BEYOND NIMBY

FACTORIES, FAMILIES AND FAIRNESS

creating symbiosis between heavy industry and the surrounding residents in the energy transition

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Quarter 3 | MSc Urbanism | April 9, 2025
AR2U086 R&D Studio | Spatial Strategies for the Global Metropolis
AR2U088 Research and Design Methodology for Urbanism

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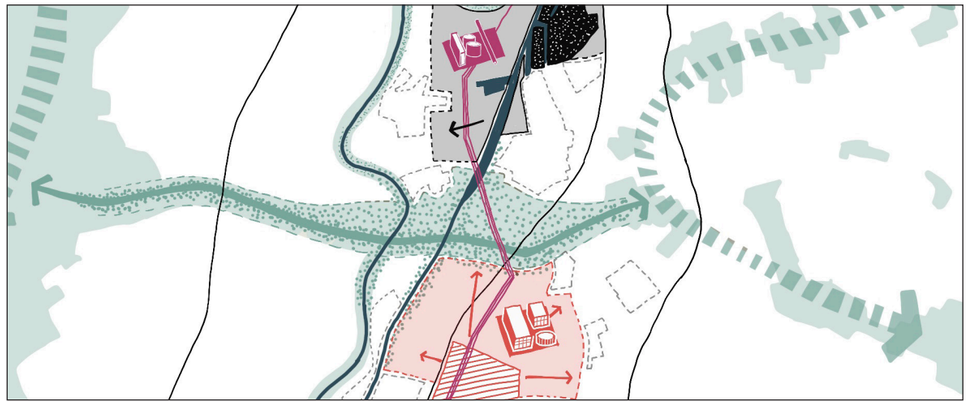
ABSTRACT



The ongoing energy transition across Europe presents significant challenges and opportunities for industries traditionally dependent on fossil fuels, particularly the chemical sector. As a cornerstone of the European economy, the chemical industry must balance the urgency of transitioning to sustainable energy with the need to maintain competitiveness and profitability. One such industry hub, Chemelot in the southern Netherlands, finds itself at a pivotal moment in this transition. As a major contributor to the regional economy and a key player in the chemical sector, Chemelot's shift toward sustainability holds profound implications not only for its own future but also for the local communities and natural environment that surround it, which are often negatively impacted by it.

This report examines how Chemelot can navigate the complex energy transition in alignment with the European Union's Green Deal and climate targets, while balancing the economic, social, and environmental needs of its region. The research explores the cross-scalar impacts of this transition, addressing the local challenges faced by surrounding communities, the spatial implications for the region, and the broader cross-border implications within the European context. The study focuses on the tensions that emerge between industrial growth, environmental preservation, and social equity, and seeks to identify strategies that reconcile these often conflicting demands.

A central element of this research's visioning process is the development of an urban-industrial symbiosis model that integrates the economic needs of Chemelot with the broader community and environmental priorities of the surrounding area. This ideal vision is situated within a larger framework of national policies, EU climate targets, and regional development plans, ensuring alignment with both local and cross-border objectives. By analysing the power-interest dynamics and policy frameworks in play, as well as understanding the attitudes of various stakeholders, we create a development strategy that balances conflict resolution with the identification of synergies.

To achieve this, co-design methodologies, such as pattern language, are employed to spatially address and facilitate conflicts and synergies. This approach allows for a more nuanced understanding of how stakeholder interests intersect and evolve. It ensures that the transition process is inclusive, with opportunities for stakeholders to collaborate in shaping a shared vision. The result is a phased strategy for Chemelot's growth, positioned within a larger metropolitan area, which not only enables industrial expansion but also fosters sustainable regional development.

The findings of this research suggest that Chemelot's energy transition can become a model for the future development of similar industrial hubs, contributing to the larger goal of achieving sustainable, inclusive, and climate-resilient urban-industrial landscapes. It also highlights the importance of collaboration and communication among stakeholders to ensure that the transition is just, equitable, and environmentally responsible.

Fig:1 A glimpse into the Project

CONTENTS

Glossary of Important Terms and Representations

Community: *All current surrounding residents imapcted by the industy and all future residents envisioning their live here.*

Industry: *Industrial sites being part of the chain of the production of plastic. The emphasis lies with the heavy industry such as Chemelot. It can have two colours:*

Emphasis lies with solely the industry

Emphasis lies with the combination of Industry with energy production

Energy: *Energy production sites through renewable energy: solar, wind and hydrogen*

Environment: *Natural areas, existing of protected sites, rivers and river banks and valueable green for the community or biodiversity.*

Conflicts: *When conflicts in land use arise between the community (in combination with environment) and the industry (in combination of the energy production). These conflicts ask for a solution through a border.*

Borders: *A patch of land between two or more landuses where between conflict arises. These borders be can soft or hard and can serve multifunctional purposes.*

Synergies: *The positive interactions between two or more landuses/stakeholders. This synergy can be made stronger through a transition.*

Transition: *This proposes spatial solutions that result in integration and cooperation, rather than enforcing separation. These patterns promote spatial integration and collaboration. Proximity results into added value for both stakeholders.*

Symbiosis: *Symbiosis: When conflicts are resolved through the application of border patterns, creating softer buffers between areas, and when synergies are strengthened through transitions that help knowledge exchange, people exchange, help make more fluent connections and reduce waste via residual flows. This occurs when all stakeholders are actively involved in the process and their interests are advocated for, ultimately helping the overall livability of the project.*

Vision: Vision: *A visualisation supported by a vision statement, presenting a desired or proposed future that advocates for specific stakeholders, or a combination of them. While it may lean towards idealistic thinking, it retains an underlying truth. The vision encourages free thinking and visually communicates what a better future could look like.*

Strategy: *Strategy: An in-depth plan supported by visualisations that demonstrate how a vision can be realised. The strategy outlines the involved stakeholders, key locations, and essential interventions. It provides a clear pathway of phasing and predictability, highlighting actions that are interdependent and those that allow for more flexibility.*

Fig: 2- Glossary Table explaining important terms and representations used throughout the report.

1 Introduction

“Framing the transition: Why now, Why here, for Whom and Why it matters?.”

ENERGY TRANSITION IN EUROPE AND NETHERLANDS

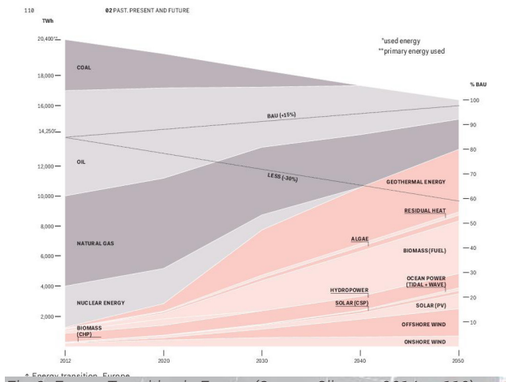


Fig: 3- Energy Transition in Europe (Source: Sijmons, 2014, p. 110)

Fig: 4- Energy Transition in Europe 2040-2050 (Source: Sijmons, 2014, p. 109)

Europe is undergoing a major energy transition, moving from fossil fuels to renewable sources like wind, solar, geothermal, and biomass. This shift is driven by the urgent need to reduce greenhouse gas emissions, address the depletion of coal, oil, and gas reserves, and ensure long-term energy security. While the transition is necessary, it brings challenges particularly in terms of space and infrastructure. Yet, progress is underway. By 2050, Europe aims for an 80% emission reduction, relying on regional strengths and cross-border cooperation to build a resilient, renewable energy landscape (Sijmons, 2014).

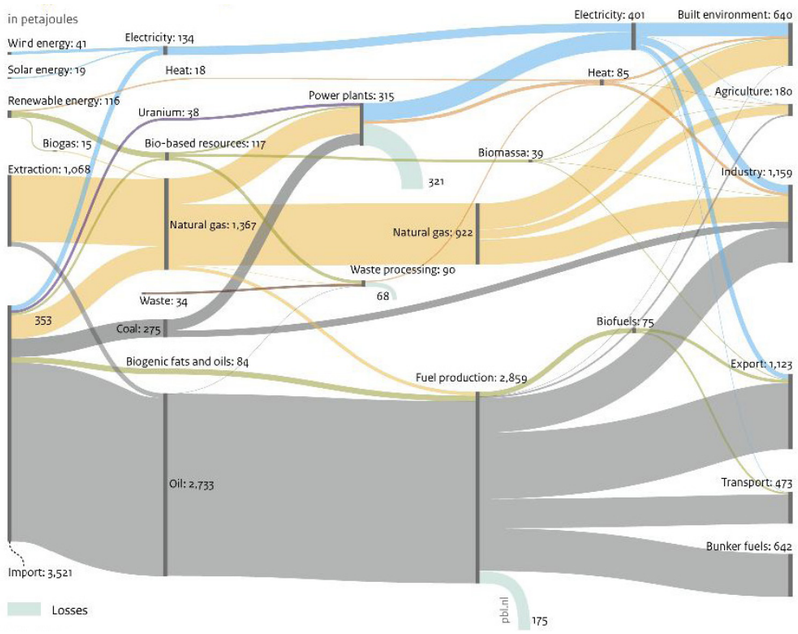


Fig: 5- Energy flows Netherlands 2019 (Source: PBL Netherlands Environmental Assessment Agency, 2019, p.20)

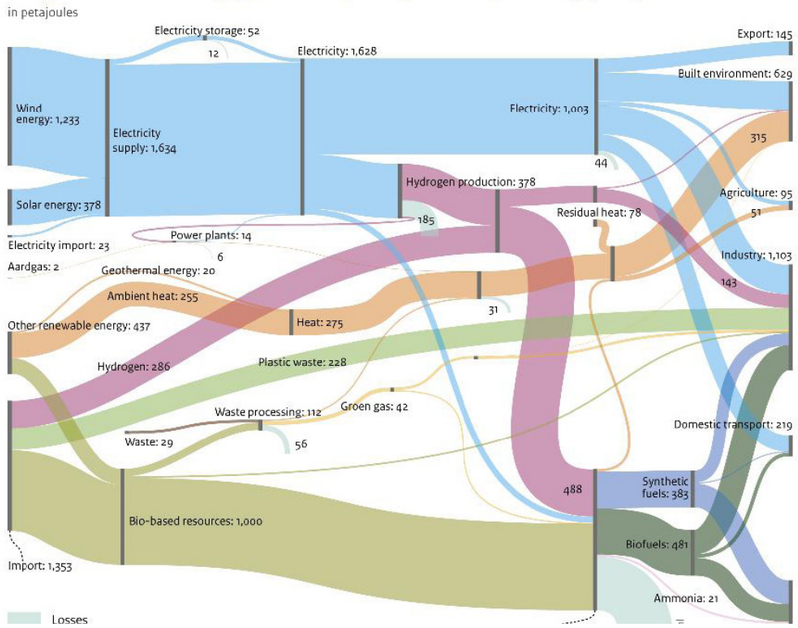


Fig: 6- Energy flows Netherlands 2050 (Source: PBL Netherlands Environmental Assessment Agency, 2019, p.22)

The Netherlands in energy transition aims to reduce its reliance on fossil fuels and combat climate change. As part of its commitment to the Paris Agreement, the Dutch government aims to reduce greenhouse gas emissions by 55% by 2030 and achieve climate neutrality by 2050 (European Parliament, 2024).
The industrial sector, particularly fossil fuel–dependent industries such as chemicals, refining, and heavy manufacturing, is facing significant challenges in its transition. These sectors are adopting cleaner technologies, including electrification, green hydrogen, and carbon capture and storage (CCS), in order to reduce emissions and align with the country's climate targets.

CHEMICAL INDUSTRY IN ENERGY TRANSITION

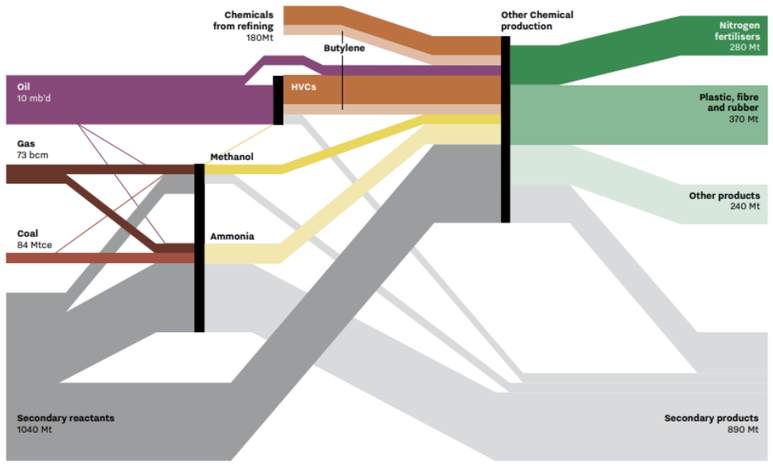


Fig: 7- Fossil Fuel Feedstocks to Chemical Products (Source: IEA ,2018)

Energy and Chemicals

The chemical industry is heavily reliant on fossil fuels, using oil and natural gas as primary feedstocks, which account for significant global energy demand. This sector is essential for producing fertilizers, plastics, and various chemicals, with feed-stocks undergoing complex transformations to become high-value products. The shift towards renewable carbon feed-stocks is vital to reduce embedded carbon in chemicals, aligning with global sustainability efforts (IEA, 2018).

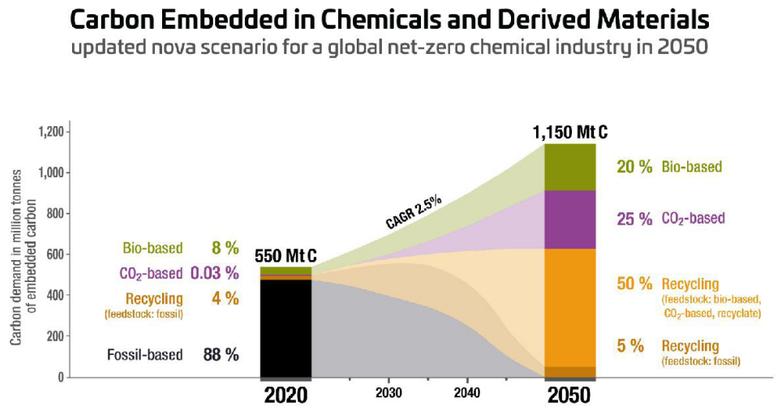


Fig: 8- Feedstock transition of chemical industry (Source: Renewable Carbon Initiative, n.d.)

Energy Transition of Chemical Industry

The energy transition in the chemical industry is crucial for achieving global climate goals. This sector is a major consumer of energy and a significant source of CO2 emissions, primarily due to its reliance on fossil fuels for production. The urgency of transitioning to renewable energy, low-carbon feed-stocks, and innovative technologies like hydrogen, electrification, and carbon capture is critical. Without these changes, the chemical industry will continue to hinder progress toward sustainability.

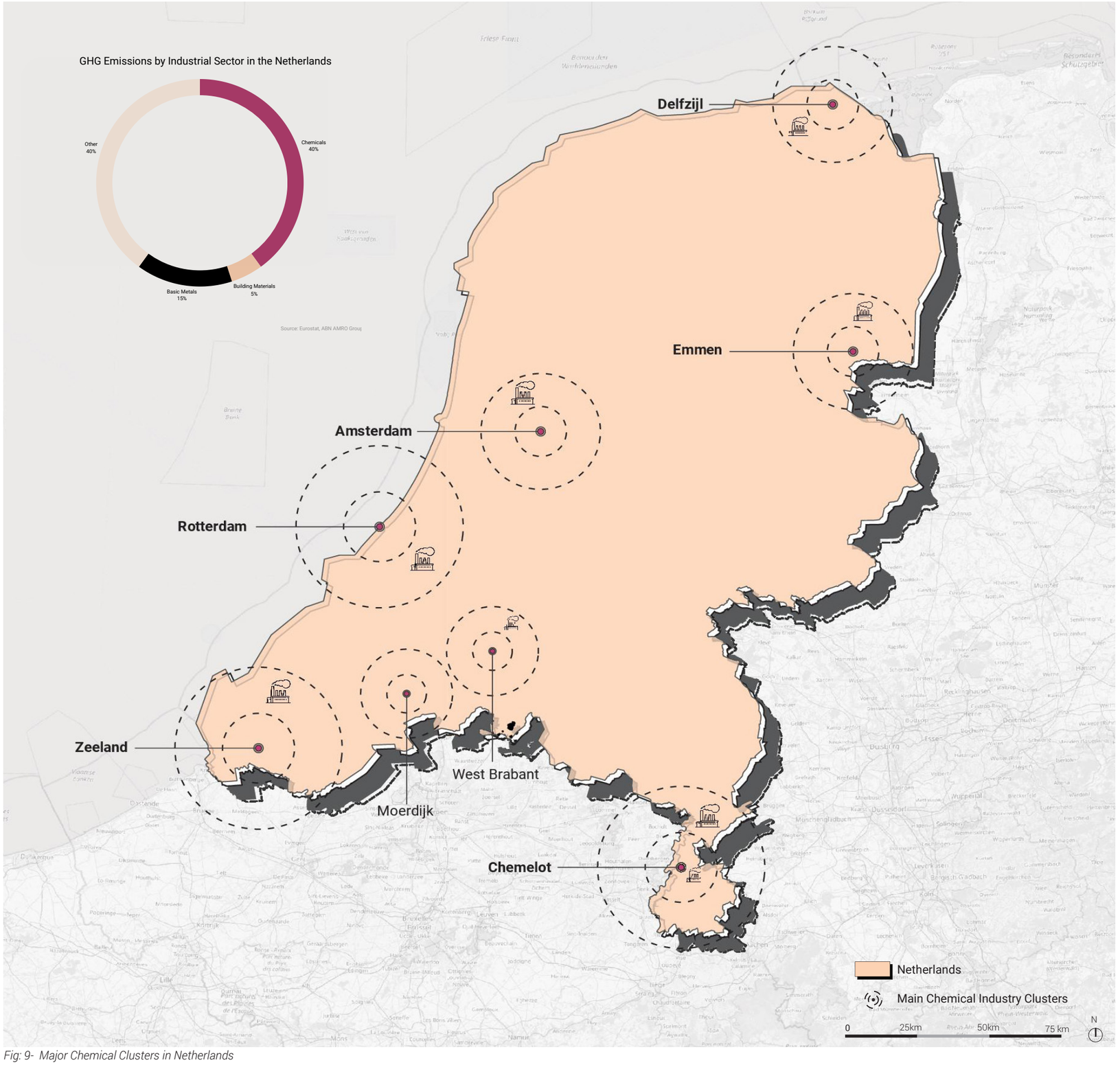


Fig: 9- Major Chemical Clusters in Netherlands

CHEMELOT: A PILLAR INDUSTRY

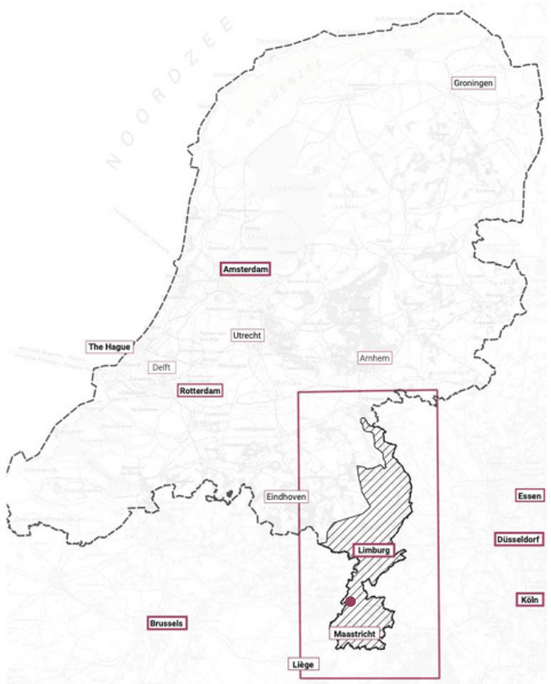


Fig: 10- Chemelot (A Key Chemical Industry) within the Province Region (Limburg), South Netherlands. (Source: Information and GIS data: Geofabrik n.d, Openstreetmap, n.d)

Located in the South of Limburg, Chemelot is not only the second-largest industrial site in the Netherlands, with a turnover exceeding €10 billion, but also a critical driver of national exports, contributing around 17% of the Netherlands' total chemical export value. As a historically fossil-dependent cluster, Chemelot is uniquely positioned to become a key site for the chemical energy transition to sustain into the future in this region.

With over 100 startups and research and development centres operating on-site or within the regional innovation ecosystem, Chemelot is already begun the transition with circular chemistry, green hydrogen technologies, and carbon capture solutions. Its strategic location along key trans-European corridors and its proximity to Germany and Belgium make it a cross-border innovation hub, well-connected to major ports such as Rotterdam and Antwerp.

This combination of economic scale, research capacity, and logistical connectivity makes Chemelot not just a pillar of regional industry but also a key site for transforming the chemical sector into a climate-neutral industry by 2050 and beyond.

Second-largest industry in the Netherlands with over 10 billion turnover

~100+ startups & R&D centers involved in Circular economy research and innovation

Important Upstream industry with 17% of total exports of Netherlands.

Strategic Location & Logistics with good cross border connections

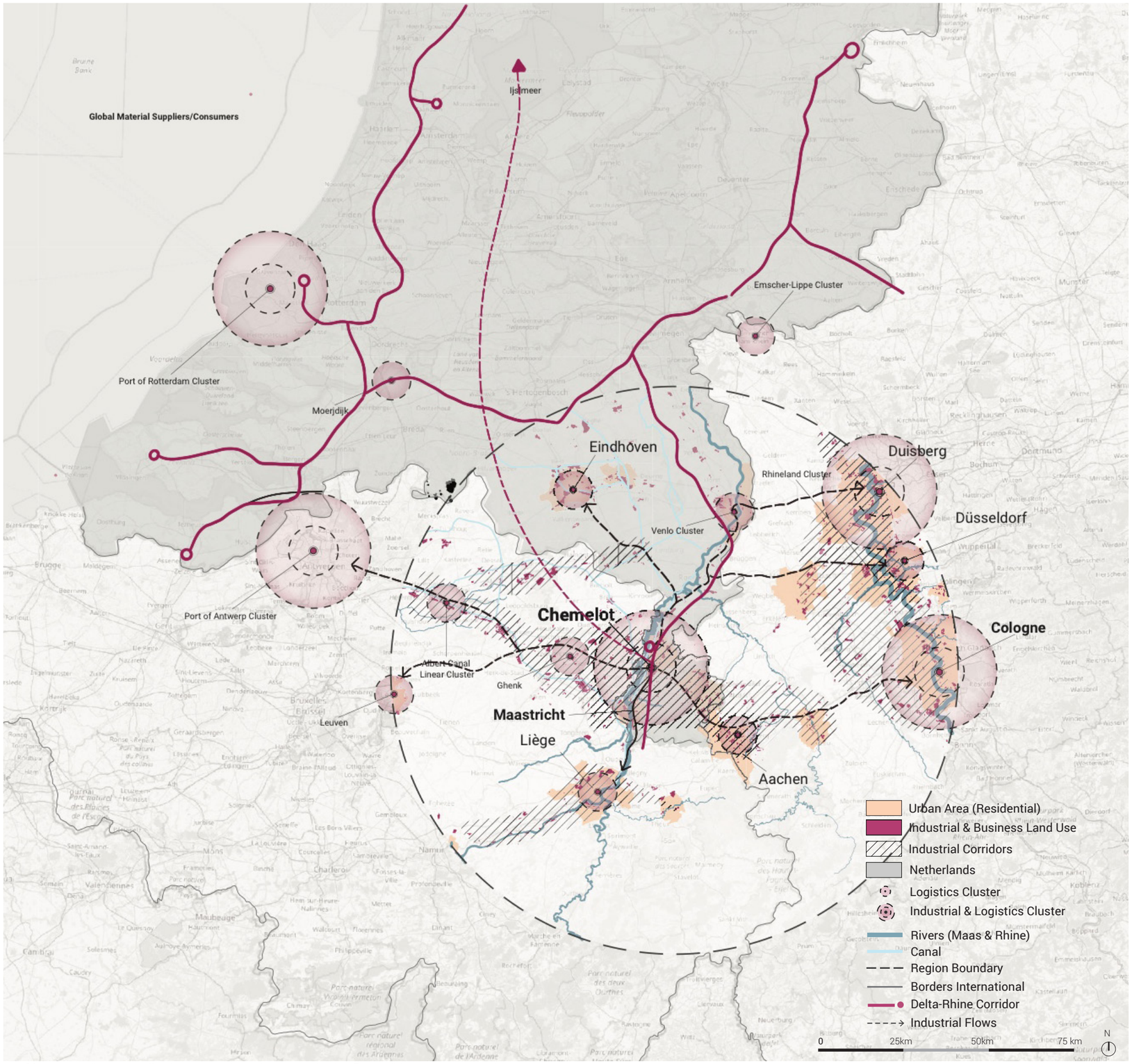


Fig: 11- Industry & Logistics Clusters associated with chemelot in the Region & the Netherlands with Energy Flows, (Source: Information and GIS data: Geofabrik n.d, Openstreetmap, n.d, IBIS Bedrijventerreinen, 2022, PDOK n.d)

CHEMELOT IN DETAIL

Chemelot Industrial Area

Covering over 800 hectares, the Chemelot Industrial Park hosts more than 60 chemical plants and approximately 150 organizations. The site employs around 8,000 people and is characterized by a high degree of integration among its facilities. Products from one factory often serve as raw materials for another, enhancing efficiency and reducing energy loss. The park's infrastructure includes over 60 kilometers of rail tracks, a port with excellent connections to neighbouring seaports, and proximity to major road networks and pipelines, facilitating direct links to industrial clusters in Antwerp, Rotterdam, and the Rhine-Ruhr area (Chemelot, n.d.).

Brightslands Campus

Adjacent to the industrial park, the Brightlands Chemelot Campus serves as an innovation ecosystem focusing on green chemistry, circular materials, and biomedical applications. The campus hosts over 90 companies and knowledge institutions, employing more than 2,700 knowledge workers and accommodating 1,200 students. It offers state-of-the-art research and development facilities, pilot plants, and laboratories, fostering collaboration between academia and industry.

Fig: 12,13- Chemelot Campus Aerial Images (Chemelot, 2025)

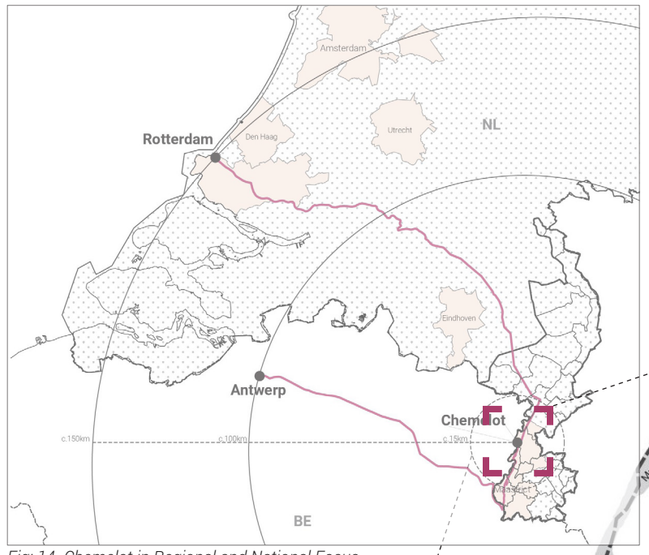


Fig: 14- Chemelot in Regional and National Focus

Fig: 15- Chemelot in Detail Map, (Source: Information and GIS data: Geofabrik n.d, Openstreetmap, n.d.)

MATERIAL AND ENERGY FLOWS OF CHEMELOT

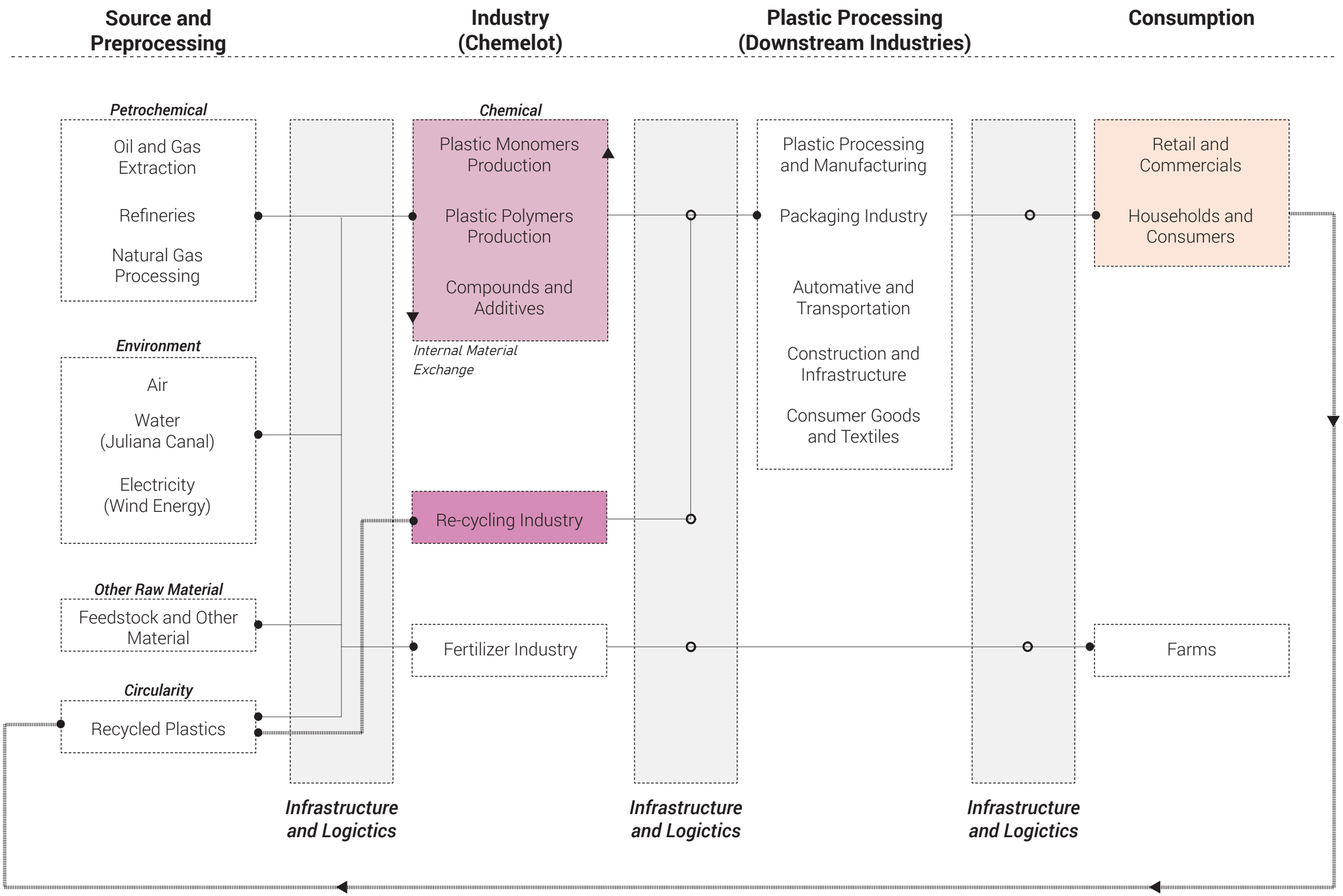
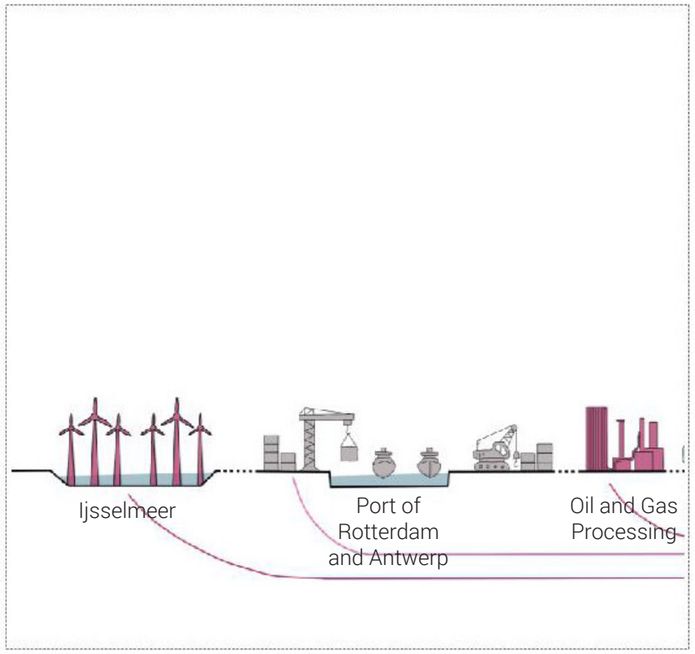


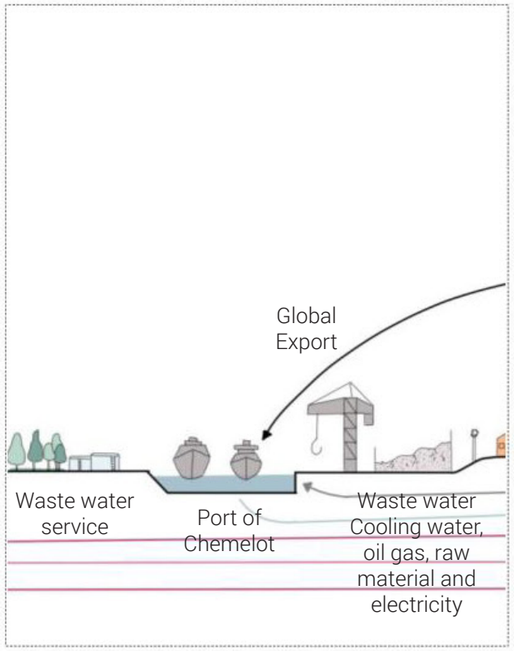
Fig: 16- Schematic diagram showing Chemelot's Material and Energy Flows

SPATIALLY DEFINING THE MATERIAL AND ENERGY FLOWS



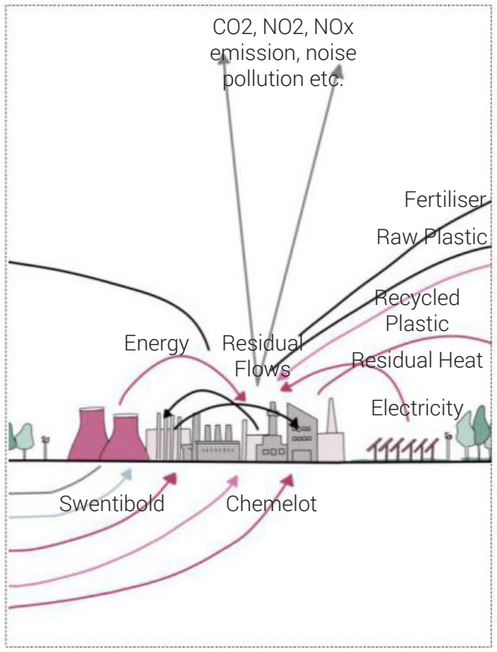
Energy and Material Input

Chemelot operates as an energy and resource intensive chemical hub, relying heavily on natural gas and naphtha for its core industrial processes. These fossil-based feedstocks are primarily transported from the Port of Rotterdam and through cross-border pipeline infrastructure, supporting high-temperature operations such as steam cracking and ammonia synthesis (PBL, 2021). The site consumes approximately 22 petajoules (PJ) of energy annually, with most of it used to generate process heat and steam critical to continuous production (RVO, 2020). In recent years, the site has started integrating recycled carbon, bio-based feedstocks, and pilot programs for green hydrogen to support the energy transition (TNO, 2022).



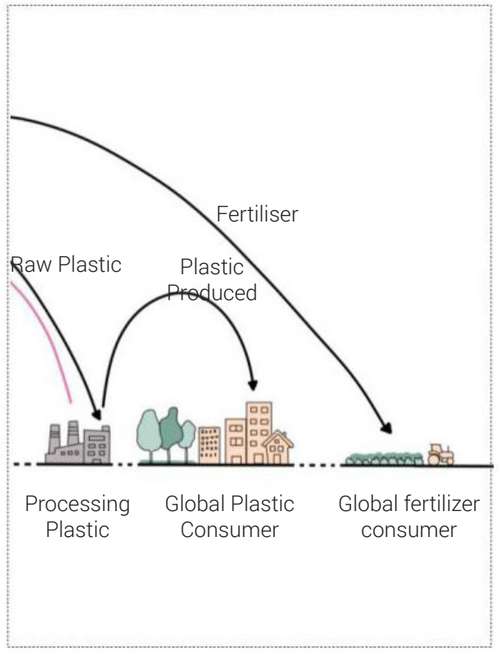
Export route

Chemelot is strategically located near the Belgian and German borders and is well connected to European logistics networks via road, rail (60 km on-site), waterways (1 port), and pipeline systems. These routes facilitate efficient transport of chemical products such as ethylene, propylene, caprolactam, ammonia, and specialty plastics to both domestic and international markets (Chemelot, 2024). Its proximity to the Rhine–Ruhr industrial zone, Antwerp, and Rotterdam enhances the site's role in trans-European supply chains.



Chemelot Industrial Area

The Chemelot site operates as a tightly integrated industrial ecosystem, where companies collaborate by sharing energy systems, utilities, and infrastructure. This setup enhances overall efficiency and significantly reduces waste.
Located right next to the industrial park, the Brightlands Chemelot Campus serves as a hub for research and innovation. It focuses on advancing circular chemistry, carbon capture and utilization, and cutting-edge materials science. (Brightlands, 2024).



Consumers

Chemelot's production is largely upstream and feeds into value chains that supply sectors such as automotive, construction, textiles, agriculture, and packaging across Europe. Its products are essential for producing fertilisers, plastics, synthetic fibers, and high-performance materials. As the chemical sector decarbonises, Chemelot is expected to evolve into a regional circular materials hub, supplying future-proof, low-carbon products to downstream industries, while leveraging digital and clean technologies for smarter energy and material use (TNO, 2022).

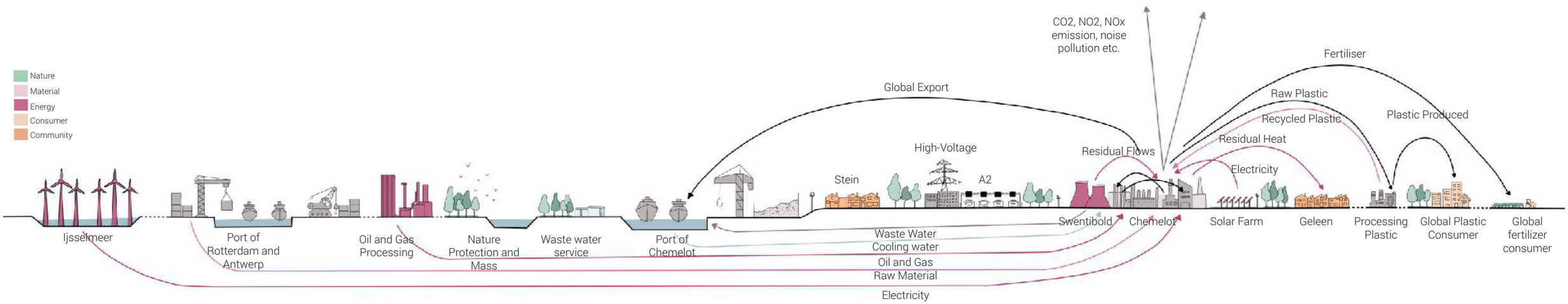


Fig: 17- Schematic section showing Chemelot's Material and Energy Flows

CHEMELOT: A Major Energy Consumer

HOW BIG IS CHEMELOT?

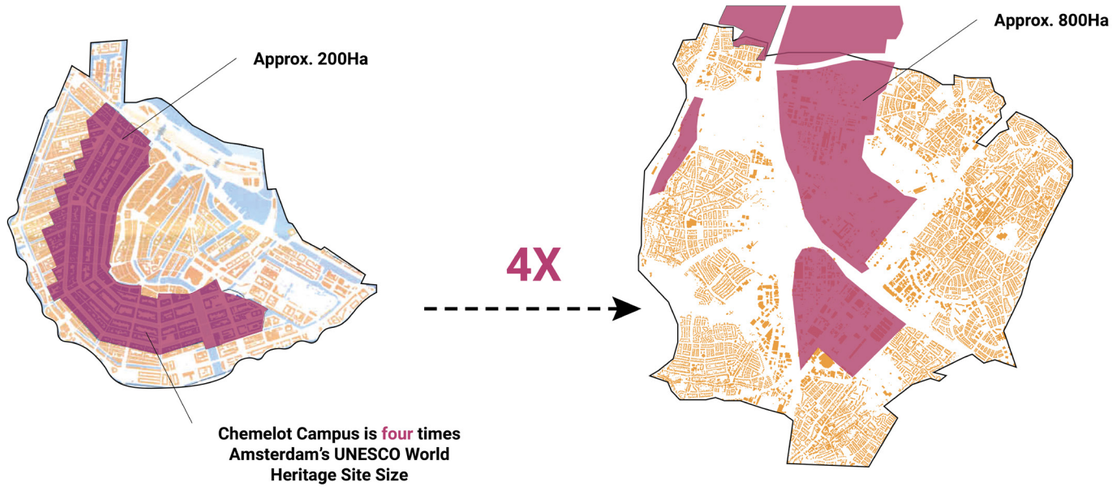


Fig: 18- Graphic representing Size of Chemelot compared to Amsterdam

HOW MUCH ENERGY CHEMELOT CONSUMES NOW?

Currently, raw fossil materials are used at Chemelot. Roughly 4 million cubic meters of natural gas and approximately 93,000 barrels of naphtha ('refinery gasoline') are used every day.

Chemelot's electricity consumption is now 200 million megawatt hours per year. The transition to electrifying the production processes will incur an increase of an estimated 1,500 MW per year. For comparison, a wind turbine on land delivers around 3 MW; at sea, that is 6 MW. 1 MW of solar requires 4.5-6 football pitches of land (approximately 2.4 ha - 3.2 ha). 1 MW can power 190 homes (Chemelot, n.d.)

HOW MUCH ENERGY CHEMELOT WILL CONSUME IN FUTURE?

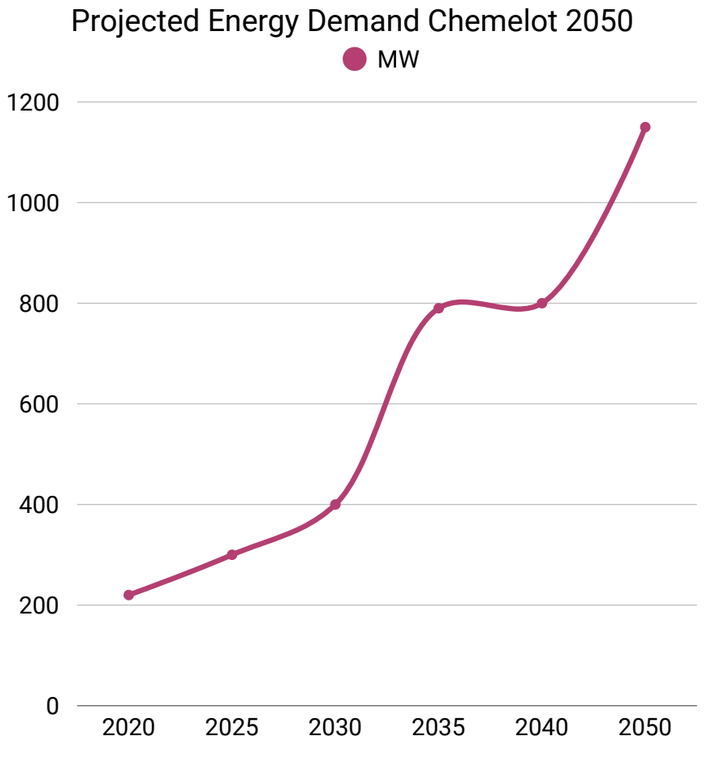
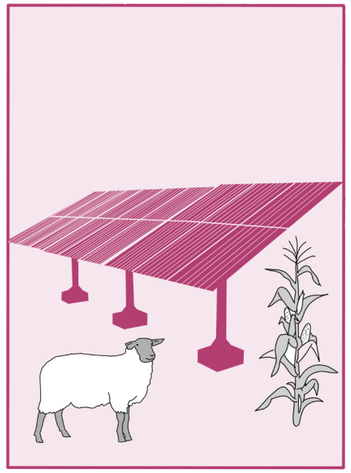
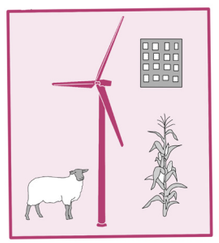


Fig: 19- Graphic representing Size of Chemelot compared to Amsterdam, (Source: Elektricteitshoefte Chemelot,

Chemelot Site Area
8 Sq.km



Solar Energy
~12 Sq.km



Wind Energy
~3 Sq.km

Hydrogen Energy
~ 2.3 Sq.km

Fig: 20- Graphic representing Size of Chemelot compared to Amsterdam

EXISTING LOCAL ENERGY PRODUCTION IN CHEMELOT

Chemelot in Limburg incorporates energy production through its Swentibold Energy facility, which uses co-generation to efficiently generate both electricity and heat. This facility plays a central role in meeting the energy demands of the site. In addition to traditional energy sources, Chemelot has also started integrating renewable energy. A small solar farm has been installed on the site, contributing to its efforts to diversify energy production and reduce its carbon footprint. While these initiatives are steps toward sustainability, the site continues to face challenges related to its environmental impact, particularly pollution.

SPATIAL IMPACT OF CHEMELOT'S HIGH ENERGY DEMAND IN FUTURE

The squares illustrate the space required for each renewable energy source to meet the current energy demand of Chemelot, relative to the map. Solar energy, in particular, would require almost the entire region. This amount of space is unfeasible. Consequently, if solar energy is chosen, it cannot operate independently and would need to be supplemented by an external energy source. However, solar panels can be installed on rooftops and integrated with agricultural activities, potentially mitigating the land use concerns.

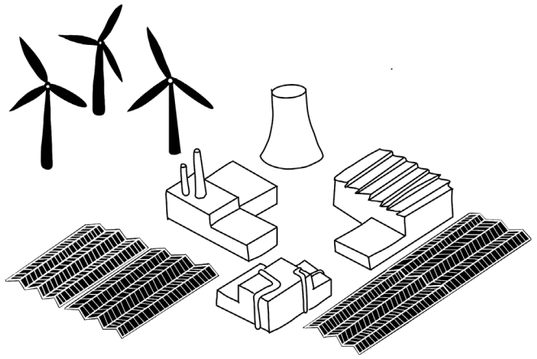
The second renewable energy source is wind energy, which also demands significant space. Fortunately, since wind turbines require a buffer zone between each other, this space could be utilised for buildings and agricultural purposes. However, since windfarms are more in sight, this can lead to a higher feeling of NIMBYism (Not In My Back Yard).

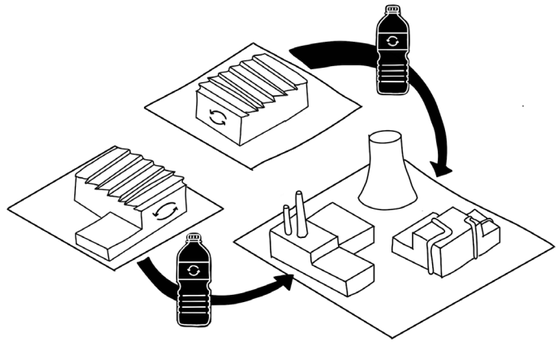
The final renewable energy source is hydrogen (H2), which necessitates space for electrolysis plants. Despite its potential, hydrogen is highly explosive, making large-scale storage risky. It is therefore advisable to produce hydrogen only when necessary, rather than storing it in substantial quantities.

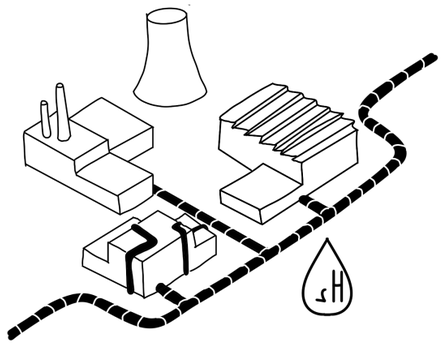
In more general terms, it is clear that the energy requirements for Chemelot will continue to grow. While the aim should be to generate as much energy as possible locally, achieving 100% local energy production is unlikely to be feasible. As such, external energy sources may need to be integrated, though it is important to note that local energy production remains more secure and efficient, due to energy congestion when a source is further away (transmission losses due to distance) (Müller, 2024).

** See Appendix section Spatial Aspect of Renewable Energy for Sizing References.*

CHEMELOT'S PLAN FOR ENERGY TRANSITION







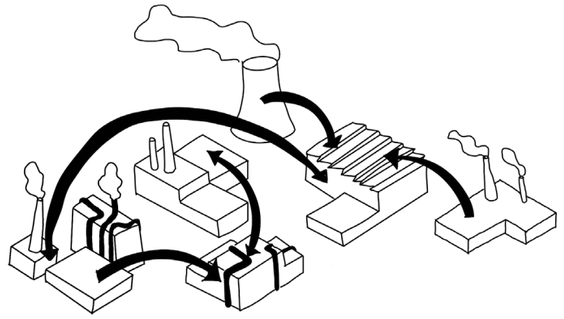


Fig: 21- Local Energy Production (Source: Reduced energy yield due to rapid shading of solar panels by wind turbines, n.d.)

LOCAL ENERGY PRODUCTION

Chemelot is investing in local renewable energy sources to reduce dependence on fossil fuels. A key project involves the production of biogas from manure, which will be used directly in industrial processes on site. This helps lower CO2 emissions and supports a transition toward circular energy systems. The project also uses residual heat from existing factories, making the system more efficient (Chemelot, 2024a).

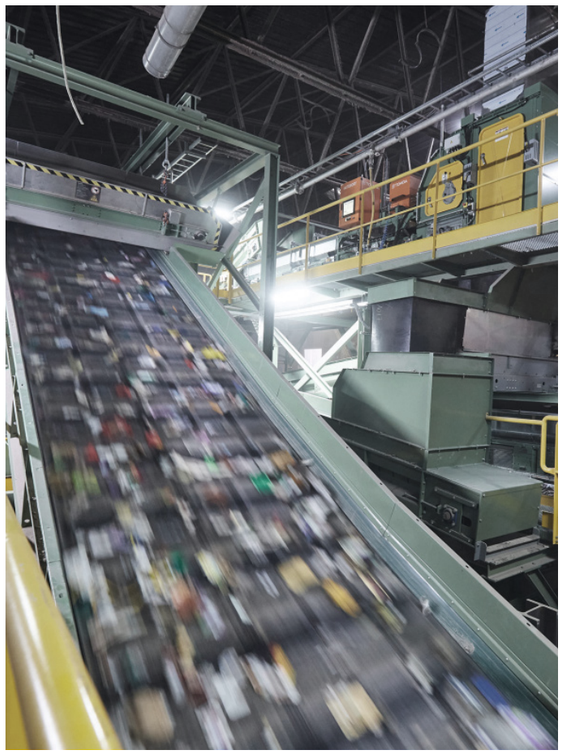


Fig: 22- Recycling Industry (Source: Agrivoltaics: Combining solar panels and agriculture into a win-win result, n.d.)

NEW MATERIALS: RECYCLING INDUSTRY

To reduce waste and support the circular economy, Chemelot is developing new technologies that make it possible to recycle difficult to process plastics and other materials. These efforts aim to create new raw materials for the chemical industry and reduce reliance on virgin fossil resources (Chemelot, 2023a).

Fig: 23- Hydrogen Network (Source:Hydrogen Network: H2 core network approved | ONTRAS Gastransport GmbH, n.d.)

HYDROGEN NETWORK

Chemelot is preparing to be part of the national hydrogen network, which is expected to play a major role in the future of energy in the Netherlands. Together with partners, they are planning to connect the site to the national hydrogen infrastructure and also develop internal hydrogen distribution systems. This will help make production processes more sustainable in the long term (Chemelot, 2024b).

Fig: 24- Internal Recycling (Source: Waste360 Staff, 2024)

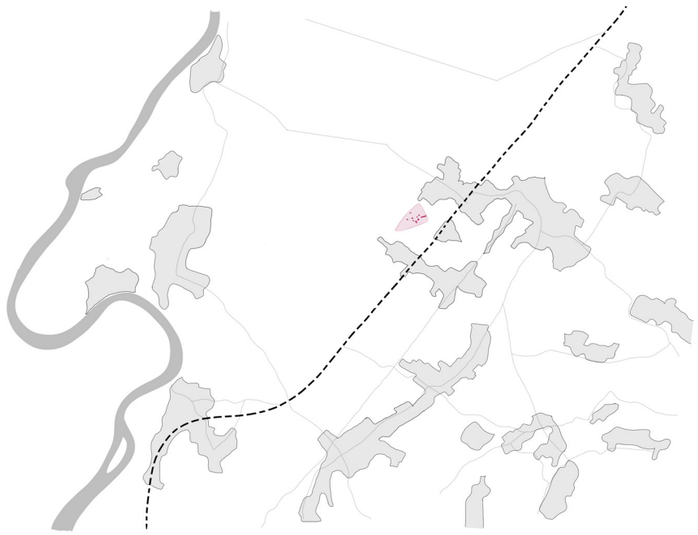
INTERNAL RECYCLING

Many companies at Chemelot share energy, utilities, and by-products in a closed-loop system. This means that waste from one factory can become a resource for another. Such internal recycling helps reduce environmental impact and improves the overall efficiency of the industrial site (Chemelot, 2023b).

CHEMELOT THROUGH HISTORY: Rising Conflict with Residents

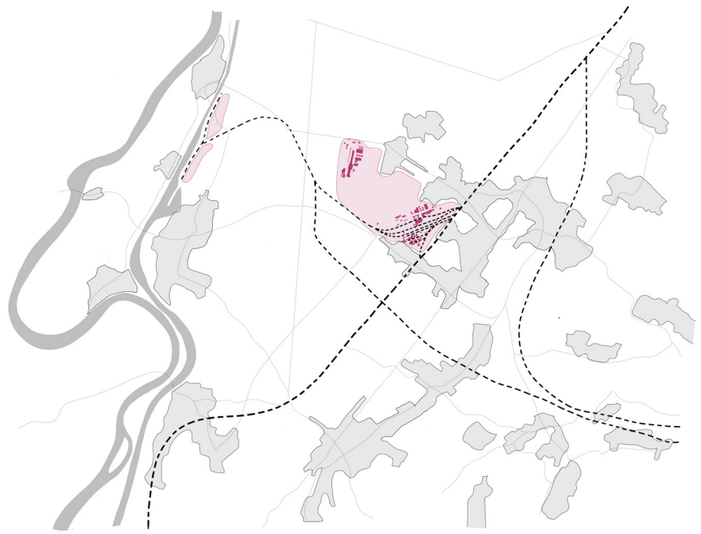
1900-1920- Beginning

The area was predominantly agricultural, with small villages. There was a single train connection running from north to south and the Maas river.



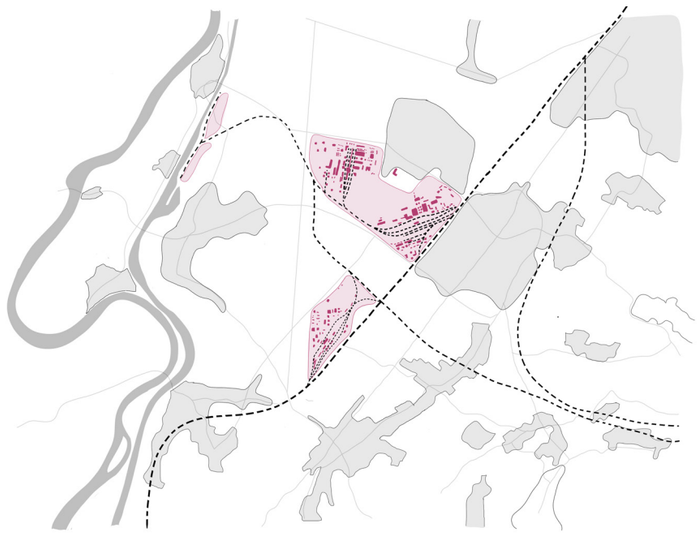
1920-1940- Opening of a mine

The mine in Geleen was opened, playing a significant role in the Netherlands' economy. A coke factory was also established, and as a result of the production process, the production of nitrogenous fertilisers began (Homburg, 2019)



1940-1960- Plastic Production begins

The area was bombed during the war, which caused significant damage to the factory and halted production. The focus then shifted to the production of resources for resins, synthetic fibres, and plastics. Over two hundred researchers began working at the site, and a new laboratory for the state mines was constructed (Homburg, 2019)



1960-1980- Shift to fine chemicals

By this time, more than a thousand researchers were employed at the site. The mine closed down, and the focus moved from bulk chemicals to finer chemicals (Homburg, 2019). Connectivity also improved with the construction of the A2 and A76 motorways.

1980-2000-Growth of Chemelot

New laboratories and factories were developed to produce materials such as Dyneema and Aspartame, both of which are engineering plastics. DSM sold several factories to other companies, with only a small part remaining under DSM's ownership (Homburg, 2019). It can be seen that the community and the industry are coming quickly closer together, which raises friction.

2000-present- Chemelot now

Half of the petrochemical activities were transferred to SABIC, and a new master plan for the Brightlands Campus created an innovation centre for the industry. Today, Chemelot represents 20% of the chemical sector, with 6,000 employees on the industrial park, 2,000 on the campus, and 750 students. However, Chemelot is also one of the largest polluters, contributing to health issues in the surrounding areas (CBS, 2019).

Fig: 25- All drawings on Region Sittard Geleen from 1900-2000, Based on (Source: Topotijdreis, n.d.)

