



the cloud is not in the sky,
but in Groningen

Democratic management of energy, resources, land, and
technology through the AI revolution

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Colophon

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AI use statement

This text aims to explore ethics of the development of ai; therefore, we have been conscious around our use of ai while acknowledging its potential as a tool. For a detailed account of when and how ai was used in this project, and the resulting environmental impacts - please see the appendix.

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Abstract

Artificial intelligence (AI) is a rapidly expanding industry and an increasingly significant consumer of energy. Its growing electricity demand poses challenges to Dutch and European Union ambitions for a renewable energy transition. In Groningen, plans to develop an AI supercomputer present both opportunities and risks. This paper examines how such a project can be implemented in ways that avoid extractivist practices while fostering socio-ecological accountability and stewardship.

The report explores how democratic procedures and participatory processes can involve urban and rural communities, as well as more-than-human actors, in the just development of AI data centres in Groningen. Drawing on the work of Latour and Haraway, we investigate how technological systems might be designed to remain accountable to Gaia. The political dimensions of AI are further analysed through the perspectives of Morozov, Hao, and Suleyman, while their spatial implications are considered with reference to Otero-Verzier.

To understand the regional context, we combine media analysis with situated fieldwork and interviews. Scientific literature is used to assess the

energy demands of AI, while its broader political implications are examined through Winner's work on technological systems.

Based on this analysis, we propose a decentralised model for data centre development, alongside the establishment of energy communities along a corridor between Eemshaven and Groningen. In this model, the data centre acts as a catalyst for regional development in energy infrastructure, mobility, and spatial densification. Technological operations are aligned with the temporal variability of renewable energy generation, while decisions regarding energy use and job prioritisation are made democratically within these communities.

Rather than pursuing artificial general intelligence, this approach emphasises the development of specialised AI for the public good, in collaboration with industry experts based in Groningen's excellence centre. Given the rapid pace of AI development and its substantial resource demands, this paper argues for governance models and spatial designs that prioritise stewardship of both technology and the landscape.

Keywords

AI data centres, Groningen, accountability, Gaia energy transition, energy communities

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Preface

"Our communities, air, water and land are not playgrounds for billionaires chasing another buck"

-Abre' Conner, the director of environmental and climate justice for the NAACP

"We are in a period of infrastructural excess. Mirroring an economy that cannot stop producing even when producing is detached from necessity, reality, or truth."

-Marina Otero Verzier, Wheelwright Prize Lecture: Ferrel Clouds, 2026

"There is immense value in demonstrating, through real world prototypes and institutional reforms, that untethering these tools from their market driven development model is not only possible - but beneficial for democracy, humanity, and the planet"

-Evgeny Morozov, AI Futures, 2025

The accelerating wave of technological development, particularly in artificial intelligence, is often framed as inevitable. This report challenges that assumption. We are not powerless in the face of these transformations; their trajectories are shaped by decisions, design, and governance. As such, emerging technologies, and their substantial demands on energy systems, must be carefully considered, spatially situated, and collectively regulated.

This work seeks to understand the spatial, ecological, and societal implications of these developments, while questioning the dominant narratives of continuous growth and consumption that underpin them. In doing so, it asks how technological systems might instead support stewardship, foster community involvement, and operate within broader environmental and social limits.

cloud

theoretical understandings of politics and technology

hope

threats and dangers

critical zone

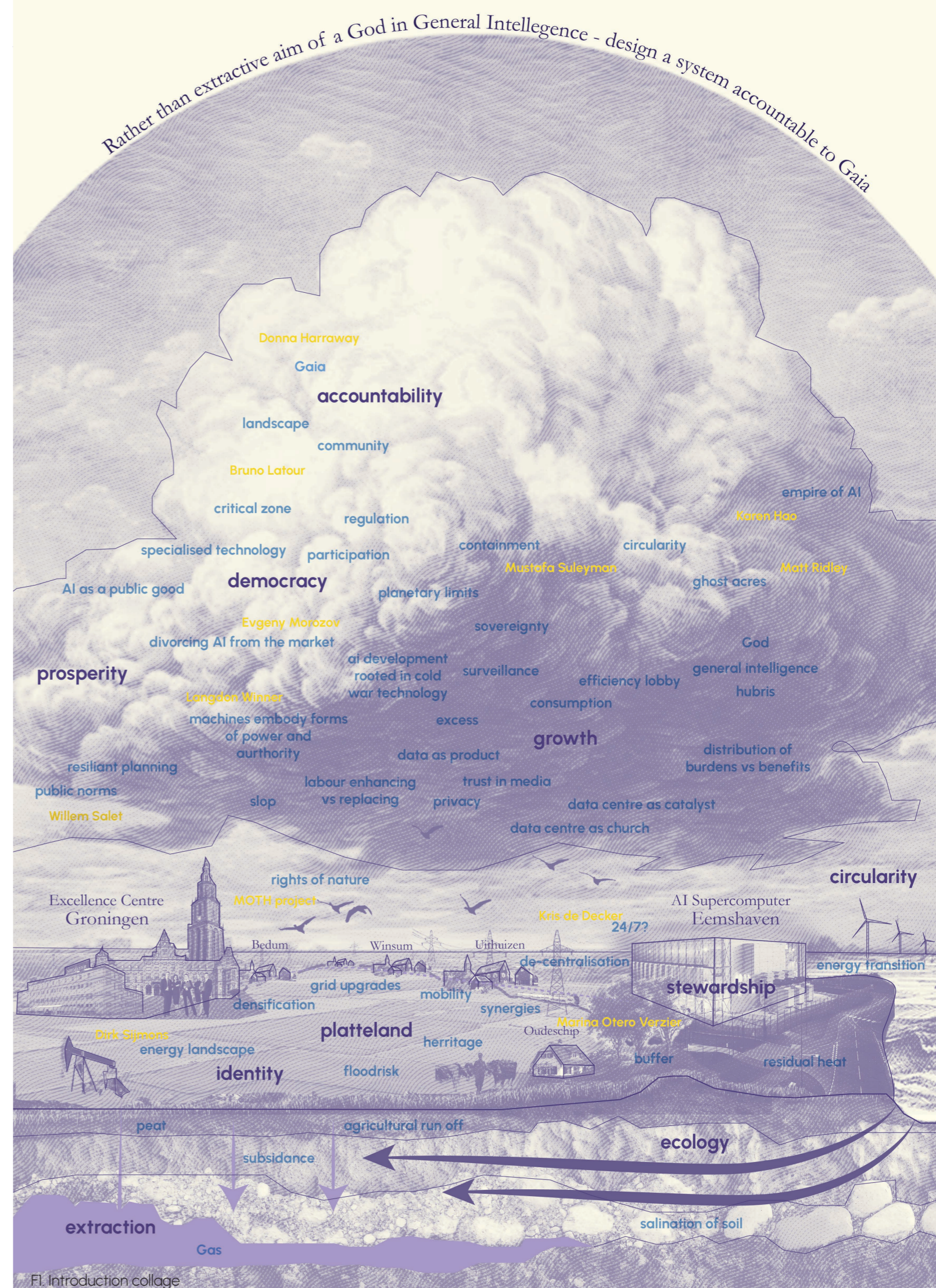
spatial implications

identities

subsurface

histories of extraction

climate risks



FI. Introduction collage

01 Introducing

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Brief

The energy transition presents not only a technical challenge, but a fundamentally spatial and societal one. As energy systems shift toward renewable sources, their spatial implications become increasingly visible, raising questions around land use and division. At the same time, this transition requires new forms of participation, demanding a clearer understanding of the roles, responsibilities, and interests of diverse stakeholders. This report approaches these challenges through a research-driven design methodology that connects spatial design with participatory governance and policy recommendations.

In response to the urgency of the climate crisis and following international and European commitments such as the Paris Agreement (2016), the European Green Deal (2019), and the European Climate Law (2021), the Government of the Netherlands introduced the National Climate Agreement (Klimaatakkoord) in 2019. This agreement sets out a pathway toward climate neutrality by 2050 and aims to reduce CO₂ emissions by 55% by 2030 compared to 1990 levels. However, this transition is complicated by the simultaneous emergence of new, energy-intensive infrastructures, most notably AI data centres, which introduce significant additional demand on already strained energy systems.

This report is structured in four parts. The first section focuses on research and analysis, examining the spatial and systemic conditions of the energy transition. The second establishes a conceptual framework that defines how these challenges are understood. The third develops a set of community visions, outlining the expectations, values, and concerns of local actors, alongside a deliberative arena that brings together key governance stakeholders. Building on this, a multiscalar and multistakeholder governance structure and strategy is proposed, articulated through a phased approach and a series of action cards designed to support ongoing participation. The report concludes with a reflection on the findings and their implications for future spatial and energy planning.

Introducing AI

ChatGPT was launched in November 2022, and since then we have all personally witnessed the extraordinary pace of development. In a relatively short time, these systems have improved dramatically, thus AI is increasingly shaping the digitisation of our socio-political and economic lives. Each of us is already making conscious decisions about how we engage with and use this technology*.

However, behind these digital tools lies a rapidly expanding physical infrastructure. The development of artificial intelligence requires an enormous network of data centres. Sam Altman, the CEO of OpenAI, has suggested that by 2033 the company wants to build around 250 gigawatts of data centre capacity (Hao, 2025a). To put this into perspective, this is roughly equivalent to the energy consumption of seventy cities the size of Amsterdam.

The construction of these data centres places significant pressure on the communities where they are located and are often built in regions that are already experiencing resource stress. Their demand for electricity can also strain local grids, contributing to rising energy prices. In the United States, electricity prices have risen by 13% since Trump came into office the second time (Climate Power, 2025) – and has reduced the regulations on data centre construction and operation.

When existing grids are unable to supply the required energy, companies often turn to temporary or highly polluting energy solutions. A clear example of this can be seen in Memphis, where dozens of gas turbine generators were installed to power Elon Musk's xAI data centre. The facility was constructed and operational in just 122 days and consumes around 150 megawatts of electricity, which is enough to power approximately 100,000 homes (Verzier, 2026a). At the same time, the turbines release harmful nitrogen oxides into communities that are already facing high levels of pollution.

*See appendix I for our AI use statement

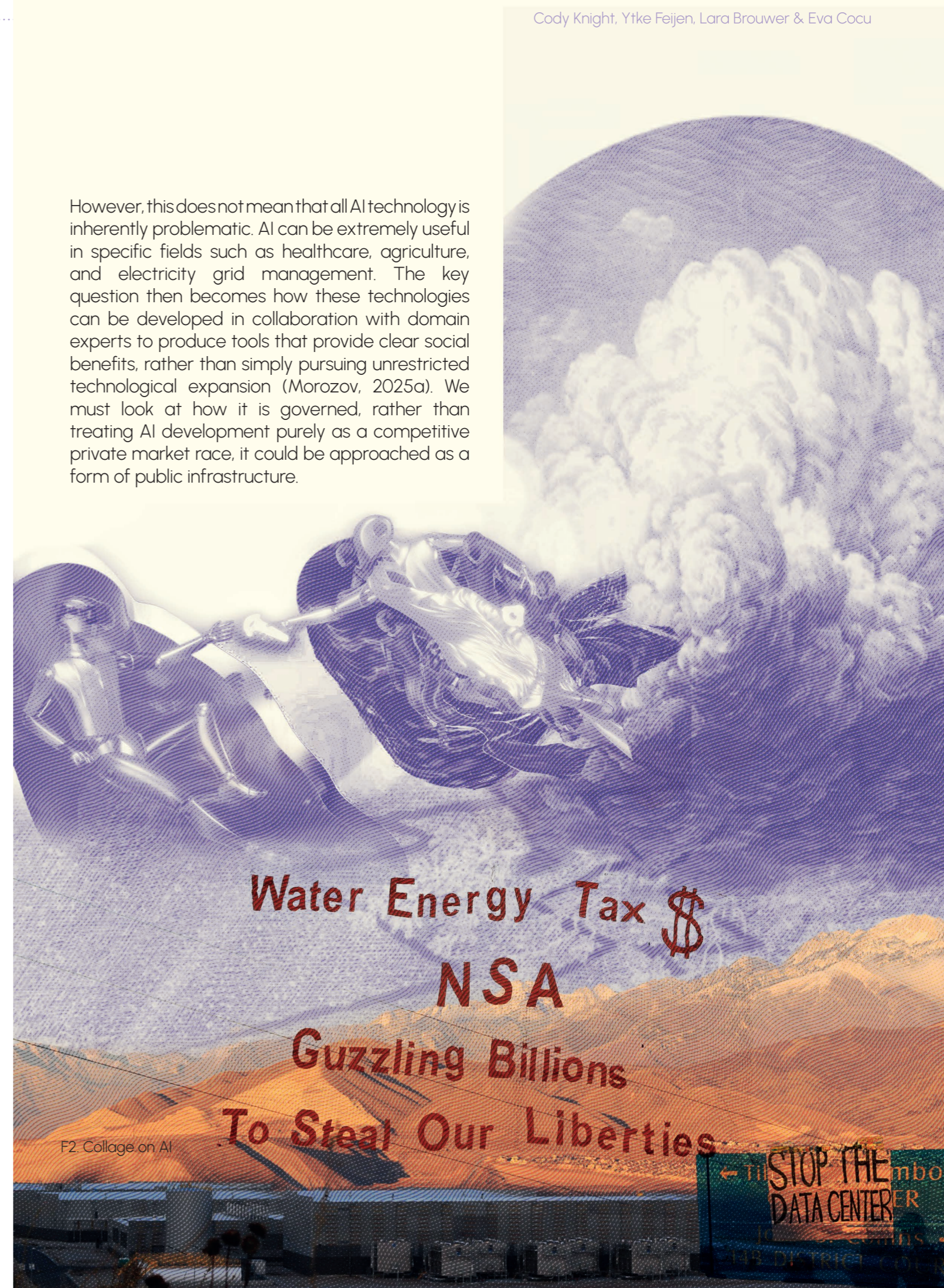
The rapid growth of this industry is therefore not only a technological issue, but also a political and spatial one. This expansion also has global climate implications. Going against the energy transition as we cannot currently produce the quantity of energy required through renewable means – continuing our dependence on fossil fuels. At current growth rates, data centres could add around 44 million tons of carbon dioxide emissions by 2030 (Milman, 2025).

For many communities, the benefits of AI development are not clearly visible. In some places, communities have begun to push back. In Chile, for example, public protests successfully halted the construction of a new data centre. These protests helped highlight the ecological and social vulnerabilities associated with this infrastructure and led to the introduction of the first regulatory framework for AI data centres in the country. This demonstrates the importance of community participation as well as clear policy and regulatory oversight in shaping this rapidly growing industry.

At the same time, the economic benefits of these facilities are often unevenly distributed. Although AI is presented as a transformative technology, the communities hosting the infrastructure frequently see limited job creation or long-term local investment.

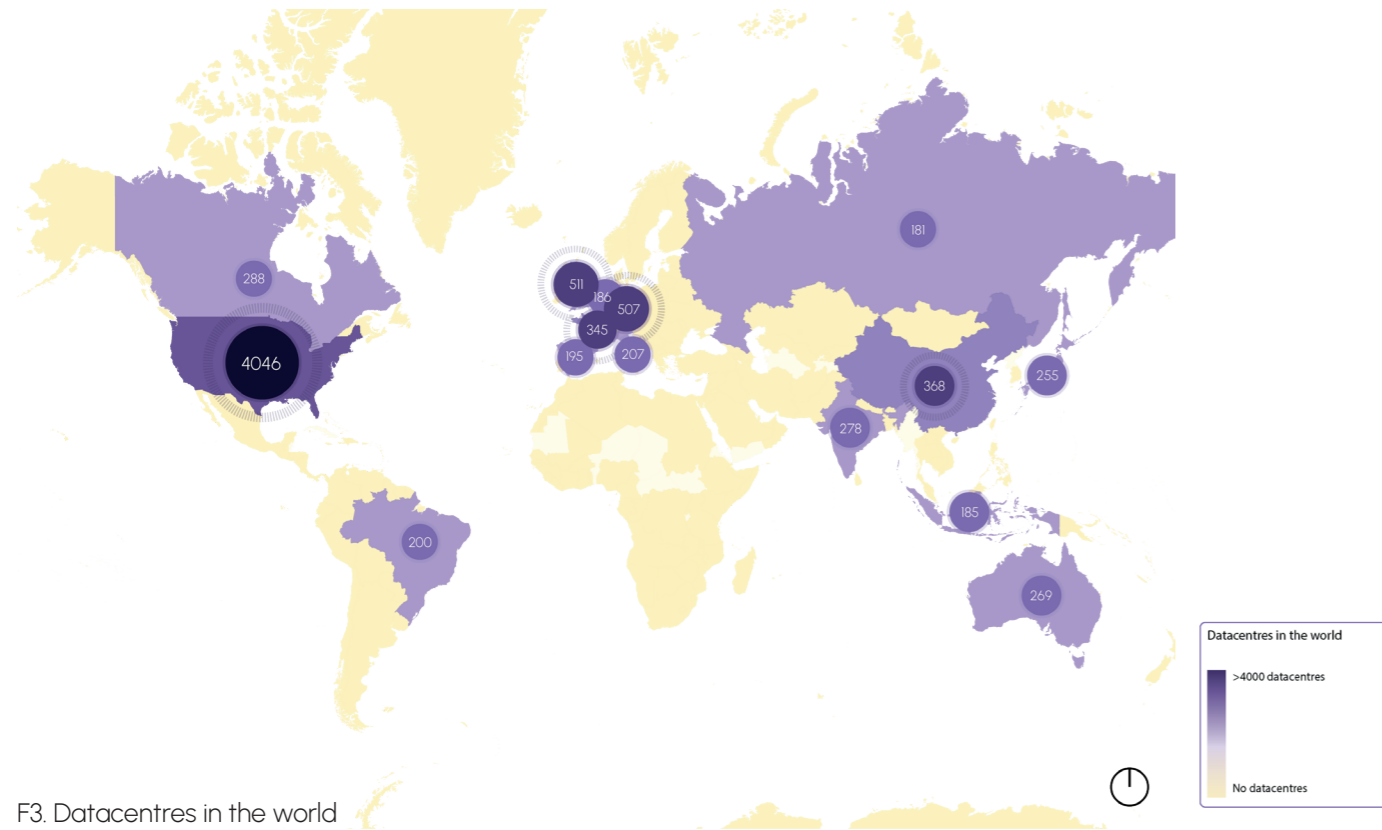
One reason this industry is so energy intensive is the ambition within Big Tech to develop Artificial General Intelligence, or AGI. This idea is often framed as a technology that could solve many of the world's problems. However, the definition of AGI tends to shift depending on the context in which companies are discussing it (Hao, 2025a). The one consistent feature is of hubris and the aim of creating an AI God, that achieving it requires ever-larger models, more computing power, and therefore significantly more energy.

However, this does not mean that all AI technology is inherently problematic. AI can be extremely useful in specific fields such as healthcare, agriculture, and electricity grid management. The key question then becomes how these technologies can be developed in collaboration with domain experts to produce tools that provide clear social benefits, rather than simply pursuing unrestricted technological expansion (Morozov, 2025a). We must look at how it is governed, rather than treating AI development purely as a competitive private market race, it could be approached as a form of public infrastructure.



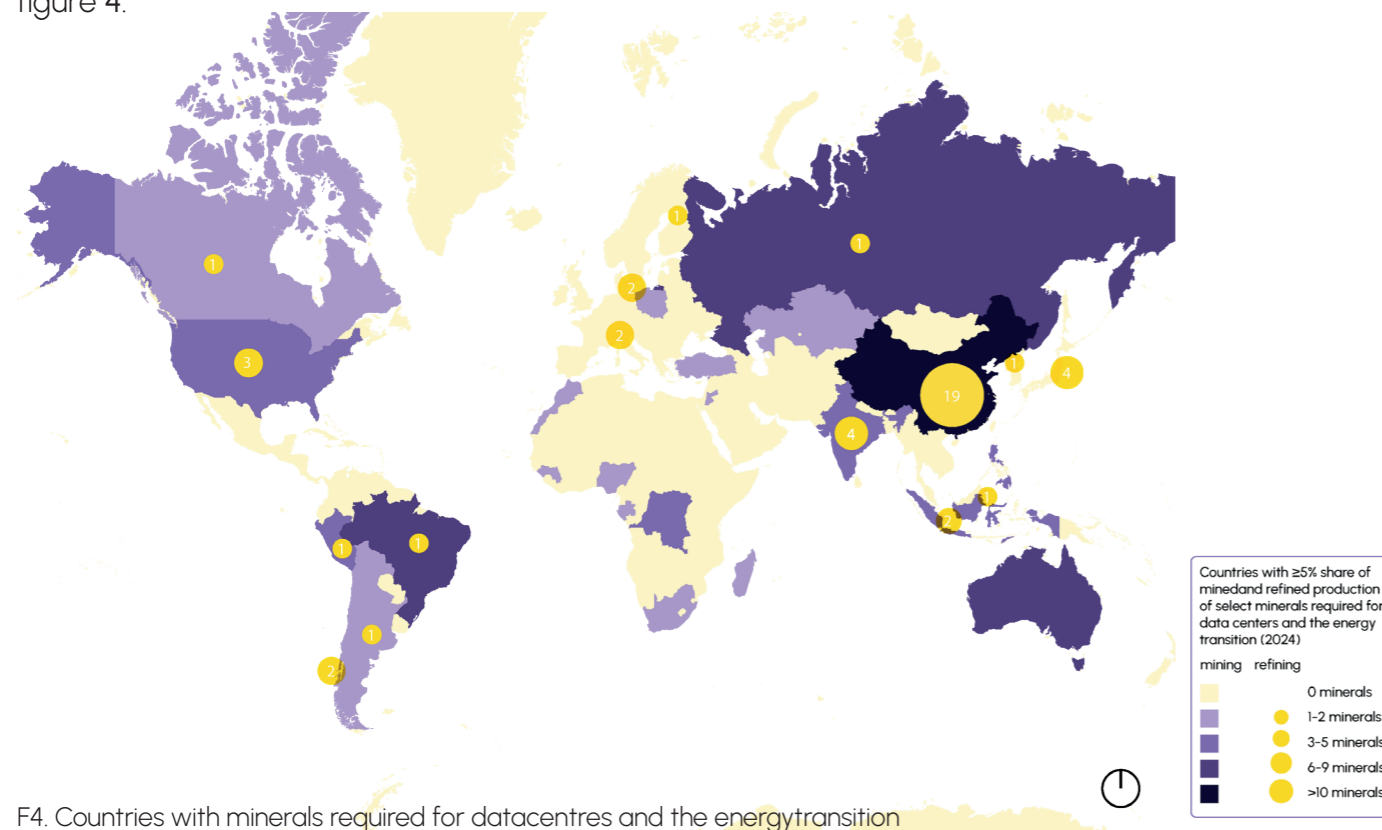
F2. Collage on AI

Geopolitical context

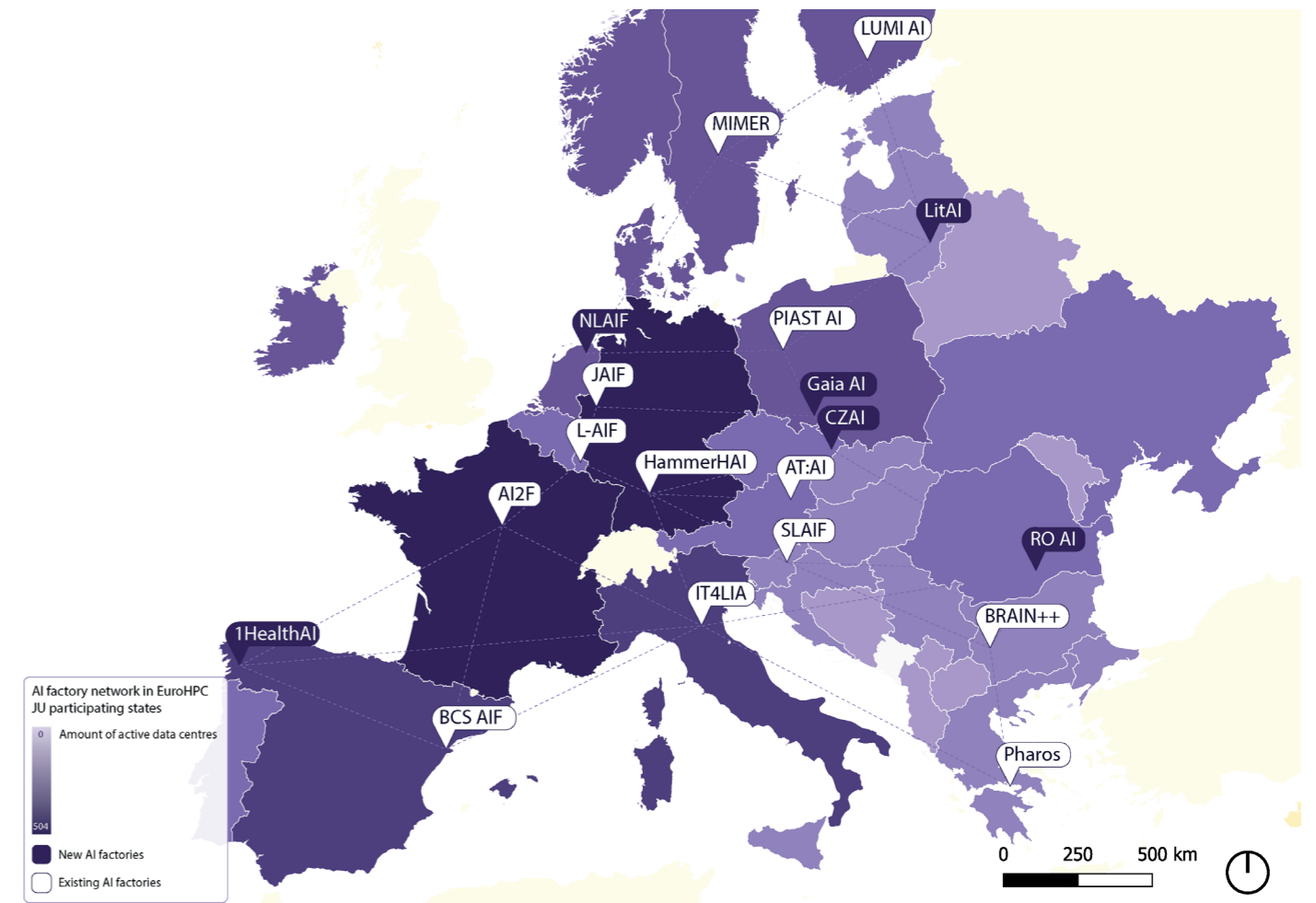


F3. Datacentres in the world

At the same time, this technological race is unfolding within a broader geopolitical context. In the United States, the rapid expansion of data centres is largely driven by private industry. China, meanwhile, is also developing advanced AI technologies, often with a different business model that prioritises efficiency and lower costs. Importantly, China also controls much of the global mining and processing infrastructure for the rare minerals required to produce advanced computer chips, see figure 4.



F4. Countries with minerals required for datacentres and the energy transition



F5. AI factory network in EuroHPC JU participation states

The European Union finds itself navigating between these two global powers. On the one hand, the EU aims to remain competitive in AI development and digital infrastructure. On the other hand, it also seeks to position itself as a leader in the energy transition. This has led to efforts to strengthen European innovation ecosystems and develop a more unified digital infrastructure across the continent.

Within this context, the Netherlands occupies an interesting position. The country was one of the earliest adopters of the internet and has long been active in the development of digital infrastructure. Today, several large private data centres already operate in the Netherlands. For example, Google's facility in Eemshaven is often presented as one of the first large data centres designed to operate using fully renewable energy sources.

At the same time, the Netherlands has strong traditions of democratic organisation, social welfare, and participatory planning processes. This creates an interesting opportunity. Rather than simply hosting privately driven infrastructure, there is a foundation for exploring how data centres and digital technologies could be developed through more careful, participatory governance. This needs to be done before contracts get signed, based on public norms, and with the development of policy and a regulatory framework. This raises the possibility of managing both the technological development and its spatial and resource implications in a socially balanced way.

AI is coming to Groningen

The assignment of Q3 revolves around the impact of the Dutch energy transition on various communities. Therefore, we have been looking at the construction of new data centres and its related energy infrastructure in Groningen.

Our research started with a media analysis mentioning the new AI-factory coming to the city of Groningen. The AI-Factory is to be placed in the Niemeyer building, an old tobacco factory near the city centre. It is funded by the European Union, the Dutch government and the regional Nij Begun fund.

The image presented in the media is incredibly positive. The region deals with a declining amount of inhabitants, especially young students leave Groningen after their studies. This AI industry will give the region an economic boost by creating new tech jobs and thus keeping young people in the region. However, many of these articles do not show the extent of this industry.

The AI-factory in the Niemeyer building is merely the knowledge centre. This office can indeed increase job opportunities and have a positive economic influence on the city. But this knowledge centre is connected to a much larger AI-super computer together. The spatial and physical requirements of these data centres is extensive and will therefore have to be placed elsewhere in the region.

They require large pieces of cheap land, enormous and consistent renewable energy supply, a lot of fresh water to cool their systems and chips containing rare minerals that are resourced outside of Europe having significant consequences for communities elsewhere

In this research we aim to show the full story of technological development. To generate more ideas for possible directions in which AI can find a place in our society and how we, as a society can react to such interventions.

