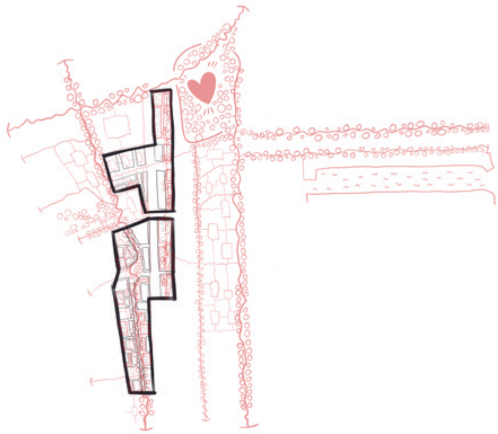
The Eco-Campus is located in the existing education facilities along Wiener Straße. With a new bridge system for slow traffic, the campus develops into the previous coke plant using its facilities for research and education. Nature based solutions help to regenerate polluted soil.





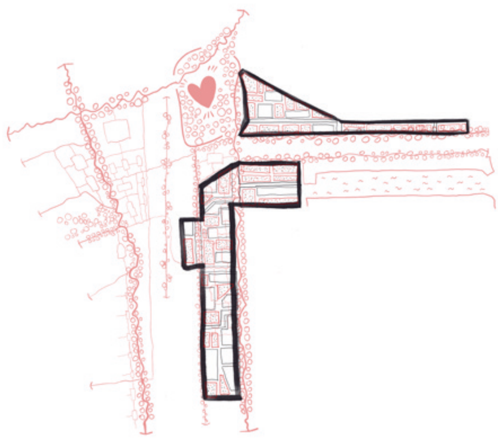
Living In-Between

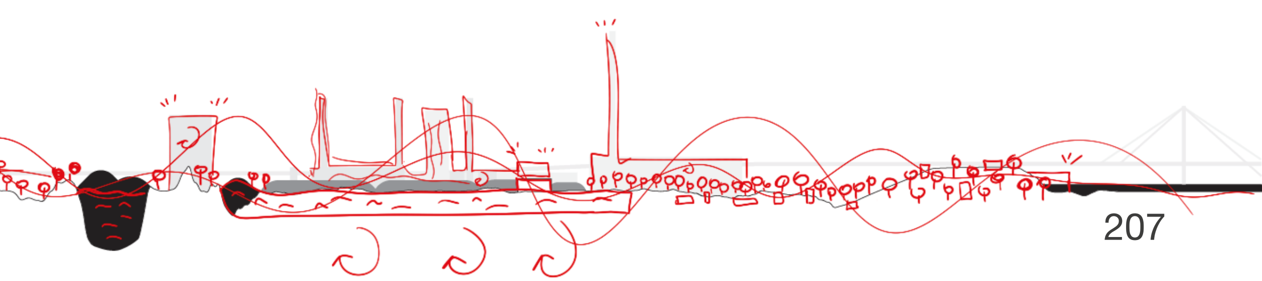
To generate exchange between living and learning, the living quarters are located in their existing locations between the campus and along the Wiener Straße. To meet future needs, existing structures are re purposed, repaired and flexible redesigned. A certain amount of circular space is provided to organise self sufficient food production, repair activities and other common practices.

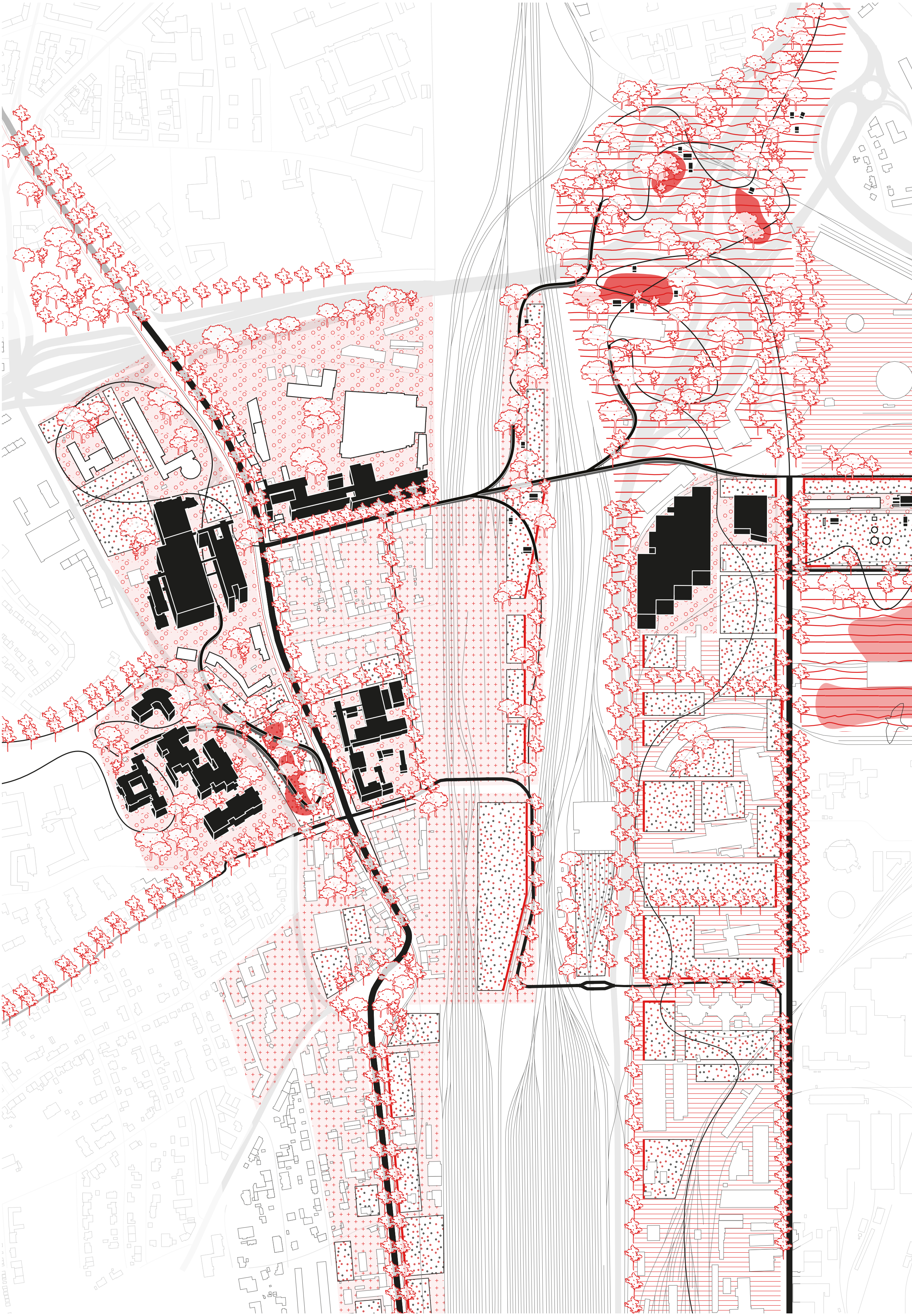


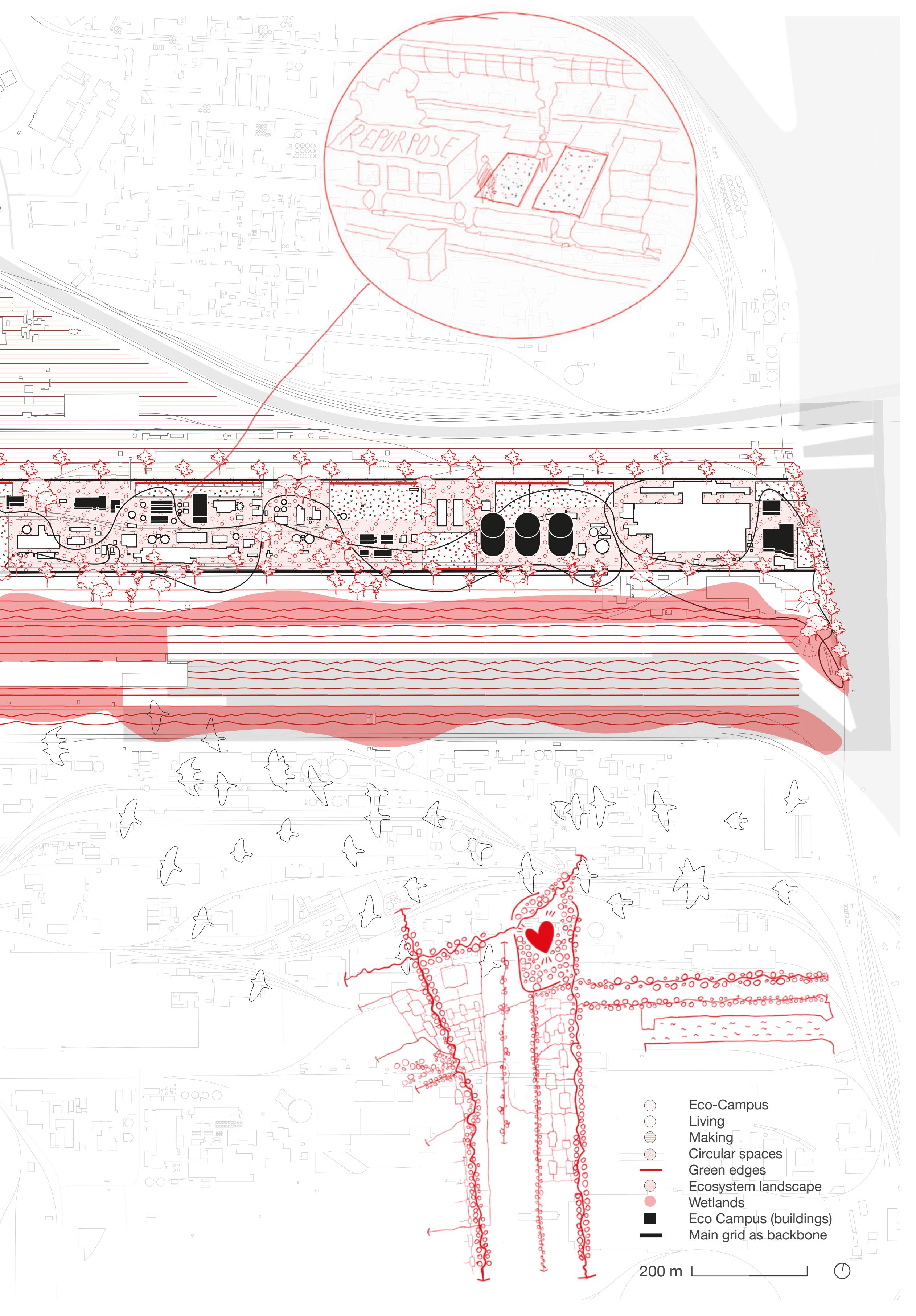
Making along learning

Making and learning goes hand in hand to support each others ideas to find sustainable ways to facilitate local resources.



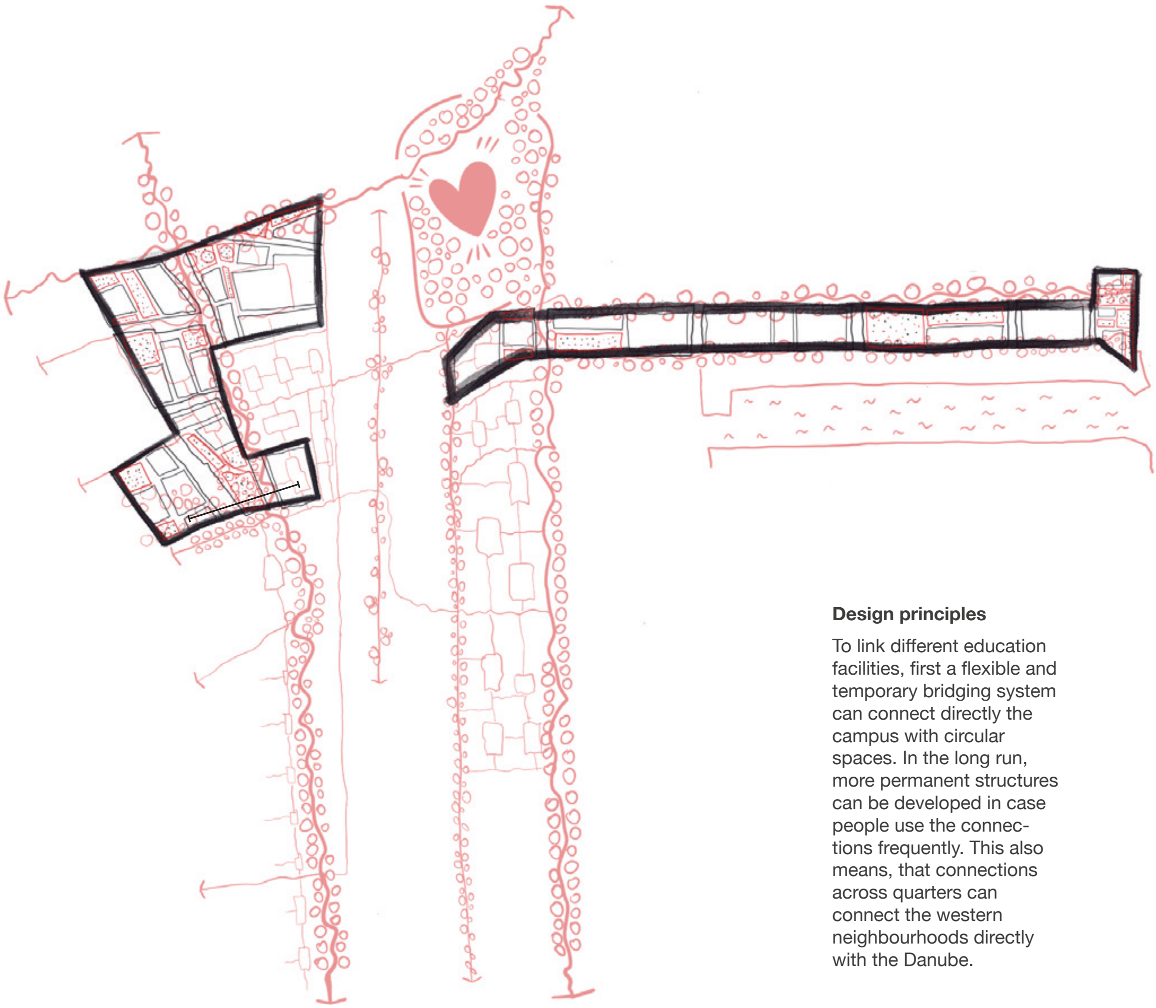






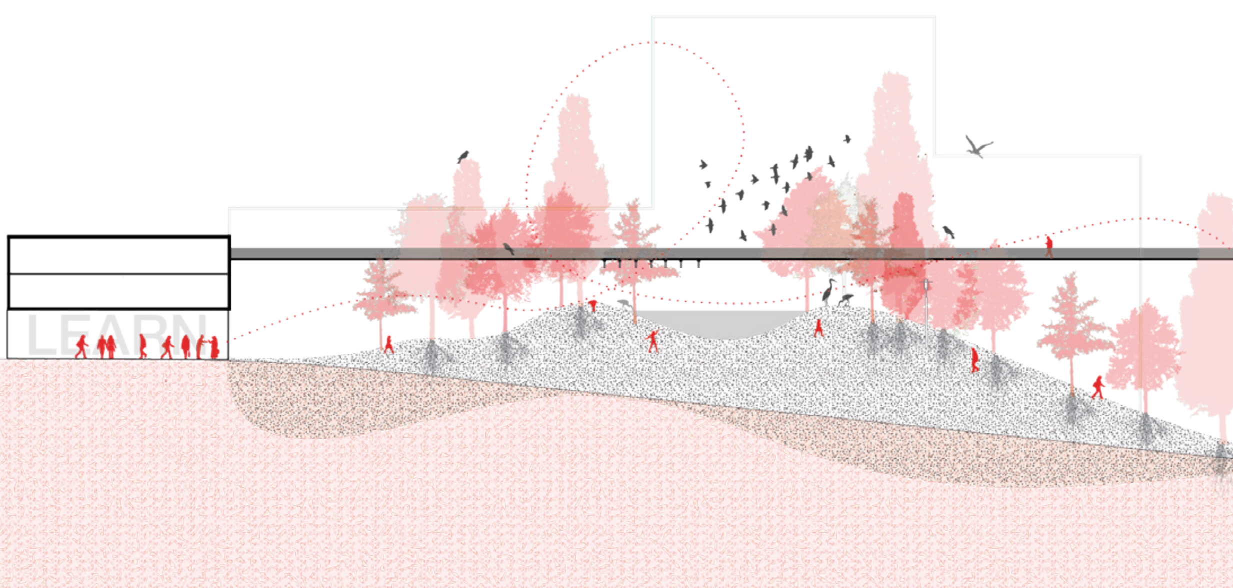
REPURPOSE
Eco-Campus
Living
Making
Circular spaces
Green edges
Ecosystem landscape
Wetlands
Eco Campus (buildings)
Main grid as backbone
200 m