CONSEQUENCES OF LIVING NEXT TO CHEMELOT

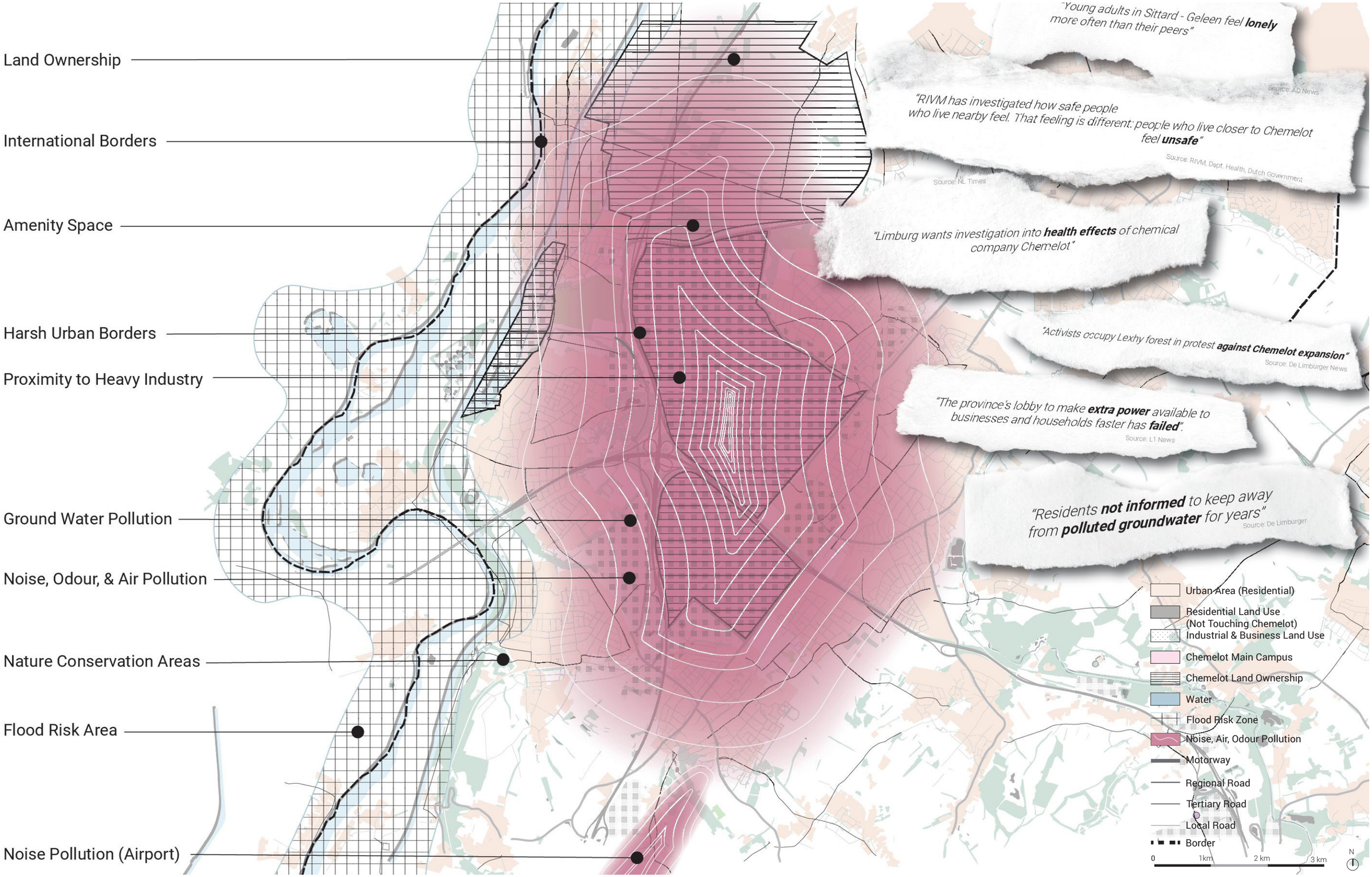


Fig: 26- Map depicting Environmental impact of Chemelot on nearby communities, (Source: Information and GIS data: Geofabrik n.d, Openstreetmap, n.d, IBIS Bedrijventerreinen, 2022, PDOK n.d., Environmental Health Atlas n.d.)

COMMUNITY WORRIES

DO I WANT TO KEEP LIVING HERE?

With environmental health continuously declining around Chemelot and me being an older person, I am increasingly concerned about my well-being.

DO WE WANT TO GROW OLD HERE?

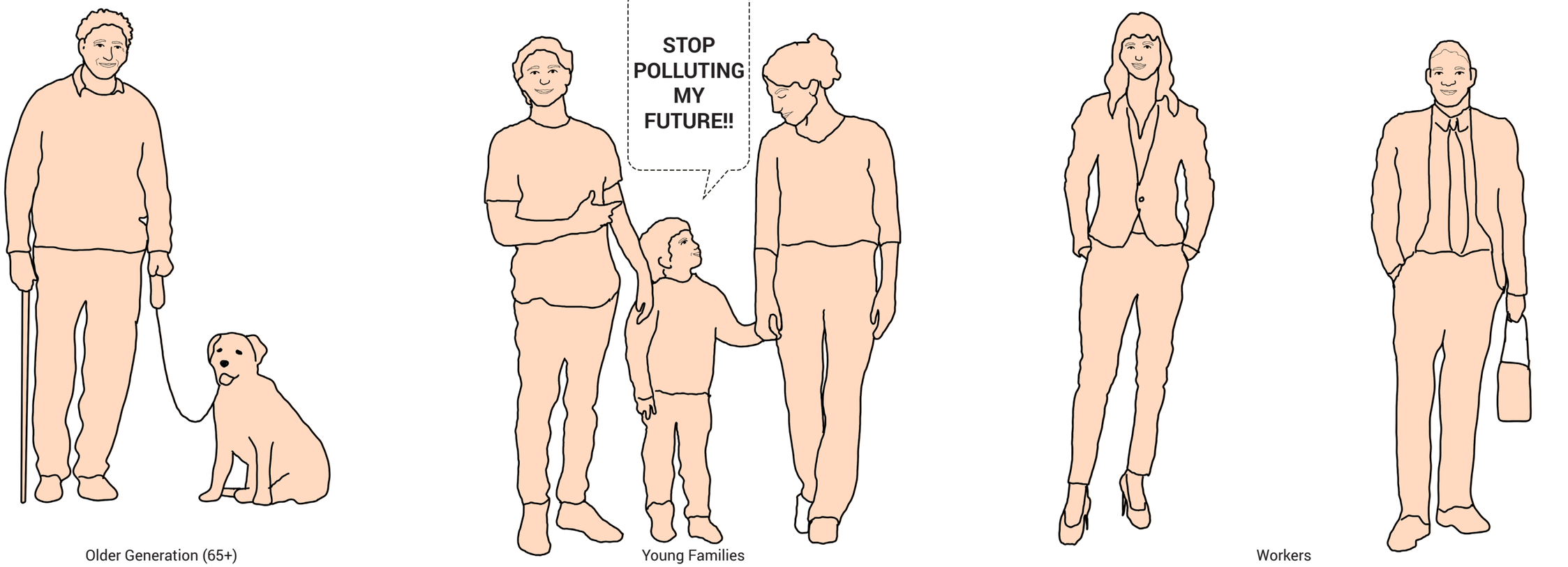
The towns around Chemelot lack sufficient schools and amenities for our children to thrive. Shouldn't we move somewhere that offers a better future?

CAN I HAVE A GOOD LIFE HERE?

I can have a good job here, but does that truly equal a good life? With environmental conditions worsening, limited healthcare and essential amenities, I wonder if job alone is enough.

CAN I BUILD A FAMILY HERE?

Where will my kids play? Where will they study? Will they have good health? A stable job might keep me here, but is that enough?



Older Generation (65+)

Young Families

Workers

Current Residents

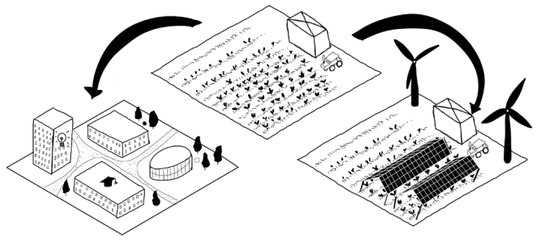
Future Residents

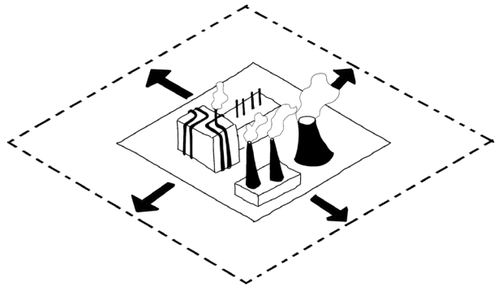
COMMUNITY THEME

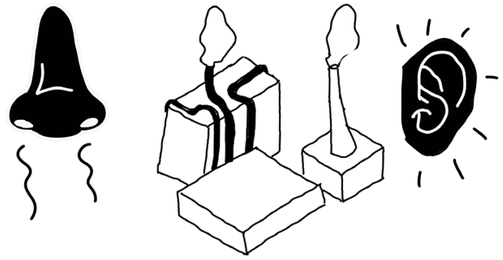
All current residents impacted by Chemelot, and all future residents who envision their lives here—
How will they cope with its effects today and in the years to come?

Fig: 27- Community Persona's voicing their worries about living next to Chemelot

IMPACT OF CHEMELOT AND ITS ENERGY TRANSITION ON LOCAL RESIDENTS







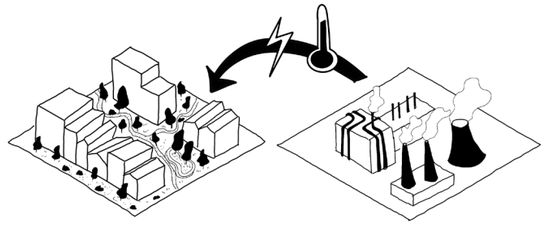


Fig: 29- Industrial expansion spatial impact reference (Source: McCuaig. A, 2020)

POSSIBLE INDUSTRY EXPANSION

To facilitate its transformation into a climate neutral industrial cluster, Chemelot may expand its operations. This includes attracting new sustainable businesses and upgrading existing facilities. While such expansion can bring economic benefits, it may raise concerns among residents about environmental impacts and spatial pressures in surrounding areas (NL Times, 2023).

Fig: 30- Land use conflict leading to land-use competition (Source: Glen McLeod Legal, 2021)

LAND USE CHANGES

The expansion of Chemelot in the context of the energy transition is expected to bring about significant land use changes. This includes the development of new facilities such as solar parks, hydrogen infrastructure, and sustainable production units. These shifts require updated zoning plans and close coordination with municipalities to balance industrial needs with residential and ecological spaces (Witteveen & Bos, 2023).

Fig: 31- Higher pollution levels for nearby residents.(Source: Southern Environmental Law Center, n.d.)

HIGHER ENVIRONMENTAL NUISANCE

Despite ambitions for sustainability, the transition may increase short-term environmental nuisance, such as construction-related noise, traffic, or emissions from transitional energy sources. Local communities have voiced health concerns, prompting calls for additional monitoring and transparency in emissions data (NL Times, 2023). In the longer term the local residents will benifit with the energy transition from lower noise, air, and emissions nusisances.

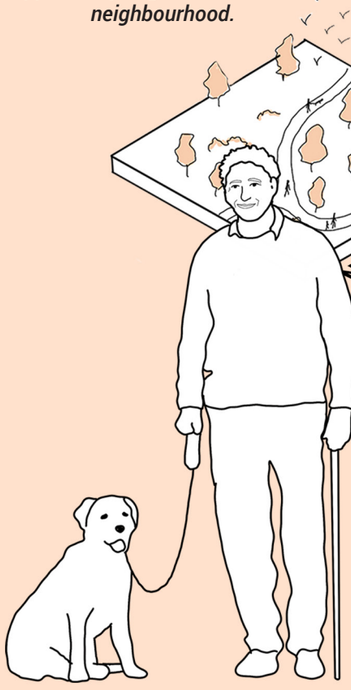
Fig: 32- Replacing cooling towers by transferring residual heat for community use. (Source: Shah.J, 2021)

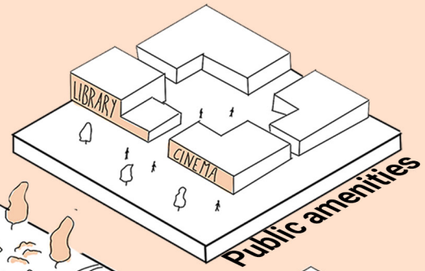
RESIDUAL HEAT GAINS

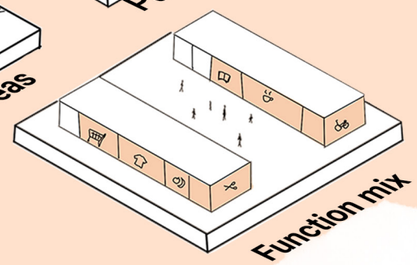
A major benefit of Chemelot's evolving energy system is the potential for utilising residual heat. Waste heat from the industrial processes can be recovered and used to supply heating for nearby neighborhoods, improving energy efficiency and reducing household carbon dioxide emissions (Province of Limburg, 2022).

COMMUNITY MANIFESTO

We want a more diverse range of housing options to better meet the needs of our community. This includes providing more accessible homes for older generations, allowing them to live comfortably as they age. At the same time, we want to ensure there is more space available for families, giving them the opportunity to grow and thrive in our neighbourhood.





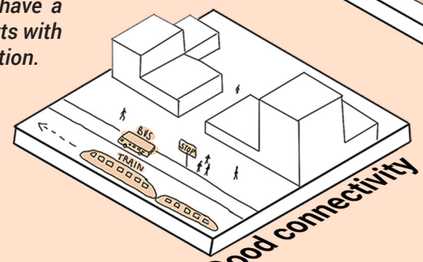


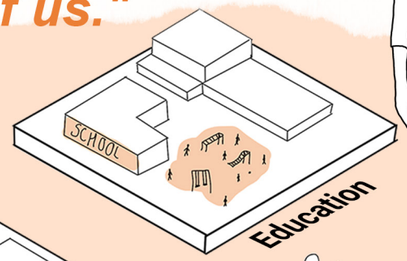
We also believe that equal access to resources is crucial for everyone. This includes not only green spaces and amenities but also essential services like healthcare. Ensuring that all members of our community have access to these resources is vital for creating a fair and thriving environment for everyone.

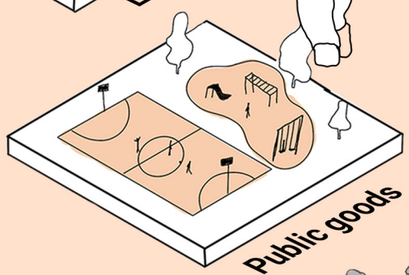
"Our community's well-being starts with resouces for all"

"Investing in education today means a brighter tomorrow for all of us."

We want more investment in education, as there are not enough schools in our area. We want our children to have a bright future, and that starts with access to quality education.

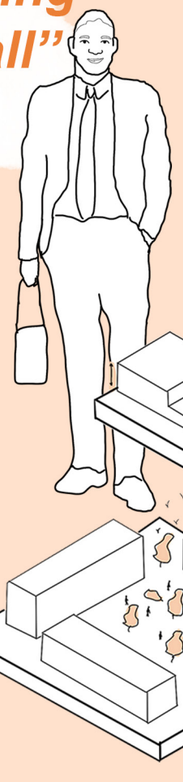


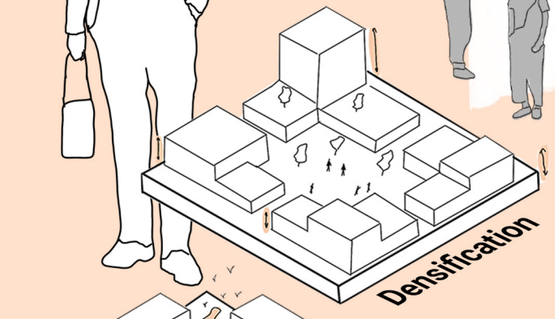


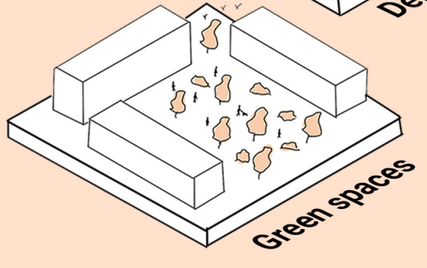


"Transparency is non-negotiable."

We feel there is a lack of transparency from Chemelot towards us. We want to be informed about what's happening, and when something is going on, we expect to be notified immediately. We also want them to stop polluting our future and take responsibility for their impact on our community.







"We need transportation that connects people, not divides them."

Due to the expansive presence of Chemelot, we feel isolated in this area. The public transport options are insufficient, making it necessary for us to rely on cars to get around. We want better connectivity and a reduction in the constant feeling of being surrounded by industry, to improve our quality of life and create a more accessible environment.

Fig: 30- Graphic representing Community Manifesto showing Needs and Desires of the Community

2 Methodology

“What’s the problem, what are we asking, and how do we find the answers?”

PROBLEM STATEMENT AND RESEARCH QUESTION

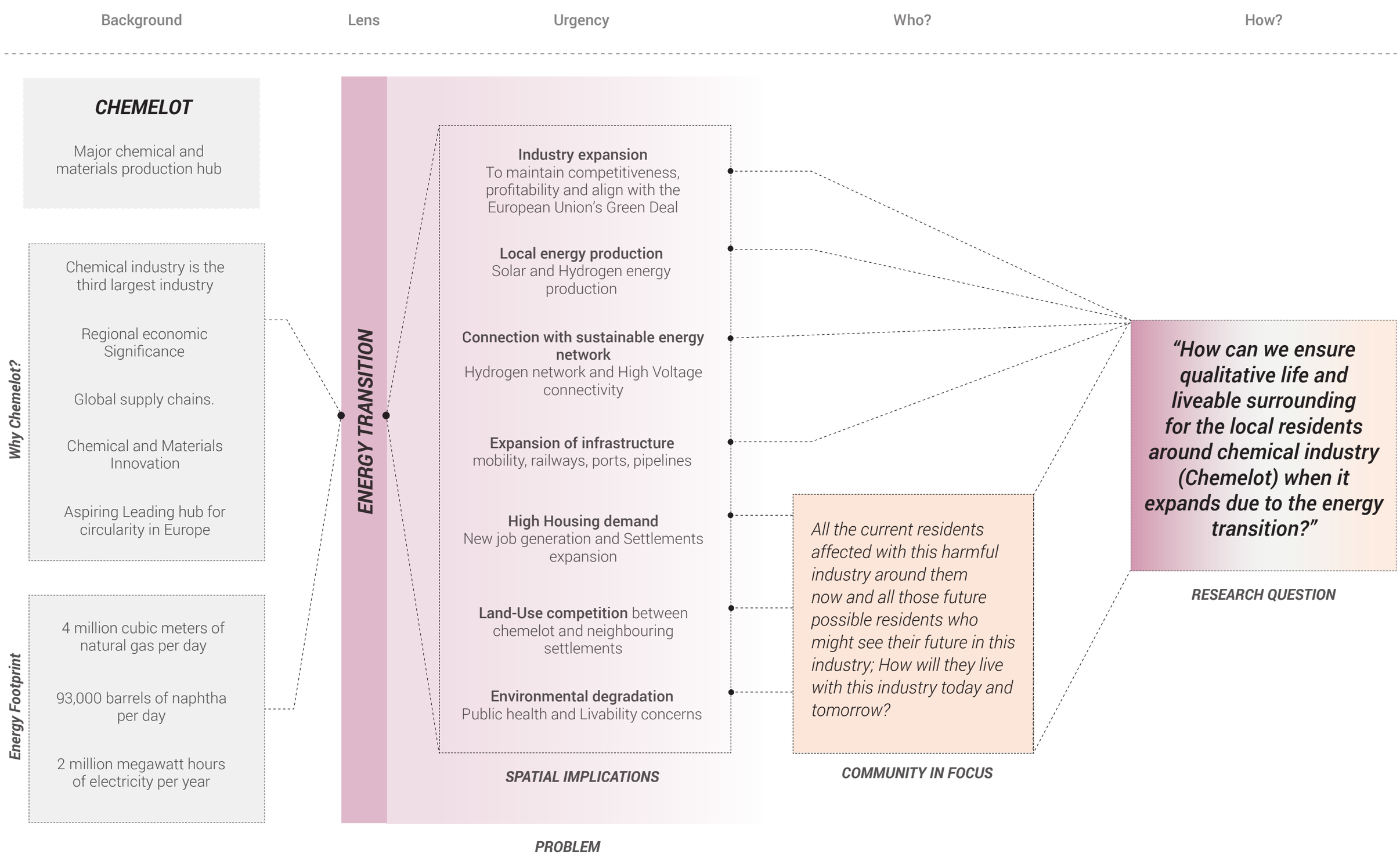


Fig: 31- Diagram representing the Process of Problem statement and reaserch questions

PROBLEM STATEMENT AND RESEARCH QUESTION

Fig: 32- Aerial view of Chemelot Campus showing its close interactionb with Residential areas and Local Energy production (Source: Chemelot, 2025)

PROBLEM STATEMENT HIGHLIGHTING THE URGENCY

The ongoing energy transition is reshaping industrial landscapes worldwide, with significant implications for energy-intensive sectors. Chemelot, a major chemical industrial hub in the Southern Netherlands (Limburg Province), plays a critical role in regional economic activity and global supply chains.

To maintain competitiveness, profitability and align with the European Union's Green Deal and climate targets, Chemelot may pursue an expansion strategy that enhances its connectivity with key infrastructure networks and strengthens its integration with upstream and downstream industries driving energy transition. This strategic move aims to solidify its role as a leading hub for circularity in Europe. As industries shift toward sustainable energy sources and circular production models, Chemelot faces both opportunities for expansion and innovation and challenges related to environmental and social sustainability.

Chemelot's transformation has far-reaching implications for industrial sustainability, economic development, and social equity. Its strategic location at the crossroads of the Netherlands, Germany, and Belgium makes it a unique case for regional and international industrial development, providing valuable insights into cross-border collaboration, infrastructure planning, and policy coordination in the energy transition.

However, the consequences of this transformation extend beyond industrial development. Expansion efforts could significantly impact local communities, public health, land use, and ecosystems, raising concerns about sustainable and inclusive development. These tensions underscore the need for a comprehensive examination of Chemelot's role in the energy transition, balancing industrial progress with environmental and social responsibilities.
If Chemelot's expansion is strategically planned with a strong focus on community well-being and the energy transition, it could serve as a model for sustainable industrial hubs, showcasing how economic growth, social equity, and environmental responsibility can coexist.

MAIN RESEARCH QUESTION

We formulated this research question to address the growing tension between industrial development and the well-being of local communities. As Chemelot expands due to the energy transition, it becomes crucial to understand how this growth impacts the daily lives, health, and environment of the surrounding residents. By focusing on the concept of a "qualitative life" and a "liveable surrounding," the question allows us to explore social, environmental, and spatial dimensions in a balanced way.

"How can we ensure qualitative life and liveable surrounding for the local residents around chemical industry (Chemelot) when it expands due to the energy transition?"

SUB-RESEARCH QUESTIONS

These sub-questions break down the main research question into focused, actionable topics. They help us explore specific spatial, environmental, social, and economic factors that influence liveability around Chemelot during its energy transition and expansion.

SUB-RESEARCH QUESTION	SIGNIFICANCE	METHODS
What areas around Chemelot are best suited for hosting renewable energy facilities (e.g., solar farms, wind energy, hydrogen plants) while minimizing negative community and environmental impacts?	Identifies optimal locations for renewable energy projects that balance industrial needs with environmental and community wellbeing.	Flow Diagrams (Energy Generation and Distribution), Potential Land Assessment through analysis
What residential areas and non-industrial zones are most at risk of land-use conflicts/competitions due to spatial requirements for Chemelot's expansion and New energy landscapes?	Highlights areas at risk of spatial pressure, helping to prevent future conflicts between industrial growth and residential or public use.	Land-Use Mapping, Conflict analysis, Urban policies, Study of Expansion plans
What key public spaces, amenities, and infrastructure should be preserved, enhanced, or developed to ensure a high-quality living environment for local residents around Chemelot?	Ensures the preservation and enhancement of everyday spaces that contribute to the well-being and social cohesion of residents.	Literature and media reports, livability index reports and charts
What key energy infrastructure developments (e.g., renewable energy grids, hydrogen networks, CO2 storage) are planned/required for Chemelot's energy transition, and what portions of nearby areas (community areas) are affected by them?	Examines how essential infrastructure developments will affect local communities, guiding more inclusive and less disruptive planning.	Review of Energy Transition Plans, Impact Analysis, Energy Infrastructure Maps, Flow Diagrams
What are the pollution hotspots (air, water, noise) near Chemelot, and how the transition to renewable energy impact their distribution?	Assesses current environmental stress zones and how the shift to renewables might redistribute or reduce them.	Pollution Hotspot and assessment mapping, Literature review
What are the economic implications of Chemelot's expansion for local residents (e.g., job opportunities, housing affordability)?	Explores how Chemelot's growth can benefit or challenge the local population economically, ensuring more equitable outcomes.	Employment Data Review, Housing Market Analysis, Demographic studies

CONCEPTUAL FRAMEWORK

Our conceptual framework is designed to explore and explain the complex relationships between three main actors: the community, the environment, and the industry. It aims to address the challenge of achieving symbiosis—a state where all three actors can coexist and benefit from one another in a sustainable and collaborative manner. Our framework builds on existing bodies of knowledge while offering a structured and simplified way to understand theoretical relationships. Rather than relying solely on abstract theories, we grounded our approach in the dynamics between real-world actors and the practical concepts that connect them.

The framework is organized into several key components:

Main Actors – community, environment, and industry are positioned as core participants, each with unique roles and influences.

Factors Affecting Each Actor – we identify social, ecological, economic, and institutional factors that shape the behavior and priorities of each actor.

Aligning Concepts – concepts such as sustainability, mutual benefit, cooperation, and resilience serve as bridges between the actors, highlighting potential areas of alignment.

Tools and Strategies – we incorporate practical mechanisms (e.g., policy instruments, collaborative platforms, green technologies) that help translate these concepts into action.

Aim: Symbiosis – the ultimate goal is a synergistic relationship where the interests of the community, the health of the environment, and the needs of industry are all met in a balanced and integrated way.

This framework helps clarify how we view the interdependence of various systems and actors, while guiding the design of our research and interpretation of data. It also allows us to position our work within existing academic discussions, while highlighting the innovative value of our actor-centered, tool-driven approach to achieving systemic change.

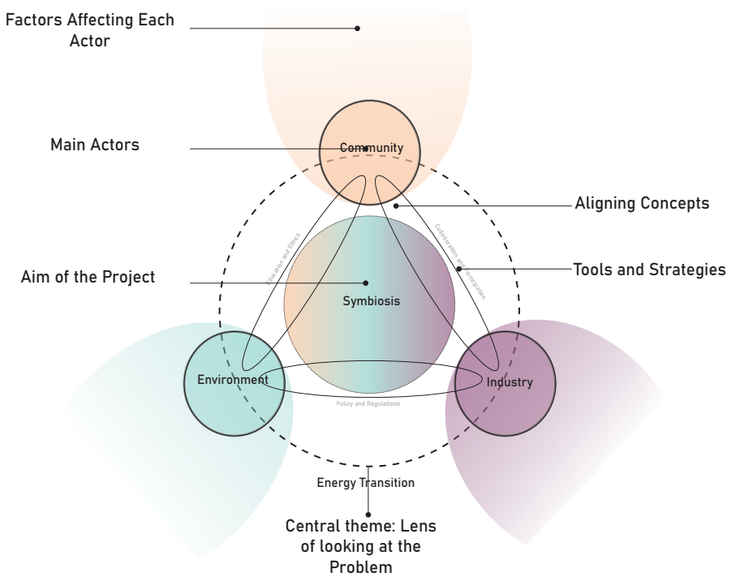


Fig: 33- Graphic explaining components of Conceptual Framework

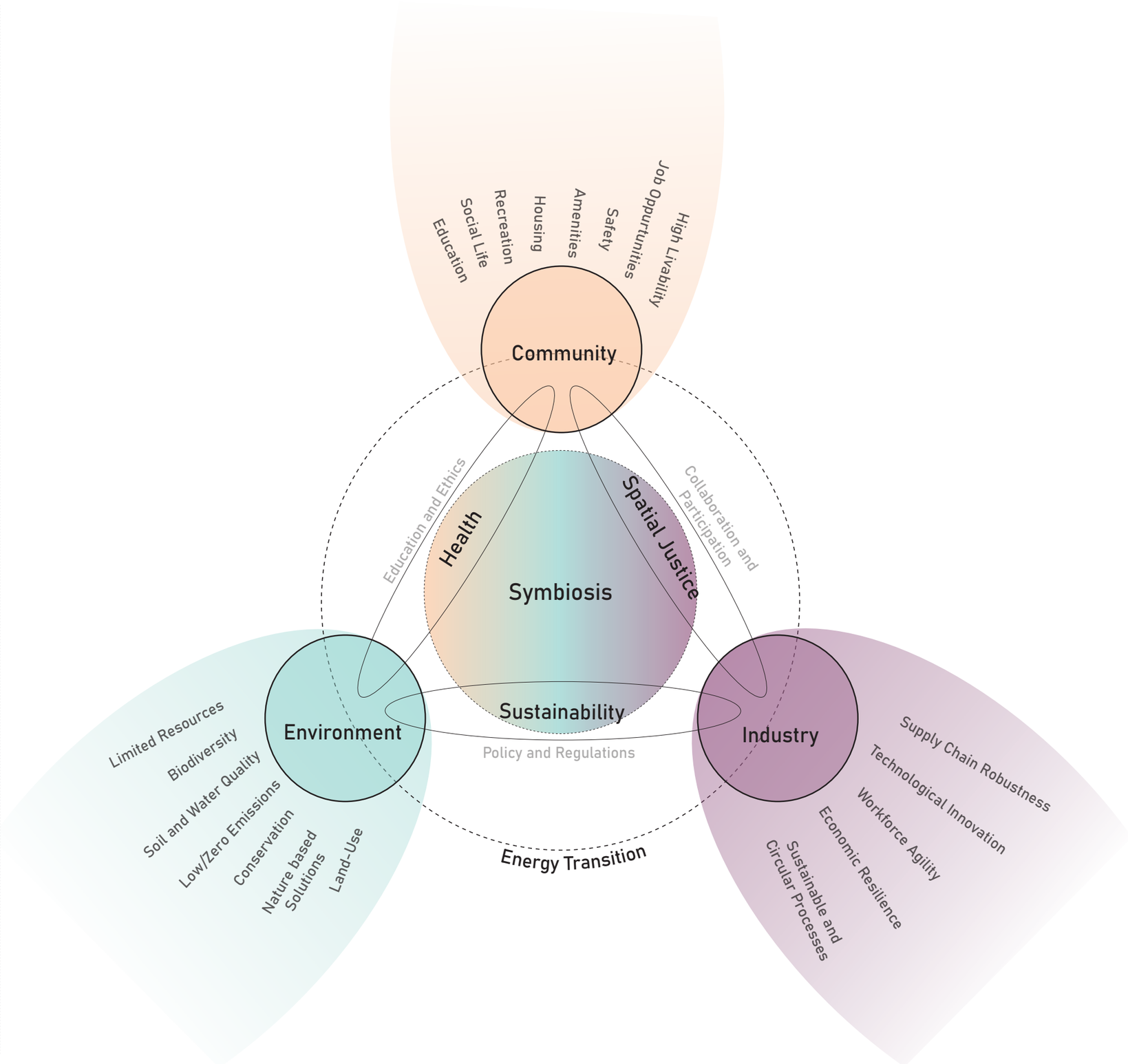


Fig: 34- Graphic showing the Conceptual Framework

THEORETICAL FRAMEWORK

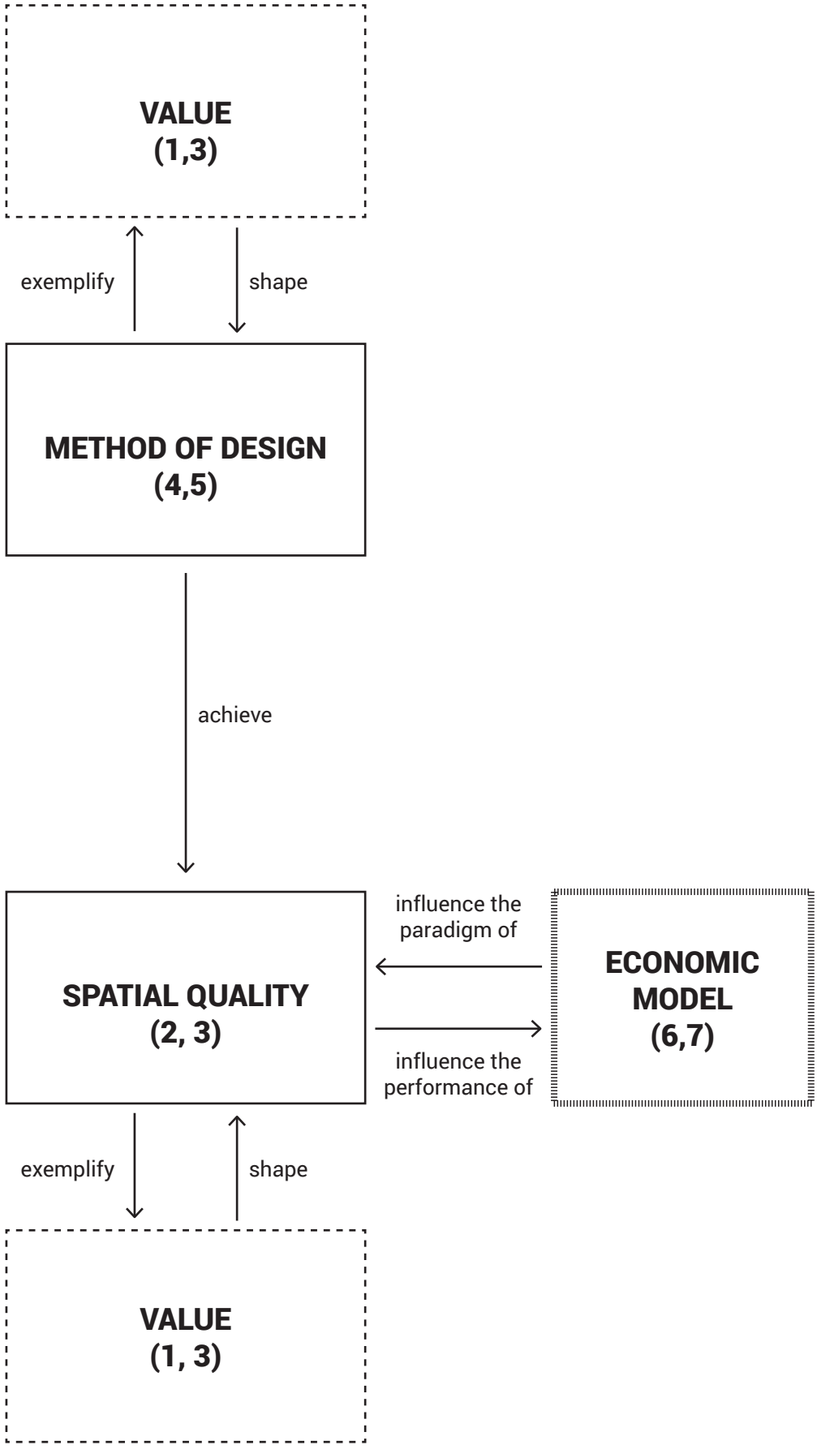


Fig: 35- Graphic explaining relation of various theories studied

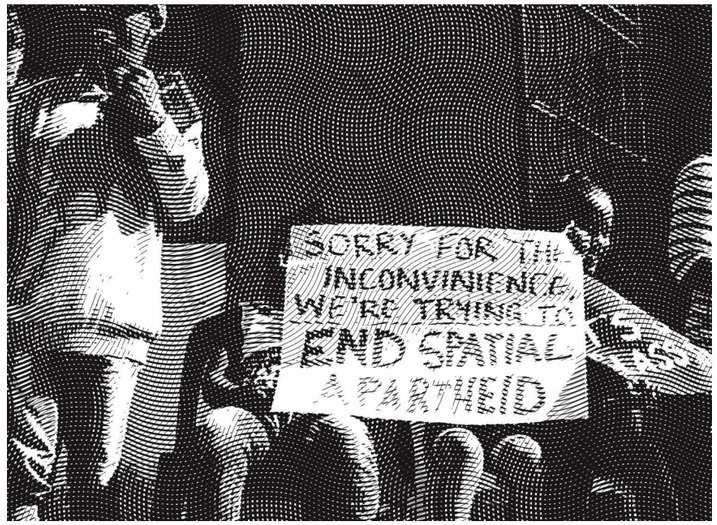


Fig: 36- Spatial justice demand by public (Source: Soja, 2010)

1. SPATIAL JUSTICE

Spatial justice can be understood through two key dimensions: distributive justice and procedural justice (Soja, 2010).

Distributive justice focuses on the fair allocation of resources and benefits within a given space. In urban contexts, this involves addressing inequalities in access to essential services like housing, education, and healthcare. As Dillard, Dujon, and King (2009) and Larsen (2012) argue, increasing inequality and a lack of access to public goods directly threaten the sustainability of cities, especially when sustainability is considered in its social, economic, and environmental aspects. Ensuring that resources are distributed equitably allows all residents, regardless of their background or location, to have an equal opportunity to thrive and participate in urban life. This dimension of justice is crucial for mitigating the spatial fragmentation and growing social divides that are often seen in urban environments.

Procedural justice, on the other hand, concerns the fairness and inclusivity of decision-making processes. It emphasizes the need for transparency and active citizen participation in shaping the policies that govern their lives. According to Campbell (2013), fair processes are essential for ensuring that the voices of all stakeholders are heard, particularly those who are marginalized or have historically been excluded from decision-making. In urban planning, this means engaging communities in the planning, design, and management of spaces that directly impact their lives. A transparent, inclusive decision-making process strengthens the legitimacy of policies and fosters a sense of ownership among residents, which in turn leads to more equitable and sustainable outcomes. Both dimensions, distributive and procedural, are essential for creating urban spaces that are just, equitable, and sustainable.

Fig: 37- Categories of environmental zoning (Source: De Zwarte Hond, 2022)

2. ENVIRONMENTAL ZONING

Located in the South of Limburg, Chemelot is not only the second-largest industrial site in the Netherlands, with a turnover exceeding €10 billion, but also a critical driver of national exports, contributing around 17% of the Netherlands' total chemical export value. As a historically fossil-dependent cluster, Chemelot is uniquely positioned to become a key site for the chemical energy transition to sustain into the future in this region.

With over 100 startups and research and development centres operating on-site or within the regional innovation ecosystem, Chemelot is already begun the transition with circular chemistry, green hydrogen technologies, and carbon capture solutions. Its strategic location along key trans-European corridors and its proximity to Germany and Belgium make it a cross-border innovation hub, well-connected to major ports such as Rotterdam and Antwerp.

This combination of economic scale, research capacity, and logistical connectivity makes Chemelot not just a pillar of regional industry but also a key site for transforming the chemical sector into a climate-neutral industry by 2050 and beyond.

THEORETICAL FRAMEWORK

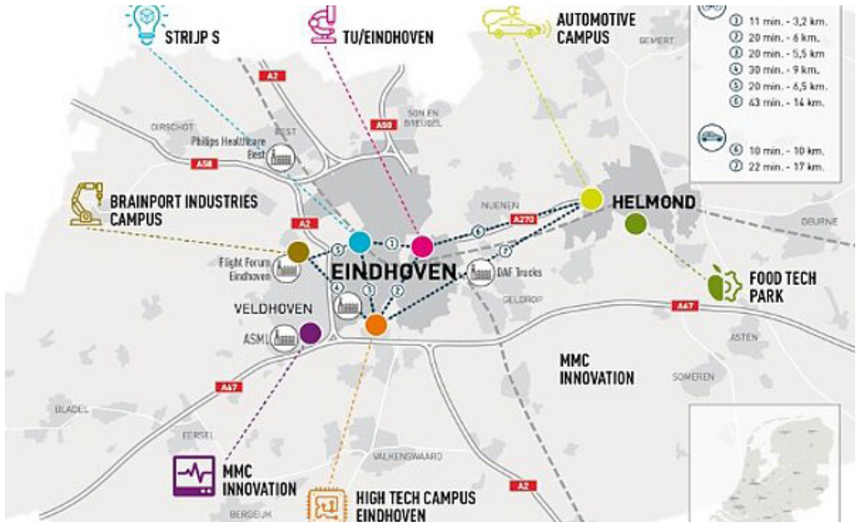


Fig: 38- Bird eye view of Eindhoven Brainport (Source: Brainport Eindhoven, n.d.)

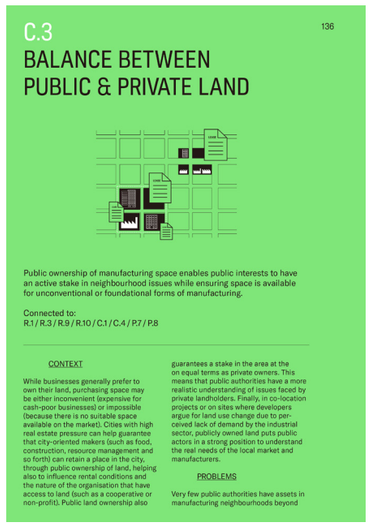


Fig: 39- Example of action (Source: Hill A.V. et. Al, 2018)

3. SYMBIOSIS

Urban-industrial symbiosis (UIS) refers to the collaborative relationship between urban areas and industries, with the aim of optimising resources, reducing environmental impacts, and generating mutually beneficial outcomes.

Social Symbiosis: Social symbiosis focuses on the collaboration between industries and urban communities to improve the quality of life for local residents. Initiatives like Brainport in Eindhoven, where shared social value is created through participation and social projects (Brainport Eindhoven Home of Pioneers, n.d.).

Economic Symbiosis: Economic symbiosis involves the efficient use of resources and reduction of waste through collaboration between industries, which leads to economic growth. By facilitating circular economies, UIS allows industries to exchange resources, such as waste materials or energy, helping industrial zones and stimulating local economies (D'Amico et al., 2007). Life Cycle Assessments (LCA) are often used in this context to evaluate the environmental and economic impacts of these exchanges. This helps industries and cities optimise their economic outcomes while addressing environmental concerns (Kerdlap et al., 2019). This form of symbiosis has proven especially valuable in rapidly urbanising areas, with land scarcity and waste management issues, contributing to more sustainable urban development (Raabe et al., 2017; Fang et al., 2017).

Energy Symbiosis: Energy symbiosis aims to improve energy efficiency through collaborative energy exchanges between industries. This can involve shared use of energy resources, such as heat recovery systems or waste energy, helping to optimise energy consumption and reduce greenhouse gas emissions. It plays a critical role in the creation of low-carbon cities and addressing issues like energy poverty (Bass, 2011; Illsley et al., 2007). Case studies from regions such as Finland, Italy, and Japan show the reduction of energy consumption and lowering emissions, demonstrating the impact of industrial collaboration on energy sustainability (Sokka et al., 2011; Marchi et al., 2017; Kanematsu et al., 2017).

Case Study: The Brainport project in Eindhoven serves as an example of how community and industry can be brought closer together, creating a mutually beneficial relationship, a symbiosis. In the project industries and the surrounding community collaborate for mutual growth and development. The region, which is a high-tech hub, consists of many global companies such as Philips, ASML, and NXP, which contribute to both economic prosperity and social well-being (Brainport Eindhoven, n.d.).
The symbiosis is driven by various social initiatives that improve the quality of life in the region. One key area is education and innovation, where companies collaborate with institutions like Eindhoven University of Technology to provide internships, research opportunities, and employment. This strengthens the region's knowledge base and develops essential skills within the local workforce (Brainport Eindhoven Home of Pioneers, n.d.). Sustainability is also a central focus, with projects like Eindhoven Green City promoting energy-efficient urban development. These initiatives create environmentally friendly neighbourhoods while following the climate goals (Brainport Eindhoven Home of Pioneers, n.d.).
In terms of inclusive employment, companies work with local institutions to provide opportunities for vulnerable groups, such as those distanced from the labour market (Brainport Eindhoven, n.d.). This contributes to a more inclusive society and a more resilient workforce.
Additionally, businesses invest in healthcare and well-being projects that improve public health and promote healthier living environments. Cultural initiatives further strengthen community ties by bringing together residents from diverse backgrounds (Brainport Eindhoven Home of Pioneers, n.d.).
In conclusion, the Brainport project demonstrates how industry and community can thrive together. By investing in education, sustainability, inclusivity, and well-being, it creates a stronger, more connected, and sustainable region where both the economy and residents benefit.

4. PATTERN LANGUAGE

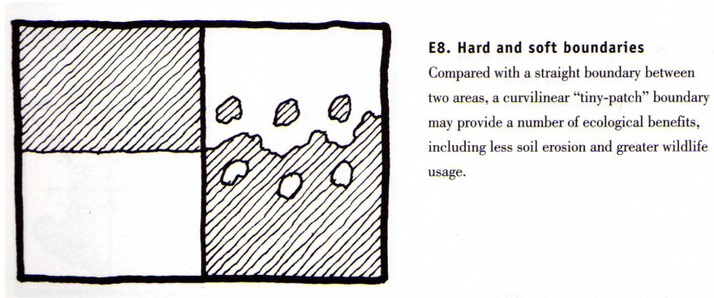
A Pattern Language is a theoretical framework that informs methods for designing built environments through a compendium of spatial "patterns". It identifies spatial problems that recur across cities, towns, buildings, and landscapes, and proposes a process through which these issues may be addressed. These patterns operate at multiple spatial scales, ranging from the regional to the architectural, which are intended to be applied in combination, forming a flexible, scalable, and human-centred design framework. The sequence of patterns is described as a "basemap from which you can make a language" (Alexander et al., 1977, p. xviii).

The patterns also advocate a bottom-up approach to development processes, whereby design is informed by the lived experiences and needs of local communities, rather than imposed through top-down planning or policy, which is also an approach aligned with the aims of this report. The research question—"How can we ensure a qualitative life and liveable surroundings for the local residents around the chemical industry (Chemelot) when it expands due to the energy transition?"—is particularly relevant in applying this theoretical lens to both the process and outcomes of the project, within the constraints of its scope (Alexander et al., 1977).

The Cities of Making (2018) report builds upon these ideas, applying them specifically to the revitalisation of urban manufacturing in European cities. This is of particular relevance to the current study, given its focus on Chemelot and the broader post-industrial context. The publication highlights the importance of productive land uses, environmental (or functional) zoning—an evolution of traditional land use zoning—and spatial adaptability in creating resilient and liveable urban environments, especially in areas undergoing structural transformation (Hill A.V. et al., 2018).

In the context of this project, the relevance of this theory lies in its emphasis on liveability and the qualitative experience of space—key concerns at the heart of our research question. The underlying principles in the theory—context sensitivity, community-oriented design, and adaptability—have guided the strategic approach adopted, which inform the development of key actions later visualised through a series of 'cards' presented in the report (Alexander et al., 1977).

THEORETICAL FRAMEWORK



E8. Hard and soft boundaries
Compared with a straight boundary between two areas, a curvilinear "tiny-patch" boundary may provide a number of ecological benefits, including less soil erosion and greater wildlife usage.

Fig: 40- Types of edges and boundaries (Source: Dramstad, W. E., 1996)

5. TRANSITIONS AND BORDERS

Urban borders should not be understood as fixed divisions, but rather as dynamic and permeable spaces shaped by patterns of movement, spatial configuration, and socio-ecological flows. Legeby (2005) highlights the role of urban spatial structure in shaping patterns of co-presence, which can either reinforce or alleviate social segregation. Similarly, Forman (2006) and Dramstad, Olson, and Forman (1996), drawing on landscape ecology, conceptualise the urban environment as a land mosaic—comprising corridors, patches, and boundaries—that influences both ecological continuity and human accessibility. These theoretical perspectives are particularly pertinent to areas undergoing spatial transformation, such as Chemelot amid the energy transition. They inform an approach that views borders not as barriers but as opportunities for integration—facilitating transitions between industrial, residential, and ecological zones in ways that enhance both liveability and resilience.

Fig: 41- Circular economy model (Source: European Parliament, n.d.)

6. CIRCULAR ECONONY

To achieve CO2 neutrality by 2050, the European Parliament aims to transition from a linear economic model to a circular economic model. The linear economic model follows a "produce, use, dispose" pattern, whereas the circular economic model advocates for a closed-loop system, ensuring that the lifecycle of a product continues. When a product reaches the end of its life, it can be recycled and repurposed, thereby generating added value from the material (Circular Economy: Definition, Importance and Benefits, European Parliament, n.d.). By keeping products within the material loop, resource security is strengthened, reducing reliance on new raw materials. An example of this can be seen in the raw materials used for batteries, which often require the importation of new resources, leading to less stable prices (Circular Economy: Definition, Importance and Benefits, European Parliament, n.d.). Recycling offers not only economic benefits but also environmental advantages. Fewer new resources are extracted, which leads to a reduction in greenhouse gas emissions. Additionally, reducing packaging wherever possible further mitigates the environmental impact (Circular Economy: Definition, Importance and Benefits, European Parliament, n.d.). Furthermore, a circular economy can stimulate economic growth and create more employment opportunities. It is estimated that the transition could generate "700,000 jobs in the EU alone by 2030" (Circular Economy: Definition, Importance and Benefits, section Creating jobs and saving consumers money, n.d.).

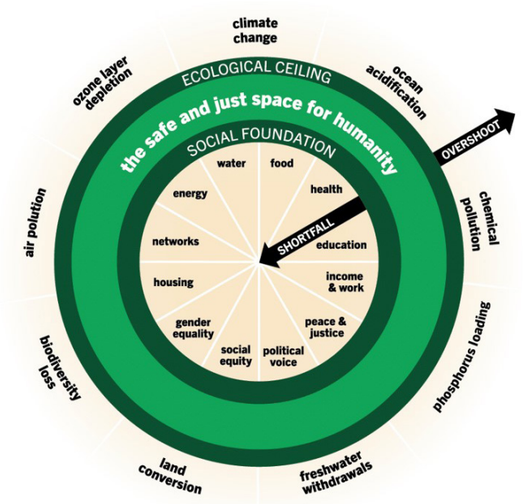


Fig: 42- Donut economy model (Source: University of Leeds, 2024)

7. SUSTAINABILITY DONUT

The 'Doughnut Economy' is an economic model that balances the needs of society with the health of the planet. Developed by economist Kate Raworth, it visualises the economy as a doughnut, with the inner ring representing the social foundation, basic human needs such as clean water, education, and healthcar, and the outer ring representing the ecological ceiling, which defines the planet's environmental limits, including resource use and waste absorption capacity (Raworth, 2017). The ideal economy operates in the space between these two rings, the doughnut, ensuring that human well-being is achieved without surpassing environmental boundaries. Unlike traditional models that focus on continuous economic growth, the Doughnut Economy promotes sustainable development that respects both social and ecological limits (Raworth, 2017). Its goal is to create an economy that meets everyone's needs fairly, while staying within the Earth's capacity to sustain life. This model advocates a shift from prioritising GDP growth to measuring success based on the fulfilment of human needs and environmental sustainability. It calls for rethinking policies, business models, and community practices to reduce environmental harm, optimise resource use, and build systems that provide for everyone's basic needs in a more equitable and sustainable way (Raworth, 2017).

METHODOLOGICAL FRAMEWORK

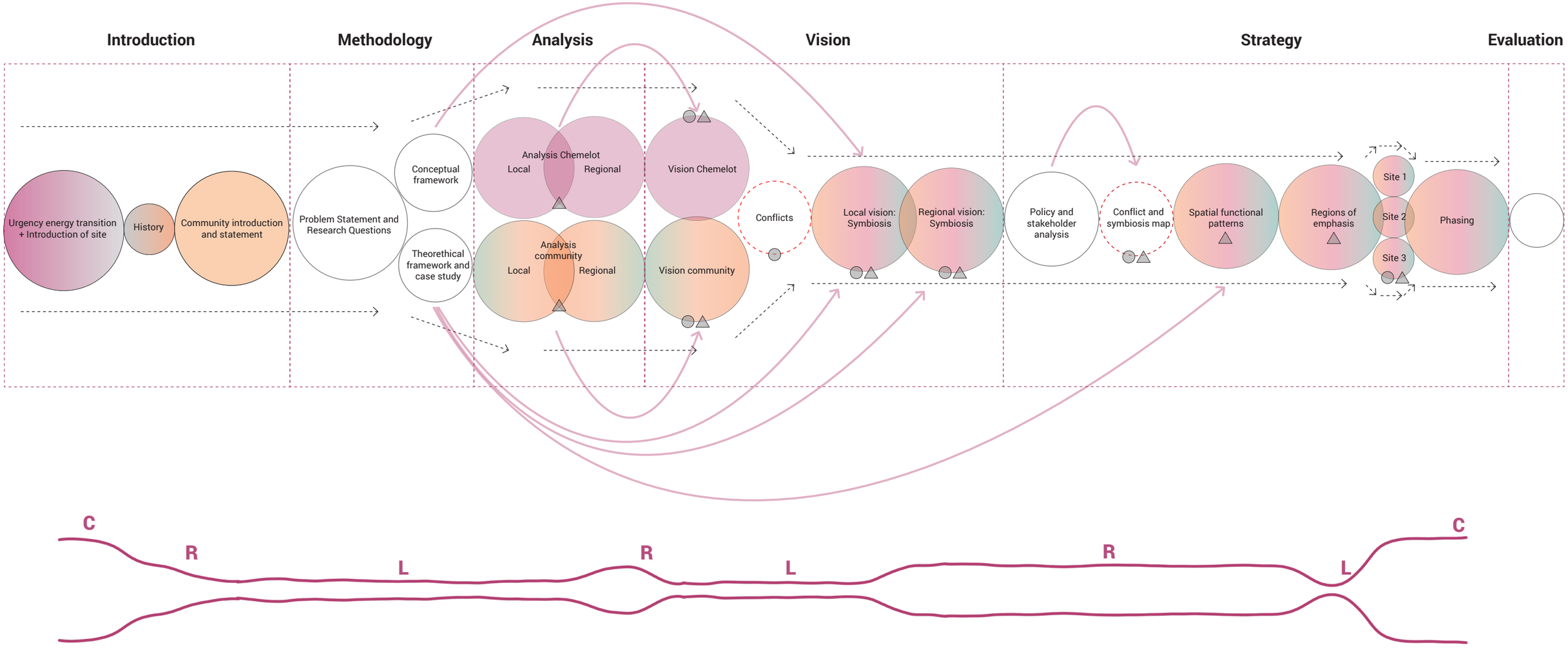
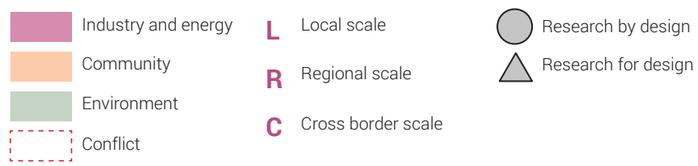


Fig: 43- Graphic depicting the Methodological Framework and Process across 'Scales'

The methodological framework outlines the structure of this report and narrates the design process. It identifies the key stakeholders involved in each phase and illustrates how they were examined independently, each with their own vision. These visions were then brought into dialogue, exposing conflicts, tensions, and synergies, which ultimately informed a unified and symbiotic outcome.

The framework also reflects the role of various tools and methods used throughout the process, including analyses, literature and policy research, and GIS mapping. It clarifies how each part of the narrative evolved through the application of ***Research by Design***—where design is used as a tool for exploration—and ***Research for Design***—which gathers knowledge to inform design decisions. In many cases, these approaches were used in combination.

Additionally, the framework highlights the multiscalar nature of the project. It began at the regional level to establish a broad understanding of the issues, then zoomed into the local scale for site selection and vision development. Insights from the local investigations were ultimately used to shape principles applicable at the broader, cross-border scale.



3 Analysis

“What are the existing conditions — spatially, socially, and structurally?”

HOW DOES IT LOOK TODAY? : SITE VISIT

Industrial Landscape

The huge-scale industrial landscape is very dominant in this area, which can be easily perceived on the train. Our site visit included a short walking tour into the chemelot site, where the odor strongly suggested the possible health concern of living in the vicinity.

Sub-Urban Settlement

The suburban residential settlements around chemelot are quite homogenuous and mostly single family housings. The centers of these settlements have only basic amenities and do not act as active community centers for gathering.

Center with Higher Density

In the center of Stein there are buildings of higher density and mixed-use development with first-floor commercial spaces. There are also some social housings standing around the center, which is not common in this area.

Industrial Port

The port of Stein is quite essential to the material flow of chemelot, which is close to the border of residential area and fenced off from residents.

Fig: 44- Observations from Site Visit

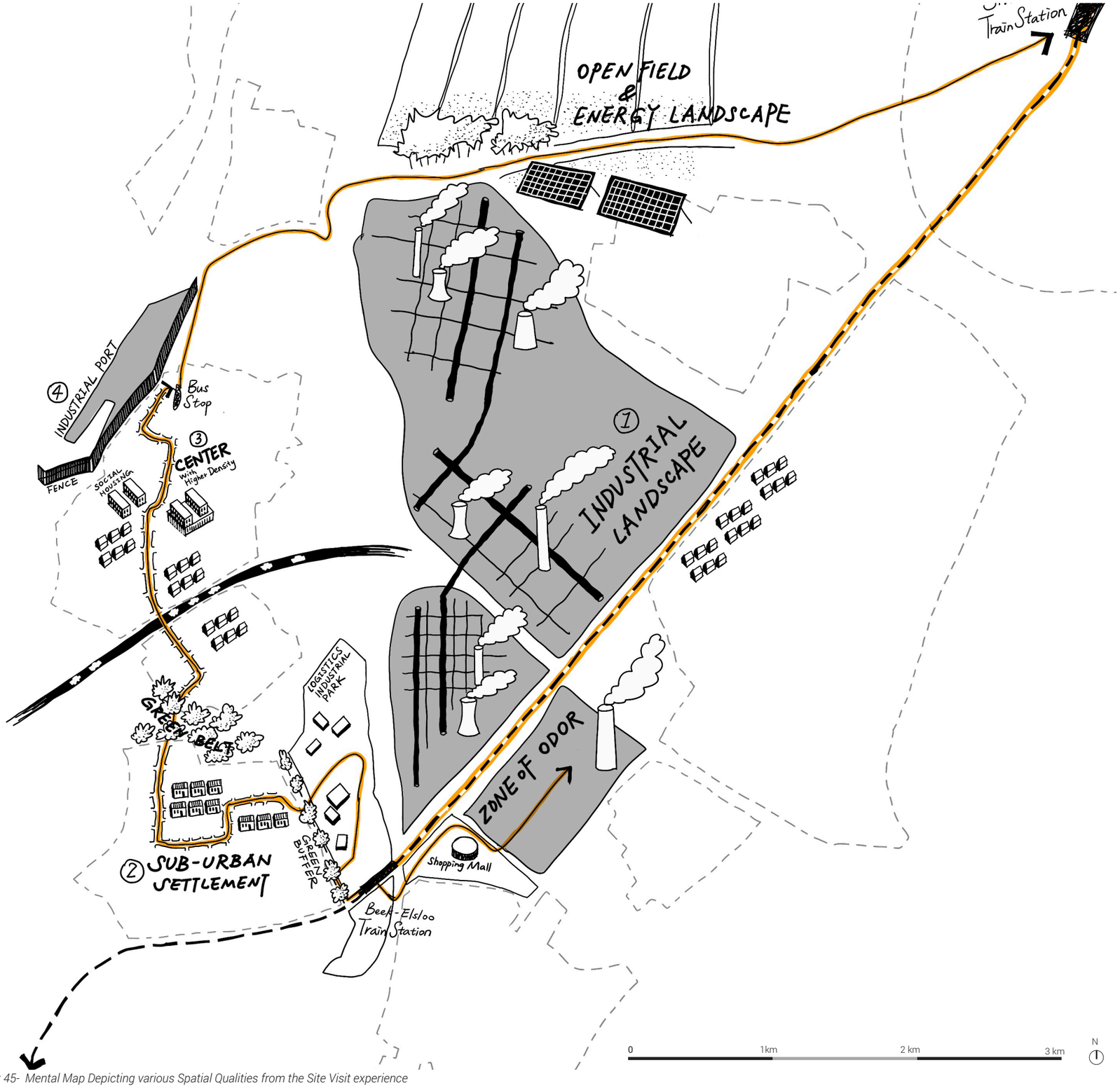


Fig: 45- Mental Map Depicting various Spatial Qualities from the Site Visit experience

SPATIAL TYPOLOGIES: Chemelot Structures

Heavy Industries

The core production areas of chemelot are spred across the campus and interconnected in terms of material and energy. They are also the major source of pollution nuisance and hazard risk.