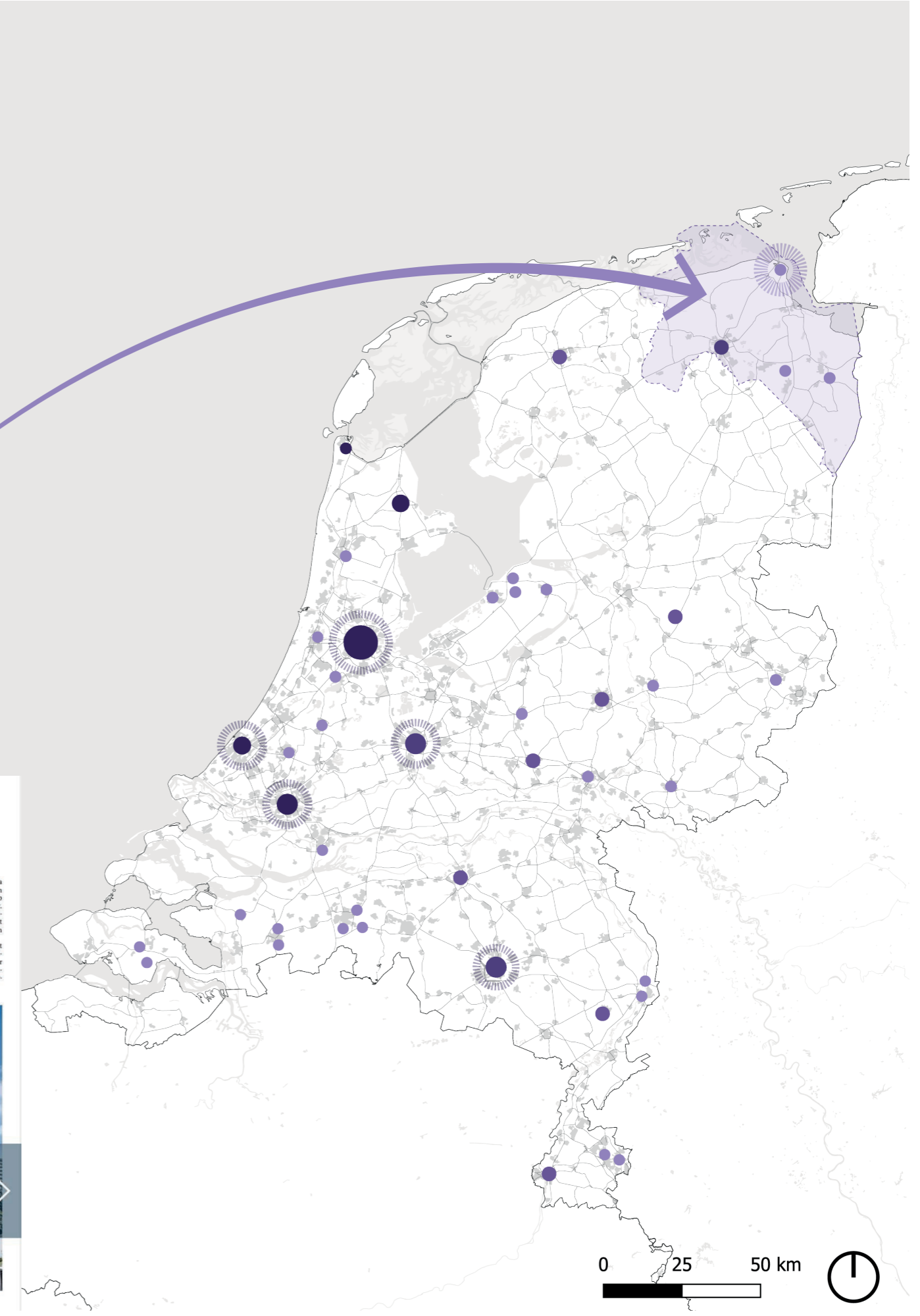
To conduct this research, the perspectives of three communities were used. Firstly, the residents of Eemshaven suffering from the direct spatial consequences of the growth of data centres. Secondly the young urban professionals, whom benefit from the presumed economic boost, but also are concerned with this unregulated growth of Artificial Intelligence. And the last community, are the meadow birds; their habitat is affected by the data centres and the consequences of this developments will have long lasting effects on their environment.

Regio wil 60 miljoen betalen: AI Fabriek op weg naar Groningen

RICHOOLD BRANDSMA
GRONINGEN/ASSEN Groningen en Noord-Drenthe willen 60 miljoen euro bijdragen aan een zogeheten AI Fabriek. De fabriek, feitelijk een supercomputer, krijgt een plek in Groningen.
 Dat blijkt uit een brief die maandagavond is verstuurd aan alle gemeentebesturen in Groningen en Noord-Drenthe, waterschappen en provinciale staten van Groningen.
 Een AI Fabriek (ook wel AI Factory) biedt de mogelijkheid om toepassingen te ontwikkelen op het gebied van kunstmatige intelligentie (AI). Toepassingen die een antwoord kunnen zijn op maatschappelijke uitdagingen, zoals het personeelstekort in de zorg. Vooral onderwijs, onderzoek, overheden en bedrijfsleven in het Noorden kunnen erin voordeel mee hebben.
 De AI Fabriek valt uiteen in drie delen. Een supercomputer die is ontworpen voor het trainen en ontwikkelen van AI-toepassingen, toegang tot betrouwbare Europese of Nederlandse databronnen die voldoen aan de Europese normen voor veiligheid, privacy en betrouwbaarheid. Tot slot komt er een expertisecentrum van specialisten. In Groningen is het de bedoeling dit centrum onder te brengen bij de IT-hub in de voormalige tabakfabriek van Niemeyer in Groningen.
 Tijdens een bijeenkomst over de AI Fabriek werd begin april in het UMCC de aandacht gevestigd op een onderzoek waarbij de rekenkracht van computers werd ingezet om vroegtijdig prostaatanker vast te stellen. Een supercomputer zou de mogelijkheden vereenvoudigen.
 In de brief aan de raads en staten wordt gesteld dat de AI Fabriek Groningen en Noord-Drenthe in staat is zich te profileren als Europees AI centrum. Een van de voorwaarden die wordt gesteld is dat regionale partijen met voorrang toegang hebben tot 25 procent van de rekenkracht van de supercomputer en de inzet van het expertisecentrum. Dat vergroot de aantrekkelijkheid van Groningen en Noord-Drenthe als vestigingsplaats voor bedrijven en onderzoekseenheden van grote bedrijven.
 Een onderzoek onder instellingen, overheden en bedrijfsleven toonde begin dit jaar aan dat hier het enthousiasme voor een supercomputer in de regio groot is. In de brief wordt gesteld dat effectieve inzet van AI in het mkb kan leiden tot een forse stijging van de productiviteit.
 Vanuit de Economische Agenda van Nij Begun willen Groningen en Noord-Drenthe daarom 40 tot 60 miljoen betalen voor een AI Fabriek. In Den Haag valt binnenkort een besluit over eenzelfde bijdrage. Dat maakt de Nederlandse inzet tot een bedrag van 80 tot 120 miljoen.
 Ligt dat bedrag op tafel, dan gaat er eind juni een verzoek voor een nationale AI Fabriek in Groningen naar de Europese Commissie. Is die positief, dan verdubbelt de EU het Nederlandse bedrag.



F6. News report: Region wil pay 60 million to help the AI factory to Groningen



F7. Datacentres in the Netherlands

02 Project structure

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F8. Landsc (made by authors)

Problem statement

Artificial intelligence (AI) is developing at an unprecedented pace, outstripping existing regulatory frameworks and operating within systems of continuous growth that exceed planetary limits. This rapid expansion is materialized through energy-intensive AI data centres that require significant amounts of electricity, water, rare minerals, and land.

The planned AI factory in Groningen exemplifies this tension. Positioned within broader European Union and Dutch governmental efforts to define a geopolitical role in AI, the project presents both an opportunity to establish AI as a public good and a risk of reinforcing existing inequalities and environmental pressures. While such initiatives may set important precedents, they also carry the potential for significant social and ecological harm.

AI infrastructure often imposes localized burdens on surrounding communities, including competition for energy resources, as well as light and noise pollution. At the same time, the benefits of AI development are disproportionately concentrated among big tech firms and urban centres. This creates an uneven distribution in which rural communities and natural ecosystems bear the burdens while receiving limited direct advantages.

This research addresses the Groningen AI factory as a site-specific case within a broader global trend of AI infrastructure expansion. The central problem is how to govern and design AI infrastructure in ways that encourage stewardship, and genuinely contribute to the prosperity, ecology, and identity of the region.

To address this, the project combines literature review, spatial and data analysis, media analysis, and fieldwork interviews with local communities and domain experts. Through this multi-scalar approach, it seeks to understand both the local impacts and the systemic dynamics of AI development and energy transition.

The ultimate aim is to propose a governance framework that empowers affected communities by improving their access to knowledge, enabling meaningful participation, and supporting their ability to articulate concerns, aspirations, and values within decision-making processes.

Research question

Research question

How can the residents of surrounding the development in Eemshaven, the meadow birds* and the young urban professionals be involved in participatory processes to co-develop a plan for the democratic implementation of AI super computers in Groningen? How can we design a system of stewardship?

Sub research questions

What are the current socio-economic structures in the Groningen region, and how might they be affected by the development of AI (infrastructure)?

What are the ecological systems in the Groningen region, and how might they be impacted by the AI development?

What are the spatial and energy demands of ai data centers?

What does the energy landscape of Groningen look like, and how might the ai development and its data centers interact with or influence this system?

How can participatory processes enable residents het platteland, the young urban professionals & the meadow birds* to be included in the decision making process regarding the development of ai infrastructure in Groningen?

*Meadow birds as representatives for the more than human.

Glossary

Gaia

The hypothesis that the human, non human and nonliving components of earth function as a single system in such a way that the living component regulates and maintains conditions (such as the temperature of the ocean or composition of the atmosphere) so as to be suitable for life. (see Bruno Latour; Donna Harraway).

Critical Zone

The thin, dynamic layer of the Earth where water, soil, rocks, weather, and human and non-human life interact through interdependent processes. Understood as a matter of care and political concern, the critical zone frames environmental systems as inseparable from social and economic activity, requiring stewardship and accountability in their management.

Stewardship

The shared responsibility for the careful management and protection of environmental, social, and material systems within the critical zone. It implies active care, collective governance, and long-term commitment to sustaining ecosystems and resources across generations, closely linked to principles of circularity and accountability.

Accountability

The obligation of actors to take responsibility for their decisions and their environmental, social, and material impacts within interconnected systems. It entails transparency, answerability, and the capacity to be held to account by communities and institutions, particularly in the governance of technologies and resource use.

Circularity

An approach within the circular economy that seeks to minimise waste and maintain the value of materials, water, and energy through closed-loop systems. It connects technological systems with ecological processes, emphasising reuse, recovery, and regeneration to reduce extraction pressures within the critical zone.

Artificial General Intelligence (AGI)

A theoretical form of artificial intelligence capable of performing a wide range of cognitive tasks at or beyond human-level ability across domains without task-specific training. While often framed as a future technological milestone, AGI also functions as a strategic narrative shaping research agendas, investment flows, and governance debates, raising questions about power, resources, and impacts within the critical zone (see Evgeny Morozov; Karen Hao).

Specialised Technology

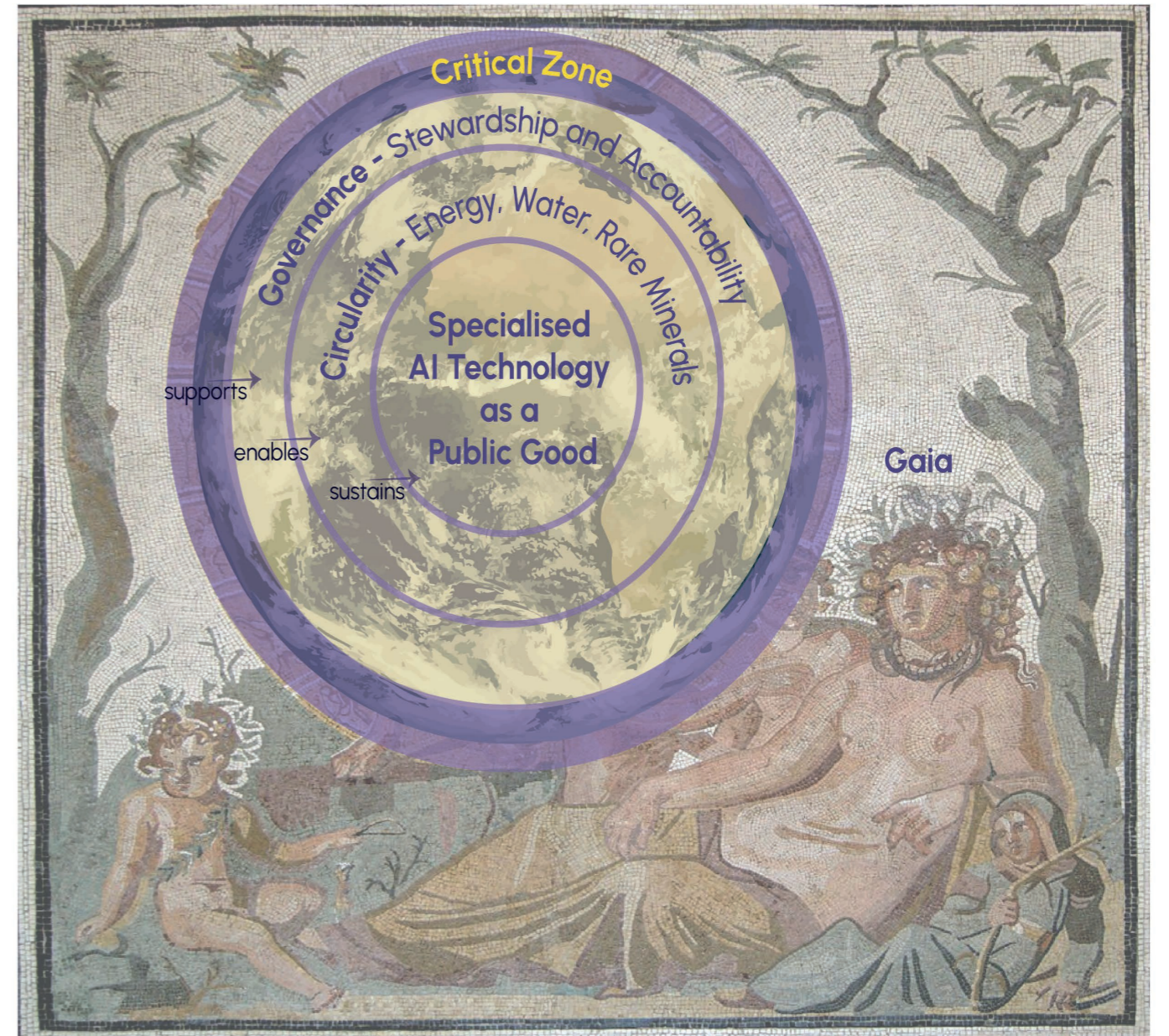
Technological systems designed for specific, narrowly defined tasks, operating within particular infrastructures and resource flows. In contrast to AGI, specialised technologies are embedded in sectoral contexts and materially grounded systems, linking their performance to energy use, rare minerals, and local environmental conditions (see Evgeny Morozov; Karen Hao).

Rare Minerals

Finite and often geopolitically sensitive materials essential to modern technologies, including AI infrastructure, solar panels, and wind turbines. Their extraction, processing, and disposal challenge circularity, requiring improved recovery, recycling, and stewardship to reduce environmental degradation and external dependencies.

Energy Community

A collective governance model in which citizens, local organisations, and institutions co-produce, manage, and benefit from energy systems. Energy communities support decentralised, renewable energy generation and distribution, reinforcing stewardship, accountability, and circularity at the local scale within the critical zone.



F9. Collaged into mosaic of Aeon and Gaia with child like representations of the seasons 3rd c. BC, Sentinum. Munich Glyptothek.(made by authors)

Public Good (AI)

A resource, service, or technology that is accessible to all members of society, providing collective benefits without exclusion or depletion. In the context of AI, it refers to systems, data, and infrastructure designed to serve societal needs; such as knowledge, education, sustainability, or governance, rather than private profit, while being governed with transparency, accountability, and attention to social and ecological impacts. Public-good AI intersects with stewardship, circularity, and the critical zone by ensuring equitable and responsible use of technological resources.

Het Platteland

Rural agricultural land surrounding an urban area. This land is poldered and man made, and a key part of the heritage and identity of the Netherlands, and Groningen specifically; deeply rooted in the unique combination of tranquillity, space, cultural history, and a strong sense of community. It requires continuous maintenance and effort to manage the water level and keep the soil fertile.

Theoretical framework

Rather than the extractive aim of finding God in General Intelligence, build a system accountable to Gaia.

Through our theoretical framework we build an argument that AI must be reconceptualised as a planetary infrastructure spanning the cloud, critical zone, and subsurface, requiring new democratic and ecological governance frameworks. This section is divided into 3 sections, looking at the cloud, which explores politics, the critical zone with a focus on ecology, and the subsurface which centres extraction.

The Cloud

Artificial intelligence (AI) must be understood not as an abstract computational system, but as a **political and infrastructural formation**. As Langdon Winner argues, technologies are inherently political (Winner, 2017a): their design and material requirements shape governance structures and social relations. His comparison between decentralised solar energy and centralised nuclear systems demonstrates how infrastructures condition forms of power. Extending this logic, AI does not merely operate within political systems; it actively reproduces and stabilises them.

This becomes evident in contrasting geopolitical models. In the United States, AI development is driven by venture capital and corporate competition, producing an expansionary model oriented toward scale, market dominance, and continuous growth. In China, AI is embedded within a state-coordinated framework, enabling rapid deployment and integration with national infrastructures, including renewable energy systems. These models illustrate how AI infrastructures materialise distinct political economies while generating uneven ecological consequences.

Building on this, Evgeny Morozov conceptualises AI within the **"efficiency lobby,"** where technological development is aligned with productivity gains that often exacerbate social inequality (Morozov, 2025b). Karen Hao further demonstrates how the pursuit of **artificial general intelligence** (an ambiguously defined yet highly capitalised goal) drives escalating resource consumption (Hao,

2025b). Together, these perspectives reveal AI as embedded within a logic of **extractive growth**, where efficiency and scale are prioritised over social and ecological considerations.

At the level of infrastructure, this condition has been described by Marina Otero-Verzier as one of **"infrastructural excess,"** in which systems expand beyond necessity, reinforcing patterns of overproduction and overconsumption (Verzier, 2026b). AI systems, particularly those optimised for engagement, intensify this dynamic by incentivising continuous interaction and, consequently, continuous resource use.

In response, different governance approaches emerge. Mustafa Suleyman advocates for containment, recognising the historical tendency of technologies to proliferate uncontrollably (Suleyman & Bhaskar, 2023). In contrast, Morozov and Hao argue for the **democratisation of AI**, including its treatment as a public good and the prioritisation of specialised, purpose-driven systems over general intelligence. These positions converge on a central question: how can AI become a public good, divorced from the market?

For the European context, this implies embedding AI development within democratic institutions, social welfare traditions, and renewable energy transitions. The cloud, therefore, is not placeless; it is a politically charged infrastructure whose future depends on how governance, ownership, and purpose are defined.

Rather than extractive aim of a God in General Intelligence - design a system accountable to Gaia



F10 Landscape collage Groningen



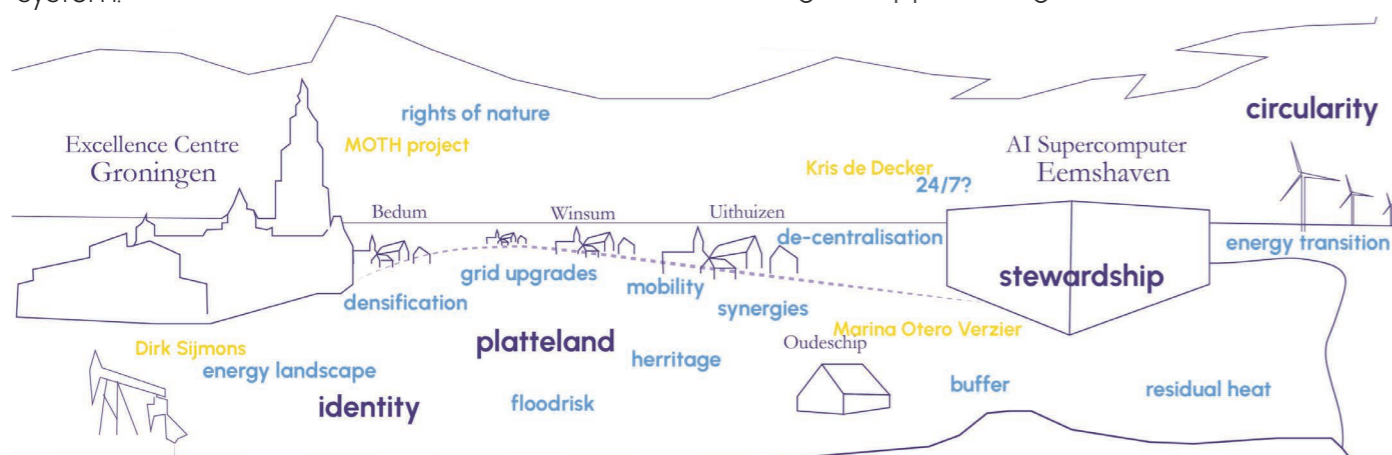
The Critical Zone

While often perceived as immaterial, the cloud is fundamentally grounded in the Earth's systems. To conceptualise this, this research draws on Bruno Latour's notion of the **critical zone**: the thin layer of the planet where life unfolds, encompassing the atmosphere, biosphere, and upper crust (Latour et al., 2020). This perspective reframes technological systems as embedded within **interdependent socio-ecological relations**, where actions produce distributed and reciprocal effects.

Within this framework, AI infrastructures are not external to nature but actively reorganise it; through energy consumption, mineral extraction, and environmental externalities. This demands a shift from viewing technology as neutral to understanding it as a participant in what Latour conceptualises as Gaia: a dynamic, self-regulating system.

Donna Haraway deepens this perspective by emphasising the co-constitution of myth and machine. Her cyborg manifesto challenges the separation between human, technological, and ecological systems, highlighting how power, labour, and knowledge are embedded within technological assemblages (Haraway, 1991). Importantly, she calls for situated, accountable engagements with these systems, particularly in contexts where their operations are obscured.

This is particularly relevant in the case of AI, which increasingly functions as a black box, distancing users from its material and ecological conditions. The concept of **"ghost acres"** makes this disconnection visible, tracing how environmental impacts are displaced across space - linking, for example, data centre development in Groningen to extractive practices elsewhere, such as the mining of copper wiring in Chile.



F12. The critical zone (made by authors)

Reconnecting AI to the critical zone therefore becomes a political and spatial project. It requires making visible the flows of energy, materials, and labour that sustain digital infrastructures, and embedding these within frameworks of accountability. This includes extending participation beyond human actors.

Emerging legal and planning frameworks, such as the **rights of nature** (Rodríguez-Garavito, 2024), provide one avenue for this. By recognising ecosystems as stakeholders, these approaches challenge anthropocentric models of development. In this research, this is operationalised through attention to ecological communities such as meadow birds, whose habitats are directly affected by infrastructural transformation.

This aligns with planning theories that emphasise public norms and participatory governance, as articulated by Willem Salet (Salet, 2021). Integrating ecological and social actors within decision-making processes is essential for developing resilient and just infrastructures; particularly in the context of both the energy transition and AI expansion.

Subsurface

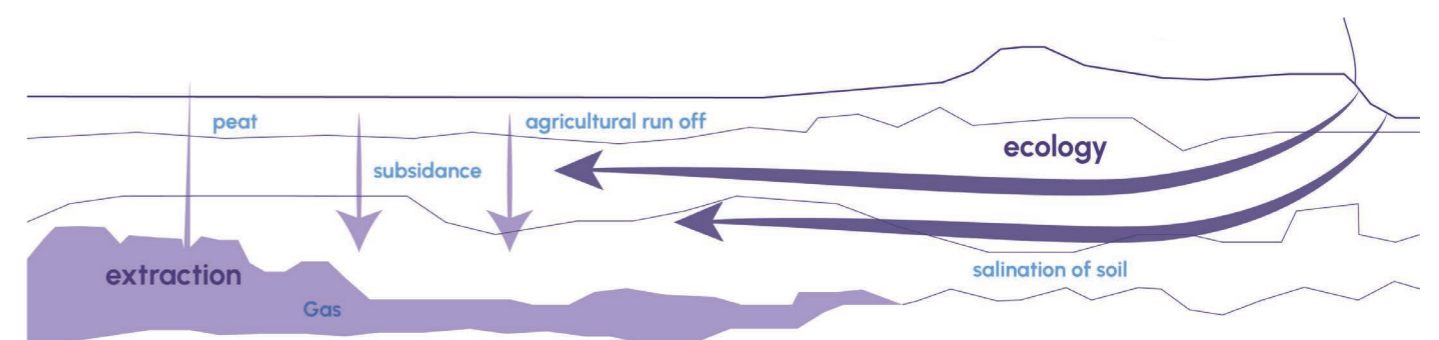
The critical zone is underpinned by the subsurface, where the material conditions of AI are most acutely expressed. Groningen provides a paradigmatic case, shaped by a history of extraction from peat and agriculture to natural gas. These processes have produced lasting environmental and social impacts, including subsidence, earthquakes, and soil salinisation.

These dynamics reveal the asymmetrical distribution of burdens and benefits inherent in extractive systems. While resources are mobilised for national and global economies, local communities often bear the environmental and social burdens. This can be understood in how the rare minerals required for these AI technologies are mined and processed in an often extractive political system and a separate context and from their end use in AI supercomputers. In this sense, Groningen can also be understood as a "ghost acre" within the Netherlands itself; a peripheralised landscape that sustains broader systems of accumulation.

The expansion of AI infrastructure risks reproducing these patterns. Data centres, as materially intensive systems, require vast amounts of energy, water, and land, generating localised environmental pressures. However, as Marina Otero-Verzier suggests, these infrastructures also hold the potential for new forms of integration. For example, waste heat recovery and adaptive energy use could create **synergies** with local ecological and urban systems (Verzier, 2026a).

Crucially, this requires rethinking temporalities of operation. Rather than demanding continuous, **24/7 energy supply**, AI systems could be aligned with the variability of renewable energy production. Projects such as Low-tech Magazine demonstrate how technological systems can operate within environmental limits (De Decker, 2023), embracing intermittency as a design principle rather than a constraint.

At the subsurface level, therefore, the question is not only how resources are extracted, but how infrastructures can be reconfigured to support **long-term socio-ecological resilience**. This necessitates a shift from extractive to regenerative models, grounded in local participation and equitable distribution of benefits.



F13. The subsurface (made by authors)

Conceptual framework

Building on the theoretical framework outlined above, this research develops a corresponding conceptual framework centred on accountability and stewardship as guiding principles for AI infrastructure. This framework advances a predominantly bottom-up approach, structured around three interrelated themes: identity, prosperity, and ecology, while also acknowledging the influence of top-down institutional and policy frameworks. The intersections and gaps between these perspectives (represented as white dots) reveal how different actors and communities perceive, prioritise, and contest these themes.

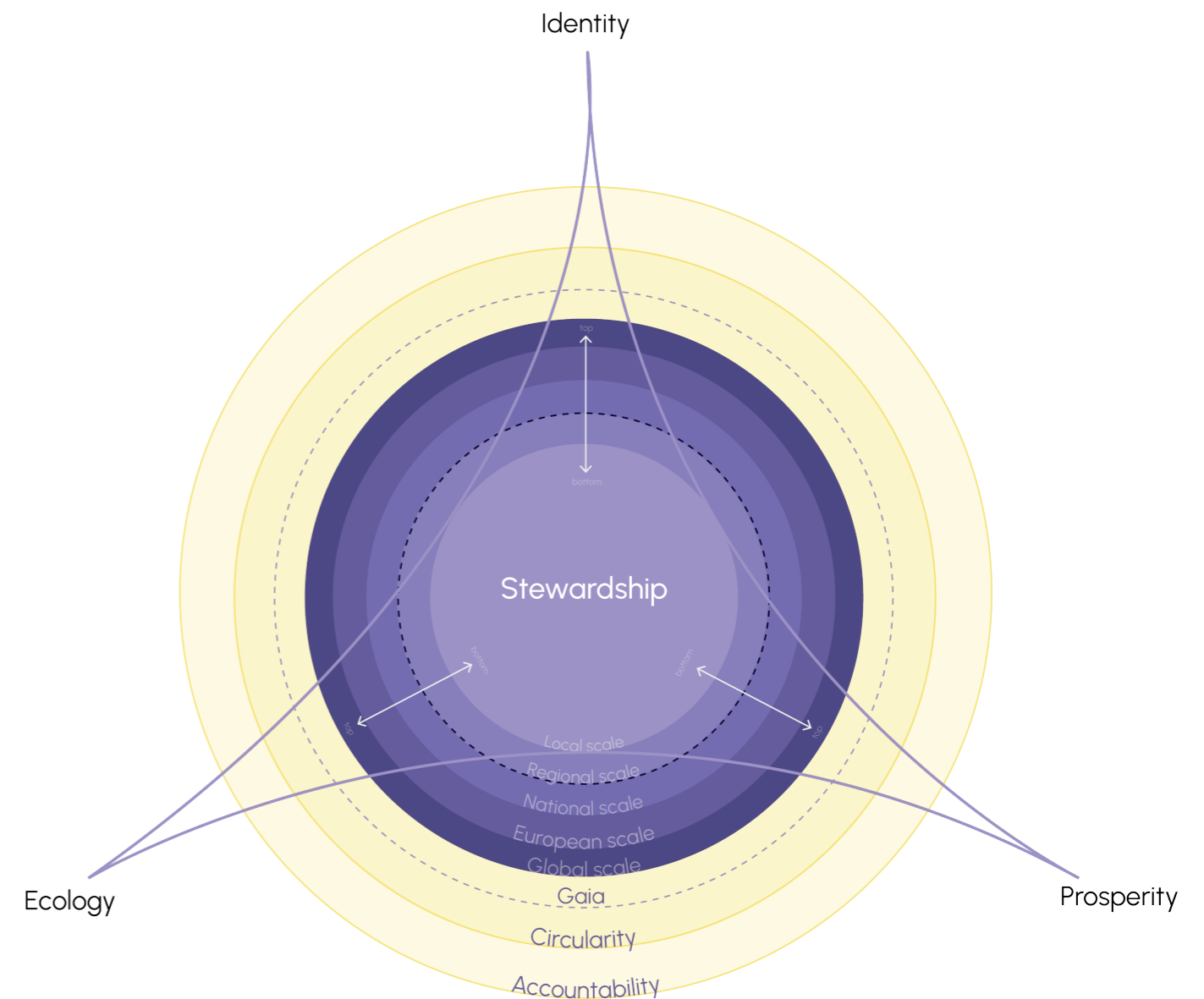
These three themes are used to reinterpret the classical dimensions of sustainability: social, economic, and environmental, through a situated, regional lens.