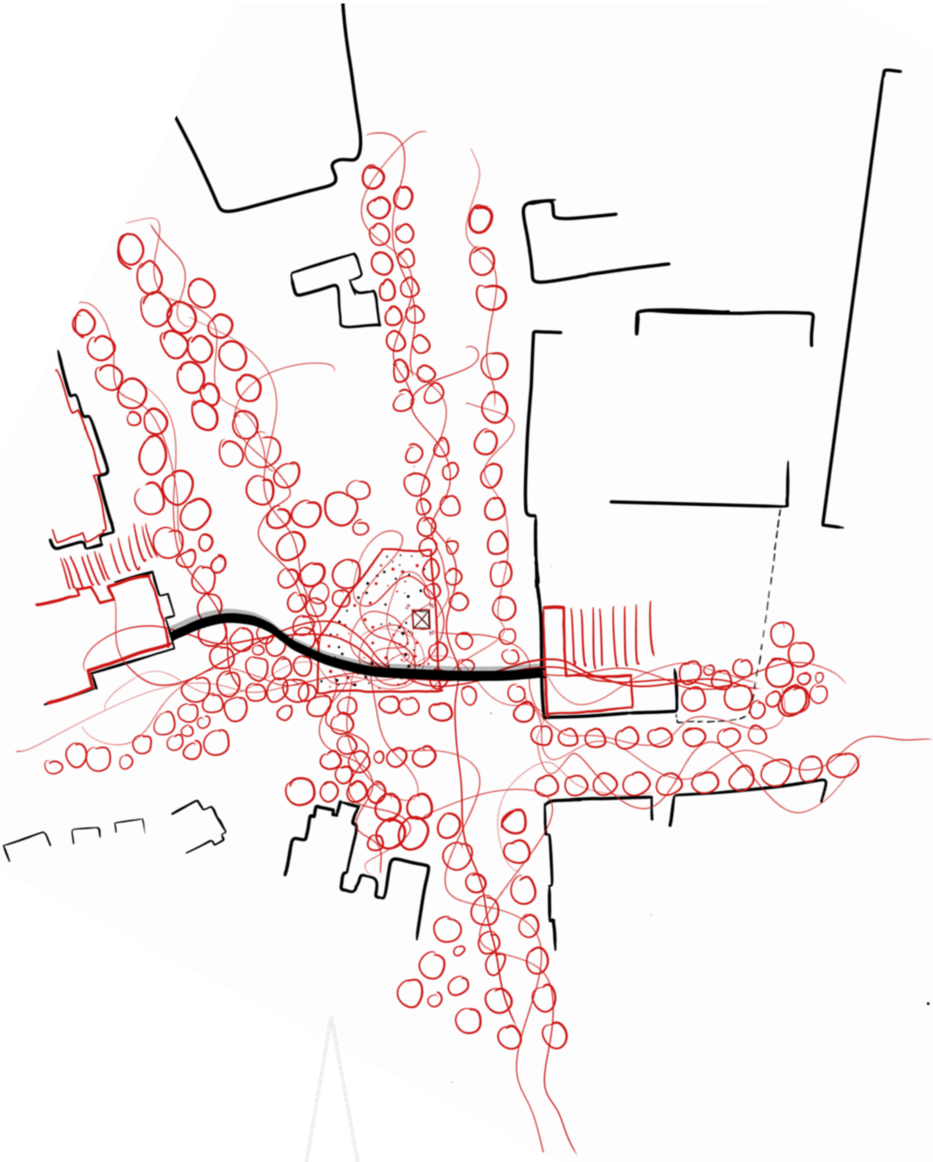
CIRCULAR SPACE: CAMPUS LINK

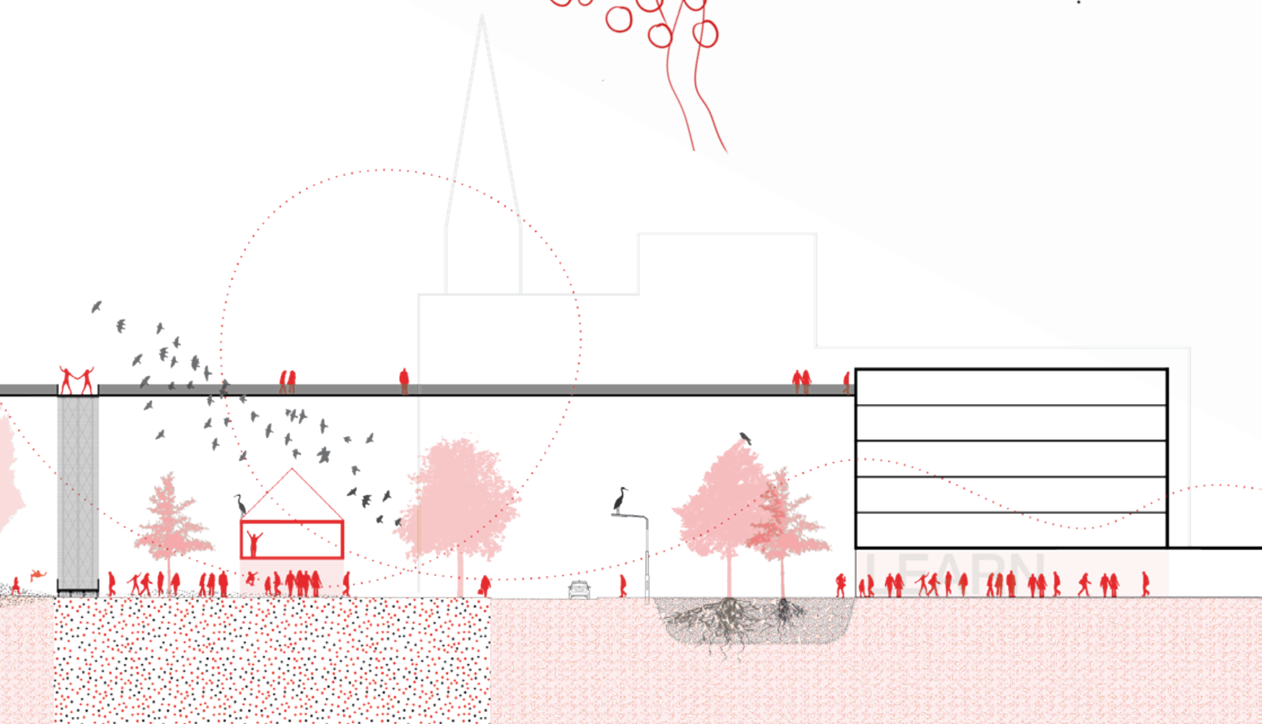


Design principles

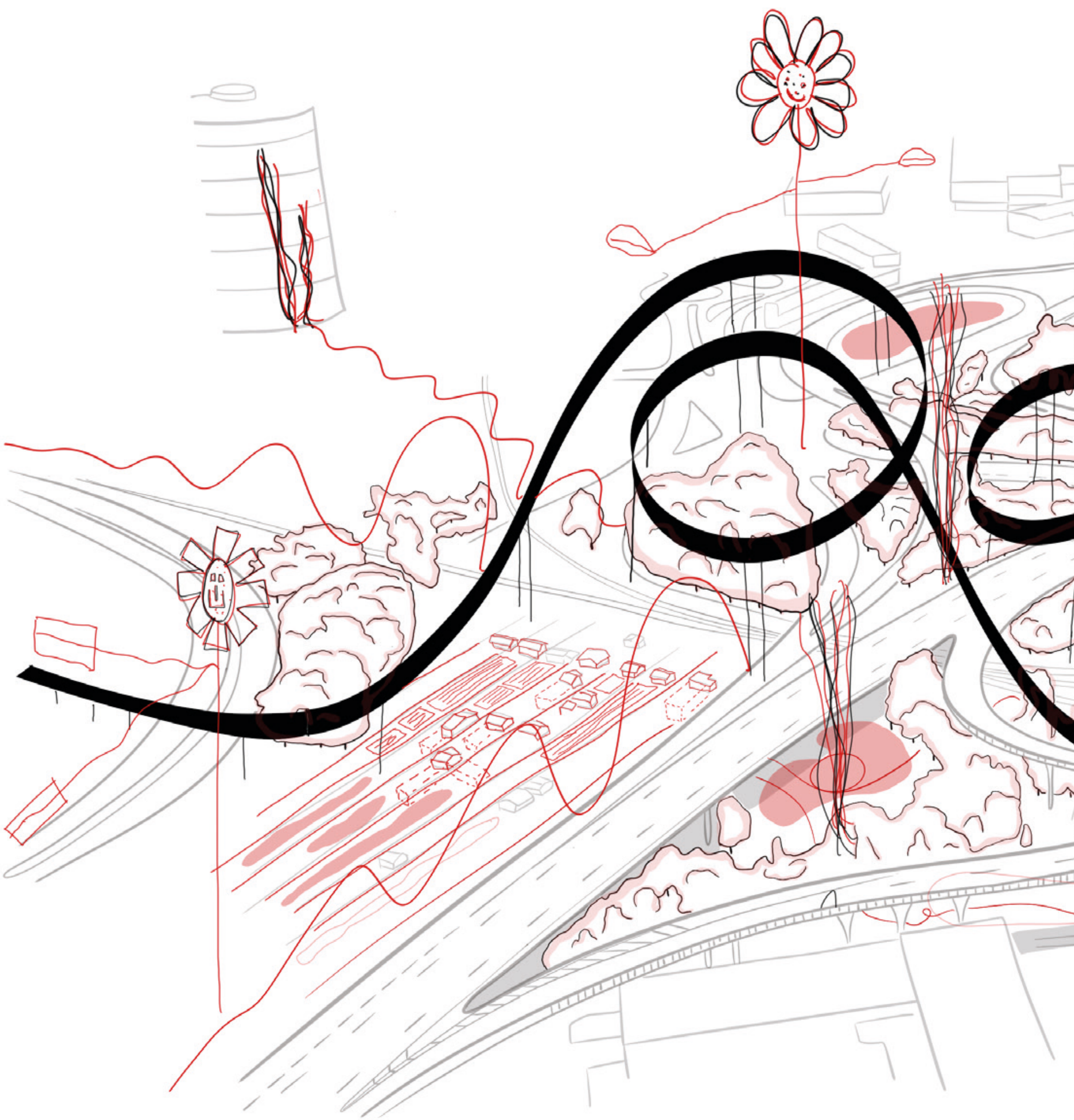
To link different education facilities, first a flexible and temporary bridging system can connect directly the campus with circular spaces. In the long run, more permanent structures can be developed in case people use the connections frequently. This also means, that connections across quarters can connect the western neighbourhoods directly with the Danube.

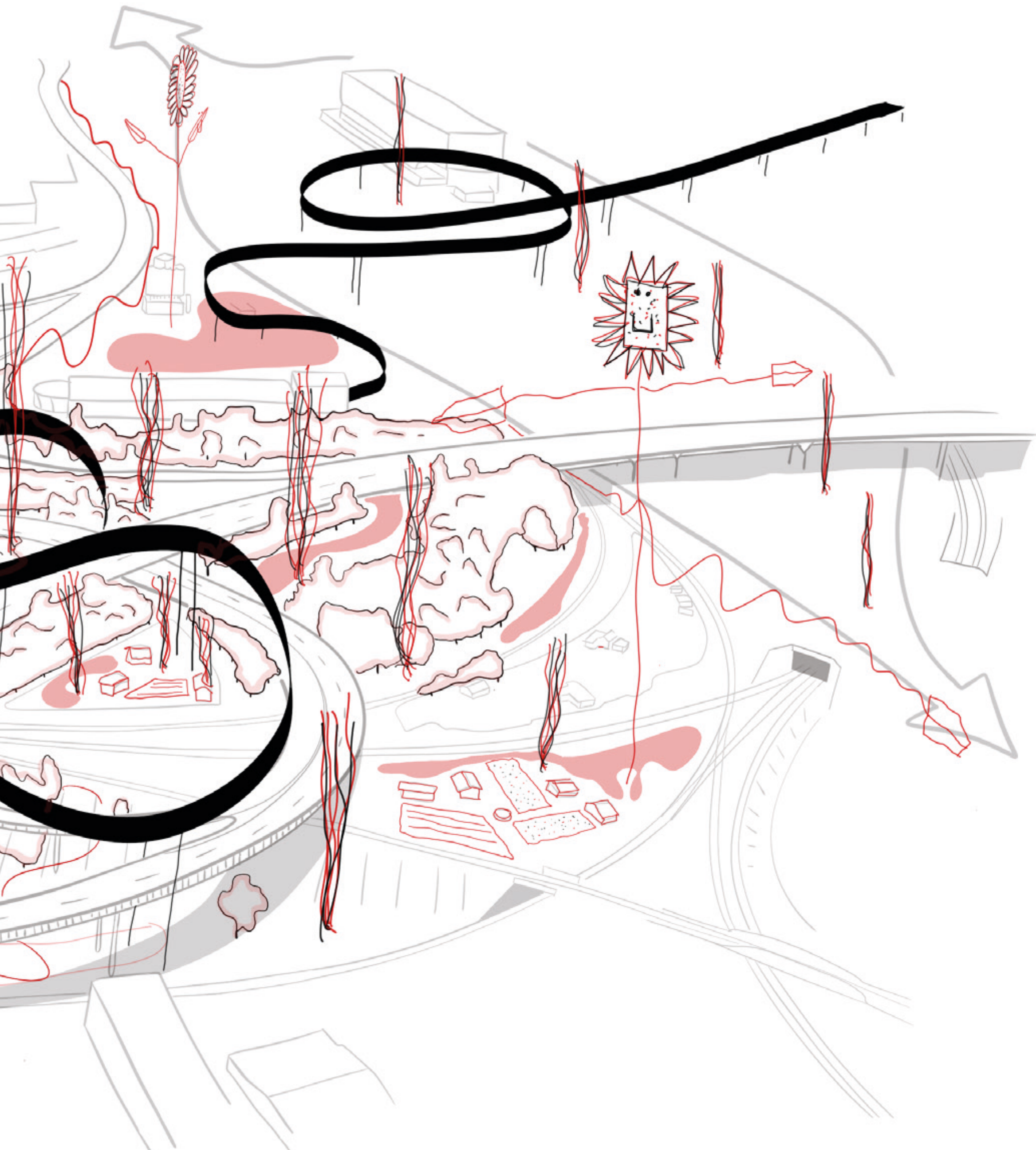





LEARN

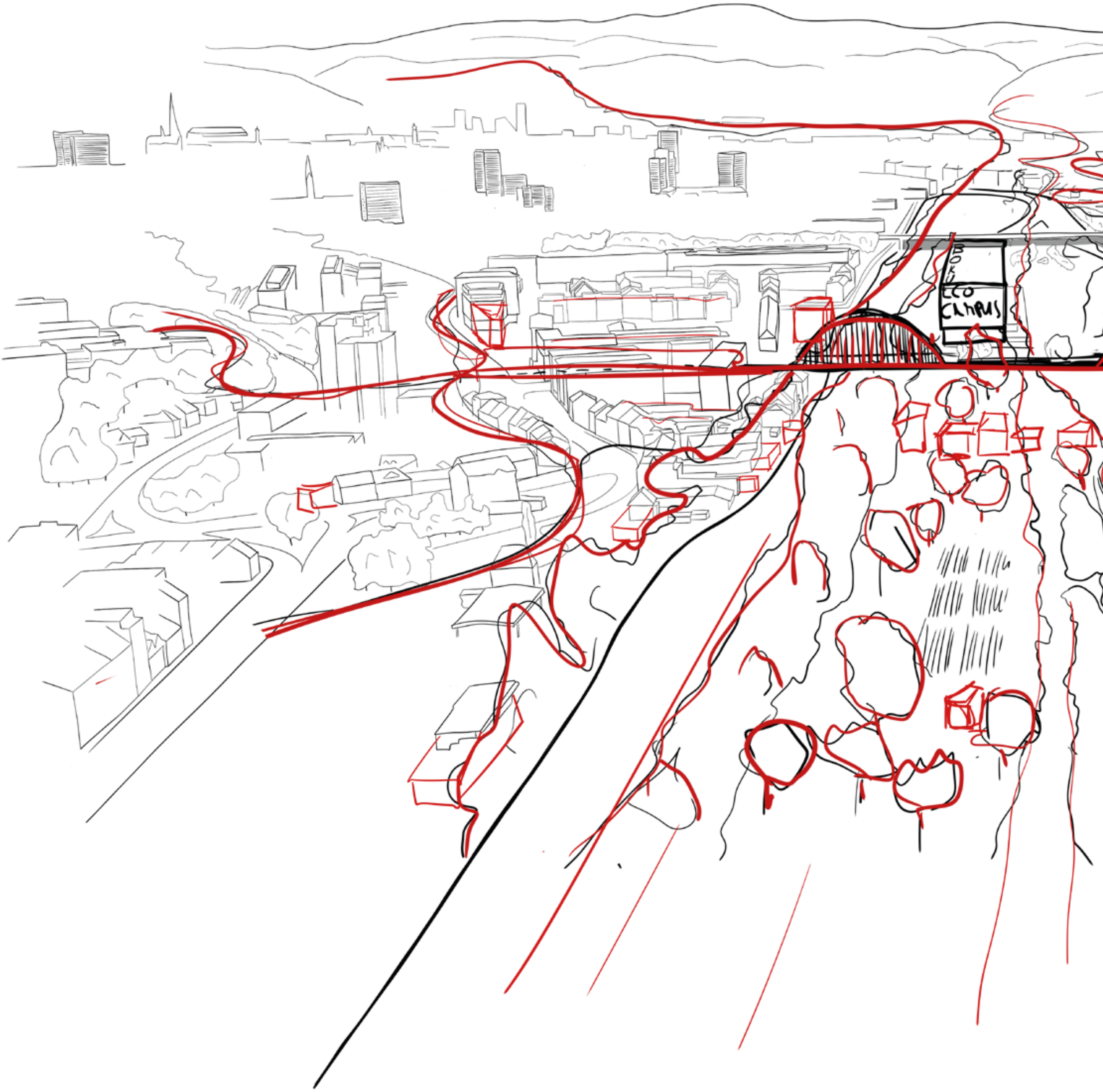
CIRCULAR SPACE: VOEST NODE

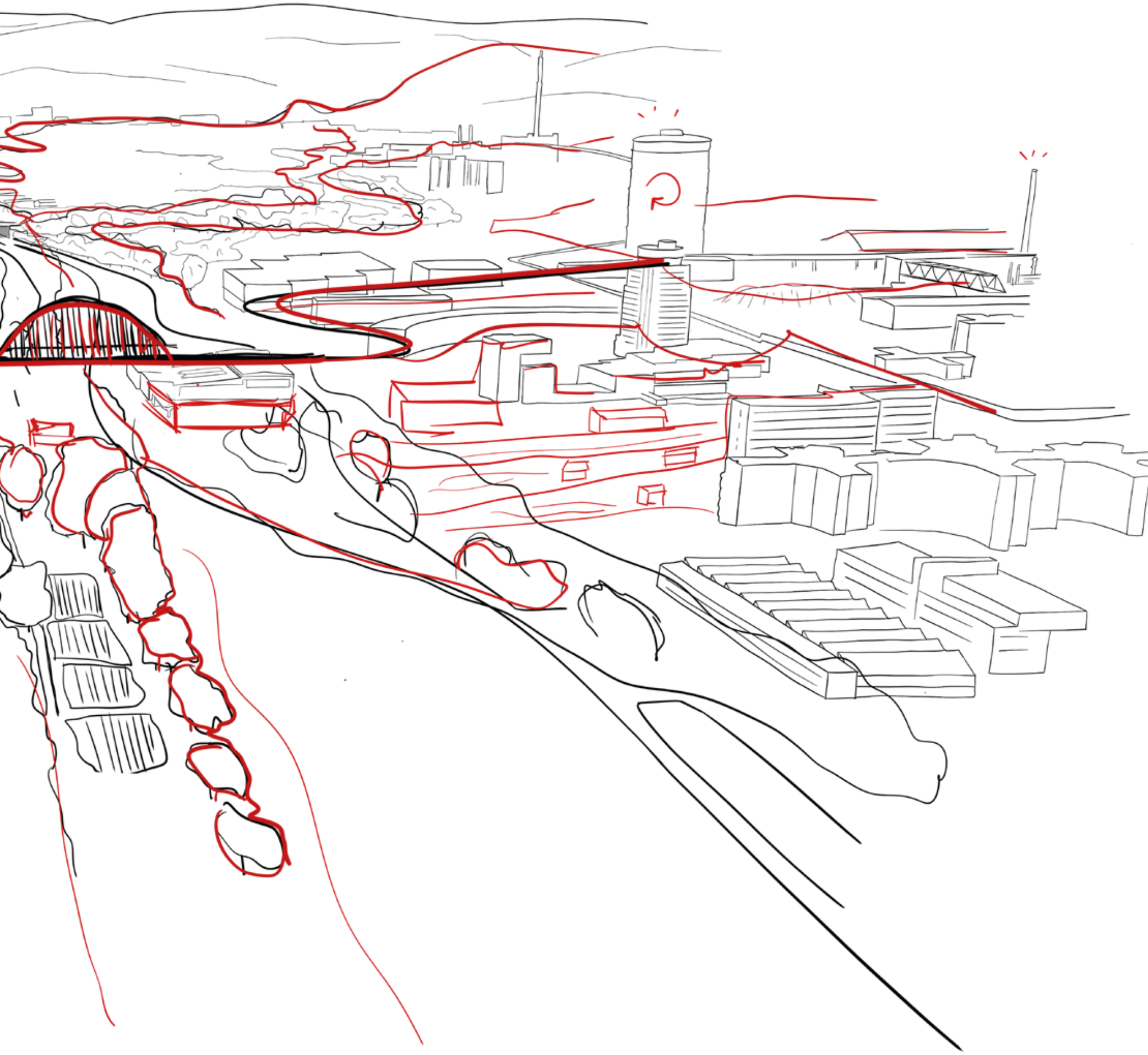




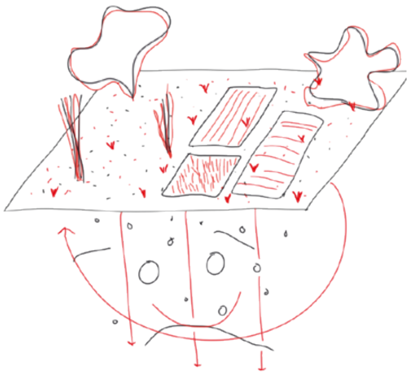
Design principles

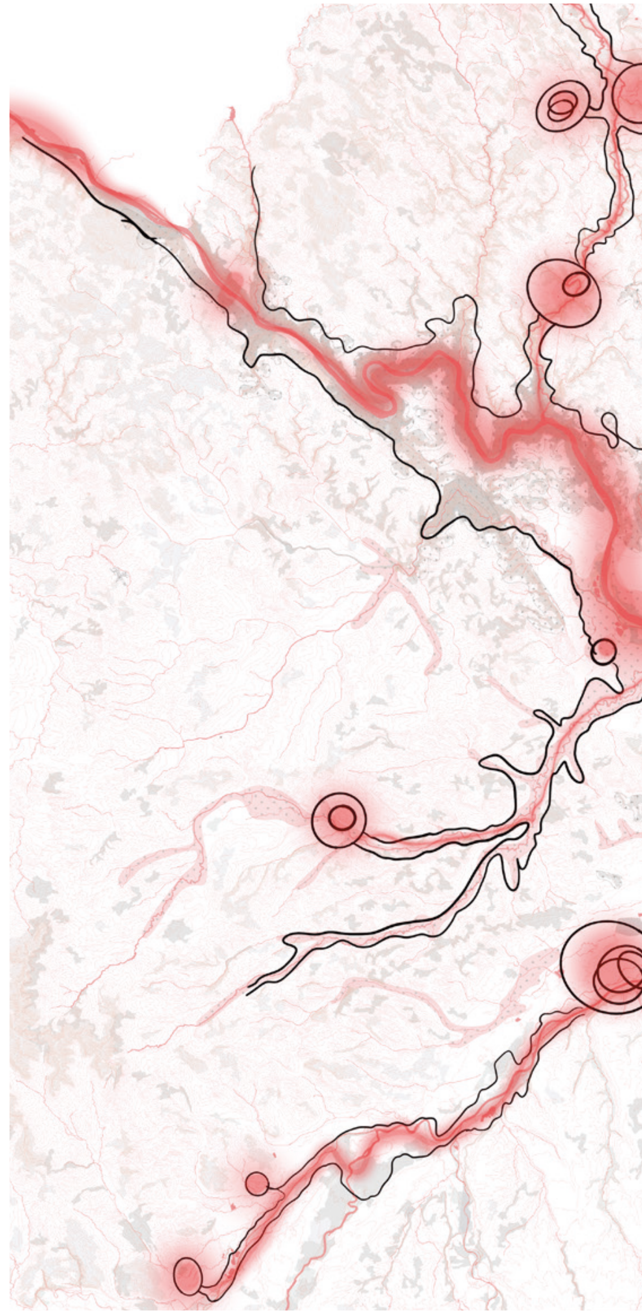
The heart of the design evolves from the already existing ruderal vegetation which could evolve on it's own over years within a complex infrastructure system. This valuable eco-system can help to connect green spaces within the quarters and simultaneously function as mitigator during climate extremes like heavy rain events.