Light Industry: Research

The Brightland Campus is a major part of Chemelot site, which consists of offices and labs. In the energy transition, it is required that the campus becomes an important engine for research and innovation.

Port and Logistics

The Stein Port on Juliana Kanaal is quite essential for the material flow of Chemelot site, which is connected with the port through a multi-modal corridor. Through the canal, Chemelot is well connected with Rotterdam and Antwerp Port.

Energy Infrastructure

As an energy-intensive industry, chemelot needs to be supported by sufficient energy infrastructure, such as gas pipelines and high-voltage electricity transmission.

Fig: 46- Visual images of the typologies present

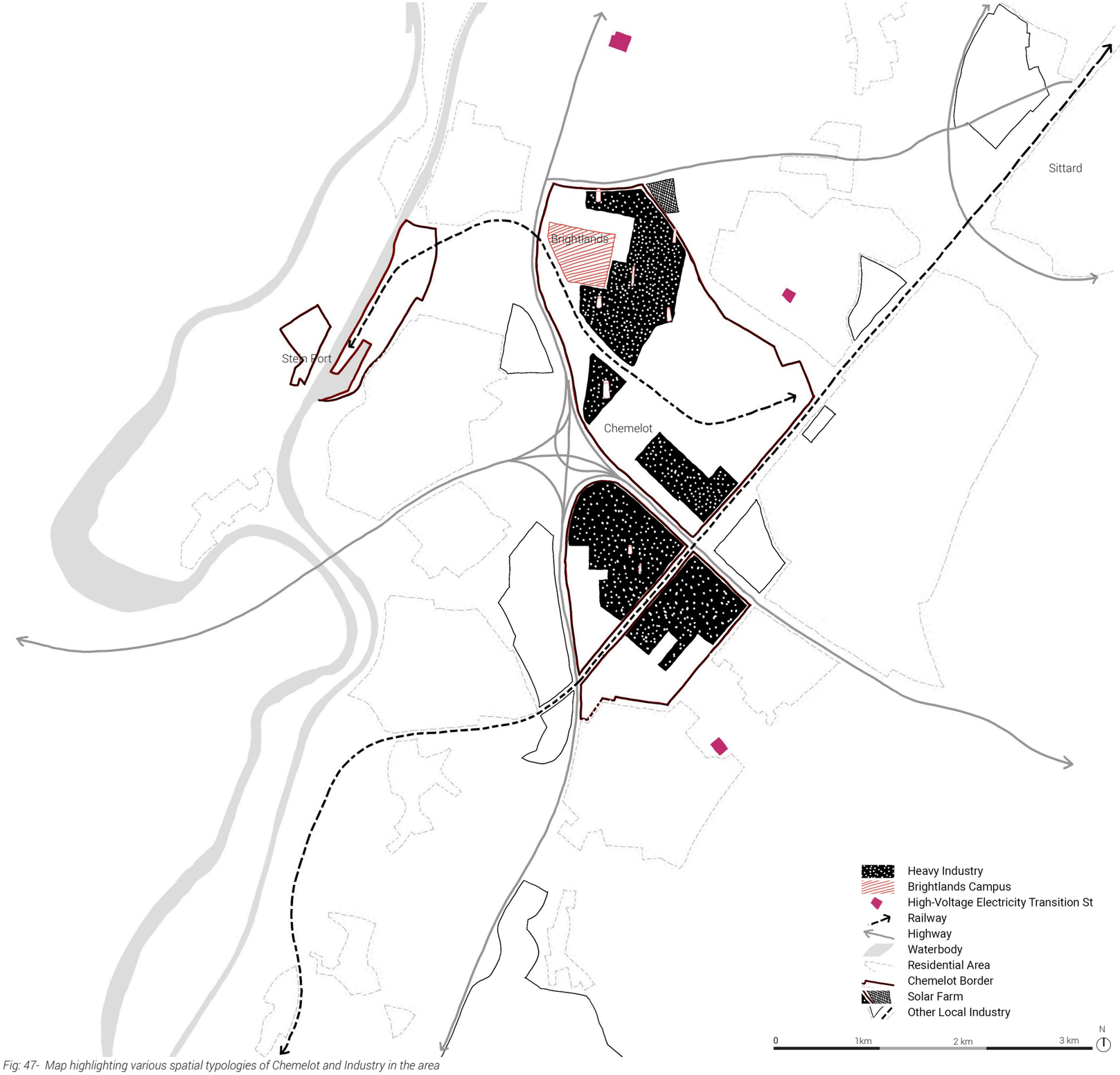


Fig: 47- Map highlighting various spatial typologies of Chemelot and Industry in the area

SPATIAL TYPOLOGIES: Community Structures

Low Density Residential areas

Most of the surrounding urban areas consist of lower-density residential housing in semi-detached form. The nature of this development designates a large proportion of space for private transport and parking. Community centres can be found dispersed within the residential neighbourhoods.

Medium Density Urban Cores

Generally, these areas lack strong centralities, with few amenities and services available in these spaces. The exiting urban cores are typically characterised by commercial uses.

Fragmented Green Structures

Although urban areas form island-like structures around the Chemelot site, the remaining gaps do not create continuous green corridors of high ecological value. These spaces lack the connectivity and ecological significance necessary to contribute meaningfully to a core green infrastructure.

Lack of Slow Mobility

The area is heavily car-dependent, with limited infrastructure for slower modes of mobility both within and between neighborhoods, as well as to the Chemelot Campus. This results in fragmented urban islands forming around the industrial site.

Fig: 48- Visual images of the typologies present

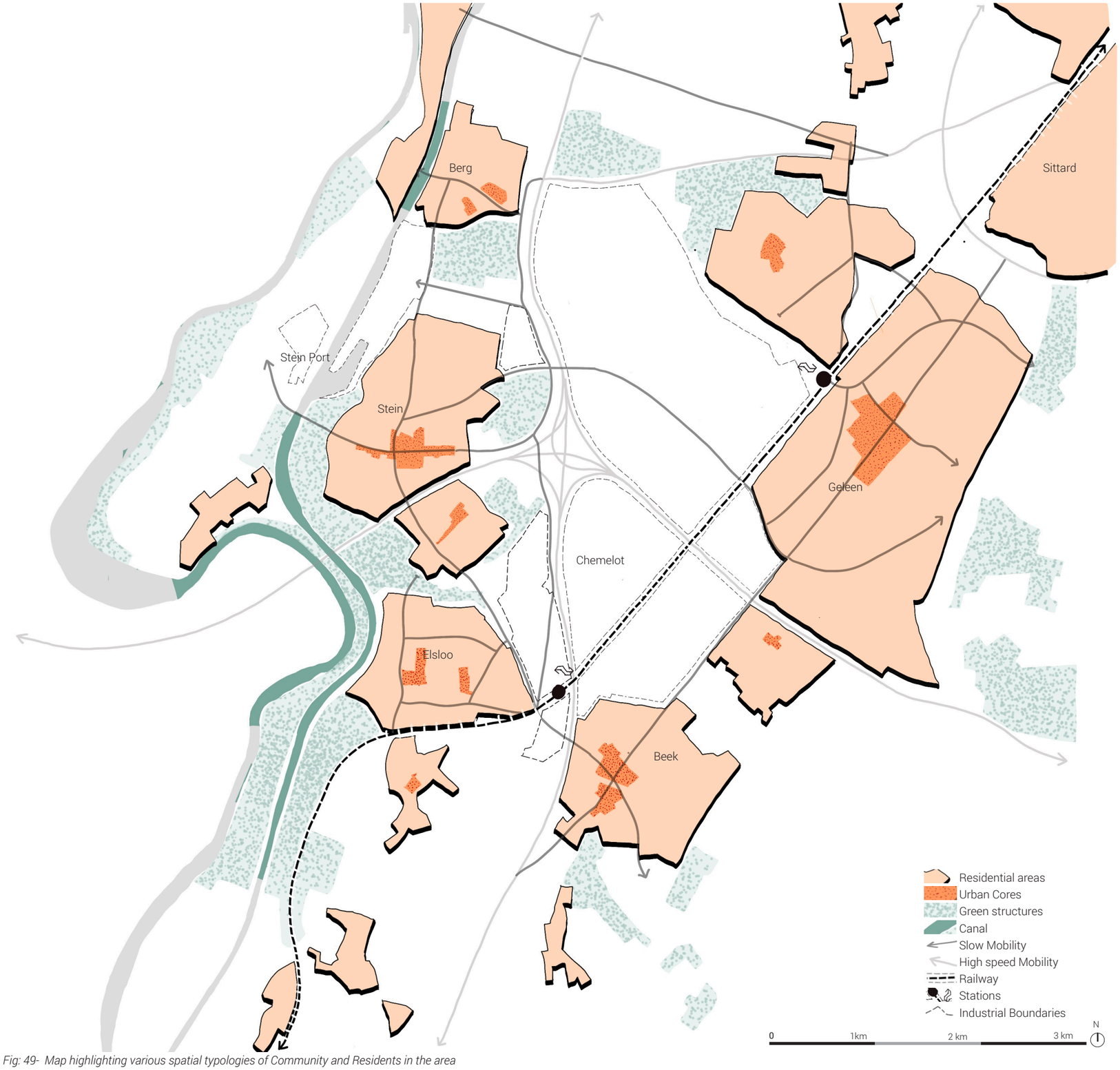
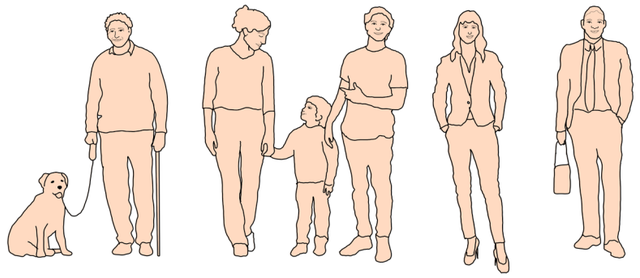
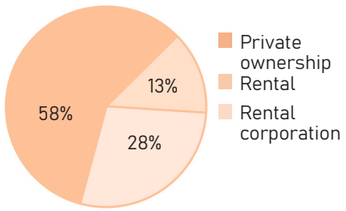


Fig: 49- Map highlighting various spatial typologies of Community and Residents in the area

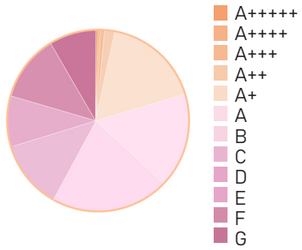
COMMUNITY PORTRAIT



Ownership housing

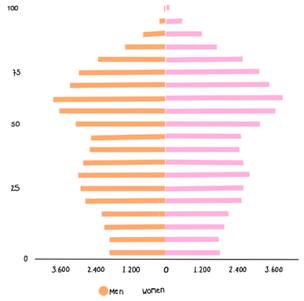


Energy label



Age pyramid

Sittard-Geleen, number of people



Expected growth 2050

-15,5%
Sittard-Geleen

+9,6%
Netherlands

Age inhabitants

Sittard-Geleen vs Netherlands

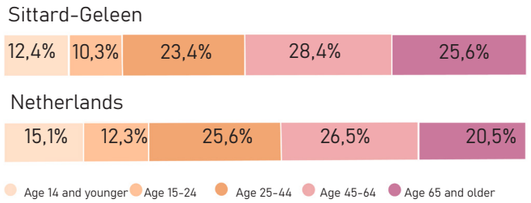


Fig: 50- Diagrams showing demographic data
(Source: Gemeente Sittard-Geleen in Cijfers En Grafieken, 2025)

Livability

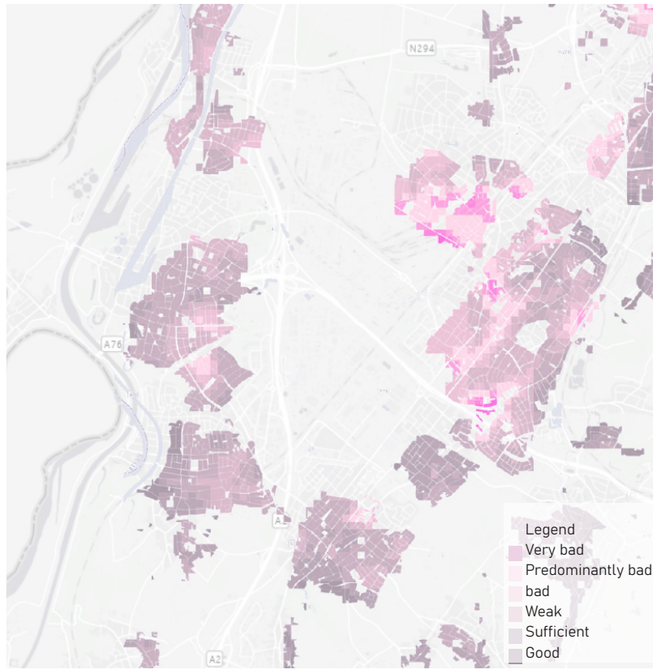


Fig: 51- Map showing livability in the area
(Source: Planbureau voor de Leefomgeving, n.d.)

WOZ-Housing Value

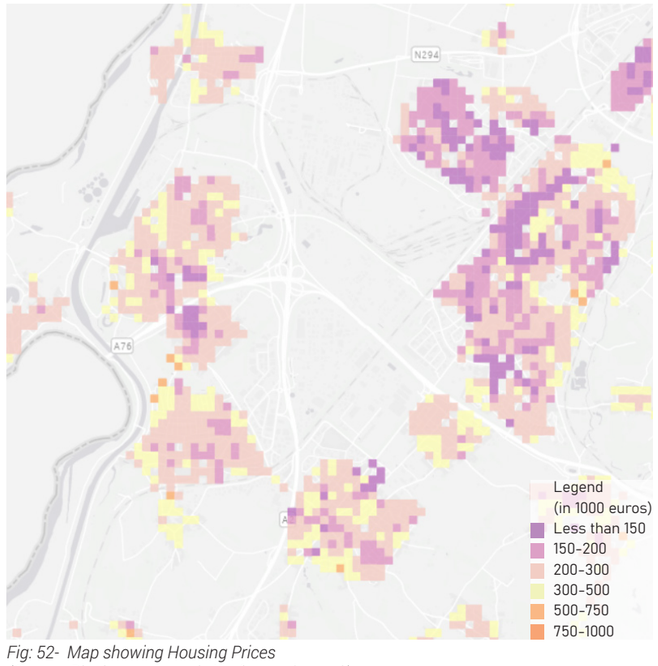


Fig: 52- Map showing Housing Prices
(Source: Planbureau voor de Leefomgeving, n.d.)

Health risk based on noise and pollution

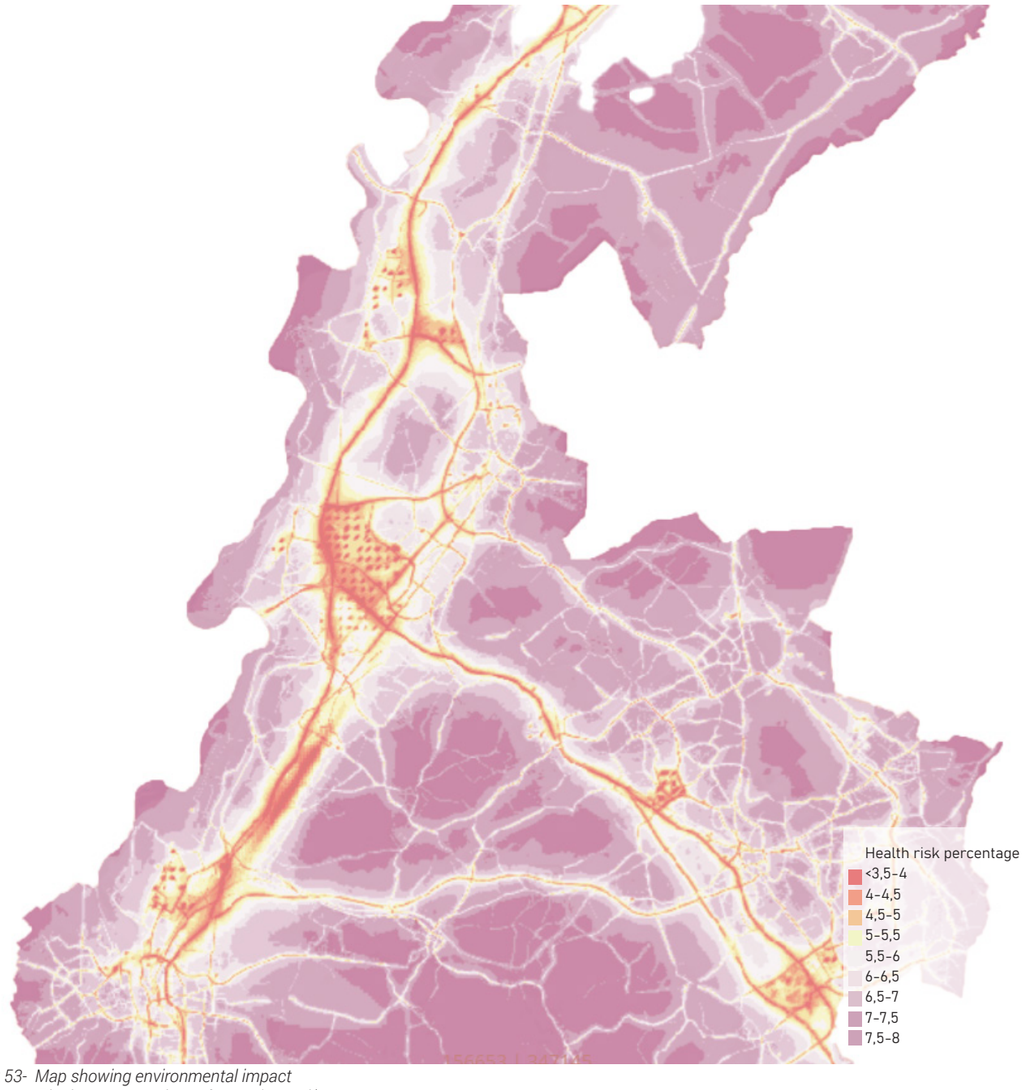


Fig: 53- Map showing environmental impact
(Source: Planbureau voor de Leefomgeving, n.d.)

Conclusion

The community in the Chemelot region of Limburg is experiencing a steady population decline, a trend expected to intensify in the coming years. To ensure long-term vitality, it is crucial to strengthen support systems for the aging population while making the area more attractive to younger generations through improved opportunities, amenities, and quality of life. However, environmental challenges present a significant barrier to this goal. The nearby Chemelot industrial site is a major source of noise and air pollution, contributing to health risks for residents. Research shows that 5–6% of illnesses in the Netherlands can be attributed to such environmental factors (Milieugezondheidsrisico's (MGR) Van Overijssel Tot Eindhoven, n.d.). In addition to health concerns, properties located near Chemelot suffer from reduced market value and diminished livability, making it harder to attract and retain residents. Addressing these environmental and social challenges is essential to reversing the region's decline and building a more sustainable future for Limburg.

SETTLEMENT TYPOLOGY

The residential areas surrounding the Chemelot industrial site are characterized by a lack of strong central hubs and a fragmented mix of housing typologies, predominantly semi-detached homes. These neighborhoods form a ring of village-like “islands” encircling the industrial campus. In several locations, residential zones are in close proximity to the Chemelot site, leading to tensions between the community and industry. This proximity has resulted in harsh physical and social boundaries. Furthermore, Chemelot’s significant land ownership in the region contributes to high-conflict zones and further complicates the relationship between the site and its surrounding communities.

Historical settlements

Historical settlements in the area are characterized by compact, tightly-knit communities with traditional architecture, often centered around central squares or market areas. They have narrow streets and limited amenities, reflecting the more agrarian and industrially focused lifestyles of the past.

Modern Settlements

Modern settlements in the area primarily consist of row houses and residential colonies, featuring contemporary amenities, wider roads, and upgraded infrastructure. These communities also incorporate sustainable energy solutions, such as integrated solar panels.

Fig: 54- Visual images of the typologies present

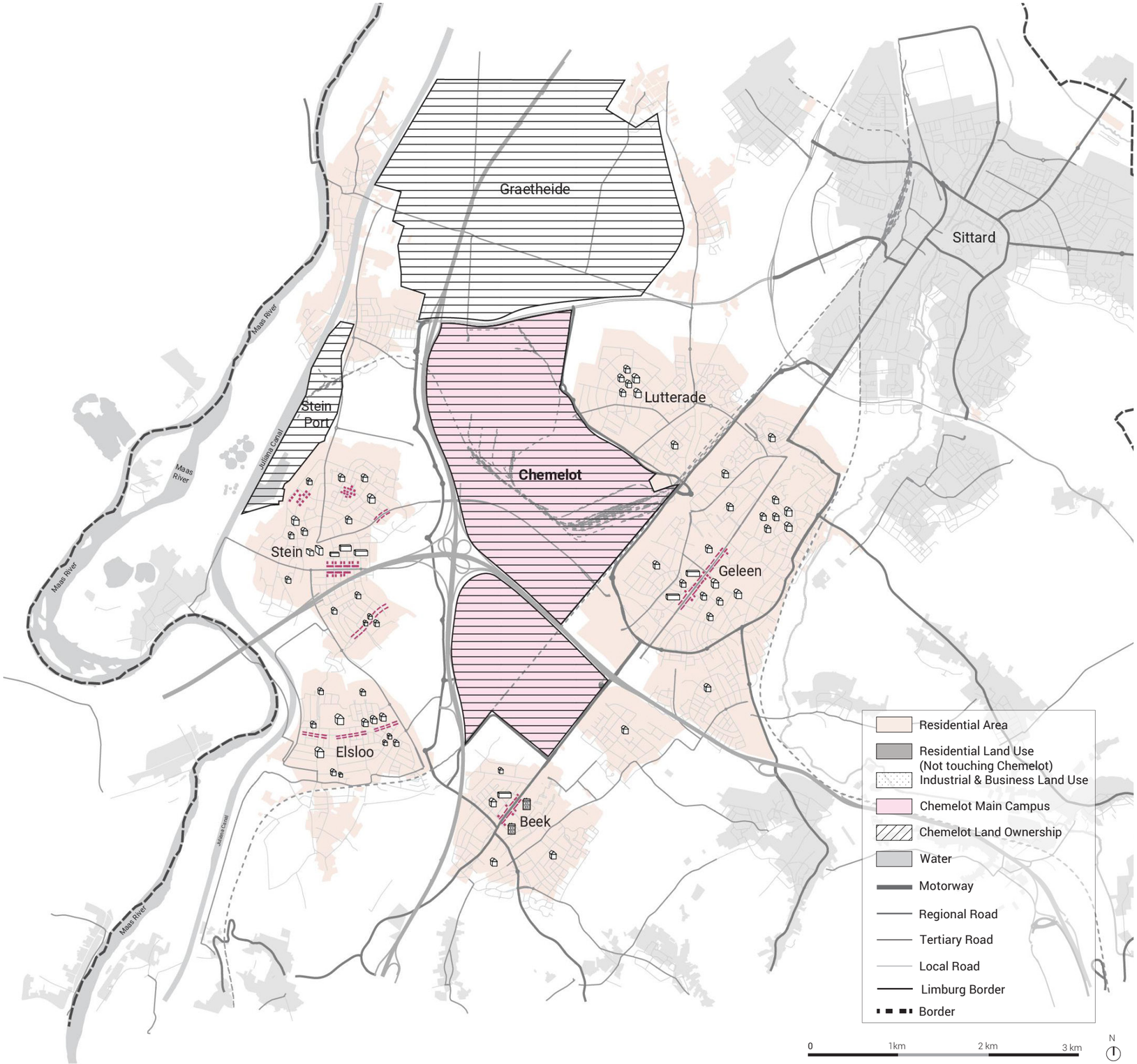


Fig: 55- Map highlighting the spatial typologies of settlements around Chemelot (Source: Information and GIS data: Geofabrik n.d, Openstreetmap, n.d, IBIS Bedrijventerreinen, 2022, PDOK n.d)

ENVIRONMENTAL AND INFRASTRUCTURAL ANALYSIS

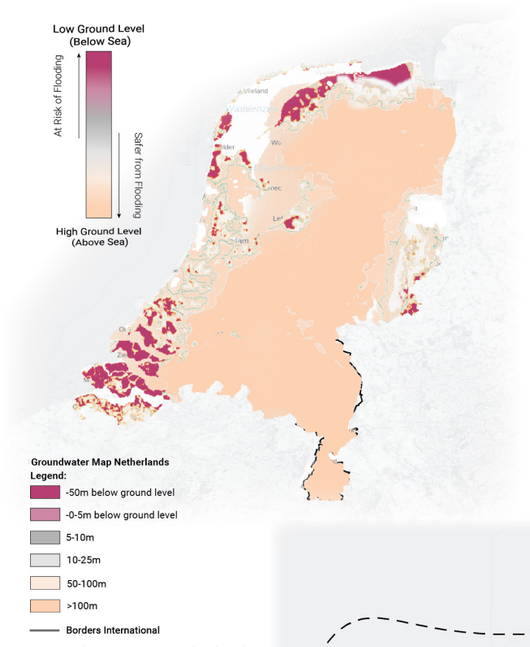


Fig: 56- Groundwater Map Netherlands. (Source: Deltares, 2015)

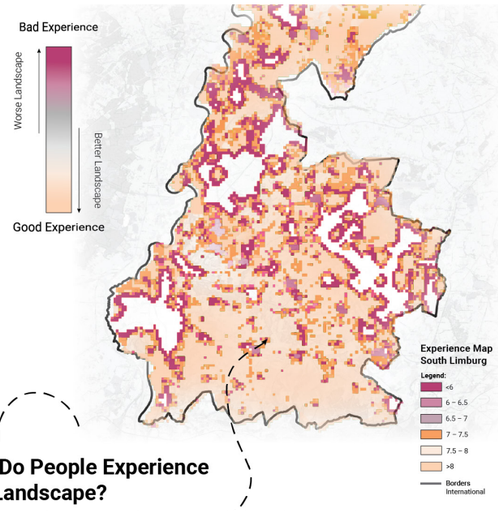
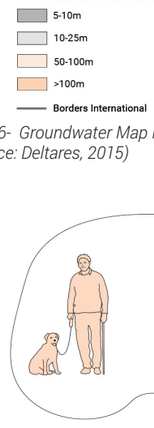
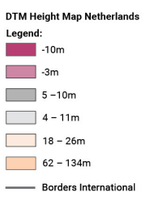


Fig: 57- Landscape Experience Map, Limburg (Source: Alterra, Wageningen UR, 2010)



How Do People Experience this Landscape?

The region of Limburg has a higher elevation and groundwater level from sea level than the rest of the country making it a less risky from sea flood risk ,but more from adjacent rivers merging together. The attractiveness of the landscape has a strong relationship peoples connection to the place. There is a relationship between the attractiveness of the surrounding landscape and house prices.



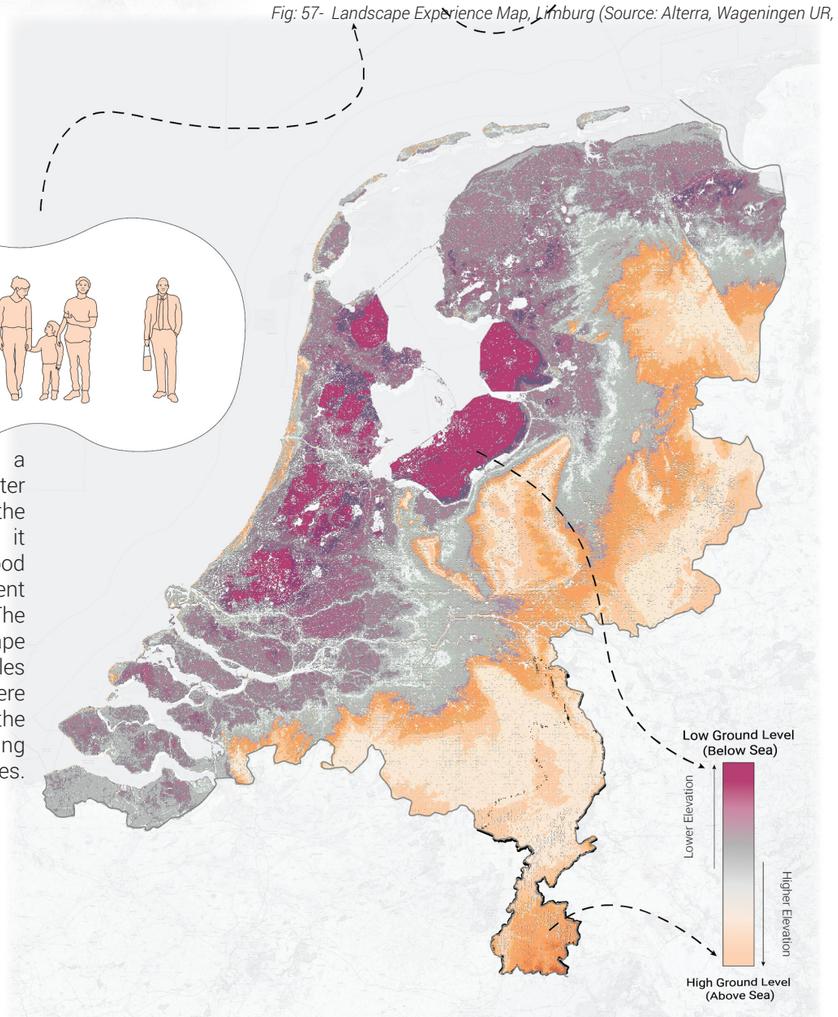


Fig: 58- Digital Terrain Map, Netherlands, (Source: DTM AHN 4)

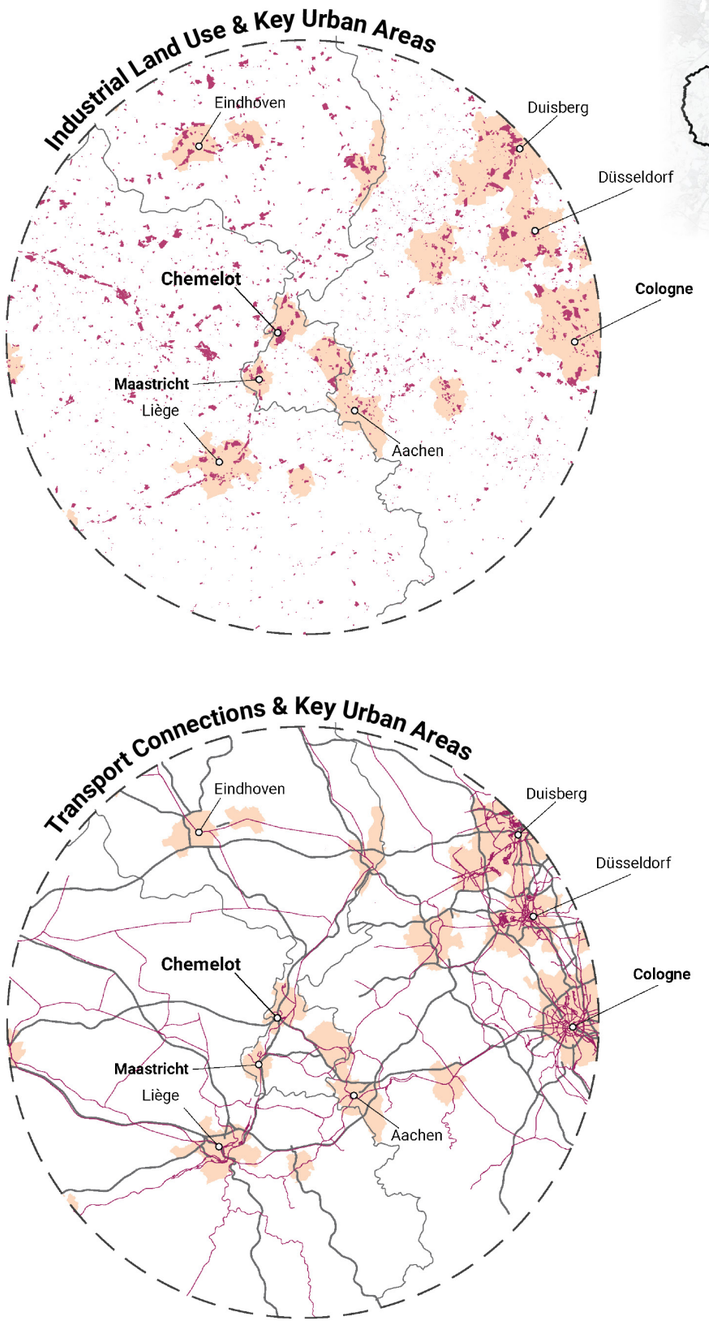


Fig: 59- Regional Indsutrial Land Use & Urban Area Map (Top) & Transport Network with Urban Areas Map (Bottom), (Source: Information and GIS data: Geofabrik n.d, Openstreetmap, n.d, IBIS Bedrijventerreinen, 2022, PDOK n.d)

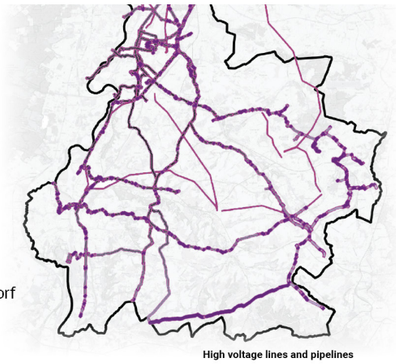
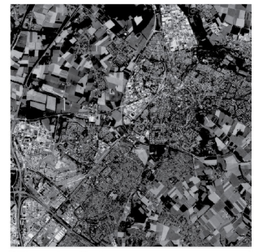
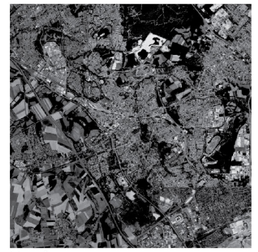


Fig: 60- High Voltage Network & Underground Pipeline Network, Limburg. Source: RIVM, 2023 2024

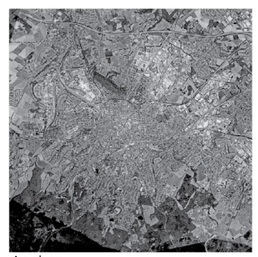


Sittard – Geleen



Heerlen

Maastricht



Aachen

Fig: 61- Aerial Images Key Urban Areas Source: Google Earth, 2025.

EXTENDING BOUNDARIES: STATUS QUO AT REGIONAL SCALE

Looking at the regional scale, it is apparent there are are number of key urban areas nearby. These are Sittard, Maastricht, Heerlen, Liege, Aachen. Extending to the periphery of the selected defined region, large urban areas such are Cologne, Dusseldorf, Duisberg, Venlo, Eindhoven, Genk, and Antwerp are found.

There are two core rivers passing through this region, these are the river Maas and Rhine which have significant effects on the landscape, provision of services, and are essential for water based transport.

There is a core network of motorways and railways that converge in this region, providing important cross-border links, connecting the three countries and contributing to the overall European longer-distance transport network. This makes the region already strategically well placed to cater to increased growth.

There are a number of nature reserves and areas of dense forests in the region that appear to lack larger-scale connections and struggle to form a network. The elevation level of the land is higher and the soil type in the region is predominantly loess soil, making the land arable and suitable for agricultural production compared to the rest of the Netherlands. This is a complex situation with combination of flood risk.

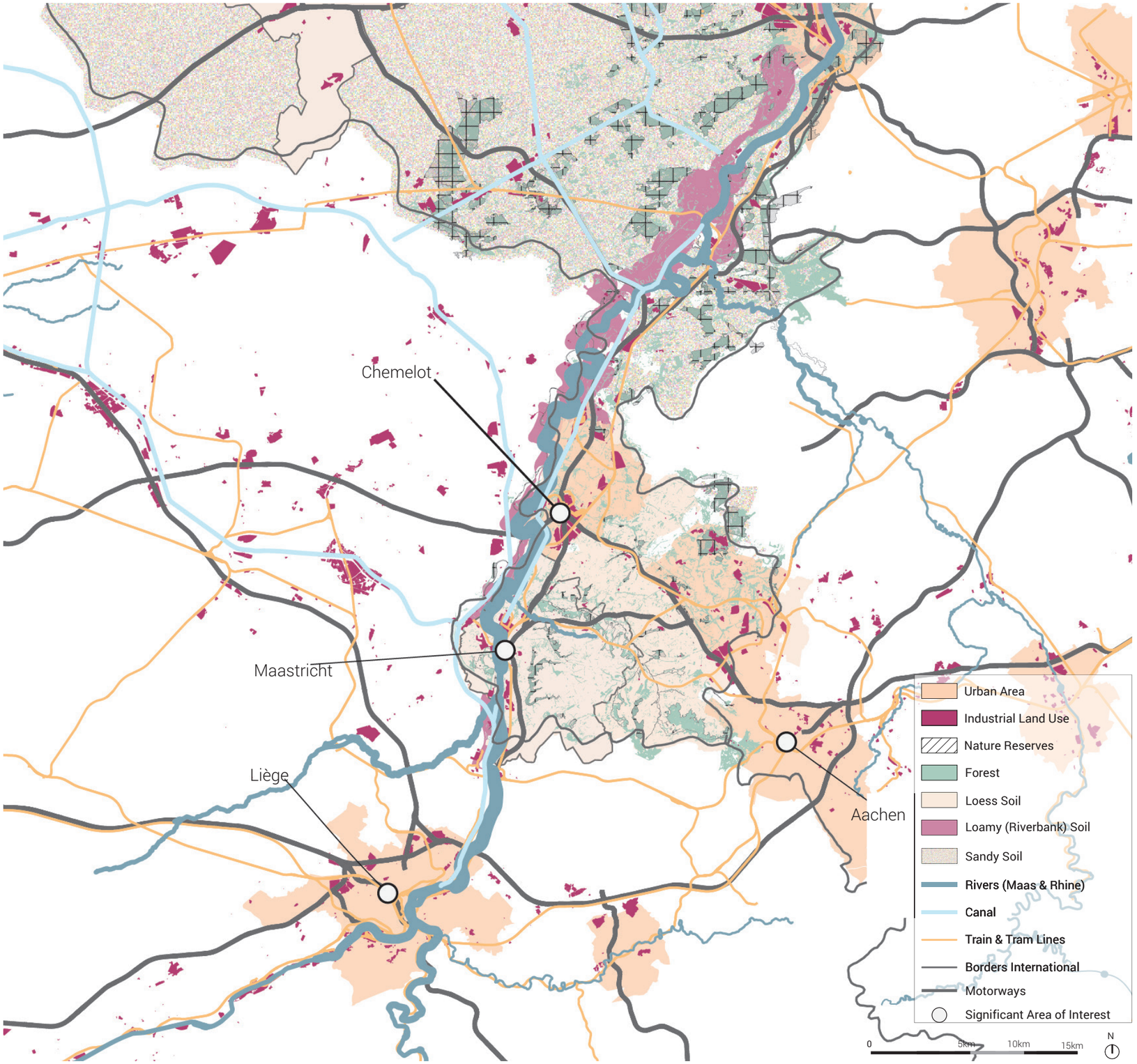


Fig: 62- Regional Status Quo Map, Showing Key Built & Natural Environment Elements of the Region. (Source: Information and GIS data: Geofabrik n.d, Openstreetmap, n.d, IBIS Bedrijventerreinen, 2022, PDOK n.d)

4 Vision

“What does Chemelot want, what does the community need — and can their futures align?”

WHAT DOES CHEMELOT WANT: Local Impact of Energy transition

Industry expansion (less environment impact)

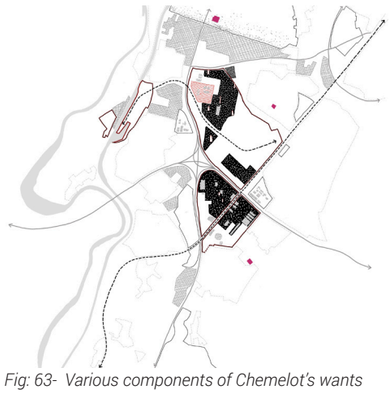
For light industry and research institutes, Chemelot is proposing to expand them beyond the existing border of the campus

Expansion of Port and Multi modal Corridor

For port infrastructure and the multi-modal corridor connecting it with Chemelot site, an enlargement is proposed in order to use more water transport in the future, which has bigger capacity and lower emission than freight transport

Industry expansion (heavy environment impact)

For heavy industry of Chemelot, it is proposed that the further expansion will be limited inside the current border of Chemelot site.



Local Energy Production

For local energy production, Chemelot is proposing some roof-top production on industrial site, but at the same time also claiming a lot of open green fields in the surrounding to become solar farms. It is worth mentioning that Chemelot owns a large piece of land in the north, and it is not impossible that they will further expand in the future.

Fig: 63- Various components of Chemelot's wants

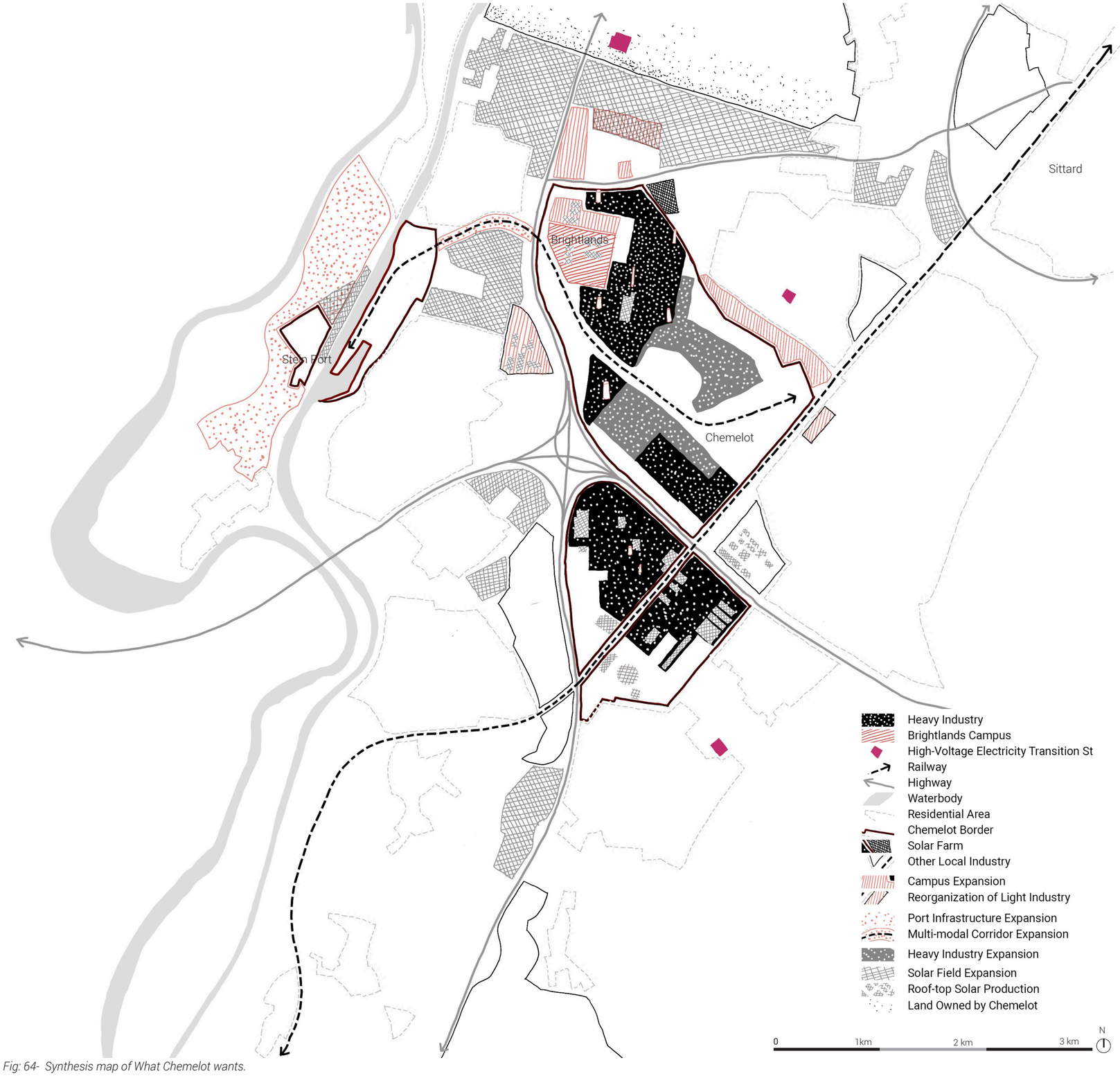
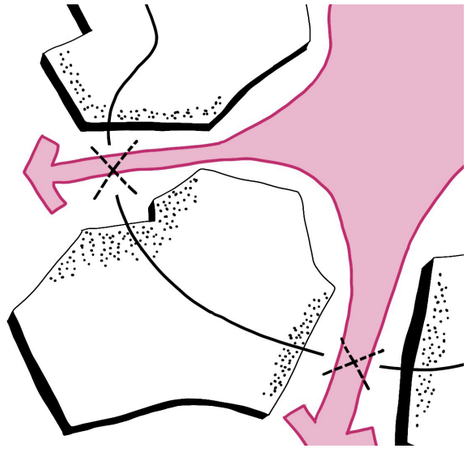


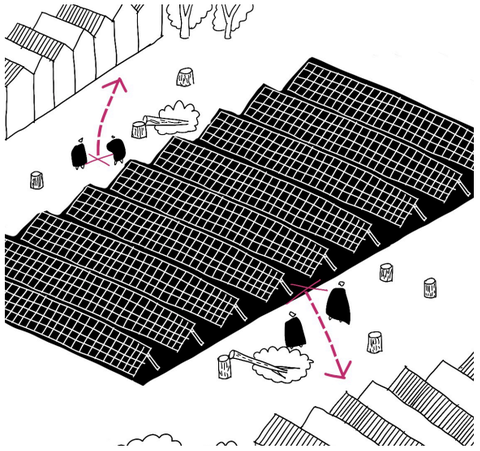
Fig: 64- Synthesis map of What Chemelot wants.

WHAT WILL CHEMELOT LOOK LIKE IN 2100: Spatial Implication of Expansion



Cut Urban Fabric

With the current trend of Chemelot expanding, if no further moves are taken to limit its ambition, one of the most direct impact is that the fabric surrounding Chemlot will be cut and isolated, causing inconvenience for local residents and raising further health concern.



Take up green space

In addition, with the ambitious local solar production plan of Chemelot, the green spaces in the vicinity of the residential area, either already used for recreational function or with the potential, will be taken up by Chemelot. These solar panel fields will form a homogenuous landscape and cut possible pedestrian connection.

Border Confrontation

Another of the major impacts of this uncontrolled expansion is that the industrial spaces would push towards the border of residential area without a proper buffer zone. This kind of confrontation could lead to nuisance and further shrinkage of residential area.

Fig: 65- Diagrams representing Spatial implications of Chemelot's Vision

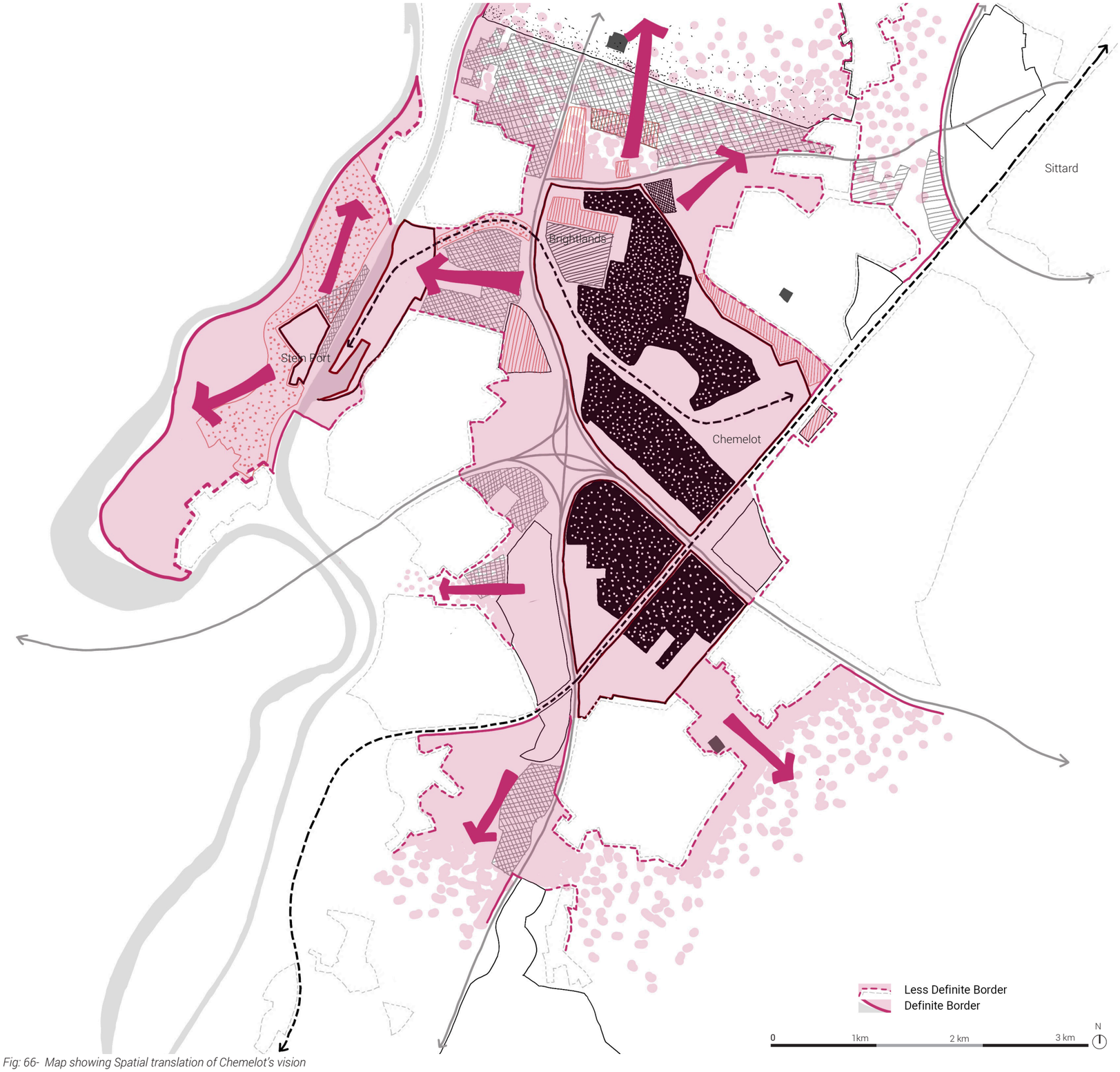


Fig: 66- Map showing Spatial translation of Chemelot's vision

WHAT DOES COMMUNITY WANT: Local Impact of community manifesto

Seemless connectivity corridor between towns

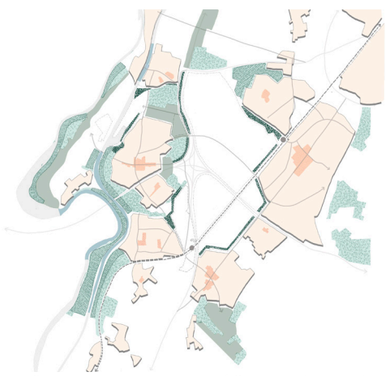
For the fragmented settlements surrounding Chemelot site, our first priority is make better connection and transform the neighborhoods into a cohesive, livable community. There is requirement of a slow mobility corridor—a network priortising cyclists and pedestrians.

Higher Density and Amenities in Cores

With the existing cores of the settlements connected by the proposed ring road, it is possible that these cores would densify and attract more amenities, thus improving the liveability of the area

Expansion of town boundaries: New Housing Typologies

With job opportunities provided by Chemelot and improved liveability in this area, these settlements would attract more residents and would need to expand and densify. A more diverse housing typology including mixed-use development is necessary to accomodate the future needs.



Environment and Natural structures

The communities in their benefit will also alter spatial qualities of the green structures in their interests. This includes protecting denser green areas to preserve vital natural spaces, adding green structures to ensure continuity of green spaces across neighborhoods, and creating green buffers especially along industrial zones for health and safety concern.

Fig: 67- Various components of Community's wants

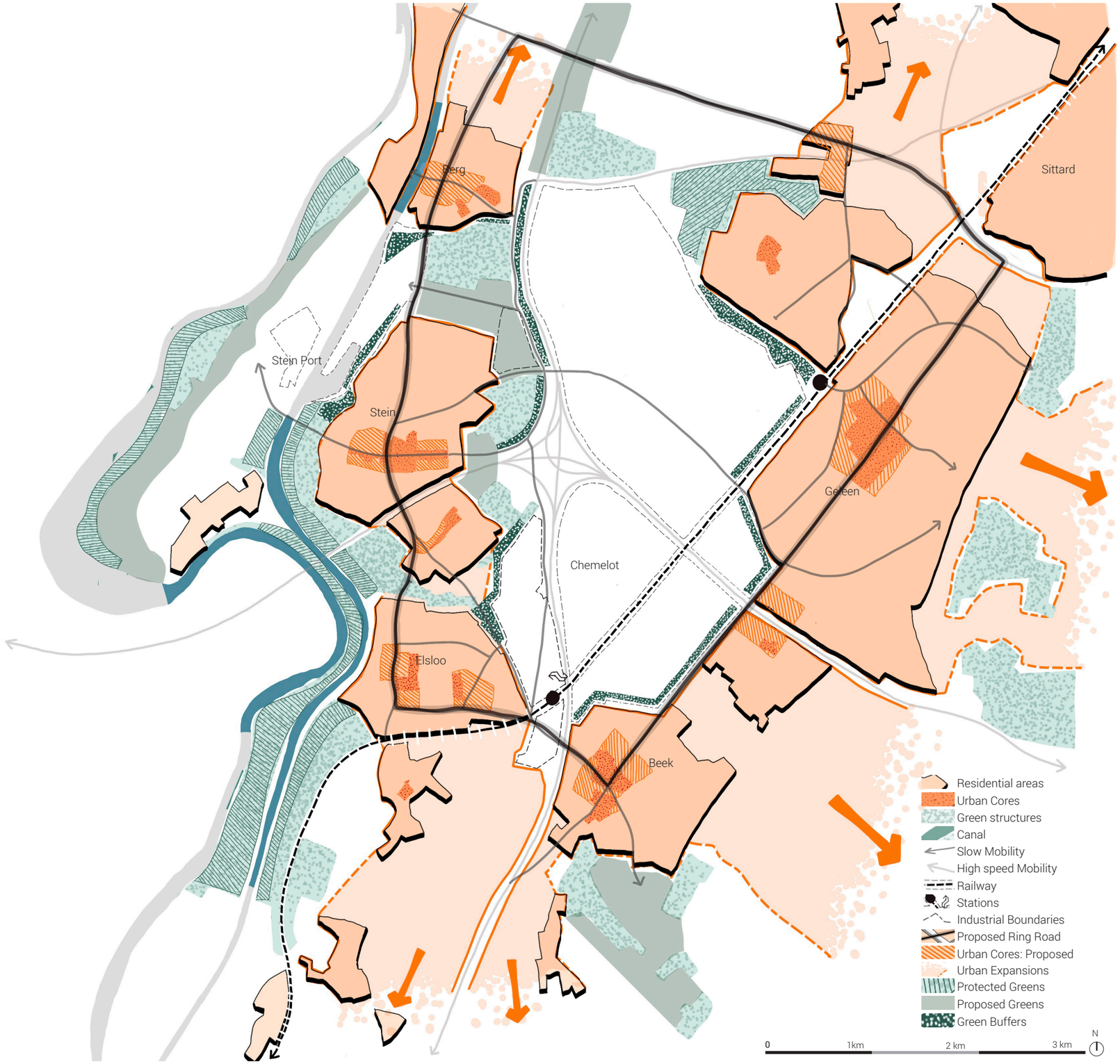
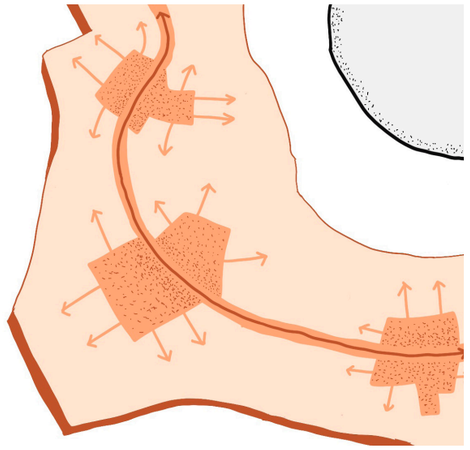


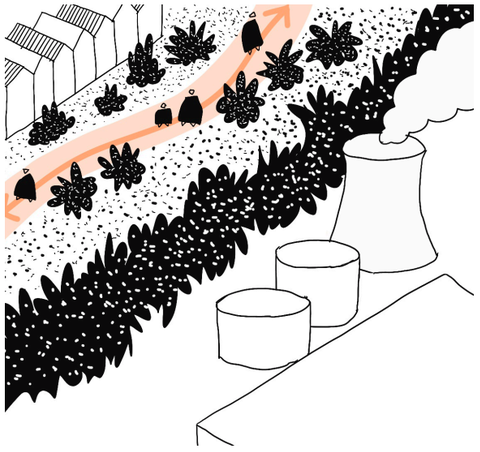
Fig: 68- Synthesis map of What Community wants.

WHAT WILL COMMUNITY LOOK LIKE IN 2100: Spatial Implication of Expansion



Ring City around Chemelot

With the proposed connection of the ring road, the now fragmented settlements around Chemelot would form a cohesive ring city that better shares amenities and conveniences.