Identity corresponds to social sustainability and foregrounds questions of belonging, participation, and governance. In this project, it is operationalised through the development of democratic procedures and participatory systems that enable both urban and rural communities to engage in decision-making processes. The decentralisation of AI infrastructure plays a crucial role here, redistributing both the benefits and burdens of technological development and embedding accountability within local contexts.

Prosperity reflects economic sustainability but is reframed beyond conventional growth metrics to emphasise regional resilience and long-term stability. The introduction of AI infrastructure is positioned as a catalyst for local development, with the potential to mitigate brain drain, attract investment, and strengthen regional economies. Crucially, this approach aligns with a model of embedded economic development, in which technological innovation is tied to local needs, labour markets, and institutional capacities rather than globalised extraction.

Ecology addresses environmental sustainability, situating the project within the broader context of the energy transition. The shift towards renewable energy sources is central, but the framework extends further by challenging extractivist logics and continuous growth paradigms. By focussing on circularity and closed loop systems we acknowledge the harmful cycles of input and waste and aim to reduce the impact of the resources required. Through an emphasis on stewardship, the project advocates for operating within planetary limits, incorporating principles such as the rights of nature and the protection of biodiversity. Ecological systems are therefore not treated as external constraints, but as active participants within the design and governance of infrastructure.

Taken together, these three dimensions form an interconnected system in which social, economic, and environmental considerations are not treated as separate domains, but as mutually constitutive. This integrated approach enables the articulation of a model of AI development that is accountable not only to human communities, but to the broader socio-ecological systems conceptualised as Gaia.



FI4. Conceptual framework visualised (made by authors)

Methodology

This research is developed within a research-by-design approach which consists of a wide selection of methods. As visualised in figure 15 the process consists of four phases: analysis, vision, positioning and strategy. Each method is placed in its respective phase of the overall process. This phasing is not strictly linear, but operates in iterative loops, where ideas and narrative are continuously redefined. Sub products like the problem statement, conceptual framework and the vision, structure moments of divergence and convergence.

What kind of knowledge is produced?

The project produces a combination of critical and propositional knowledge. It seeks to critically understand existing systems and dive deep into the political, ecological and spatial implications of the ai development, especially in relation to the extractive histories and previous governance gaps. Based on this critical history, the project develops a future perspective that reframes AI as a collectively governed public good. This includes a card game which makes interdisciplinary participation possible, a spatial design strategy and proposed policy actions.

Which methods are doing the main work?

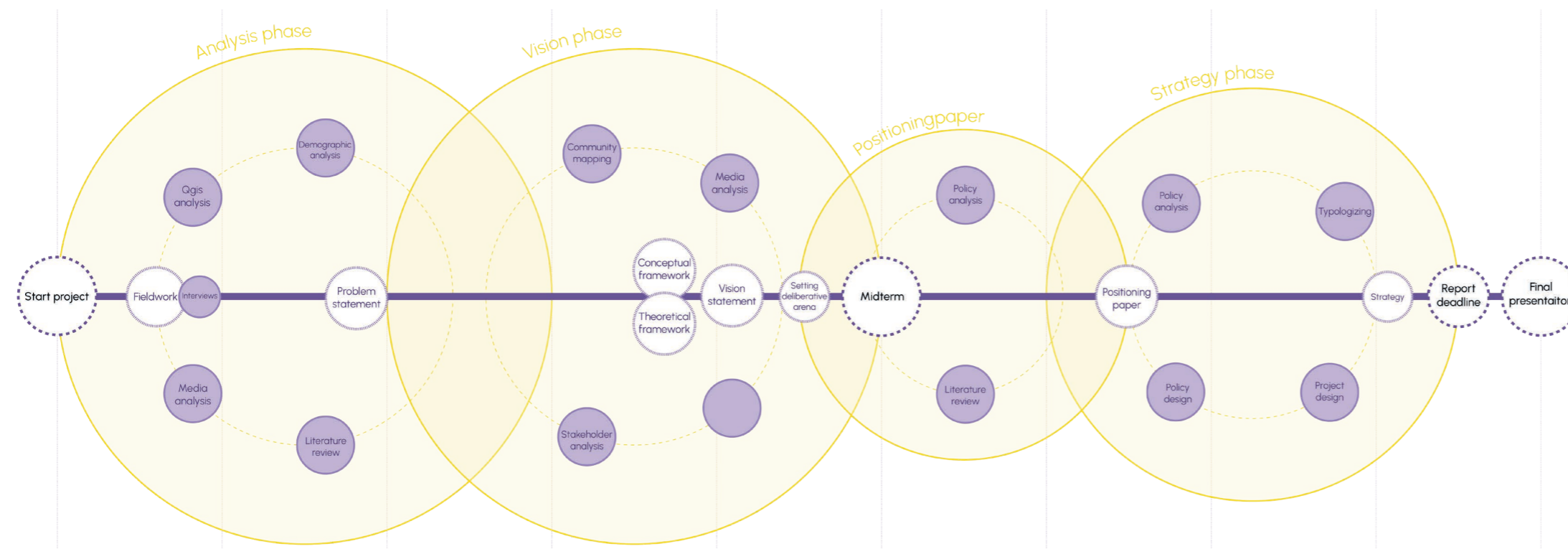
The project is primarily done by a combination of social science analysis, which are supported by technical analysis to be able to do design iterations. The social science analysis like interviews, media analysis, stakeholder mapping and community mapping are essential in understanding values and conflicts of the relevant actors. This is the core of the project as the project seeks to look through the lens of the communities. This social science analysis is supported by the spatial and technical analyses like GIS mapping and recourse calculations, which set the project within measurable and material realities. The design iteration then plays a big role in translating these findings into visions, governance propositions and spatial strategies. As stated before this is not a linear process and continuous feedback between analysis and design proposal are key.

What values are guiding the project?

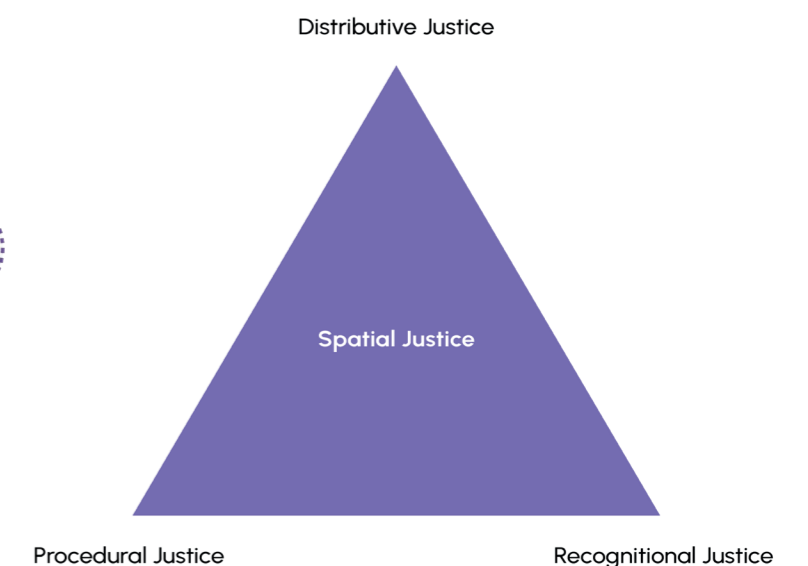
The guiding values of this project are stewardship, democracy and socio & ecological justice, rather than just focusing efficiency or growth. It prioritizes working within natural limits to ensure that AI development does not relive the extractive patterns Groningen has historically experienced. Additionally it emphasizes participatory governance, redistribute the decision-making power among the communities, institutions and ecological representatives. As will be explored in the next chapter; these values translate to the main focus on accountability and circularity, ensuring fair distribution of the benefits and burdens coming with AI development, making it a public good.

What is treated as real?

This project sees reality as a relational system where physical-, ecological- and social systems are interconnected. AI is not an abstract digital technology, but a spatial grounded infrastructure set within energy and water systems.



Fl5. Methodology diagram



Fl6. Social justice diagram

Values, ethics, and societal relevance

We are undertaking this project during a period of profound transition, making its social and political relevance particularly urgent. The emergence of AI carries the potential for significant societal and ecological impacts; it is therefore essential that this work is grounded in a clear set of values and guided by strong ethical considerations.

Spatial Justice

Here we can look at the three pillars of spatial justice, and how our project engages with each.

Recognitional Justice

recognising the rights of nature in their inclusion as a community, our approach to decentralisation brings new voices to the table, and ensures their inclusion in decision making around development of technology along with energy infrastructure.

Distributive Justice

Through the process of decentralisation, and the creation of energy communities – we aim to ensure the even distribution of burdens and benefits. Procedural Justice: much of this project is around designing processes that hold ai technologies development accountable to gaia, meaning having participation and community representation to ensure spatial justice. The governance structures proposed aim at facilitating procedural justice.



F17. SDG used in the design

Sustainable Development Goals

15 – life on land

By designing a system that accounts for Gaia, taking the meadow birds as a key community, and advocating for the rights of nature – this proposal aims to centre healthy interconnected ecosystems for humans and more than humans.

7 – affordable and clean energy

This project revolves around the energy transition and its spatial repercussions. AI reflects a major new consumer of energy, yet we are proposing regulations that ensure it is done on renewable energy sources and aims to use this investment as a catalyst to improve the affordability and access to green energy throughout the region.

9 – industry, innovation, and infrastructure

At the centre of this project is the emergence of a new industry, and much of our work aims to design a resilient infrastructure supporting it. We aim to develop a responsible system to support innovation but one which is not purely motivated by growth, ensuring a fair distribution of the burdens and benefits of industry.

11 – sustainable cities and communities

Best embodied in this project through the intention of participation with communities, engaging them in key decisions about the development of their environments. The direction of development on the regional level considers the serious threats posed by climate change and aims to build strong sustainable resilient communities.

12 – responsible production and consumption

A core value of this project is to develop the artificial intelligence, and its supporting industrial infrastructure responsibly. This means that it is socially responsible and does not have disproportionate societal or ecological impacts.

16 – peace justice and strong institutions

The governance structure here is a key element of this proposal. AI needs to be strongly regulated to be contained. The proposed structure encourages participation and empowers a wide range of stakeholders to build a strong institution that can allow for social and spatial justice.

3 – good health and wellbeing – indirect

The development of specialised artificial intelligence models has a lot of potential in healthcare. The governance structure proposed, and the emphasis on the involvement of experts in this development, means that the public health care in the Netherlands receive directly the benefits of the technology.

4 – quality education - indirect

AI will have large impacts on education systems. This project aims to better connect the research and education institutions with the development of the technology. Improving career opportunities and technical education in Groningen.

14 – life below water - indirect

This project takes seriously the rights of nature and thus the aquatic life's needs. The flooding of certain areas of the platteland focuses on building biodiversity in these areas, and creating healthy habitats and ecosystems. The development of energy infrastructure such as wind turbines in the North Sea has the aim of synergies with aquatic life.

Values, ethics, and societal relevance

Inclusivity and Representation

Contemporary technological development, particularly in the domain of AI, is often shaped by actors with disproportionate influence. Large technology companies exert significant lobbying power, reinforcing top-down governance structures that limit meaningful participation. This raises a fundamental question: who is currently at the table, and who remains excluded? In response, this project seeks to broaden participation by actively including stakeholders who have been historically marginalised within decision-making processes.

This includes not only human communities, but also the more-than-human systems upon which all activity depends. Through a right of nature approach (Rodríguez-Garavito, 2024b) (Rodríguez-Garavito, 2024b), ecological actors—here represented by meadow birds and their habitats—are considered as stakeholders within the planning process. In doing so, the project aligns with an understanding of the Earth as an interconnected system, or Gaia, in which environmental, social, and technological processes are inseparable within the critical zone.

At a regional scale, this issue of exclusion is further reinforced by historical patterns. In provinces such as Groningen, communities have long experienced extractive relationships with national systems, often bearing the impacts of resource exploitation while remaining peripheral to decision-making. Addressing this imbalance requires governance structures that extend accountability beyond the local scale, ensuring that national-level actors are also held responsible for spatial, ecological, and societal outcomes.

Communicative and Participatory Approach

A communicative and participatory perspective frames planning as a dialogic process in which knowledge is co-created, and decisions emerge through negotiation between diverse actors

(Healey, 1997). However, meaningful participation is often constrained by structural barriers, including limited access to information, technical complexity, and the opaque nature of emerging technologies such as AI. These systems are frequently presented in ways that obscure their material impacts, making it difficult for affected communities to engage critically or effectively.

To address these barriers, this project introduces tools designed to translate complexity into accessible formats. A key example is the development of a set of “action cards,” which enable stakeholders to assemble proposals, articulate concerns, and engage with governance processes in a tangible and collaborative way. By lowering the threshold for participation, such tools aim to foster more inclusive engagement and enable communities to meaningfully shape the systems that affect them.

Pluriverse

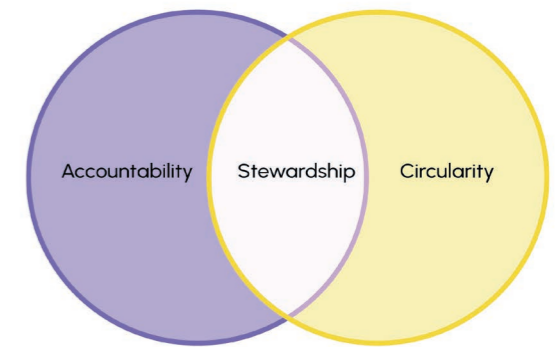
The futures surrounding technological and spatial development remain deeply uncertain, shaped by a wide range of interacting social, ecological, and political factors. While the expansion of systems such as AI infrastructure is often framed as inevitable, this project challenges that assumption, emphasising the role of governance, participation, and spatial design in actively shaping alternative trajectories. Engaging with the concept of the pluriverse, it holds space for multiple ways of knowing, recognising ontological differences in how communities relate to land, technology, and development (Escobar, 2018). Through the lens of the critical zone and Gaia, these relationships are understood as fundamentally interdependent; linking humans, non-humans, landscapes, memory, and cultural identity. This includes taking seriously the knowledge and lived realities of het platteland, as well as recognising ecological actors, such as meadow birds, as part of a broader community with rights and agency. In this context, participation is not limited to technical expertise, but extends to diverse forms

of knowledge, enabling the co-development of technologies that respond to local conditions, such as weather systems, and are shaped in collaboration with energy communities; without requiring full comprehension of the underlying AI systems themselves, but allowing meaningful engagement with how its development will impact them.

these principles contribute to a broader ethic of stewardship, in which technological and spatial development is collectively managed in relation to ecological limits and shared futures as explored in figure 19

Accountability – Circularity - Stewardship

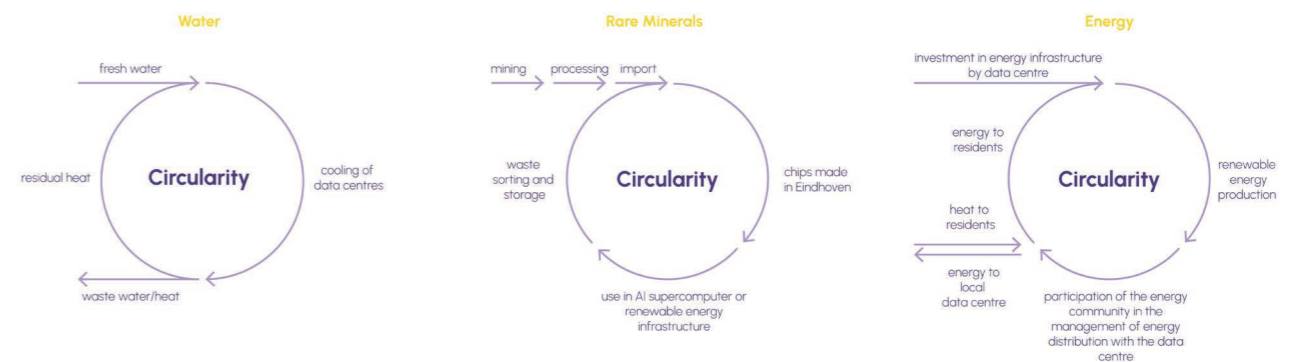
Ultimately, this approach is grounded in a set of core values. Expanding participation strengthens accountability, ensuring that decisions are transparent and actors are answerable to those affected as in explored in figure 20 This, in turn, supports circularity, by making visible the flows of energy, water, resources, and impacts across systems, as explored in figure 21 Together,



F19. Accountability, stewardship and circularity diagram



F20. Accountability diagram



F21. Circularity diagram

03 Analysis

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F22. Groningen is not an exploitation region (NA/Anefo, 1980)



F23. Climate risk: Subsidence, peat oxidation, and rising sea levels means that the region is increasingly vulnerable to flooding as a result of climate change. We must therefore think how we can develop a climate resilient landscape, expanding and densifying towns on the higher land, in order to avoid catastrophe as the flood of 1686 depicted here by Jan Luyken. (J. Luyken, 1689)



F24. Identity: Het platteland, and agriculture forms a strong component of the cultural identity, heritage, and history of the region of Groningen. This can be seen in the Gezicht op Groningen but Giuseppe Filosi in 1742. (G. Filosi, 1742)

AI is coming to Eemshaven

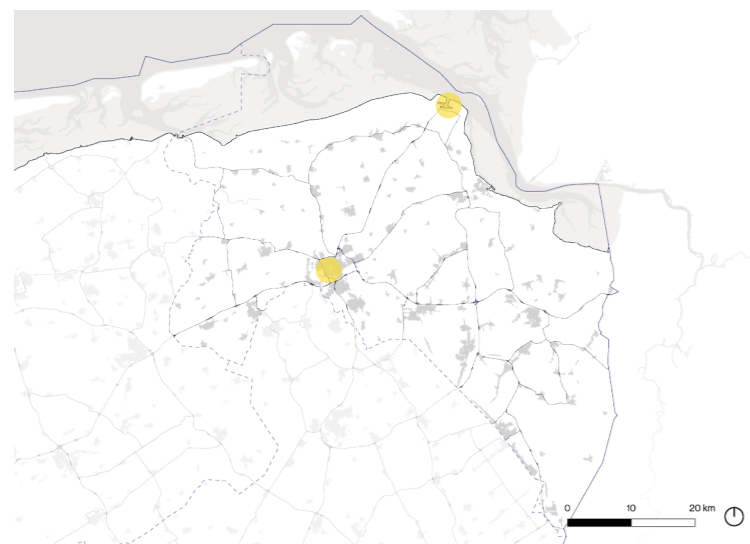
AI is coming to Groningen! It was recently announced that a joint project between the Dutch government, the EU, and the Nij Begun will open at Excellence Centre in 2026 and an AI supercomputer in 2027 (AI Factory Working Together on the Technology of Tomorrow., 2025).

The Excellence Centre will be connected to various institutions and communities in central Groningen such as WUR, de Hanze, the Dutch government, startups and SME's, professionals, students, etc. There will be shared workspaces available, and this is proposed as a public project opening access to ai supercomputing power, and secure data storage. This proposal hopes to mitigate brain drain and create new technical jobs for the region. It is in an old tobacco factory and is adaptive reuse within the urban core of Groningen itself.

It has not yet been announced where the AI supercomputer will be, or about its size or energy requirements. There are a few existing datacentres in Groningen, notably in Winschoten and in Eemshaven, these are privately owned and managed by Microsoft and Google respectively (Data Center Map, 2026). It is often recommended to co-locate data centres in order to increase efficiency, and be in proximity to renewable energy sources, and cooling water. They require a lot of space to generate their immense power requirements, and this has a large impact on

the landscape and thus nearby communities.

For this project, we will assume that the AI supercomputer will be built in Eemshaven. We made this decision since there is already a data centre ran by Google here (Mennega, 2026). There is plenty of access to salt water, and fresh water is being pumped currently from nearby villages, allowing space for the cooling technology to improve. It is close to offshore wind power stations; it is important to use this high voltage energy in as proximity to its source – so having energy be used in the port area by this data centre would be ideal. There are also plans to build a new trainline to Eemshaven which implies this is a region for highlighted for development by the municipality. It has also been proposed as a potential site for a nuclear power station if the Netherlands decides to pursue this path. Overall indicating this is planned to be a key industrial area, with energy production and consumption, potentially in the form of AI supercomputers.



F25. Datacentres in region Groningen



F26. Datacentres in Eemshaven



F27. Datacentres in Groningen



F28. AI factory in the old Niemeier building



F29. AI factory in the old Niemeier building 2



F30. Methodology diagram



F31. Methodology diagram



F32. Solarpanel fields in Winschoten



F33. Datacentre in Winschoten



F34. Eemshaven

Fieldwork interviews

On a site visit to Groningen and one potential site for the AI supercomputer (Winschoten) we conducted a series of interviews with members of the public. This was a useful step to gain a general understanding of the public's perception of the proposed development. These were the key findings from these interviews:

Thoughts on AI

Everyone we talked to had used AI at some point, however each had different hopes, dreams, fears, and aspirations about the technology. In general, people recognised that it was coming and its value in industries such as healthcare. Some felt that it was the future and were excited about its development, but others felt it was out of their control. People were particularly afraid of its impact on the job market and in trust in the media, along with the ecological consequences.

"the bad things about AI are bad and the good things about AI are good... get the regulations and things in. You can't withhold the AI anymore. It's everywhere. You have to deal with it."

(Man and Woman, 60s, Retired, Personal Communication, 16 Feb 2026)

"And I'm a bit afraid AI might take over and take over our job."

(Woman, 20s, Art Student, Personal Communication, 16 Feb 2026)

Trust in the Government

The history of gas extraction and earthquakes made a big impact in people's trust in government. There was a general lack of awareness about the incoming development. People would appreciate being involved in the spatial decisions and the development of energy infrastructure. People felt that the decisions made in The Hague were often to benefit the Randstad and not distributed fairly in Groningen. There was an awareness and fear of the involvement of private industry exporting the benefits (as was the case with gas), and a sense of powerlessness to the upcoming AI developments.

"If the residents are well informed and involved at the first stage of such a development, doubts and uncertainty will diminish and people will forget about it."

(Man from Groningen, 40 years old, Personal Communication, 16 Feb 2026)

"So if it was really municipality (managing AI), I would feel okay, maybe we have something to say. But the thing with developments about AI is the big companies who pay a lot of money to be here and to build here. I think there are even more powerful people and institutions that take those decisions... I think it's the world that we live in right now, so I actually

don't feel that I can do much about it"

(Woman, 30s, Teacher, Personal Communication, 16 Feb 2026)

Energy transition:

People were aware of the importance of the energy transition, and the moving away from fossil fuels, and had hope in hydrogen. They recognized Groningen as a major energy producing region, and therefore were less worried about strains of the grid than other regions of the Netherlands. Some people believed that the transition was not happening fast enough, while others noted how gas and fossil fuels would have to be phased out quite slowly. There were some NIMBY attitudes around the wind turbines and solar fields. People were aware of the large amount of energy required by datacentres.

"If there are a lot of data centers being built here, they also take a lot of energy. Energy that would otherwise provide care for the people in the region. I don't think it's going to be like this at the moment, but I think it will come."

(Retired Couple, 60s, Personal Communication, 16 Feb 2026)

"This gas, they don't use it here in Holland. They sell it. It's all exported. Yeah. It's strange. Yeah. They take it from the ground, but they don't use it by themselves. They buy gas from Russia, Russian gas or Sweden or so. It all comes down to money"

(Plumber, 40s, AI factory, Personal Communication, 16 Feb 2026)

Identity and het platteLand:

In general, people felt quite proud of Groningen, and rooted in their landscape. They raised concerns with it all being taken over by the energy transition. They also noted the importance of meadow birds and ecology, and how population numbers of these birds are currently diminishing.

"I don't like the windmills. It's ugly. Very ugly. If you see the site, when you look outside, Yeah, then you see only windmills."

"And the solar panels are also ugly."

(Plumber, 40s, AI factory, Personal Communication, 16 Feb 2026)

"Building a data centre on the landscape might impact the meadow bird habitats, so you are increasing the ecological impact they have on the surrounding area. There are lots of meadow birds in Groningen but in recent years they are coming less and less as their habitat degrades."

(Man and Woman, late teens, Students, Personal Communication, 16 Feb 2026)

Key stakeholder perspectives

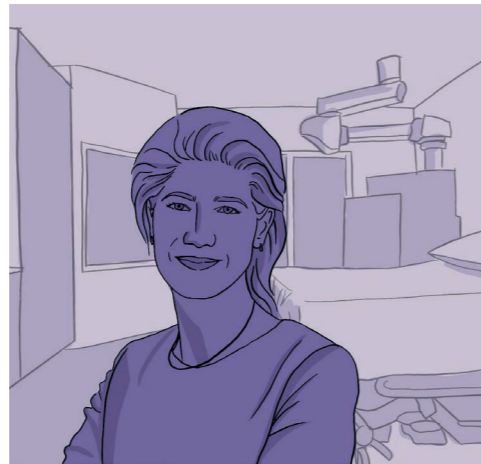
This research is a situated and site specific project. It has been developed in reaction to emerging proposals for the development of the new ai excellence centre and supercomputer proposal. Therefore we can look at the perspectives of some of these key stakeholders upon these developments.



F35 Willem Jonker

Willem Jonker (Chairman of AI4CNL):

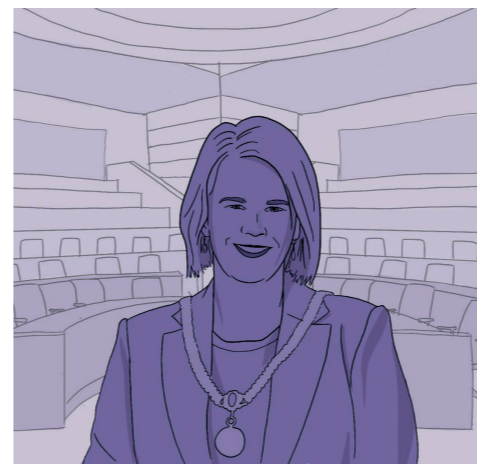
He highlights the necessity of the AI factory as part of **a broader strategy to boost the Netherlands' AI industry**. Jonker notes that while the factory is a significant step, it is only one piece of the puzzle in addressing the investment backlog in AI.



F36 Stephanie Klein Nagelvoort Schuit

Stephanie Klein Nagelvoort Schuit (Vice-chair of the board of UMCG):

She expresses eagerness for AI developments, particularly in healthcare, where AI can help in **faster disease detection and reduce administrative burdens on medical staff**.



F37 Roeling Kamminga

Roeling Kamminga (Mayor of Groningen):

She emphasizes the importance of the AI factory for the region, stating that it **will attract knowledge and talent, and provide opportunities for businesses and startups**. Kamminga believes that the factory will enhance Groningen's position within the European AI network.



F38 Residents of Oudeschip

Residents of Oudeschip

They feel **abandoned by politicians**. The Provincial Council approved a plan to develop a 600-hectare industrial estate in the Oostpolder, next to their village (Koper, 2025).



F39 Eemshaven

AI Students at the University of Groningen:

Students like Gijs Peletier and Julian Sprietsma are enthusiastic about the AI factory, seeing it as a chance to **work on impactful projects**. They express a desire for the factory to be operational quickly, as they believe that the fast-paced nature of AI development requires **immediate action**. They also acknowledge the allure of opportunities in Silicon Valley but emphasize the importance of making **a meaningful contribution through local projects**.

The impact of AI

In 2025, Greenpeace, together with the independent non-profit Öko-Institut, published a study outlining the physical and spatial requirements of AI data centres, as well as their environmental impacts. This study was used to understand this complex system and to visualise it through a diagram of inputs and outputs.

Input

Energy

The European Union requires AI data centres built before 2030 to run fully on renewable energy by 2040. Renewable energy is generated through wind turbines or solar fields, while the EU also recognises nuclear energy as a green source. The energy consumption of AI data centres is expected to triple between 2023 and 2030 (Öko-Institut). According to the study, this additional demand for electricity may prolong the operation of fossil fuel power plants, further exceeding planetary boundaries.

AI data centres operate 24/7 and therefore require a stable energy supply, which renewable sources alone cannot guarantee. Additional energy sources are needed, each with their own disadvantages. Fossil fuels contradict the energy transition; nuclear power plants require long construction times, produce radioactive waste, involve high water use, and raise safety concerns. Batteries rely on minerals that must be mined elsewhere, with significant global impacts. Hydrogen presents potential, but still requires further technological development.

Water

Approximately half of the energy used in data centres must be removed as heat through cooling processes. These systems typically rely on (fresh) water, meaning that data centre water use may

compete with domestic and agricultural needs. Water consumption is similarly expected to triple within the next seven years (Öko-Institut).

This does not yet account for the ultra-pure water required in the production of hardware (chips, servers, etc.), nor the water used in cooling processes for energy generation.

Resources

Neither the Netherlands nor the European Union has sufficient mineral resources or a mining industry to support this growth. As a result, large quantities of minerals and hardware are imported. Mining activities have significant ecological and social impacts elsewhere - producing ghost acres.

Output

Heat

Data centres generate large amounts of heat that must be dissipated. Cooling methods vary in their water intensity, but one of the most efficient approaches is to integrate data centres into residual heat networks. In this way, heat can be reused instead of being lost to the air or discharged into surface water.

Electronic Waste

AI technology evolves rapidly, causing hardware to become obsolete quickly. Currently, components such as chips are replaced approximately every four years, resulting in significant amounts of electronic waste (Öko-Institut). This e-waste is not yet managed adequately and is often exported elsewhere.