BOKU
ECO CAMPUS



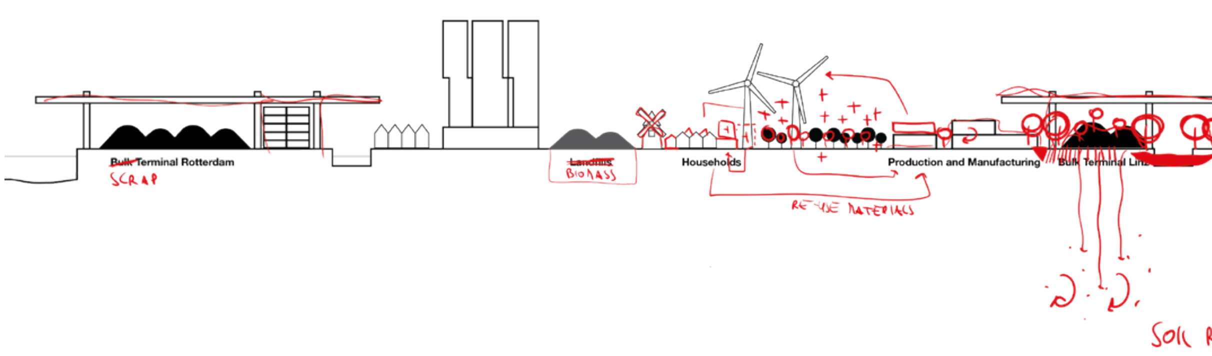
TERRITORIAL DIMENSION OF RR

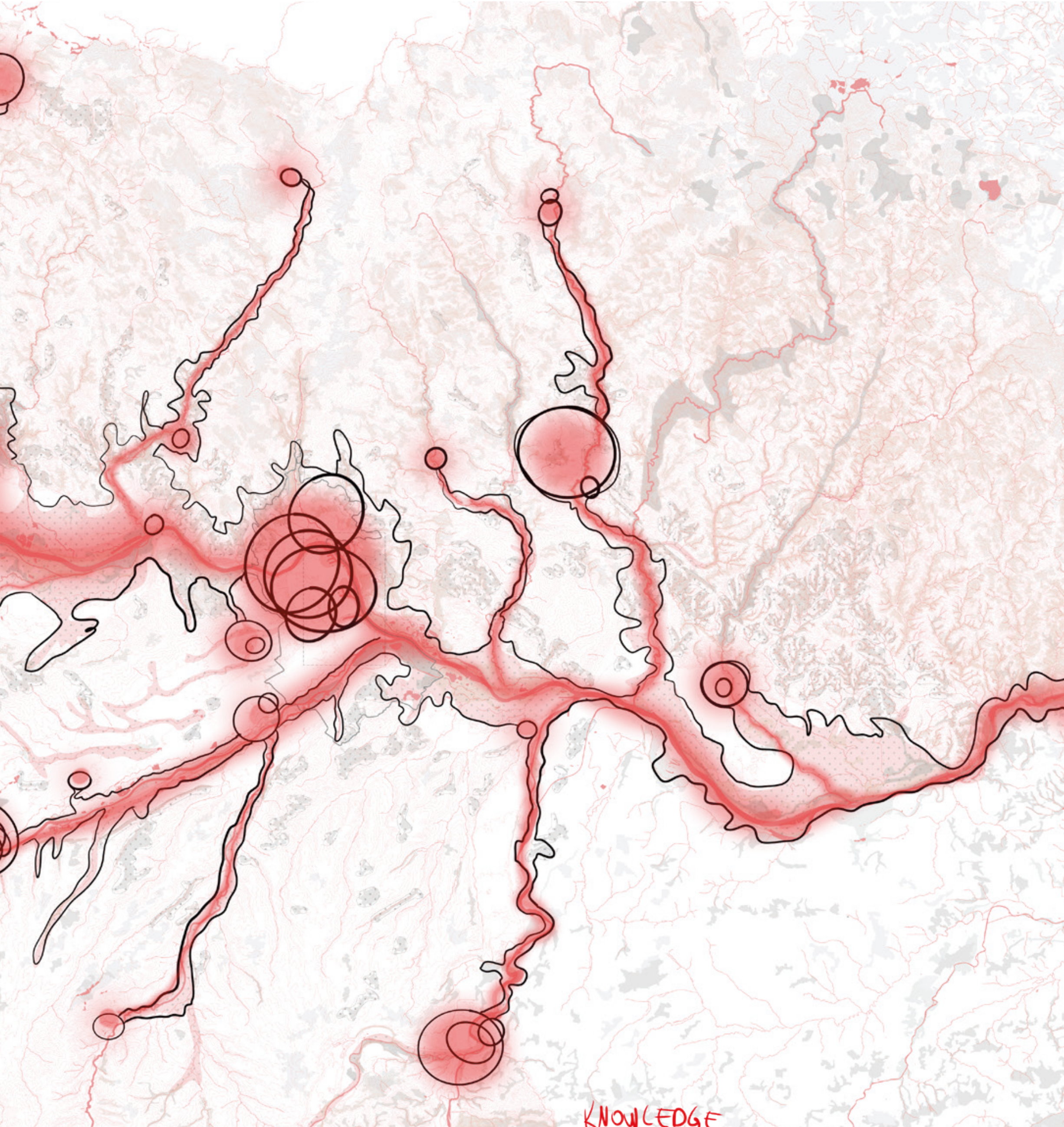




A matter of scale

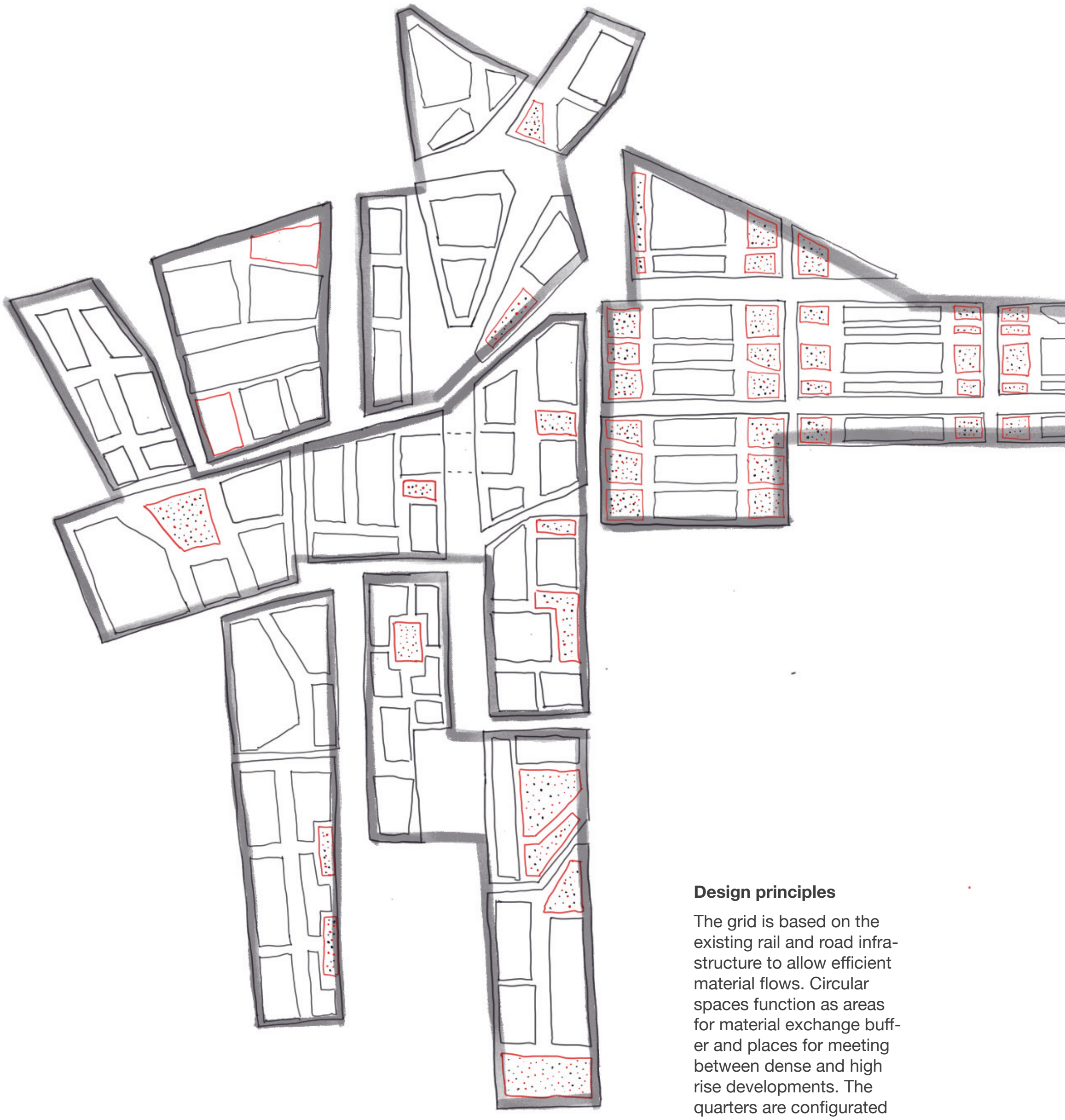
New ways of making, living and learning effect the urban fabric, but also the territorial dimension. In this scenario, living with nature is the key principle to understand, support and enhance ecosystems. This happens along existing ecosystems like rivers and nature reservoirs. Along those, education facilities in the hinterland are interwoven in a network of re-imagined living and learning experiences.





KNOWLEDGE
EXCHANGE
FRESH
AIR
REGIONAL
FOOD SUPPLY
COMPOST
BIOGAS
FOOD
Coke Plant
Electric Arc Furnance
Sinter Plant
Danube
Linz City
Government
Peri-Urban Linz
Rural Upper Austria
Coal Mines Poland - Czech Republik
SOIL
CAMPUS
ROOM FOR
COMPOST
BIOMASS
AUSTRIA
SOIL

5.7 HYPERLINKED HORIZON FRAMEWORK



Design principles

The grid is based on the existing rail and road infrastructure to allow efficient material flows. Circular spaces function as areas for material exchange buffer and places for meeting between dense and high rise developments. The quarters are configurated to interlock them with each other to allow exchange between them.

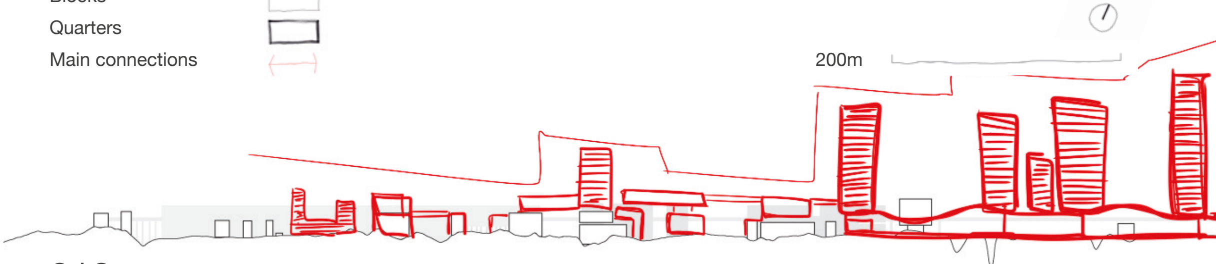
Circular spaces

Blocks

Quarters

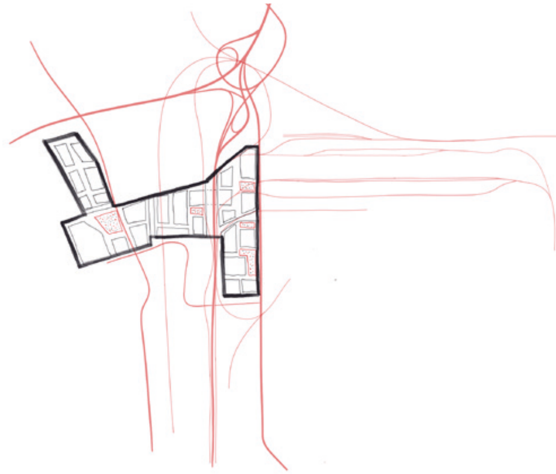
Main connections

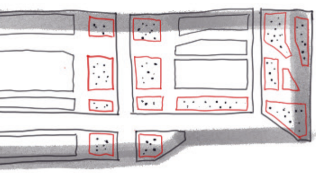
200m



Tech-Campus as connector

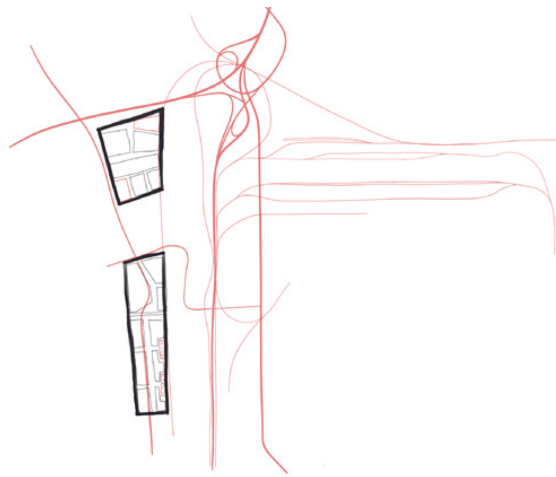
New developments on vacant land makes it possible to host a new campus focusing on digital information technologies. In a high rise and dense environment, with a direct connection to international destinations by high-speed rail, a prime location evolves for knowledge transfer.





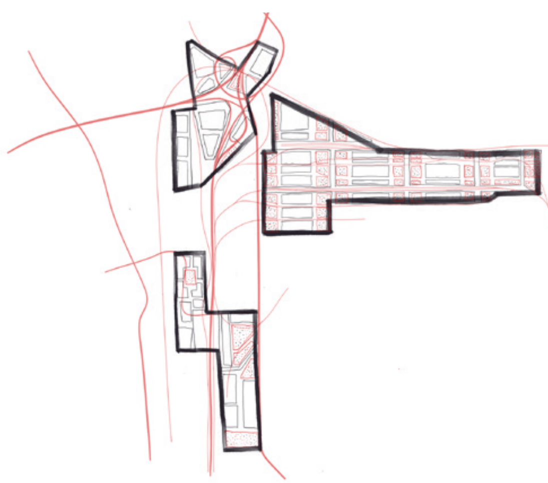
Living along the Wiener

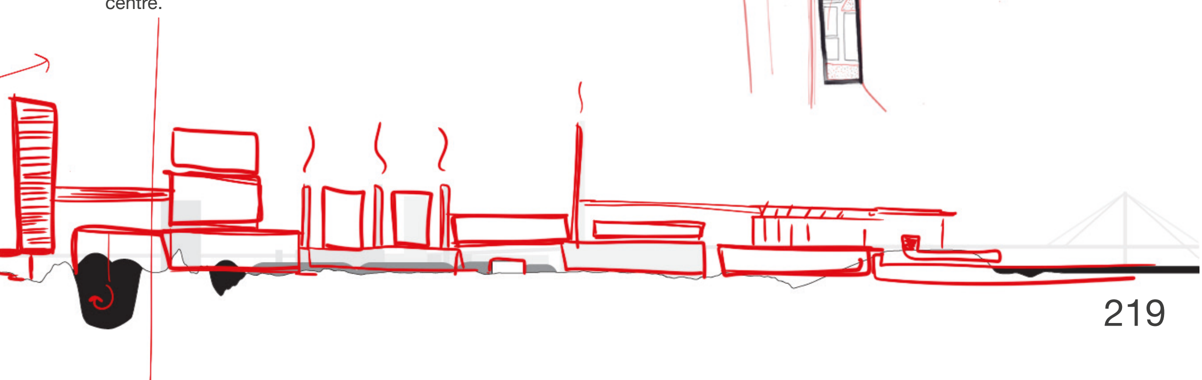
Living environments are updated to more dense and modern livelihoods. Circular spaces function as buffer zones for high rise development. The demolished buildings are fully recycled in the recycling hub close by.