Rigid Seggregation

The ring city comes also with strong buffer zones against Chemelot, ensuring clear separation between industrial and residential areas for safety and health.

High Livability

With access to more amenities, better green connections and healthier environments, the area would achieve a high liveability and demonstrate the possible symbiosis of local residents, the industry and the environment.

Fig: 69- Diagrams representing Spatial implications of Community's Vision (Source: Bristol Post, n.d.)

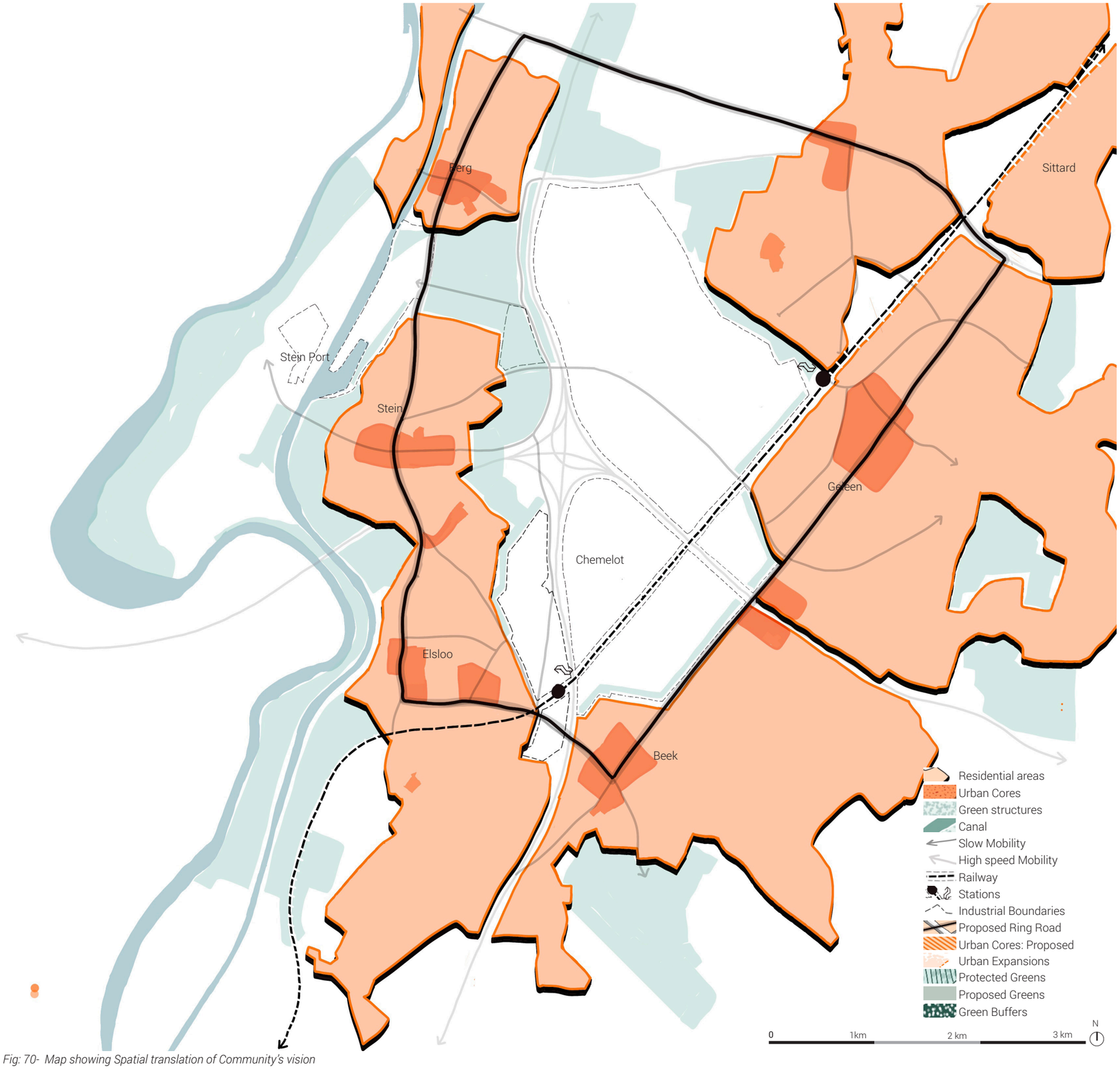
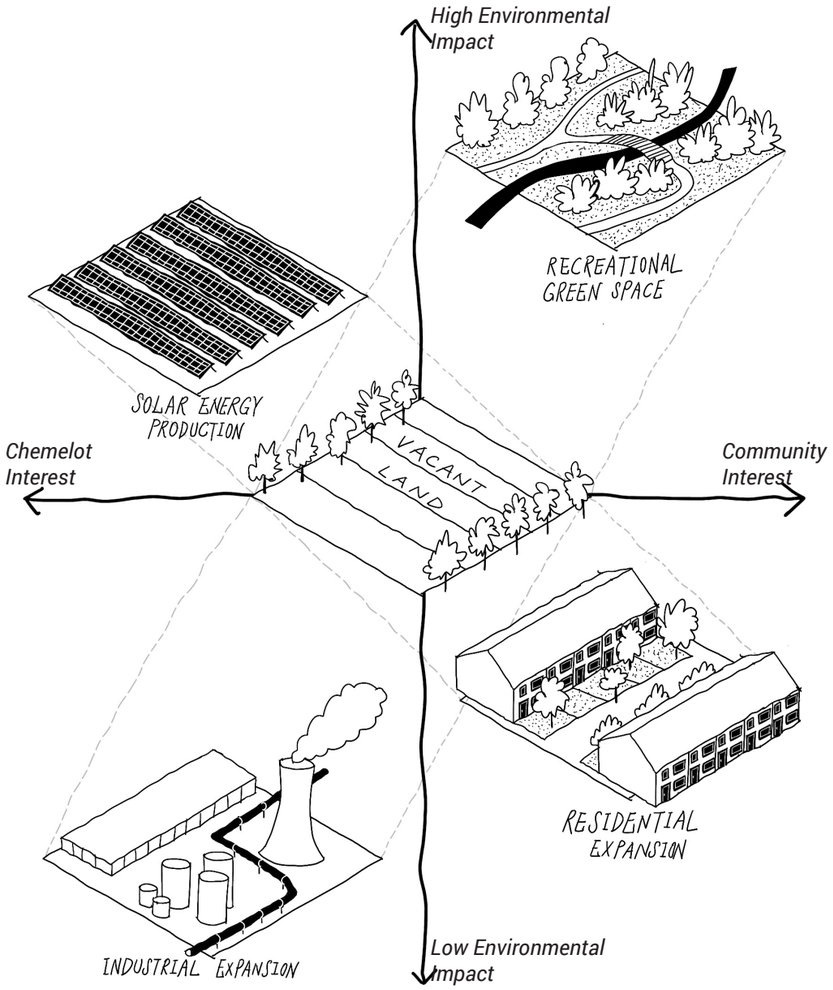


Fig: 70- Map showing Spatial translation of Community's vision

CONFLICTS BETWEEN CHEMELOT AND COMMUNITY: Land Use



Land-Use Conflicts

From the analysis of community and chemelot interest, we can come up with the spatial conflicts. The first type we identified is the landuse conflict.

From previous analysis, we can conclude two kinds of borders (solid line and dashed line). On the local scale the solid lines are indicating boundaries that are difficult to cross such as borders with a river, infrastructure, or a national border. While the other type of border (dashed line) showing the current boundaries of industry and residential areas, which might shift in a long term. For example, residential areas may expand, industry may shrink, or the other way around.

The borders outline the areas of conflicting interest in landuse. Those areas, mostly vacant land now, might develop into different landuse according to different goals stated in the vision. We create a coordinate system to explain that towards different directions of interest and resulting in different degrees of environmental impact, there are several scenarios for future development.

Fig: 71- Diagram Depicting Spatial Possibilities for Land-Use Conflict

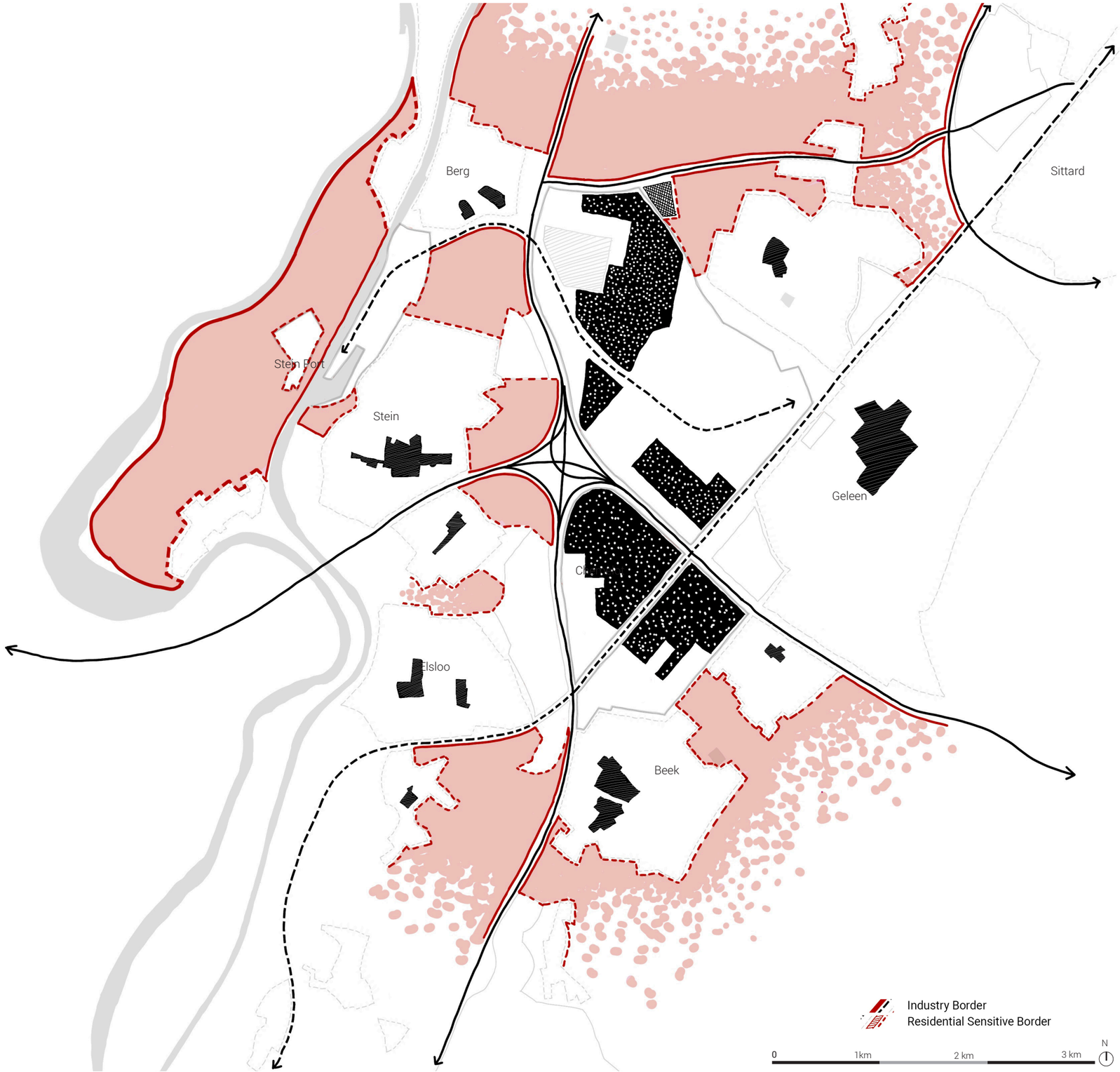
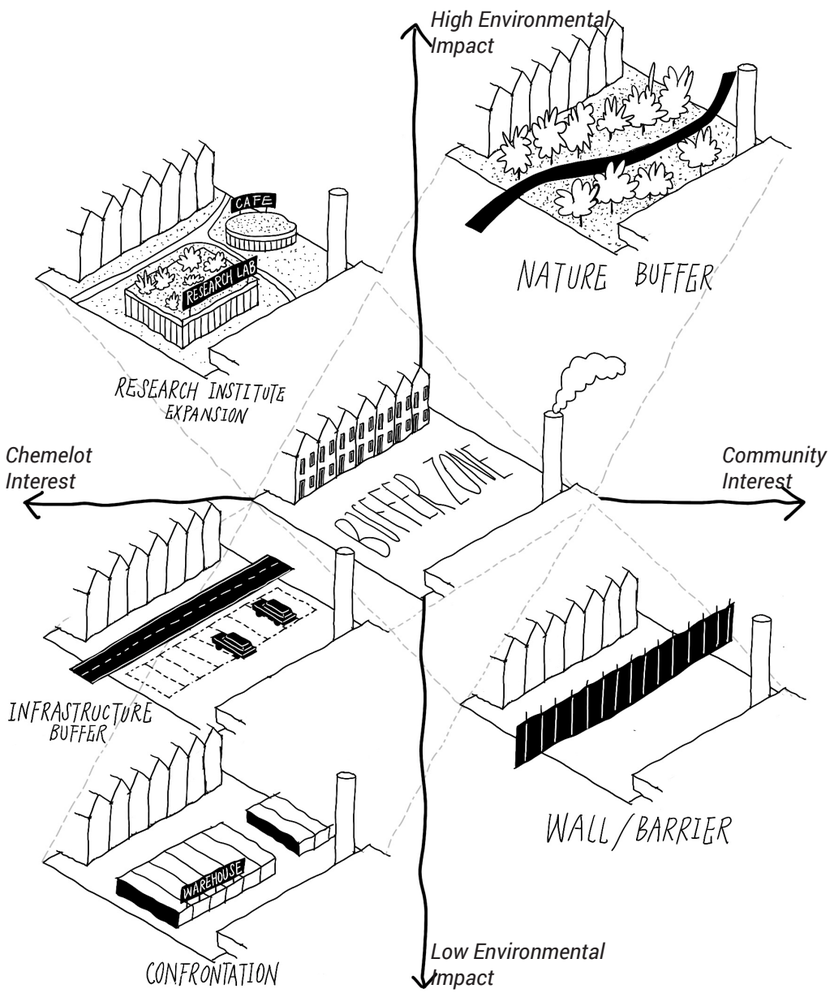


Fig: 72- Map Depicting Sptial Implications of Land-Use Conflict

CONFLICTS BETWEEN CHEMELOT AND COMMUNITY: Borders



Border Conflicts

The second type of conflict we identified is the border conflict. The conflict between residential and industrial communties are not only about the future landuse, but also out of their intrinsic feature. Where residential and industrial function come close to each other, a buffer zone is needed to avoid risk and nuisance.

Again we use the coordination system to explain the possible scenarios. In general the residents want larger buffer zones and industry would prefer more utilitatian buffer zones. All of those possible type of buffer zones come with different degrees of environmental impact.

Fig: 73- Diagram Depicting Spatial Possibilities for Border Conflict

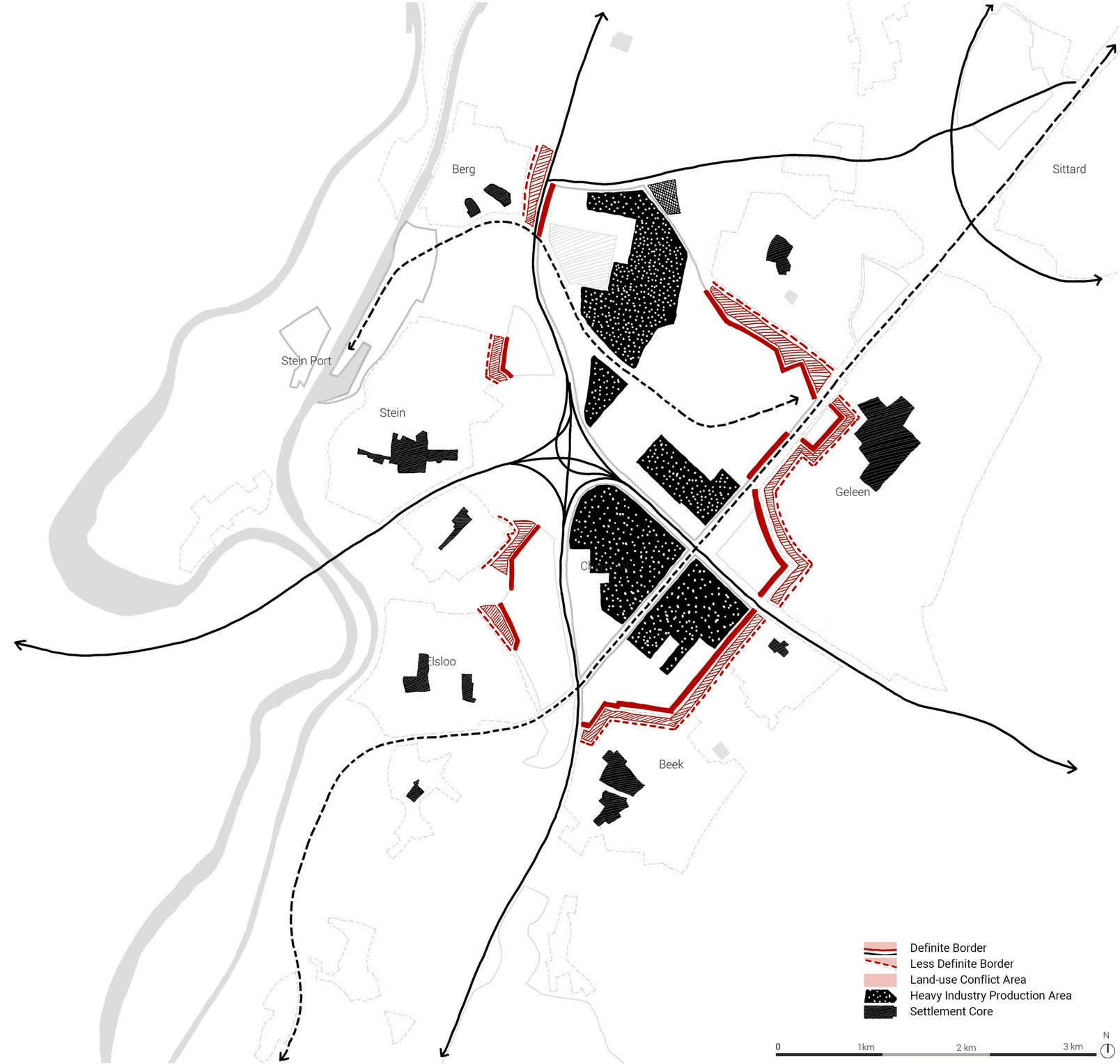
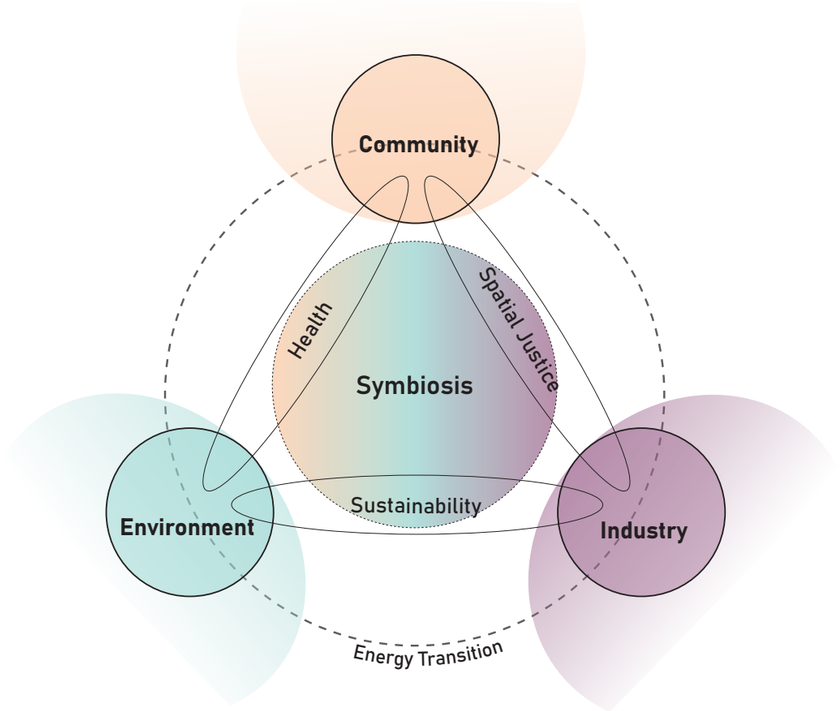


Fig: 74- Map Depicting Sptial Implications of Border Conflict

VISION STATEMENT

Fig: 75- Graphic presenting a abstract visual of 'Symbiosis' as per the Vision 2100



"By 2100, Chemelot stands as Europe's leading hub for circularity and sustainable industry—a thriving ecosystem where business, community, and nature are in harmony. No longer just an industrial site, it has evolved into a dynamic district where clean industries drive a robust economy without compromising the environment. Surrounding towns have developed into vibrant, livable neighborhoods with high-quality housing, schools, parks, and cultural spaces, ensuring a high quality of life. Green corridors and ecological buffers seamlessly integrate nature into daily life. Recreational green spaces, such as walking trails, open fields, and community parks, offer residents opportunities for relaxation, leisure, and connection with nature.

Rooted in the needs and balance of its three key forces—community, industry, and environment—this vision supports a 'Symbiosis' built on health, sustainability, and spatial justice, ensuring that none overpowers the others, but instead, they grow together, actively supporting and strengthening one another."

Fig: 76- Simplified diagram of the conceptual framework showing how the vision is grounded in the balance between community, industry, and environment.

VISION 2100: COMMUNITY

• The community currently faces a lack of amenities, with the area being quiet and offering limited activities. Its proximity to industrial zones leads to health concerns and potential hazards. Additionally, the urban neighborhoods are car-centric, with poor connectivity.

• The vision for the future includes expanding urban areas in response to new job opportunities created by the energy transition at Chemelot. This new investment and development will also result in densifying the existing urban areas, offering a broader range of housing options to meet the needs of both older generations and newcomers.

• Improvements will also be made to city centers, with more amenities and recreational spaces, including green areas.

• To address the isolation of current urban zones, the visionproposes a new ring road and improved public transportation, increasing connectivity and making the region more attractive.

• Finally, the areas where community and industry intersect will feature a buffer zone, contributing to a higher quality of life for residents.

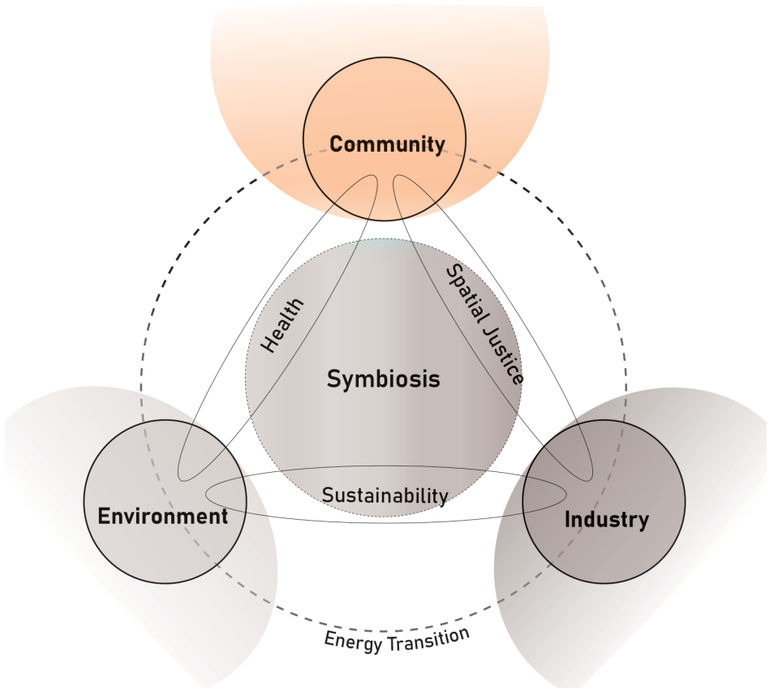


Fig: 77- Conceptual framework, Community Actor

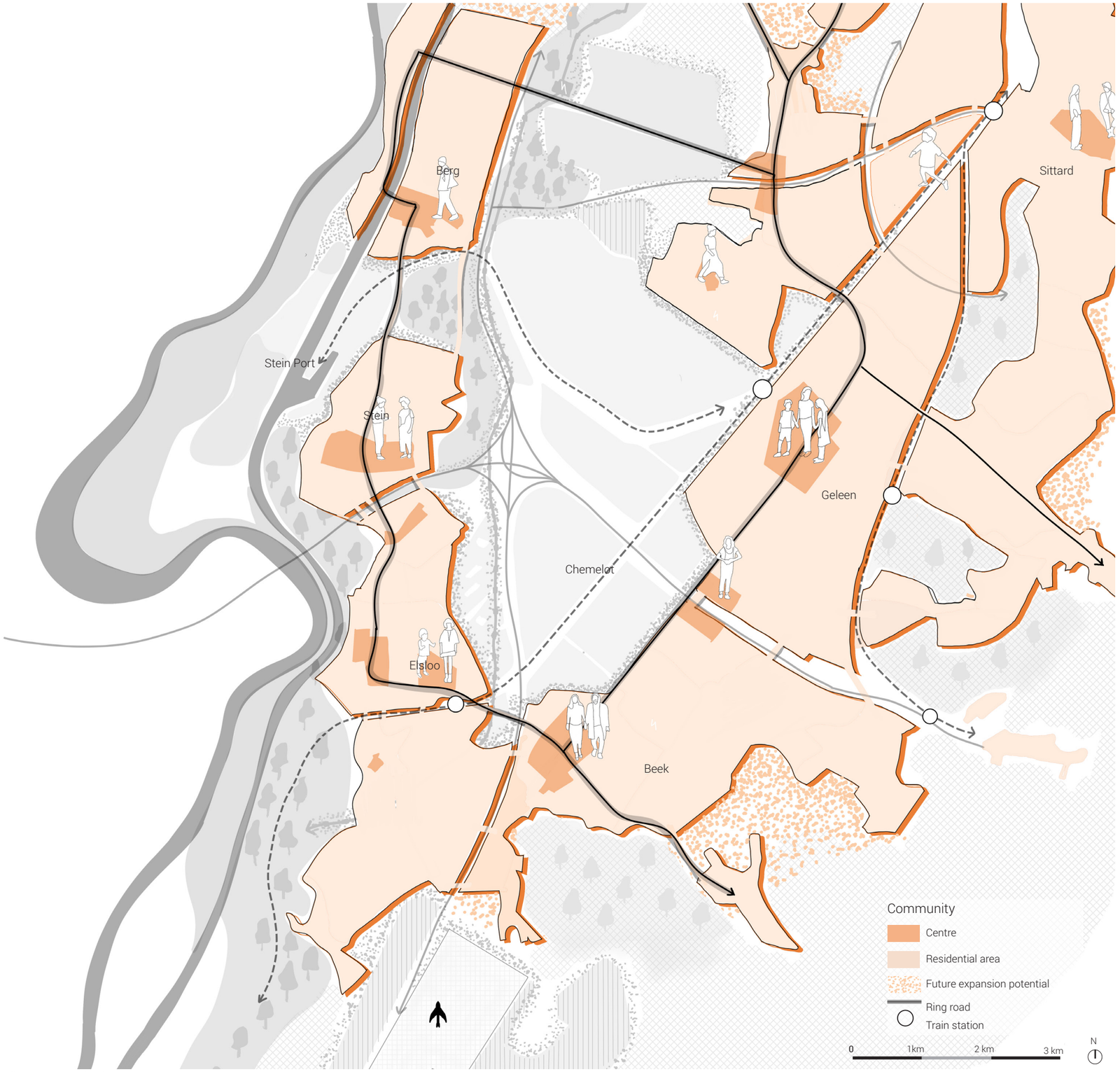


Fig: 78- Local vision for the community

VISION 2100: INDUSTRY

• Due to the energy transition, Chemelot must take action to ensure its future viability. Additional space for nearby energy production is necessary, but this cannot come at the expense of the surrounding community. As such, space for energy production has been allocated to the north, an underdeveloped green area with fewer residential areas. Since Chemelot owns this land, it is a logical choice. However, the expansion should be limited to avoid encroaching too far into the region.

• Additionally, the area around the airport has been designated for energy production, as it is less desirable for residential development. This site will have less impact on local communities.

• As industries become more collaborative due to the energy transition, with greater exchanges of resources such as plastic recycling, the vision also includes expanding the port to accommodate this increased activity.

• Finally, the vision proposes expanding the energy network to meet future demand. The high-voltage line will be extended from north to south, covering the entire industrial site. The national hydrogen network will also connect to Chemelot for energy supply, while Chemelot will also produce its own hydrogen in the future.

• The residual heat and energy from Chemelot could be supplied to surrounding communities, contributing to more sustainable energy use.

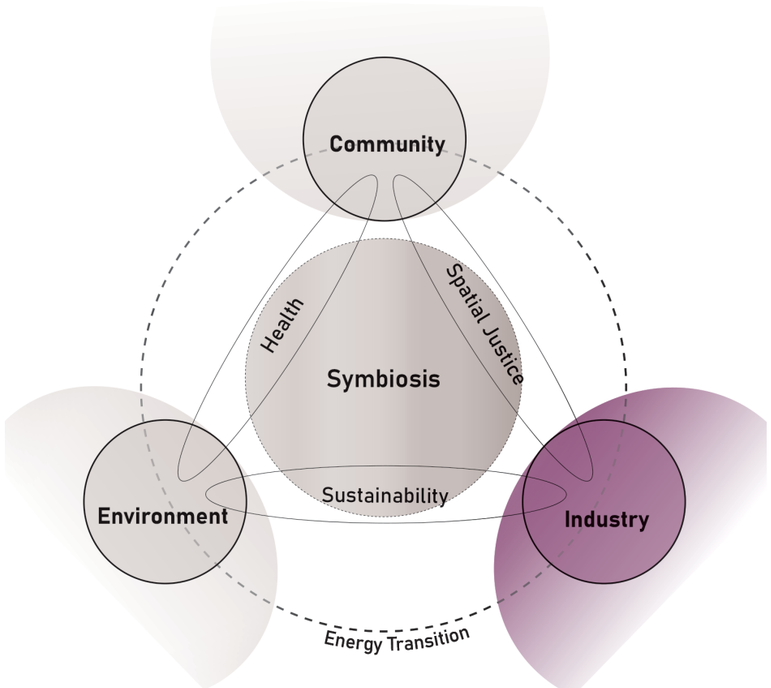


Fig: 79- Conceptual framework, Industry Actor

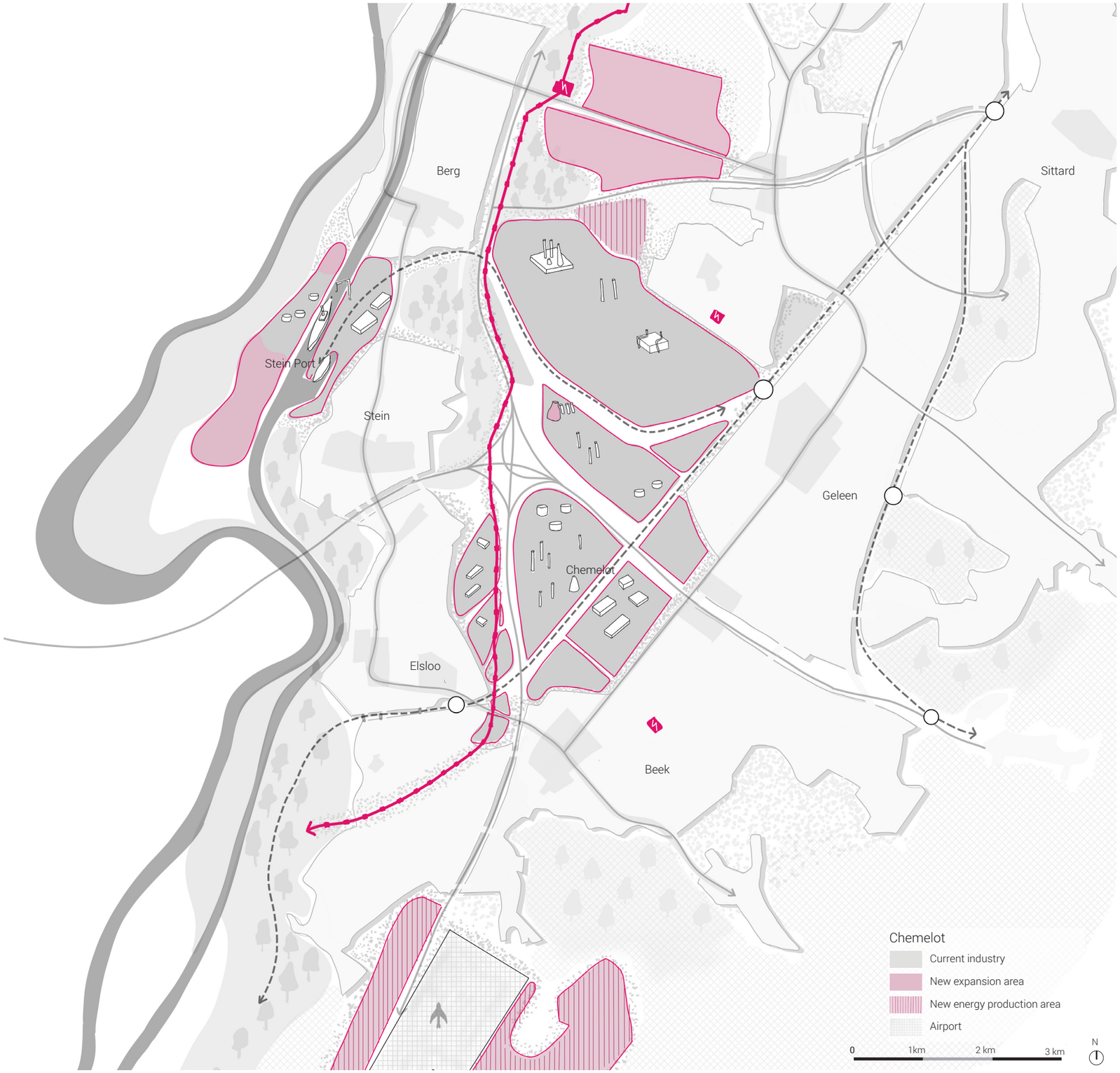


Fig: 80- Local vision for the Industry

VISION 2100: ENVIRONMENT

• Due to the high flood risk in Limburg, caused by the convergence of several rivers, significant action is needed to ensure the region remains viable.

• The vision proposes creating more space for the river by deepening the watercourse and widening the floodplains. This additional space can also serve as a new nature corridor along the river, connecting natural areas from north to south.

• Furthermore, the vision suggests linking the green spaces within residential areas to form a continuous network, which will, in turn, support biodiversity. By providing more space for biodiversity, they become less reliant on isolated patches of nature, allowing them to move more freely between better-suited habitats when necessary, leading to greater ecological stability.

• These green connections can be made possible through the creation of green buffers between communities and industrial areas. This dual-purpose approach ensures that these buffers not only provide a barrier between industry and residential areas but also contribute to the overall ecological network.

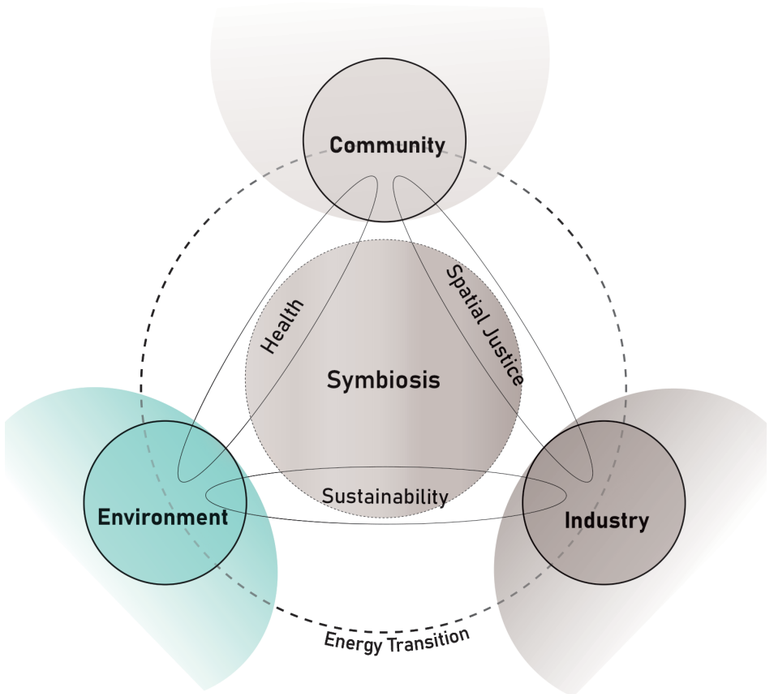


Fig: 81- Conceptual framework, Environmental Actor

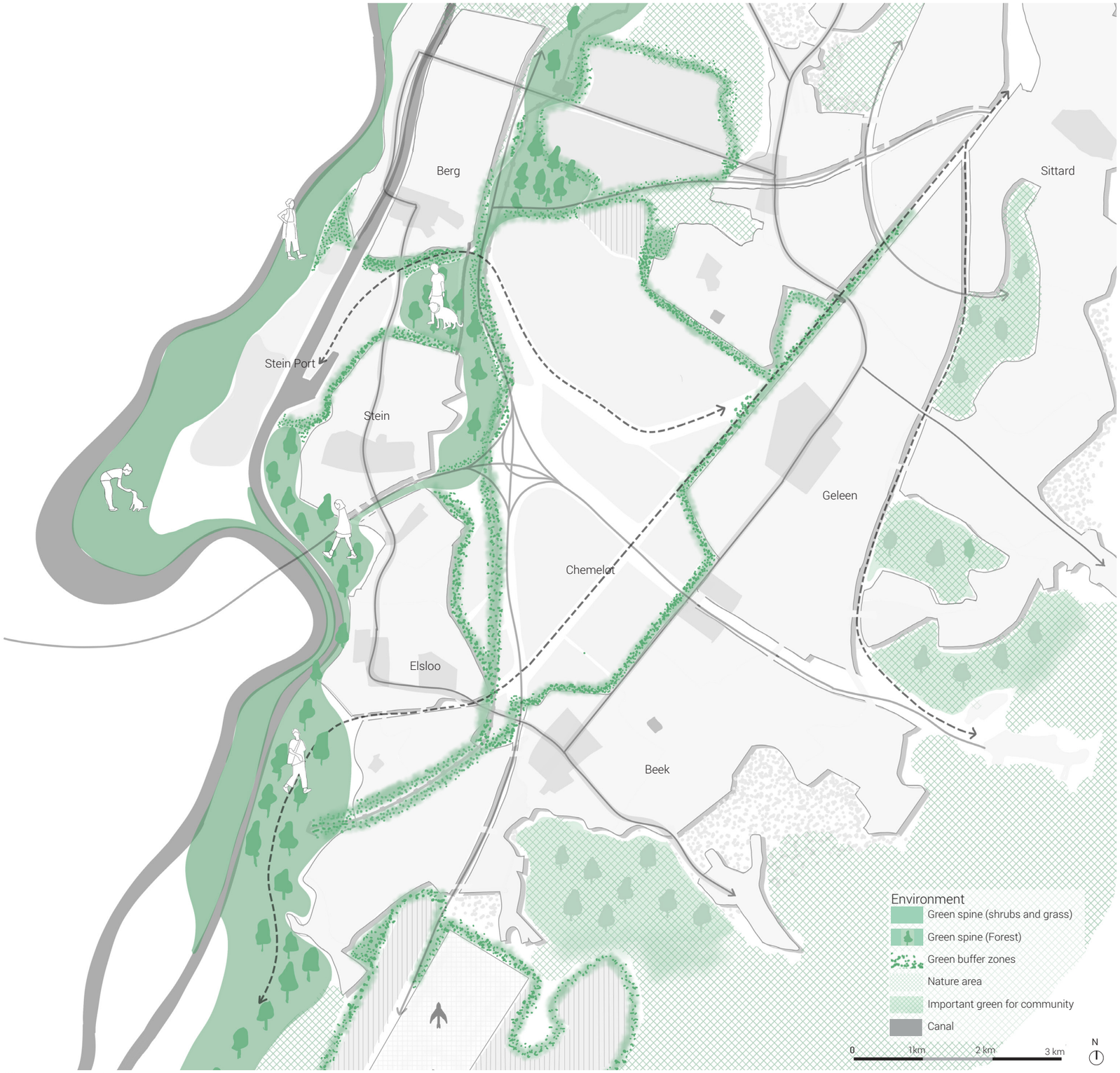


Fig: 82- Local vision for the Environment

VISION 2100: SYMBIOSIS

When the three aspects of the vision are layered over each other, a clear symbiosis emerges. The focus shifts from conflict to collaboration. The symbiotic processes are as follows:

• **Community + Industry**
There is a clear connection between industry and community through the new workers who bring innovation to Chemelot, as well as the new investments and developments in the urban areas.

The new energy production at Chemelot will also provide residual heat and energy that can be supplied to the community. Furthermore, the energy transition and reduced reliance on fossil fuels will likely result in lower emissions.

• **Community + Environment**

The symbiosis between the community and the environment is evident through the creation of more recreational spaces and the establishment of buffers between industry and residential areas, which will also strengthen the biodiversity.

• **Environment + Industry**

Lastly, the symbiosis between industry and the environment is reflected in the increased space for the river, which will provide more certainty for shipping routes, while the green spaces can help offset emissions.

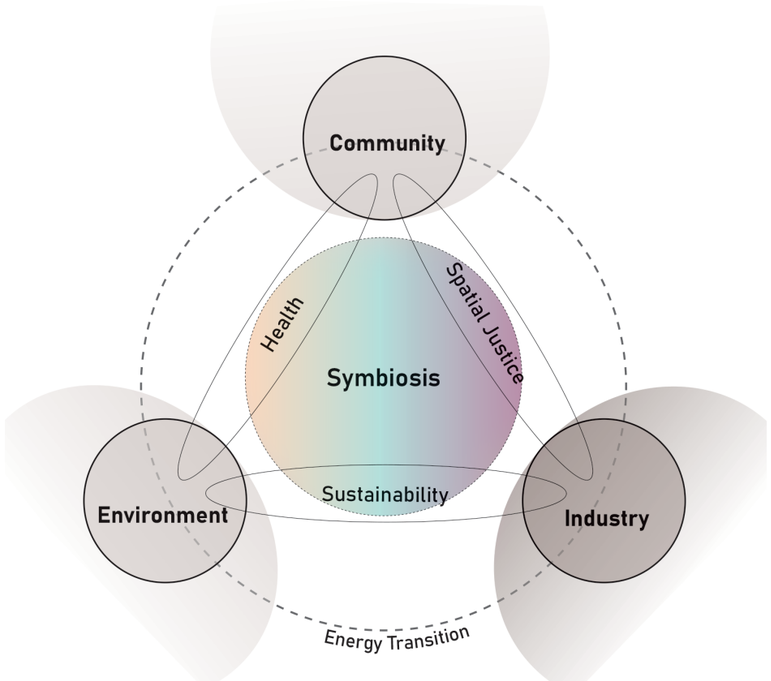


Fig: 83- Conceptual framework, Symbiosis

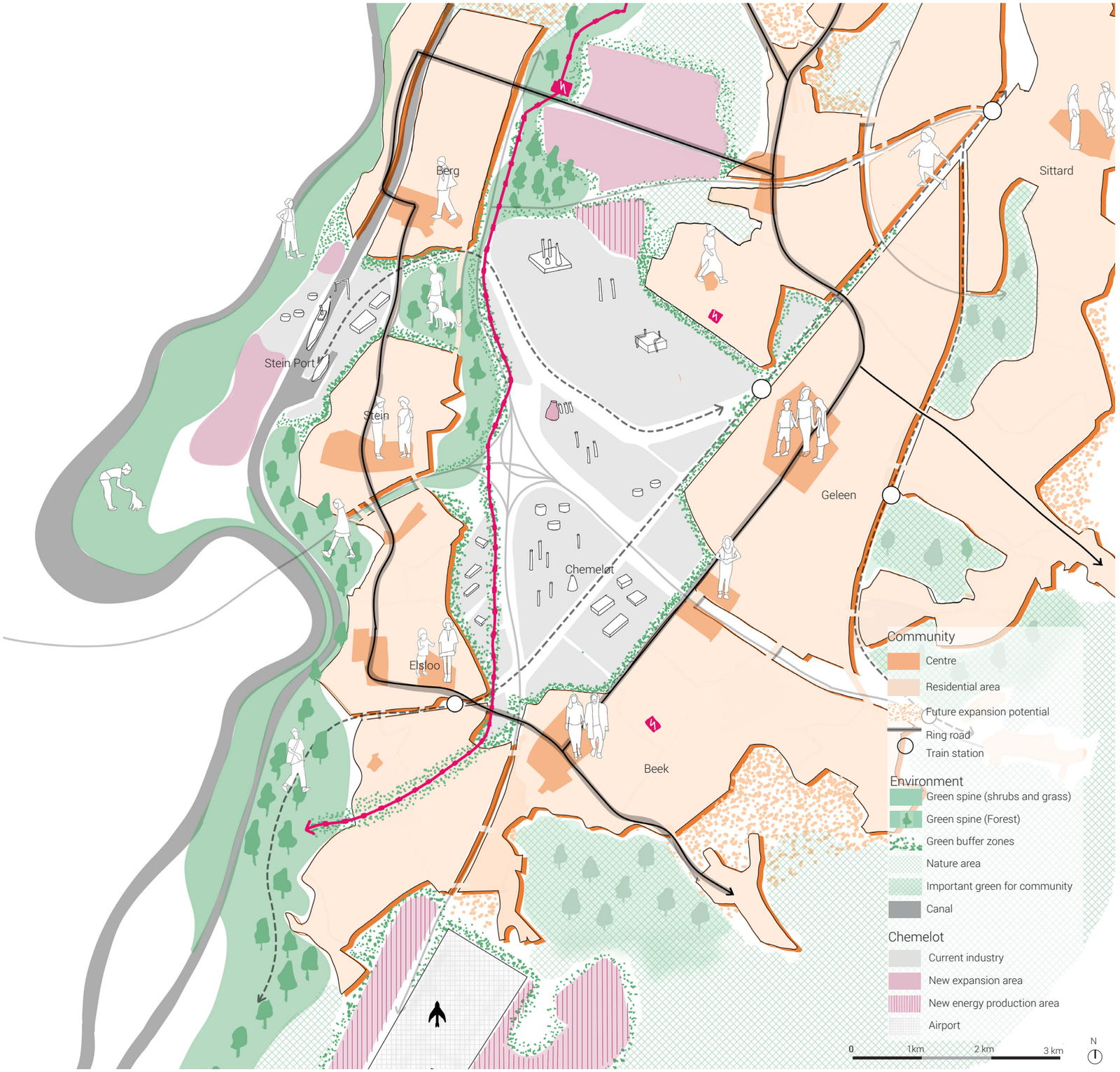
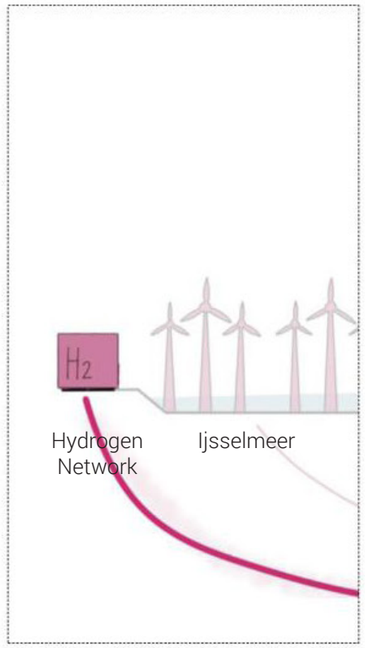


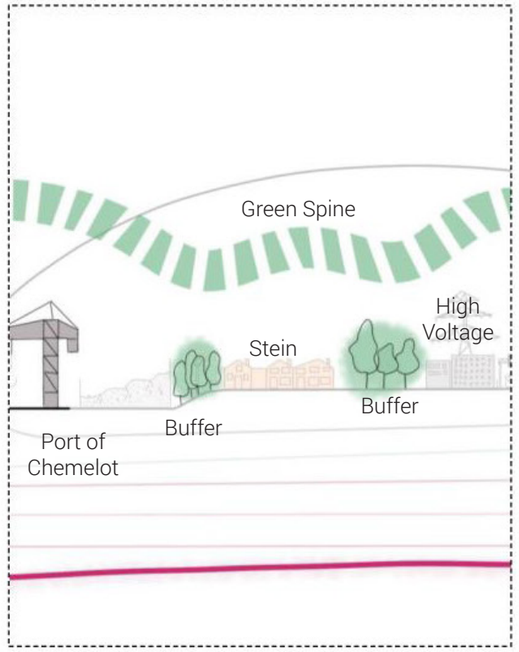
Fig: 84- Local vision for the Symbiosis of three actors

NEW MATERIAL AND ENERGY FLOWS



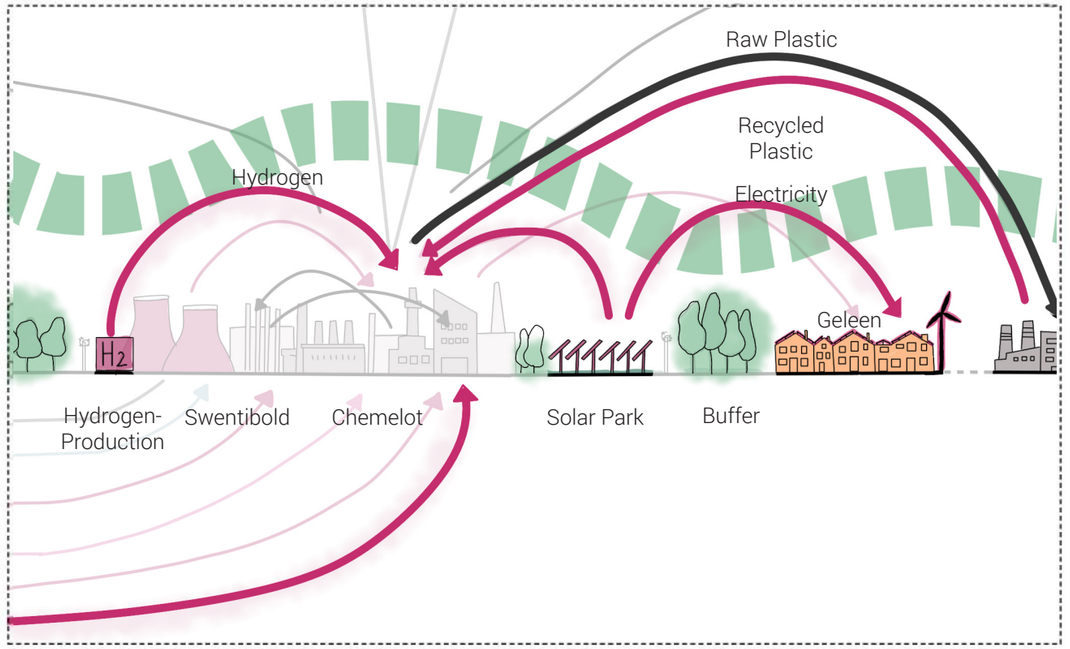
National Hydrogen Network

The Chemelot region has become better integrated with the national hydrogen network, with Chemelot now producing its own hydrogen. This connection to the hydrogen network facilitates the exchange of clean energy resources and supports the transition away from fossil fuels, fostering sustainability across industries.



Green Buffers

New buffer zones have been established between the community and Chemelot, enhancing the overall livability of the area. These green buffers serve as natural barriers, reducing environmental pollution such as noise and air contamination, while also providing space for local biodiversity and improving the quality of life for residents.



Chemelot Industrial Area and Local energy production

Chemelot has significantly improved its energy independence by generating its own power through solar energy. Additionally, the residual heat and energy produced by the facility are now being supplied to surrounding communities, creating a mutually beneficial relationship. Housing within the community has been upgraded with better insulation and solar panel installations, further promoting energy efficiency and sustainability.

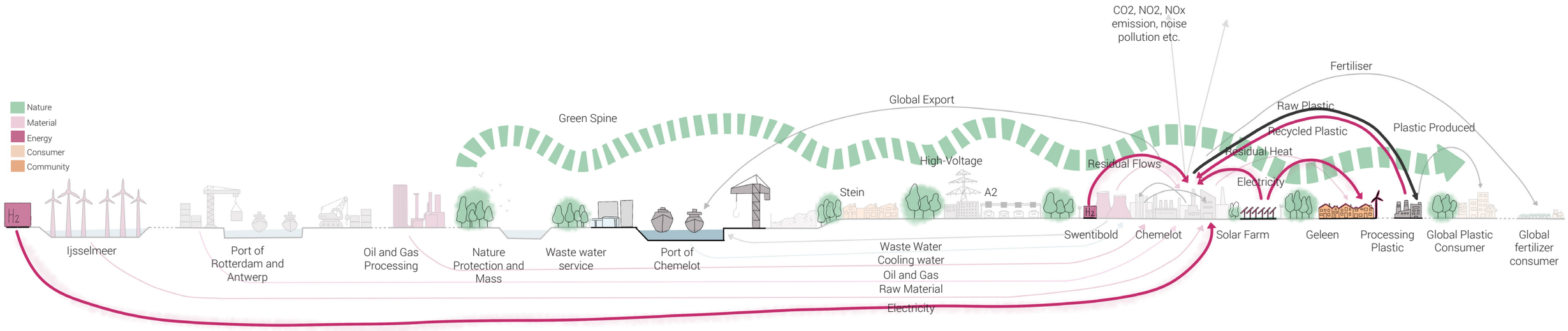
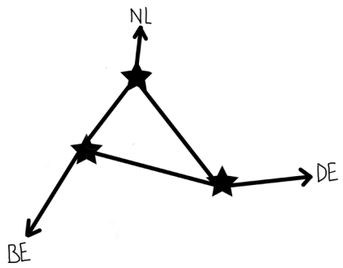
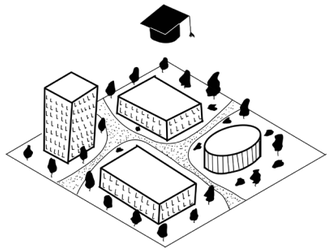


Fig: 85- Schematic Section showing new material and energy flows for Chemelot based on the Vision

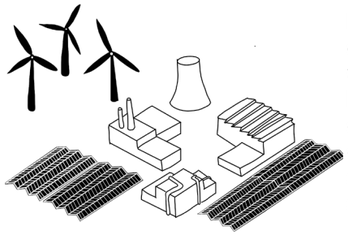
REGIONAL IMPLICATIONS OF VISION



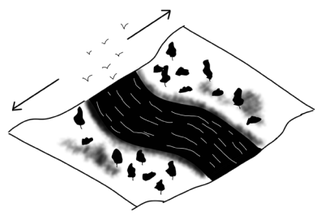
Triangular Connection



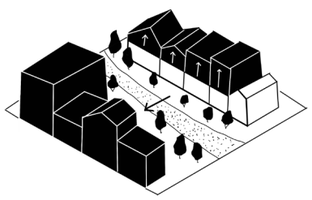
Education and Innovation



Industrial and Energy expansion



Room for River and Bio-diversity



Urban Development and Expansion

The vision on a local scale can also be applied on a larger scale, with the same key concepts: a ring road, a green spine, urban expansion, improvement and densification, as well as the education and expansion of industrial networks. At the regional level, the vision suggests that, due to future intensified industrial collaboration driven by the energy transition, there should be better connections between key cities. Maastricht, Aachen, and Sittard-Geleen are vital cities, as they host educational institutions, industry, and, most importantly, hold strategic locations. Aachen serves as a gateway to Germany, Sittard-Geleen as a gateway to the rest of the Netherlands, and Maastricht as a gateway to Belgium.

The vision proposes improving connectivity between these cities through a triangular road and public transport links. The train line between Aachen and Maastricht does not yet exist, but by establishing this connection, the cities can better exchange resources and people, which will boost the economy.

Furthermore, established universities and other important educational institutions will be more connected, facilitating easier knowledge exchange, which is crucial in the context of the energy transition. Improved connectivity will make these cities more attractive, leading to more investment and ultimately a higher quality of life.

Industrial expansions will require more energy in the future, however due to energy congestion (loss of energy when the source is too far away), this energy production should be proximate. To address this, there should be space allocated for local energy production. While there are already significant wind farms in Germany, the vision also proposes new energy production sites within the triangular region, close to the three cities. These sites with solar energy can be integrated with agricultural activities, allowing for multi-use of the land.

The vision also calls for creating more space for the river along the Maas, which will simultaneously form a green spine. Additionally, a green spine in the opposite diagonal direction is proposed to connect the protected green areas in the cross-border region.

These new developments will make the area more attarctive and will also result in more housing development. This leads to the expansion and improvement of the cities.