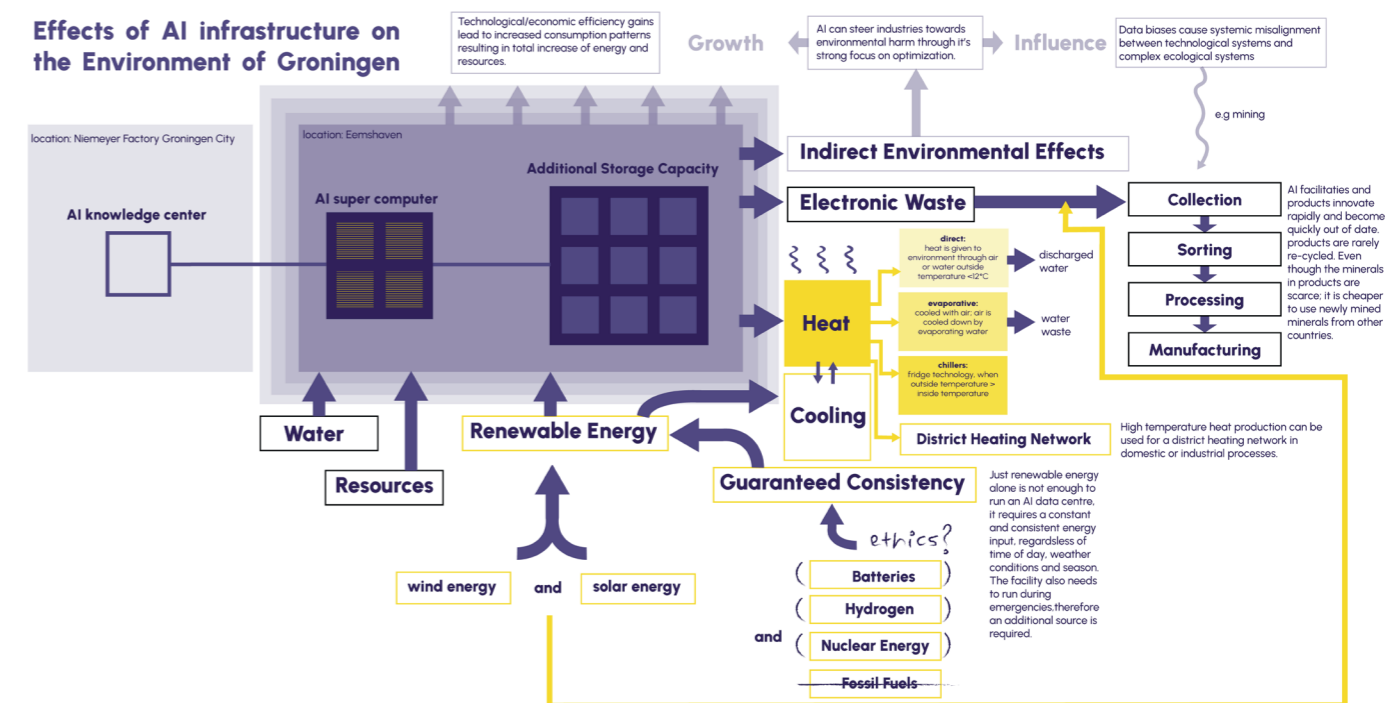
Indirect Effects

Beyond direct outputs such as heat and waste, AI data centres have indirect effects that extend far

beyond the Groningen region. As illustrated in the diagram, these include influence and growth.

Influence refers to the impact of AI-driven decision-making on the environment. AI models rely on datasets that may contain biases, potentially leading to misalignment between technological systems and complex ecological realities.

Growth refers to the inherent logic of AI development, which is driven by efficiency. Technological and economic efficiency gains often lead to increased consumption, resulting in a net rise in energy and resource use, also known as the rebound effect.



F40. Effects of AI infrastructure on the environment of Groningen

The impact of AI

We can then spatialise these requirements, we made these calculations based on a mid-sized AI supercomputer of 12MW, this is in relation to case studies of international AI supercomputers, which could also power 10,000 households. It is worth noting that this would be for an initial phase, of development of the technology, and that the current limitations for a Dutch data centre to connect to the grid is at 70MW (Keyzer & Eikelboom, 2026), and that the current world's largest data centre (Colossus in Memphis) consumes as much as 250 MW of electricity. Then looking at the space required to generate this amount of energy through different renewable sources. The water required through different cooling technologies – and how this compares to household usage. Finally, how much space would be needed for a magnet recycling facility – vs the mines and manufacturing (which be exporting and hiding the extractive environmental harm in a potentially neocolonial form).

If we are to take an approach of accountability, we need to immediately tackle the direct and indirect environmental harm caused by the construction and operation of a data centre. This comes in the resources it consumes, water, energy. Along with the requirements of the hardware, we are dependent on importing raw materials. There is a new chip factory being built in Eindhoven, but to aim for a circular system, and with the aims of self-sufficiency it is important to also factor in magnet and rare mineral recycling.

In conclusion, this project aims to avoid the pitfalls of historic extraction in Groningen through developing participatory and democratic systems that hold the emerging industry accountable. This accountability is both in the resource use and the spatial implications, but also in how the technology is developed and how the economic benefits are distributed. Aiming for specialized development and uses of AI that improve the lives of communities, as opposed to unfettered growth.



F41. Spatial requirements of different forms of production and consumption of 12 MW AI Supercomputer

Groningen as a site of extraction

Groningen has a landscape shaped by successive phases of resource extraction. For centuries, natural systems in the region have been systematically exploited to serve broader economic and political interests on a regional, national, and global level. The analysis shows how different forms of extraction have transformed the landscape over time. These processes have not only altered the physical landscape but have also produced long-lasting social inequalities and uneven economic developments.



F42. Peat extraction in Groningen

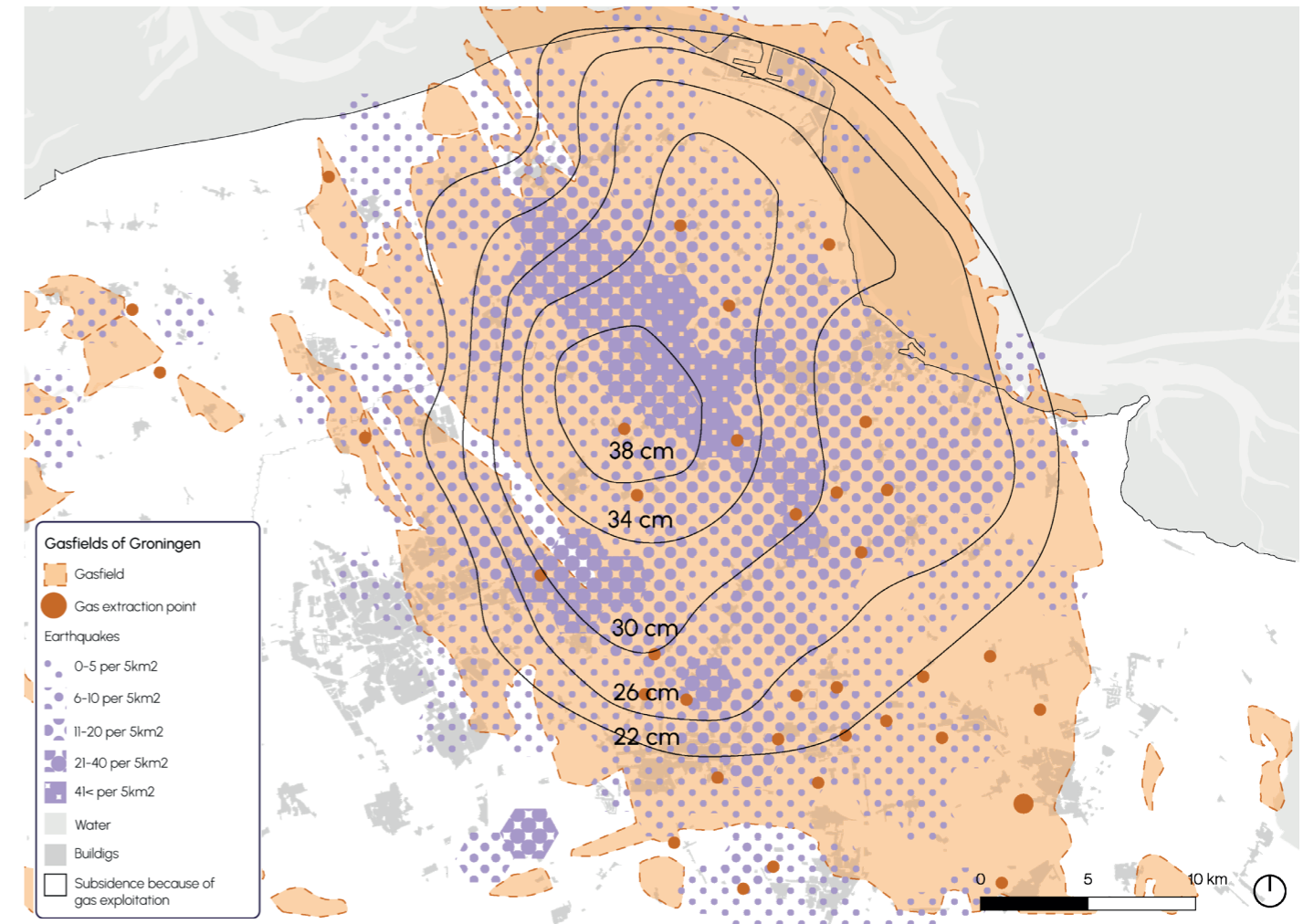


F43. Natural gas location of the Dutch Petroleum Company in Slochteren. Historical Archives of Central Groningen.



F44. On the land of farmer Smit from Hoogezand in 1929.

Groningen as a site of extraction



F45. Gas extraction and physical consequences in Groningen

Gas extraction

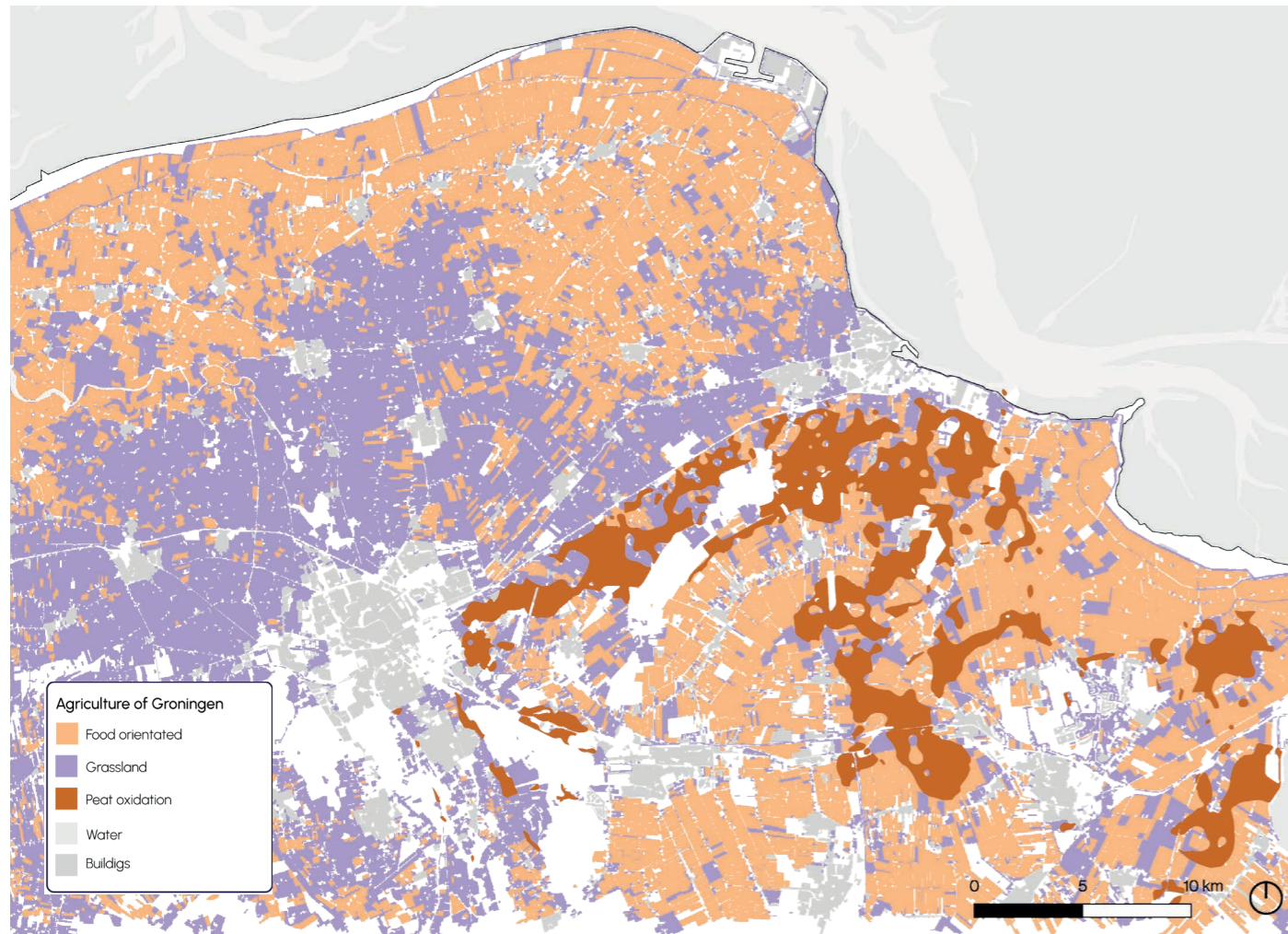
The discovery of the Groningen gas fields in the mid-20th century marked a turning point in the region's history. Initially farmed as an opportunity for regional prosperity, the economic benefits of gas extraction largely accrued to the national government and private corporations, rather than to local communities (Shell, n.d.).

Over time, the environmental consequences became increasingly evident. Earthquakes caused by the drilling began to occur. For a period of time, the Dutch government insisted that gas extraction could not cause earthquakes. As the earthquakes intensified, widespread structural damage to buildings emerged, alongside land subsidence. With nearly 1,500 recorded earthquakes and many

protests, extraction has now been reduced to minimal levels (milieu defensie, n.d.). However, the prolonged institutional response has led to a deep disconnect between residents and government. This highlights issues of environmental injustice and governance failure (self-conducted street interview, 16 February 2026).

Today, just as it was assumed that this chapter had come to an end, political actors have begun to reconsider the decision to fully shut down gas extraction. In light of global geopolitical tensions and the increasing threat of conflict, energy prices have risen to unprecedented levels, prompting renewed consideration of potential future scenarios (NOS Nieuws, 2026).

Groningen as a site of extraction

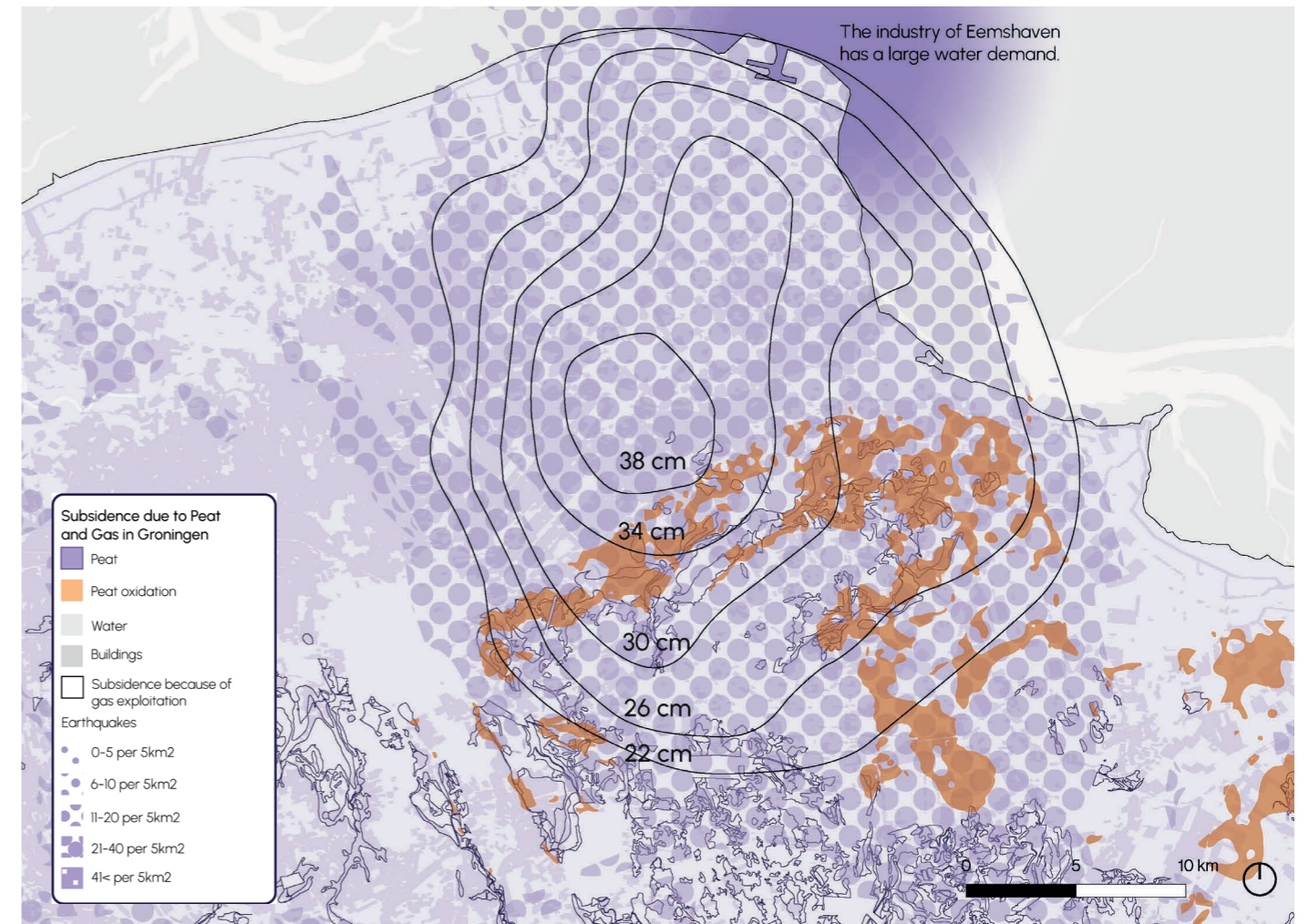


F46. The agricultural landscape of Groningen and its physical consequences

Water extraction

Agriculture intensification has driven significant alterations in Groningen's hydrological system. To maintain productive farmland, groundwater levels are artificially regulated through extensive drainage systems. While this has enabled stable harvests, it has also resulted in ecological degradation (Jansen, 2026).

Lowered water tables disrupt natural habitats, leading to a decline in biodiversity and the loss of wetland ecosystems. The map illustrates how water extraction operates as a less visible, yet pervasive, form of landscape transformation with long-term environmental consequences.



F47. Water, soil and peat extraction in Groningen mapped

Soil and peat extraction

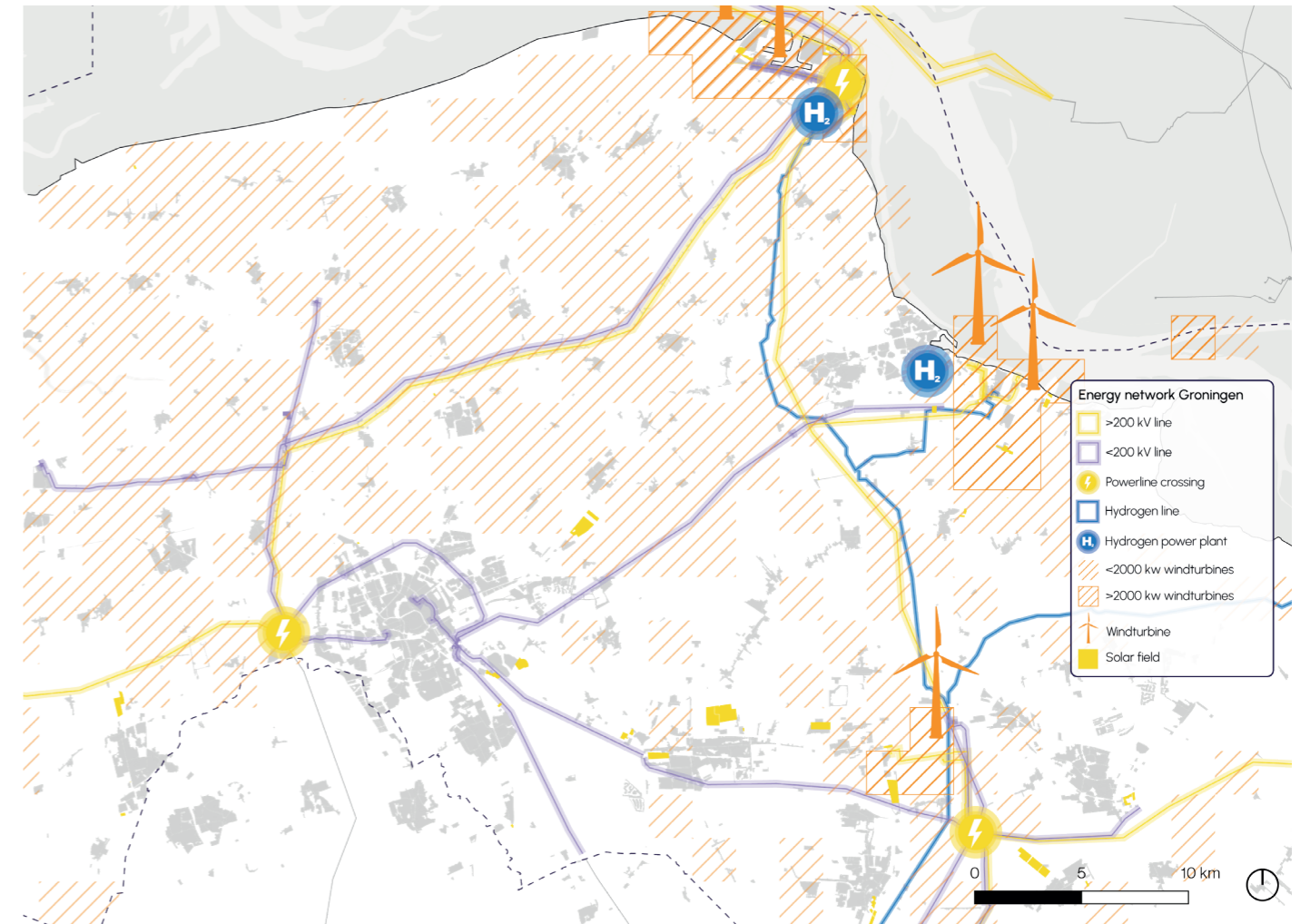
Historically, Groningen has also been a site of peat extraction. Peatlands were drained and excavated primarily for use as fuel, particularly before the widespread adoption of fossil energy sources. This process fundamentally altered the soil structure and released significant amounts of stored carbon into the atmosphere (Van Huissteden, 2024).

The history of peat extraction is twofold: it contributed to historical energy provision, but also to land subsidence and increased greenhouse gas emissions. It continues to affect both the ecological resilience and climate dynamics.

Systems of Groningen spatialized

To develop a thorough understanding of the dynamics that shape Groningen, it is essential to examine the interaction between its key systems. These systems reveal the underlying structures that have historically defined the region and continue to influence its current development. In particular, the energy, economic and social systems provide insight into both the ongoing transformations and persistent spatial inequalities.

Through this analyses, one gains a better understanding of Groningen's position within of the energy transition and the uneven distribution of prosperity in the region.



F47. Current energy system of Groningen

Energy system

Contemporary Groningen is once again positioned as a key site of energy production, this time within the context of the energy transition. Large-scale wind turbine fields, solar parks, and emerging hydrogen infrastructures are reshaping the landscape (Ronde & RES Groningen, 2025). These systems are integrated into national and transnational energy grids, reinforcing Groningen's role as an energy supplier (Provincie Groningen, n.d.).

While renewable energy represents a transition away from fossil fuels, it also raises questions about spatial justice and local benefits distribution.

The maps show how the energy infrastructure occupies large areas of land, continuing the historical patterns of external demand shaping the region.

Systems of Groningen spatialized

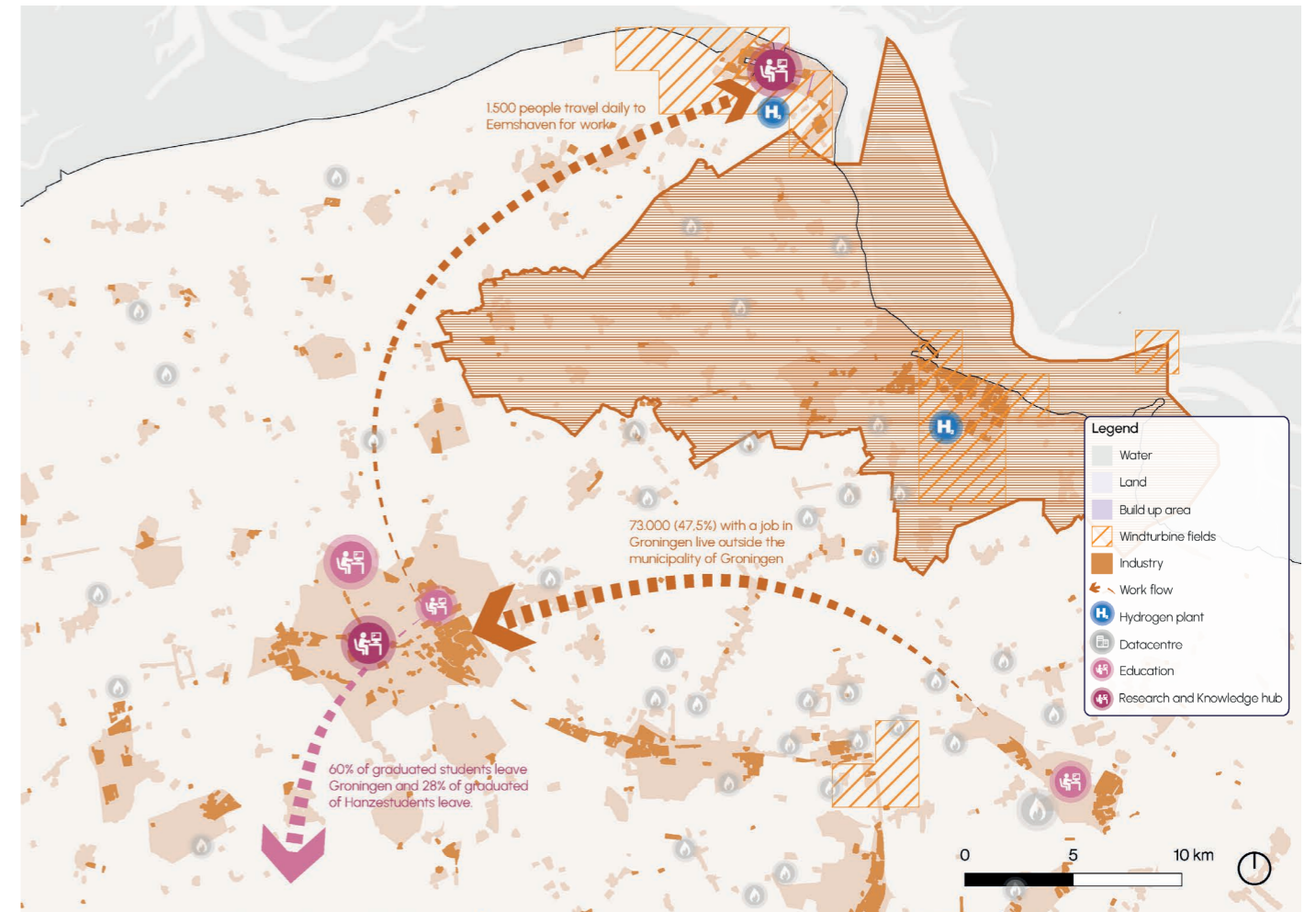


F48. Effects of AI infrastructure on the environment of Groningen

Social systems

Extraction in Groningen is not limited to natural resources but extends into the social domain. The region experiences a continuous outflow of its residents, particularly among the highly educated. Students are drawn to Groningen for education but often leave after graduation in search of employment opportunities elsewhere (Rijksuniversiteit Groningen, 2021).

This "brain drain" reflects structural imbalances in regional development and contributes to demographic challenges. The map visualizes the flows, emphasizing the relationship between knowledge production and spatial inequality.