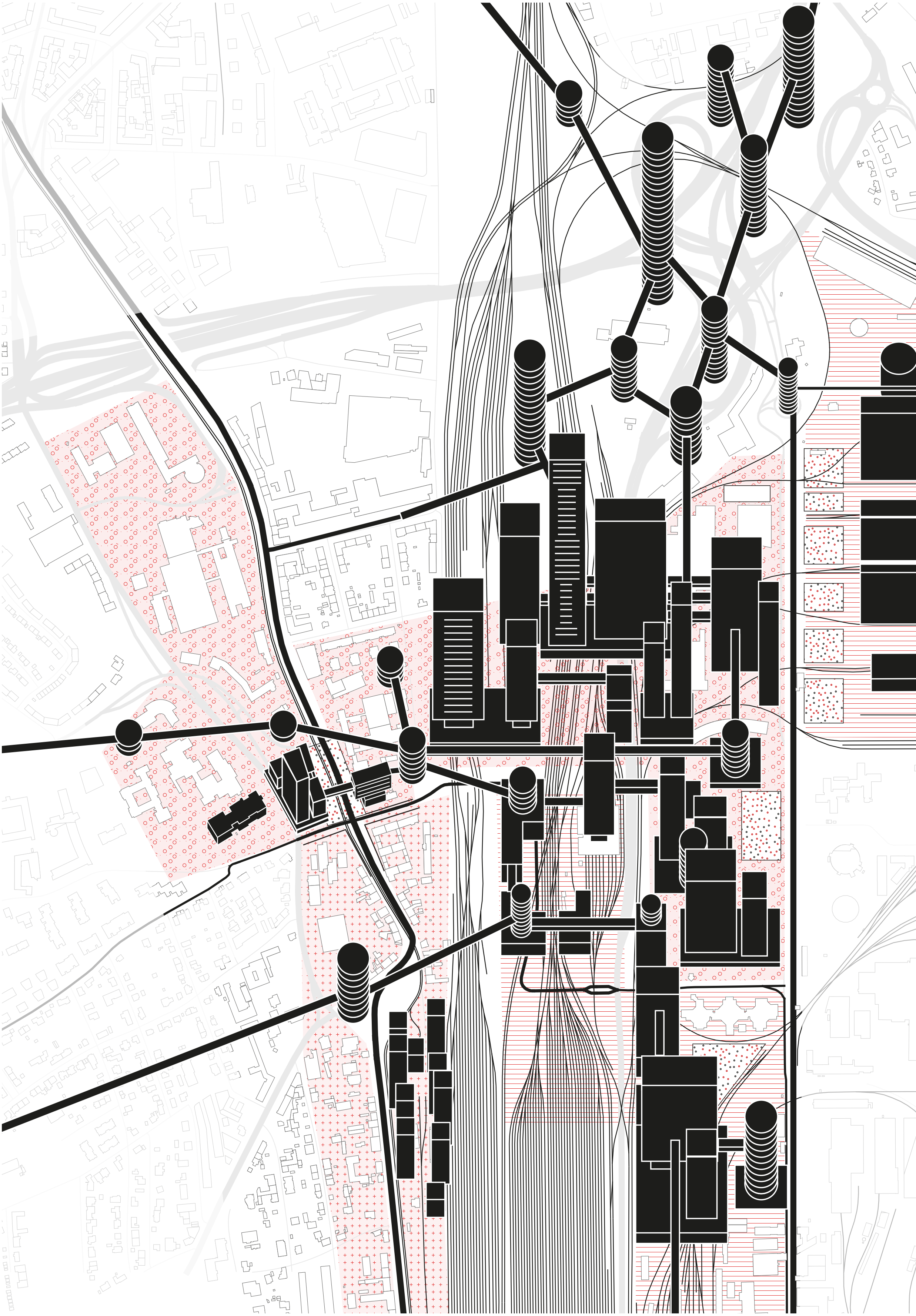


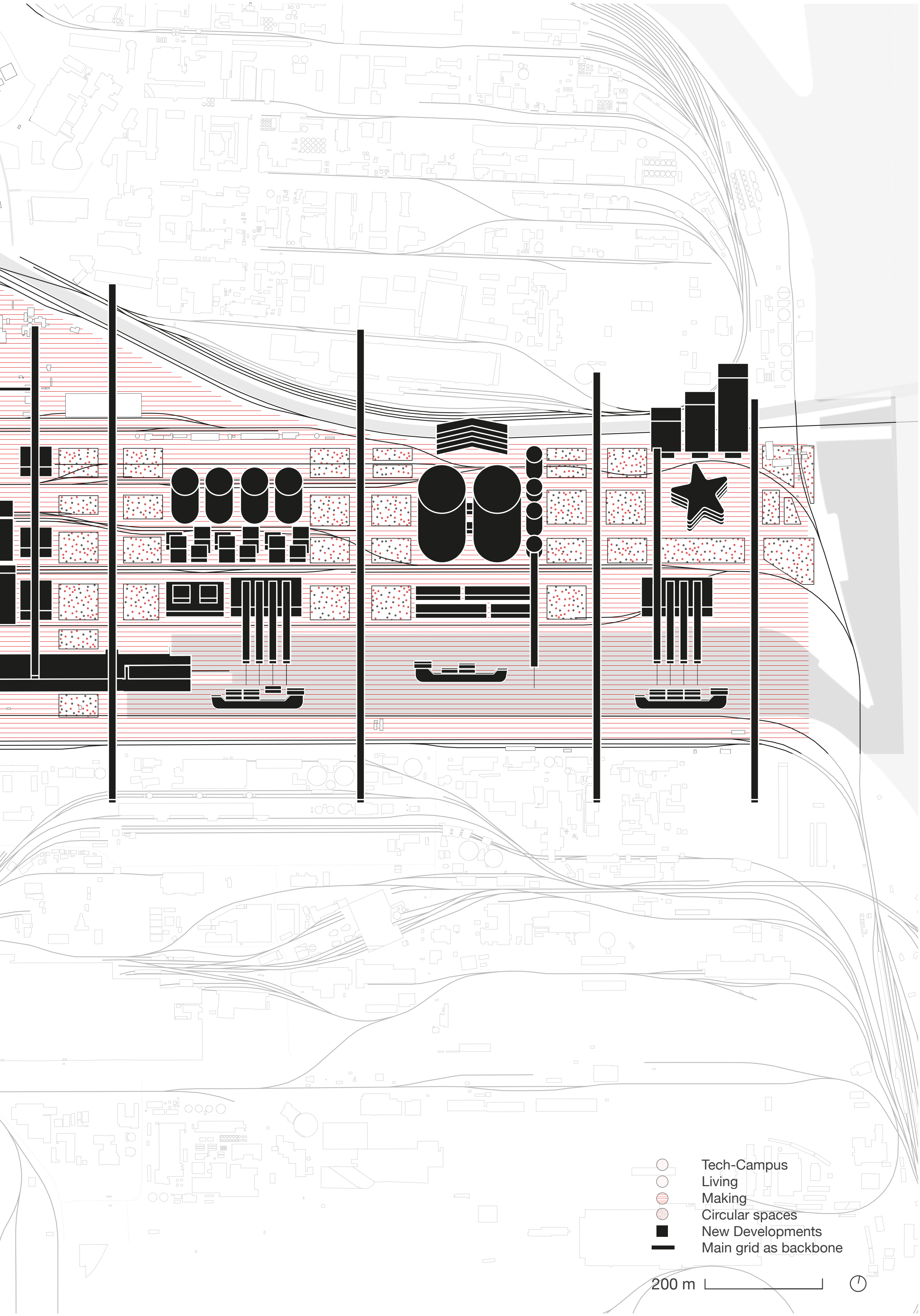
Making it everywhere

Making is the key strength of this framework, allowing digital enterprises as well as heavy industries focusing on recycling, to flourish. The former coke plant evolves as a key hub for regional and cross-regional recycling efforts. Along the train station, a dense business cluster evolves and builds with the campus a innovation centre.

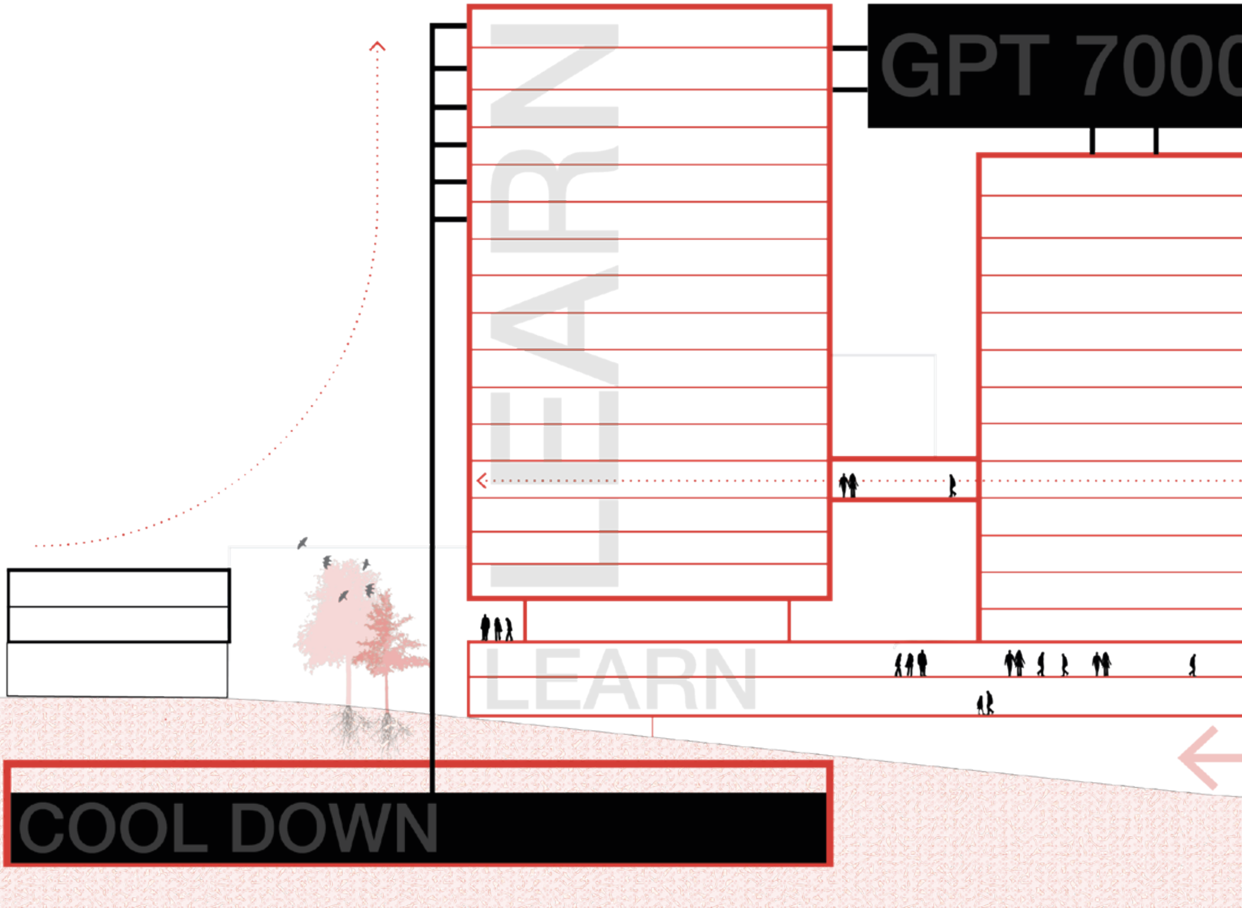


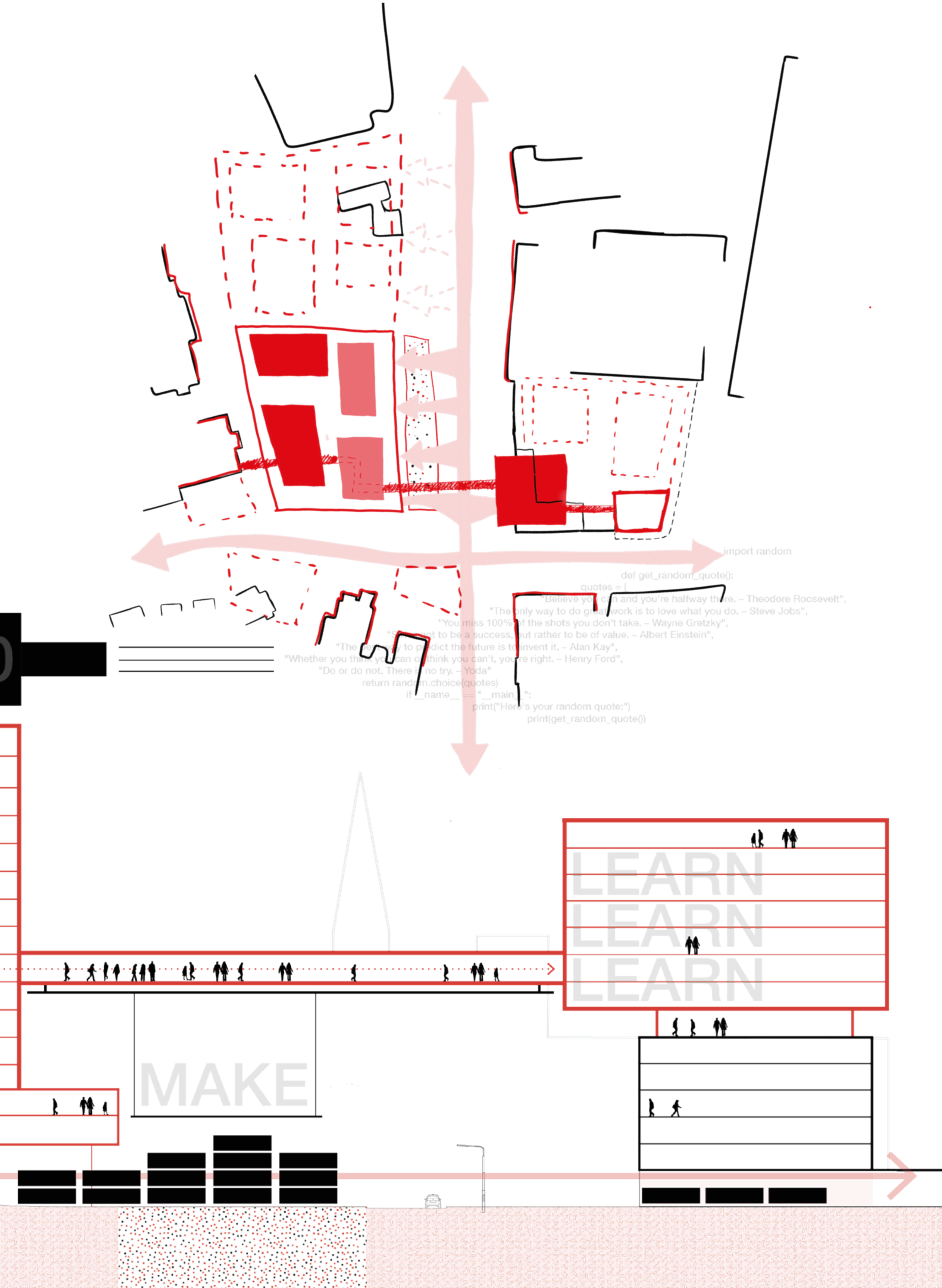




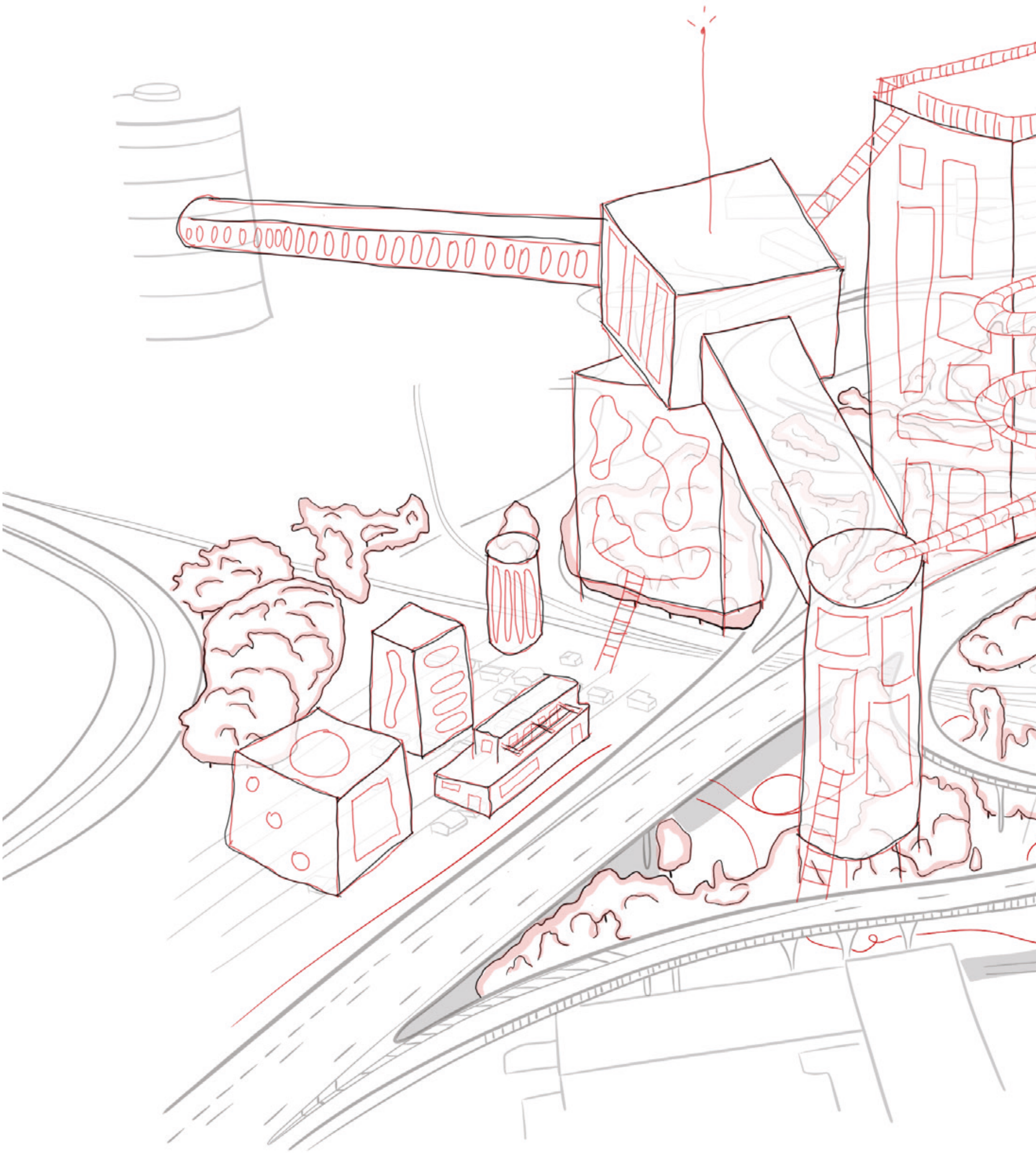

Tech-Campus
Living
Making
Circular spaces
New Developments
Main grid as backbone
200 m