Fig: 86- Principles of the regional vision

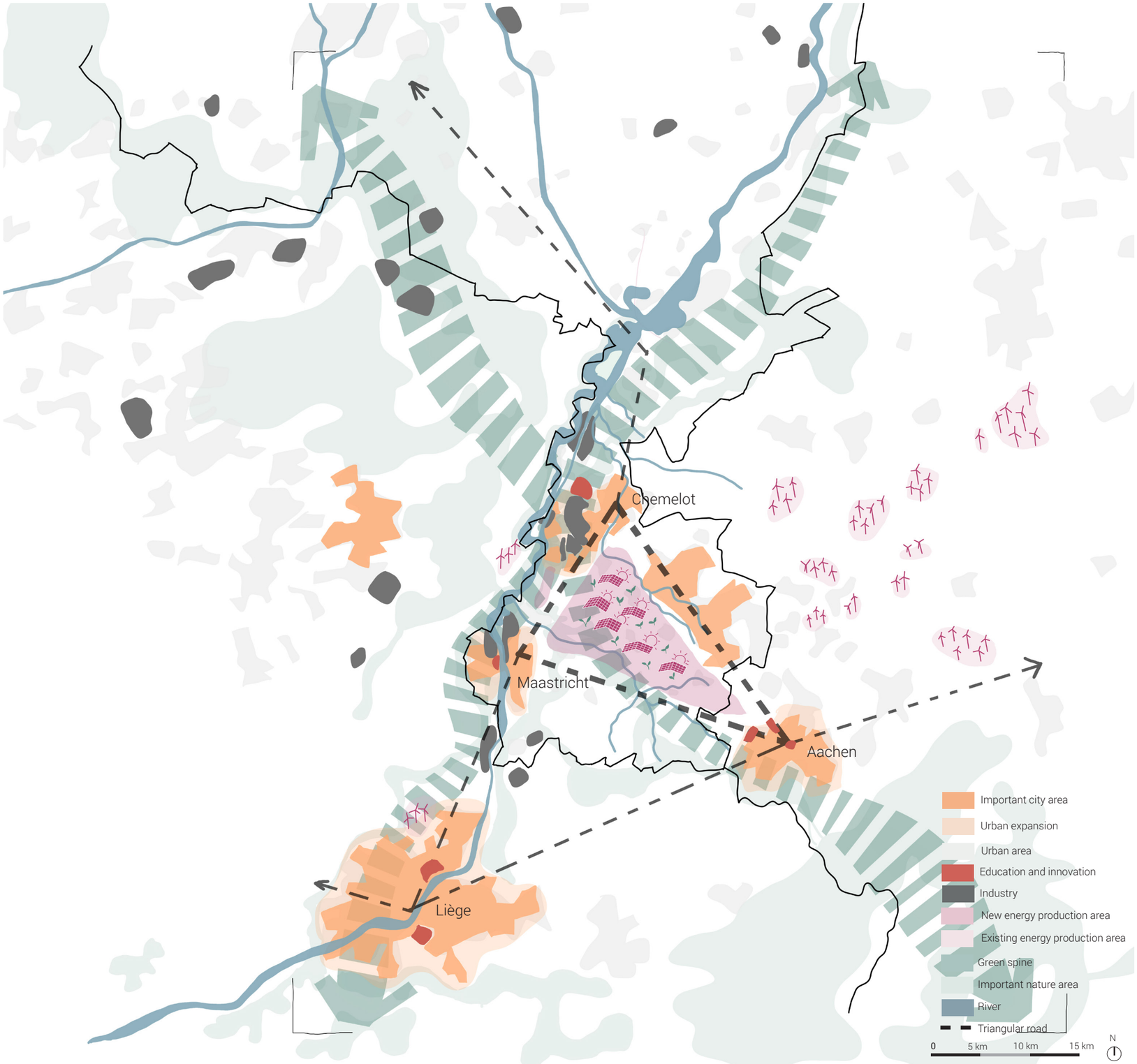


Fig: 87- Map of Regional vision

5 Strategy

“Who shapes the transition, what guides it, and how do we move forward — step by step?”

STAKEHOLDERS INVOLVED

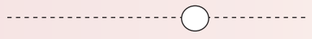
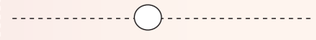
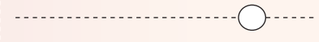
STAKEHOLDER	INTERESTS	PROBLEM PERCEPTION	VISION ATTITUDE	POWER	RECOURCES
Residents ***Now*** ***Future***	Health, connectivity, livability, amenities, sufficient housing, sufficient jobs, engagement in local projects, social initiatives by industry	Health thread, nuisance, lack of transparacy from industry, lack of space			Citizenship, human rights, engagement
Consumer plastic and fertilizer	Affordability, transparancy, performance and efficiency	Thread of affodrability			Demand
Nature	Exist, valued, healthy, future adpative and resilient	Health thread, thread of fragmented landscape			Ethics, rights to exist, policy
Chemelot	Profit, exist, expand, sustainability and circularity, competitive, resource exchange, energy security	Lack of space, lack of energy security			Money, ownership, law, political influence, education
Downstream industry and logistical associates	Profit, (expand) business, resource exchange, dependancy, eocnomic growth	Careful about dependancy of one industry			Exchange, money, maerials
Ports	Good infrastructure, economic growth, exchange	Careful about dependancy of one industry			Exchange, money, materials, strategic location
Ruhr area	Good connectivity, exchange resources, diversification of industries, economic growth	Lack of energy security, underdeveloped resource exchange through pipelines			Exchange, money, maerials
Recycling industries	Profit, resource exchange	Careful of dependancy of one industry			Exchange, maerials
Energy companies	Profit, grid stability and management, high demand, innovation, government incentives and subsidies	Energy conjection, not optimal grid capacity, energy loss			Energy
R&D and Education	Good connectivity, sufficient housing, collaboration with industry, funding for research projects , qulitative education, innovation	Thread of future insuffient amount workers			Knowledge, future workers
Investors	Profit, tax credits and grants	Uncertainty about returns, regulatory risks, hugh initial investment costs, long-term project horizons			Money
Transport and logistics companies	Good connectivity, partnership opportunities	Availability of sustainable fuel options, network capacity			Transport service
Local municipalities	Economic growth, livability, development, sustainability	Job creation, infrastructure development needs, public health and environmental concerns, balancing industrial growth with quality of life			Authority, law, money
National government	Economic growth, livability, energy security, International competitiveness, sustainability, climate goals, regulation and policy	Challenges in meeting climate targets, insufficient speed of innovation adoption, risk of economic disruption			Authority, law
European union	Sustainability, climate action goals, Green Deal initiatives, energy security, economic integration, global competitiveness	Legislation and regulation, meeting climate goals			Authority, law

Fig: 88- Table showing the Stakeholder Analysis

POLICY ANALYSIS

Local scale

Regional scale

National scale

International scale

SITTARD-GELEEN:

Inclusive policy: Space for interaction, movement, and development.
Demographics: More age-friendly housing, amenities for attracting new residents.
Social renewal: Modernizationof social facilities and having more sustainability incentives for housing.
CO2-neutral mobility (2050): Less car dependency, towards interconnected cities through public transport.
Safety risks: Less pollution and health risks, protection against potential safety risks.
Environment and businesses: Space for environmentally friendly businesses, towards a circular economy.
Chemelot: Circular production, recycling, minimizing environmental impact.
Transport: Better connected goods transport (underground, roads, water, rail).
Nature: Interconnecting nature areas.
Energy: Reducing energy consumption, using sustainable energy sources, connecting to national hydrogen network, preventing energy poverty.

(Gemeente Sittard-Geleen, 2024)

CHEMELOT:

(Collaboration between Limburg Province, Sittard-Geleen and Stein municipalities, Chemelot, Brightlands, DSM.)

Environment and safety: Minimizing environmental impact and safety risks.
Housing development: Upgrading existing housing, developing new housing for knowledge workers.
Vacancy: Transforming vacant spaces into meeting areas.
Recreation and tourism: Strengthening recreational facilities.
Energy: Sustainable energy production, utilizing residual heat, utilizing rooftops and vacant land for energy production.

(Province Limburg et al., 2021)

Port: Expanding the port.

VOORBIJ GRENZEN, NOVEX SOUTH LIMBURG:

Circular economy: Focus on circular and knowledge-based economy.
Urbanization: Near intercity hubs mixed-use developments.
Innovation and technology: Cross-border collaboration.
Social well-being: Addressing health, (climate change) poverty, and labor shortages.
Mobility: Towards sustainable networks, strengthening intercity connections (HSL to Germany and Belgium).
Energy infrastructure: Improving networks for energy and resources.
Chemelot transition: Nationally important, cross-border pipelines.
Logistics: Future with more car, train and ship traffic, therefore expansion of networks.

(Rijksoverheid, 2024)

MAASWERKEN PROGRAMME:

Room for the river: Deepening shiproutes, elevating bridges, widening the riverbed, better flood protection.

(Ministerie van Infrastructuur en Waterstaat, 2025)

NOVI:

Industry: More sustainable and compact land use, emission reduction.
Economic strengthening: Cross-border connections for Limburg.
Sustainable and circular: Focus on sustainability and circular economy.
Quality of life: Improving quality of life in urban and rural areas.
Safety and health: Limiting pollution and hazards
Space for climate adaptation and energy transition: Integrating climate adaptation into policies, updating energy infrastructure.

(Rijksoverheid, 2020)

MOOI NEDERLAND:

Clustering large businesses: Location planning for large businesses, integration with other functions.
Energy infrastructure: Combining multiple functions in energy infrastructure-heavy areas.
Environmental and spatial integration: Minimizing environmental impact of energy infrastructure in sensitive areas.
Energy and climate goals: Balancing energy transition with environmental and health protection

(Rijksoverheid, 2022)

EUROPEAN COMMISSION:

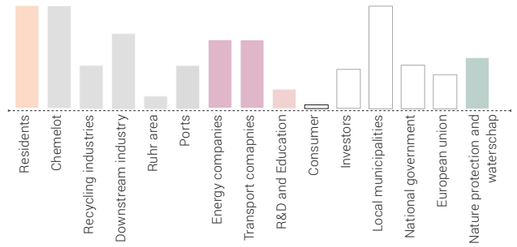
Circular economy: Action plan for circular economy, sustainable production processes, mandatory waste reduction.
Recycling and waste: Focus on waste reduction, addressing waste exports from the EU.

(European Commission, 2020)

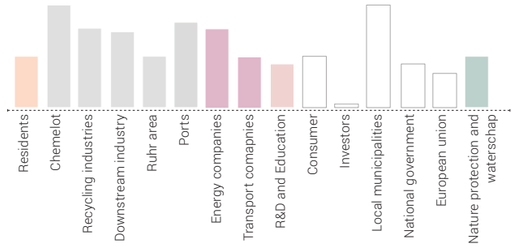
Importance stakeholders

Based on our understanding, the degree of representation in Policy documents

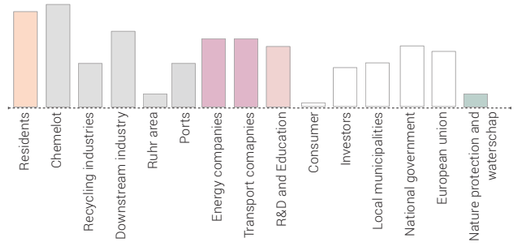
SITTARD-GELEEN



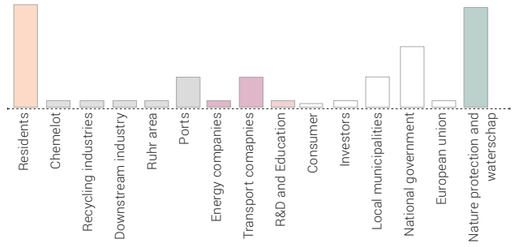
CHEMELOT



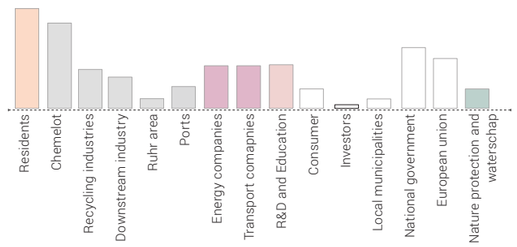
NOVEX



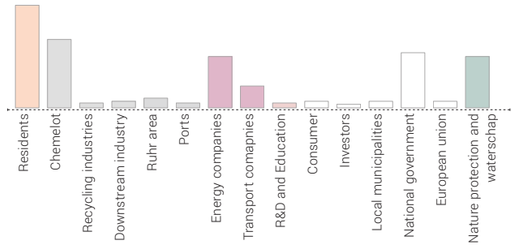
MAASWERKEN



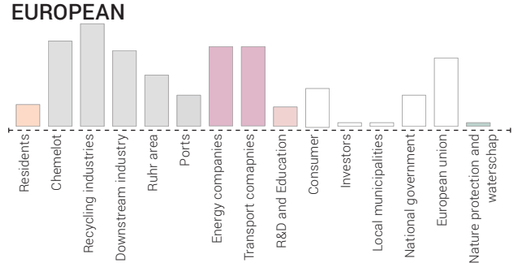
NOVI



MOOI NEDERLAND



EUROPEAN



It is evident that most policies encompass all relevant stakeholders. However, many of these policies tend to place a greater emphasis on economic interests, with Chemelot being a significant player in this context. While the interests of residents are also considered, the policies suggest that they should be required to deal with the consequences associated with Chemelot in the energy transition in order to retain their significance. This highlights the importance of advocacy for the community, as they often have a less influential voice compared to large industrial entities such as Chemelot.

POWER INTEREST RELATION

CURRENT SCENARIO

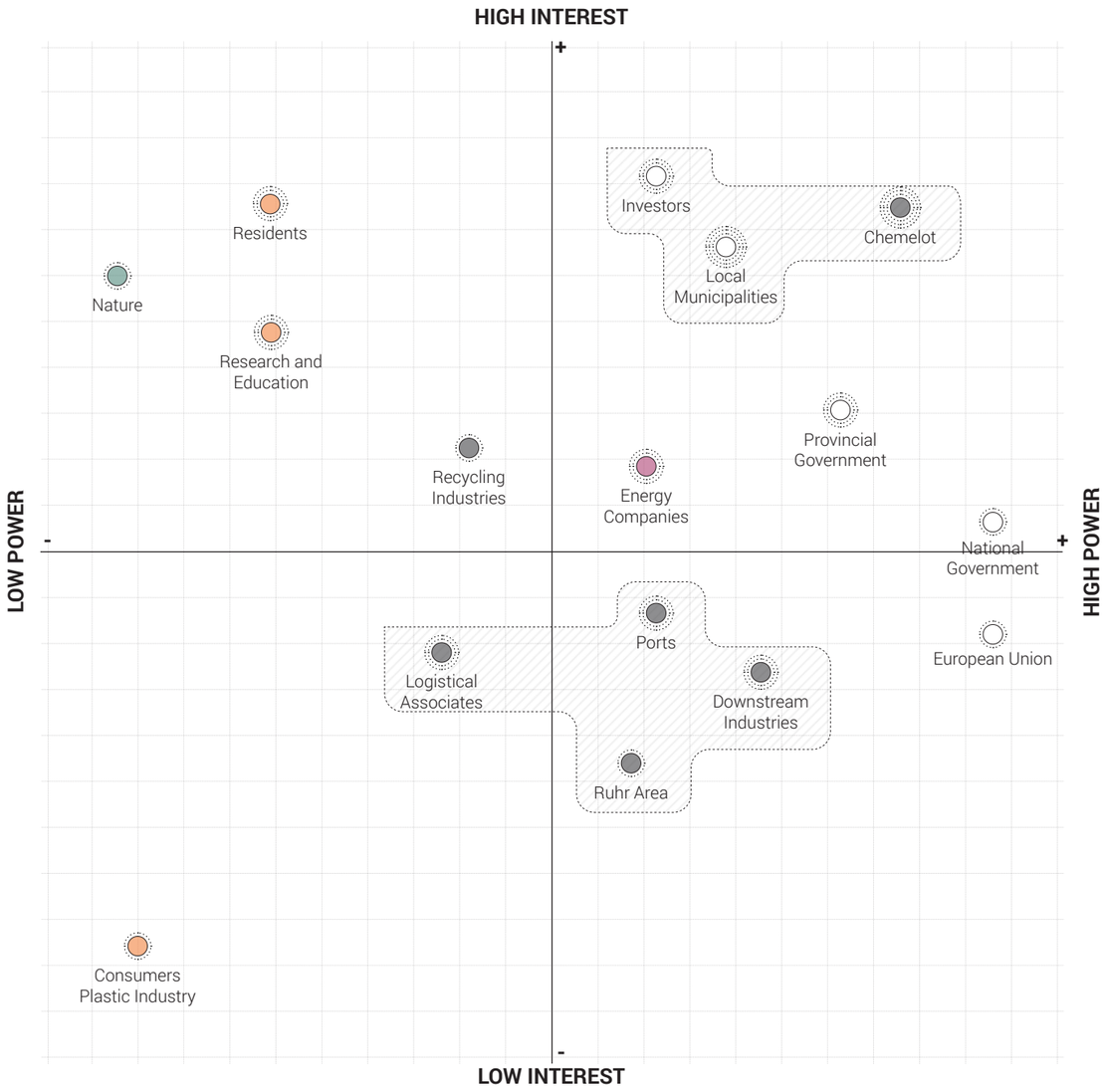
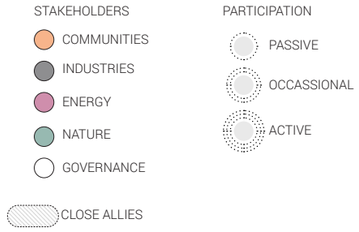


Fig: 89- Power Interest Matrix- Currently

Given the current situation, the Power-Interest Matrix of key stakeholders reveals a clear divide. Many industrial players, closely aligned as part of the broader industrial ecosystem, possess relatively high power to influence a cluster such as Chemelot, though they exhibit slightly lower levels of direct interest. The primary power holders—Chemelot, investors, and the municipality—form a strong alliance with one another. In contrast, other important stakeholders such as local residents and environmental interests, despite having a high level of interest, hold limited power and participation in the decision-making process.



FUTURE SCENARIO

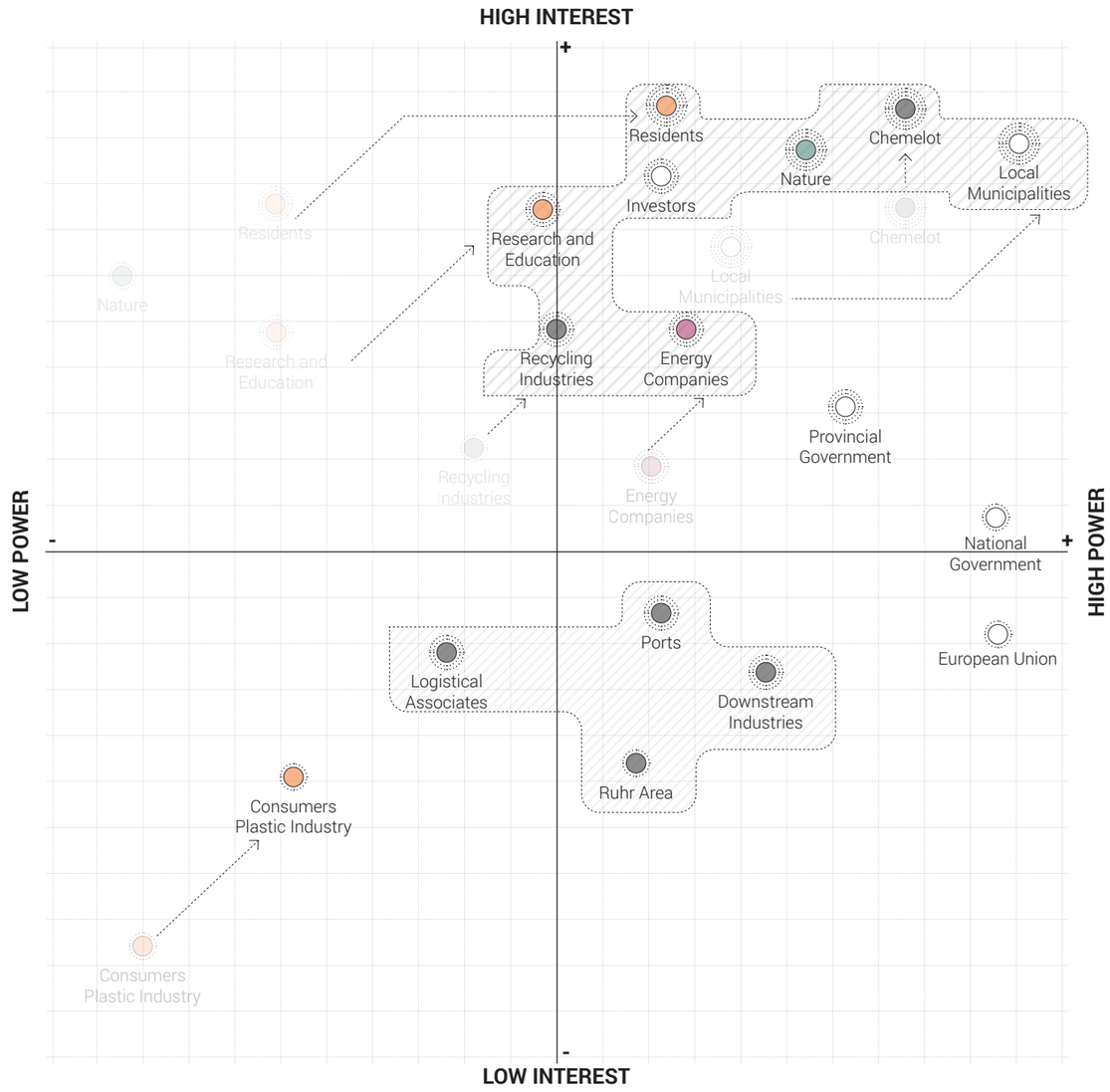
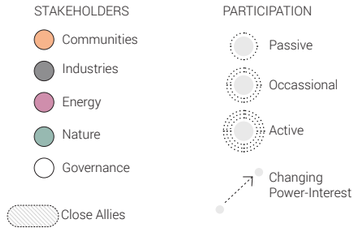


Fig: 90- Power Interest Matrix: Proposed

In the proposed Power-Interest Matrix, we aim to give more power and involvement to high-interest stakeholders like the community and nature, encouraging a bottom-up approach. With greater participation, these groups now join other key players to form a new, more balanced stakeholder cluster, working together as close allies. This shift supports the vision's core idea of symbiosis—different interests cooperating for mutual benefit and a more sustainable outcome.



SPATIAL IMPACT OF THE STAKEHOLDERS

The stakeholders can be categorised based on their environmental impact to understand their spatial behaviour. This classification follows the principle of Rust, Ruis, Reuring—meaning Calmness, Rustle, and Commotion—from De Zwarte Hond (De Zwarte Hond & Province Zuid Holland, 2022). This principle has been further developed into six environmental categories, each based on noise levels:

SPATIAL ZONES

1. Calmness: Predominantly nature areas.

2. Rustle: Characterised by soft sounds, typically found in agricultural and rural areas.

3. Commotion: Primarily residential neighbourhoods with less functional diversity.

4. Hustle and bustle: Refers to urban city centres, with a high concentration of functions, activities, and people.

5. Rough: Areas with more industrial characteristics, such as distribution centres and manufacturing sites.

6. Noise: Heavy industrial zones, such as Chemelot.

These environmental zones facilitate the differentiation of areas not solely by their use but by their environmental impact. This approach offers a clearer understanding of potential conflicts, where certain zones may lead to nuisance issues, and areas where symbiosis could occur, allowing for co-existence or even beneficial exchanges. To mitigate conflicts, buffer zones should be introduced between these areas. Additionally, to promote symbiosis, transitional spaces can be implemented, facilitating smoother integration between different environmental zones.

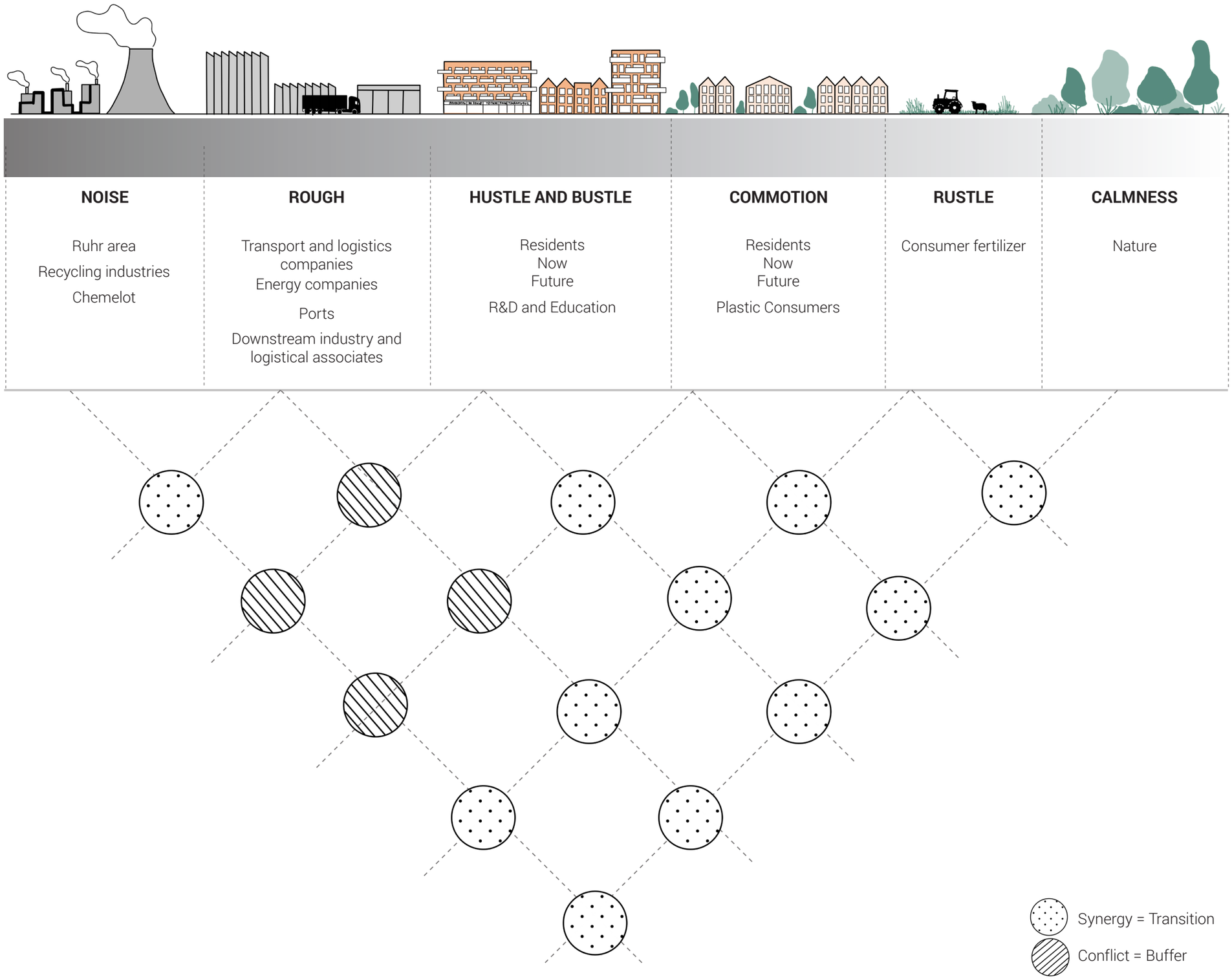


Fig: 91- Diagram showing Conflicts and Synergies in Spatial impact of Various stakeholders

ENVIRONMENTAL ZONING

This map visually represents the environmental zones within the region, with the intensity of the colour indicating the level of noise in each area. Darker colours correspond to areas with higher levels of noise. This provides a clear overview of locations where significant noise concentrations overlap. When highly noisy environmental zones are located near residential areas, a potential conflict can be identified, which would require the establishment of a buffer zone. Conversely, when similar types of zones are situated close to one another, or when complementary zones are in proximity, a symbiosis can occur, allowing for the possibility of a smooth transition between the zones.

This environmental zoning is carried out by color-coding various spatial characteristics into six zones using Google Earth, as explained earlier.

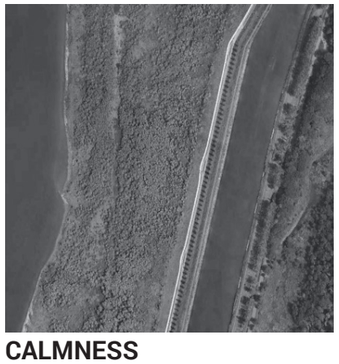
NOISE

ROUGH

HUSTLE AND BUSTLE

COMMOTION

RUSTLE



CALMNESS

Fig: 92- Images showing spatial characters used to do environmental zoning (Source: Google Earth)

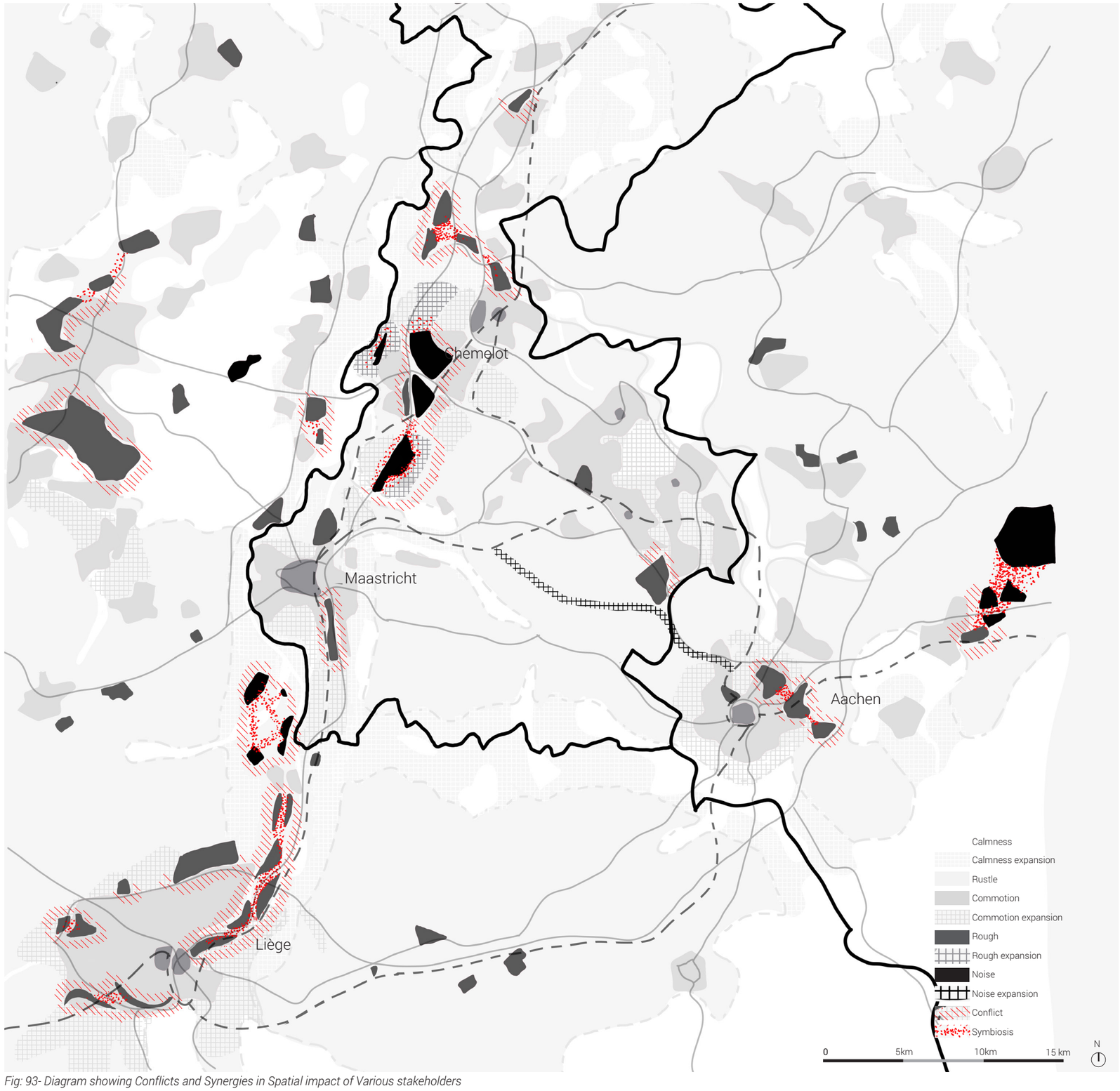


Fig: 93- Diagram showing Conflicts and Synergies in Spatial impact of Various stakeholders

OVERVIEW: PATTERN LANGUAGE FOR DEVELOPMENT STRATEGY

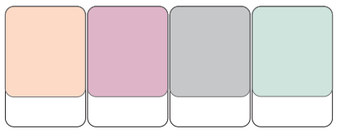
WHY PATTERN LANGUAGE?

A pattern language Inspired from 'Cities of Making' offers a powerful way to understand and shape complex spatial systems by breaking them down into clear, repeatable units of spatial knowledge—patterns. Instead of addressing isolated problems, patterns capture recurring spatial situations and propose grounded, adaptable solutions. This structured yet flexible approach enables diverse stakeholders—from different disciplines and backgrounds—to engage in constructive, solution-focused dialogue without oversimplifying or losing sight of complexity. Each pattern is rooted in research, refined through design exploration, and aimed at achieving a desired spatial quality. Together, these interconnected patterns form a practical toolkit for navigating and designing complex spatial futures. (Neyrinck, Kelly, Hoekstra, & van den Berg, 2018)

DEVELOPMENT OF PATTERN LANGUAGE

The Pattern Language has been developed through a bottom-up process, primarily informed by the Vision, Stakeholder Analysis, and the confrontation of existing Policies with this Vision. At its core, the Vision identifies four key actor groups, each with distinct spatial needs and aspirations. These form the foundation for the first set of patterns: Spatial-Functional Patterns, which capture how different actors imagine and use space. As these patterns interact—whether through alignment or contradiction—they generate Spatial Conditions. When policies or stakeholder interests clash, conflicts arise; when they align, they create opportunities for synergy. In cases of conflict, spatial segregation may serve as a practical solution. In contrast, synergy between actors is best supported through spatial integration. These dynamics are addressed in the next two decks of the Pattern Language: Borders and Transitions, which offer spatial strategies to mediate tensions or enhance cooperation. The final layer consists of Policy Patterns, developed through a top-down analysis of governance frameworks and stakeholder roles. This deck provides essential regulatory, institutional, and financial mechanisms that support the implementation of the spatial strategies. Together, these four decks—Spatial-Functional, Borders, Transitions, and Policy Patterns—form a comprehensive Pattern Language. As a co-design tool, it enables context-sensitive spatial planning and collaborative decision-making across diverse locations within the region.

TYPES OF PATTERNS



SPATIAL FUNCTIONAL PATTERNS

Each pattern in this deck articulates a spatial situation grounded in the needs of a specific actor. These patterns are not isolated; they are intentionally designed to be specific yet adaptable, representing recurring spatial configurations that can be translated across different contexts.

BORDER PATTERNS

The Borders deck offers spatial solutions for managing such conflicts through careful separation, buffering, or zoning. These spatial tactics help reduce friction between incompatible functions, allowing them to coexist within the same urban fabric without negatively impacting each other.

TRANSITION PATTERNS

The Transitions deck captures the positive interactions and proposes spatial solutions that foster integration and cooperation. Rather than enforcing separation, these patterns promote spatial integration and collaboration—transforming proximity into added value for both stakeholders.

POLICY PATTERNS

These enable the implementation and long-term sustainability of spatial strategies, ensuring that the physical interventions proposed in the previous decks are backed by governance structures and economic support.

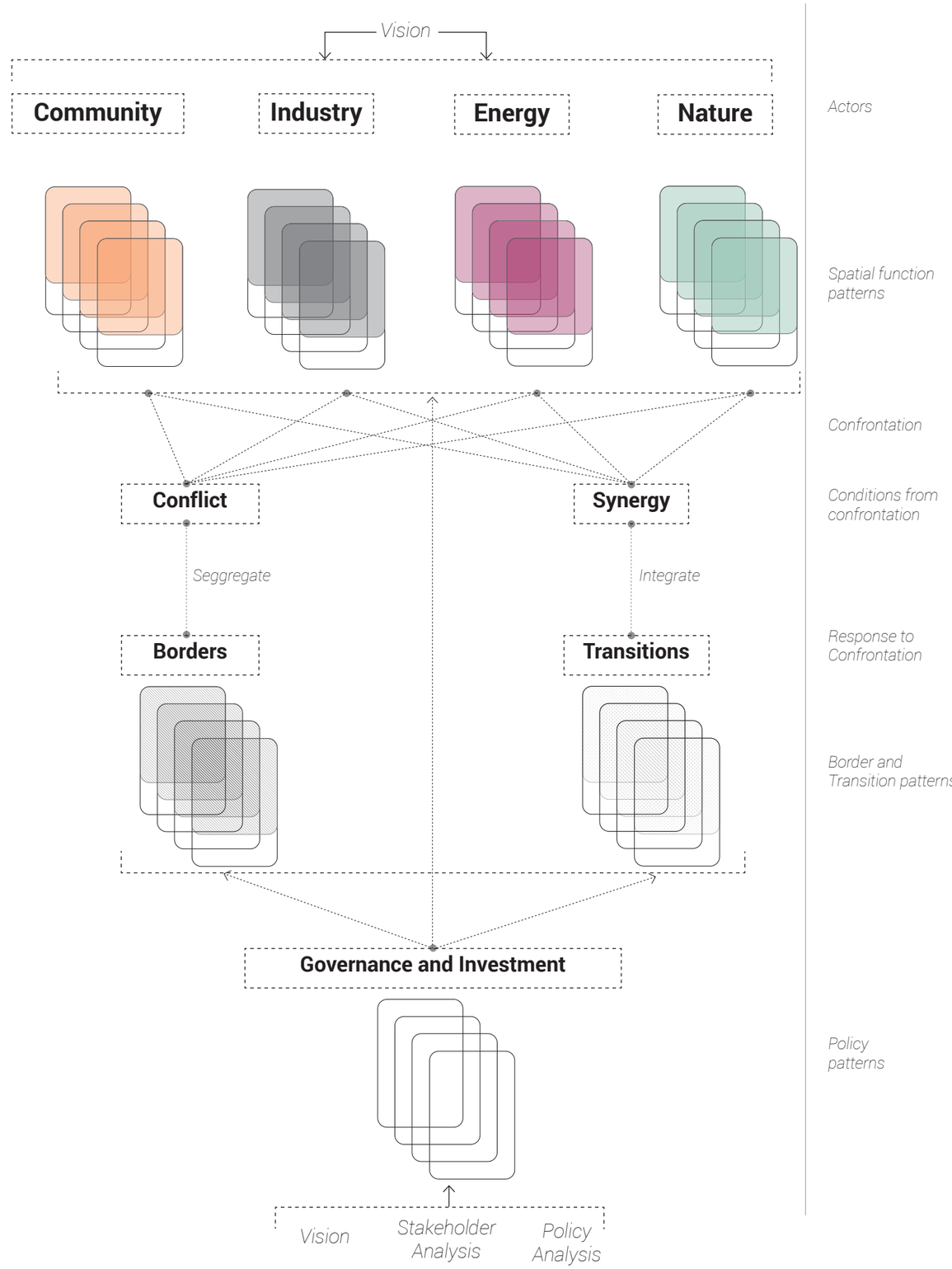


Fig: 94- Diagram explaining Derivation and Development of The Pattern Language

EXPLAINATION OF PATTERN CARD FORMAT

IDENTIFICATION CODE
This is a unique alphanumeric code assigned to each pattern card for easy reference and categorization. It ensures that every pattern can be quickly identified and located within the larger pattern language framework.

TITLE OF THE PATTERN
The title is a brief, clear name that summarizes the core idea or function of the pattern. It serves as a quick reference for the user, encapsulating the pattern's intent and its role in the spatial design solution.

VISUAL DEPICTION
A visual representation that illustrates the spatial arrangement or concept described in the pattern. The image helps users visualize the pattern in context, providing a clearer understanding of its application. These Images for all Spatial cards are kept in Isometric format to depict form and qualities.

RELATED PATTERNS
This section provides guidance on how the pattern interacts with others in the pattern language. It suggests complementary patterns or identifies potential conflicts that users should consider when applying the pattern in a design process. It helps stakeholders understand the interrelationships between different patterns and how they can be integrated effectively.

STRENGTH MEASUREMENT
The Strength Bars provide a visual gauge of three critical factors for each pattern:
Resilience: Measures the pattern's ability to adapt to changes over time or under varying conditions.
Urgency: Indicates how urgently the pattern needs to be implemented in the design process.
Degree of Effort: Reflects the level of effort required to implement the pattern, including resources, time, and complexity.

FINANCIAL SUPPORT
This section indicates which sector—Private, Public, or Civic—is responsible for funding the implementation of the design associated with the pattern.

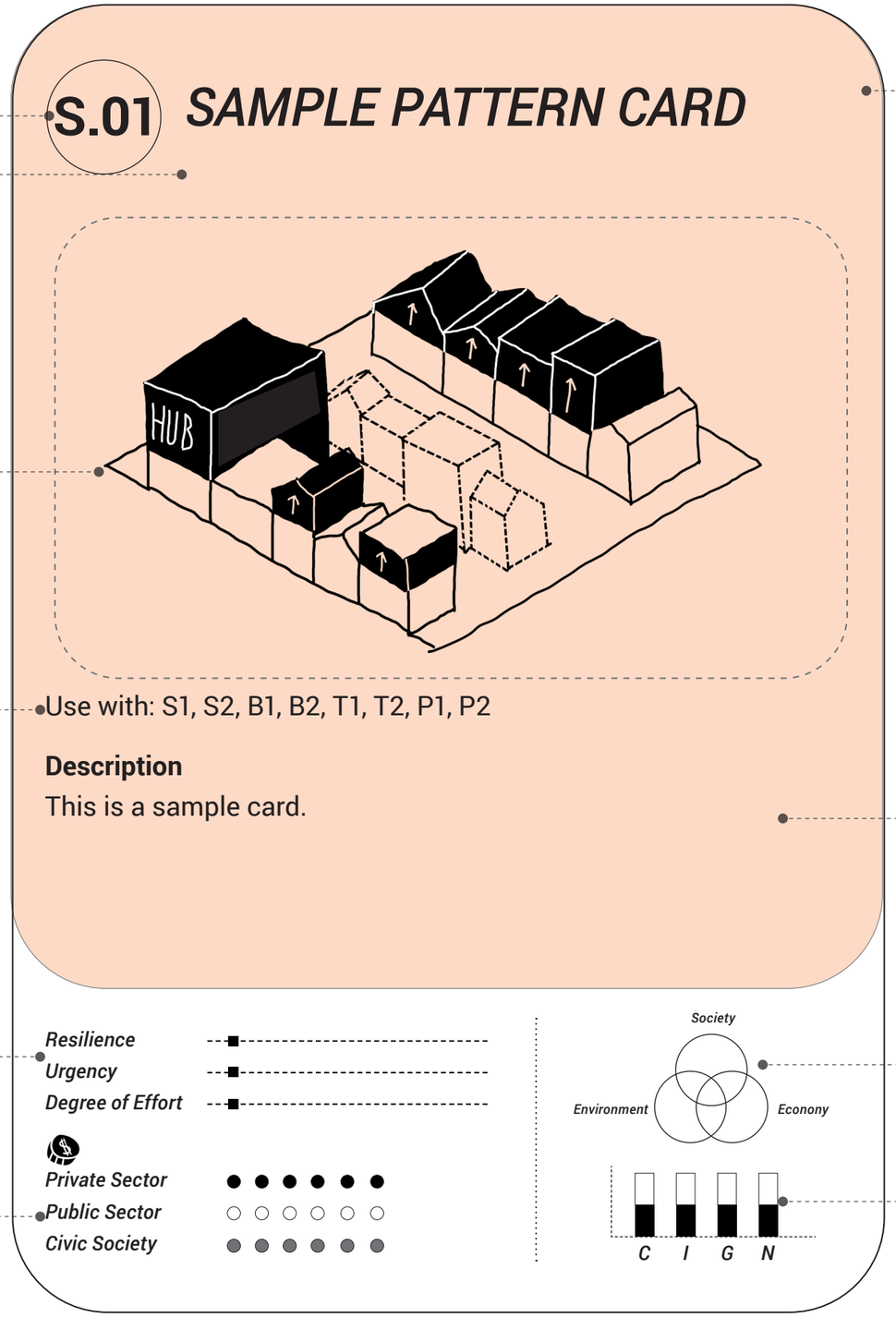
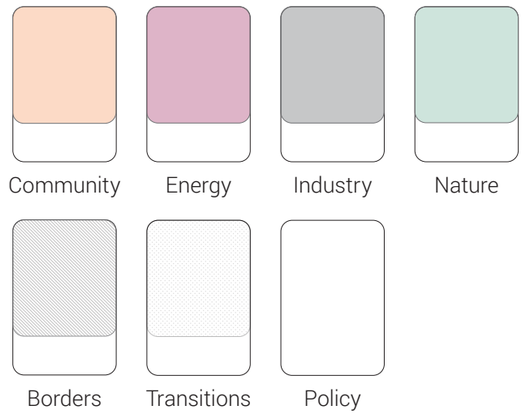


Fig: 95- Pattern Language Sample Card

PATTERN TYPE
Each card is color-coded to signify its specific category or thematic focus. The color serves as a visual cue, allowing users to quickly identify the type of pattern. All types of cards are:



DESCRIPTION
The description provides a concise explanation of the pattern's purpose and the context in which it can be applied. It outlines the problem the pattern addresses, the spatial dynamics it seeks to resolve, and the solution it proposes. This section is crucial for understanding the pattern's relevance and how it fits into the overall design process.

ALIGNMENT WITH CONCEPTUAL FRAMEWORK
The diagram visually highlights how the pattern aligns with the overarching conceptual framework of the project. It shows the connections between the pattern and the larger goals or themes, allowing users to see how the pattern supports the project's vision.

Power-Interest
This section assesses the power and interest of each stakeholder involved in the design process.

C: Communities

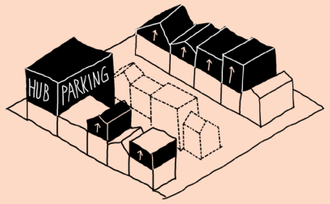
I: Industries

G: Government

N: Nature

SPATIAL FUNCTIONAL PATTERNS

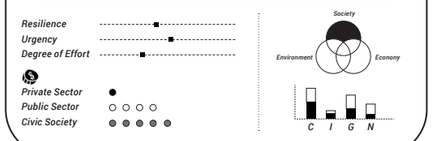
S.01 DENSIFICATION OF EXISTING TOWNS



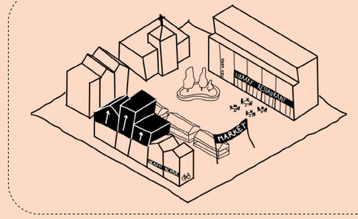
Use with: B4, B5, P1, P3, P4, P9, T1, T3, T4, T5

Description

Enhancing the livability of towns through more efficient land use—such as increasing residential density and repurposing on-street parking for community amenities and public spaces—creates more vibrant, accessible, and people-friendly environments.



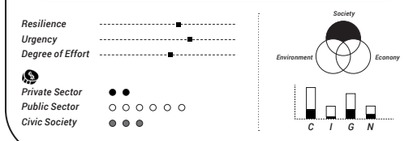
S.02 LIVELY URBAN CORES



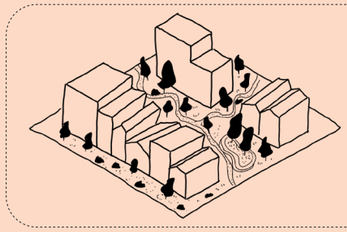
Use with: B2, B4, T1, T2, T3, T8, P6, P8

Description

Establishing distinctive and vibrant central hubs where communities can gather and access essential services enhances social interaction and convenience. In the short term, implementing zero-emission zones can improve air quality and public spaces while broader efforts to enhance centralities and urban livability are underway.



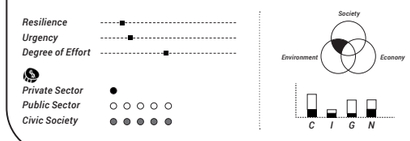
S.03 CONNECTED URBAN EXPANSION



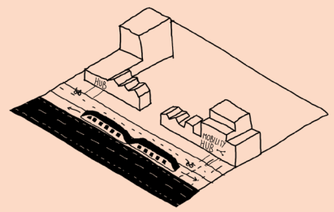
Use with: B1, B2, B3, B5, T1, T2, T9, P4, P5, P6, P8

Description

As towns densify, strategic residential growth should prioritize sustainability, accessibility, and quality of life by leveraging existing infrastructure, promoting mixed-use development, protecting green spaces, and enhancing public transport and community amenities.



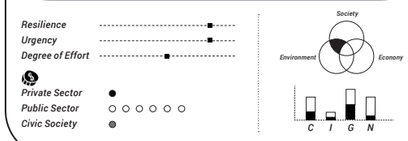
S.04 SLOW MOBILITY CONNECTIVITY



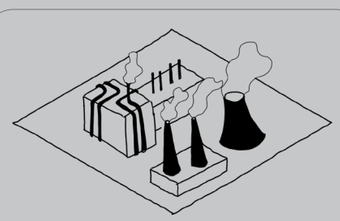
Use with: B5, T6, T9, P3

Description

Improving access to services and facilities by developing a slow mobility network enhances walkability and pedestrian movement while prioritizing the needs of vulnerable groups, ensuring safer, more inclusive, and easily navigable urban spaces.



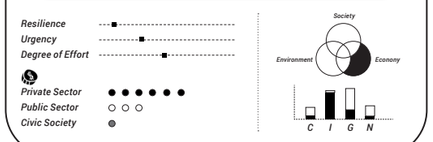
S.05 CLUSTERING OF HEAVY INDUSTRIES



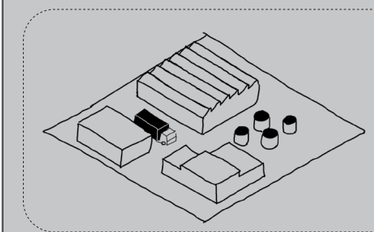
Use with: B1, B3, B4, B5, B6, T4, T8, P1, P3, P6, P7, P8, P10

Description

Strategic clustering of heavy industries through land use and environmental zoning promotes high circularity, efficient segregation, and interdependent resource use, fostering sustainability and reducing waste.



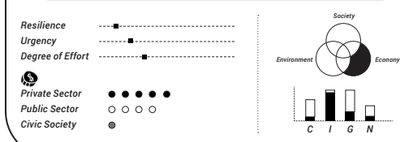
S.06 LIGHT INDUSTRIES AS A DYNAMIC ZONES



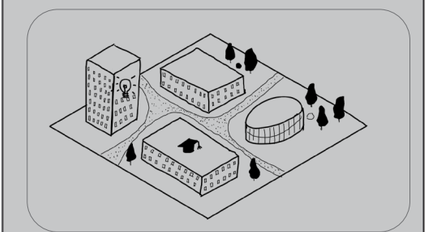
Use with: B2, B4, B5, T1, T2, T3, T4, T7, T8, P6, P8

Description

Implementing light industrial zones as buffers between residential and heavy industry ensures a smooth transition in land use, minimizing disruptions while integrating industry with public spaces for accessibility and economic vitality.



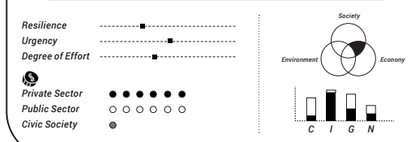
S.07 PUBLIC RESEARCH AND INNOVATION HUBS



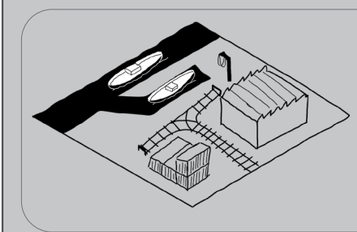
Use with: T1, T2, T3, T4, T6, T7, T8, T9, P6, P7, P8, P10

Description

Establishing research and innovation facilities as focal points benefitting community and industry should incorporate public and activity spaces to encourage collaboration, community engagement, and a vibrant, interactive environment.



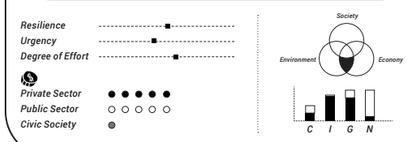
S.08 NATURE SENSITIVE PORT INFRASTRUCTURE



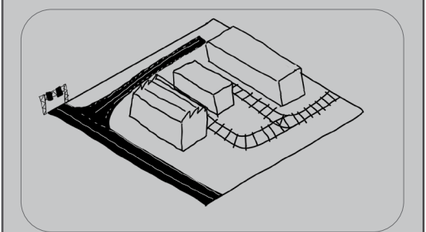
Use with: B1, B4, B6, T2, T8, T9, P2, P3, P8

Description

Expanding port facilities should focus on integrating sustainable transport options, like rail and road, while ensuring that surrounding natural reserves and water flow are protected. The design should include ample space for both functional port operations and environmental preservation, creating a balanced, efficient, and eco-friendly space.



S.09 FAST LOGISTICS AND TRANSPORT NETWORK



Use with: B5, T6, T8, P2, P3

Description

Enhancing transport infrastructure to provide direct, fast, and reliable connections between logistics hubs, supply chains, and production centers in the region strengthens logistics efficiency, reduces transit times, and boosts regional economic connectivity.

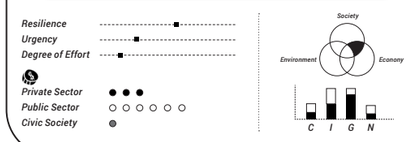
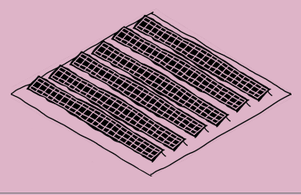


Fig: 96- Pattern Language Cards: Spatial Functional Patterns

SPATIAL FUNCTIONAL PATTERNS

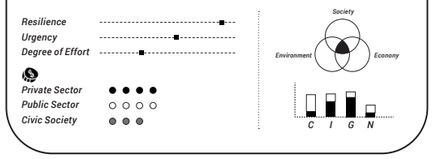
S.10 SOLAR ENERGY ON SUITABLE LAND



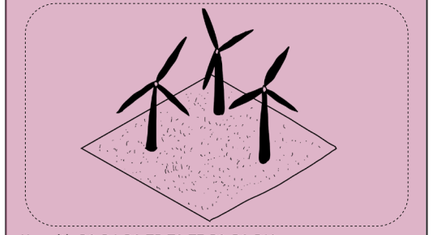
Use with: B2, B4, B5, T2, T4, T7, P2, P6, P10

Description

Deploying solar energy on adaptable land, such as agricultural sites, ensures efficient energy production while preserving space for future land use and development.



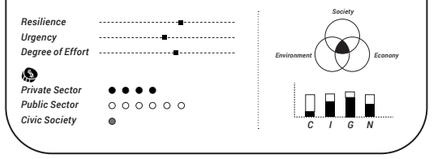
S.11 WIND ENERGY PROVISIONS AT HIGH POTENTIALS



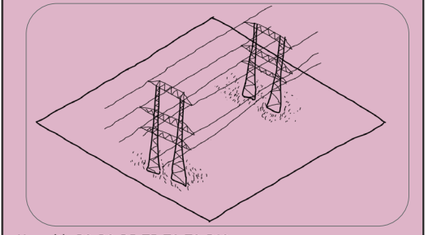
Use with: B3, B4, B6, T5, T6, T7, P2, P6, P10

Description

Utilizing high wind potential areas with low arable land for wind energy generation provides a sustainable local energy source while preserving land for future uses, such as nature conservation or development.



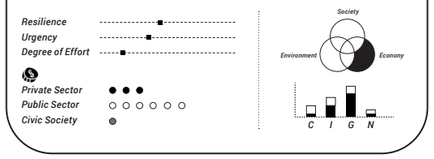
S.12 ENERGY TRANSMISSION CORRIDORS WITH BUFFERS



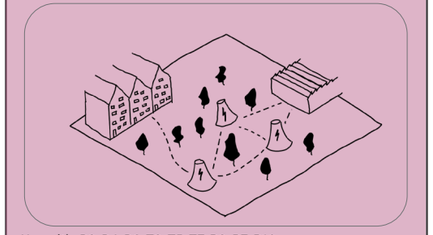
Use with: B2, B3, B5, T5, T6, T8, P10

Description

Enhancing energy transmission lines and transformers boosts grid capacity, reduces congestion and losses, and future-proofs the area to accommodate growing electricity demand driven by the energy transition and increased regional density.



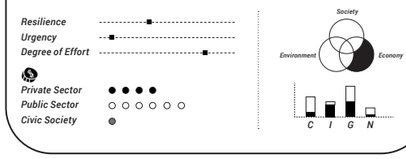
S.13 SAFE ZONES FOR NUCLEAR-SMR'S



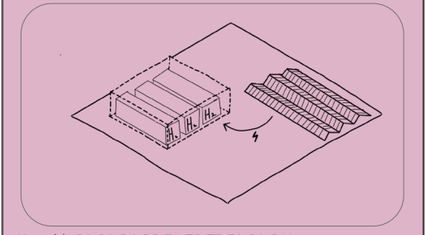
Use with: B3, B4, B6, T2, T5, T7, P2, P7, P10

Description

Implementing Small Modular Reactors (SMRs) across the region can provide reliable energy, potentially utilizing land reserves or replacing other energy land uses, depending on the safety and technological advancements of the reactors at the time of implementation.



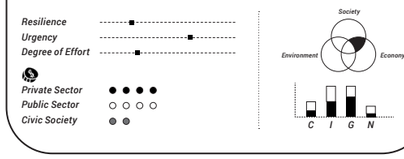
S.14 ENERGY STORAGE CAPACITY WITHIN USE



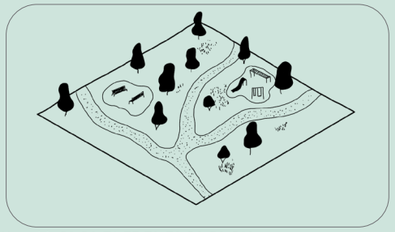
Use with: B2, B3, B4, B5, T1, T5, T7, T8, P2, P10

Description

Energy storage facilities, using advanced batteries like metal-hydrogen or sodium-ion, can be integrated into repurposed industrial buildings and community homes, optimizing space for sustainable energy storage at both large and local scales.



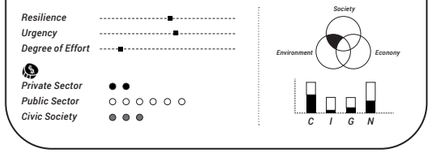
S.15 ACCESSIBLE RECREATIONAL AREAS



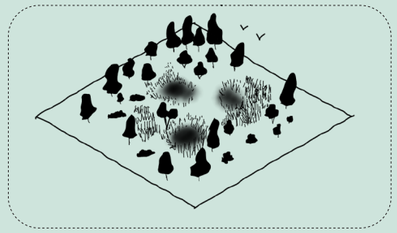
Use with: B1, B6, T4, T7, T8, T9, P2, P3, P10

Description

Providing well-designed recreational areas and green spaces with varied landscapes, walking paths, and communal zones enhances community amenities, fosters connection with nature, and improves the spatial quality and livability of the region.



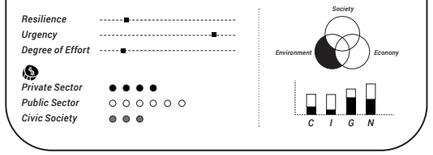
S.16 HIGH BIO-DIVERSITY ZONES



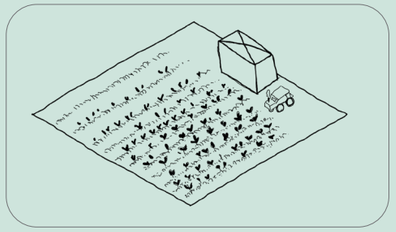
Use with: B1, T3, T8, T9, P4, P5,

Description

Reserving space for a diverse mix of flora and fauna within the region creates natural habitats, integrates green corridors, and enhances the spatial quality by providing accessible, immersive natural areas that support biodiversity and ecosystem health.