F49. Effects of AI infrastructure on the environment of Groningen

Economic systems

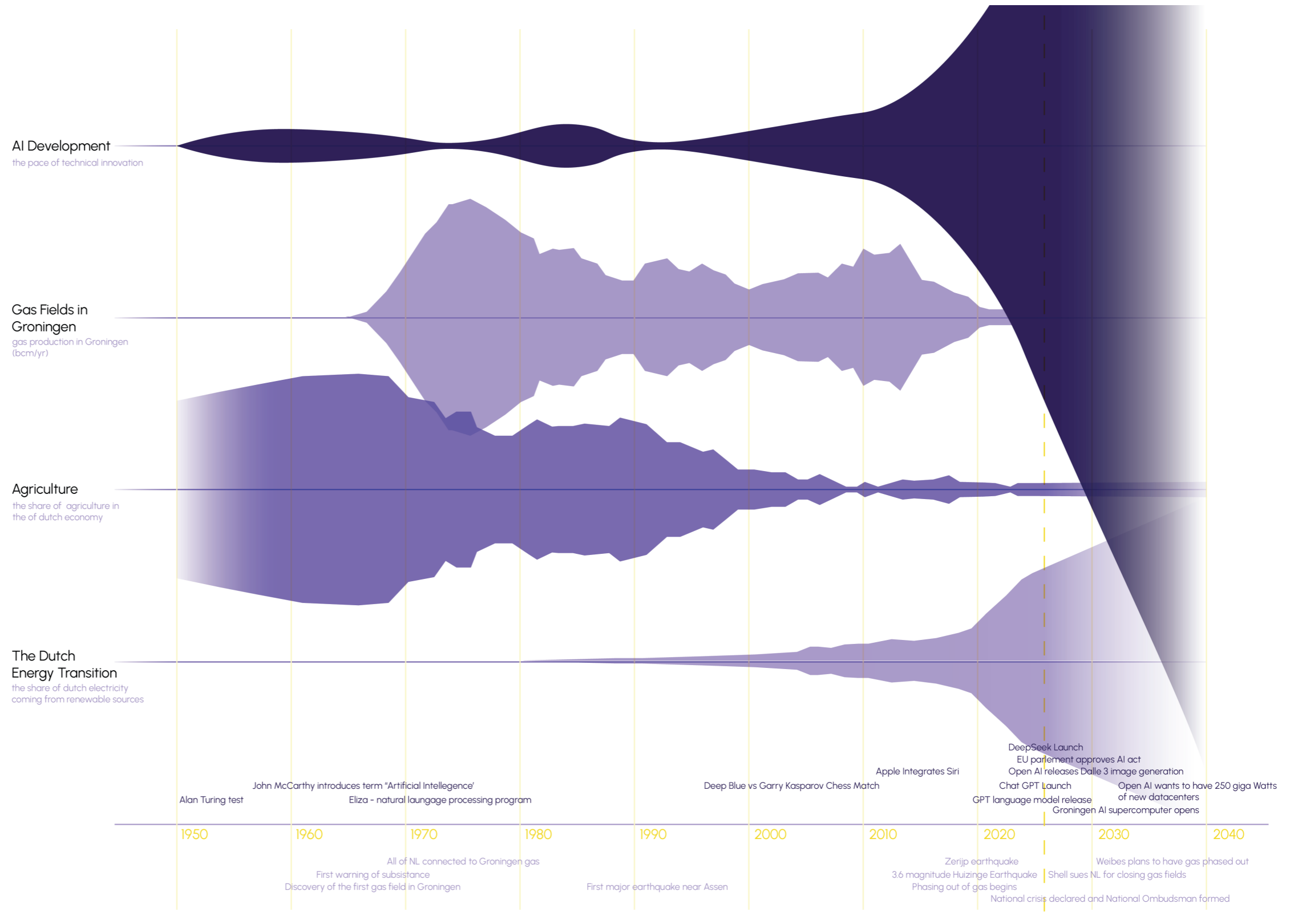
The economic landscape of Groningen is deeply intertwined with its history of extraction. Despite decades of gas revenues, the region has experienced limited economic growth. The impacts of subsidence and earthquake damage have further contributed to vacancy and declining property values (OIS Groningen & LISA, 2023).

At the same time, new opportunities are emerging within the green energy sector and related technical industries. This creates a complex economic condition in which decline and growth coexist. The map illustrates these spatial patterns, revealing both the vulnerabilities and potentials of Groningen's evolving economy.

This is a long history of extraction with new industries emerging continuing these patterns. It is however hopeful to look at the fact that the gas fields are appearing to close, despite the fact that there is still economic potential in the leftover gas. The process of stopping the drilling has of course been flawed, and far too late, with lots of damage sustained throughout, but it has dramatically slowed production. We must learn from this by knowing when to put on the brakes on AI.

Timeline of extraction

Here we can look at this timeline of extractive industries in the area, analyzing the growth patterns of agriculture, gas, green energy, and AI. Part of the Recovery Fund for the damage caused by gas extraction is directly invested in the ai factory by NijBegun. Each of these industries impacts on landscape and communities are overlapping and interlinked. Thus one can see this as a chance to improve upon these participatory and democratic processes to avoid the same mistakes. Learning from this to develop a way to put on the breaks, and looking at how to stop unfettered growth for the benefits of these communities and the planet, to avoid this large and all-encompassing growth of AI.



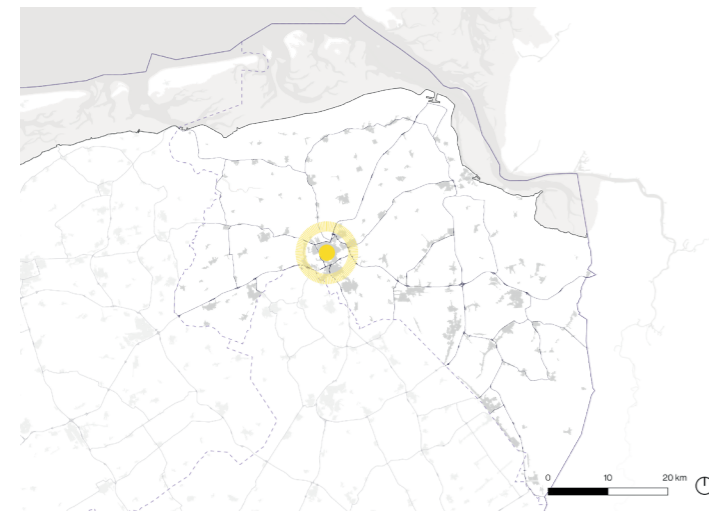
F50. Timeline of the different forms of extraction in Groningen

Communities in Groningen



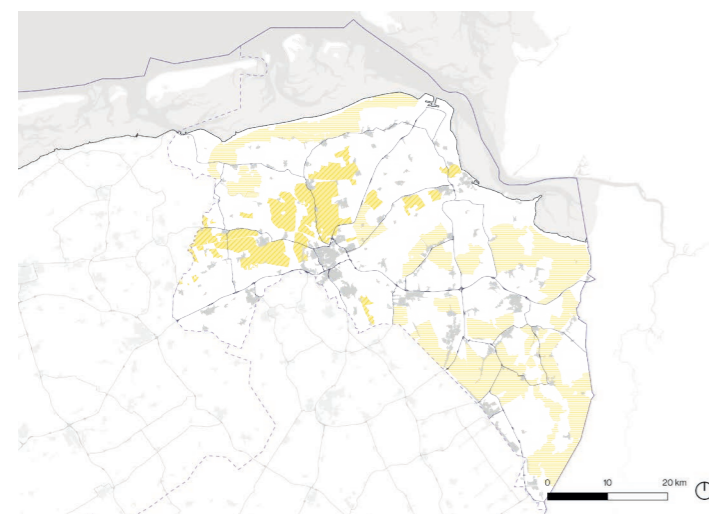
F51. Location of the residents of Oudeschip

Residents of Oudeschip
 The inhabitants of Oudeschip live in the northernmost village of the Netherlands. There are many village activities to enjoy. For instance, they can also appreciate the beautiful landscape that the residents are so proud of. Nevertheless, tension prevails due to the new developments in Eemshaven, the industrial area just a few kilometers away from them.



F52. Location of the young urban professionals

Urban professionals
 The urban professionals have just completed their education and have already been heavily involved with innovation and AI. They want room to grow within the city. There are many opportunities for this in the new AI factory.

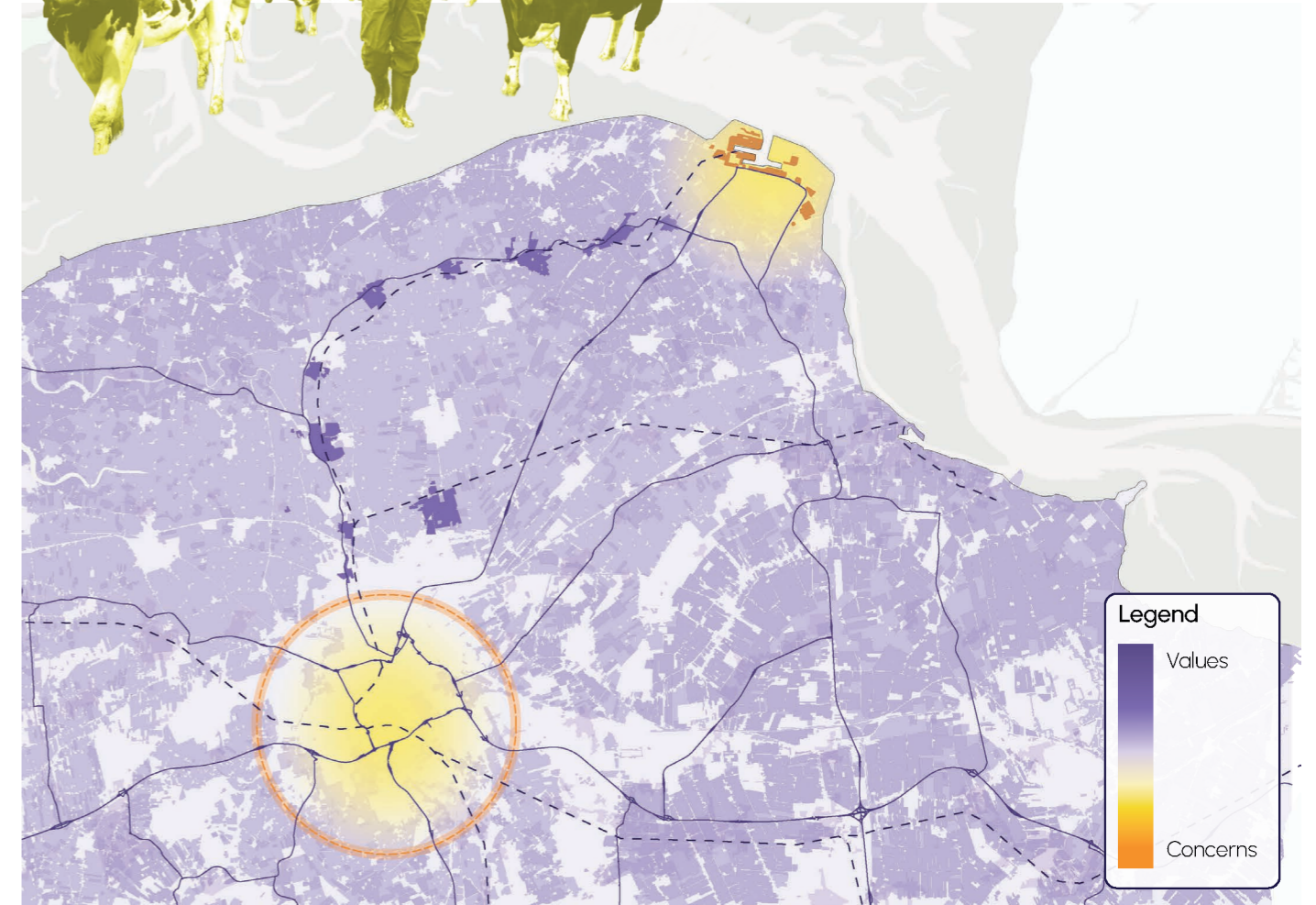


F53. Location of the meadow birds

Meadow birds
 The meadow birds live on the man-made Groningen landscape. It is their home, and they find their food there. The new AI factory could pose a major threat to their habitat and living conditions.



Residents of Oudeschip



F54. Location of the residents of Oudeschip

Values

- Agriculture
- Mobility (train connection and roads)
- Small communities
- Strong sense of belonging and identity

Concerns

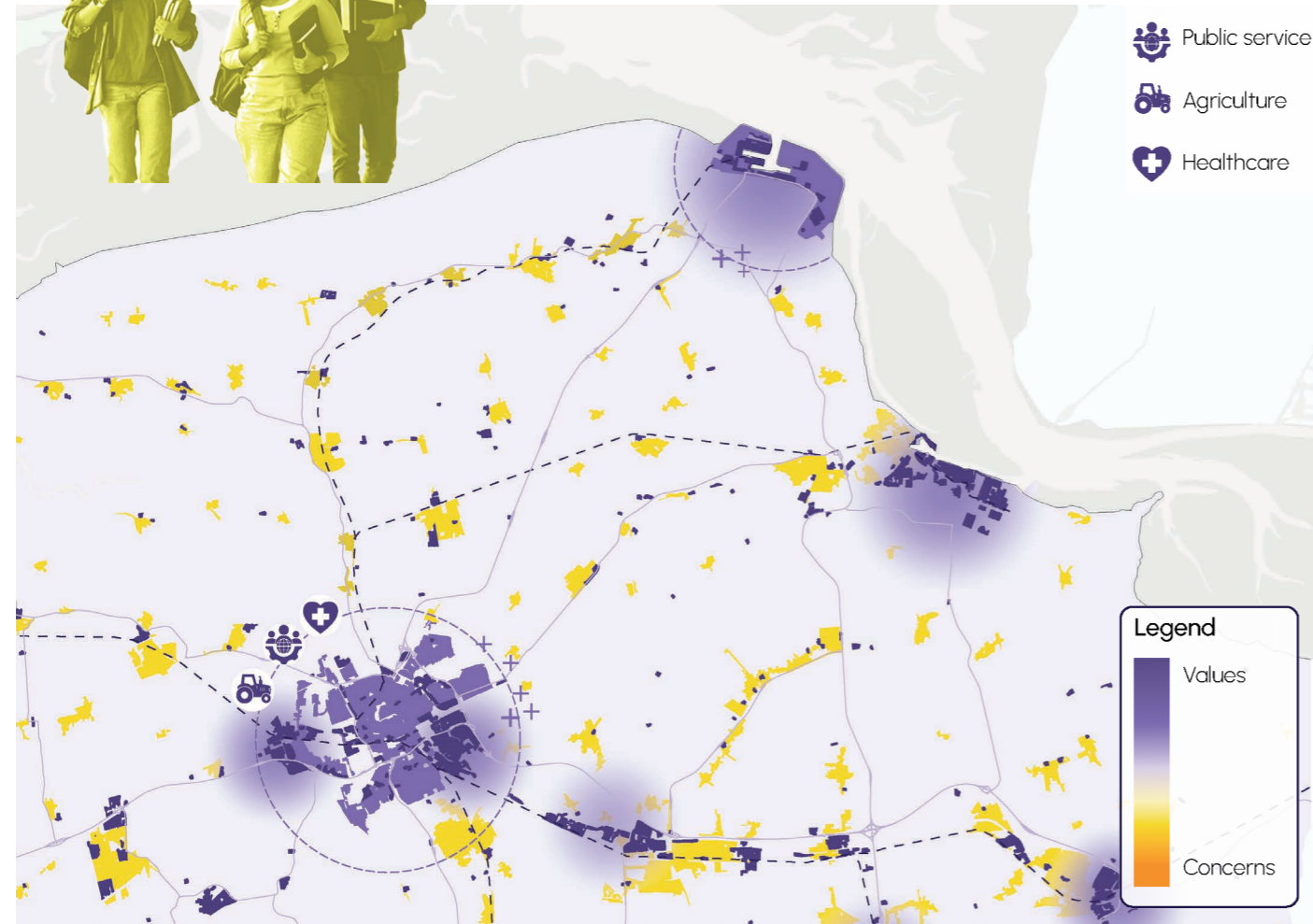
- Expansion of Eemshaven and its polluting effect on agriculture
- Disconnect to Groningen and its decisionmaking

The peripheral residents see the possibilities in AI helping to improve healthcare and the education, rather than serving solely corporate profit motives. Although the concerns outgrow their optimism. They see the enormous environmental footprint the AI datacentre will have and the large amount of energy it needs. Also the threat to local democracy by large companies is a real living fear among this community (Dagblad van het Noorden, 2025a).

Communities in Groningen



Young urban professionals



F55. Location of the young urban professionals

Values

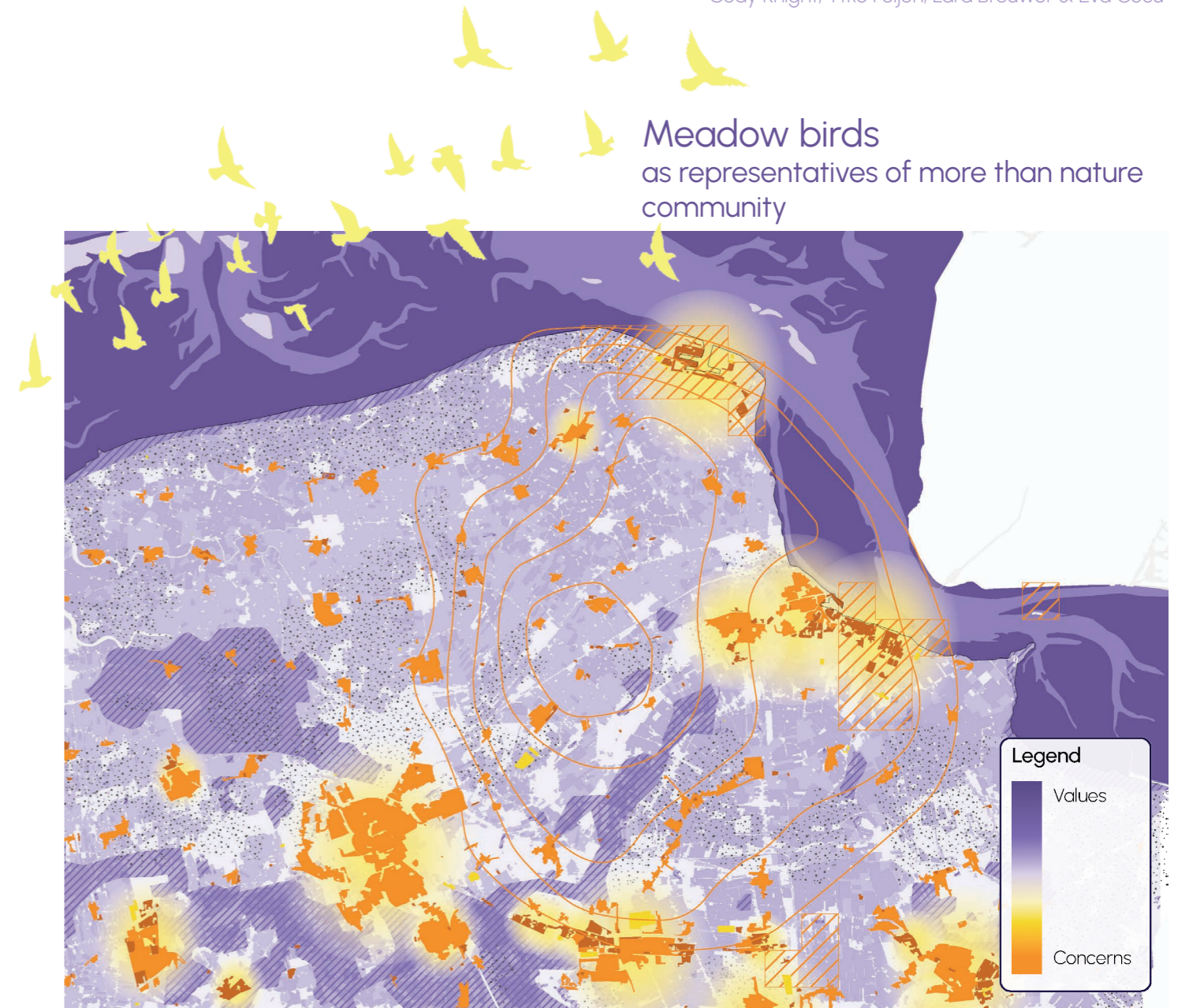
- Mobility (train connection and roads)
- High variety in facilities
- Good industry infrastructure

Concerns

- Disconnected small villages
- Environmental harm of AI
- Housing availability

Under the urban professionals there is a strong belief that the AI factory will enhance Groningen's appeal, attract talent, and create opportunities for businesses and startups. It will strengthen its position within the European AI network.

However there are concerns about the potential economic consequences of an "AI bubble", and the risks associated with over-investment in AI technologies where the future of it is uncertain (Dagblad van het Noorden, 2025b).



Meadow birds as representatives of more than nature community

F56. Location of the meadow birds

Values

- National Nature Network
- Agricultural landscape
- Sea

Concerns

- Subsidence of the land
- Build up area
- Pollution of industry and datacentres

The nature and meadow birds have quite a lot of concerns about this AI datacentre. Their values lay in the landscape, the water, and space. These resources are exactly what is needed for the AI datacentre to run. It is incredibly concerning to acknowledge that it will only grow, and therefore the need for resources (nature) will not shrink, but will grow exponentially and will change the landscape indefinitely (Dagblad van het Noorden, 2025b).

Systemic section

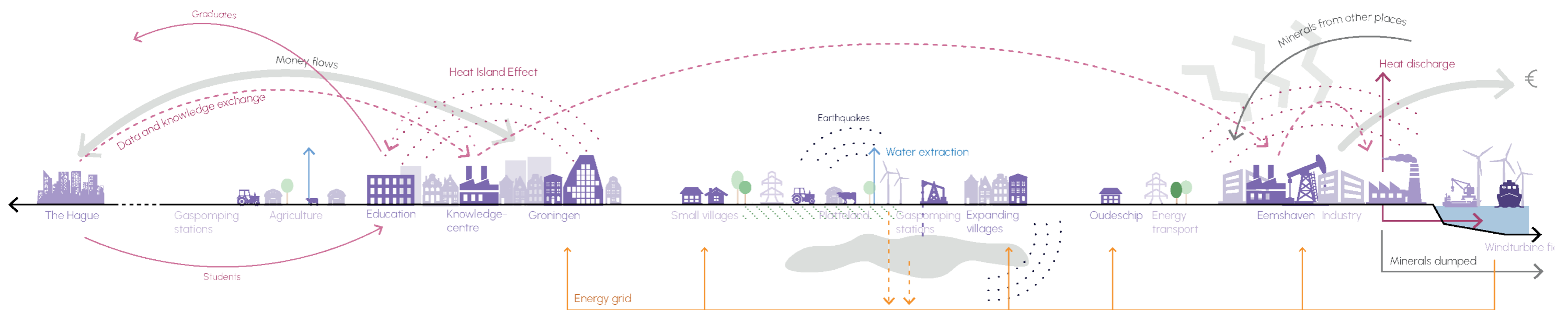
At this moment, various systems can be identified in Groningen, many of which contribute to the deterioration of the economic situation currently unfolding. This is not a situation that appeared out of nowhere. A long history of exploitation has shaped the landscape.

The exploitation of gas, water, and land has led to land subsidence, causing significant damage to buildings, resulting in widespread vacancy. The fact that villages are gradually depopulating does not mean that the residents feel disconnected from their homes, quite the opposite is true. For instance, they are incredibly proud of Het platteland.

However, there are major concerns regarding the expansion of the Eemshaven. The industrial site already generates a lot of noise and produces a large amount of waste. There is a fear that this will only increase with the expansion. In addition, there is the growing demand for energy. Many experience that the energy grid is already being overloaded, and the continued growth of industry will only increase this demand. This also means that more land is needed to accommodate for this

energy production, which will impact the beloved open horizon of the landscape.

Not only are people leaving het platteland, but many people are also leaving the city. This is largely due to students leaving Groningen after graduation to seek employment elsewhere. As a result, there are few innovation and development opportunities for companies in the city.



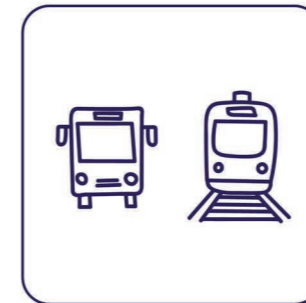
F57. Current systems in Groningen

04 Vision

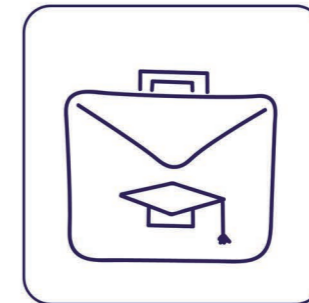
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Communities visions

Residents Surrounding Eemshaven



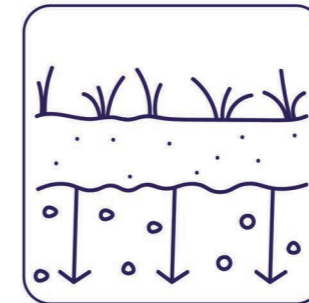
improved mobility



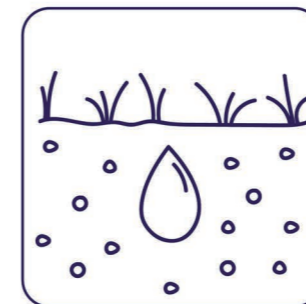
job availability



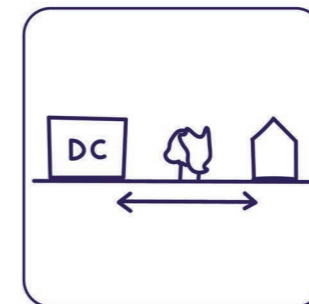
traditional agriculture



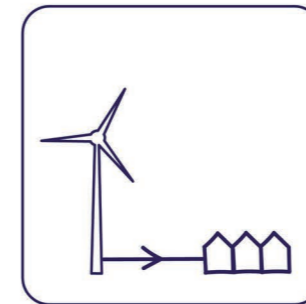
soil and water quality



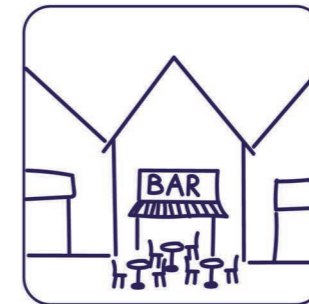
soil and water quality



spatial and visual buffer



sustainable energy production for own use



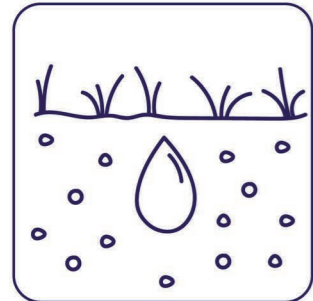
vibrant village life

Residents around Eemshaven

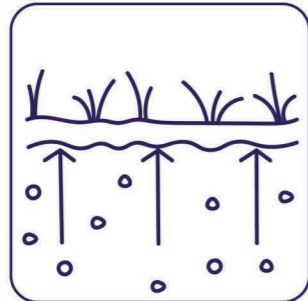
Residents around Eemshaven similarly value job availability. At the same time, they want to preserve their village lifestyle, meaning improvements in local facilities and transport connections are important. They are generally opposed to data centres unless there is a significant spatial and/or visual buffer. Most importantly, they strongly value the identity of the landscape.

Communities visions

Meadow Birds



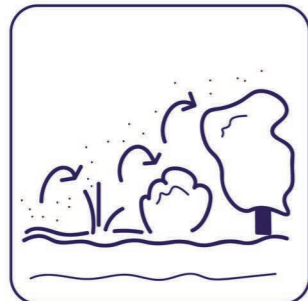
soil and water quality



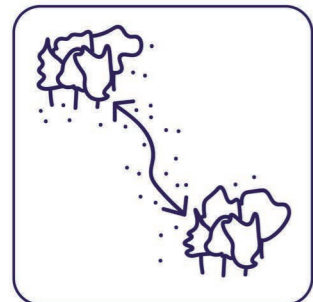
high groundwater level



silence and darkness



diverse vegetation

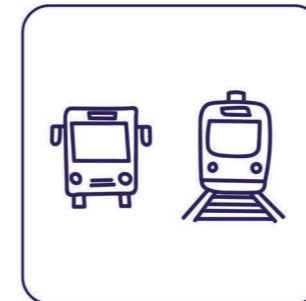


well connected ecosystem

Meadow birds

Meadow birds are concerned with the decline of their habitat and its ecological value due to data centre development. Their primary habitat is agricultural land, where they depend on good water and soil quality, as well as high groundwater levels for food security. They also require diverse vegetation, open fields combined with bushy areas for shelter. Additionally, their habitat relies on conditions of darkness and silence, which may be negatively affected by data centres.

Young Urban Professionals



improved mobility



housing availability



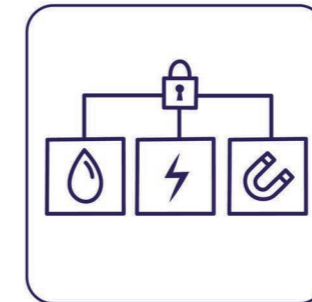
job availability



vibrant city life



regulations on AI



restricting environmental impact of AI

Young Urban Professionals

The young urban professionals community values a vibrant urban life, with strong public transport connections, and the availability of jobs and housing. Overall, everything that supports their lifestyle. At the same time, they are concerned about the lack of resource restrictions and insufficient regulation of AI.

Vision statement

Looking out of your window in Oudeschip around the year 2050, the wetlands stretch far towards the horizon. Wind turbines turn slowly in the distance while meadow birds move through the wetlands. Just beyond the dense forest/buffer the AI supercomputers are whirring, helping manage agriculture, healthcare, energy, and security. A neighbouring industrial plant is recycling raw materials and e-waste providing new specialised jobs. The people of Groningen take pride in this balance between technology and nature. Artificial intelligence (AI) and data infrastructure are no longer controlled by distant corporations, but governed collectively as a public good, serving society while protecting the landscape that defines the region.