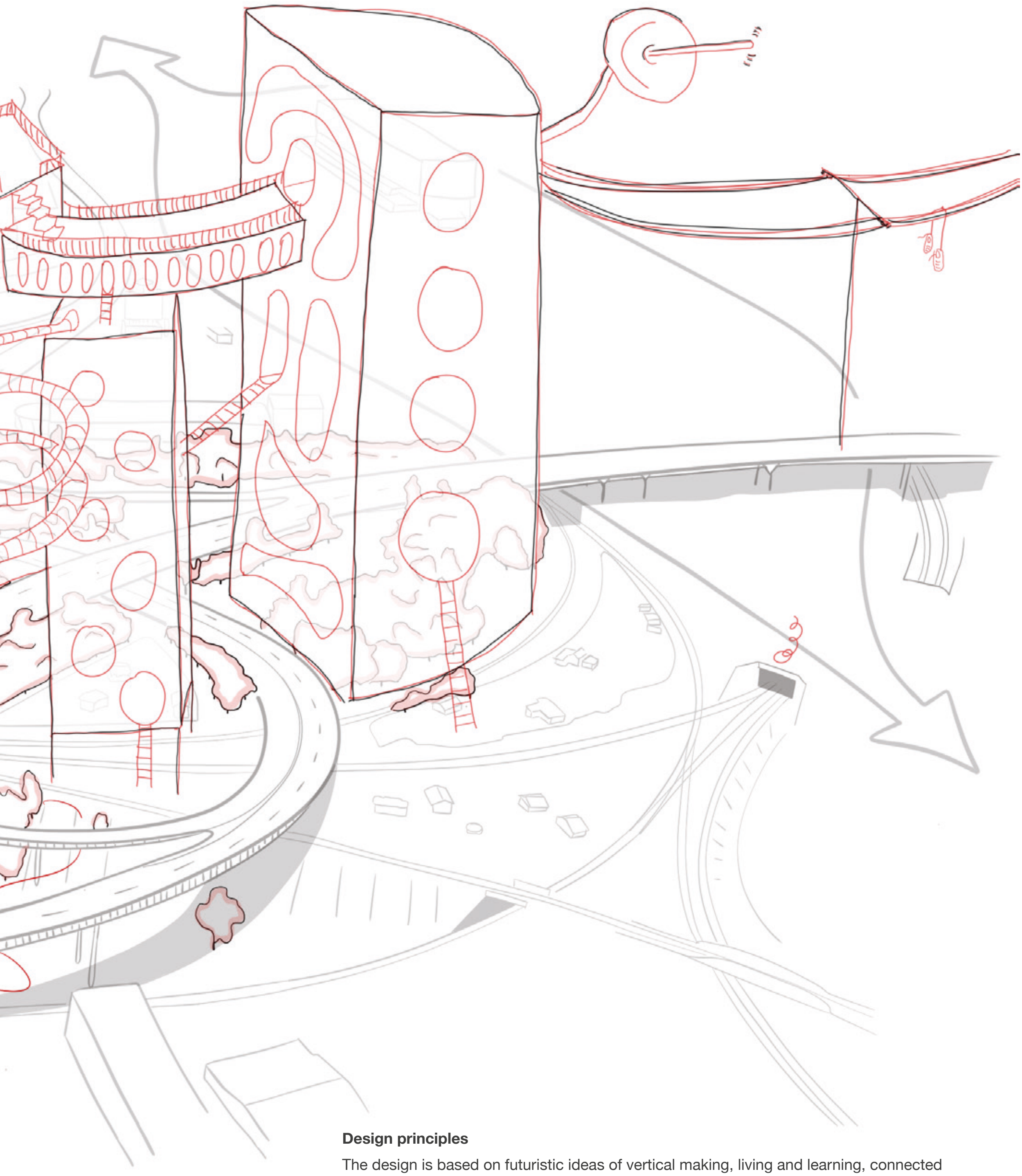
CIRCULAR SPACE: CAMPUS LINK




import random
def get_random_quote():
quotes = [
"Believe you can and you're halfway there. – Theodore Roosevelt",
"The only way to do great work is to love what you do. – Steve Jobs",
"You miss 100% of the shots you don't take. – Wayne Gretzky",
"Strive not to be a success, but rather to be of value. – Albert Einstein",
"The best way to predict the future is to invent it. – Alan Kay",
"Whether you think you can or think you can't, you're right. – Henry Ford",
"Do or do not. There is no try. – Yoda"
return random.choice(quotes)
if __name__ == "__main__":
print("Here's your random quote:")
print(get_random_quote())
LEARN
LEARN
LEARN
MAKE

CIRCULAR SPACE: VOEST NODE

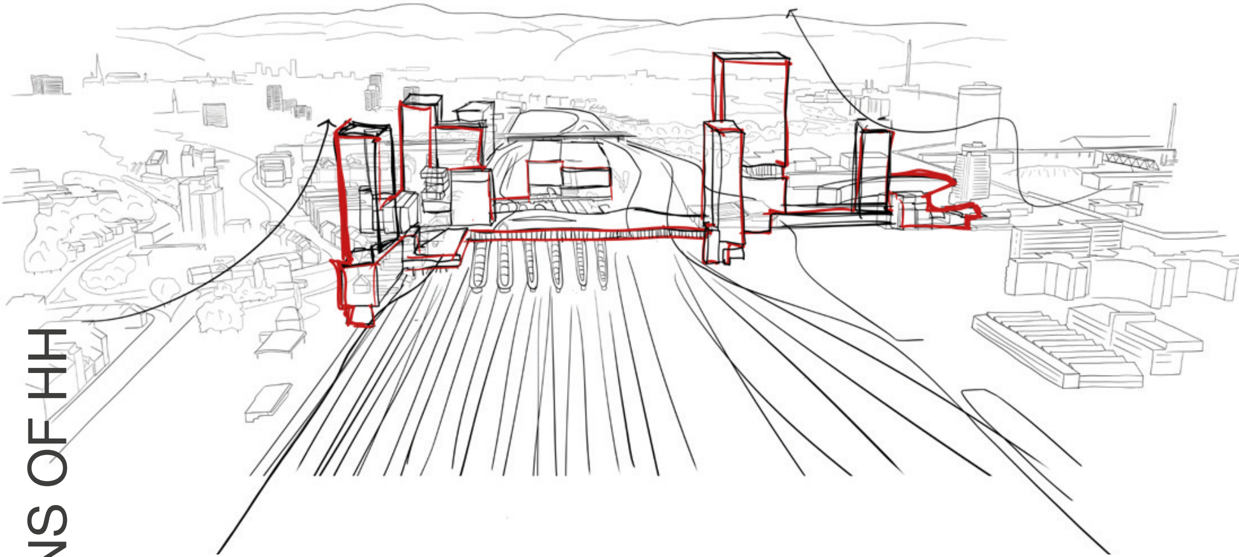




Design principles

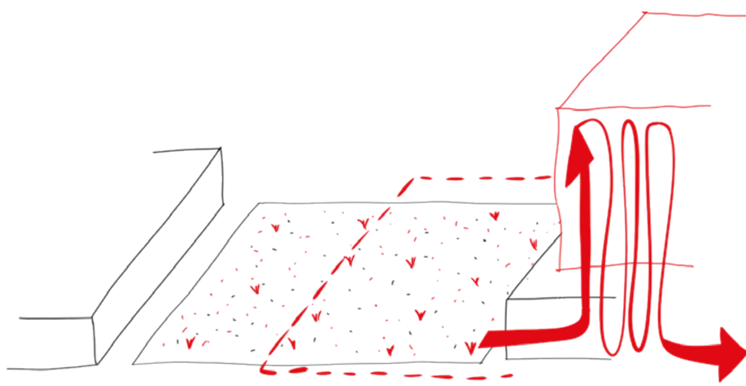
The design is based on futuristic ideas of vertical making, living and learning, connected via elevated sky walks to provide efficient flows on the ground. To use space efficient and sustainable the intersection at the steel factory provides valuable space for vertical expansion.

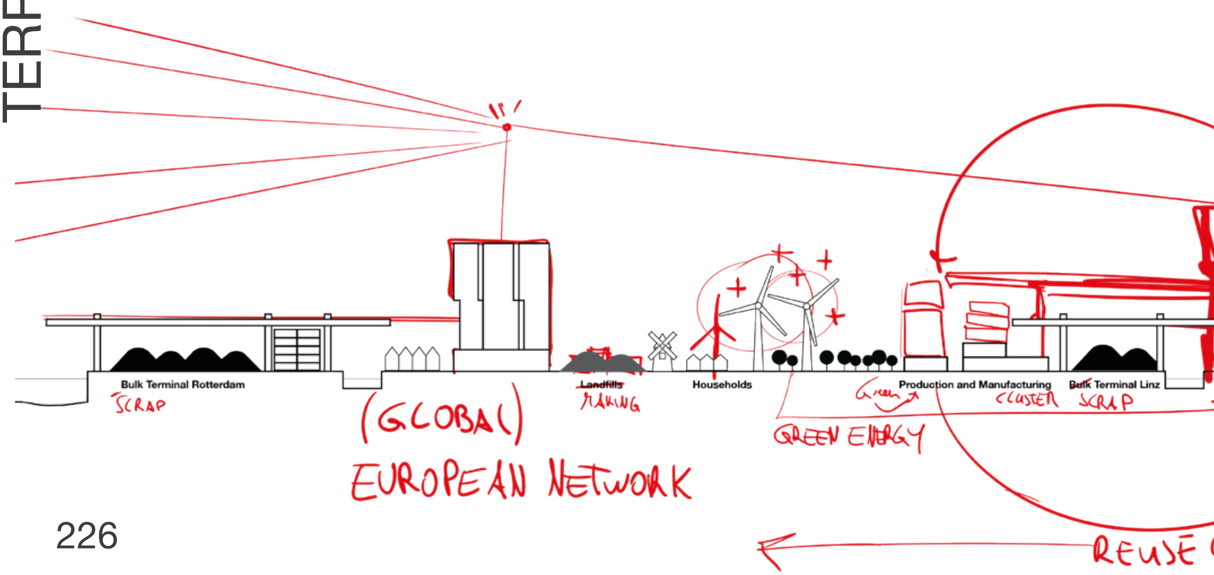
TERRITORIAL DIMENSIONS OF HH

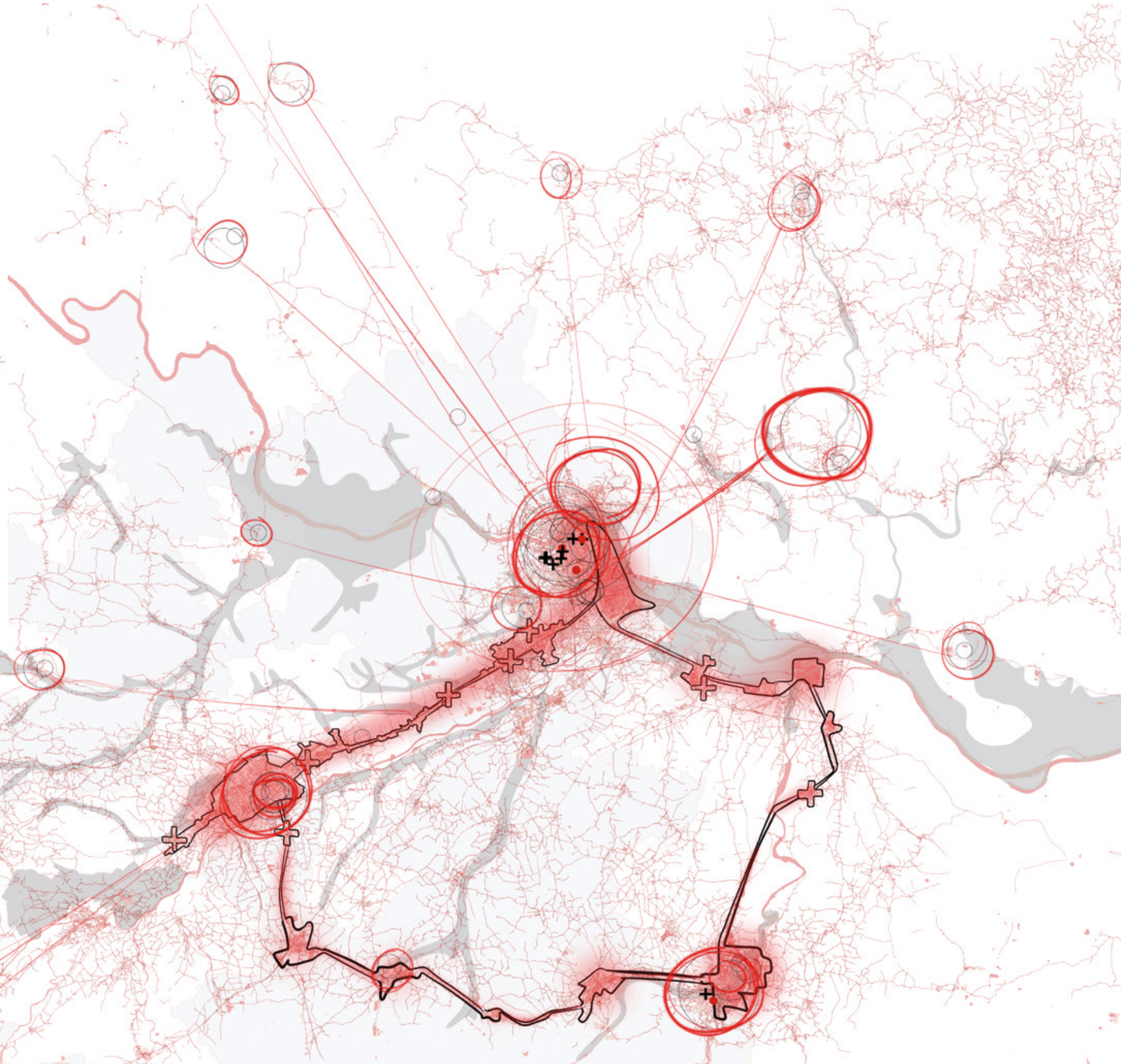


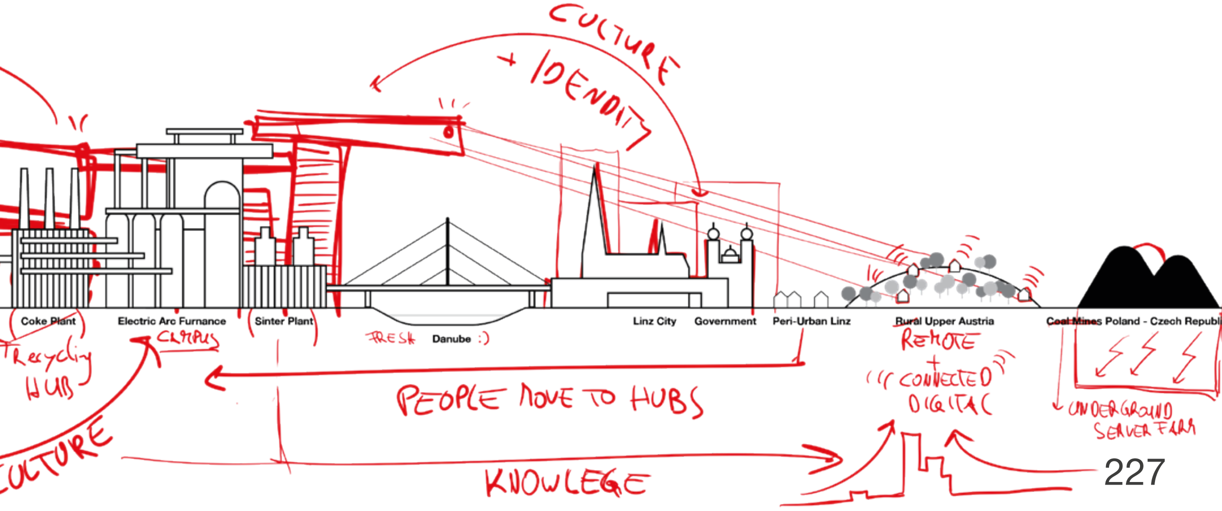
A matter of scale

New ways of making, living and learning effect the urban fabric, but also the territorial dimension. In this scenario, technology driven developments define the pathways for efficiency. Developments are happening along existing mobility infrastructures. Along those, education facilities in the hinterland build key hubs for innovation and business development to enhance competition amongst other regions. More remote areas are connected as mobile outposts.









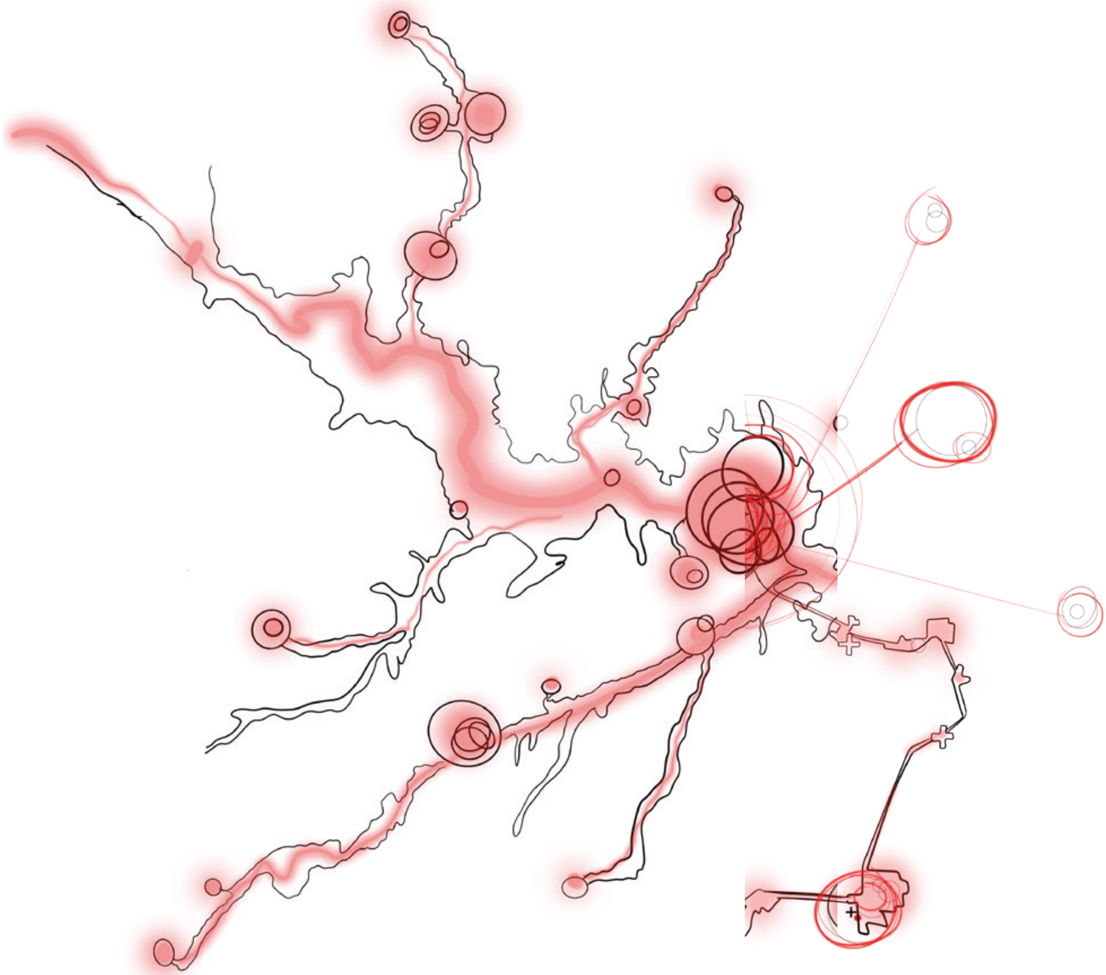
Coke Plant
Electric Arc Furnance
Sinter Plant
Danube :)
Linz City
Government
Peri-Urban Linz
Rural Upper Austria
Coal Mines Poland - Czech Republik