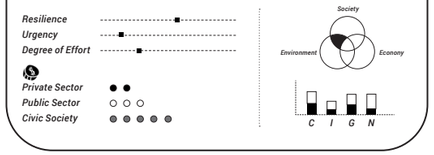
S.17 PRODUCTIVE AGRICULTURAL LAND



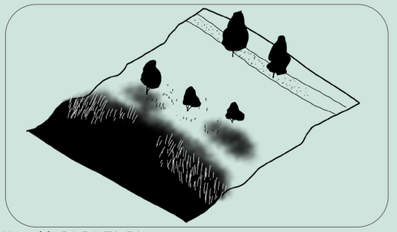
Use with: B1, B4, T6, T7, T9, P2, P5

Description

Designating space for agricultural land within the region supports local food and resource production, reducing reliance on external transport. This land should be integrated with well-planned layouts, ensuring easy access, efficient land use, and connections to nearby communities.



S.18 RESERVATION ROOMS FOR WATER LEVELS



Use with: B1, B4, T8, P2

Description

Reserving space for potential flooding and watercourse changes over time helps mitigate future conflicts between humans and water. This space should be designed with natural buffers, such as wetlands and floodplains, enhancing spatial quality by integrating water management into the landscape while preserving environmental resilience and reducing impact on urban areas.

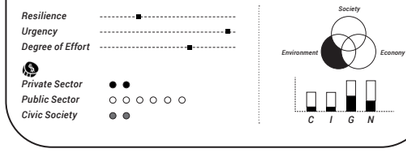
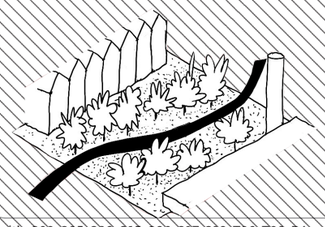


Fig: 97- Pattern Language Cards: Spatial Functional Patterns

BORDER PATTERNS

B.01 *ECOLOGICAL CORRIDORS*



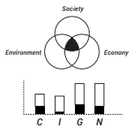
Use with: S03, S05, S08, S15, S26, S17, S18, T06, T09, P4

Description

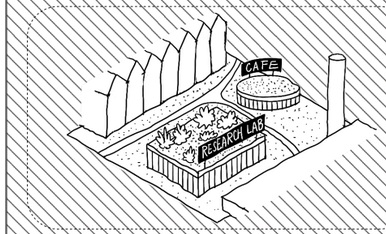
Creating and strengthening ecological corridors to connect natural areas while integrating amenities and utilities where needed. These corridors support wildlife movement, protect biodiversity, and can also serve as natural boundaries.

Resilience
Urgency
Degree of Effort

Private Sector ● ● ● ●
Public Sector ○ ○ ○ ○
Civic Society ●



B.02 *UTILITY AS A SHARED BUFFER*



Use with: S2, S3, S6, S10, S12, S14, P6, P7

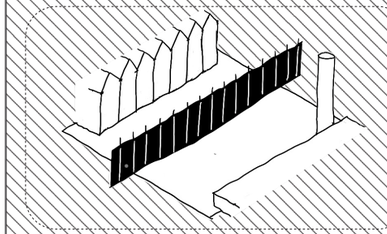
Description

Plan and reserve space for shared utility infrastructure that supports both residential and industrial areas. As a transitional zone, it can also accommodate compatible secondary uses—such as light industrial activities, commercial services, or public amenities—creating a multifunctional space that enhances land efficiency while maintaining separation between different land uses.

Resilience
Urgency
Degree of Effort

Private Sector ● ● ● ● ● ●
Public Sector ○ ○ ○ ○ ○ ○
Civic Society ● ●

B.03 *PHYSICAL BARRIERS*



Use with: S3, S5, S4, S12, S13, S14, P9

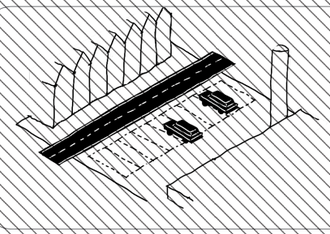
Description

Deploy physical barriers only where spatial definition or separation is essential to improve the overall experience and function of a place. When carefully integrated with other border types—such as landscape buffers, elevation changes, or transitional land uses—can enhance spatial clarity, define edges, or improve transitions.

Resilience
Urgency
Degree of Effort

Private Sector ● ●
Public Sector ○ ○ ○ ○ ○ ○
Civic Society ● ●

B.04 *INFRASTRUCTURAL BUFFERS*



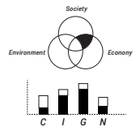
Use with: S1, S2, S5, S6, S8, S10, S11, S13, S14, S17, S18, P7

Description

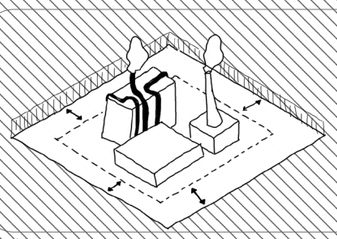
Introduce infrastructural edges—such as roads or railways—where they improve accessibility and support the spatial organization of land uses. Combined with other patterns, these elements can enhance spatial legibility, connectivity, and overall quality of place.

Resilience
Urgency
Degree of Effort

Private Sector ● ● ● ●
Public Sector ○ ○ ○ ○ ○ ○
Civic Society ●



B.05 *USE OF SETBACKS*



Use with: S1, S3, S4, S5, S6, S9, S10, S12, S14, P4

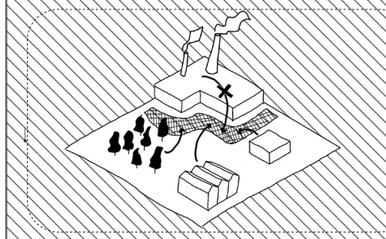
Description

Strategic setbacks can create necessary buffers for high-impact uses like heavy industry or transportation hubs, improving spatial quality by providing separation. These spaces can incorporate green buffers, pedestrian pathways, or open areas, helping mitigate environmental effects like noise and pollution while enhancing aesthetics and connectivity.

Resilience
Urgency
Degree of Effort

Private Sector ● ● ● ● ● ●
Public Sector ○ ○ ○
Civic Society ●

B.06 *EXCLUSIONARY ZONING*



Use with: S5, S8, S11, S13, S15, P9

Description

Exclusionary zoning involves land-use policies to protect environmentally sensitive areas by limiting certain types of development in regions vulnerable to environmental degradation.

Resilience
Urgency
Degree of Effort

Private Sector ● ● ● ●
Public Sector ○ ○ ○ ○
Civic Society ●

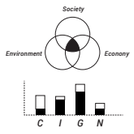
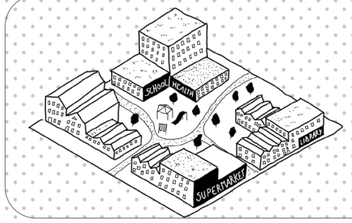


Fig: 98- Pattern Language Cards: Border Patterns

TRANSITION PATTERNS

T.01 SHARED AMENITIES FOR MUTUAL BENEFITS



Use with: S1, S2, S3, S6, S7, S14, P05, P06, P08,

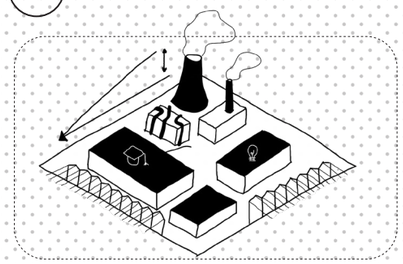
Description

By designing spaces that cater to both industrial workers and residential communities, these shared resources—such as parks, cafes, gyms, or meeting areas—enhance the functionality of the area while promoting social cohesion. Strategically placed between contrasting land uses, shared amenities create seamless transitions, allowing for a richer, more dynamic spatial experience.

Resilience ■
Urgency ■
Degree of Effort ■

Private Sector ● ● ● ●
Public Sector ○ ○
Civic Society ● ● ● ●

T.02 GRADIENT ZONING



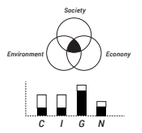
Use with: S2, S3, S6, S7, S8, S10, S13, P2, P4

Description

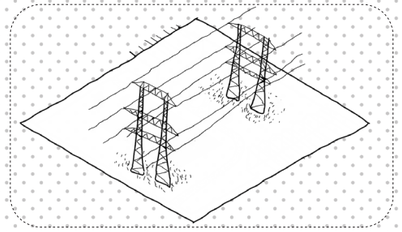
By carefully considering environmental zoning and the specific characteristics of each area, this approach creates buffer zones that blend residential, commercial, and industrial spaces in a way that feels natural and cohesive. The gradual shift in scale, density, and function not only enhances spatial continuity but also promotes a higher quality of life, improving access, circulation, and aesthetic harmony across the zone.

Resilience ■
Urgency ■
Degree of Effort ■

Private Sector ● ● ● ●
Public Sector ○ ○ ○ ○
Civic Society ● ● ● ●



T.03 PUBLIC COMMONS AS A SHARED SPACE



Use with: S1, S2, S6, S7, S16, P8, P9

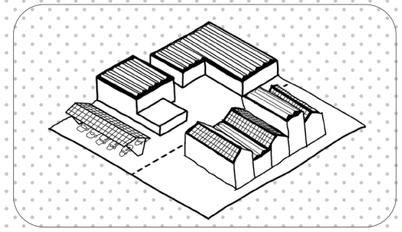
Description

Open public spaces can serve as shared areas for complementary functions, like recreation and community events. By designing these spaces to accommodate diverse activities, they enhance spatial quality and social interaction, creating dynamic environments. Features such as seating, green areas, and flexible layouts allow these spaces to adapt to various uses, fostering connection and improving urban funetionality.

Resilience ■
Urgency ■
Degree of Effort ■

Private Sector ● ● ●
Public Sector ○ ○ ○ ○ ○ ○
Civic Society ● ●

T.04 ROOFTOP POTENTIALS



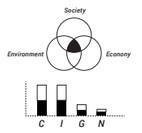
Use with: S1, S5, S6, S7, S16, P10

Description

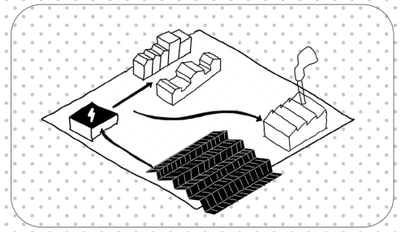
Maximizing roof surfaces for functional uses—such as solar panels or urban farming—enhances both spatial efficiency and environmental sustainability.

Resilience ■
Urgency ■
Degree of Effort ■

Private Sector ● ● ● ● ●
Public Sector ○
Civic Society ● ● ● ● ●



T.05 GENERATING MICRO-GRIDS



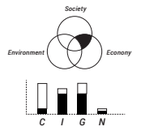
Use with: S1, S11, S12, S13, S14, P7, P10

Description

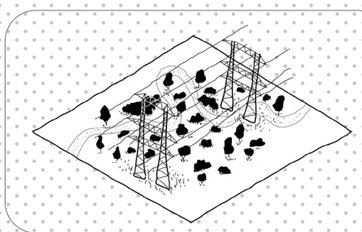
Microgrids can function as effective transitional zones between energy infrastructure and other land uses, such as residential, commercial, or industrial areas. They an reduce the strain on the larger energy grid, improving spatial efficiency in energy production, consumption, and distribution.

Resilience ■
Urgency ■
Degree of Effort ■

Private Sector ● ●
Public Sector ○ ○ ○ ○ ○
Civic Society ● ● ● ● ●



T.06 CREATING FUNCTIONAL OVERLAYS: CORRIDORS



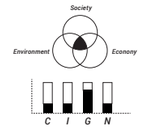
Use with: S4, S7, S9, S11, S12, B1, P6, P8

Description

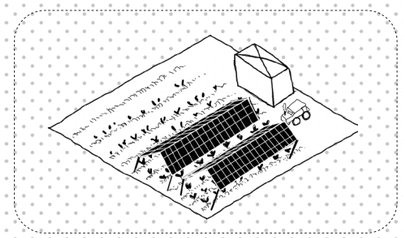
Functional overlays along corridors combine different infrastructural elements—such as transportation routes, utilities, and green spaces—to create smooth, efficient transitions between diverse land uses. These corridors act as flexible spaces that adapt to various needs, enhancing connectivity and fostering more sustainable urban movement.

Resilience ■
Urgency ■
Degree of Effort ■

Private Sector ● ● ●
Public Sector ○ ○ ○
Civic Society ● ● ● ●



T.07 CREATING FUNCTIONAL OVERLAYS: LAND USE



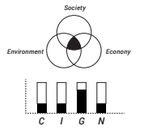
Use with: S6, S7, S10, S11, S12, S13, S14, S15, S17, P6, P8

Description

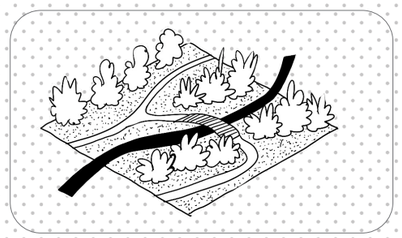
Functional overlays in land use areas integrate compatible activities, such as residential, commercial, and recreational spaces, to create harmonious transitions. By layering different functions within a single zone, this approach helps balance density, enhance spatial quality, and promote multifunctionality, ensuring that each area serves multiple roles effectively.

Resilience ■
Urgency ■
Degree of Effort ■

Private Sector ● ● ●
Public Sector ○ ○ ○
Civic Society ● ● ● ●



T.08 CONNECTING WITH GREEN SPINES



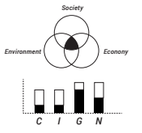
Use with: S2, S5, S6, S7, S8, S9, S14, S15, S16, S18, P4, P10

Description

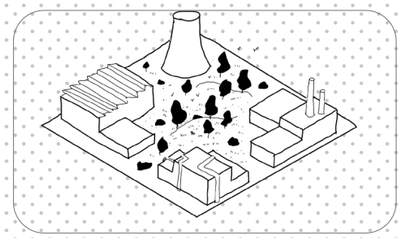
A green spine acts as a continuous, multifunctional corridor that links diverse land uses, from residential to commercial and industrial areas. By integrating green spaces, pedestrian pathways, and recreational zones, it creates a seamless transition between different urban environments. .

Resilience ■
Urgency ■
Degree of Effort ■

Private Sector ● ●
Public Sector ○ ○ ○ ○ ○
Civic Society ● ●



T.09 ECO+ FUNCTION



Use with: S1, S3, S4, S7, S8, S15, S16, S17, B1, P8, P10

Description

Eco-function focuses on seamlessly blending natural elements with urban environments across all land uses—residential, energy, and industrial. By incorporating green infrastructure, such as parks, green roofs, and natural drainage systems, we can enhance spatial quality while improving environmental performance.

Resilience ■
Urgency ■
Degree of Effort ■

Private Sector ● ● ● ●
Public Sector ○ ○ ○ ○
Civic Society ● ● ●

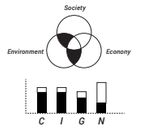
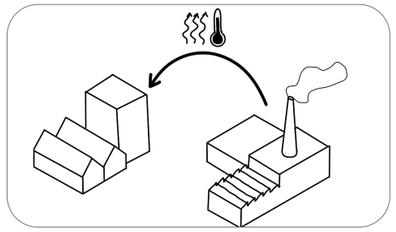


Fig: 99- Pattern Language Cards: Transition Patterns

POLICY PATTERNS

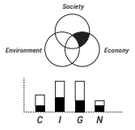
P.01 RESIDUAL HEATING RECYCLING



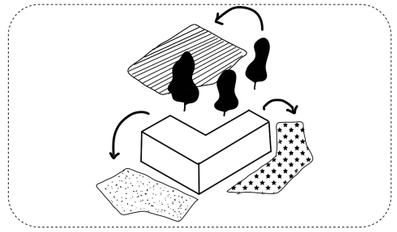
Use with: S1, S5

Description

Reduce carbon emissions and enhance energy efficiency by utilizing excess heat from industrial processes to supply heating to nearby buildings through district heating networks.



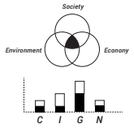
P.02 LAND RESERVES FOR FUTURE USES



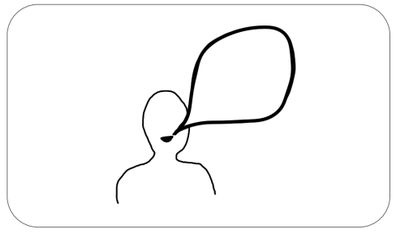
Use with: S8, S9, S10, S1, S13, S14, S15, S17, S18, T2

Description

Reservation of land for future, unforeseen needs and developments, ensuring cities and regions can adapt to population growth, economic shifts, and technological advancements. By setting aside land for potential uses such as housing, infrastructure, and green spaces, the policy promotes sustainable, flexible urban planning and reduces conflicts as new requirements emerge.



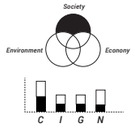
P.03 ADVOCACY



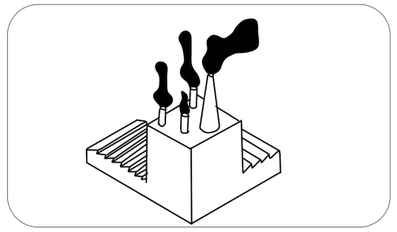
Use with: S1, S5, S8, S9, S15

Description

Establish frameworks that enable communities to express their needs and desires, ensuring their active participation in decision-making processes. It emphasizes the importance of educating stakeholders on a just transition, equipping them with the knowledge to make balanced, informed decisions that support equitable and sustainable development.



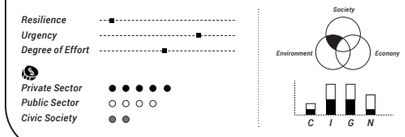
P.04 EMISSION CONTROL



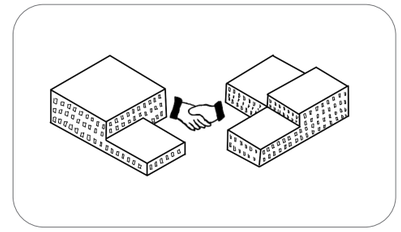
Use with: S1, S3, S16, B1, B5, T2, T8

Description

Implementing effective emission control measures to reduce harmful pollutants and greenhouse gases. It includes setting strict emission standards for industries, transportation, and energy production, promoting the use of cleaner technologies, and encouraging sustainable practices. The goal is to improve air quality, reduce environmental impact, and mitigate climate change.



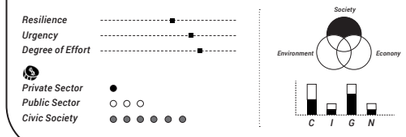
P.05 CO-OPERATIONS FOR COMMUNITY UNITY



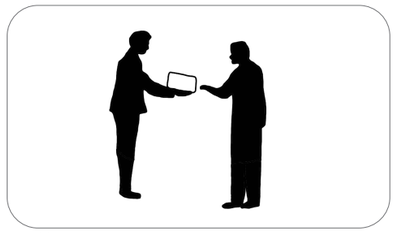
Use with: S3, S16, S17, T1

Description

This policy promotes community empowerment by encouraging the establishment of cooperatives for essential services like housing and energy. It aims to give local communities more control over these services, fostering shared ownership, sustainability, and collaboration while improving access, affordability, and resilience in these critical sectors.



P.06 PUBLIC-PRIVATE PARTNERSHIPS

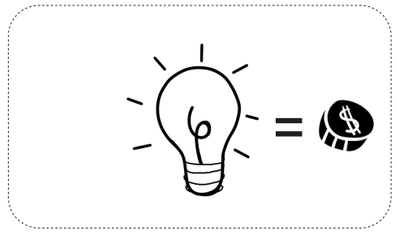


Use with: S2, S3, S5, S6, S7, S10, S11, B2, T1, T6, T7

Description

This policy encourages the development of public-private partnerships (PPPs) to drive mutually beneficial projects. By leveraging the strengths of both sectors, such as public oversight and private innovation, PPPs aim to improve infrastructure, services, and community outcomes. These collaborations focus on shared goals like economic development, sustainability, and social welfare, ensuring efficient use of resources and long-term benefits for all

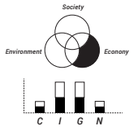
P.07 INNOVATION INCENTIVES



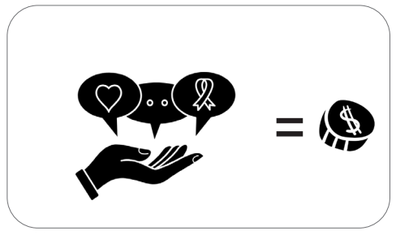
Use with: S5, S7, S13, B2, B4, T5

Description

This policy promotes innovation by providing incentives for businesses, startups, and research institutions to develop new technologies and solutions. These incentives could include tax breaks, grants, subsidies, and access to funding for research and development. The goal is to stimulate creativity, drive economic growth, and foster advancements in areas like sustainability, technology, and social impact.



P.08 INCENTIVES FOR SOCIAL DEVELOPMENT



Use with: S2, S3, S5, S6, S7, S8, T1, T3, T6, T7, T9

Description

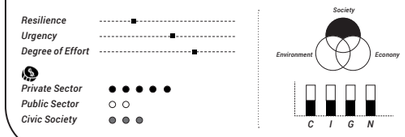
This policy offers incentives to encourage social development initiatives that address community needs and promote well-being. Incentives may include financial support, tax benefits, and recognition for organizations or projects that improve education, healthcare, housing, and social inclusion. The aim is to foster equitable growth, enhance quality of life, and create a more inclusive society through targeted social impact efforts.

P.09 CO-DESIGING AS A MANDATE

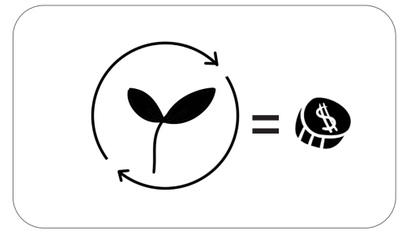
Use with: S5, B3, B6, T3

Description

This policy mandates the use of co-design in the development of public projects, ensuring that communities and stakeholders actively participate in the design and decision-making processes. By involving diverse perspectives, co-design fosters more inclusive, effective, and contextually relevant solutions, leading to better outcomes in areas such as urban planning, services, and infrastructure development.



P.10 CIRCULARITY INCENTIVES



Use with: S5, S7, S10, S11, S12, S13, S14, T4, T5, T8, T9

Description

This policy provides incentives to encourage circular economy practices, such as waste reduction, recycling, and resource reuse. These incentives may include tax breaks, grants, or subsidies for businesses that adopt sustainable production methods, use recycled materials, or implement take-back schemes. The goal is to promote sustainability, reduce environmental impact, and create a more resource-efficient economy.

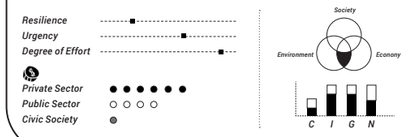


Fig: 100- Pattern Language Cards: Policy Patterns

APPLYING THE PATTERN LANGUAGE TO DESIGN

GAMEPLAY OF THE PATTERNS

The Pattern Language as a Co-Design Tool is a collaborative process where stakeholders from diverse backgrounds work together to co-create spatial solutions.

Introduction to the Co-Design Process
The process begins after a focused vision has been prepared by stakeholders for the space—this could be an urban district, a site or a region, depending on the context. Stakeholders, each representing different actors and a Facilitator from Governemnt are introduced to the Pattern Language and its four main decks: Spatial-Functional Patterns, Borders, Transitions, and Policy Patterns.

Each participant is given a deck of patterns relevant to their role and expertise. The idea is for everyone to contribute their insights based on the patterns in their deck, using them as a language to communicate needs, challenges, and ideas for solutions.

Identifying Spatial Needs & Aspirations
The first step in the game is to explore the Spatial-Functional Patterns. In this phase, participants discuss the spatial needs and aspirations of different actor groups involved in the project. Each participant selects relevant Spatial-Functional Patterns that align with their actor's vision.

Resolving Conflicts: The Borders Deck
Once the spatial needs are identified and mapped, the next phase is to address conflicts between different spatial requirements. The Borders deck comes into play here. When different actors' spatial needs clash, participants use the Borders patterns to find solutions. Patterns from the Borders deck are placed in areas where conflicts are identified, ensuring that each solution is tailored to the context.

Enhancing Synergies: The Transitions Deck
The game continues with a focus on synergies. When actors' spatial needs align or complement each other, the Transitions deck offers strategies for spatial integration. This deck encourages players to think about how spaces can merge, overlap, or be shared to create more value for everyone involved. Players test different arrangements on the map or model, exploring how one pattern may evolve into another as new uses emerge over time.

Governance & Finance: The Policy Patterns Deck
As the spatial design takes shape, the final phase of the game brings in the Policy Patterns deck. This deck supports the integration of governance structures, policies, and financial mechanisms needed to implement the design. Participants now shift from spatial thinking to strategic planning, ensuring that the solutions are not only feasible but also supported by appropriate policies and funding.

Reflection & Iteration
The final stage of the game involves reflecting on the overall design and making adjustments as needed. The patterns are not static—they evolve through iterations based on feedback, new insights, or unforeseen challenges. This stage reinforces the adaptive nature of the Pattern Language, allowing players to revisit earlier decisions and refine the design.

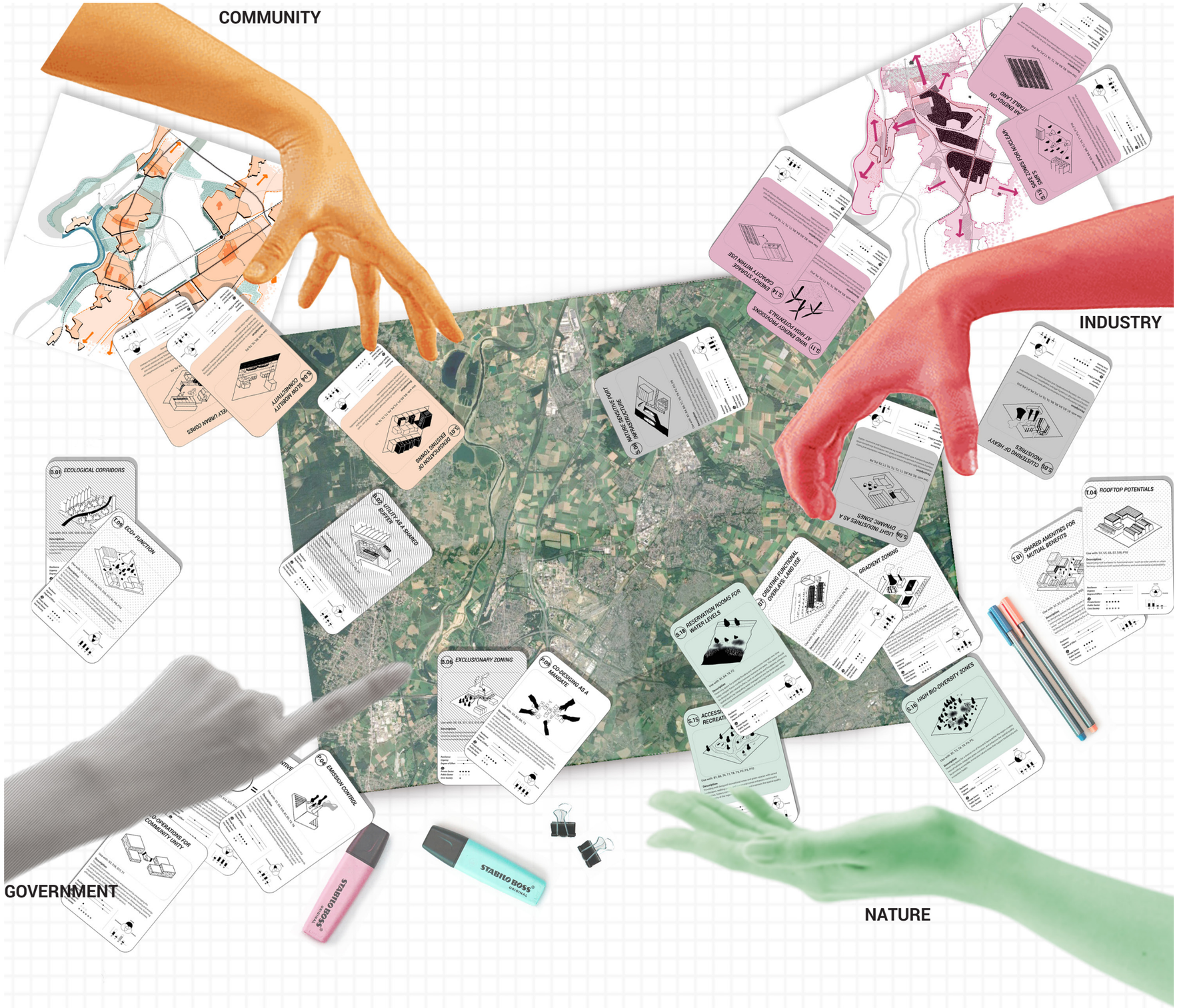
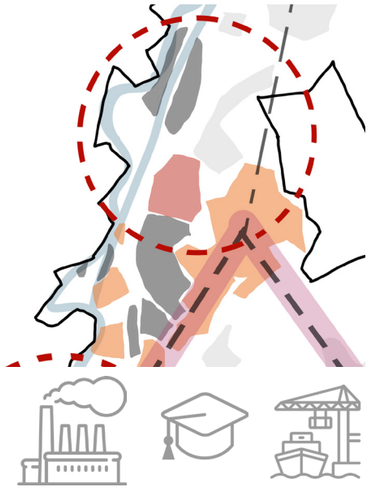


Fig: 101- Graphic depicting Gameplay of the Pattern Language with the Stakeholders

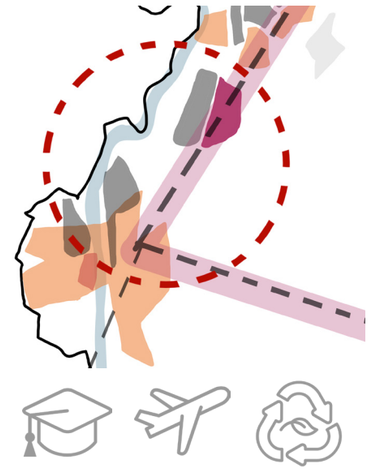
COMPLIMENTARY CITIES: REGIONAL STRUCTURE



In the context of the regional vision, three strategically significant cities can be identified: Chemelot, Maastricht, and Aachen. These cities form vital nodes in a regional network, with direct connections to the Netherlands, Belgium, and Germany. By reinforcing their interconnections, these cities have the potential to emerge as a new economic centre in north-western Europe.

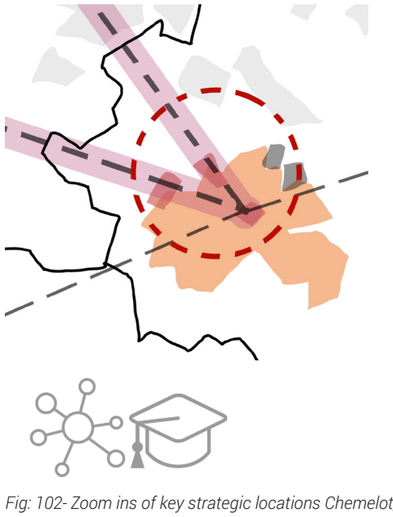
CHEMELOT CAMPUS: INDUSTRIAL PILLAR

Chemelot is a key industrial hub, hosting not only a major industrial site but also the Brightlands Campus, a prominent education and research centre. Additionally, Chemelot benefits from its strategic location along the Juliana Canal, adjacent to the Maas River, providing important logistical advantages.



MAASTRICT: SERVICE INDUSTRY CENTRE

Maastricht is home to a renowned university and an airport with the capacity to play an increasingly significant role in the region's connectivity. Moreover, the city has a growing recycling industry, which is expected to become more important in the future, particularly within the context of the plastics sector.



AACHEN: EDUCATION CENTRE

Aachen, also is known for its university. Additionally, Aachen is also strategically positioned with direct transport links to the Ruhr area in Germany, a region that is home to a substantial concentration of major industries. These three areas will be the key strategic areas in the strategy.

Fig: 102- Zoom ins of key strategic locations Chemelot, Maastricht and Aachen

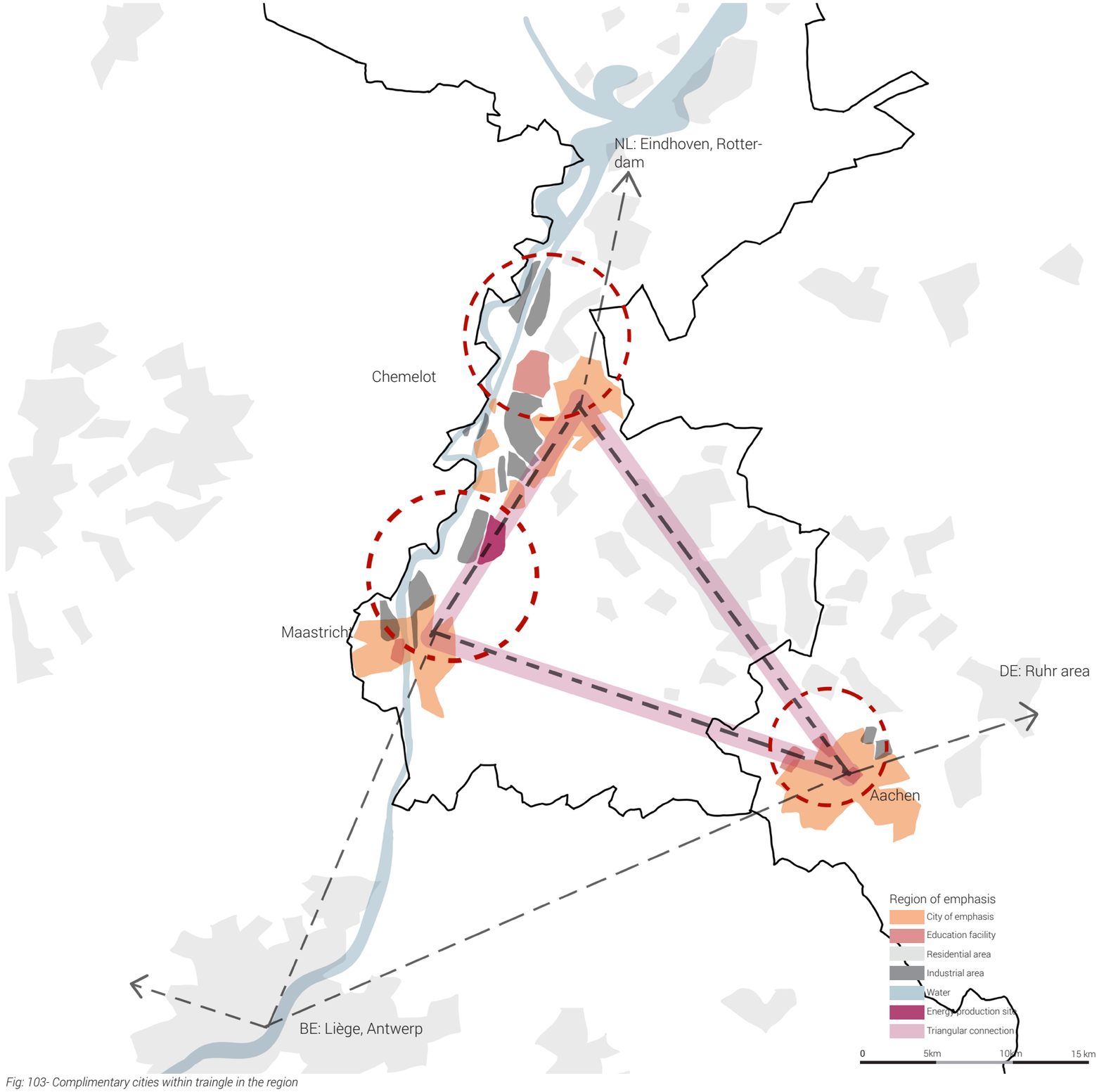


Fig: 103- Complimentary cities within traingle in the region

OVERVIEW OF PHASING: PHASE 1

PHASE 1
DIRECT RESPONSE TO LOCAL URGENCY

Reasoning of the Phase

As Chemelot and its associated research community function not only as a local but also as a regional driver of economic and industrial activity, the initial phase of the strategy prioritises enhancing Chemelot's competitiveness. Simultaneously, the health concerns and interests of local residents—who constitute the most directly affected and relevant community—must also be duly acknowledged and addressed.

Expected Outcome

The primary objectives of this phase are to enhance the competitiveness of Chemelot through the expansion of the Brightlands Campus and the development of industrial infrastructure. Concurrently, the integration of a refined green structure is essential to improving the liveability of the local population, thereby fostering urban-industrial symbiosis.

Stakeholders & Finance

The principal stakeholders in this phase include local residents, Chemelot, and the municipal authorities. The expansion of industrial infrastructure and the Brightlands Campus is likely to be financed through a combination of public and private sector investment. Moreover, certain amenities developed by Chemelot for the Brightlands Campus could also be made accessible to local residents, thereby enhancing urban-industrial symbiosis and contributing positively to the enterprise's public image.

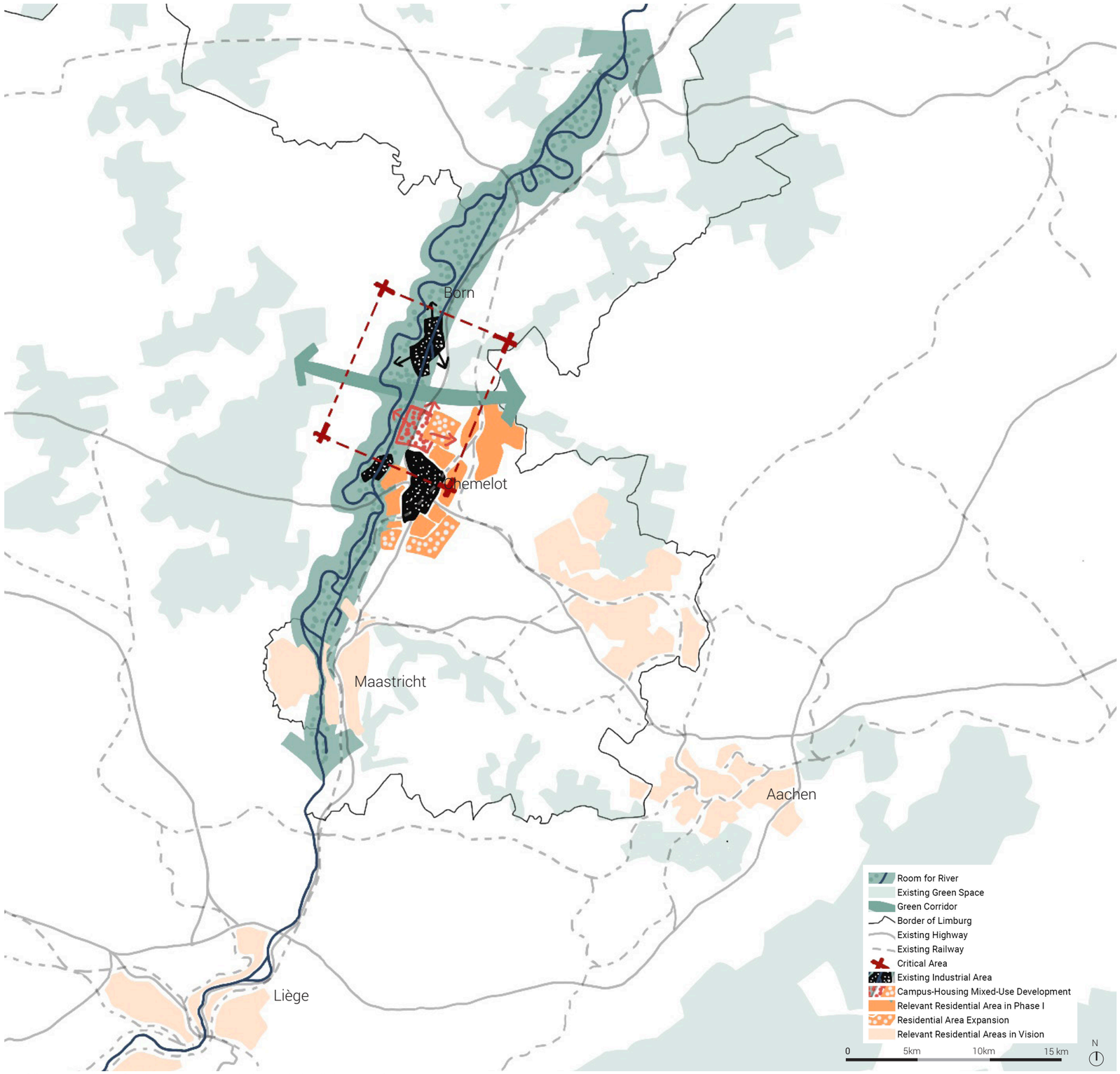


Fig: 104- Map of Phase 1 of the development strategy with the Critical area 1 highlighted

OVERVIEW OF PHASING: PHASE 2

PHASE 2
STRENGTHENING REGIONAL CONNECTION

Reasoning of the Phase

The subsequent phase involves extending outward from the enhanced Chemelot complex—now possessing increased competitiveness—to establish a reinforced triangular regional network. Through this approach, the three cities or areas, each with complementary strengths, can collaborate more effectively and operate in a more integrated and cohesive manner.

Expected Outcome

The primary objectives of this phase are, firstly, to further strengthen the individual advantages of each area within the triangular region, thereby reinforcing their complementarity. Secondly, the development of a more integrated network is essential, to be achieved through the enhancement of both physical infrastructure and energy connectivity.

Stakeholders & Finance

The principal stakeholders in this phase include the provincial governments of the two countries, academic and research institutions, energy production companies, landowners of the proposed energy production sites, and related industries within the triangular region. Infrastructure investment is expected to be primarily funded by the public sector, whereas energy production initiatives may attract private capital, potentially supported by public subsidies.

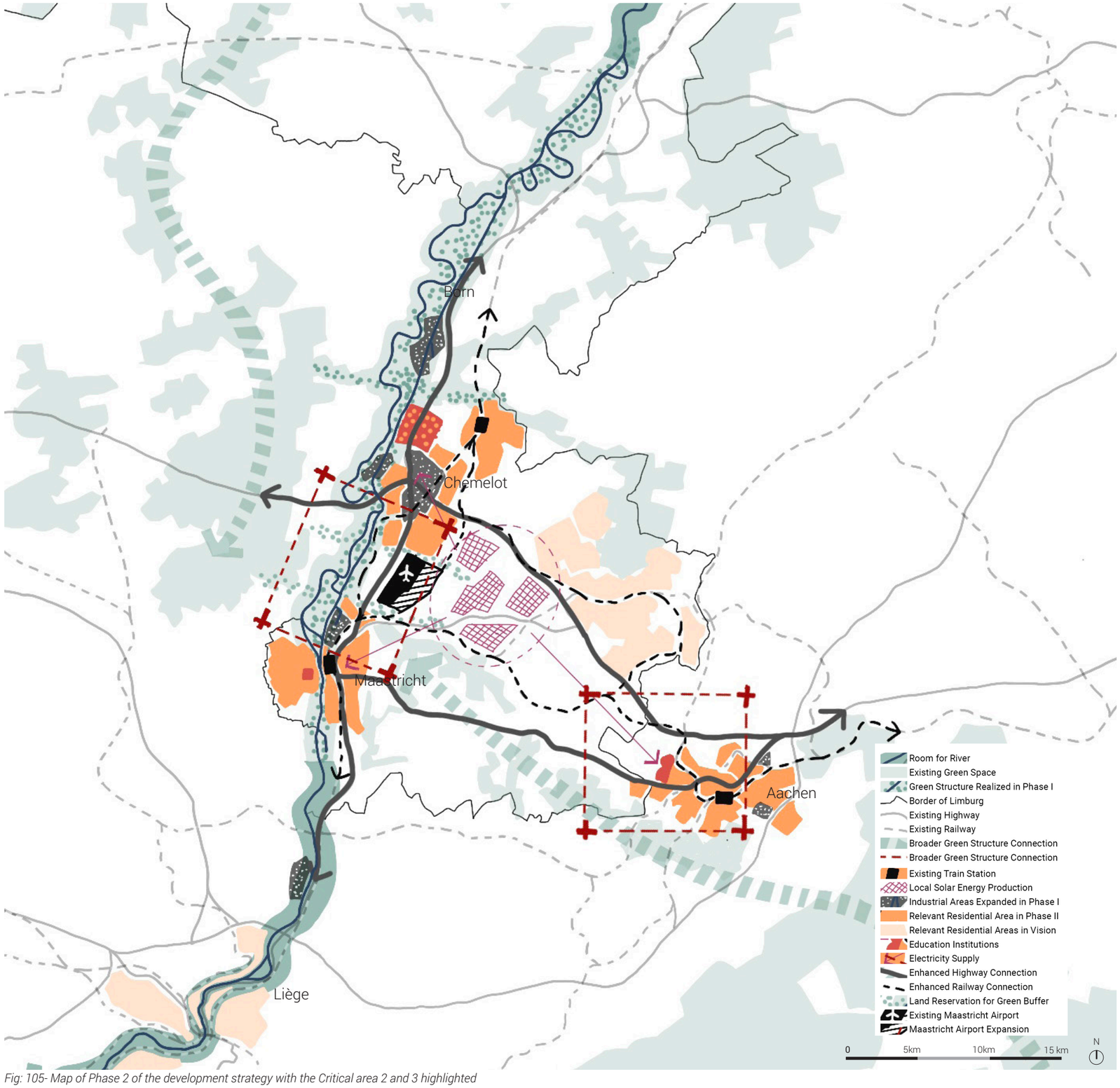


Fig: 105- Map of Phase 2 of the development strategy with the Critical area 2 and 3 highlighted

OVERVIEW OF PHASING: PHASE 3

PHASE 3
REACHING OUT AS CROSS-BORDER CIRCULAR ECONOMY HUB

Reasoning of the Phase

In the subsequent phase, the triangular region will have evolved into a robust circular economy hub, functioning as a cohesive and integrated entity with significant social, political, and economic influence. At this stage, the region can extend its reach to further refine connections across the entire production chain and enhance both regional and cross-border cooperation.

Expected Outcome

The primary objectives of this phase are to establish stronger connections with relevant areas across the production chain, thereby further enhancing industrial competitiveness. Simultaneously, strengthening ties with major cities in North-Western Europe is essential for increasing the strategic influence and visibility of the triangular region.

Stakeholders & Finance

The key stakeholders in this phase include the national governments of the three countries, upstream and downstream enterprises within the production chain, as well as energy producers operating both locally and across the wider region. Investment in mobility infrastructure is likely to be primarily sourced from the public sector, while industrial development is expected to be supported through a combination of public and private sector funding.

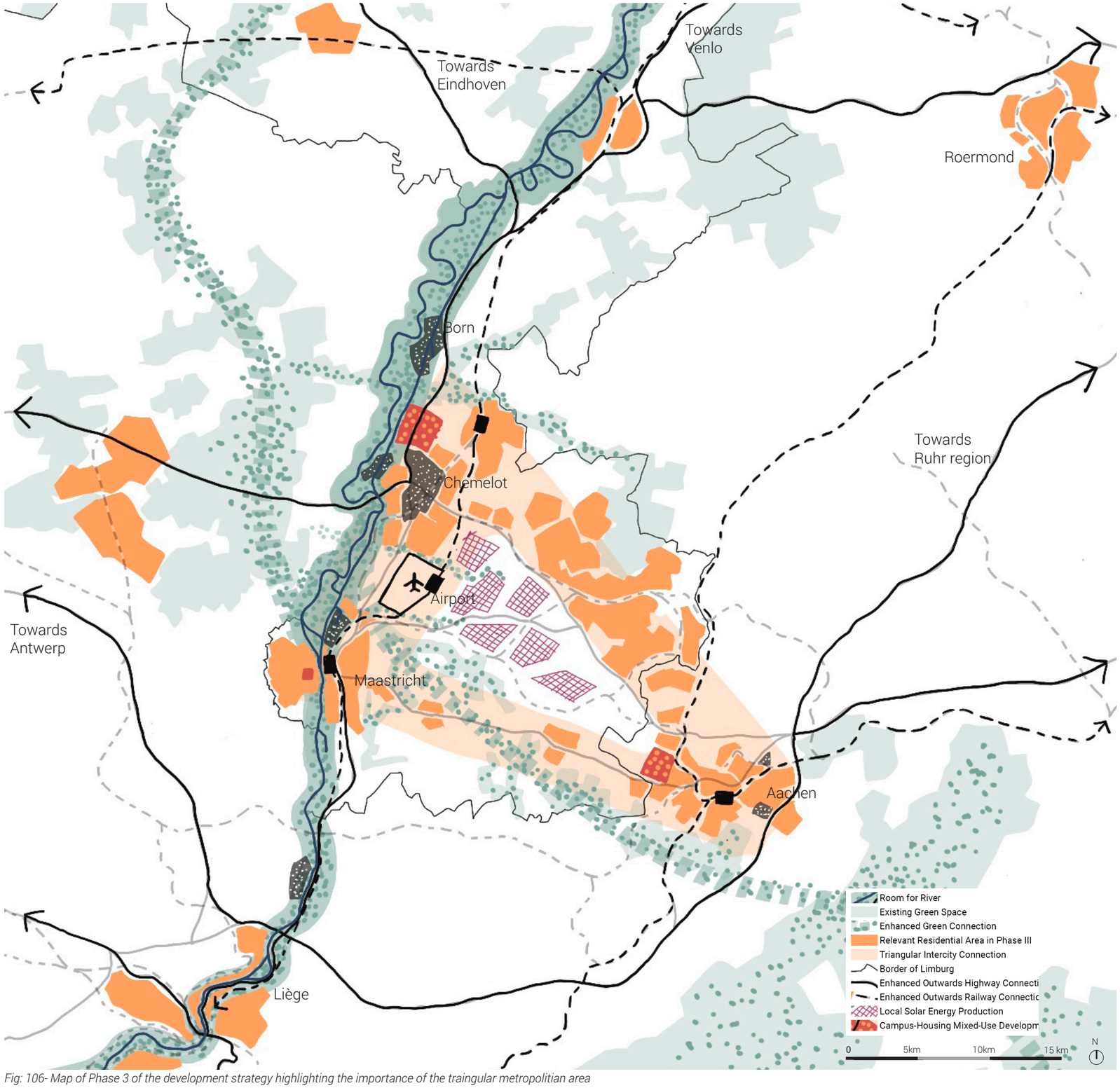


Fig: 106- Map of Phase 3 of the development strategy highlighting the importance of the traingular metropolitian area

PHASE 1: CRITICAL AREA AND APPLYING THE PATTERN LANGUAGE

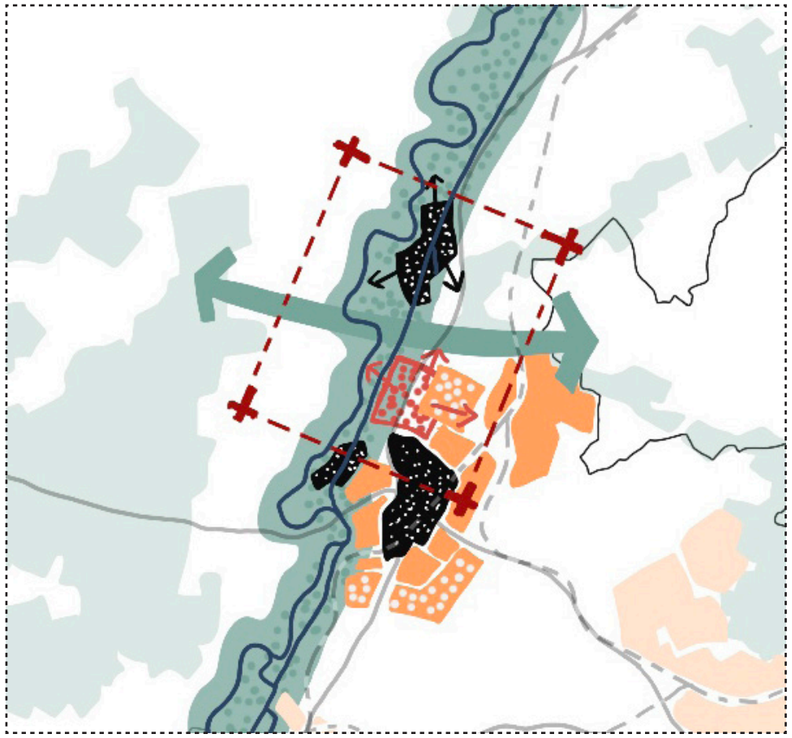


Fig: 107- Key Map Showing the Critical Area I in Phase 1

Principle of picking the Critical area

The area around the strategic projects of this phase: Brightlands Campus expansion and hydrogen production plant on Port Born.
This area will be the central node of the Future chemical innovation and research in the cross-border region.

SPATIAL IMPLICATIONS

Environmental Zoning (from noise to calmness):

-High-nuisance industry
-Low-nuisance industry
-Lively urban cores
-Research institutes
-Residential area
-Nature

Conflicts of Interest

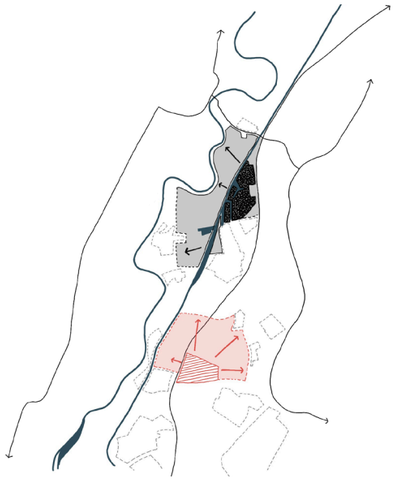
-Stakeholders (power descending): Industry, Government, Local residents, Environment
-The expansion of industry and infrastructure confronts the need of reserving lands for nature

Symbiosis of activities

-Integration of local energy production with housing
-Shared amenities between research institutes and residential area
-Green corridor used as buffer zone between high-nuisance industry and residential area

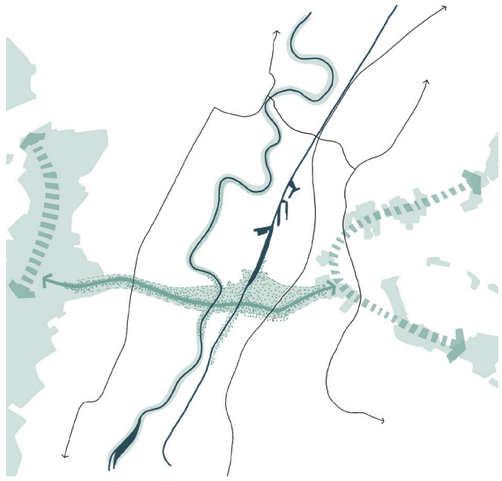
Fig: 108- Key Patterns used in the Critical Area 1

DEVELOPMENT STRATEGY: NORTH OF CHEMELOT



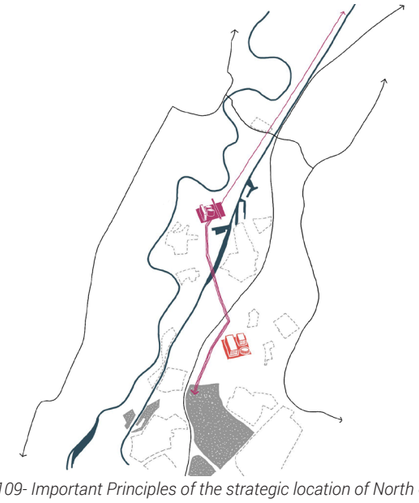
MAIN GOAL FOR THIS AREA

Main Goal for this Area For this critical area in the north of Chemelot site, is first to expand the Brighlands Campus in order to enhance the competitiveness in innovation technology, and second to expand the port of Born to accomodate future needs in production and energy facilities.



NECESSARY LAND RESERVES

In order to achieve this main goal, certain land reserve is necessary. Inbetween the mixed-use development of Brightlands Campus and the port expansion, a buffer zone is necessary, which can also be used as a green corridor connecting cross-border green areas.



STRATEGIC PROJECTS

In this critical area, the Brightlands Campus expansion triggers a broader development of circular economy. Additionally, the hydrogen production plant on Port Born and its infrastructural connection with both the Delta Corridor Pipelines and the Chemelot site is a strategic project, which is essential for energy transition and the future production of Chemelot.

Fig: 109- Important Principles of the strategic location of North Chemelot

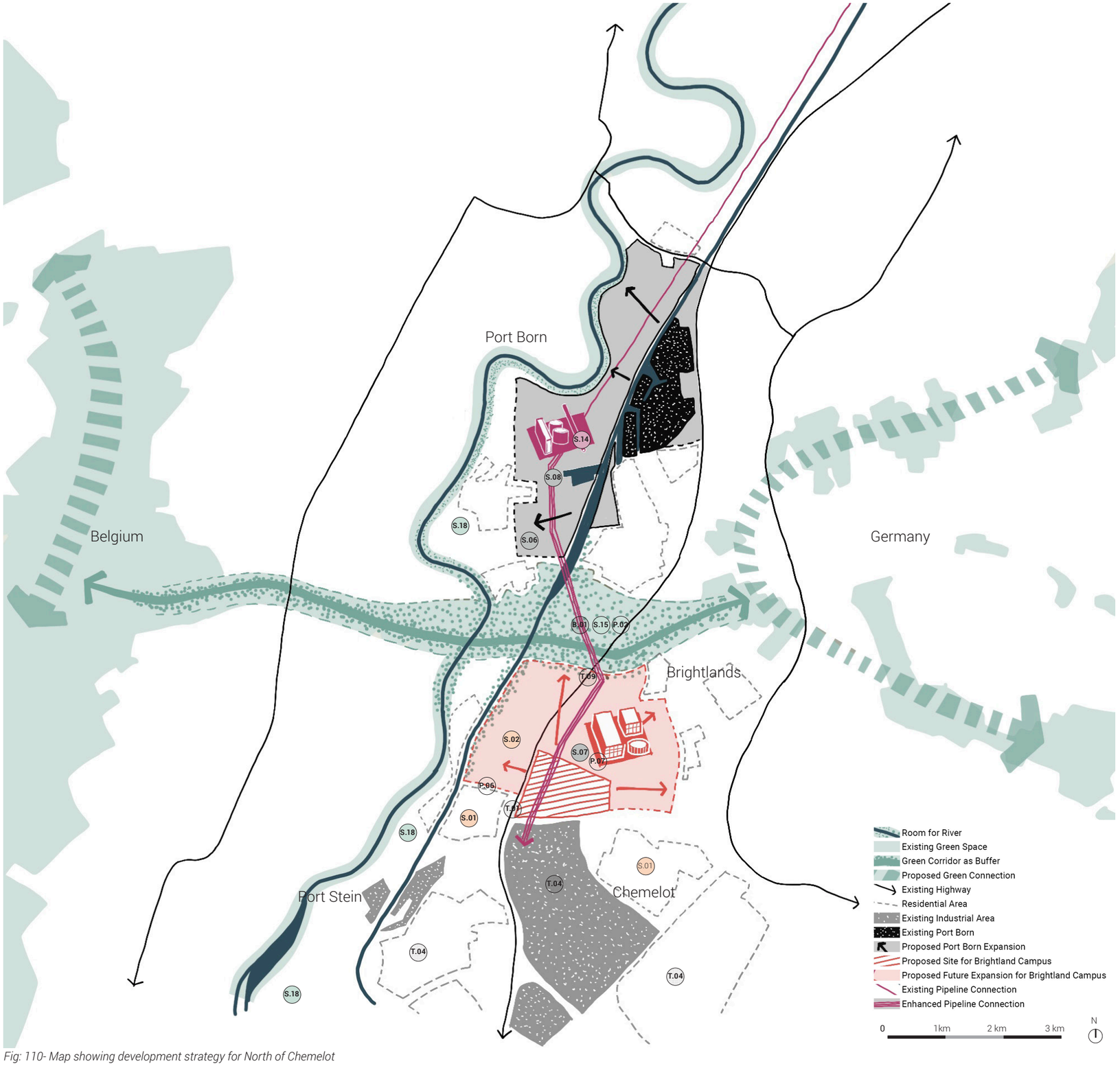


Fig: 110- Map showing development strategy for North of Chemelot

DEVELOPMENT STRATEGY: NORTH OF CHEMELOT

Fig: 111- Graphic illustrating visualisation of new North Chemelot Region

The section shows a new gradient in the spatial organisation of the area, using the environmental zoning principle. Rather than maintaining a rigid separation between heavy industry and the community, the heavy industry now gradually transitions into the Brightlands campus, an innovative hub, before merging into the surrounding natural space. This natural space serves as a corridor to connect fragmented green patches across a cross-border region. It includes an ecoduct over the highway A2 (in a north-south direction), linking natural patches from east to west across Germany and Belgium. This connection of habitats boosts biodiversity in the area.