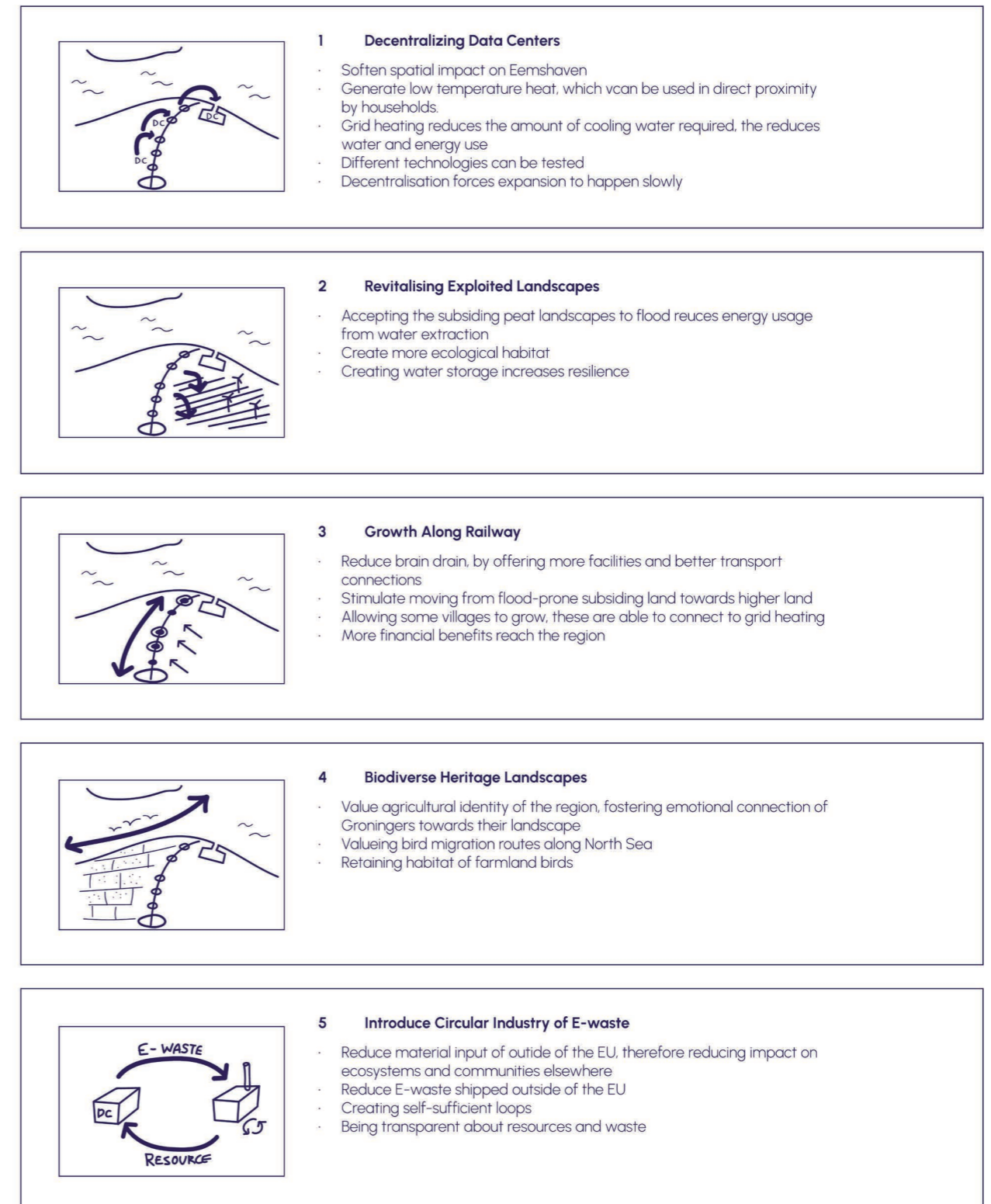
Today, however, this balance does not yet exist. The fast-paced expansion of AI and datacentres is mainly driven by the big tech and top-down decision making. Local communities often have little influence over developments that reshape their environment, with limited public information and participation before deals are signed. As data infrastructure grows and energy demand rises, it becomes clear: Without direction the technological growth (on AI) could gradually overtake the ecosystems and landscapes of Groningen, continuing the historic extractive patterns of gas and agriculture.

In this future, Groningen builds a new spatial and institutional system. Regional resources such as energy, data and knowledge are managed through shared stewardship between municipalities, citizens and public institutions that hold its growth and consumption of resources accountable. A strategic corridor connecting Eemshaven, Uithuizen, Bedum, Winsum, the smaller villages in between and the city of Groningen distributes energy, data, economic growth, knowledge and residual heat across the region. Here data centres are used as catalysts for development, in terms of public transport

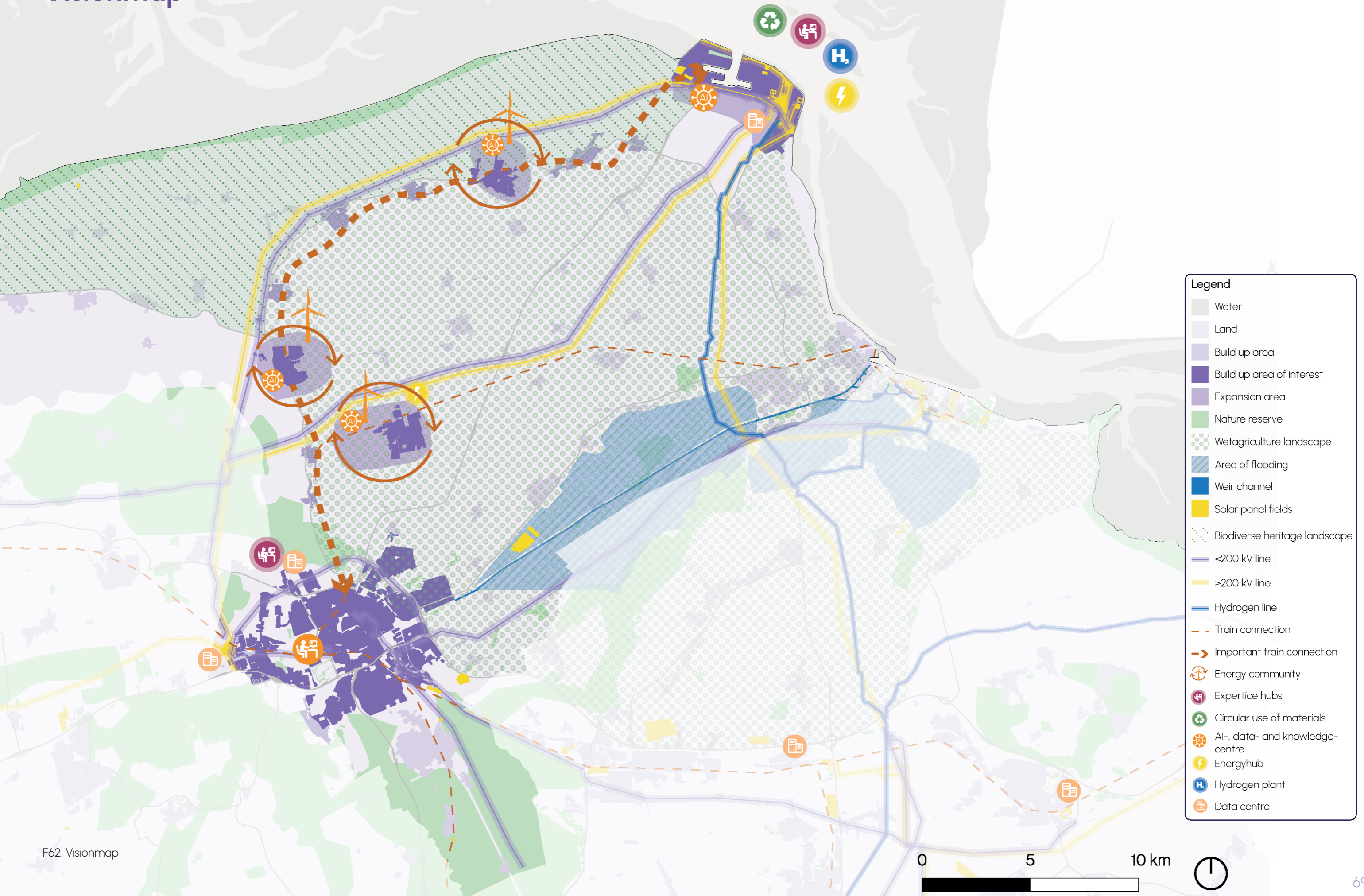
connections, grid upgrades, and densification along the corridor. The associated investment is used to create energy communities, who have their homes heated via the data centres, and are involved in the creation of a schedule which dictates where the energy goes. Allowing the data centre to turn off in certain conditions, following and responding to community demands and the weather. At the same time is the agricultural landscape of mid Groningen transitioning towards wetland agriculture combined with renewable energy landscapes, restoring biodiversity while sustaining rural livelihoods, creating a plan that is resilient to the potential flooding of the area.

AI is developing exponentially, its demand for resources is escalating - quickly transforming our socio-economic climate. Given this new challenge with the additional uncertainty, we must explore innovation - while not falling into similar extractive histories of gas and agriculture, giving nature its rights back.

Given that the transition into renewable energy will determine the development of this technology and its effect on the landscape, it should be held accountable. Therefore, this process goes hand in hand with democratic participation from local residents, ensuring that communities have stewardship over the developments that affect them, and see the benefits of the technology locally. At the same time, governance structures must evolve. A new governance framework for AI and other technological innovations will provide the direction, boundaries and guidance needed to ensure that technological growth supports both the landscape and the wellbeing of the people of Groningen, the Netherlands, and the world.



Visionmap



Legend

- Water
- Land
- Build up area
- Build up area of interest
- Expansion area
- Nature reserve
- Wetagriculture landscape
- Area of flooding
- Weir channel
- Solar panel fields
- Biodiverse heritage landscape
- <200 kV line
- >200 kV line
- Hydrogen line
- Train connection
- Important train connection
- ⚙️ Energy community
- 👤 Expertice hubs
- ♻️ Circular use of materials
- 🧠 AI-, data- and knowledge- centre
- ⚡ Energyhub
- 🏭 Hydrogen plant
- 📄 Data centre

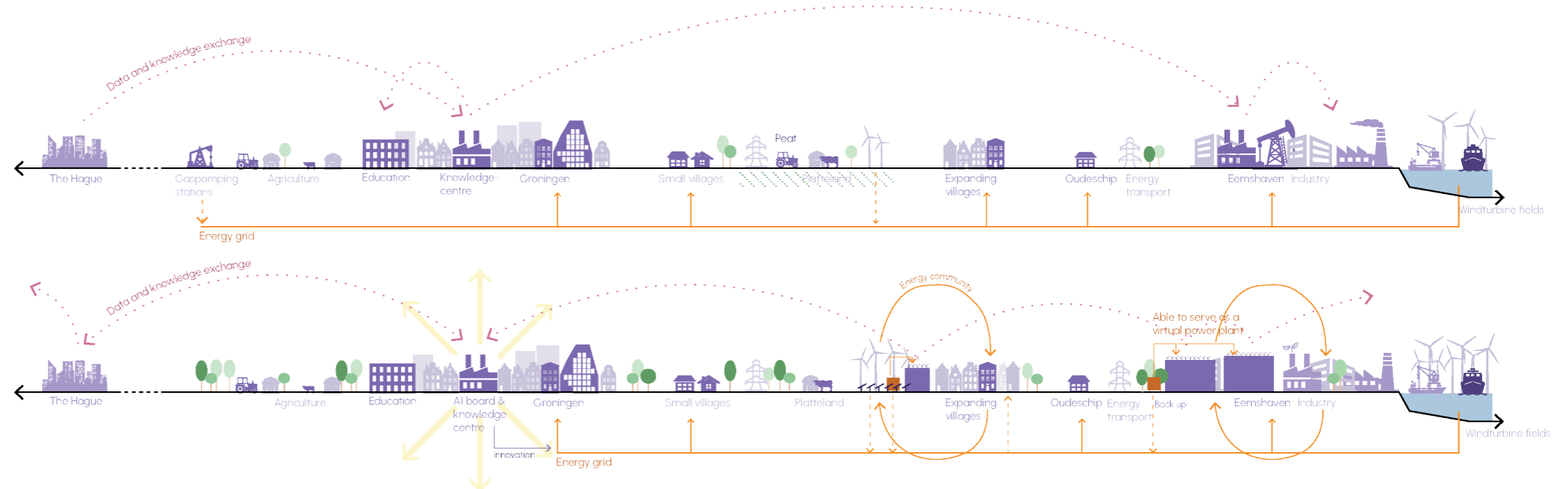


System sections

Energy and data

Currently, the energy grid is connected to all villages and cities. Much of this power comes from offshore wind farms. In the vision, this will change to a more local form of energy. For instance, energy communities will emerge in the larger villages (Uithuizen, Winsum, Bedum). They will primarily rely on their own self-produced energy, while remaining connected to the grid for emergency access.

Data centre backups will serve as a virtual power plant capable of balancing energy when the grid is overloaded or underloaded. Furthermore, the sharing of data and knowledge still takes place on a large scale. In the vision, data will no longer be dependent on large companies abroad, and local villages will be included in decision-making regarding energy.

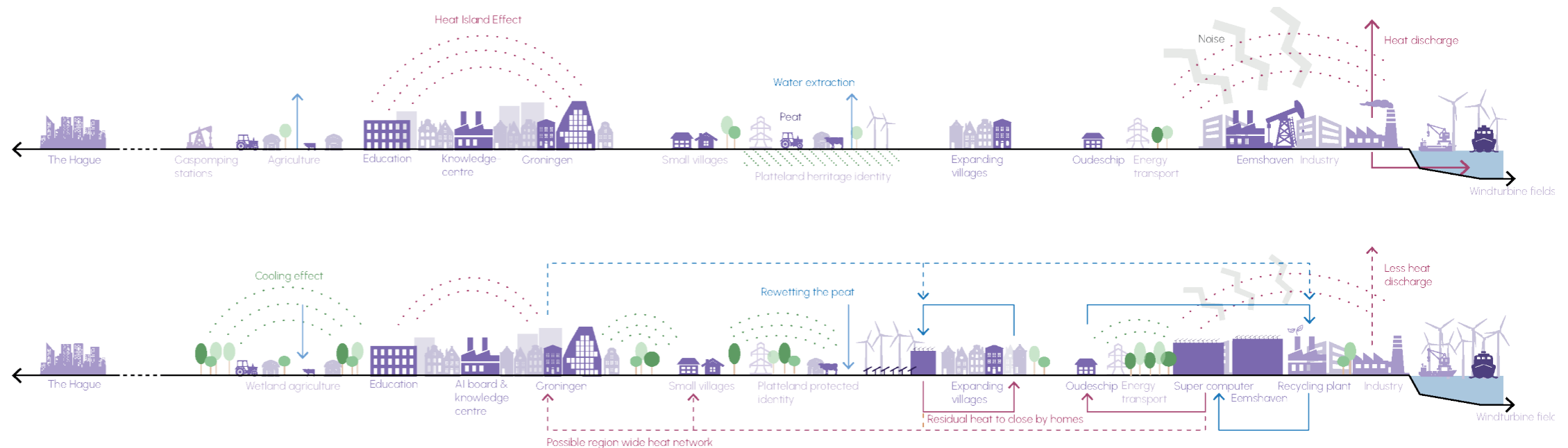


F63. Energy and data

Heat, water and nature

The current landscape of Groningen consists primarily of agricultural land. Farmers extract water from this land to maintain the groundwater at the correct level. This has a detrimental effect on biodiversity and causes the peat-based areas to subside. Industry also emits a large amount of residual heat in the form of air and water, all of which ends up in the natural environment.

Therefore, the vision explores how this residual heat can be used to heat nearby homes. The landscape is also being restored through soil and water management solution. Agriculture will adapt to become a wetland agriculture. This also has many benefits for the peat, where CO2 can be stored again and prevent further subsidence.



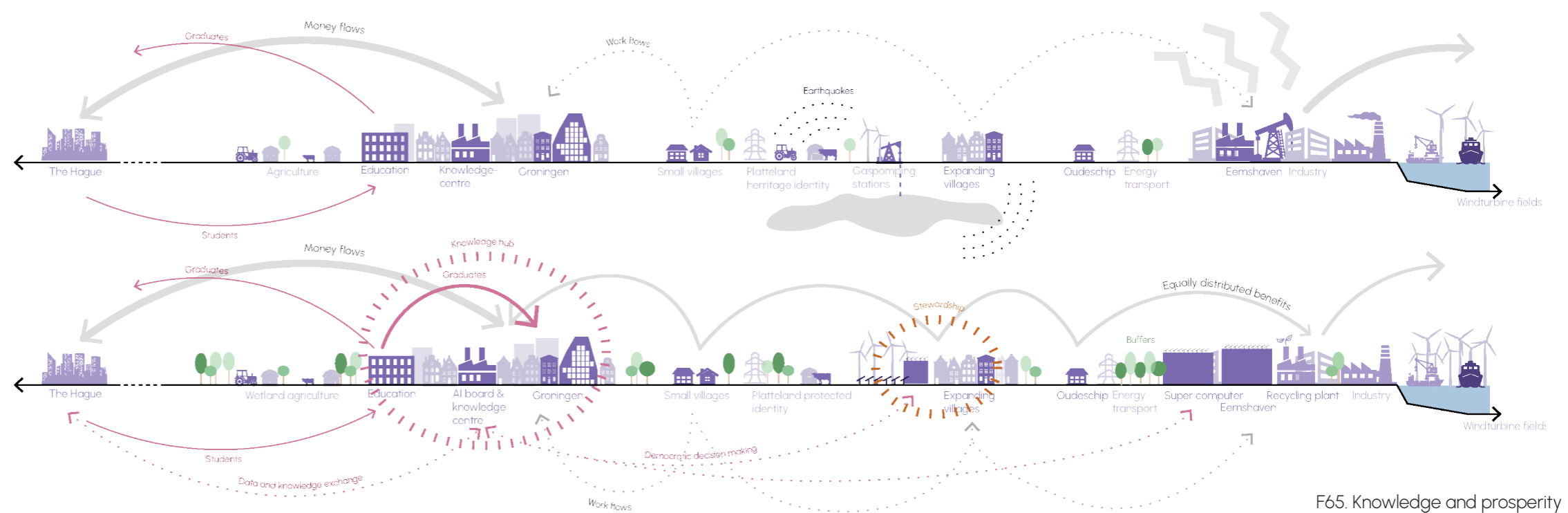
F64. Water, heat and nature

System sections

Knowledge and prosperity

Currently, knowledge is primarily leaving Groningen, this is also known as "brain drain." Many students come to Groningen to study, but after completing their studies, they seek employment elsewhere. At present a lot of the workforce within Groningen currently also commutes from surrounding villages within Groningen.

The vision aims to change this. By developing Groningen into a new knowledge hub, companies will be encouraged to establish themselves in the region, and graduates will be more inclined to stay. Furthermore, developing AI as a public good ensures that local residents are more involved. This gives them a sense of involvement, engagement and belonging. Additionally, the growing villages will become regional centres where more employment opportunities will emerge.



F65. Knowledge and prosperity

Recycling and circulation

Currently most of the rare minerals and e-waste produced in the Netherlands is exported. With the arrival of an AI factory and multiple data centres, the inflow of minerals into the region will increase significantly. Therefore, careful consideration must be given to how this can be managed. In order to create a circular system, encouraging recycling and reuse.

Establishing strong partnerships with companies such as ASML and other mineral recycling facilities will be crucial. A dedicated recycling hub will also be established in Eemshaven. Recycled materials can then be reused by smaller, emerging businesses in the region, contributing to a more circular and sustainable local economy.



F66. Recycling and circulation

Energy community

In the villages of Uithuizen, Winsum, and Bedum—where the decentralised AI data centres will be located—energy communities and a local heat distribution network will be established.

Energy communities enable local residents to collectively invest in and manage energy production and consumption. They are becoming increasingly prominent as a model for energy governance, offering greater local agency and resilience (Winner, 2017b). In this case, the model assumes the installation of rooftop solar panels and small-scale wind turbines in the surrounding landscape.

Recent research highlights significant potential for synergies between data centres and local energy communities (Paredes et al., 2024). One study identifies a 38% reduction in operating costs for the community, alongside an 87% decrease in heat demand. These synergies create opportunities for community participation and empowerment, contributing to the demystification of AI and supporting its development as a public good.

Residents within the energy communities, together with stakeholders from the excellence centre in Groningen, would collaboratively contribute to the design of algorithms for energy optimisation, this is the energy optimisation assesment. Through this process, they would negotiate local energy needs alongside those of the data centres, ensuring that computational demands do not disproportionately dominate local energy consumption. In addition, communities would be connected to a residual heat network, utilising waste heat generated by the data centres through HVAC systems. This heat could also be used to supply public amenities, such as swimming pools. As heat transmission is spatially limited, this reinforces the importance of localising data centre infrastructure.

The placement of data centres in urban environments means that we must question the big box typology, and instead think about how their architecture invites public participation. This design should also play into the heritage of the

towns, and reflect the changing identity of the area. One potential idea would be to look at the churches, creating active community spaces, and alters to ai. There is a reference project where this has been done in Barcelona: the MareNostrum 4 in the Torre Girona Chapel.

The fragmentation of these data centres also allows for more agile development, more innovation, and less raw material waste. This is a result of hetrogenous systems and racks as opposed to large scale homogenous systems that are common in hyperscaled ai supercomputers that need to be replaced frequently and simultaneously (Filiposka & Juiz, 2015). The smaller scale more temporal approach is therefor part of our circular design approach.

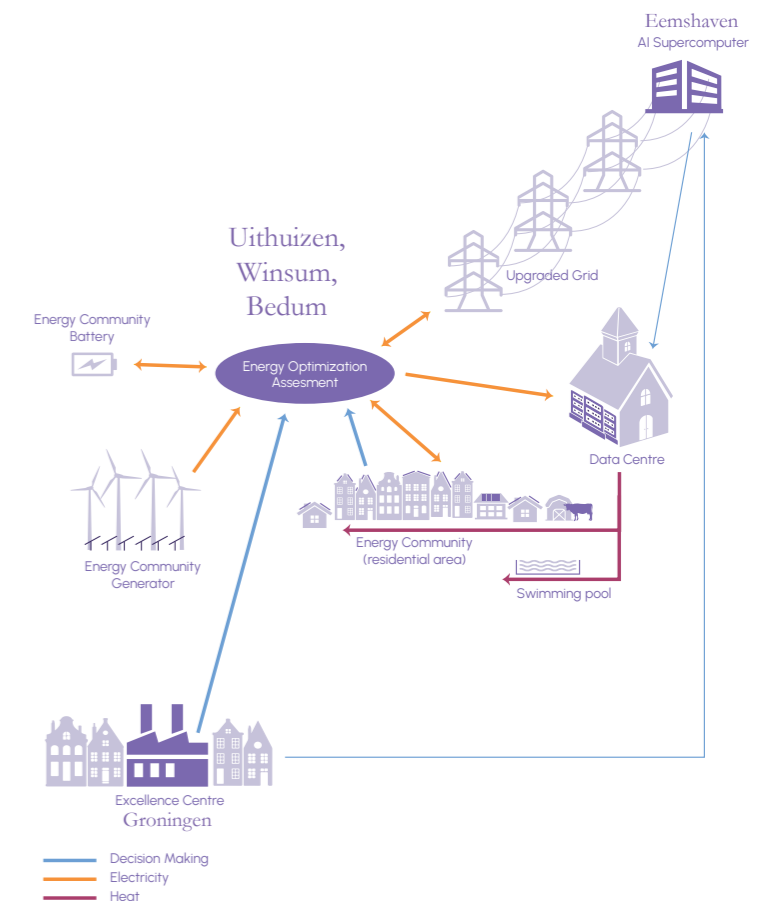
The prioritisation of computational tasks and associated employment opportunities would be coordinated through the excellence centre in Groningen. These decisions would be made by an AI governance board in collaboration with researchers, domain experts, small businesses, and local government actors.

By temporarily pausing and rescheduling certain computational processes, the system introduces flexibility into AI operations. This temporal approach allows computing activity to respond to fluctuations in renewable energy availability, community needs, and broader planetary constraints. In doing so, it challenges assumptions of continuous, 24/7 operation and introduces limits to growth through forms of technological containment (Verzier, 2026a).

This decentralised model of data centre development fosters a sense of stewardship. By embedding infrastructure within local contexts, it demystifies AI technologies, redistributes both benefits and burdens more equitably, and supports the creation of new, locally embedded forms of employment.



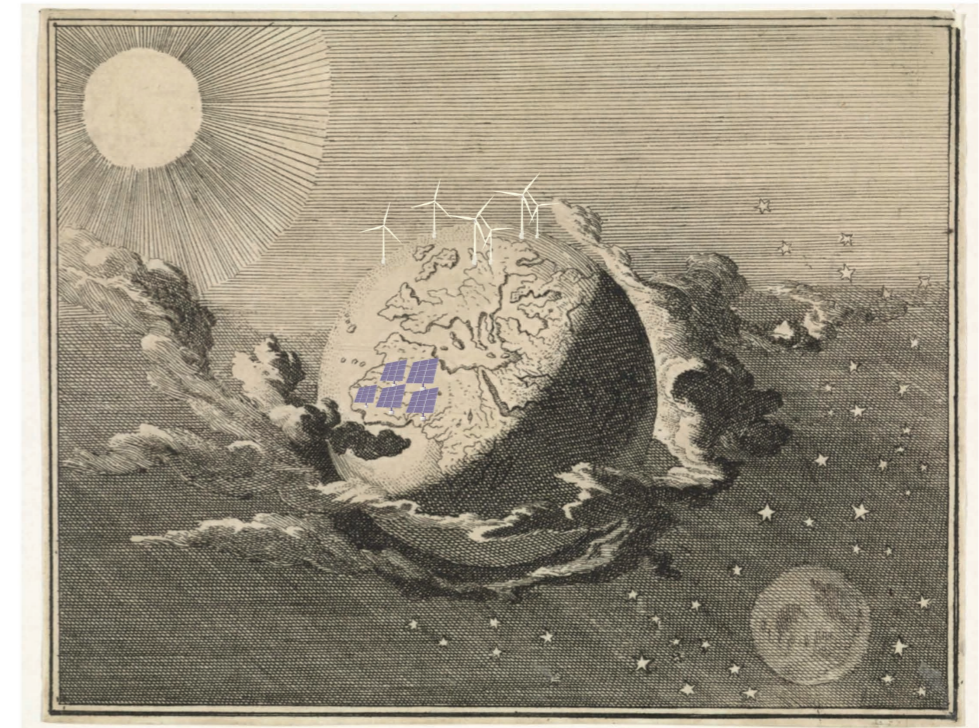
F67. Energy community



F68. Energy community

05 Strategy

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F69. Energy community

Delebarative arena

Here we can zoom in on a few of the key stakeholders highlighted in the governance structure and analyse their perspectives on the vision proposed by our communities. This is done for the relevant EU funding body, the local municipality, the waterboards, and a representative of nature. We can then look at the synergies and conflicts in each of their goals for ai development in Groningen. For a deeper analysis of these stakeholders perspectives, please see the full position papers in the appendix

EuroHPC JU – appendix 2

The EuroHPC Joint Undertaking (EuroHPC JU) is mandated to fund, procure, and operate a federated network of supercomputing and AI infrastructure across Europe. Since its establishment in 2018, it has deployed projects, supporting applications ranging from climate modelling and drug discovery to advanced manufacturing and energy system optimization (Office of the European Union L-, 2026). In parallel, EuroHPC JU manages and coordinates public-private investment instruments designed to mobilize the substantial capital required for next-generation AI infrastructure

- Advance European AI infrastructure and digital sovereignty, grow innovation and technical industry to compete on the global scale.
- Scale capacity through modular, competitive, and future-proof systems
- Integrate renewable energy, reuse heat, and optimise system efficiency
- Strengthen material resilience via recycling and reduced external dependencies
- Align compute growth with energy availability and supply chains
- Leverage co-location and job creation to build a competitive EU AI ecosystem

Municipality Het Hogeland – appendix 3

Het Hogeland is a rural municipality in the North of Groningen. As a local government, the residents interests are represented through municipal elections. The most recent elections saw nearly 60% turnout, with GroenLinks/PvdA (7 seats), Gemeentebelangen Het Hogeland (6 seats) and CDA (4 seats) as largest parties (Stemmen Tellen En Uitslag - Gemeente Het Hogeland, 2026; NU, 2026). The main priorities of the municipality focus on coordinating regional development strategies to address sustainable land use and the transition towards renewable energy systems, while maintaining the cultural and spatial identity of its rural communities. It is worried that Eemshaven will become a sacrificial zone - where national transitions are spatially concentrated at the expense of local livability and landscape quality.