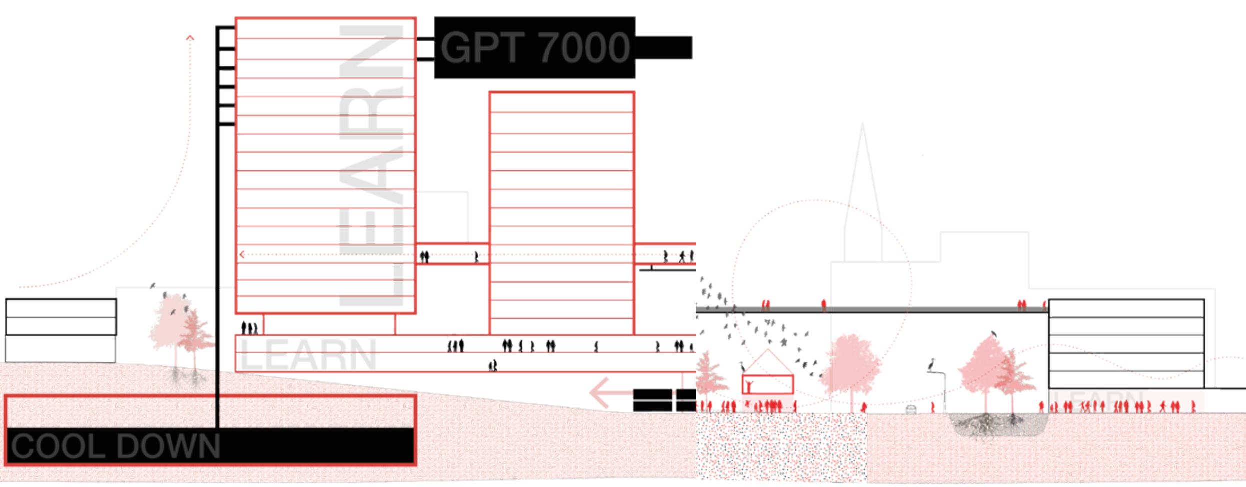
Chapter 6

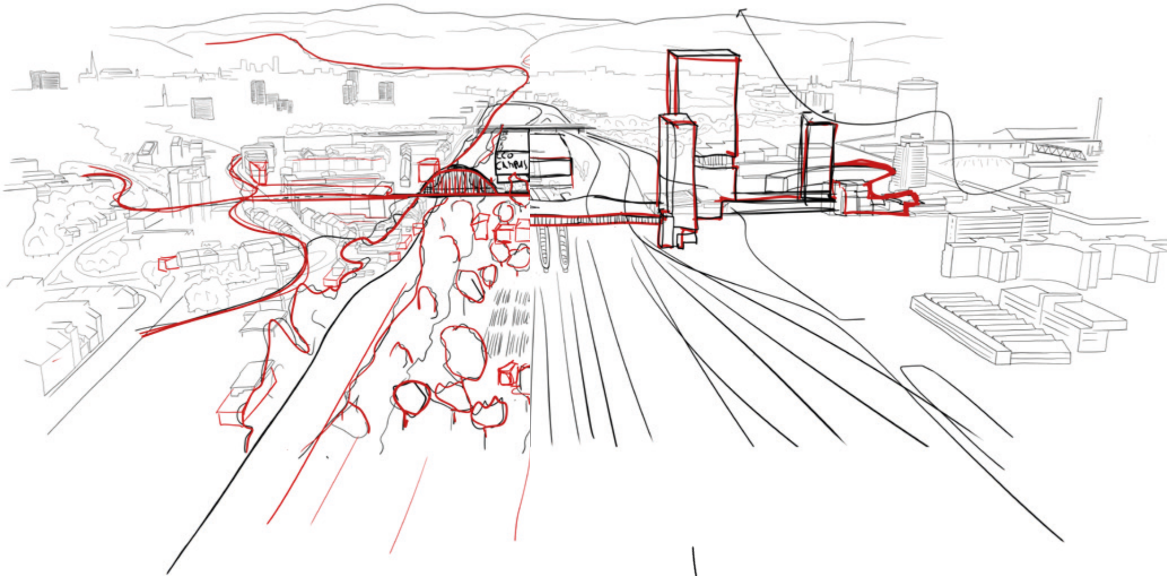
learn

ings

MIX'N'MATCH





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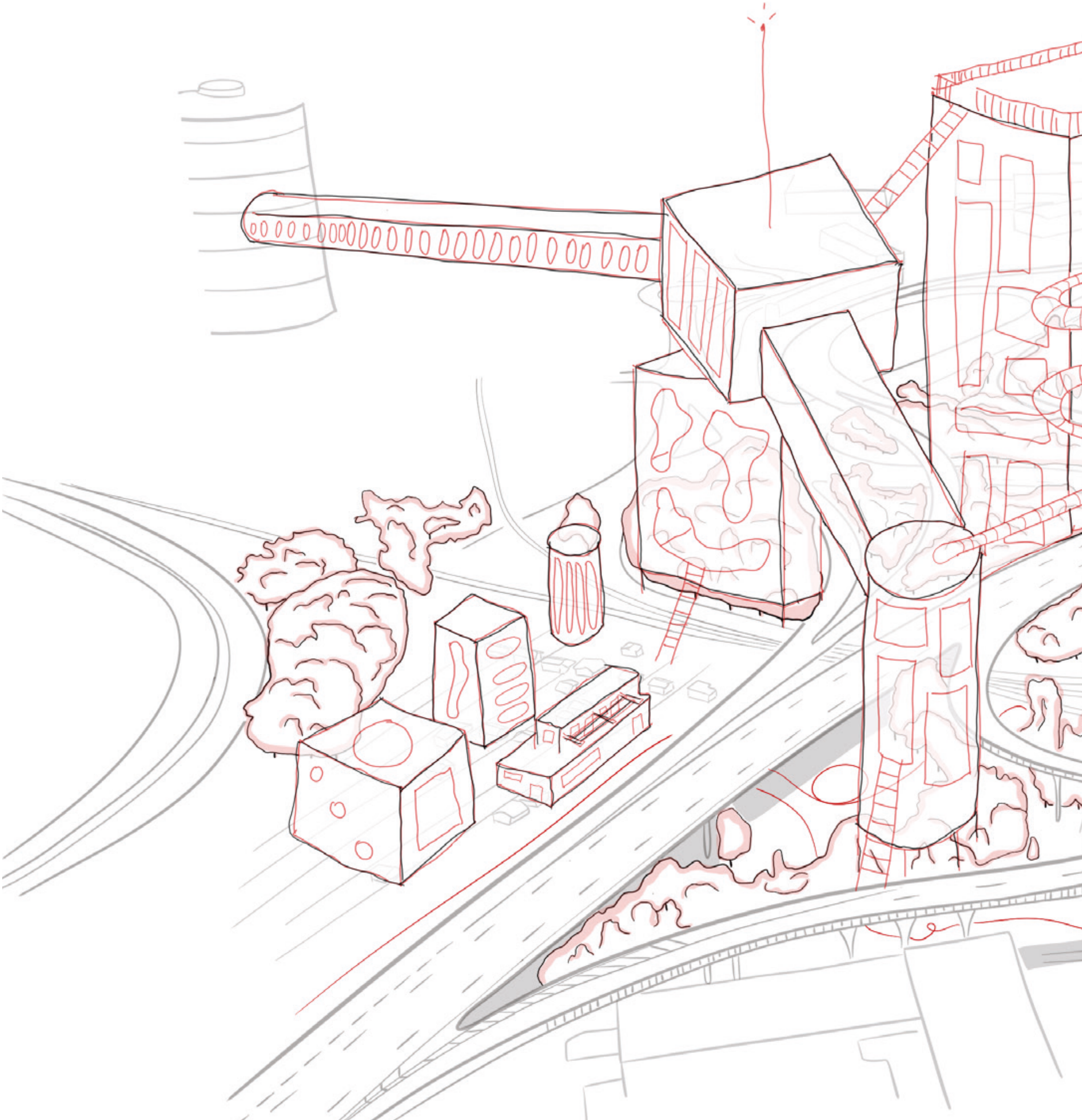
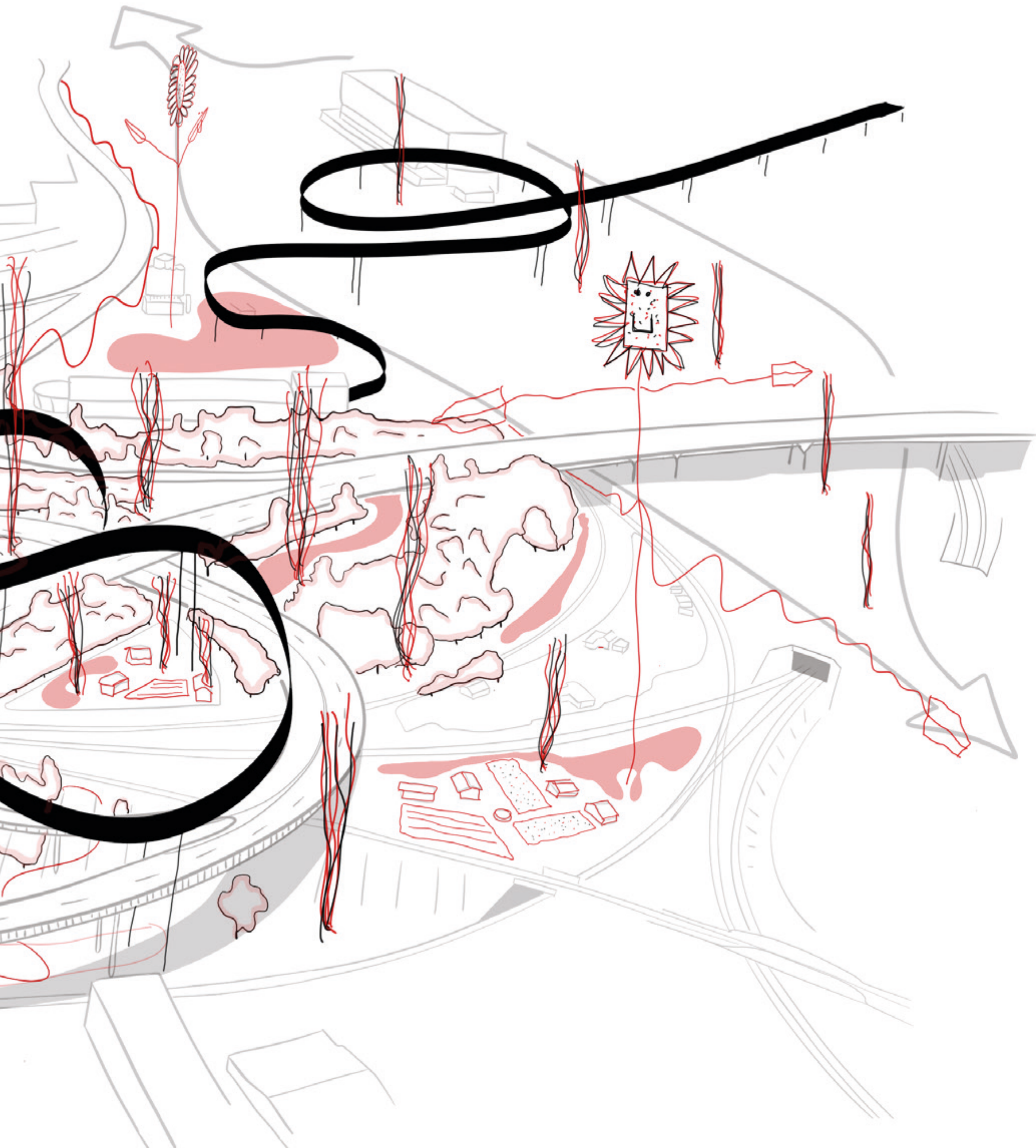




6.1 CONCLUSION

Aim of Research

This thesis investigated the spatial and social dimensions of the energy transition, focusing on steel-related territories defined as Steelscapes, using voestalpine in Linz, Austria as a local case study. The aim was to understand how such industrial facilities are embedded within urban, territorial, and international contexts, and how shifts in the steelmaking process might influence the spatial conditions of these areas and their related societal dynamics. Grounded in metabolic theories and practices, the conceptual approach was developed from a critical perspective on circular economies, which still focus primarily on material flows. This perspective was then expanded toward theories of circular societies, placing greater emphasis on the socio-ecological and environmental dimensions of circularity.

Findings of Make, Live and Learn

The findings across the three thematic scopes Make, Live, and Learn, reveal how deeply the steel industry is embedded within the spatial, social, and educational fabric of Linz. From an industrial perspective (Make), large-scale steel production requires massive infrastructures such as rail and road networks, cooling water access, and recycling facilities. The close integration of the factory within the urban system of Linz identifies it as a district of the city itself, creating spatial challenges around shared infrastructure and environmental vulnerability. At the same time, underutilised plots along key transport corridors show potential for new spatial strategies, particularly in support of circular economies as well as opportunities for enhancing ecosystems.

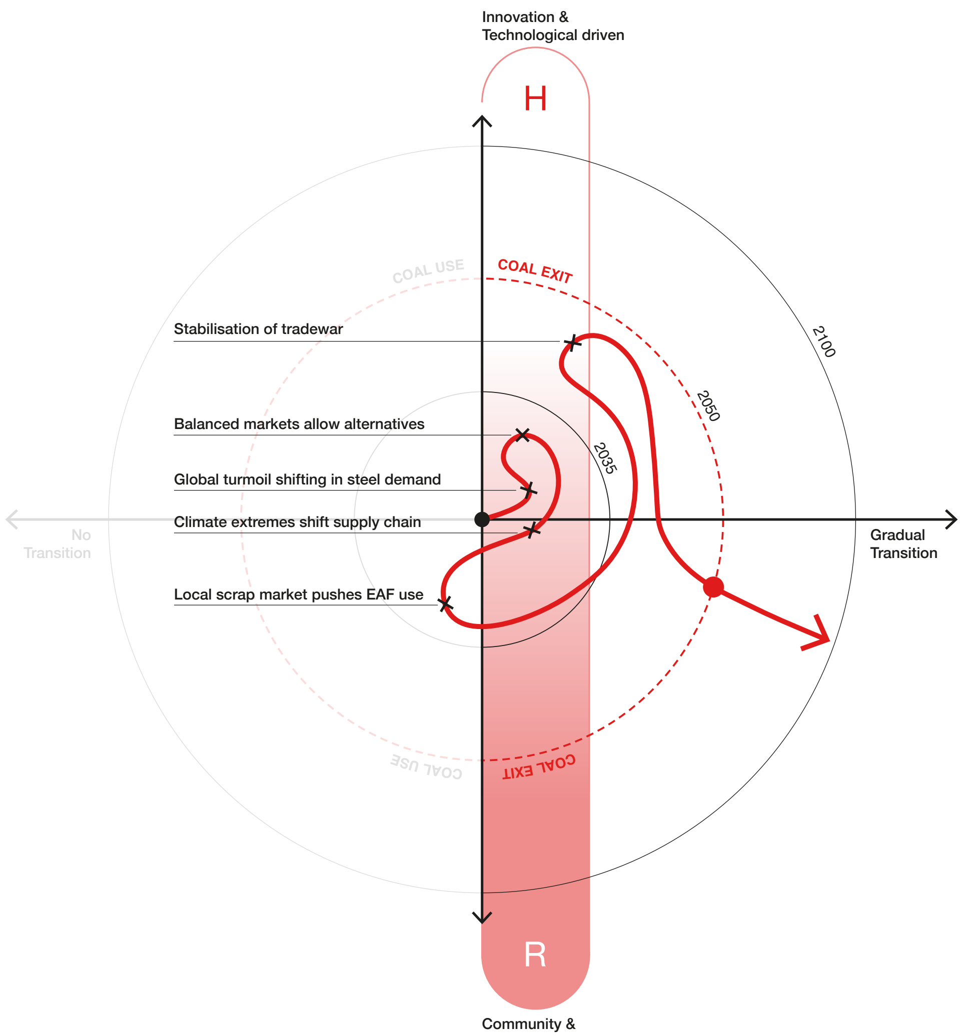
In the context of livelihoods (Live), the factory's role as a major employer leads to significant commuter flows from the surrounding hinterland, describing Linz's function as a "drive-in city." However, this dynamic also highlights urban fragmentation, local infrastructure overload, and social inequalities in adjacent neighbourhoods due to industrial emissions.

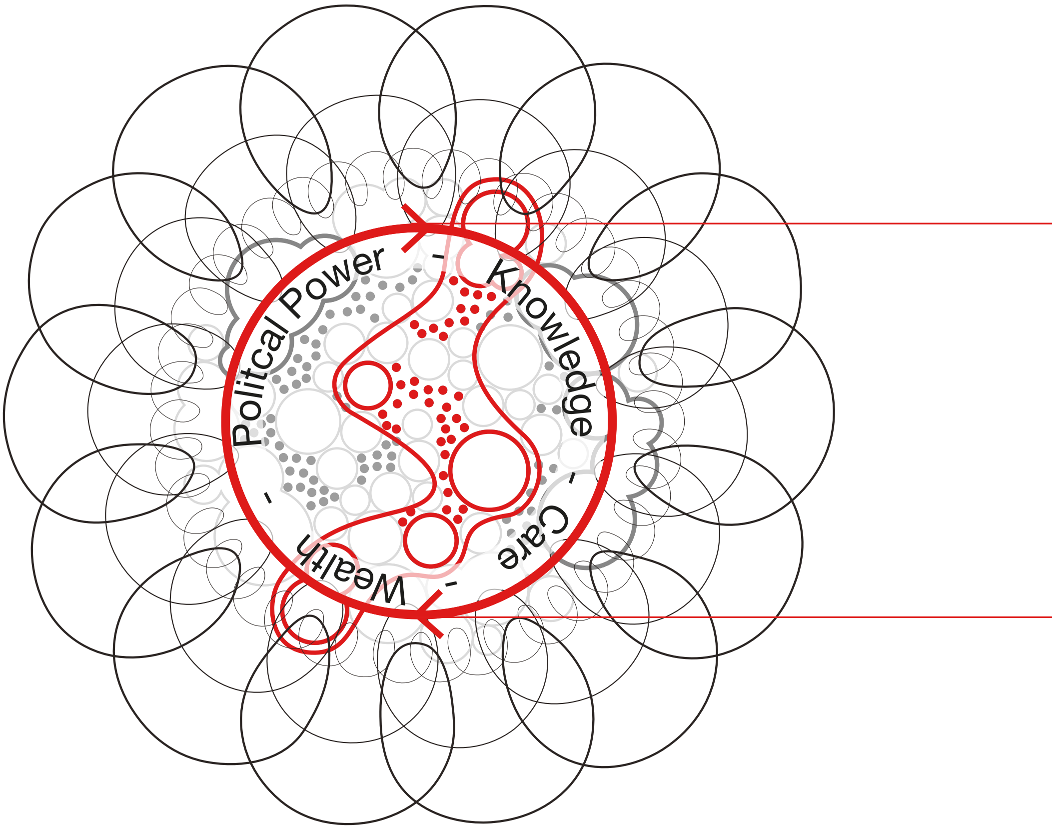
Finally, findings from the educational landscape (Learn) emphasise that industrial transformation is closely tied to innovation in education. Linz's development towards a digitally oriented hub, through universities, research clusters, and adult learning facilities, positions it well for supporting a just transition. The proximity between industrial zones and educational institutions presents strong opportunities for fostering re-skilling, lifelong learning, and structural adaptation.

Together, these findings show the necessity for integrated spatial strategies to guide Linz through its ongoing industrial and socio-ecological transitions. Structural barriers in education and employment continue to exclude those who have dropped out or been displaced by technological change. Critical reflection is needed to address these systemic issues and to improve access to education and retraining, especially for vulnerable groups. Without inclusive, programmatic strategies, the risk remains that parts of the population will be left behind.

Re-organising spaces and programme

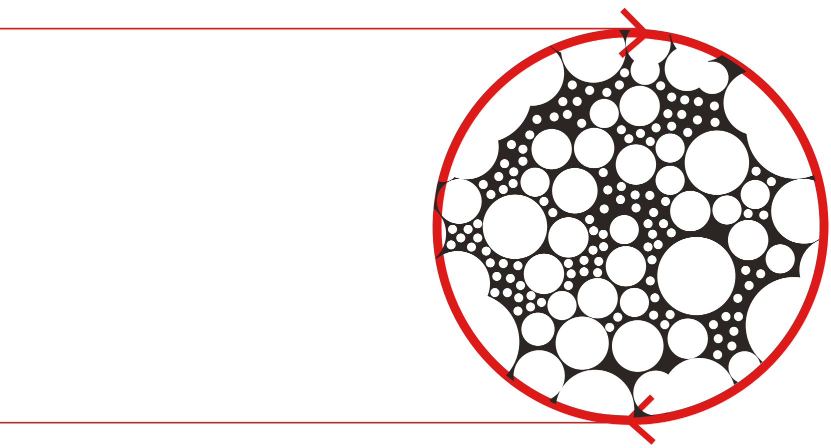
The development of two diverging future scenarios identified extremes in both growth-oriented and degrowth-oriented directions. The main aim of this approach was to highlight that binary thinking and leaning in one direction can be problematic when dealing with uncertainties and unknown futures. Therefore, a more realistic pathway can be described in the scenario framework below and in further testing with hybrids, understanding that the energy transition is not a predictable process. It is affected by multiple factors and uncertainties, affecting the interconnected systems of the steel industry e.g. the spheres of making living and learning. This means, that a flexible combination of enablers from both scenarios can function as navigators related to the spatial and programmatic organisation of this transition.