A soft transition in environmental zoning is also visible at the Port of Born, where the industrial zone extends into a more distributive area, which is lower in environmental impact. This area then flows into a green buffer zone, which serves both recreational and ecological purposes, before reaching the urban area of Born. This approach results in improved livability within the region, while not unduly restricting industrial activities.

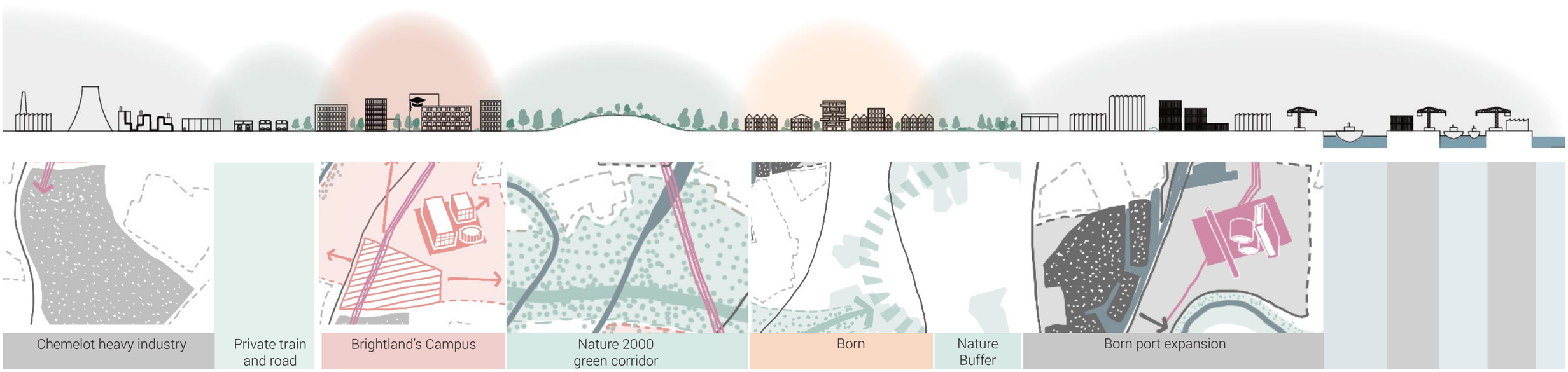


Fig: 112- Schematic section showing development strategy for North of Chemelot

PHASE 2: PRINCIPLE OF PICKING STRATEGIC AREA 2 AND 3

Fig: 113- Key Map Showing the Critical Area II in Phase 2

Principle of picking the Critical area

The area around the strategic projects of this phase: Maastricht Airport expansion and multi-modal connection hub.
This area is particularly important as an multi-modal transportation hub for the future with higher population growth as per economic growth of the area.

SPATIAL IMPLICATIONS

Environmental Zoning (from noise to calmness):

-Infrastructure
-Residential area
-Local energy production site
-Agricultural lands
-Nature

Conflicts of Interest

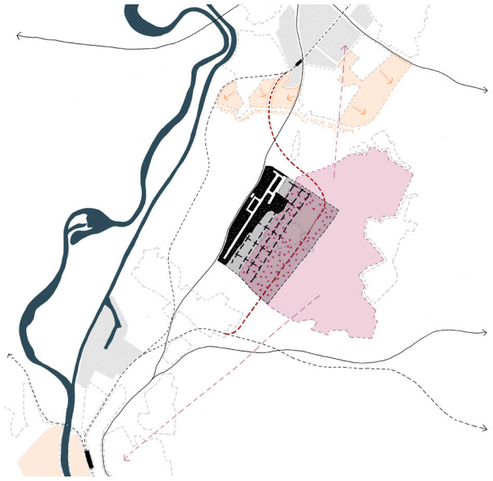
-Stakeholders (power descending): government, energy producer, developers, farmers, residents
-The expansion of infrastructure confronts the need of reserving lands for nature and urban expansion

Symbiosis of activities

-Integration of local energy production with agricultural lands
-Integration of local energy production with airport
-Local energy production as land reserve for airport expansion
-Green corridor used as buffer zone between high-nuisance infrastructure and residential area

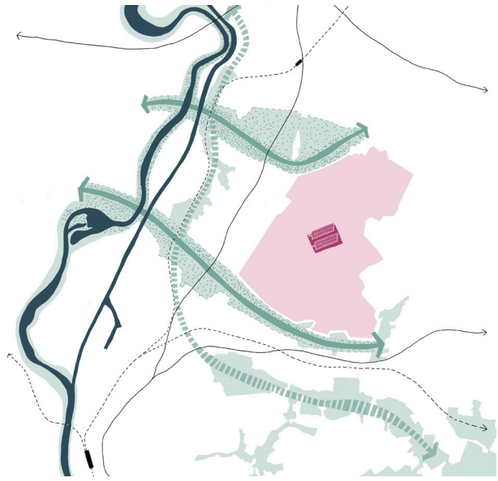
Fig: 114- Key Patterns used in the Critical Area 2

DEVELOPMENT STRATEGY: MAASTRICHT AIRPORT



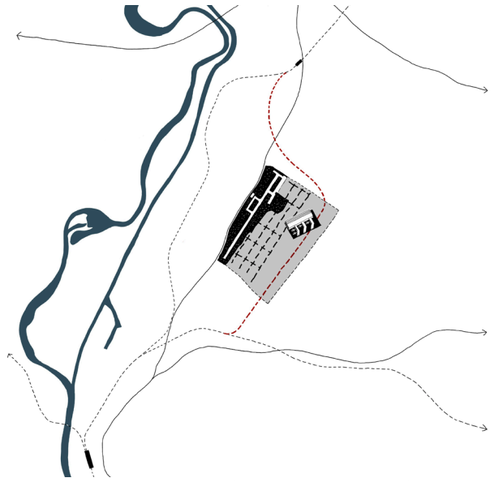
MAIN GOAL FOR THIS AREA

Our second key strategic location is at Maastricht Airport. We propose the expansion of Maastricht Aachen Airport to establish it as a significant multimodal hub, which will enhance regional connectivity and simultaneously reduce reliance on Schiphol Airport to support the growth of regional importance. On top of that, local energy production should be implemented.



NECESSARY LAND RESERVES

The expansion of the new multi-modal hub includes green buffers and solar farms, which are well-suited due to the large land area needed for noise mitigation. Temporary solar energy production can also serve as a land reserve during development. While future quieter air travel may allow for alternative zoning, the current plan primarily designates the surrounding land for nature, which is expected to remain.



STRATEGIC PROJECTS

These initiatives aim to mitigate the environmental impact of the expansion, promote biodiversity, and support our planned increase in the region's importance for not only domestically in the Netherlands but North-Western Europe. Additionally, the strategic project of a new train station which connects the airport with a broader transportation network is also necessary.

Fig: 115- Important Principles of the strategic location of Maastricht Airport

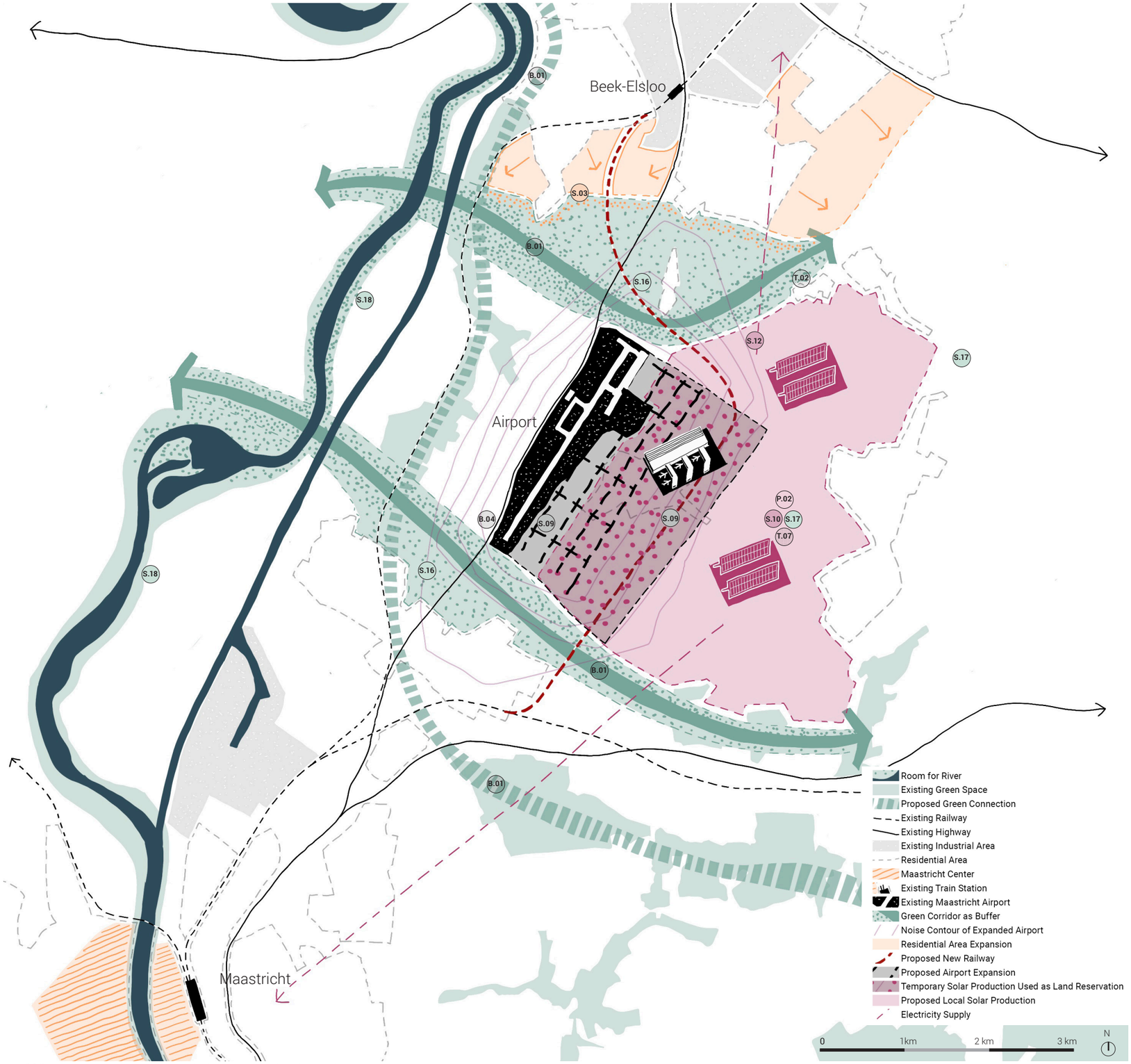


Fig: 116- Map showing development strategy for Maastricht airport

DEVELOPMENT STRATEGY: MAASTRICHT AIRPORT

Fig: 117- Graphic illustration a visualtion of new maastricht airport area

The section illustrates how the environmental zoning gradually transitions across the area. It begins with the vibrancy of Maastricht, a mixed-use zone with an expanded educational function. This area slowly transitions into a predominantly residential zone, which eventually merges with natural space. This natural area serves multiple purposes: it functions not only as a recreational space and a habitat for biodiversity, but also as a significant buffer between the residential area and the expanded airport. This expansive natural buffer zone extends to the opposite side of the airport, where it gradually blends into the urban area of Beek.
Some of these natural buffer zones could be repurposed for energy production, particularly through solar energy. This is a viable option due to the limited desirability of living directly next to the airport. Given that solar panels have a lifespan of approximately 25 years, they provide a flexible solution for land reservation, offering an interim use for areas that may not be ideal for permanent residential development.

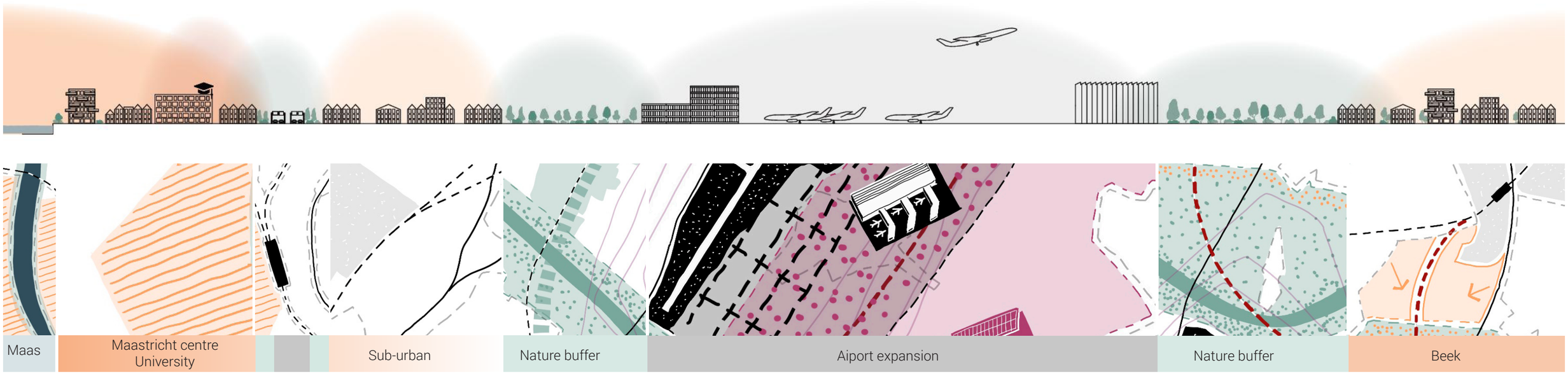


Fig: 118- Schematic section showing development strategy for Maastricht airport

PHASE 2: PRINCIPLE OF PICKING STRATEGIC AREA 3

Fig: 119- Key Map Showing the Critical Area III in Phase 2

Principle of picking the Critical area

The area around the strategic projects of this phase: railway connection between Maastricht and Aachen, Aachen RWTH train station.
This area particularly has importance as a future educational hub of the region with the expansion of the Aachen University.

SPATIAL IMPLICATIONS

Environmental Zoning (from noise to calmness):

-Infrastructure
-Lively urban cores
-Education institutes
-Residential area
-Agricultural lands
-Nature

Conflicts of Interest

-Stakeholders (power descending): government, education institutes, developers, farmers & residents
-The construction and expansion of infrastructure confronts the need of reserving lands for mixed-use urban expansion

Symbiosis of activities

-Integration of mobility hub with lively urban center
-Shared amenities between education institutes and residential area

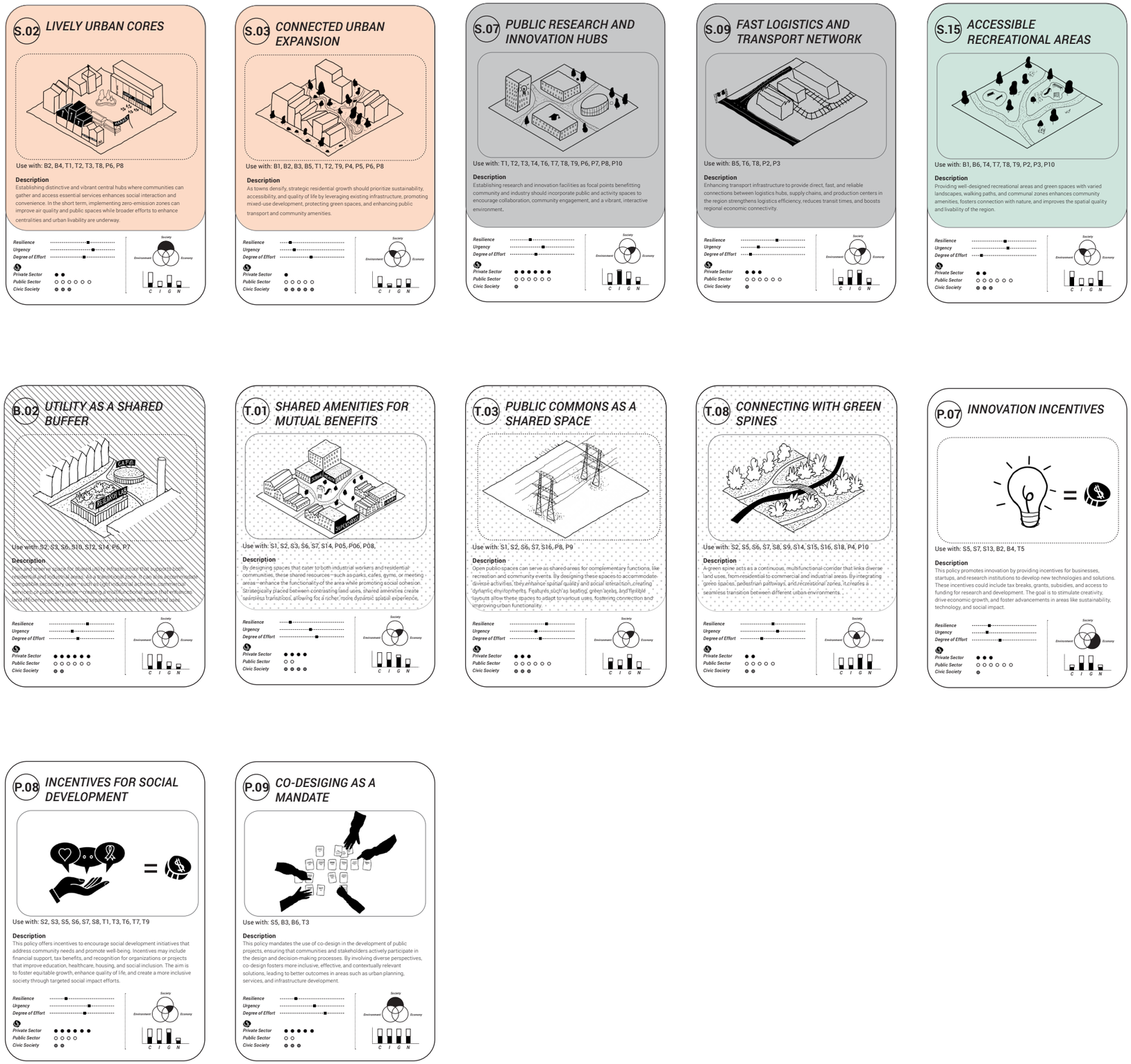
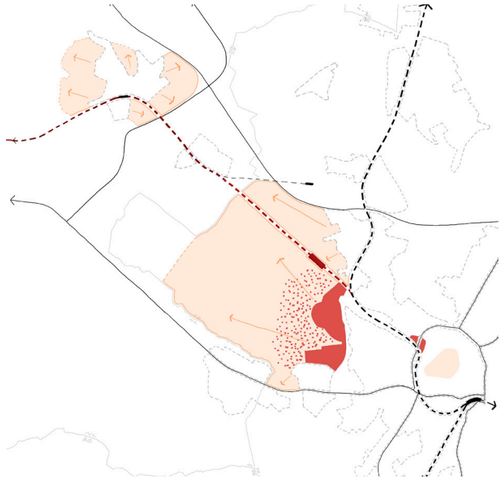


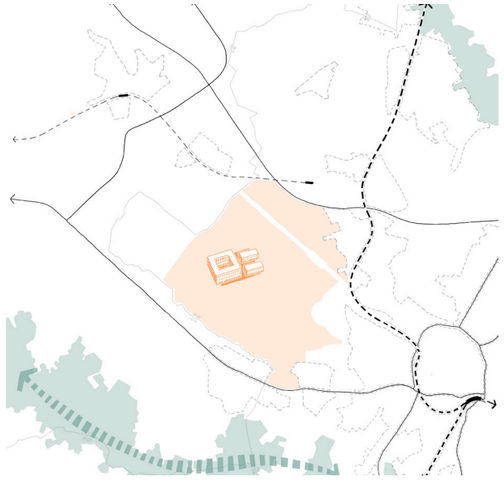
Fig: 120- Key Patterns used in the Critical Area 3

DEVELOPMENT STRATEGY: AACHEN



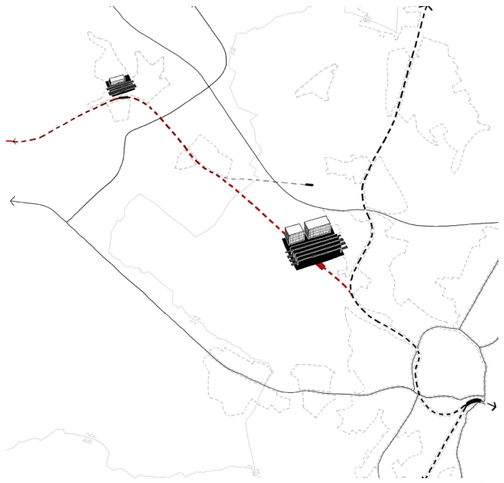
MAIN GOAL FOR THIS AREA

Because of its prestigious academic institutions and strategic location on the border of the Netherlands and Germany, Aachen should be better connected with Chemelot area and Maastricht. The new station area can also be regarded as an opportunity for active mixed-use development.



NECESSARY LAND RESERVES

In order to achieve this main goal, the land around the new station area should be reserved for well-designed mixed-use area that works as a new center for cross-border communication.



STRATEGIC PROJECTS

The strategic project for this area is the construction of high-speed intercity railway and a new train station for RWTH Campus. For now there is a section of missing link between Maastricht and Aachen. Additionally, a large section of the existing railway should be electrifed and widen.

Fig: 121- Important Principles of the strategic location of Aachen City

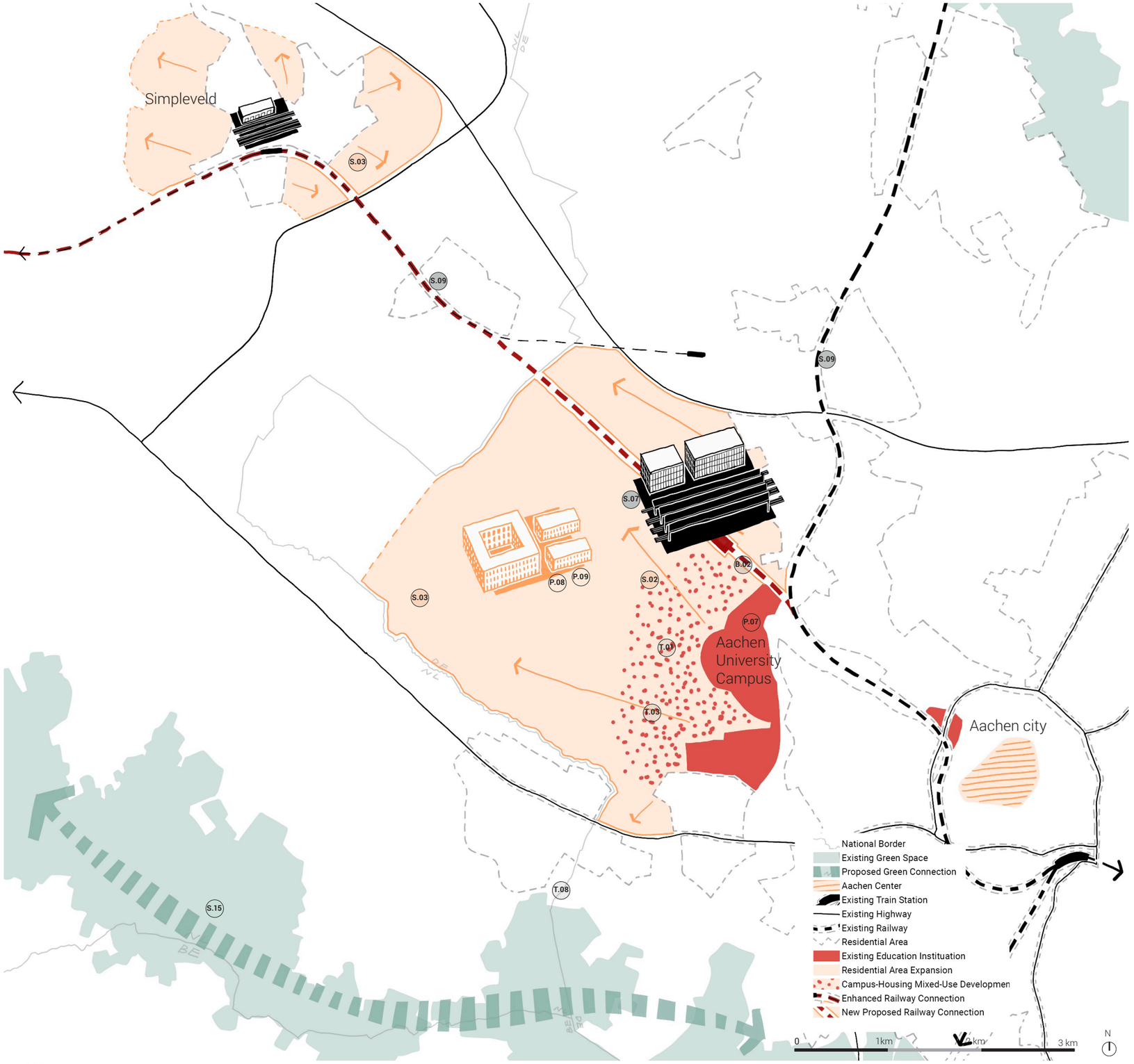


Fig: 122- Map showing development strategy for Aachen city

DEVELOPMENT STRATEGY: AACHEN

Fig: 123- Graphic illustration a visualtion of Aachen

The section illustrates the transition from the vibrant city centre of Aachen to its outer districts, which present potential for redevelopment. Given that Aachen and Maastricht lack a direct train connection, but still have an old, unused railway track, this presents an opportunity to redevelop this link. The existing railway corridor already offers the necessary space to make this reconnection feasible. This new development will open up opportunities for growth along the railway line, with its station. A high-density urban core could be developed here due to the attractiveness of living in a highly connected region. The development also incorporates an expansion of the university and other educational facilities. In this way, Aachen's educational institutions can also become integral to the triangular city plan.

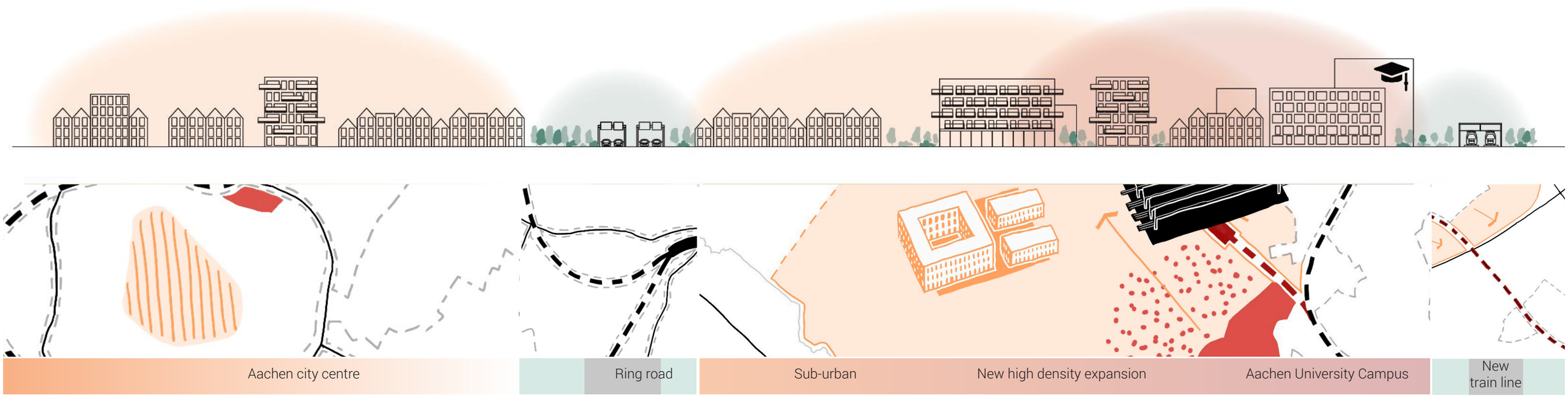


Fig: 124- Schematic section showing development strategy for Aachen City

PHASE 3: CIRCULAR ECONOMY HUB

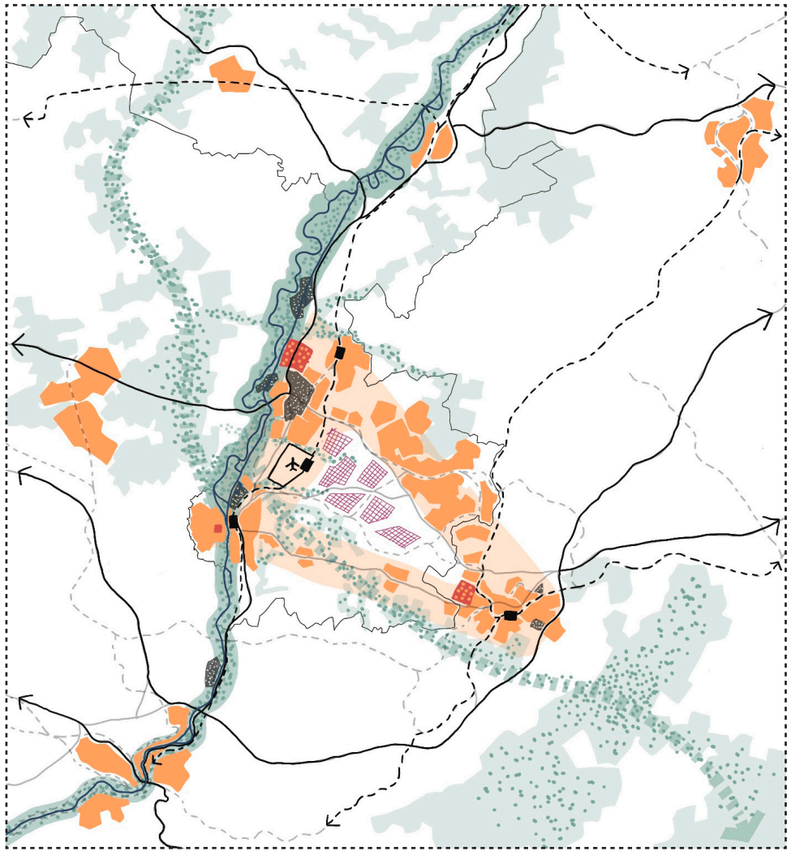


Fig: 125- Key Map Showing the Phase 3 of the Development Strategy

Resilience of energy and material flow

When situating the strategy into a broader context, we can see the resilience in the redundance across scales. The essential energy input and material flow for the triangular region are proposed not only locally, but also through infrastructural connections of different distances.

Promoting cross-border cooperation

The strategic cross-border location of the triangular region is sufficiently made use of to promote cross-border cooperation and cohesive development.

Taking responsiblity for the future

Land reserve and environmental consideration has always been an important part of the strategy. In a broader context, the green connections we proposed can be integrated into a larger structure that would do benefit to the environment in a larger scale.

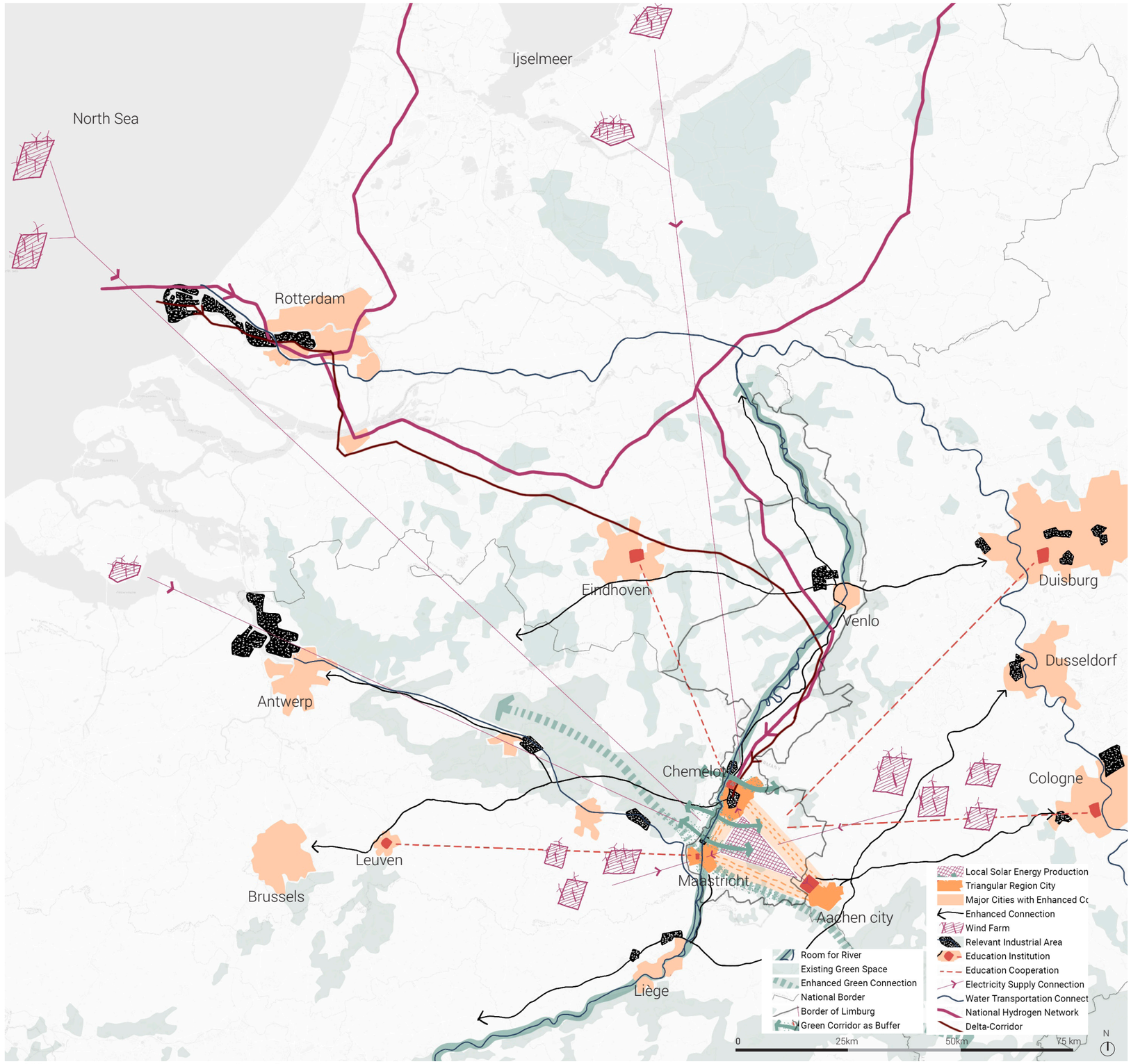


Fig: 126- Map showing extending of the phase 3 in the Regional/ National scale.

TIMELINE

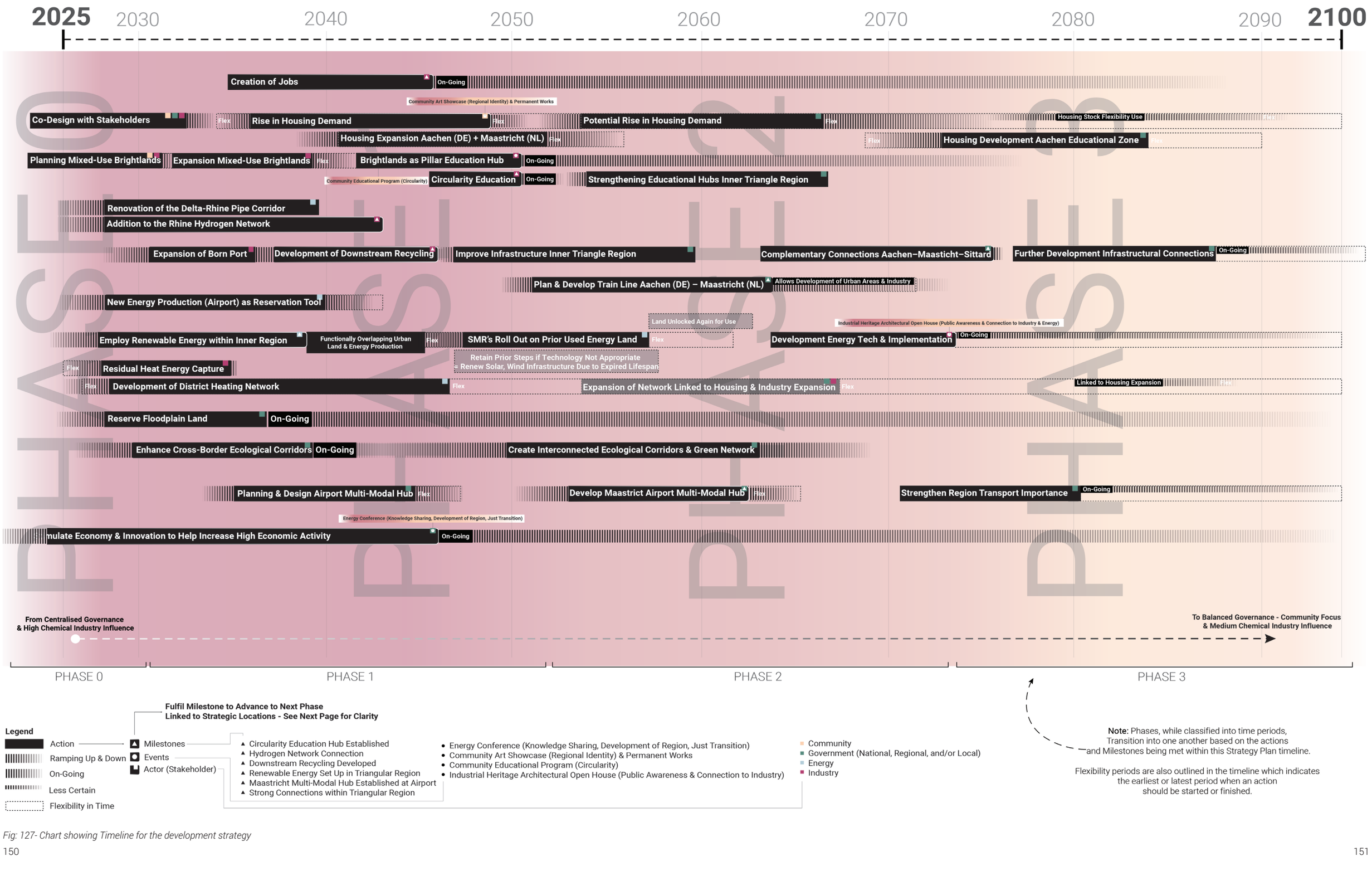


Fig: 127- Chart showing Timeline for the development strategy

TIMELINE: IN DETAIL

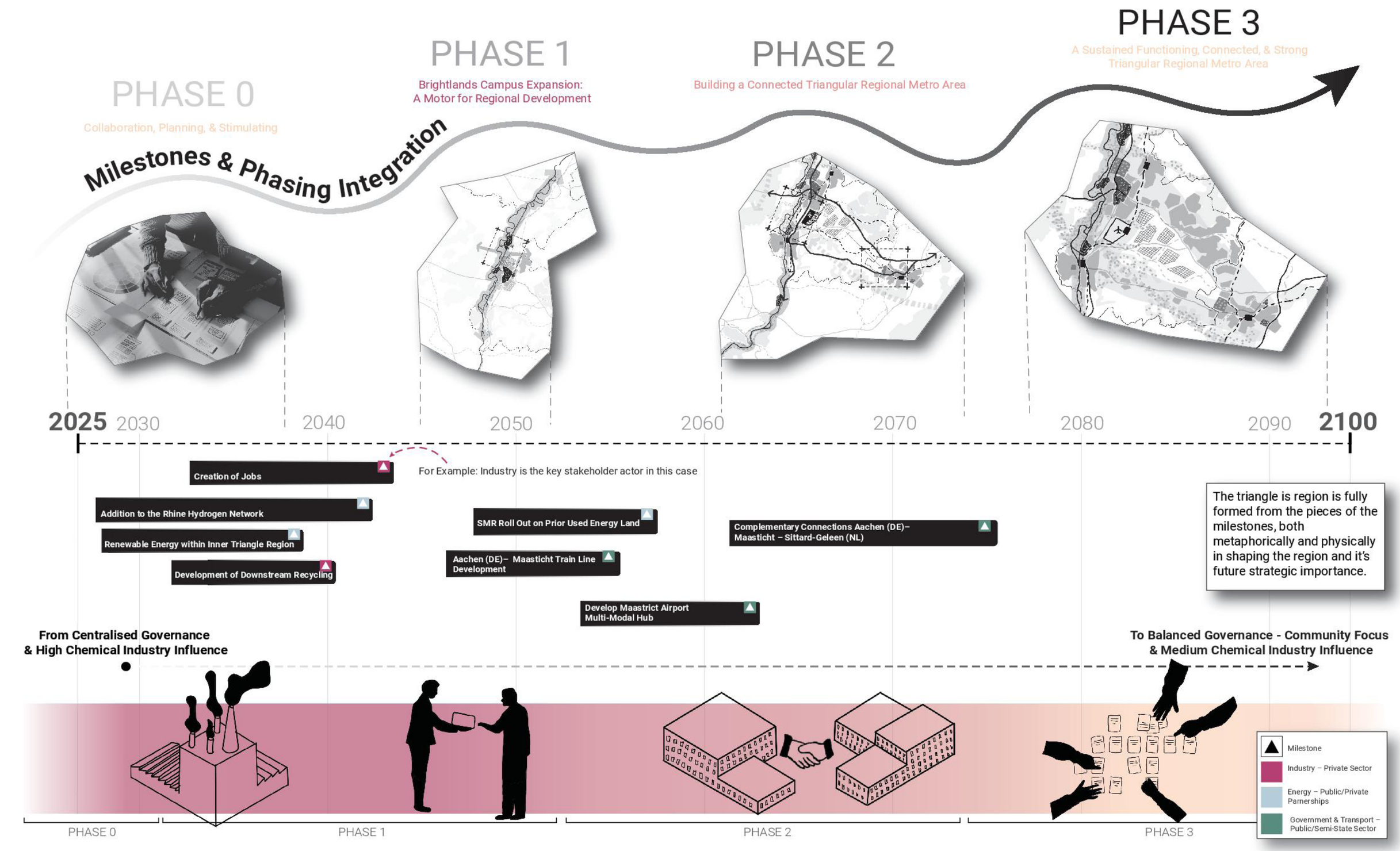


Fig: 128- Chart explaining timeline in detail

TIMELINE: IN DETAIL

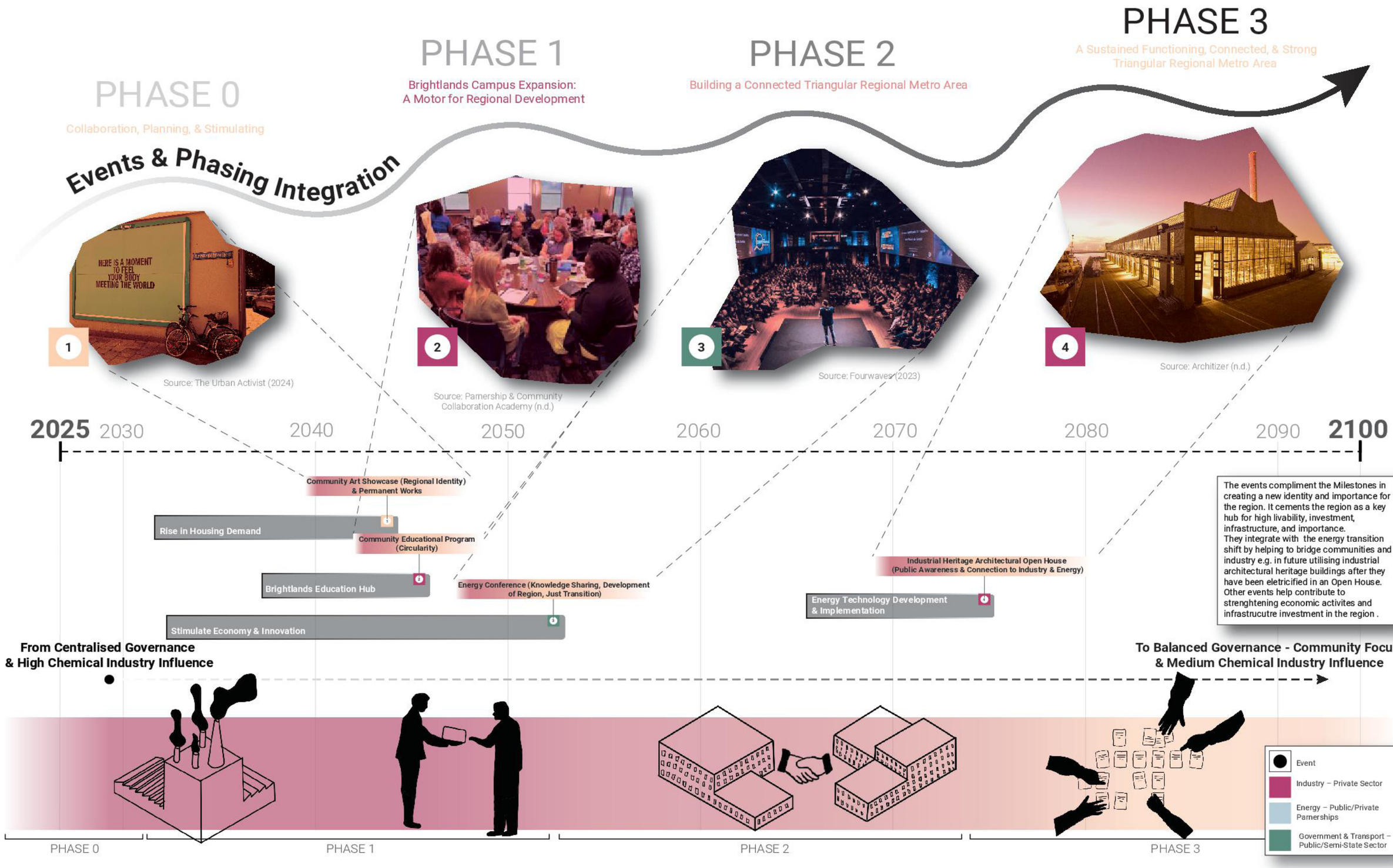


Fig: 129- Chart explaining timeline in detail

Conclusion

CONCLUSION

“How can we ensure qualitative life and liveable surrounding for the local residents around chemical industry (Chemelot) when it expands due to the energy transition?”

This research prioritises both the livability of local residents and Chemelot’s transition towards a more sustainable industrial future. These dual objectives are embedded throughout the study, from the initial positioning to the formulation of a long-term vision and the development of strategic proposals grounded in both top-down and bottom-up approaches.

To achieve this urban-industrial symbiosis, we first adopt the position that neither stakeholder group, industry nor residents can be disregarded in the pursuit of sustainability and resilience. Chemelot serves as a key economic pillar in the region and, under the pressures of the energy transition, holds the potential to emerge as a regional hub for the circular economy and innovation in recycled plastics. This transformation presents both opportunities and risks. While it may generate employment, stimulate the economy, and enhance regional cooperation, the associated environmental and social burdens such as pollution and nuisance could adversely impact local residents. Thus, the expansion of Chemelot must be seen as a model project for Europe’s energy transition, requiring a careful balance between industrial growth and social-environmental well-being.

Secondly, our approach involves analysing the inherent tensions and potential synergies between industrial and residential interests. Key theoretical frameworks; pattern language, doughnut economy, border-transition theory and environmental zoning have been employed to understand these dynamics. Acknowledging the intrinsic contradictions between heavy industry and residential quality of life, we argue that with thoughtful spatial design and room for future adaptation, these conflicts can be transformed into urban-industrial symbiosis. Spatial interventions are used as the main medium to translate abstract values, such as spatial justice, into tangible strategies including infrastructure development, densification, and land reservation.

Thirdly, we address uncertainty by embedding robustness and adaptability into our strategic framework. Given the long-term horizon and complexity of the transition entailing multiple stakeholders and sectors, we emphasise flexibility and phased implementation. To this end, we employ three complementary methodologies: pattern language, phasing, and critical area design.

Pattern language enables us to deconstruct strategies into discrete, adaptable actions, facilitating both flexibility and participatory engagement. This method also supports a bottom-up planning approach by making the rationale and relationships between patterns explicit, thus allowing stakeholders including local communities to engage more meaningfully in decision-making. This is especially crucial when addressing livability and social sustainability in urban-industrial contexts.

Phasing and critical area design are employed to identify uncertainty and construct a more resilient development trajectory. In the context of our study area, the initial focus is on enhancing Chemelot’s competitiveness as a foundational step. Building upon this, we propose strengthening regional cooperation to generate mutual benefits for both industry and residents. The strategy is structured in three distinct phases: the first two focus on key intervention areas with critical projects, while the final phase shifts towards enhancing regional connectivity, reflecting the greater uncertainty associated with longer-term objectives. Through the analysis and design of these areas, we prioritise actions and establish a robust, adaptable system aligned with our overarching vision.

In summary, our strategic pathway aims to reinforce robustness and resilience by aligning industrial expansion, residential well-being, and environmental sustainability. While uncertainty and risk are inevitable in long-term planning, our approach identifies these challenges proactively and responds with theory-informed strategies geared towards a resilient and inclusive future.

How does our strategy address social, environmental and economic sustainability (in an integrated manner)?

In our strategy, sustainability is not treated as a set of isolated dimensions, social, environmental, and economic, but rather as an integrated and interdependent framework essential to building spatial resilience. Guided by this principle, we adopt multiple methods to ensure the effective integration of these three dimensions.

Economic sustainability is addressed by positioning Chemelot as a central driver in the regional circular economy. The strategy leverages Chemelot’s key role as an economic actor (stakeholder) to enhance competitiveness, create employment opportunities, and create regional cooperation across industries and national borders.

Social sustainability is prioritised through the improvement of livability for local residents and the inclusion of community interests within the planning process. By utilising participatory tools such as pattern language and emphasising spatial justice, the strategy aims to reduce potential social conflicts and promote a symbiotic relationship between urban life and industrial development.

Environmental sustainability is incorporated through measures that preserve and strengthen ecological continuity while encouraging resilient land use practices.

Crucially, the integration of these three aspects is operationalised through the use of pattern language, phasing, and critical area design tools which facilitate the comprehensive balancing of diverse stakeholder interests. These methods allow for both flexibility and robustness in planning, enabling us to address sustainability in a cohesive and mutually reinforcing manner.

Does our strategy address intra and inter generational justice?

Both intra- and inter-generational justice are central considerations within our strategy. Intra-generational justice is embodied in the adoption of the urban-industrial symbiosis principle, which seeks to equitably balance the interests and needs of various societal groups within the current generation, particularly local residents and industrial stakeholders.

Inter-generational justice is reflected in the integration of social, economic, and environmental sustainability, as well as in the emphasis on robustness and resilience in long-term planning. By ensuring that current development does not compromise the wellbeing of future generations, the strategy aims to support a just and sustainable transition over time.

RECOGNITIONAL
Does our strategy recognise vulnerabilities, identities and trajectories?

Vulnerabilities:
In our strategy, pattern language is employed not only as a design tool but also as a means of incorporating bottom-up approaches, enabling the active participation of communities, particularly those with less institutional power. This method contributes to more inclusive and context-sensitive planning by translating complex strategies into accessible and adaptable actions.
Additionally, we adopt a phasing approach to mitigate the potential negative impacts of long-term uncertainty. By structuring development in stages, the strategy allows for flexibility and timely adjustment, thereby enhancing the overall robustness and adaptability of the planning process.

Identities
By adopting the principle of urban-industrial symbiosis, our strategy encourages enhanced cooperation and communication between key stakeholders, particularly between local residents and the industrial sector. Through the inclusion and articulation of their interests, the identities of these groups can be more effectively recognised and represented within the spatial and policy-making processes.

Trajectory:
We acknowledge the inherent uncertainty associated with long-term transitions and therefore adopt a range of methods to enhance both the resilience and robustness of the strategy.

PROCEDURAL
Does our strategy or proposals incorporate the voices of the most vulnerable/ the voices of stakeholders (including the planet)?

In our strategy, through the integrated consideration of social, economic, and environmental sustainability, alongside the adoption of methods such as pattern language to facilitate a bottom-up approach, we aim to incorporate the voices of the most vulnerable communities.

DISTRIBUTIVE
Does our strategy distribute the burdens and benefits of actions fairly?

Through the use of pattern language and the incorporation of a bottom-up approach, our strategy seeks to ensure a more equitable distribution of both burdens and benefits. By empowering communities traditionally marginalised in top-down planning processes, these groups are given an opportunity to actively participate in decision-making and articulate their interests. Furthermore, the theory of urban-industrial symbiosis provides valuable insights into achieving a fairer distribution, guiding the balance between industrial development and community well-being, such as sharing amenities and mixed-use development.

What commons are being created or sustained? Are they fairly distributed? Who are the communities managing those commons? Who has access?

Social Commons:
We try to include the vulnerable communities in the decision-making process through a bottom-up approach which encourages social cohesion and collective ownership of the planning process. By empowering these communities, the strategy creates a more inclusive and participatory environment, ensuring that social capital and community networks are strengthened.

Economic Commons:
The regional circular economy established around Chemelot is an example of a shared economic resource. By positioning Chemelot as a central economic actor in the region, the strategy creates opportunities for collective economic growth, employment, and regional cooperation, benefiting both the industrial sector and local residents.

Environmental Commons:
The integration of environmental sustainability, such as room for river and a better connected cross-border green structure, into the strategy ensures ecological continuity and resilient land use. Shared green spaces, ecological corridors, and sustainable land use practices contribute to a collective environmental resource that benefits the broader community and future generations.

The communities managing those commons are the ones included in our combined bottom-up top-down approach, namely the local residents, Chemelot and related industries and governments. Based on our fair distribution proposal. All of the communities should have direct or indirect access to these commons. Furthermore, the future generation would also have access.

What kind of people and society does this strategy help us become?

For individuals, this strategy helps cultivate a society where people are engaged, socially aware, environmentally responsible, resilient, and future-focused.

Between individuals, it encourages collaboration, equity, and shared prosperity, ensuring that both current and future generations can thrive in a balanced, sustainable environment.

Through these principles, the strategy aims to create a society that is not only technologically advanced and economically successful, but also socially just and ecologically harmonious.

United Nations Sustainable Development Goals

3. Good Health and Well-being: The strategy promotes the creation of a green corridor for biodiversity and recreation, alongside increased amenities for residents. It advocates for mixed-use functions and a diversity of housing typologies to improve overall quality of life.

7. Affordable and Clean Energy: Local energy production is prioritised through the use of solar panels on industry and residential rooftops. Improved insulation and better energy quality in housing, as well as the utilisation of residual heat and energy flows from the industry, will contribute to more sustainable energy practices.

8. Decent Work and Economic Growth: The expansion of Chemelot is expected to generate additional job opportunities, particularly in the energy transition sector. This will lead to economic growth while advancing a circular economy approach.

9. Industry, Innovation, and Infrastructure: The expansion of Chemelot ensures future adaptability, while the growth of the Brightlands campus, the University of Maastricht, and the University of Aachen creates more opportunities for innovation and supports a new generation of thinkers. Additionally, the expansion of Maastricht Airport will improve international connectivity. The development of a triangular infrastructure will strengthen cross-border connections.

10. Reduced Inequalities: A bottom-up decision-making approach ensures that the community's needs are represented. The strategy promotes more diverse housing options, accessible healthcare, a better distribution of schools, investments in renewable energy and improved insulation and a higher offer of public goods. These actions will help reduce inequalities. Limiting Chemelot's pollution and establishing clear boundaries between the community and industry will further mitigate the burden on vulnerable groups.

11. Sustainable Cities and Communities: Improved connectivity between urban areas will strengthen communities and provide better access to amenities. The development of a more resilient triangular city region will ensure greater cohesion and better sustainability.

12. Responsible Consumption and Production: The strategy promotes a circular economy, focusing on recycling and reducing the use of new materials. Additionally, the use of residual heat and energy will contribute to more sustainable production practices.

13. Climate Action: A clear transition to renewable energy sources is central to the strategy, supporting long-term sustainability goals.

15. Life on Land: The creation of a green corridor provides space for nature and reduces the risk of future flooding by accommodating river expansion, contributing to ecological resilience.

17. Partnerships for the Goals: A combination of bottom-up and top-down decision-making is encouraged through the use of pattern language and community participation, ensuring that all stakeholders are involved in shaping the future of the region.

Fig 130: SDG's (Source: UN)

GROUP REFLECTION

Key Learnings

This quarter was especially enriching in terms of learning and exposure. We explored urban systems through the broader lens of regional design and systemic flows, which challenged our usual approach of starting at local scale with details. Designing at a macro level first, and then zooming into finer details, was a new yet valuable shift in perspective. The focus on community, particularly through the Research and Methodology course deepened our understanding of community engagement and the importance of spatial justice. These concepts were crucial in helping us navigate land-use conflicts and make more inclusive design choices. We also discovered the value of pattern language as a tool to both develop spatial strategies and engage stakeholders in a structured yet creative way something entirely new and exciting for us. Additionally, the detailed feedback and drawing insights from our tutors significantly helped us improve how we communicate ideas visually, refining our skills in using drawings as an effective medium in urbanism. Lastly, while developing strategic locations and timelines, we gained experience in forecasting future conditions, anticipating challenges, and identifying triggers, skills that will be especially useful in our graduation projects.