- Balance local benefits vs. risk of Eemshaven becoming a "sacrificial zone"
- Focus growth in Winsum, Uithuizen, Bedum with clustered development
- Reject new data centres in Eemshaven; restrict to existing industrial zones
- Protect open landscape and cultural-historic values
- Ensure energy infrastructure is independent/upgraded; avoid grid competition
- Require local benefits and stronger resident participation

	 Waterboard	 Nature	 Municipality	 European Union
decentralizing	Decentralization makes the reuse of heat and effluent more efficient and effective. However, decentralization must follow the soil and water systems; essential functions cannot be located in a water safety risk area or a water storage area.	decentralization, divides the environmental impact of data centres over a larger area, which lowers the load on eemshaven. Eemshaven is connected to an important migration route and habitat: de Waddenzee however it also can be less efficient, causing	No decentralization, because is destructs from the open landscape, does not fit into villages, and rather not building outside village borders. only if nessecary	Decentralization in the ways that it can offer a wider more just distribution of burdens and benefits along with district heating potential. Especially if it allows for larger datacentres.
circularity; energytransition	Circularity is a major theme within the water board(s). Noorderzijlvest strives to become a climate-neutral and circular water board. The water board focuses on purifying wastewater (effluent), and biogas from sludge digestion is used for energy generation.	mitigation: less energy use when circular	More circularity, because growing needs and there is no space (energy production takes up a lot more space) personal windturbines, community/ village energy --> large windturbine	keen for circularity in terms of raw minerals - aiming for material independence and sovereignty, want to be a leader in the energy transition, but also not opposed to nuclear - and in a pinch gas.
participation	Participation is not the goal alone, but it is necessary for complex water challenges. We strive to apply participation early in the exploration phase to realize all interests and opportunities. Furthermore, we aim to promote water awareness among citizens to encourage active water behavior.	participation makes sure all citizens have (the feeling of) influence on their living environment. This can help sustainable and ecological development, by having people that care for their landscape involved, it also guarantees a wider support	Way more participation. The government has let down the residents many times. Therefore there is no more trust and for a functioning society this is really important: residual heat, no noise pollution, integrated energy system	general belief in participation - but also for progress and growth - too zoomed out to not be top down at some point
water in subsided landscape	development should not take place in floodrisk areas or on unsuitable soil. Artificially draining the land & keeping out the water has its limits. So allowing more water into the landscape offers great opportunities, under the condition that it is done in collaboration with its current users	further peat oxidation and unnatural drainage practives will destruct the soil and water quality further, changing the land function is sometimes necessary	It is important to regulate the flooding, but it doesnt need to get in the way of the agriculture (or there should be a solution for the farmers)	not especially within their scope - but have aims for justice and social AI infrastructure without harm
accountability	Attaches great value to transparency and demands this regarding freshwater demand for industry. Furthermore, the water board has an official duty of care and must therefore strictly account to the national government and the province.	nature will continue to be the last voice to be heard if there are no accountability structures in place.	province --> energy grid needs to be upgraded or seperated noise pollution no landscape pollution	

F70. Stakeholder opinions

Water boards – appendix 4

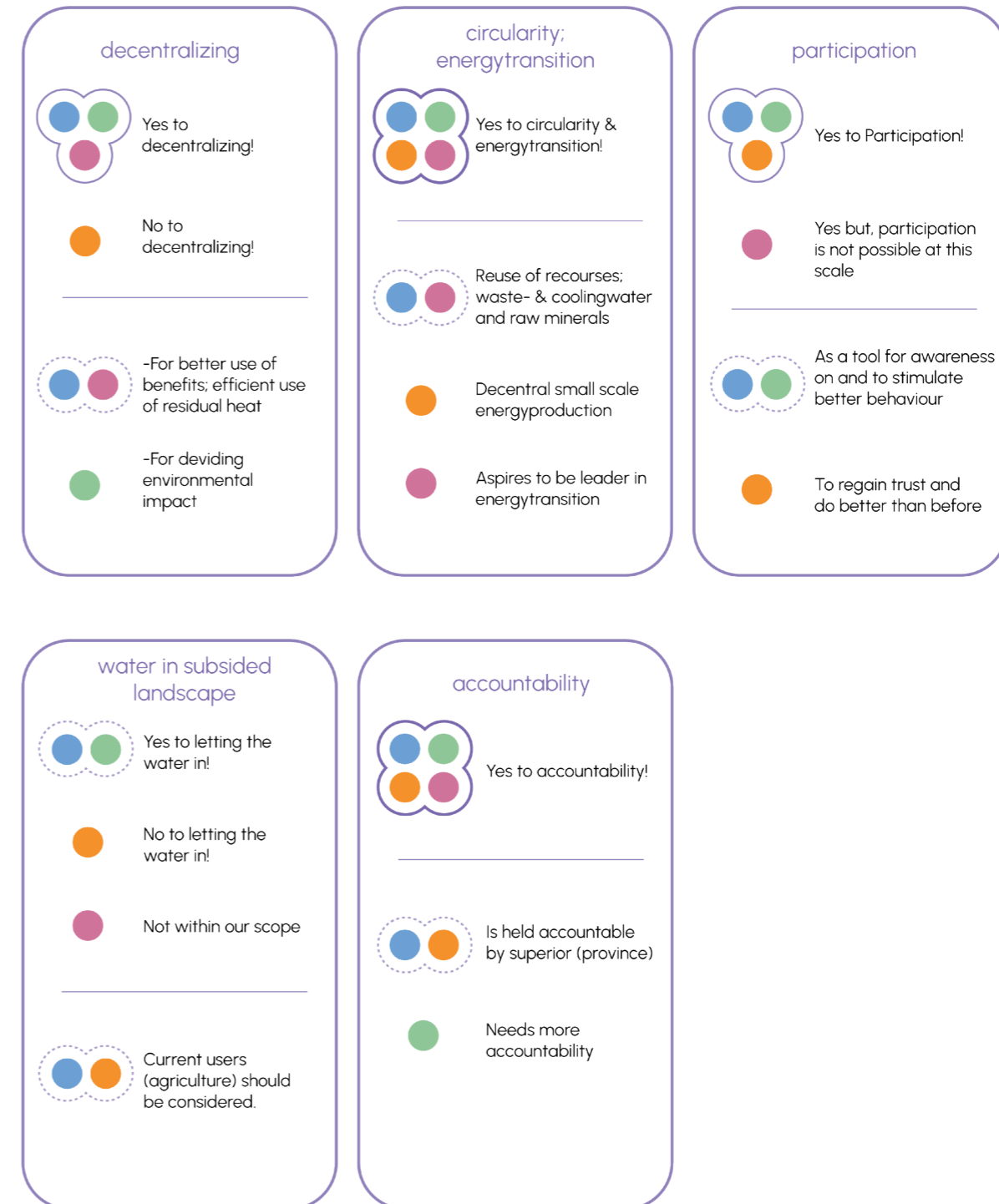
Waterboard Noorderzijlvest is one of the 21 waterboards in the Netherlands. In the north of Groningen, part of Drenthe and a part of Fryslân we are responsible for ensuring safe, sufficient and clean water. Our focus lies on remaining climate-proof and developing a more natural and sustainable water management. Major challenges we are dealing with are preventing drought and salinization, stimulating biodiversity and the circular reuse of energy and raw materials from wastewater. These are issues we face together with the region and we therefore explicitly seek collaboration with the region and partners (Waterschap Noorderzijlvest, 2021).

- Enforce strict sustainability: renewable-only energy and full lifecycle circularity
- Protect and restore biodiversity, especially in sensitive coastal ecosystems
- Strengthen inclusive governance and shared environmental stewardship
- Maintain water safety as absolute priority; protect flood defences
- Apply "soil and water guiding" principle to all spatial development
- Require transparency and limits on data centre water demand
- Support circular systems, including residual heat and water-energy integration
- Prioritise water for safety and nature over industrial use; favour moderated growth

Natuur en Milieu Federatie Groningen – Nature – appendix 5

The Natuur en Milieu Federatie Groningen (NMG) is a federation of approximately 50 organizations working on nature and sustainability. While partly funded by the province, it operates as an independent advocate for ecological systems and sustainable development. (Verantwoording NMG, 2025)

- Prioritise ecological systems as the foundation of all spatial development
- Shift from growth-driven models to planetary limits and resource reduction
- Commit to nature-inclusive energy, agriculture, and climate adaptation



F71. Stakeholder analysis

Governance arena

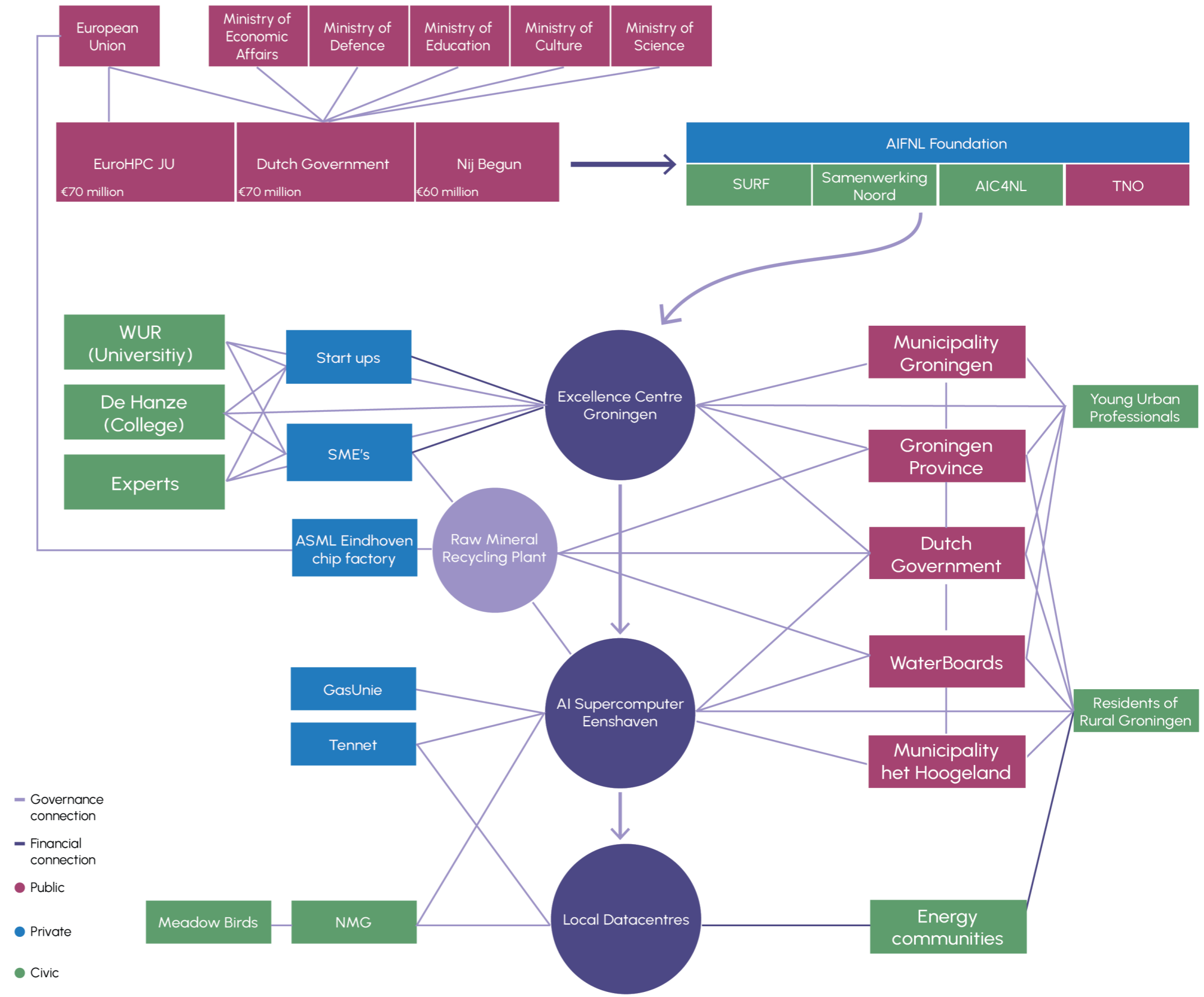
This diagram maps the organisational structure underpinning the governance of AI technology, resource flows, and their spatial distribution. It illustrates how decision-making is distributed across institutional, regional, and community scales, and how these layers interact.

The project operates with a total budget of €200 million. This funding is jointly provided by the EuroHPC Joint Undertaking and the Dutch government (€70 million each), alongside a €60 million contribution from Nij Begun, a regional organisation established to support recovery and redevelopment following the Groningen earthquakes.

The implementation of the AI supercomputer is coordinated through a multi-actor consortium. The AIFNL Foundation serves as the lead partner and hosting entity, working in collaboration with SURF, Samenwerking Noord, TNO, and AIC4NL. Together, these organisations combine expertise in digital infrastructure, research, regional development, and innovation policy. This institutional arrangement positions the project within a broader national and European innovation ecosystem, while maintaining a strong regional focus.

The consortium is based in an "Excellence centre" located in urban Groningen. This centre functions as both a governance hub and a site of knowledge production. It provides access to AI infrastructure, supports start-ups and SMEs, and facilitates collaboration between research institutions (such as Wageningen University & Research and Hanze University of Applied Sciences) and domain-specific experts. This structure is critical in steering the development of AI towards specialised, application-oriented systems, rather than artificial general intelligence, thereby aligning technological development with societal needs.

Public engagement is embedded within this framework in two key ways. First, the excellence centre acts as an interface between technology and society, supporting education, upskilling, and transparency. This creates a direct relationship between urban communities and the development of AI systems. Second, democratic accountability



F72. Governance diagram

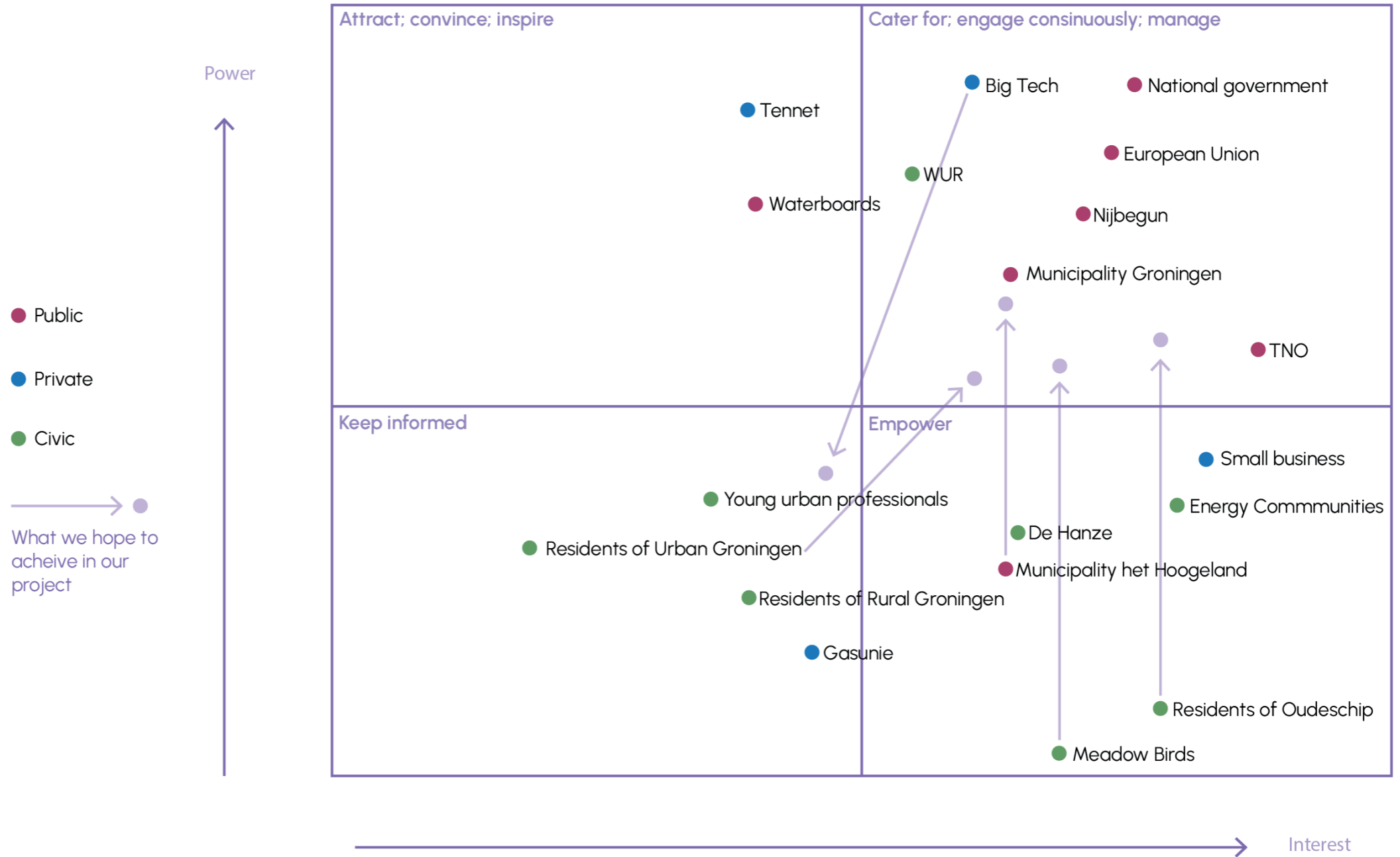
Governance arena

is ensured through existing governance structures: citizens participate indirectly in decision-making through municipal, provincial, water board, and national elections, all of which influence policies related to technology, energy, and spatial planning.

At the scale of infrastructure, there is a need for resource management for the AI supercomputer located in Eemshaven. While the excellence centre guides the direction of technological development, the Eemshaven site is more directly connected to the allocation and distribution of energy and water. Here, utility providers and water boards hold significant operational influence. At the same time, the framework recognises ecological systems as stakeholders, incorporating principles aligned with the rights of nature into decision-making processes.

At the local scale, the model extends through a network of decentralised data centres distributed across surrounding villages. These are embedded within energy communities, where residents are directly connected to infrastructure systems such as district heating and local energy grids. In this configuration, communities play an active role in managing electricity and water resources, negotiating their distribution between domestic and industrial uses. While computational priorities, such as the allocation of processing power, remain coordinated through the excellence centre, resource governance becomes increasingly localised.

Overall, this governance structure seeks to redistribute agency across scales, enabling civic participation in both the direction of AI development and the management of its material impacts. By integrating institutional oversight with community-level control, and by recognising ecological systems as stakeholders, the model aims to establish a form of governance that is both accountable and grounded in long-term socio-ecological stewardship.



F73. Stakeholder power-interest diagram

Rules of the game

It was difficult to visualise the strategy and represent the voices within our community. Some voices cannot be heard while others lack a full understanding of what AI development means for their region. Rather than imposing a top-down plan, the aim is to create a process in which stakeholders build a shared understanding of what matters and collectively shape the strategy themselves.

What is the goal of the game?

The aim of the game is to foster stewardship among stakeholders in the Groningen region in response to the rapid development of AI data centres. To achieve stewardship, stakeholders need to be informed about the spatial impacts of AI development. The game brings stakeholders together to collaboratively "solve" an inherently complex and unsolvable spatial challenge. It serves as a learning tool, helping participants better understand both the technology and the perspectives involved. Participants will learn the constraints of space and values, and look beyond their own lens to come to an agreement.

Who is playing?

Everyone can participate in this game in order to understand the complexity of this spatial challenge. We aim for it to be used as a participation tool that can be used with directly affected communities, parties whom advocate for nature in Groningen, waterboards of the region, municipalities and governments.

How to play?

The game is built around two core values that support stewardship: accountability and circularity. Action cards operate within these values.

Accountability

Accountability focuses on the spatial and policy structures that hold citizens, institutions, and governments responsible. This is particularly important in Groningen, given its extractive past, where both communities and ecosystems have often borne the consequences.

This value is divided into three categories:

- Community
- Gaia (nature and non-human life)
- Regulated AI

Each category requires actions that either strengthen its position or compensate for negative impacts caused elsewhere. The goal is to maintain balance between these categories, ensuring none is disproportionately burdened.

Circularity

While closely linked to accountability, circularity is treated as a separate value due to its complexity. It focuses on the interdependence of resource flows, particularly:

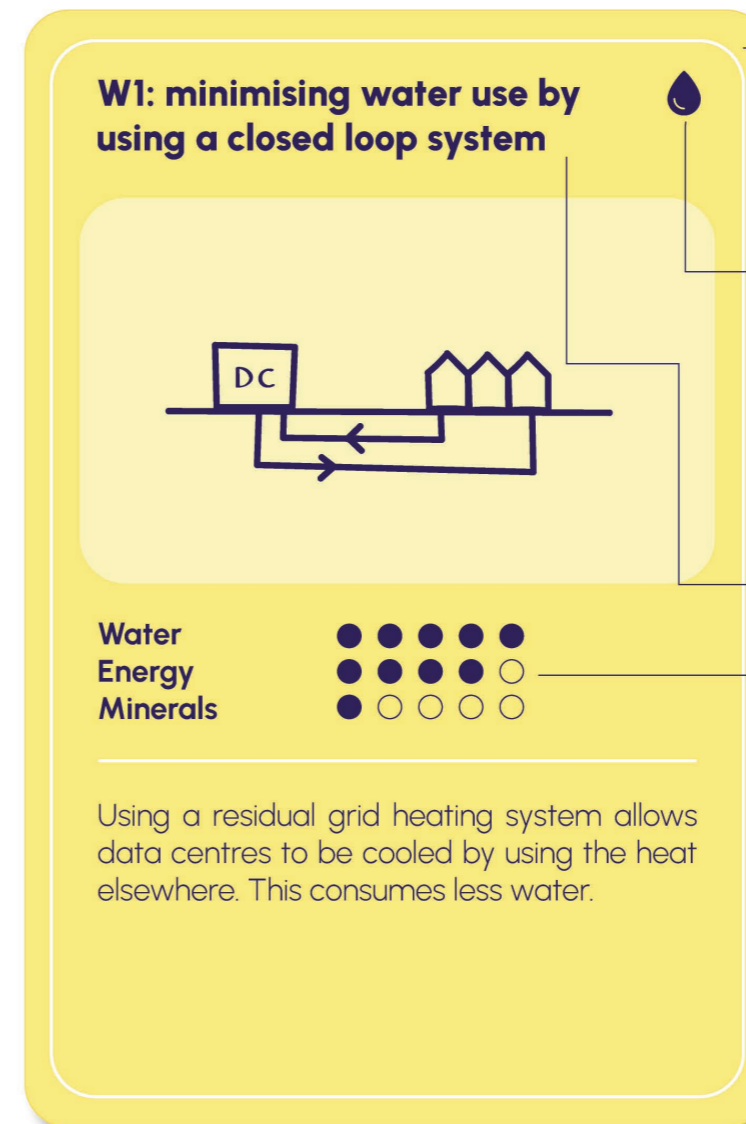
- Energy
- Water
- Minerals

The AI industry creates tensions between these systems. Some technologies are energy-efficient but water-intensive, while others reduce emissions but increase pressure on mineral extraction. Players must navigate these trade-offs and seek solutions that minimise waste and reuse resources.

Winning the game

The objective is to achieve a balanced system in which all categories score equally high. Participants must avoid shifting problems from one category to another or externalising impacts beyond the region. True stewardship is achieved when responsibility is shared.

Explanation cards



F74. Card explanation

Colour

Purple = action card within accountability

Yellow = action card within circularity

Code/Icon

Describes what category this card is part of, categories can be: Community (C), Gaia (G), Regulated AI (A), Water (W), Energy (E) and Minerals (M)

Action

Describes a spatial or policy-oriented action that benefits its given category.

Rating

Describes how much the given action benefits each category within the value of accountability or circularity. This rating is based upon the Sustainable Development Goals in the chapter Value, Ethics and Societal Relevance.

Catergories

Accountability

Accountability is the act of equally distributing burdens and benefits when applying changes to an area. The goal of the accountability cards is to ensure that these burdens and benefits are shared fairly.

Community

Community cards focus on generating economic and social benefits for the wider region, not just the city. This can be achieved by improving public transport between villages (C4), or by introducing adjacent industries that create jobs for existing communities (C5). Another important card is C1, which addresses accountability for communities currently living in flood-prone, subsiding areas.

Gaia

Gaia action cards are concerned with creating or protecting non-human habitats. This can involve physical space, air, or protecting habitat conditions such as silence and darkness.

Regulated AI

Regulated AI action cards focus on placing limits on AI development to prevent unfettered growth. This can be done by introducing an AI board (A1) to support continuous, informed, and democratic decision-making. Decentralisation (A3) can further limit growth by enabling gradual, step-by-step expansion rather than large, sudden developments.

The accountability deck consists of 21 cards, organized into three rows and seven columns. Each card features a title, an icon, a progress indicator for three categories (Community, Gaia, Regulated AI), and a short description of the action.

- Row 1 (Community):**
 - C1: expand towns to accommodate subsiding areas** (Icon: houses with arrows pointing out)
 - C2: expand towns to accommodate new workers** (Icon: factory and houses)
 - C3: combine data centres with public functions** (Icon: church with 'DC' label)
 - C4: increasing mobility and facilities** (Icon: bus and train)
 - C5: creating entry-level jobs through new circular industry** (Icon: graduation cap and hands)
 - C6: connecting schools and excellence centre** (Icon: school and lightbulb)
 - C7: energy communities involved in energy distribution** (Icon: power plug and lightning bolt)
- Row 2 (Gaia):**
 - G1: transition of platteland to wetlands** (Icon: fields with water)
 - G2: transition of platteland to nature inclusive agriculture** (Icon: fields with trees)
 - G3: transition of platteland to biodiverse energy landscapes** (Icon: solar panels and trees)
 - G4: making the shore free of wind turbines** (Icon: wind turbine and bird)
 - G5: introduce extra noise restrictions** (Icon: sound waves and house)
 - G5: introduce extra light restrictions** (Icon: lightbulb and house)
- Row 3 (Regulated AI):**
 - A1: introducing an AI board** (Icon: AI brain with people)
 - A2: scheduling job prioritisation. AI does not run 24/7** (Icon: clock)
 - A3: decentralising data centers** (Icon: network diagram)
 - A4: AI infrastructure is a mandated public good** (Icon: crossed-out dollar sign)
 - A5: regulations on development of private data centres** (Icon: scales of justice)
 - A6: data centres not take more than 7% of energy production** (Icon: 25% box and DC box)

F75. Accountatbility deck

Catergories

Circularity

Circularity is the act of closing resource loops. However, closing one loop can place pressure on another resource. The circularity cards aim to distribute these pressures fairly.

Water

Water cards focus on reducing the amount of freshwater required to cool data centres, while also addressing water quality and safety. For example, card W5 is about stopping the extraction of water of the peat landscapes.

Energy

Energy cards are concerned with generating sufficient energy for both data centres and communities. This category also includes more controversial options, such as building a nuclear power plant (E4) or reopening gas fields (E5). These options are currently not preferred by communities, Gaia, municipalities, or the national government. However, these positions may shift in emergency scenarios. The purpose of including these cards is not necessarily to implement them, but to facilitate discussion in which all perspectives are heard.

Minerals

Mineral cards focus on developing (parts of) a circular industry in Groningen, taking responsibility for the resources required and the turnover of data centre infrastructure.

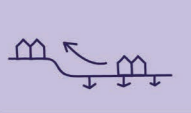
The image displays a grid of 25 circularity cards, organized into three rows. Each card is yellow with a white border and contains an icon, a title, a resource impact indicator (Water, Energy, Minerals), and a brief description.

- Water Cards (W1-W5):**
 - W1:** Minimising water use by using a closed loop system. Impact: Water (5/5), Energy (4/5), Minerals (4/5).
 - W2:** Direct-to-chip cooling minimise waste water & energy. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - W3:** Develop water treatment plant for industrial waste water. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - W4:** Data centre sites capture rainwater. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - W5:** Flooding of subsiding peat landscapes. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
- Energy Cards (E1-E8):**
 - E1:** Data centers use offshore energy. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - E2:** Data centers use on land wind and solar energy. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - E3:** Data centers use hydrogen fuel cells. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - E4:** Data centers use nuclear energy. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - E5:** Gas fields open back up to power data centers. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - E6:** Data centers are attached to residual heating grid. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - E7:** Developing of energy communities. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - E8:** Data center batteries stabilise the grid. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
- Minerals Cards (M1-M5):**
 - M1:** Development of rare mineral recycling plant. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - M2:** Storing and sorting of e-waste. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - M3:** 90% of e-waste is to be recycled. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - M4:** 50% input materials is recycled. Impact: Water (4/5), Energy (4/5), Minerals (4/5).
 - M5:** Connect Eemshaven to other mineral consumers. Impact: Water (4/5), Energy (4/5), Minerals (4/5).

F76. Circulation deck

The whole deck


C1: expand towns to accommodate subsiding area's



Community ●●●●●
Gaia ●●●●●
Regulated AI ○○○○○

The area's in the East of Groningen are subsiding due to the gas extraction and the process of peat oxidation. The towns Winsum, IJdem, and Uithuizen can grow in size and population. The facilities moving away from subsiding areas.


C2: expand towns to accommodate new workers



Community ●●●●●
Gaia ●●●●●
Regulated AI ●●○○○

A new circular industry in the Groningen region could stimulate financial investment, particularly in the housing sector. The towns Winsum, IJdem, and Uithuizen would have the opportunity to expand in size and population, strengthening the network of communities.


C3: combine data centres with public functions



Community ●●●●●
Gaia ●●○○○
Regulated AI ●●●○○

Data centers produce consistent heat which can be used to heat public buildings (eg. swimming pool). Additionally, making data centers part of the urban fabric invites more interaction and understanding of the technology, which can benefit local support.


C4: increasing mobility and facilities



Community ●●●●●
Gaia ●●●●●
Regulated AI ○○○○○

Increasing activity between Groningen and Eemshaven allows for the mobility network to be improved - with more frequent trains or an extension of the tram/bus network.


C5: creating entry-level jobs through new circular industry



Community ●●●●●
Gaia ●●○○○
Regulated AI ●○○○○

The AI innovation will have significant impact on the work force worldwide, but also in Groningen. The circular industry of E-waste can create both entry-level jobs as well as specialised technological positions.


C6: connecting schools and excellence centre



Community ●●●●●
Gaia ●○○○○
Regulated AI ●●●○○

Schools and universities can act as a bridge between local communities and the AI knowledge centre, fostering familiarity with the technologies while also helping to counter brain drain by creating local opportunities for education and employment.


C7: energy communities involved in energy distribution



Community ●●●●●
Gaia ●●●●●
Regulated AI ●●○○○

Energy communities have a voice on how the energy of their region is distributed. Communities feel stewardship over their own energy production and consumption. This resilience is especially relevant in times of energy crisis.


G1: transition of platteland to wetlands



Community ○○○○○
Gaia ●●○○○
Regulated AI ○○○○○

Areas in eastern Groningen are largely used for agriculture, requiring continuous drainage to keep the land dry. This leads to peat oxidation and subsidence, reinforcing the need for further drainage. Transitioning these areas into wetlands can help break this cycle and restore balance.


G2: transition of platteland to nature inclusive agriculture



Community ●●●●●
Gaia ●●●●●
Regulated AI ○○○○○

Groningen's agriculture is dominated by large farms with livestock emissions that offer little diversity in the landscape, yet it still offers ecological value. Nature-inclusive farming creates more space for ecology and aims to improve soil and water quality.


G3: transition of platteland to biodiverse energy landscapes



Community ○○○○○
Gaia ●●○○○
Regulated AI ●●●○○

Groningen already has large energy landscapes such as large windfarms or solar park. These have the potential to become more nature inclusive.

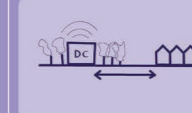
G4: making the shore free of wind turbines



Community ●●●●●
Gaia ●●●●●
Regulated AI ○○○○○

Keeping the shore free of wind turbines is important because the coast of the Waddenzee serves as a vital habitat and a key route for bird migration.


G5: introduce extra noise restrictions



Community ●●●●●
Gaia ●●●●●
Regulated AI ○○○○○

Introduce stricter noise regulations by creating visual and spatial buffer zones around data centres, industrial sites, and energy infrastructure.


G5: introduce extra light restrictions



Community ○○○○○
Gaia ●●○○○
Regulated AI ●●●○○

New industry, data infrastructure, and housing development increase the need for lighting, but this must be restricted to protect surrounding ecosystems.


A1: introducing an AI board



Community ●●●○○
Gaia ●○○○○
Regulated AI ●●●○○

Implementing a governance structure to manage this development of the technology. This is based in the Excellence Centre, and includes research institutions, experts, democratically elected government and local businesses.


A2: scheduling job prioritisation. AI does not run 24/7



Community ●●●○○
Gaia ●○○○○
Regulated AI ●●●○○

AI compute is limited by weather systems and renewable energy generation. AI board defines the prioritisation of jobs requiring computing power. Energy communities in the towns negotiate a schedule for power distribution.