Steelscape Metabolism

Biogechemical cycles
Resource cycles
Ecosystem cycles
Human System
Morphological Sphere
Physiological Sphere
Steelscapes
Human Systems in Steelscapes



In-between spaces as circular ressource

Referring back to the research question, the main opportunities for a shift towards circular societies from a spatial and programmatic viewpoint, lie in this case in the elaborated circular spaces. These are spaces that, while functioning as productive landscapes or left behind spaces today, hold the potential to be reimagined through integrated ideas such as those explored in this thesis. Those can offer a highly flexible organisation instead of standalone and static infill projects. On an operational and programmatic level, it is essential to foster horizontal integration among various stakeholders and community groups to understand the situation holistically across scales and professions. Such collaborations are key to challenge the static and often rigid planning systems in Urban and Peri-Urban areas.

Evaluation

Within a survey, based on the the Circular Economy Transitions Self-Assessment tool by Wandl et. al (2023), an evaluation of the current status of the region in terms of Circular Economy (CE) and Circular Society (CS) efforts was conducted. The self-assessment tool was originally developed for stakeholder workshops **(see appendix).**

A total of 10 stakeholders from practice, industry, planning, and civil society within the GLA evaluated the current situation. To connect the results to the project, the developed enablers from the scenario design are connected to the categories of the assessment tool. This means, that if the assessment tool is applied as usual within a stakeholder workshop, the results can be already connected to possible actions to develop strategies to enhance circularity.

Overall, stakeholders tended to rate their region's performance with relatively low scores. Higher values were assigned to aspects such as corporate awareness, stakeholder involvement, and the integration of circular practices into everyday life. In contrast, significantly lower ratings were given to areas related to policy implementation, the physical built environment and to wastescapes.

However, it is important to mention that this tool is designed to use it in face to face settings, enabling discussions and exchanging viewpoints. Therefore, the results may differ from the online survey in its original format.

Limitations

The complexity of the steelmaking system requires an understanding of multiple interconnected spheres, from material flows and spatial patterns to social, ecological, and economic dimensions. While the integrated approach applied in this thesis, through the lens of the seven socio-ecological cycles and the spatialisation of selected cycles within the *Steelscape Metabolism framework*, has helped to untangle these systems, many questions remain unanswered. For instance, this research could not fully address the impacts of the transition on humans, the effect on local and territorial ecosystems, or the broader effects on related manufacturing sectors such as the region-specific and labour-intensive automotive sector. Therefore, a deeper examination of other Steelscapes, such as Steelscapes of Living, Re-Use, or Manufacturing, was beyond the scope of this thesis. Many of these dimensions are embedded in vulnerable peri-urban areas, and further research is needed to understand the interdependencies between these spaces and the Hinterland's role of steel factories more in-depth. This can help to draw a more complete picture of how industrial transformations affect spatial, ecological, and societal systems.

Der Sinn des Lebens ist das Unvollendete
The meaning of life is the unfinished

Bruno Kreisky

6.2 REFLECTION

This reflection explains the process of developing my research and design project as part of my graduation. I will explain my methods, approach, and results in three main sections, followed by thoughts, reflections, and an outlook on the further steps. Additionally, this text aims to address seven key questions. Five are predefined by the Graduation Manual of the Master track in Architecture, Urbanism & Building Sciences, along with two that I have formulated myself. The first question, which will be answered in the introduction, highlights the connection between my graduation project topic and my master's track. Urbanism is a multifaceted field, offering an opportunity to understand the environment as a variety of many complex, interconnected systems. It is well known in the field that this complexity necessitates collaboration across disciplines. My graduation project embraces this interdisciplinary approach, using a systemic perspective to analyse, visualise, and communicate ideas for adapting, transforming, and rethinking current paradigms and processes.

The questions are following:

- *What is the relation between your graduation project topic, your master track and your master programme (MSc AUBS)?*
- *How did your research influence your design/recommendations and how did the design/recommendations influence your research?*
- *How do you assess the value of your way of working (your approach, your used methods, used methodology)?*
- *How do you assess the academic and societal value, scope and implication of your graduation project, including ethical aspects?*
- *How do you assess the value of the transferability of your project results?*
- *Which specific fields of expertise and ways of collaboration do you see as beneficial thinking about further steps in your research, thinking of continuing the research project after graduation?*
- *What are the main skills you gained during your Masters at TU Delft, and which methods would you like to transfer to your professional career after graduation?*

I worked with a mixed-method approach, starting with an intensive research phase based on literature reviews to understand the many aspects of my research topic. A significant help was the methodology provided by the studio on systemic thinking, which allowed me to grasp the interdependent nature of my research topic from an early stage. Creating an early systemic section drawing helped me identify and focus on the most important aspects early on.

This process showed me that writing a master's thesis is an ongoing decision-making process that narrows down the focus without excluding important information or oversimplifying the topic. My main areas of focus, namely the steel industry, regenerative design, Austrian morphological settlement structures, and global economic and political dynamics, played a key role from the beginning. This led me to dive deeper into research, reading academic literature and news articles on current developments. The intensity of reviewing scientific papers was a new challenge for me, and at first, it was sometimes difficult to navigate complex theories and processes, especially those from disciplines which were unfamiliar to me.

This challenge was partly rooted in my previous approach, which in my view, has changed since I started studying at TU Delft. In the past, I tended to begin designing (too) early in the process, putting many ideas on paper right away, as I am a visual thinker. For me, this approach always helped in drawing conclusions early on and in effectively communicating ideas with peers and professors. This was a skill I developed during my Bachelor's in Spatial Planning, where strong design skills were useful, especially in a program that was more analytical and process-oriented compared to architecture or other design-oriented tracks. However, during my first quarter at TU Delft, I realised that this approach sometimes lacked the depth of research and analytical findings necessary to conclude my findings to further strengthen my design ideas. Switching between research and design taught me to recognise research as a crucial element of the process. Because of this, I focused more on the research phase at the beginning of my thesis and put more effort into this aspect by the time I reached my P2. This decision was based, compared to my previous University, on the detailed feedback I received from my teachers during the first quarter in my first year at TU Delft, which highlighted areas where my research skills could improve. That being said, I still sketched and designed alongside my research, constantly expanding, refining, and narrowing down my topic. I believe this balance kept me both flexible and motivated throughout the process. From my perspective, the value of this approach is that after graduation, I might be able to understand theories faster and effectively integrate them into my projects to create meaningful proposals. It also introduced me to the exciting field of research, building upon existing concepts to develop new directions, which was a completely new perspective for me. In a way, this process even felt creative, which I had not expected.

However, focusing mainly on the process of steelmaking at the beginning to better understand the overall system led me to neglect the spatial dimensions for a while, which is something I would approach differently today. Investing more energy and time in understanding the spatial qualities from the start would have been key to reaching conclusions more quickly. This is definitely something I will carry forward with me.

It brings me to the point of receiving feedback from my mentors and how I handled it. Early on, I made sure to communicate to them that I tend to work in the way described above, and that I aim to focus more on the research phase to strengthen those skills. They accepted this approach, and the precise feedback from my first mentor, Brigit Hausleitner, on the theoretical aspects was very valuable and motivating. Arjan van Timmeren's feedback was very helpful, as he quickly understood my ideas and provided input without steering me in a specific direction. At this point, I would like to refer to the methodologies I applied, particularly the Pattern Language method, which my first mentor, Brigit, also uses in her research. I attempted to integrate it into my process early on, but initially, I struggled to apply it without fully understanding the spatial conditions of my focus area and the overall context of my project in this phase. Over time, I realised that the method can also serve as a tool for analysing and understanding systems in a broader sense. As my work progressed, I moved away more and more from using this method as part of my research project. However, it was still beneficial in the early stages, helping me to better organise my work and explore different directions. Looking at my final steps, I do not see the methodology making a strong comeback, given my current approach and the more defined focus areas I decided to work on. However, if I continue to develop this project after my graduation, I see potential in further exploring a Pattern Language approach. This could allow me to work with higher levels of complexity and open up other topics again that I had to set aside for now to complete the project within my expectations and timeline.

From my perspective, the academic value of my work lies in the method I developed within theories regarding to Metabolism and Circularity. I aimed to bridge theories that do not necessarily have a spatial component with those that do not primarily have a societal focus. This bridge connects a more technology based perspective on material flows with a more theoretical and philosophical approach on socio-ecological spheres. I am aware that this method and the developed concept still require adjustments and may not be directly transferable in real-life settings. However, the acceptance of my abstract at the *International Forum on Urbanism Conference 2025* in Lisbon reinforced my belief that this topic is highly relevant. It shows that my work might contribute to ongoing discussions on adapting territories and landscapes to sustainability, resilience, and circularity.

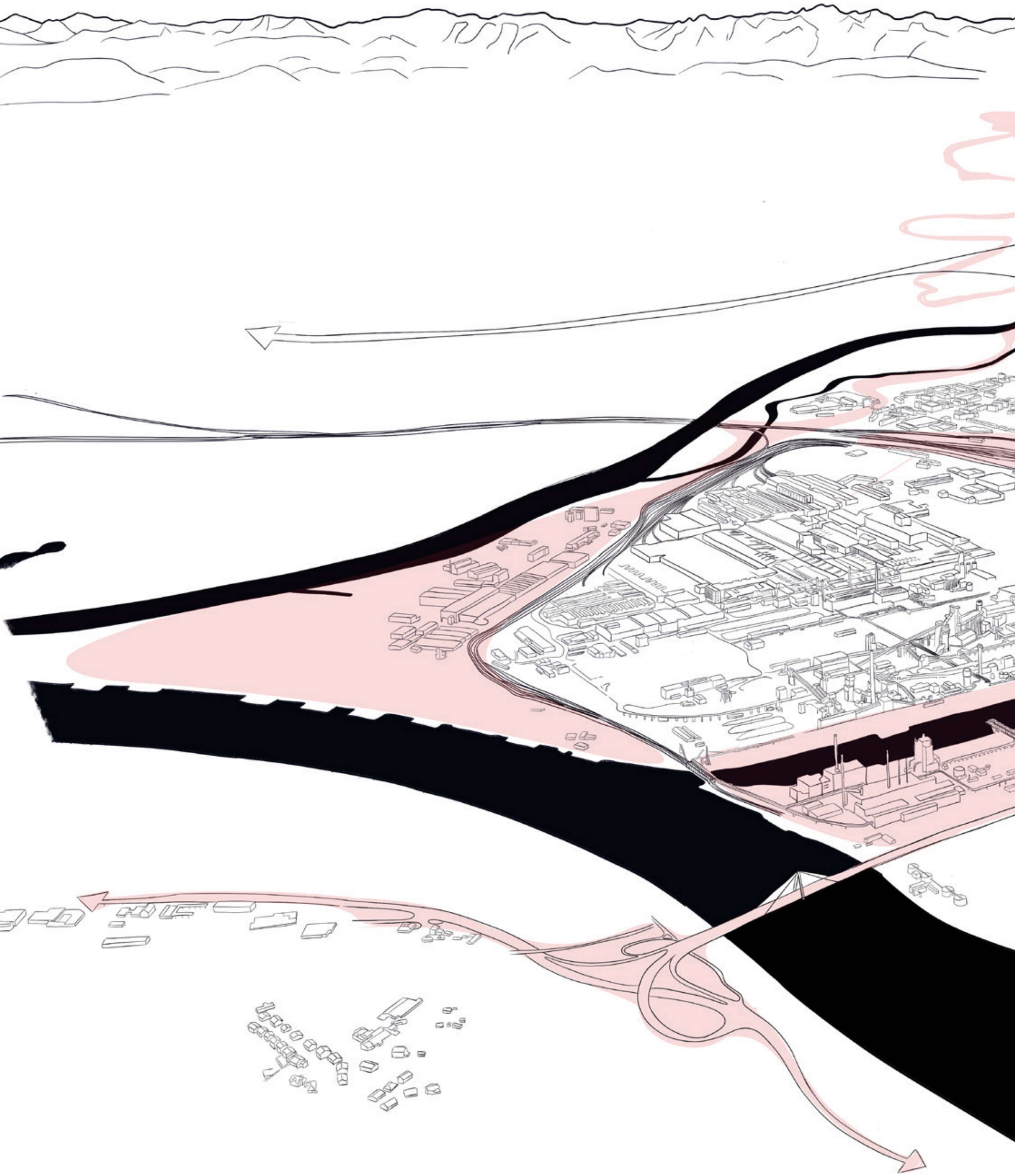
The societal value of my graduation project is still more grounded in theoretical concepts, rather than focusing on real-life actions that directly engage citizens, like some of the graduation projects of my fellow students. However, this theoretical foundation can serve as a starting point for further actions and more specific research that can eventually translate into tangible societal impact, particularly in the field of social studies. The main aim of my project is to address designers, planners, decision-makers, and stakeholders by raising awareness of topics such as sustainability, regenerative design, and circularity, and their connections to societal, ecological, and economic needs. Theirfore, I see a high value in bottom-up approaches and co-creation methods emerging from the project. However, the extent to which these can be implemented depends on the overall setting in which the project is performed, which reflects my more pragmatic view on the field of Urbanism. Within two design scenarios, the idea was to simulate two different contrasting futures to explore the needs and requirements in the form of actions to make for those scenarios. The main idea was, on the one hand, to inform stakeholders with polarising ideas to find a middle ground for evaluating more realistic pathways. But thinking even further, the power of our profession to make ideas visual to communicate them to a broader audience can also support the discussion of future perspectives within co-creational and informative bottom-up processes.

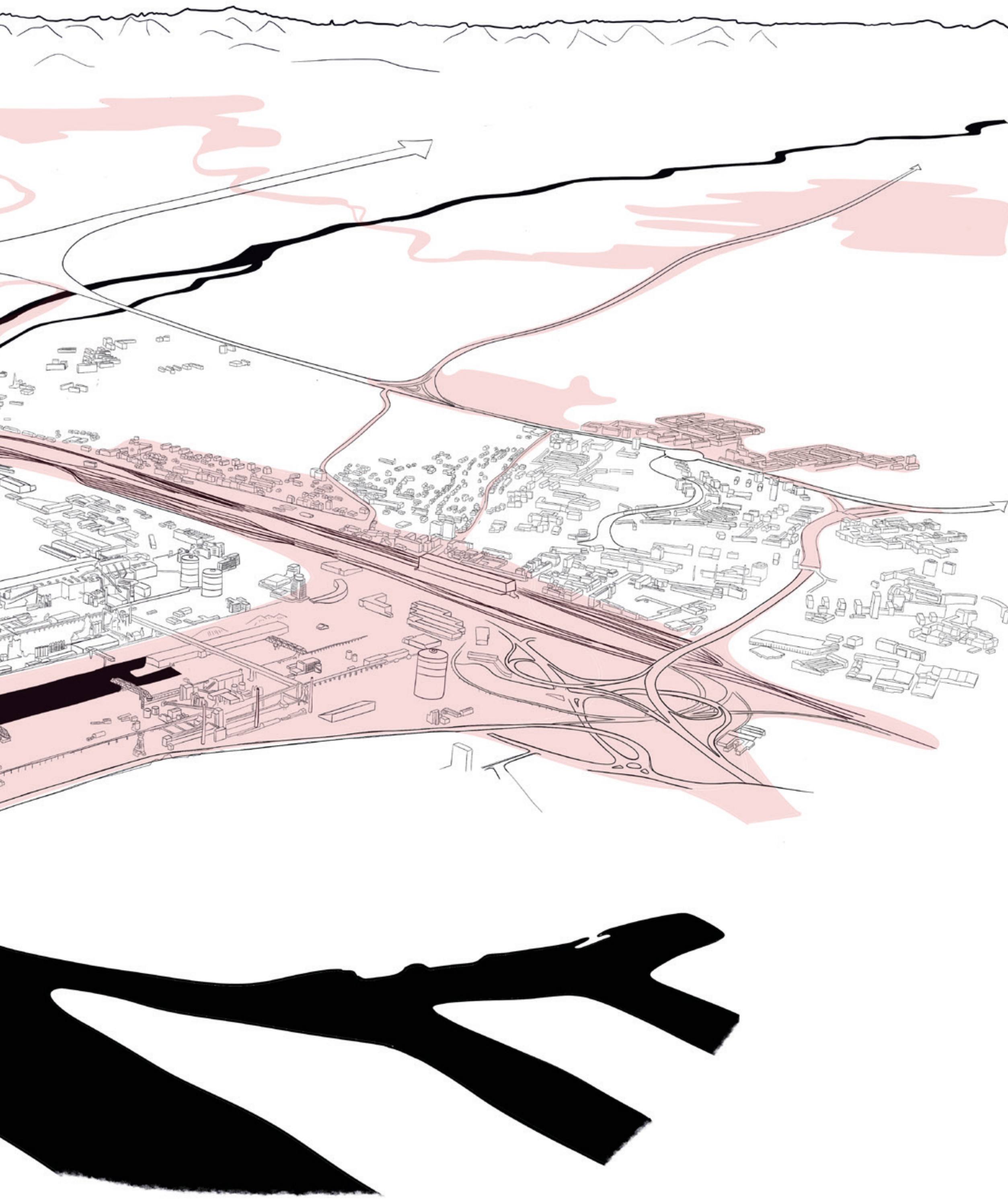
In my view, the value of the transferability of my project results is plausible, as the conceptual approach can also be applied to other industries investigating the spatial dimensions of those. While the context may change, for instance, to textiles, food, or other location-specific industries, the core principles and framework remain relevant. Variables such as material flows, processes, and environmental impacts may differ, but the underlying conceptual approach can be adapted to suit different contexts. Specifically, the flexibility of the "7 Socio-Ecological Cycles" allows a focus on key issues within each industry, while still maintaining an integrated view of the broader socio-ecological landscape. As previously mentioned, the framework provides a holistic perspective on multiple topics, enabling research from diverse angles and disciplines. This adaptability might enhance the potential for the project's impact and relevance beyond its initial scope.

I see significant potential, especially in the field of social studies, to investigate the impact of the transition on society. Qualitative methods, such as interviews and co-creation formats, could provide a more precise understanding, coupled with quantitative data. These methods can unfold the deeper, lived experiences of individuals and communities involved in the transition, offering insights that might not be captured through numbers and spatial data alone. Another interesting approach could involve engaging corporate stakeholders from various industries, building on the known fact that Circular Economies can evolve through bottom-up processes, using the applied holistic self assessment tool in a real life setting. Facilitating dialogue and knowledge exchange between stakeholders can provide a collaborative environment where perspectives from different sectors can cross-pollinate and enhance the overall process. Moreover, a deeper investigation into other *Steelscapes*, particularly the ones located in the hinterlands, may offer valuable insights into understanding the effects of the ongoing transition better. This would require expanding the scope of the project and further involving stakeholders from other regions. If this project evolves into a PhD, as I currently consider, these topics could be explored in greater depth. In that case, it would be interesting to collaborate with experts from various fields to work on papers that examine the spatial dimensions of the steel industry within Austria and beyond.

In the end, I would like to reflect on what I have learned during my journey at TU Delft and what I would like to carry with me. Ironically, when I first started my studies here, I didn't fully grasp the deeper meaning of writing a reflection. I remember trying to create a meaningful description of the process I was going through, rather than stepping back to view myself and the entire process from an outside perspective. Over time, this approach shifted, and it has had a positive influence on how I reflect on my work today.

Overall, I believe I have learned even more (or equal) about myself within the field than about the field itself. This self-discovery had a profound effect on my drive and motivation for the field. The ability to understand my process, strengths, and areas for growth has become a valuable tool that will continue to shape my future paths.





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Throughout this thesis, artificial intelligence (AI) tools have been used for grammar checking, sentence structure refinement, and formulation improvements. These AI tools were used to enhance the clarity, coherence, and overall quality of the text, ensuring that the final document is professionally presented and free of linguistic errors. It is important to note that AI was not used to generate original content or ideas but served as a support tool in the editing process.
All research, analysis, designs and conclusions presented are the work of the author, if not cited.