Values, Ethics and Responsibilties as Urbanists

From the start, we focused on gaining a deeper understanding of the community and their needs/desires by trying putting ourselves in their shoes (within the scope of the studio). We worked to approach the project from the ground up, aiming to identify the people who are most affected by the plans of industry in this energy transition. Throughout the vision making stage, we aimed to connect with the community's perspective and develop more empathy and responsibility, something that is important for us as urbanists (especially considering vulnerable groups in society). We found ourselves thinking a lot about how to give space both literally and metaphorically to those whose voices have less power and unfortunately get ignored especially when stakeholders with significant power (Chemelot) are involved. We saw ourselves not just as designers, but as advocates for those currently with less power, such as the environment and our community future generations.

At the same time, we realised that being an urbanist means being the mediator of stakeholders to ensure equal representation and balanced plan making. We saw firsthand how important it is to stay neutral, find common ground, and include those who are often excluded from the process. In that sense, we felt our role was as much about facilitating as it was about designing. We also became aware of how easily this role can be influenced, how those with more power can shape outcomes to serve their own interests. That's where we felt the ethical responsibility really comes in and the requirement for a level of advocacy in the plan to ensure equality. As urbanists, we need to stay grounded, be conscious of power dynamics, and ensure we are not unintentionally contributing to imbalances.

Our Approach to the Studio and Process of Working

This studio was particularly challenging because the topic 'Energy Transition' was something we had little background knowledge of. We spent a lot of time brainstorming (we basically overloaded two Miro boards!) and having long discussions. At the same time, we were doing detailed, parallel research on three very different actors: Chemelot, energy systems, and the communities, looking at each separately to understand their individual perspectives before bringing them together. One approach that really helped us was putting everything we knew side by side, on maps and sheets. This made it easier to have deeper discussions with our mentors, spot connections, and find directions to move forward more quickly. It also helped us spatial our research early on. Another thing we did which maybe didn't follow the usual course structure was to start from the local scale and then scale up, instead of the other way around. For us, it was important to begin locally so we could better understand the needs and interests of the community we were focusing on.

Narrative Building

Working with a diverse group of stakeholders meant we needed a clear and effective way to communicate our ideas, vision, and goals. This was important not only to get quick approvals on decisions but also to ensure that we were including the core perspective from the community as required in this studio. Our narrative evolved throughout the process, shaped by discussions with our mentors, presentations to other groups, our design work, and research. A key part of this was making sure we had solid reasons and explanations for each step explaining clearly how one decision led to the next and how they all connected. Since our project involved two main stakeholders (the resident's community and Chemelot industry) with opposing views, we had to address both perspectives in the narrative. In the end, confrontation and conflict became important tools for bringing the groups together and reaching conclusions through negotiation.

Group Dynamics

We believe that urbanism is a field where collaboration and teamwork are fundamental parts of the process. We described our team dynamics well in our mid-term assessment. We were like a group of worker ants which we see as hardworking, collaborative, and supportive. Each of us brought unique skills to the table, and together, we focused on achieving the best outcome through teamwork. We are passionate about the project and always willing to help each other out. We also made sure to be accommodating with each other, resolving conflicts through communication. We were all willing to compromise on aspects that were important to others. In that sense, we feel our teamwork was successful. Of course, there were moments of chaos, especially when we interpreted things differently or struggled with language barriers, particularly when using more complex English terms. To work through this, we decided that one person would dive into the details and present their findings. This person would then explain their approach, and the rest of us could raise concerns or ideas. This approach helped us resolve many of the issues we faced, like our choice of community, patterns, strategic areas, and timeline.

Tools Utilised and Medium of Work

We found two key tools to be especially valuable. The first was Miro, which was central to our collaborative process, from initial brainstorming and narrative development to scheduling our deadlines. It supported teamwork and helped us maintain a clear overview of our workflow. The second was GIS, which proved essential in providing base layers for our spatial analysis, as well as for shaping our vision and strategic planning. For all design-related work, we relied on hand drawings and sketches, a medium that encouraged creative expression, enabled quick iterations, and reflected our distinct working style. We also close to sketch many maps as we felt it represented the community in a stronger way and was something when the plan is presented to the community again that they can feel comfortable adding to the maps and sketching over them. To ensure clarity and cohesion, we also maintained a consistent colour and texture palette for example community is light orange and industry a magenta colour, enhancing the overall readability and visual appeal of our outputs.

Fig 131: Mid-Term Team-Work Metaphor

Difficulties and Limitations

One major difficulty was spatialising the energy and industrial infrastructure, an area where we had limited prior knowledge, and which often pushed the boundaries of our technical expertise. Another significant challenge was working across different spatial scales. Our initial focus was grounded in the local both in terms of community impact and engagement which made it difficult to immediately connect our ideas to a broader regional scale. As a result, our project evolved from detailed local insights toward larger regional strategies over time. We also identified this as a core challenge inherent to the theme of energy and communities, especially when working with communities as deeply rooted and locally focused as ours.

INDIVIDUAL REFLECTION: Rian

Learnings from the Regional Design Project & Methodology Course

The regional design forms a triangular-shaped region throughout three international cross-border areas. While so close to each other these countries have their own cultures, beliefs, nationalities, systems, social systems, political systems and others which results in varying spatial qualities and development structures. This made this region especially interesting to work with, allowing me to try to understand the perspective towards the values of these communities with the overall guiding theme of the energy transition for industry. It is important for me to grasp a hold of this to inform the realities in the design and strategy-making process. Coming from Ireland I understand the complexity of borders and how this can translate into strategic planning and thus how conflict can emerge. Relating this to the energy transition, for example people feel connected to the landscapes and forming part of their identities.

Within our regional design, it encompasses three strategic locations which helped us form the regional design itself. The plan aims to apply the core elements and ethics that emerged from creating the vision for the community on the smaller scale surrounding our chosen industrial area and scale these up. It was interesting learning in the process of how to retain and apply the community vision values to the regional scale while also trying to create a new ambitious longer-term strategy plan for the region.

In my opinion, we successfully applied, what we believed to be the core values and desires of the community at this regional scale while balancing it with our strategic ambitions to grow the region within the confines of the studio scope and brief. In which was justified by our analysis and research which favoured the development of this region, as is outlined in this report. On the other hand, I would have liked the plan to really stem from the community by working together with them to say with confidence that our plan for the community does or does not fulfil the needs and desires of the community and stakeholders involved.

Coming from a spatial planning background I was already familiar with potential power dynamics and how centralised power can lead to the community being placed on the backfoot of a regional plan to prioritise growth and economic factors. It was interesting to really build up the local level to the regional scale in helping to restructure the current power imbalance while as an Urbanist advocating for the community so that the public and common good can prevail, aiming to implement elements of our core chosen theories such as pattern language (Alexander, 1977), the doughnut economy (Raworth, K. 2017), patterns of co-presence (Legeby, A. 2005) which discusses segregation and design as has the SDSs and Capita Selecta lectures, environmental zoning (De Zwarte Hond, & Province Zuid Holland, 2022), among others as outlined in this report. I would have liked to develop our policy further to create more actions and structure how certain strategies can be implemented in further detail.

Work Process, Discussions, Collaboration, Group Dynamics, Roles, & Responsibilities in Teamwork

Generally, we worked well together as a team, all taking on a collaborative mindset with most elements of the project having input in some way shape or form from everyone at some point in the process, where relevant. By primarily discussing, drawing, and using our Miro board heavily, we were able to generate and express our thoughts and ideas together allowing us to put our individual thoughts on the table to help them to guide our mostly research and plan-making by design approach. This led to having a good understanding of all of the elements of our project as opposed to splitting the work by main topics and not knowing what one element of the project is about. The information and timeframe were quite condensed thus why I state I would have liked to delve deeper into the strategy.

Naturally, there are elements of group work that lead to misunderstandings or greater expression required for all at differing points in the process depending on the topic, but we were able to overcome these by further discussing together so that we are all on the same page to understand and progress our project together as a team.

INDIVIDUAL REFLECTION: Ritika

Impact of Regional Design and Learnings from the Project

As an architect by training, working at the regional scale was a significant shift in perspective for me. I was particularly intrigued by the cause-and-effect relationships that emerge across scales—how actions taken in one area can ripple out and influence others in unexpected ways. At the regional level, actors and systems that may not seem directly connected at the architectural or site scale begin to reveal strong interdependencies. This broader lens pushed me to think beyond the boundaries of the site and consider urban design decisions from a more systemic and implications-driven standpoint.
Zooming out allowed me to also see patterns, flows, and dependencies—such as infrastructure networks, ecological systems, or social dynamics—that might otherwise remain invisible at smaller scales, yet play a crucial role in shaping spatial outcomes. Beyond this shift in scale, I encountered two themes that were entirely new to me. The first was energy. It had previously felt like an invisible layer in my thinking—something I hadn't considered. Exploring it opened up new questions about other essential systems like food, water, and materials, and how their dynamics can be studied to understand their spatial implications in design. The second was the bottom-up approach and its connection to spatial justice. This framework has led me to reflect differently on past academic and professional projects—realizing that many of them could have been approached from a more inclusive, grounded perspective. In many ways, I see the work I did this quarter as just the beginning of a much longer journey. These themes have sparked a curiosity in me, and I'm eager to explore how they can shape my thinking and practice moving forward.

Capita selecta and SDS Lectures Insight

The lectures throughout the course, especially in the early weeks, were quite useful—particularly those focused on energy and community themes. While some content felt slightly repetitive at times, the overall framing helped build a strong foundation. The Atlas.ti workshops were also helpful, as they introduced a new tool for media analysis that was directly applicable to our research process. On the other hand, I found the GIS workshops less effective this quarter. Because they were more exercise-driven than instructional, it felt challenging to build a deeper understanding or apply the tools confidently in our own work. In contrast, Alexander's lectures on systemic flows were especially valuable. Since our project was already focused on understanding flows, his input helped us clarify and structure our thinking in a much more coherent and meaningful way.

Work Process and Discussions

The work process over the quarter felt like a bit of a journey, with its ups and downs. I found myself quite overwhelmed at times, especially at the beginning of major phases like defining our vision or developing the strategy. I tend to get stuck when things aren't fully clear in my mind—it becomes difficult for me to start drawing or putting ideas on paper, and production can feel like a hurdle. During those moments, I appreciated how our group was able to pause, reflect, and engage in thoughtful discussions to clarify our direction before moving forward. That practice was incredibly helpful for me personally, and I believe it also allowed us to communicate our ideas and progress more effectively during reviews with our mentors. The positive feedback and encouragement we received from them added a boost of motivation and made the process feel even more rewarding.

Collaboration and Group dynamics

For me, this group project was a valuable opportunity for both learning and meaningful collaboration. I was fortunate to work with teammates whose skills complemented my own, and I gained a great deal from observing and engaging with their approaches. In particular, I feel I've grown significantly in my abilities related to drawing, visual representation, and narrative building. Perhaps most importantly, I began to overcome my hesitation around producing drawings without having complete clarity from the outset. This was largely thanks to the confidence and skill my groupmates brought to that part of the process, as well as their ability to push things forward when I found myself stuck.

Roles and Responsibilities in Teamwork

Although we didn't assign strict roles within our group, everyone contributed to all stages of the production process. We approached design and decision-making collaboratively, discussing ideas together and taking on tasks as they naturally came up. I found myself particularly engaged in narrative building and content structuring, where I felt I could contribute meaningfully—especially through regular feedback and discussions with the group. I also noticed that at times, when our focus naturally shifted toward individual tasks, I often encouraged conversations and check-ins to maintain a sense of collective direction and cohesion.

INDIVIDUAL REFLECTION: Sylvia

Learnings from the Regional Design Project with the Integration of the Methodology Course

From the start of the project, I was drawn to understanding the relationship between large industrial sites and the communities that live nearby. For example, I myself grew up in Amstelveen, near the Schiphol airport, having to deal with the nuisance of this. This raised questions of spatial justice, particularly regarding the environmental and social burdens that industries place on local residents, who often do not have a choice in the matter. Unfortunately, these residents often lack a platform to voice their concerns or are ignored entirely. In the case of Chemelot, a major industrial player in the Netherlands, this challenge was exacerbated by its importance to the national economy. While it provides significant benefits to the wider population, it comes at the cost of local residents. This situation taught me the need for a bottom-up approach and for advocating more effectively for these communities, especially given Chemelot's strong government backing and the broader cross-border industrial region.

Throughout the project, I developed a deeper understanding of spatial justice, particularly how it applies to the specific needs and concerns of communities. I gained a clearer sense of how to represent these needs in my work, with a focus on recognition justice. However, we had to base these needs and concerns on research, wince we were not able to interview them, which I think would be better for future projects. One approach that proved particularly valuable was developing two distinct visions, one for the community and one for Chemelot. This allowed for an open exploration of both sets of needs and aspirations, leading to a more balanced and inclusive vision. I learned how critical it is to acknowledge the full spectrum of concerns and to ensure that these diverse perspectives are integrated into the design process.

A major challenge in the project was the presence of two key stakeholders with conflicting interests, yet both dependent on each other. This dynamic required careful navigation. The introduction of pattern language (Alexander, 1977) was a useful tool for me to manage this complexity. Developing these patterns made the relationship between conflicting interests less abstract and more tangible. Two categories of patterns, conflicts and transitions, were particularly useful in identifying potential sources of tension, suggesting ways to mitigate them, and highlighting possible synergies. This exercise in balancing the burdens and benefits of both stakeholders also demonstrated the importance of distributive justice. Moreover, the use of pattern language helped facilitate a bottom-up decision-making process, allowing all stakeholders to have a voice, which further reinforced procedural justice. I will use this tool in future projects, especially in participatory design processes.

The cross-border scale posed a unique challenge for me. It became clear that understanding the rules and regulations across different countries was essential. I learned that countries should not be viewed as isolated patches of land use but as part of a larger, interconnected system. This helped with the identification of stakeholders, their interest and a shift in their chain to a less polluting and less burdening way towards residents. I learned how the broader context influences decisions and how important it is to incorporate these insights into designing more sustainable and equitable solutions.

This experience of working on a project with a cross-border context has impacted my approach as an urbanist. I now appreciate the importance of considering both local and larger-scale dynamics, recognizing the interconnections between them and the complexity of the chain.

Group Collaboration and Studio Sessions

At the beginning of the project, we struggled to get started, as none of us had worked on such a large-scale project before. However, once we found our rhythm, the process became smoother. The collaborative nature of the team made it easier to divide tasks and maintain momentum. As someone who is visually oriented, I found sketching ideas on maps useful for formulating concepts quickly, which made the process more intuitive through research by design.

The discussions with tutors helped me refine my ability to critically assess and articulate the narrative and arguments, sharpening my skills in clear communication. This is especially something I will focus on more when thinking of my future as an urbanist, needing to be a clear communicator.

The group dynamic was very effective, allowing us to make decisions quickly and build trust throughout the process. We chose not to rigidly divide tasks but instead maintained a flexible task list, which kept everyone engaged and aware of the broader project narrative. This flexible approach, combined with our shared trust and collaboration, allowed the team to work efficiently and effectively, ensuring that no one felt overwhelmed.

INDIVIDUAL REFLECTION: Yaying

Systemic Design and Urban-Industrial Symbiosis in Regional-Scale Spatial Planning

From my perspective, the two most insightful themes explored in this course are, firstly, the use of systemic design as a tool to consolidate the complex spatial relationships within a broader regional context, and secondly, the application of urban-industrial symbiosis as a guiding principle in regional spatial planning.

For us, systemic design has served as a tool for both understanding spatial interdependencies at the regional scale and formulating strategies capable of addressing conflicts while identifying opportunities for symbiosis. This approach has proven particularly relevant to the topic of our research: the spatial implications of expanding energy-intensive heavy industry within the context of the energy transition. One of the initial challenges I encountered in regional planning was discerning the most pertinent and impactful information amidst the overwhelming volume of available regional data. In this regard, systemic design offers a clear overview of regional relevance and areas that should be taken into consideration. Furthermore, in the context of globalisation, industries are increasingly embedded within complex, multi-scalar supply chains and networks, whose effects often transcend local boundaries. Through the mapping of these supply chains and the infrastructures that support them, we were able to gain a more comprehensive understanding of the spatial interconnections between localities and the broader regional systems in which they are situated, which helped greatly when working across multiple scales, as we have done in this project. During this process, systemic design provides a continuous reminder of the simultaneity of developments at various scales. Moreover, systemic design also clarifies the role of spatial design in mediating diverse stakeholder interests, thereby providing insights into the social responsibility of urbanists. As was emphasised in the methodology course, space and society are mutually constitutive, and urbanists must be guided by principles such as spatial justice.

The second major inspiration has been the concept of urban-industrial symbiosis, which has served as a core principle throughout our research. This topic is of urgent relevance not only to European development but also to global regions undergoing structural transformation. While de-industrialisation was long considered an inevitable process of urban development, it is now increasingly recognised that long-term societal resilience depends on strategies that promote coexistence with industry. This requires an approach in which industrial activity is aligned with the well-being of both people and the environment. Furthermore, the principle of urban-industrial symbiosis is inherently linked to the notion of integrated sustainability, which simultaneously addresses social, economic, and environmental dimensions. In future research, I intend to explore this aspect in greater depth.

Work Process, Collaboration, and Group Dynamics

Throughout the collaborative process, our group maintained effective communication and constructive dialogue as central elements of our working methodology. I consistently gained valuable insights through discussions with my colleagues, largely due to our shared level of preparedness and mutual commitment to the project. It is not uncommon for prolonged individual work to lead to a narrowed or skewed perspective; in such moments, group discussions provided necessary recalibration and critical reflection, which proved indispensable to the overall coherence of our work.

We structured our collaboration by dividing tasks according to individual strengths and areas of expertise. My primary contributions involved spatial analysis and design through mapping, as well as synthesising and categorising the abundant materials that we have come up with. This allowed us to extract key findings efficiently and apply them more effectively in subsequent phases of the project.

In terms of work ethic, all members of the group demonstrated a high level of dedication and motivation, which significantly contributed to maintaining a collective enthusiasm throughout the course. The positive group dynamic fostered a productive and supportive working environment that enhanced both the quality of our output and the learning experience itself.

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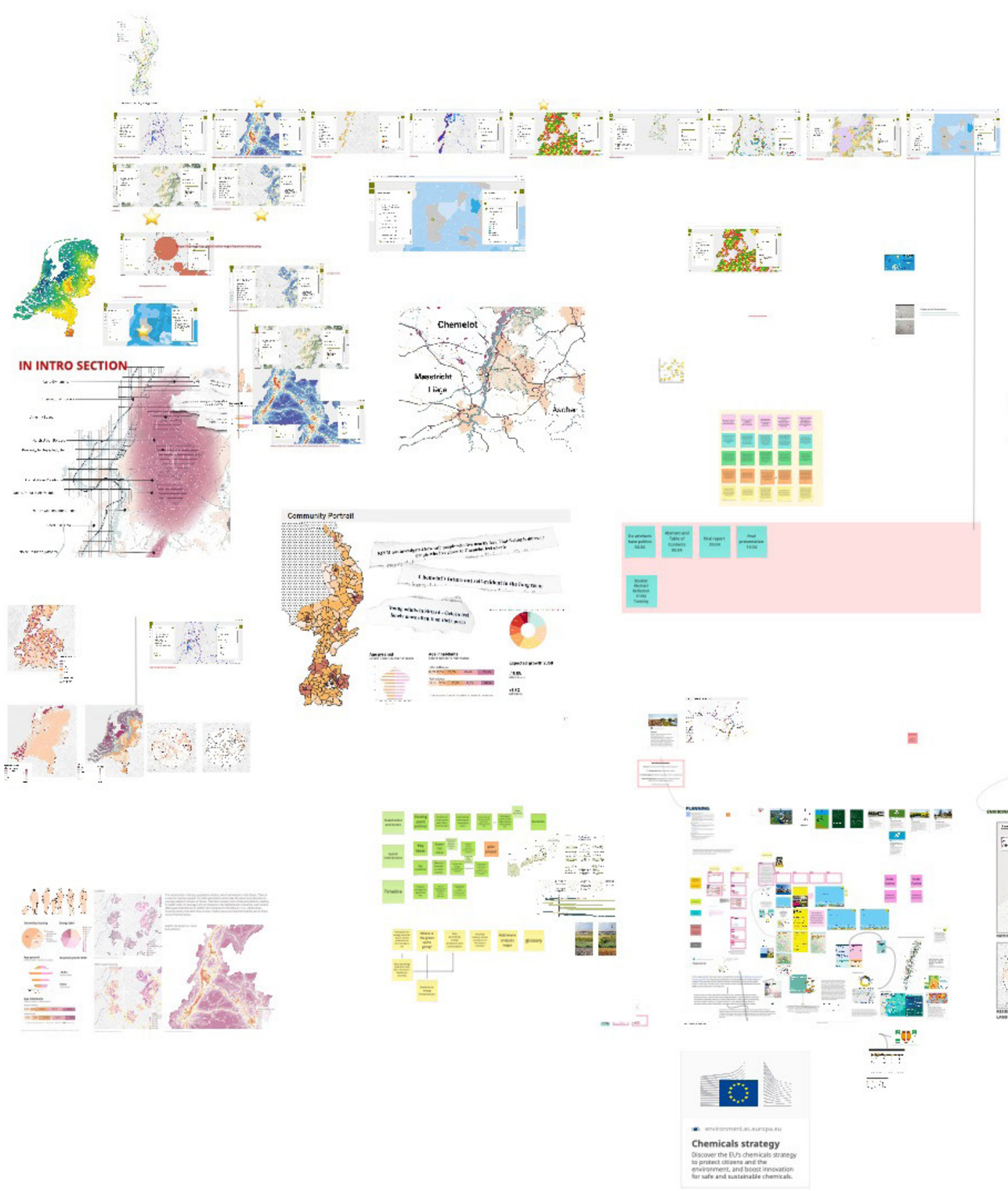
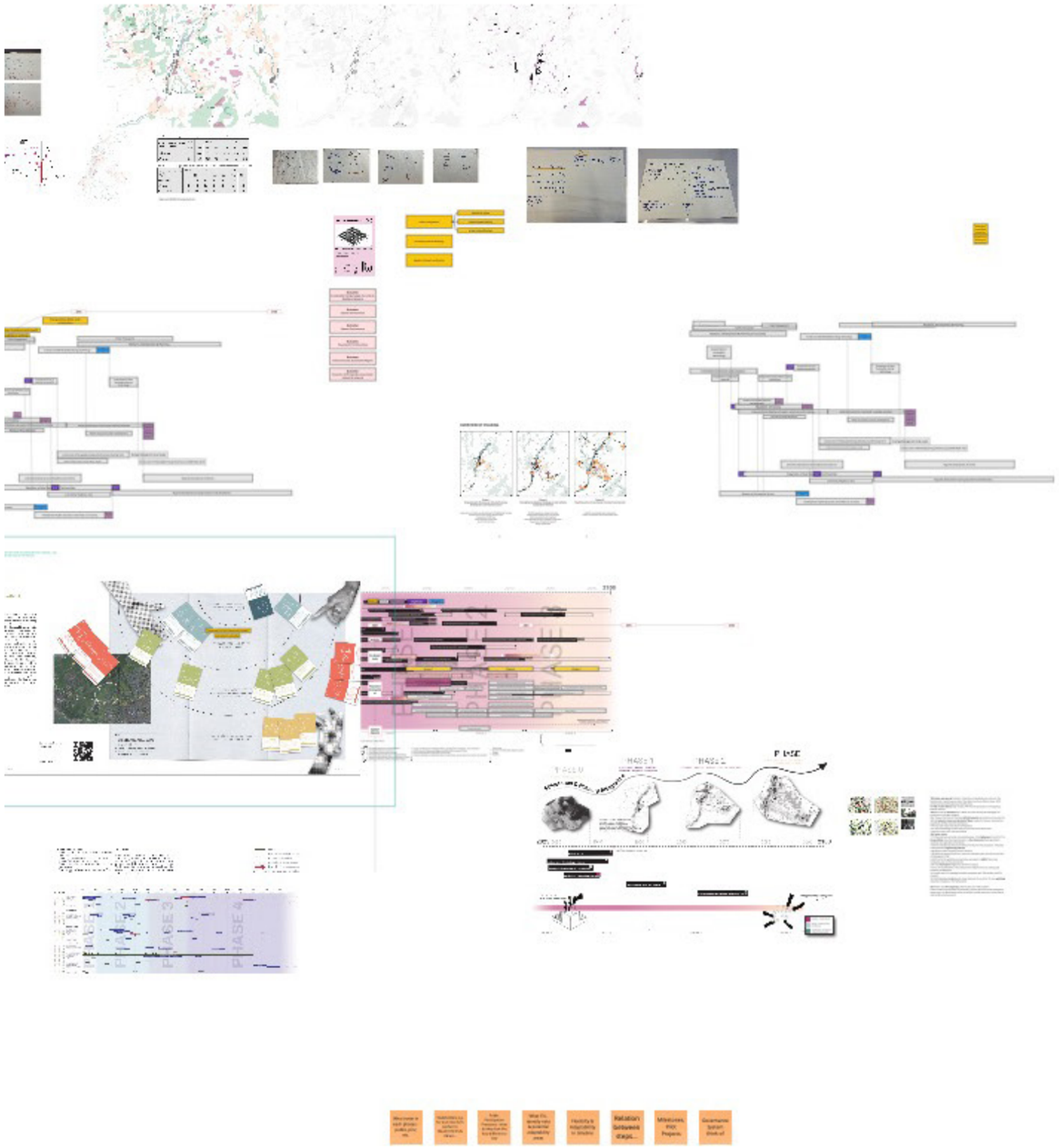
*Note: Used from February to April throughout the course now and again to assist with research, searching the web, finding sources, and fixing grammar and spelling.

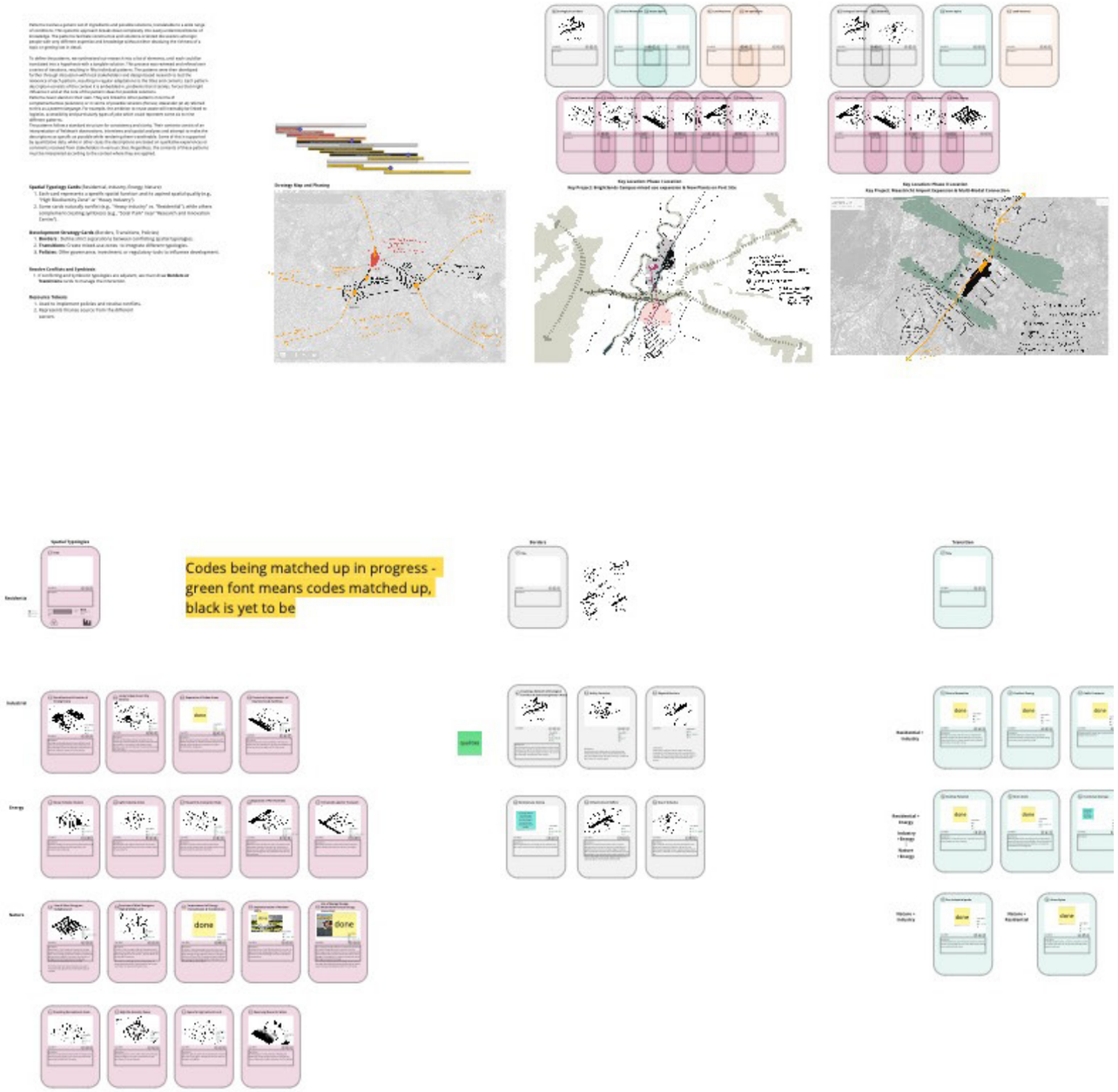
Appendix

THE PROCESS: MIRO BOARD



THE PROCESS: MIRO BOARD





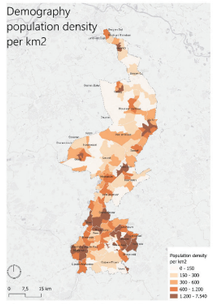
ANALYSIS

Demographics

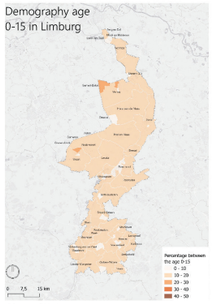
This plan considered the demography of the provincial region (Limburg). These maps were used to form our analysis by creating maps and the community profile before the vision for the community could be made.

Where information is not represented in synthesis maps or individual maps within the report they are shown here - to show the background into the data and decisions.

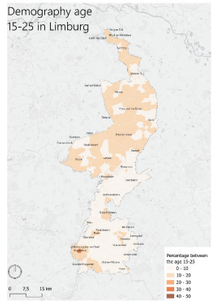
Refer to **Sections 1 & 3** of this report.



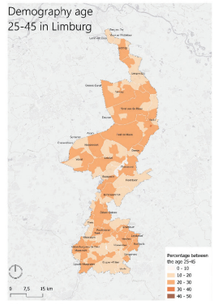
Population Density



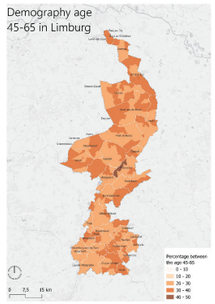
0 – 15



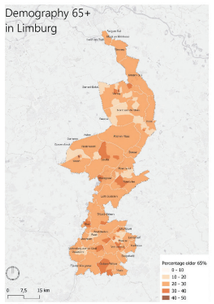
15 – 25



25 – 45



45 – 65



65+

Pollution

This plan considered the pollution within the provincial region (Limburg). These maps were used to form our analysis by creating maps and the community profile before the vision for the community could be made.

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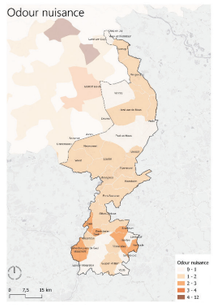
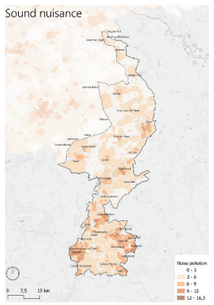
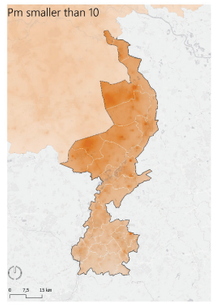


Odour Nuisance

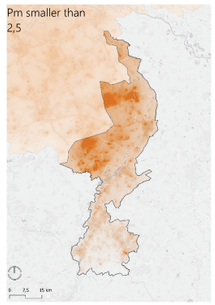


Sound Nuisance

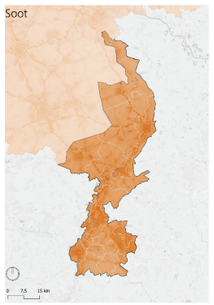


PM 10

Nitrogen



PM 2.5



Soot

Environment

This plan considered the natural environment of the provincial region (Limburg). These maps were used to form our analysis by creating maps and the community profile before the vision for the community could be made.

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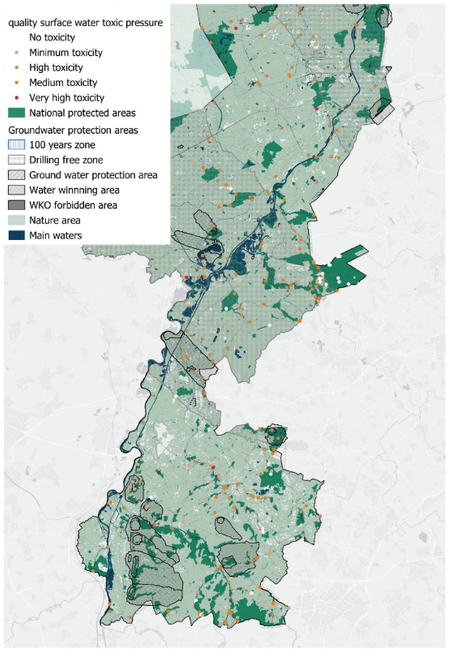
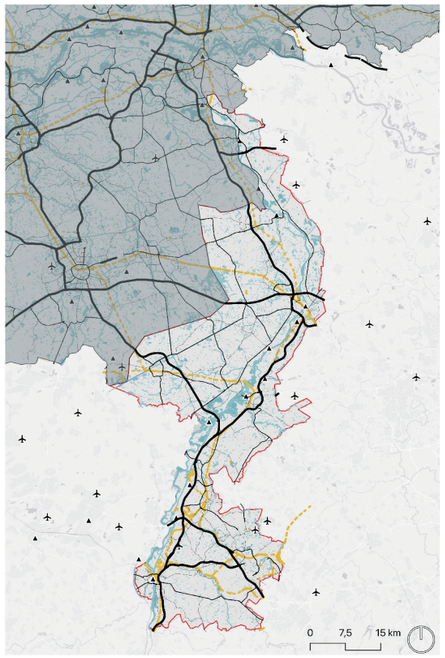
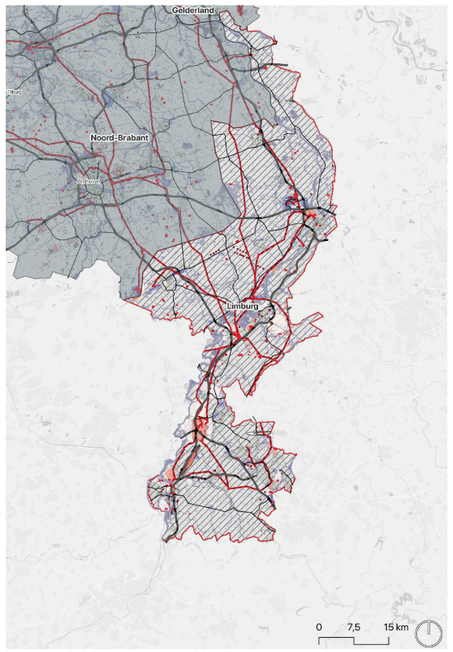
Refer to **Sections 1, 3, 4, & 5** of this report.



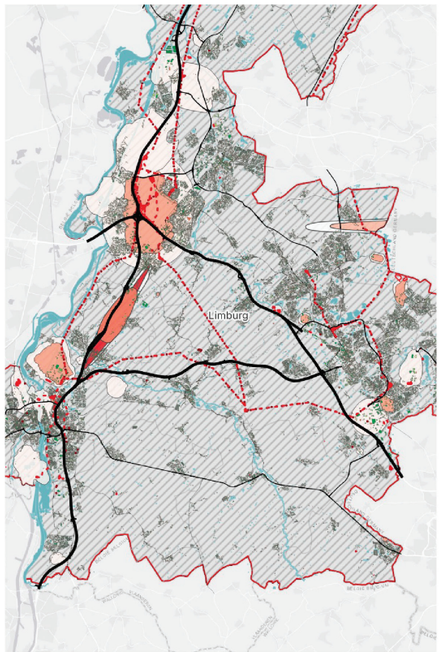
Green Network - Limburg



Transport Network including Ports - Limburg



Energy & Motorways - Limburg



Energy Network Close Up

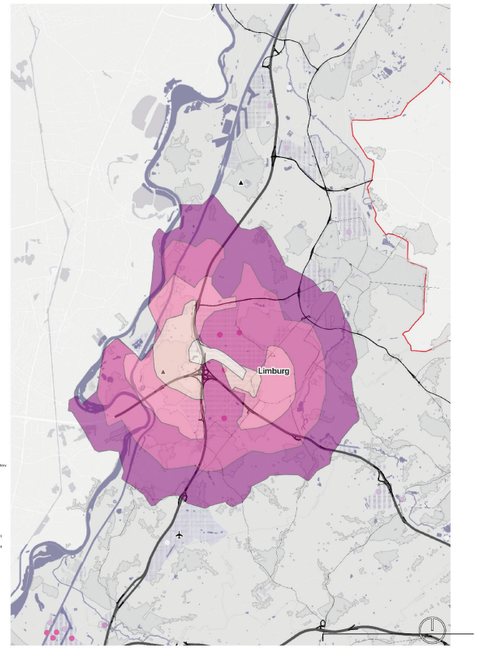
ANALYSIS

Accessibility

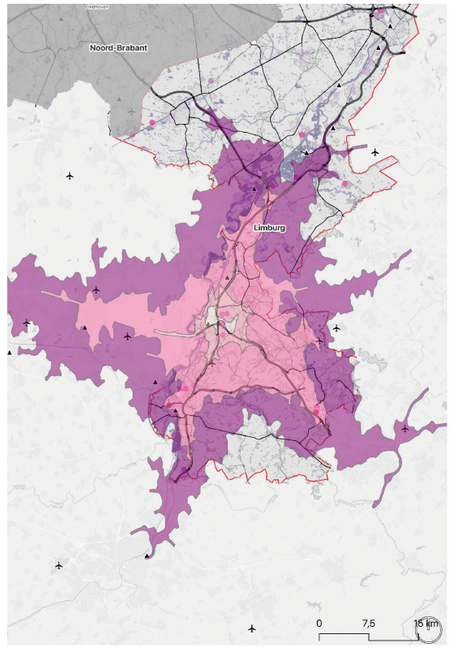
These maps show the accessibility of the campus of Chemelot by bicycle and car within reasonable journey travel times. This was used to help define and inform where and what our community is.

Where information is not represented in synthesis maps or individual maps within the report they are shown here - to show the background into the data and decisions.

Refer to **Sections 1, 3, 4, & 5** of this report.



Cycle Travel Time to/from Chemelot 5 – 25 minutes



Driving Travel Time to/from Chemelot 5 – 25 minutes

Other

This plan considered the pollution within the provincial region (Limburg). These maps were used to form our analysis by creating maps and the community profile before the vision for the community could be made.

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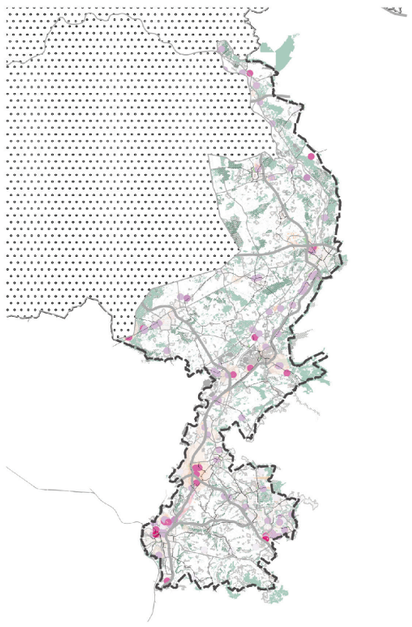
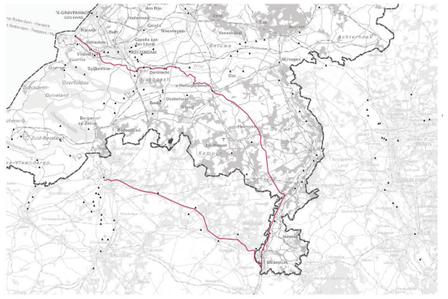
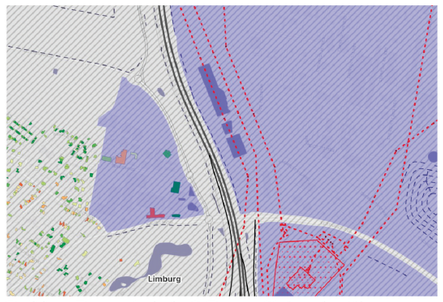
Refer to **Sections 1 and 3** of this report.



Chemical Industries & Main Networks



Freight Routes Over Water Chemelot to/from Antwerp & Rotterdam Ports.



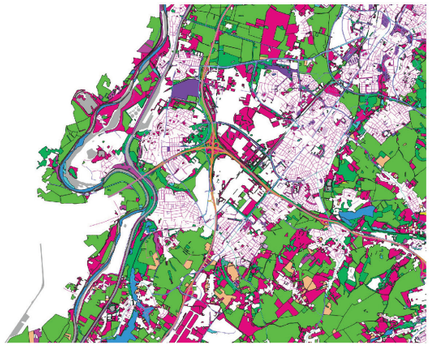
Building Energy Labels & Energy Network with Industry Land Use

Local Analysis

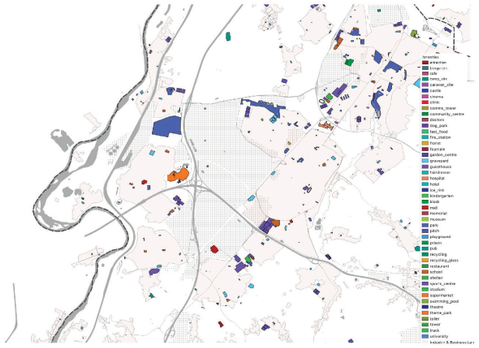
This plan considered the local environment surrounding the heavy chemical industrial site at Chemelot. These maps were used to form our analysis by creating maps and the community profile to make the vision for the community.

Where information is not represented in synthesis maps or individual maps within the report they are shown here - to show the background into the data and decisions.

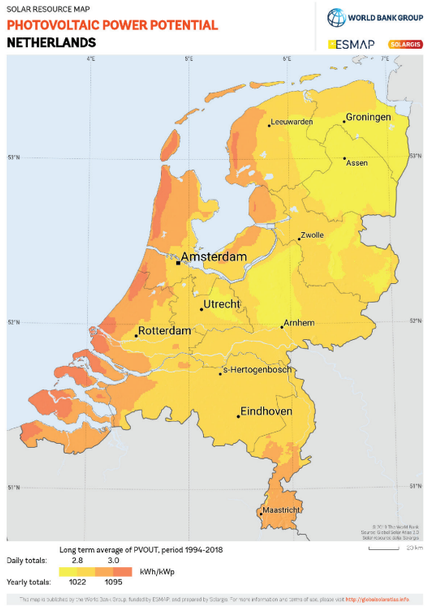
Refer to **Sections 1, 3, & 4** of this report.



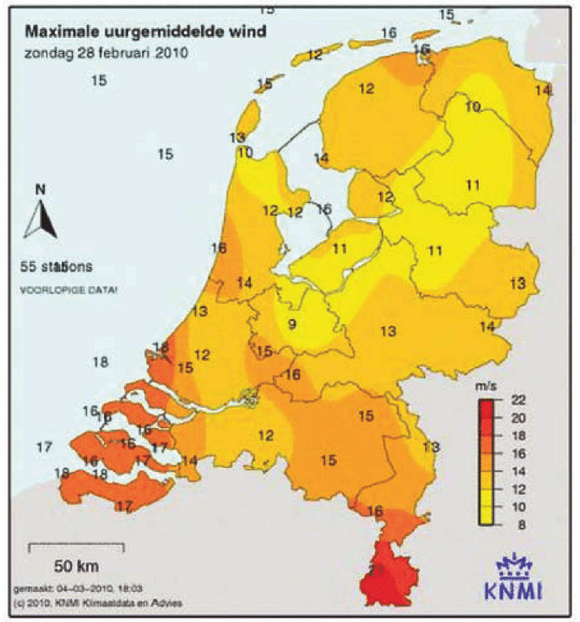
Land Use - Community Area



Existing Amenities - Community Area



Solar Energy Potential Netherlands – Limburg Higher
Source: SolarGIS, (2018).



Wind Speed Netherlands – Southern Limburg Highest in Netherlands
Source: KNMI Klimaatdata en Advies, (2010).

ANALYSIS

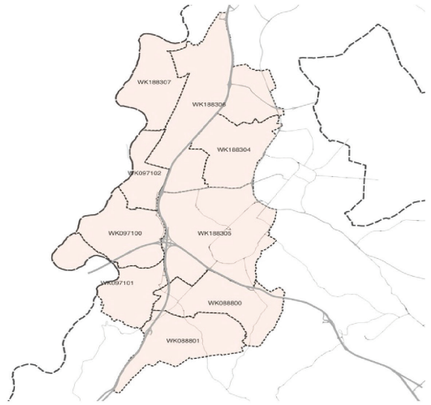
Accessibility

These maps detail the community surrounding the Chemelot Campus Geleen. This information was used to help define and inform where, what our community is and their needs and desires in the context of living nearby to the chemical industry area.

Where information is not represented in synthesis maps or individual maps within the report they are shown here - to show the background into the data and decisions.

Refer to **4** of this report.

Site Visit Route & Photographs



wijkcode	wijknaam	gemeenteco	gemeentena	indelingsw	water	omgevingsa	stedelijkh	bevolkings	aantallnwo
WK088801	Wijk 01 Beek-Zuid	GM0888	Beek	1	NEE	178	5	194	2050
WK088800	Wijk 00 Beek - Spa	GM0888	Beek	1	NEE	992	4	1343	14080
WK097101	Wijk 01 Elsloo	GM0971	Stein	1	NEE	929	4	1078	8325
WK188305	Wijk 05 Geleen	GM1883	Sittard-Geleen	1	NEE	1781	2	1593	31185
WK097100	Wijk 00 Stein	GM0971	Stein	1	NEE	1084	3	1242	10730
WK097102	Wijk 02 Urmond	GM0971	Stein	1	NEE	500	4	1253	5715
WK188306	Wijk 06 Holtum-Bo	GM1883	Sittard-Geleen	1	NEE	721	4	454	8985
WK188304	Wijk 04 Guttecover	GM1883	Sittard-Geleen	1	NEE	454	5	579	5100
WK188307	Wijk 07 Obbicht en	GM1883	Sittard-Geleen	1	NEE	393	5	621	4875
							Totals:	8357	91045

Population Data & Neighbourhoods – Community Scale

VISION

Vision Making

This plan considered the local environment surrounding the heavy chemical industrial site at Chemelot. These maps were used to form our analysis by creating maps and the community profile to make the vision for the community.

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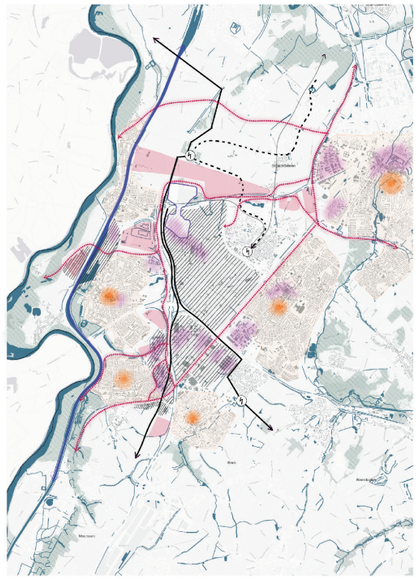
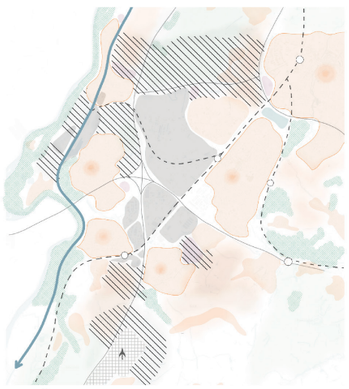
Refer to **Sections 1, 3, & 4** of this report.

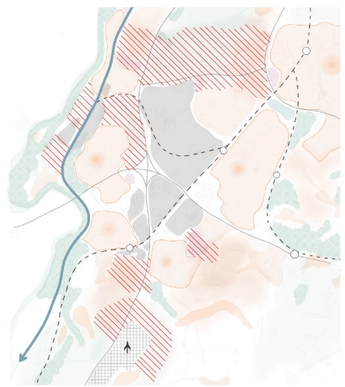


Chemelot Wants

Community Wants



Conflict Map



Conflict Map

Community Desires Map

VISION MAKING

Vision Making

These maps show the accessibility of the campus of Chemelot by bicycle and car within reasonable journey travel times. This was used to help define and inform where and what our community is.

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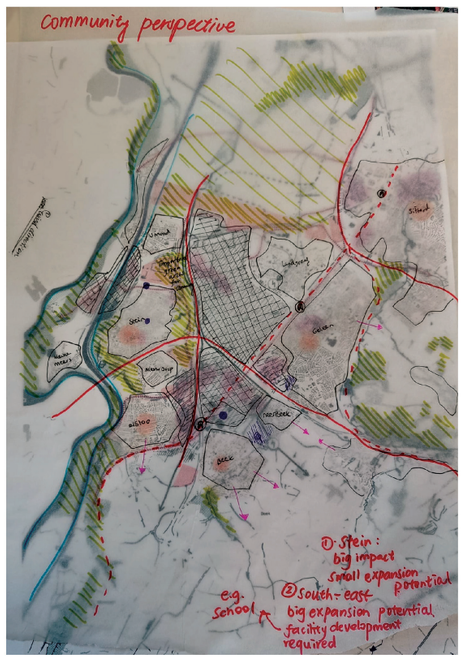
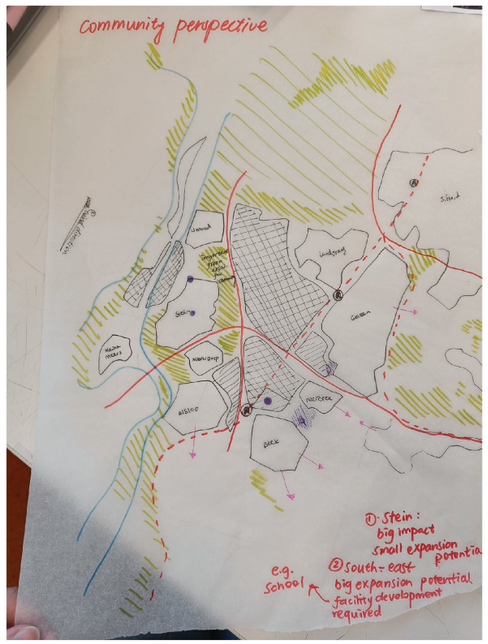
Refer to **4 & 5** of this report.

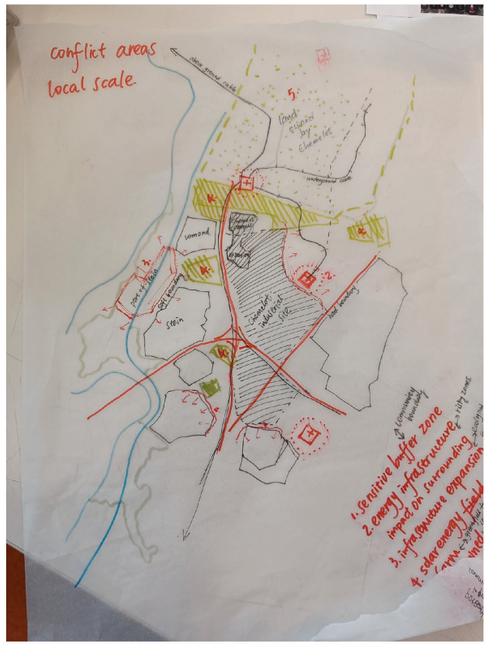
Conflict Areas Local Map



Community Perspective Map



Community Perspective Map



Local Conflict Map

VISION AND STRATEGY MAKING

Vision & Strategy Making

This plan considered the local environment surrounding the heavy chemical industrial site at Chemelot. These maps were used to form our analysis by creating maps and the community profile to make the vision for the community.

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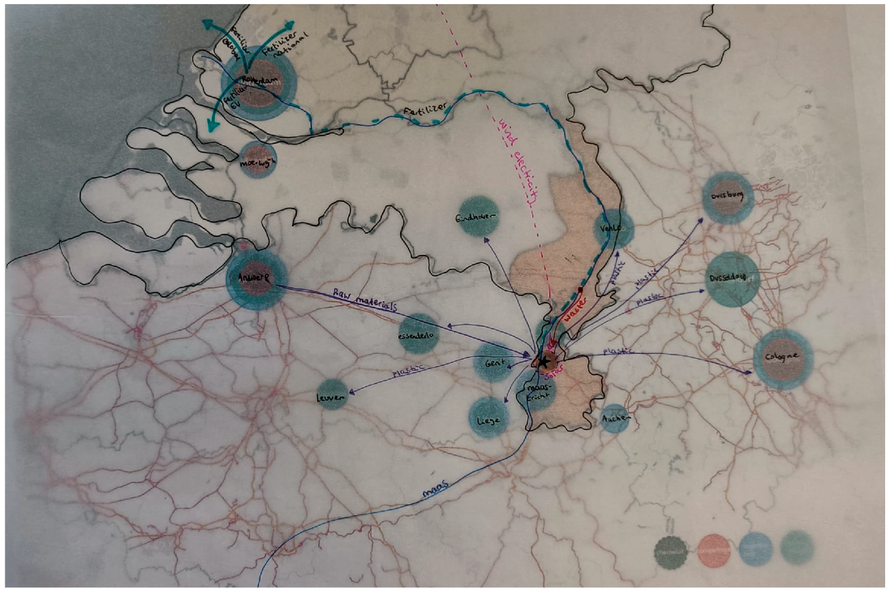
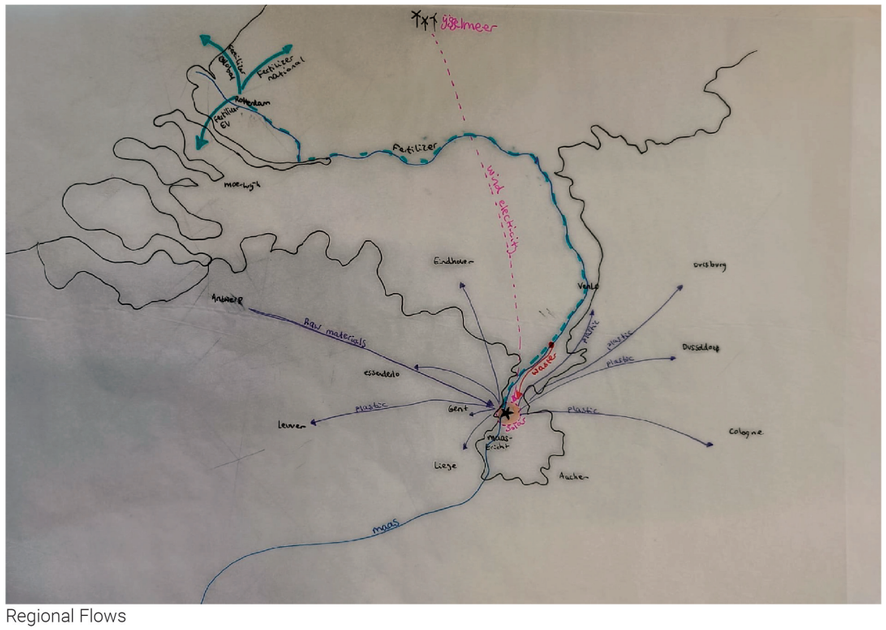


Regional Flows & Clusters



Regional Flows

VISION AND STRATEGY MAKING

Vision & Strategy Making

This mapping was used to identify the spatial claims of the stakeholders.

Where information is not represented in synthesis maps or individual maps within the report they are shown here - to show the background into the data and decisions.

Refer to **4 & 5** of this report.

Land & Spatial Interest (Stakeholders) Map

Conflict & Symbiosis (Stakeholders) Map

SPATIAL ASPECTS OF RENEWABLE ENERGY

Vision & Strategy Making

This data was used for the key area strategy and vision.

Refer to **Sections 4 & 5** of this report.

Solar farm space Chemelot

Calculation of the space required to generate 2 million MWh (megawatt-hours) per year for Chemelot using solar farms (photovoltaic cells):
(Numbers are based on the book by Sijmons et al., (2014))
1 hectare of PV cells produces approximately 1,693.5 MWh/hectare per year

Calculation area for production of 2 million MWh:
Hectares required= (Total energy required (MWh))/ (Energy produced per Hectare (MWh/hectare))= (2.000.000 MWh)/ (1,693 MWh/hectare) = 1,179 hectares
1,179 hectares= 11,79 km2
So approximately 12 km2 is needed for the energy production of 2 million MWh per year.

Wind farm space Chemelot

Calculation of the space required to generate 2 million MWh (megawatt-hours) per year for Chemelot using wind farms (photovoltaic cells):
(Numbers are based on the book by Sijmons et al., (2014))

1 hectare of wind farms produces approximately 38.470,45 MWh/hectare per year

Calculation area for production of 2 million MWh:
hectares required = (Total energy required (MWh))/ (Energy produced per Hectare (MWh/hectare))=(2.000.000 MWh) / (38.470,45 MWh/hectare) = 51,97 hectares
51,97 hectares = 0,5 km2

Although this is small, it does not consider that windfarms, need buffer zones, roads and networks in between, therefore 3km2 is a more reasonable area for windfarms.

Hydrogen plant space Chemelot

Calculation of the space required to generate 2 million MWh (megawatt-hours) per year for Chemelot using Hydrogen power:

(Numbers are based on the book by Sijmons et al., (2014))

1 hectare of hydrogen power produces approximately 8,470MW/ hectare per year

Calculation area for production of 2 million MWh:
hectares required = (Total energy required (MWh))/ (Energy produced per Hectare (MWh/hectare))=(2.000.000 MWh) / (8,470MW/hectare) = 236.14 hectares
236.14 hectares = 2.36 km2

So approximately 2,3 km2 is needed for the for the energy production os 2 million MWh per year.

Calculation Energy Use Chemelot