DATA

All maps, simulated space syntax models, density studies, drawings, and pictures presented in this thesis, unless explicitly credited within the figures, were developed and created by the author. The following data sources were used in the development of these materials.

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APPENDIX

This Chapter explains the evaluation of the status quo in terms of CE and CS efforts. It is a self-assessment tool, which was developed by researchers to perform within stakeholder workshops to gain data for evaluation purposes to build upon them and to develop further steps. In this case, the assessment tool was translated into a compact version in the form of an approachable online survey to gain knowledge about a first sentiment. However, the evaluation criteria and the parameters stayed the same as in the original assessment tool.

A Holistic Approach towards a CE

"What is the current state of the transition towards CE in the GLA from a holistic perspective?" Wandl et al. (2024), touching upon this and other questions on European cities and regions and developed a holistic method, the "Holistic Self-Assessment Tool for Circular Economy Transitions in Cities and Regions" to capture the complexity of the CE transition. Within five dimensions, the tool focuses beyond material flows on governance structures, stocks and flows, co-creation solutions and strategies with stakeholders, and the circular built environment. It can function as a tool for decision-makers and the planning society to develop CE strategies.

The Circular Economy Transitions Self-Assessment (CETSA) tool's logic is developed in four stages and five dimensions (Rings from 0 – 4 see diagram next page).

- **1. Ambition to go circular** – an early stage of the transition, at which the economy remains firmly linear, but stakeholders and policy actors express ambitions to shift towards a CE and put forward ideas, plans, and strategies to achieve this.
- **2. Niche change –** as argued by (Geels, 2011) the transition begins with changes and experimentation in niches on the fringe of the predominant model of activity. Such experimentation is critical for identifying new solutions, new ways of doing things, and methodologies, paving the way for more widespread use.
- **3. Accelerating change** – this stage corresponds to a situation where experimentation becomes widespread, institutionalised, and widely supported, reaching a critical mass that is able to drive systemic change.
- **4. Mainstreamed circular economy** – in this final stage of the transition, the linear economy would be a song of the past and circular processes would be fully mainstreamed as the predominant paradigm for production, consumption, or development of the built environment (Wandl et al., 2023, p. 19).

Furthermore, to detail each dimension, the scholars developed three specific indicators per dimension to evaluate the current state within a given territory, using the previously mentioned four-stage scale.

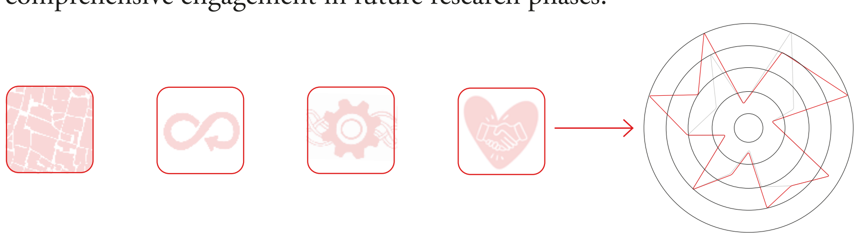
The dimensions are the following

- **1. Governance:** arenas, agendas, and experiments supporting and steering the transition;
- **2. Awareness:** corporate awareness, awareness towards policies, and everyday practices of citizens;
- **3. Tools:** tools for assessment of material flows, tools for urban mining (stock), and tools for enabling co-creation (of knowledge, solutions, strategies) with stakeholders;
- **4. Sustainability assessment:** availability of data on waste and materials, the degree of stakeholder involvement in assessment, and the degree of comprehensiveness of sustainability assessment (consideration of the pillars of sustainability);
- **5. Built environment:** The preparedness and actions taken to regenerate wastescapes – that is, areas that were degraded by linear economic processes and remain polluted and/or underused – and transform the physical and functional built environments (Wandl et al., 2024, p. 19).

The researchers argue that in a real-life setting, this assessment is applied in a stakeholder workshop to gather insights from the various perspectives and outcomes that each stakeholder contributes. These inputs are the essential foundations for the data collection used in the assessment process. However, the researchers also acknowledge certain limitations of the CETSA tool. For instance, there may be cases where no ambition toward a circular economy transition is evident at all. Additionally, the tool relies on self-assessments, which can be influenced by the personal perceptions of stakeholders. Cities that consider themselves frontrunners may rate their progress higher than those that see themselves as less advanced. As a result, caution is advised when using the tool for benchmarking purposes. The CETSA tool is designed to support decision-making processes in fostering more circular urban and regional development models (Wandl et al., 2024).

Application of the tool

To apply the scenarios in a practical and spatially grounded way, the developed enablers are thematically connected to the assessment tool. This methodological step can allow a contextual evaluation of the GLA's current position in the transition toward a Circular Economy and show possible pathways for the spatial and programmatic organisation necessary for this transition. Due to time constraints, only ten participants completed the online survey. However, they represent a diverse range of stakeholders, including individuals from industry, governance, civil society, and research institutions working in the field of circular economy, as well as governmental organizations engaged with the topic. While the sample size is limited, it provides an initial perspective and lays the groundwork for more comprehensive engagement in future research phases.



Wo steht Linz und der Zentralraum Oberösterreich auf dem Weg zur Kreislaufwirtschaft?

im Rahmen meiner **Masterarbeit im Studiengang Urbanism (Städtebau und Stadtplanung)** an der *Faculty of Architecture and the Built Environment an der Technischen Universität Delft (Niederlande)* beschäftige ich mich mit **Transformationsprozessen hin zur Kreislaufwirtschaft in der Industrie und Gesellschaft im Zentralraum Oberösterreich.** Der besondere Fokus liegt auf den räumlichen Dimensionen des **Industriegebietes in Linz** und dessen **Beziehungen zum Hinterland.**

In diesem Zusammenhang führe ich derzeit eine **Kurzbefragung** durch, die auf einem wissenschaftlich fundierten Bewertungstool basiert. Die Umfrage umfasst **15 kurze Aussagen**, die eine strukturierte Einschätzung zum Stand der Kreislaufwirtschaft in der Region ermöglichen.

Dauer: max. 10 - 15 Minuten
Ziel: Ihre Einschätzungen unterstützen nicht nur meine wissenschaftliche Arbeit, sondern liefern zugleich **wertvolle Hinweise für eine nachhaltige Entwicklung** der Stadt Linz und der Region.

Die Teilnahme ist selbstverständlich anonymisiert. Es werden **keine Namen oder institutionellen Angaben in der Arbeit veröffentlicht**.

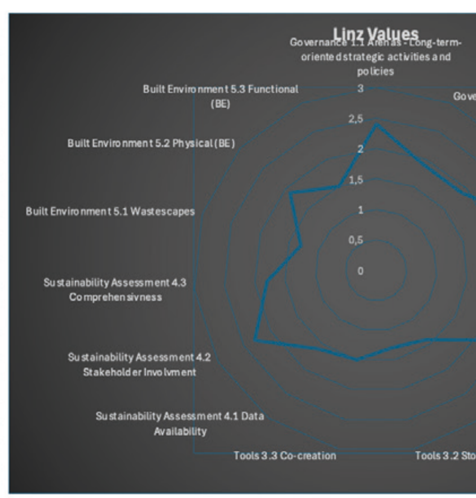
Vielen Dank für Ihre Teilnahme, ich freue mich über jeden Beitrag!

E-Mail-Adresse *

Gültige E-Mail-Adresse

Bei diesem Formular werden E-Mail-Adressen gespeichert. Einstellungen ändern

	Name of the Region:	Linz
Sector	Indicators	Values
Governance	1.1 Arenas - Long-term-oriented strategic activities and policies	2,4
	1.2 Agendas	1,9
	1.3 Experiments/Eco-Innovative Solutions	1,9
Awareness	2.1 Corporate	2,7
	2.2 Policy Implementation	1,9
	2.3 Ordinary Life Practices	2,3
Tools	3.1 Flows	1,4
	3.2 Stocks	1,3
	3.3 Co-creation	1,5
Sustainability Assessment	4.1 Data Availability	1,6
	4.2 Stakeholder Involvment	2,3
	4.3 Comprehensivness	1,8
Built Environment	5.1 Wastescapes	1,3
	5.2 Physical (BE)	1,9
	5.3 Functional (BE)	1,5
	Based on Thomas Schweitzer | Bernegger Rohstoffe	



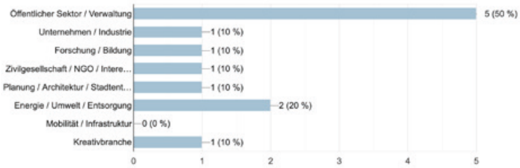
REPAiR

	AVRG										
	2,4		2	3	2	3	2	3	2	1	3	3
	1,9		2	4	2	2	2	2	1	1	1	2
	1,9		2	3	3	2	2	2	1	1	1	2
	2,7		2	3	3	3	2	2	4	2	4	2
	1,9		2	2	2	3	2	2	1	1	3	1
	2,3		3	2	2	3	2	1	3	2	3	2
	1,4		2	3	1	2	1	1	1	1	1	1
	1,3		2	1	1	2	1	2	1	1	1	1
	1,5		2	1	2	2	1	2	2	1	1	1
	1,6		3	2	2	2	1	1	2	1	1	1
	2,3		2	3	3	2	3	1	3	2	2	2
	1,8		2	3	2	2	2	1	2	1	2	1
	1,3		2	0	2	2	1	1	2	1	1	1
	1,9		2	3	2	3	1	2	2	1	1	2
	1,5		3	3	1	2	1	1	1	1	1	1

Enablers	Resilient Roots	Hyperlinked Horizons	M + L + L (RR)
C1 Circular Infrastructure	Small scale, decentralised and local defined areas for re-use and sharing	Large + centralised areas for material storage and remanufacturing	Live + Make
C2 Transformation of coke plant	Remidiation of Polluted Soil + Repurposing the site for regeneration	High-Tec HUB for recycling and distribution beyond regions	Learn + Make
C3 Waste Flow Management	Focus on organic ways of making, compostable biosbased materials	AI, real time wasteflow management estimate flows beyond regions	Live + Learn
C4 Construction Sector	Retrofit buildings, new programms, repurpose + adaptable buildings	Demolish buildings, recycle materials in proximity, new buildings	Live + Learn + Make
C5 Societal Behavior Patterns	Scarcity. people have to re-use and adapt what they have. Communal	Abundance. Everythig is available at all time. Outsourced supply	Live + Learn + Make
C6 Circular Learning Patterns	Relearning practices from indigenous - living with nature	Adapting to new ways of digital learning. Tech driven	Live + Learn
M1 Beyond Wastescapes	Adaptive landuse zones make space for circular practices (food, energy,...)	Space for new devlopment, econom-ic driven learning and making	Live + Learn + Make
M2 Places for living	Repurpose + redensified exisiting built environment in mixed use areas	New development with re-used ma-terials, high rise in central locations	Live + Learn + Make
M3 Remote outposts	Mobile + nature related outposts for food production + self sufficiency	Mobile + digital nomadic connection to information infrastructure	Live + Learn + Make
M4 New Trainstation	New trainstation connects the area with the mainstation.	New international highspeed HUB connects european destinations	Live + Learn + Make
M5 New connecting bridge	Bridge overcomes barriers for pedes-trians and connects green spaces	Trainstation connects the west/east campus districts	Live + Learn + Make
M6 Focus on Green space	Nature defines design. Reservoirs connect city within a green network.	Design defines nature. Green spaces function as technological solutions	Learn
P1 Defining a new Campus	New Eco-Campus of life sciences Curricula with environmental focus	New Digital IT-Campus Curricula with AI + IT focus	Live + Learn + Make
P2 Future ways of Learning	Schools focus on environmental edu-cation to prepare for climate crisis	Schools focus on digital technologies to prepare for shift in jobmarket	Learn
P3 Future ways of Living	Community based and supported by strong state run organisations.	Individual oriented with focus on and private investment.	Live
P4 Future ways of Making	Localy produced goods with re-sourced materials (degrowth)	Globally produced goods with re-sourced materials (abundance)	Make
P5 Future ways of Planning	Framework thinking + public driven investment in existing structures	Masterplan thinking + private driven investments in new developments	Live + Learn + Make
P6 Perspectives on change	Open minded and local based per-spective on common practices	Open minded global based perspec-tives on individual lifestyles	Live + Learn
G1 New Zoning methods	Flexible + adaptive landscapes as experimental zones	AI zoning on demand for smart solutions	Live + Make
G2 Bottom Up practices	Initiatives foster collectiv decision making + grassroot movements	Top down accepts bottom up ap-proaches for informative issues	Live + Learn + Make
G3 Emergency prevention strategies	Awareness building with strategies to overcome environmental shocks	Awareness building to overcome economic shocks with analog tools	Live + Learn
G4 Intercommunal cooperations	Strong interaction with communities in the hinterland sharing ressources.	Strong interaction with municipalities based on economic development	Live + Learn + Make
G5 Investment in Infrastrucutres	Public driven with focus on public-transport and slow traffic	Public Private driven with focus on material flow optimisation	Live + Learn
G6 Politics of Change	Citizen voices are represented in local governments - co-design	Industry and Economy voices define pathways to increase competitiveness	Live + Learn

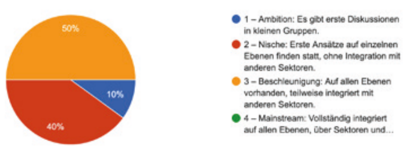
Flexibility (RR)	M + L + L (HH)	Flexibility (HH)	Repair assesment
●●●	Learn + Make	●○○	**5.3 Functional (BE)**
●●○	Make	●●○	**5.2 Physical (BE)**
●○○	Learn + Make	●●○	**3.1 Flows**
●●○	Live	●●●	**3.2 Stocks**
●○○	Live + Make	●●●	**2.3 Ordinary Life Practices**
●○○	Live + Make	●●○	**2.3 Ordinary Life Practices**
●●●	Learn + Make	●○○	**5.1 Wastescapes**
●●○	Live +Learn + Make	●●○	**5.3 Functional (BE)**
●●●	Live + Learn + Make	●●●	**5.2 Physical (BE)**
●●○	Live + Learn + Make	●○○	**5.2 Physical (BE)**
●●○	Learn + Make	●○○	**5.2 Physical (BE)**
●●●	Make	●●○	**1.3 Experiments/Eco-Innovative Solutions**
●○○	Live + Learn + Make	●○○	**1.2 Agendas**
●●○	Learn	●●○	**1.1 Arenas (long-term strategies)**
●●○	Live	●○○	**1.1 Arenas (long-term strategies)**
●●●	Make	●○○	**1.1 Arenas (long-term strategies)**
●●●	Live + Learn + Make	●○○	**5.3 Functional (BE)**
●○○	Make	●●●	**1.2 Agendas**
●●○	Make	●●●	**1.3 Experiments/Eco-Innovative Solutions**
●○○	Live	●●●	**3.3 Co-creation**
●○○	Live	●●○	**3.3 Co-creation**
●●○	Make	●○○	**3.3 Co-creation**
●○○	Live + Make	●○○	**2.2 Policy Implementation**
●●○	Learn + Make	●●○	**1.1 Arenas (long-term strategies)**

In welchem Bereich sind Sie hauptsächlich tätig? (Mehrfachauswahl möglich, falls zutreffend)
10 Antworten

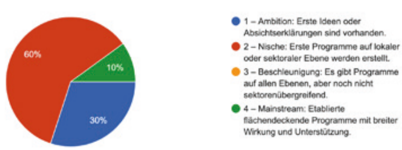


Die Umfrage umfasst **15 kurze Aussagen** die eine strukturierte Einschätzung zum Stand der Kreislaufwirtschaft in der Region ermöglichen. Die Antwortmöglichkeiten sind gewertet von 1 Ambition (gar nicht bis wenig etabliert) bis 4 Mainstream (vollständig etabliert).

Dimension 1: Governance 1.1 Es gibt strategische Visionen und langfristige politische Ziele zur Kreislaufwirtschaft.
10 Antworten



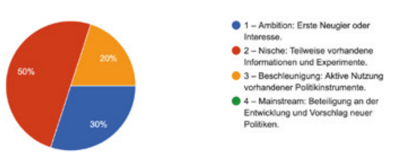
1.2 Es gibt operative Programme und Agenden zur Umsetzung der Kreislaufwirtschaft.
10 Antworten



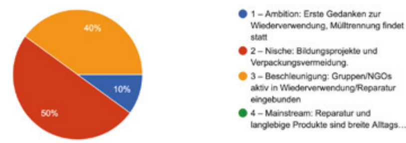
1.3 Es gibt Pilotprojekte und Experimente für zirkuläre Lösungen.
10 Antworten

Dimension 2: Bewusstsein (Awareness) 2.1 Es gibt ein hohes Bewusstsein für Kreislaufwirtschaft in Unternehmen.
10 Antworten

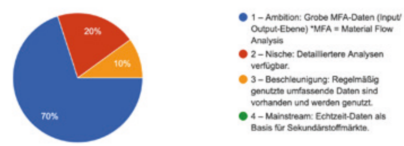
2.2 Es gibt eine aktive Beteiligung und Information der Bürger:innen zur Kreislaufwirtschaftspolitik.
10 Antworten



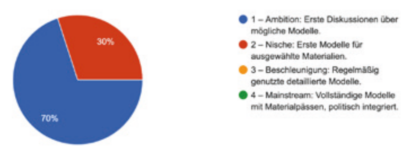
2.3 Es gibt gelebte Praktiken der Kreislaufwirtschaft im Alltag.
10 Antworten



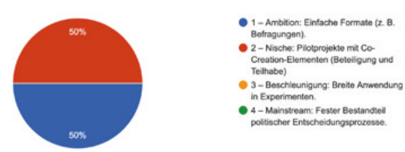
Dimension 3: Werkzeuge (Tools) 3.1 Es gibt verfügbare und regelmäßig genutzte Daten über Stoff- und Materialflüsse.
10 Antworten



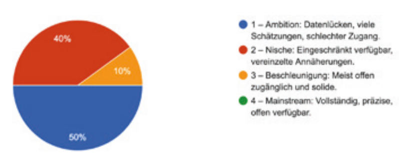
3.2 Es gibt Modelle zur Analyse von Materialbeständen (Urban Mining).
10 Antworten



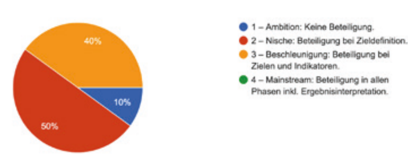
3.3 Es gibt etablierte Mitgestaltungsformate für zirkuläre Lösungen.
10 Antworten



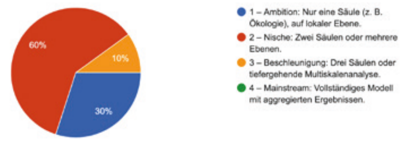
4.1 Es gibt ausreichend verfügbare, qualitativ hochwertige Daten.
10 Antworten



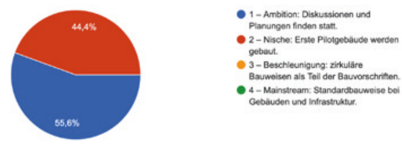
4.2 Es gibt Beteiligung von Stakeholdern bei der Bewertung.
10 Antworten



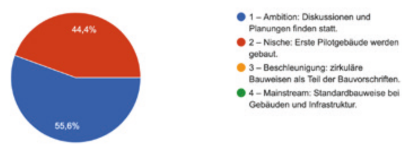
4.3 Es gibt eine umfassende Nachhaltigkeitsbewertung.
10 Antworten



Dimension 5: Gebaute Umwelt 5.1 Es gibt zirkuläre Bauweisen bei Gebäuden und Infrastrukturen.
9 Antworten



Dimension 5: Gebaute Umwelt 5.1 Es gibt zirkuläre Bauweisen bei Gebäuden und Infrastrukturen.
9 Antworten



5.3 Es gibt Maßnahmen zur Regeneration von Brachflächen und Kontaminierten Altlasten.
10 Antworten