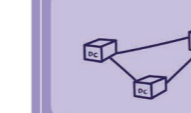
A3: decentralising data centers



Community ●●○○○
Gaia ●○○○○
Regulated AI ●●○○○

Data centres are placed in the towns, this allows for greater transparency and public engagement along with distribution of waste heat and electricity management.


A4: AI infrastructure is a mandated public good



Community ●●○○○
Gaia ●○○○○
Regulated AI ●●●○○

Legislation is put in place that divorces the development of technology away from private industry motivated by profit. The technology is used to improve public services/infrastructure.


A5: regulations on development of private data centres



Community ●●●○○
Gaia ●○○○○
Regulated AI ●●●○○

Big tech is heavily regulated in its use of AI in terms of job replacement capacity, use of resources, its approach to data and privacy. Regulations aim to keep it within planetary means with an even distribution of the burdens and benefits. Aiming for specialised compute, rather than general intelligence.

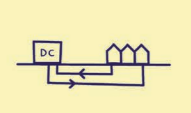
A6: data centres not take more than 7% of energy production



Community ●●●○○
Gaia ●○○○○
Regulated AI ●●●○○

Policy ensures that data centres do not put unbalanced stress on the grid. This approach ensures that the technology grows only with renewable energy production, and does not monopolise resources for the region.


W1: minimising water use by using a closed loop system



Water ●●●●●
Energy ●●●●●
Minerals ●○○○○

Using a residual grid heating system allows data centres to be cooled by using the heat elsewhere. This consumes less water.


W2: direct-to-chip cooling minimise waste water & energy



Water ●●●○○
Energy ●●○○○
Minerals ●○○○○

Direct-to-chip cooling is thus far the most efficient method of cooling.


W3: develop water treatment plant for industrial waste water



Water ●●●○○
Energy ●●○○○
Minerals ●○○○○

Treating the water before it is discharged into surface water.


W4: data centre sites capture rainwater



Water ●●○○○
Energy ●○○○○
Minerals ●○○○○

A small amount of water can be captured on the roofs of data centres. This can be used within the process.


W5: flooding of subsiding peat landscapes



Water ●●●●●
Energy ●●●●●
Minerals ●○○○○

Stopping the extraction from peat landscapes, slows the process of subsidence and reduces green house emissions.


E1: data centers use offshore energy



Water ○○○○○
Energy ●●●●●
Minerals ●○○○○

Existing and planned offshore wind energy can power data centres in Eemshaven. Using this energy close to the coast reduces the need to expand high-voltage grid infrastructure inland effectively using energy where it is produced.


E2: data centers use on land wind and solar energy



Water ○○○○○
Energy ●●○○○
Minerals ●●○○○

It is beneficial to have green energy production in direct proximity to data centers. However, this may cause friction with coastal regulations and communities that value the traditional Groningen landscape.


E3: data centers use hydrogen fuel cells



Water ○○○○○
Energy ●●○○○
Minerals ●●○○○

If innovation allows for hydrogen fuel cells to be used, this can allow for consistent green renewable energy.


E4: data centers use nuclear energy



Water ○○○○○
Energy ●○○○○
Minerals ●○○○○

Nuclear energy can allow for a fossil fuel free energy. However nuclear there are societal and safety constraints to building nuclear engines.

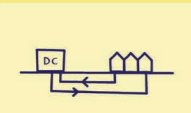
E5: gas fields open back up to power data centers



Water ○○○○○
Energy ●○○○○
Minerals ●○○○○

Though gas fields have been permanently closed. Energy crisis may put this card back on the table.

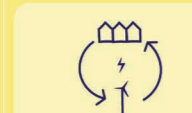
E6: data centers are attached to residual heating grid



Water ●●●●●
Energy ●●●●●
Minerals ●○○○○

Eemshaven is connected to the future. It is efficient to use the grid.


E7: developing of energy communities



Water ○○○○○
Energy ●●○○○
Minerals ○○○○○

Communities feel stewardship over their own energy production and consumption. Energy produced in proximity of the towns, is directly beneficial to the town.


E8: data center batteries stabilise the grid



Water ○○○○○
Energy ●●○○○
Minerals ○○○○○

Data centres can function as virtual powerplants to stabilise the grid when necessary.


M1: development of rare mineral recycling plant



Water ○○○○○
Energy ●●○○○
Minerals ●●○○○

The AI industry generates significant electronic waste containing scarce minerals. These materials are often mined and discarded elsewhere. Moving toward a truly circular system requires taking ownership of the waste and recovering its valuable resources locally.


M2: storing and sorting of E-waste



Water ○○○○○
Energy ●●○○○
Minerals ●●○○○

The circular industry requires space, facilities and workforce to accommodate and process e-waste flows.


M3: 90% of e-waste is to be recycled



Water ○○○○○
Energy ●●○○○
Minerals ●●○○○

Shipping our waste away is moving our impact and responsibility elsewhere.


M4: 50% input materials is recycled



Water ○○○○○
Energy ●●○○○
Minerals ●●○○○

Significantly reducing the amount of impact of mineral mining elsewhere.

M5: connect Eemshaven to other mineral consumers



Water ○○○○○
Energy ●●○○○
Minerals ●●○○○

This circular strategy is part of a larger national scale strategy. The region of Groningen can accommodate waste flows from other parts of the country and work together with the ASML chipfactory in Eindhoven.

Timeline



Action cards

Community

- C1. expand towns to accommodate for residents of subsiding area's
- C2. expand towns to accommodate new industry workers
- C3. combine data centres with public function
- C4. increasing mobility and train frequency
- C5. increasing job opportunities through circular industry
- C6. building connections between schools and the excellence center
- C7. communities involved in energy distribution between data centre and residential areas

Gaia

- G1. transition of platteland to wetlands
- G2. transition of platteland to nature inclusive agriculture
- G3. transition of platteland to nature inclusive energy landscapes
- G4. No windturbines along the shore of the Waddenzee , to accommodate bird migration routes
- G5. Combine agriculture with other functions

Regulated AI

- A1. introducing an AI board
- A2. scheduling job prioritisation, AI does not run 24/7
- A3. decentralising data centers
- A4. ai infrastructure is a mandated public good ai divorced from the market, acts as a public/civic good - no private industry - non profit
- A5. increased regulations on the development of private data centres - land, access to data.
- A6. The ai infrastructure should not take more than 7% of the regional renewabl energy production

Energy

- E1. data centers use offshore wind energy
- E2. data centers use onshore wind energy
- E3. data centers use hydrogen fuel cells
- E4. data centers use nuclear energy
- E5. gas fields open back up to power data centers
- E6. data centers are attached to residual heating grid
- E7. developing of energy communities
- E8. data center batteries stabilise the grid

Water

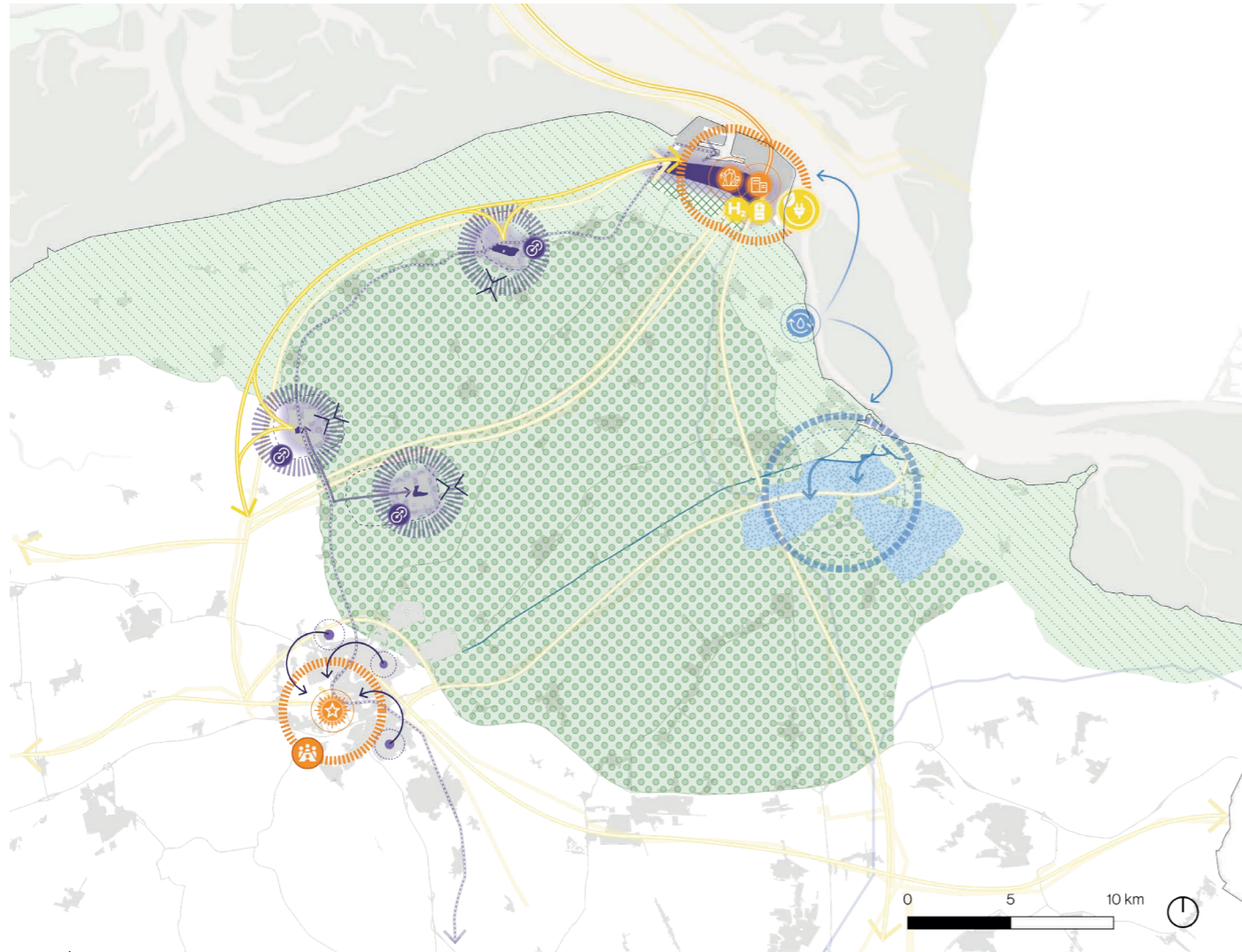
- W1. minimising water use by using a closed loop system
- W2. direct-to chip cooling minimise waste water & energy
- W3. develop water treatment plant for industrial waste water
- W4. data centre sites capture rainwater
- W5. flooding of subsiding peat landscapes
- W6. creating more water storage capacity in the landscape

Minerals

- M1. development of rare mineral recycling plant
- M2. storing and sorting of E-waste
- M3. 90% of e-waste is to be recycled
- M4. 50% input materials is recycled
- M5. connect Eemshaven to other mineral consumers

F78. This timeline looks at the phasing of the strategy, with the 3 milestones in 2030, 2050, and 2100. Each of the action cards are phased in relation to these milestones.

Strategymap



F79. Phase I

Phase I Establishment

This first phase in the strategy lays the foundation for the new AI development in Groningen. Rather than clustering infrastructure in one location, the strategy initiates a decentralized network of smaller data centres along the train connection between Eemshaven and Groningen.

In this phase the main data centre is opened in Eemshaven which is positioned in proximity to vast renewable energy sources and cooling water, relieving pressure off existing systems. To support this data centre, the batteries, hydrogen plant and water cleaning plant are realised. Furthermore, this phase focuses on accommodating the future developments and expansions in the region, the towns are thus transformed and better connected

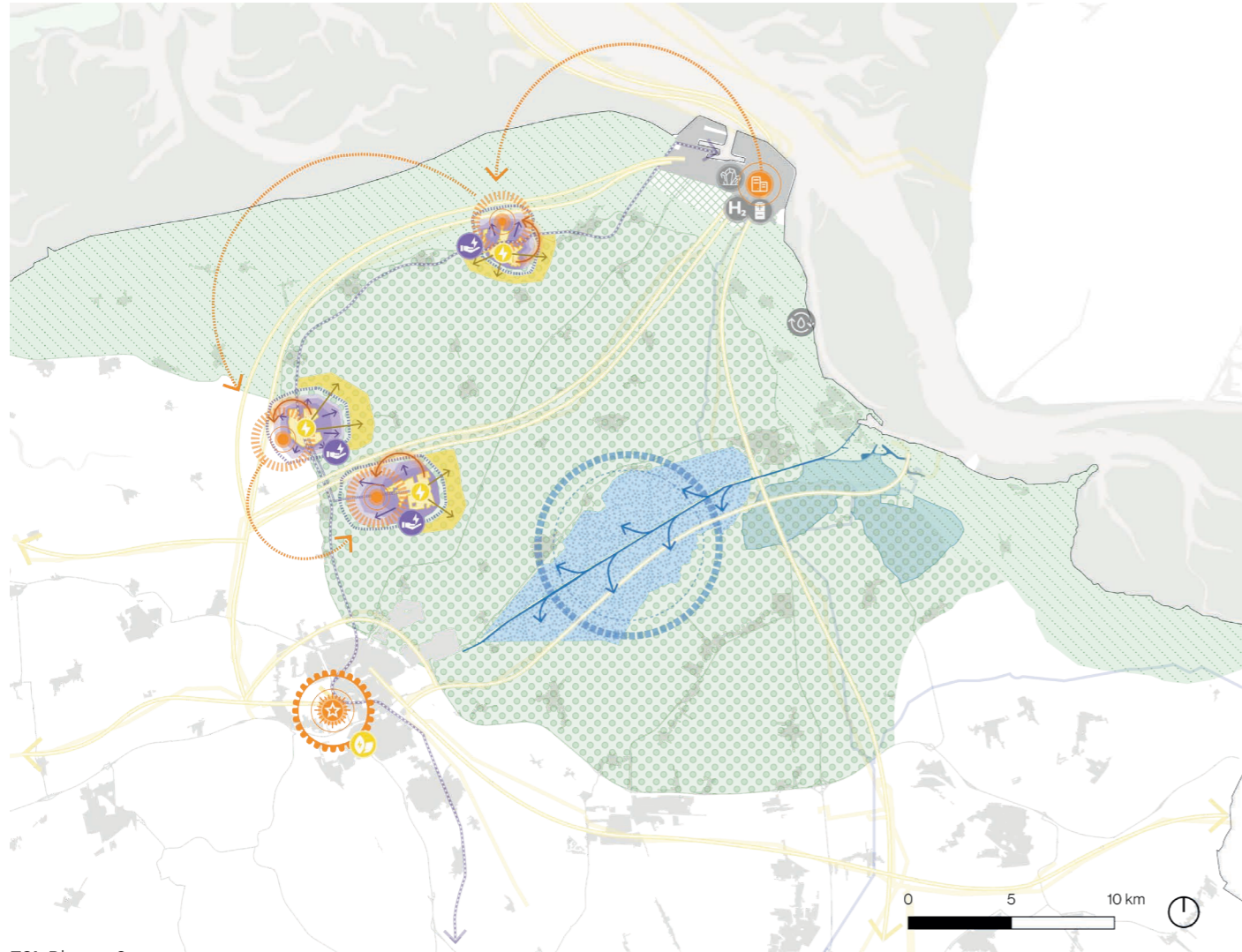
to the energy network, to accommodate the future expansion and developments with the smaller datacentres coming. Simultaneously the excellence centre is opened in the city centre of Groningen, in which fields of interest are included in decision-making process. To ensure local professional stewardship, the AI board is established in the excellence centre, which has decision-making power concerning the Dutch AI.

The first part of the subsided peat landscape is carefully flooded, initiating the transition to wetland landscape. Additionally the central 'platteland' landscape is intensified ecologically. At the same time the landscape along the shore is appointed to become protected cultural landscape, with limited change possible.



F80. Phase I collage

Strategymap



F81. Phase 2

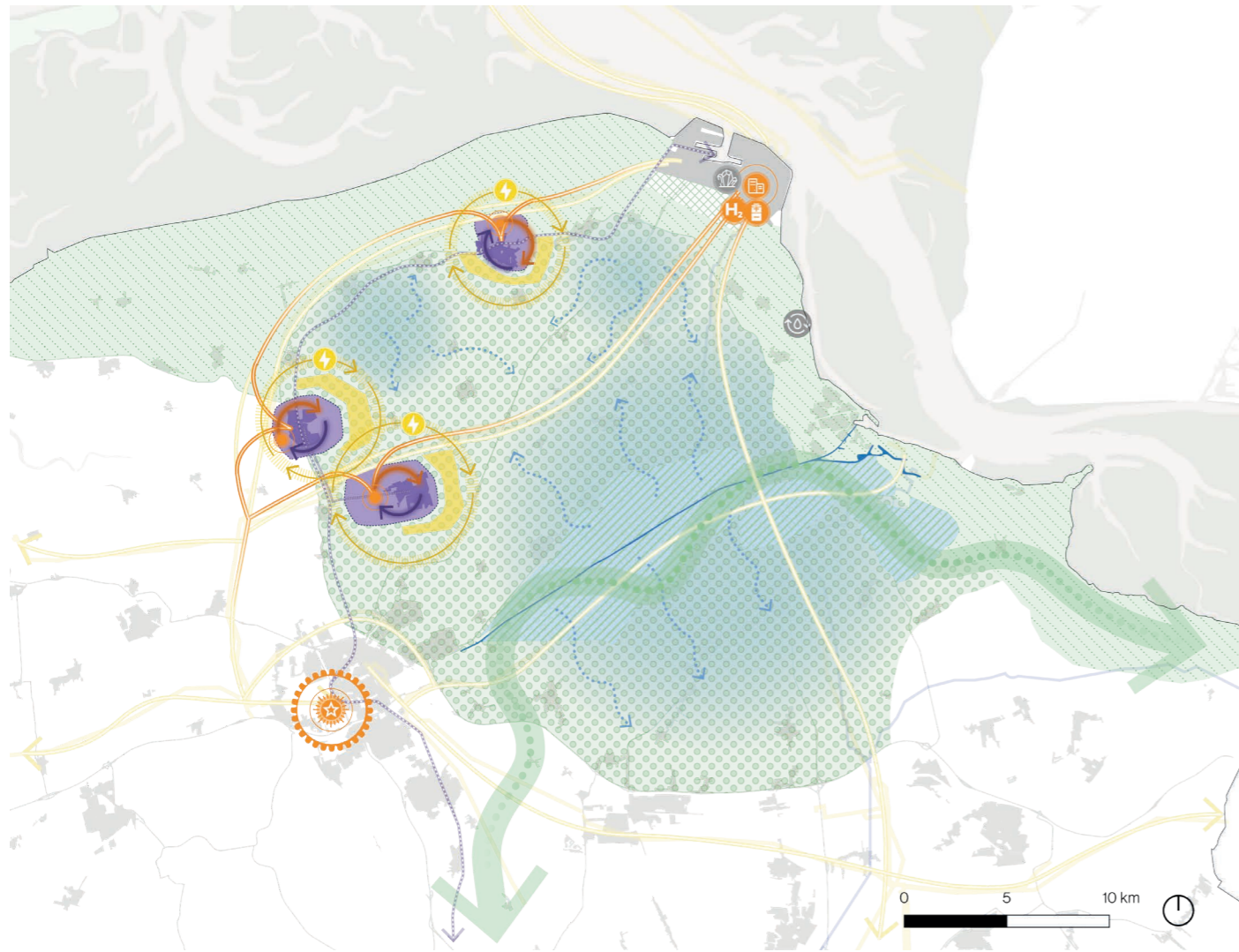
Fase 2 Expansion

In the second phase the additional smaller datacentres are realised in the towns, this is done through participatory processes including the local residents in deciding how and where the datacentre will take shape. On top of that, the towns will establish into energy communities. They will predominantly produce and use their own energy through solar panels and wind turbines either within the town or just adjacent to it. The excellence centre contributes to researching and developing more efficient and sustainable technologies concerning the ai factory and energy infrastructure. In this phase, in case the Dutch AI ecosystem would make revenue, the AI board will make decisions in how to invest back into the local communities.

At the same time very spatial transformations become visible. The agricultural landscape continues its transition into a multifunctional landscape, now combining food production, renewable energy generation and ecological restoration. The second part of the subsided peat landscape is flooded into a water retention zone and wetland network reaching between the city of Groningen and the Ems.



F82. Phase 2 collage



F83. Phase 3

Phase 3: Stewardship

In the final phase the systems have reached maturity, and are now fully intertwined. The decentralized datacentres are operating as a coordinated system, with according energy availability and secure community stewardship. AI infrastructure is no longer driven by constant growth, but regulated through collective decision-making by the AI board and energy-communities. These energy communities are now fully self-sufficient, being able to balance supply and demand, while still remaining connected to the broader grid. The residual heat from the datacentres is fully integrated in regional heating

networks, these heat flows are closely managed based on environmental conditions.

The landscape as fulfilled great transformations large areas of the former agricultural landscape have turned into a network of wetlands forests and form a biodiversity corridor connecting preexisting green spaces, increasing ecological resilience and creating a buffer for future water management. It is possible for additional parts of the landscape to be flooded.

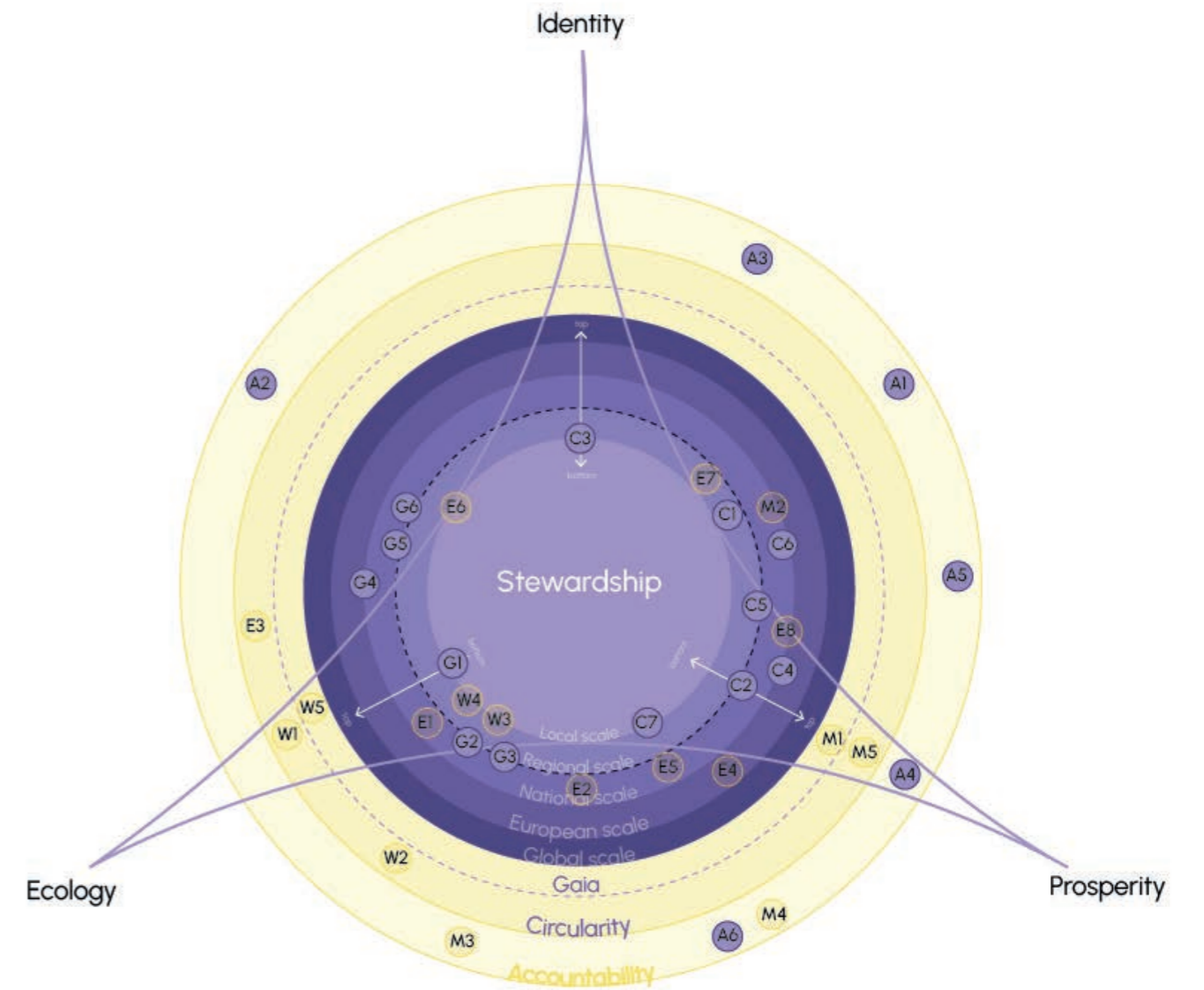


F84. Phase 3 collage

06 Evaluation

Evaluation

By applying our action cards to our conceptual framework, one can evaluate their combination in relation to stewardship, identity, ecology, and prosperity at the different scales.



F85. Evaluation diagram

07 Conclusion

Conclusion

This project begins from a position of critique: that the current trajectory of AI development is dominated by a logic of growth and efficiency, often presented as inevitable and beyond question. This report challenges that narrative. Rather than accepting unchecked expansion, it asks what is necessary, what is justifiable, and what can be limited. In doing so, it introduces the concept of infrastructural excess, questioning not only the scale of development, but also its continuous operation, resource demands, growth, and broader spatial implications. These systems are not neutral; they are embedded within the interconnected and political realities of the critical zone, where planetary limits must form the basis of planning and design decisions.

In response, this work proposes an alternative approach grounded in stewardship, participation, and accountability. By making complex and opaque technological systems more accessible through tools such as action cards and governance structures; it enables meaningful engagement within spatial design and policy development. This ensures that those historically excluded, including both marginalised communities and ecological systems, can advocate for their interests and shape the futures of their environments.

Addressing the research question, the project develops a vision and strategy for the democratic implementation of AI infrastructure in Groningen. It proposes a multiscalar and participatory governance model that redistributes power, embeds accountability, and situates technological development within ecological and social limits. In doing so, it seeks not only to guide development, but to actively “put on the brakes,” ensuring that growth is justified, regulated, and aligned with collective values.

Key Goals and Strategic Directions

- Put on the brakes

This project challenges the assumption that AI development must grow continuously and without limits. It proposes governance structures

and participatory mechanisms that actively regulate expansion, ensuring that development is necessary, justified, and aligned with societal and ecological priorities. This includes setting clear limits on energy, water, land, and material use, as well as addressing impacts such as noise and light pollution.

- Circular, accountable industry

AI infrastructure must operate within closed-loop systems that prioritise resource efficiency and responsibility. This involves the circular management of water, energy, and rare minerals, alongside a commitment to renewable energy use. Accountability is central, ensuring transparency in resource flows and responsibility for environmental and social impacts across the full lifecycle of technological systems.

- Decentralisation

The project advocates for a redistribution of power—both spatially and institutionally—through decentralised infrastructure and governance. By integrating data centres within the three villages and supporting the development of energy communities, it enables greater local control, negotiation, and benefit-sharing. This approach reduces extractive dynamics and fosters more equitable relationships between regions and technological systems.

- Climate-adaptive landscape

Spatial development must respond directly to environmental conditions and future climate risks. This includes addressing challenges such as sea-level rise, peat oxidation, and land subsidence, while protecting vulnerable ecosystems and communities. AI investment is reframed as a tool to support resilient landscape development, including the strengthening and densification of the existing towns on the higher land.

08 Reflection

Reflection

Contribution

The fast pace at which ai technology is evolving, expanding in scale while consuming increasing amounts of energy, land, resources, and labour, demands urgent and innovative responses. This project adopts a wide-ranging methodology that bridges design, social sciences, and physical sciences, resulting in an approach that is site-specific, multiscalar, and multistakeholder. Through this research-by-design process, a series of spatial proposals and policy recommendations have been developed that respond directly to real-world conditions, in real time. This urgency is underscored by the fact that the project under investigation is set to be implemented by 2027, while regulatory and policy frameworks remain insufficient to manage the rapid and largely unregulated expansion of AI infrastructure.

This work is grounded in a specific spatial context, offering a targeted intervention for an ongoing development in Groningen. As such, it has immediate practical relevance for the communities it represents. However, the insights, analysis, and strategies developed here extend beyond this site, addressing broader global conditions in which communities are increasingly affected by the construction of data centres and related infrastructures. Central to this project is the development of an action card 'game' that renders otherwise opaque technological systems more legible and accessible. In doing so, it enables historically marginalised communities to articulate their perspectives and engage in governance arenas.

Ultimately, this strategy functions as both a framework and a tool: one that empowers communities (and the ecological systems they are part of) to better understand, negotiate, and challenge the impacts of large-scale technological development. By situating these actors within an interconnected system, the project supports their capacity to advocate for their environments, assert their rights, and actively shape the futures of their landscapes.

Limitations

In order to conduct this research within a timely manner, several assumptions had to be made. First, the topic itself is rapidly evolving, meaning that new information and media input continued to emerge throughout the research process. Our findings are situated within a constantly shifting knowledge field. This also includes the worldwide energy crisis as result of geo-political conflict that escalated during the time this research was written. Resulting in a shift in energy values throughout all governance scales.

Secondly, we acknowledge the limited extent of direct participation within this research. Community involvement is central to the themes of this project and though we have done some interviews to gain insight on how communities might experience AI development, this part of the research continues to be underdeveloped.

Finally, we recognise the limitations of our understanding of AI technology, which inevitably shaped the outcomes of this research. Despite an intensive effort, our grasp of these systems remains partial. However, this limitation also reveals a larger issue of technologies outpacing public understanding. It's interesting to question whether communities can engage with this topic and feel stewardship, if researchers have difficulty to fully understand this technology.

Further research

Assignment Q3 revolves around the energy transition; however, this topic extends far beyond energy, and we therefore had to limit our research scope. On a regional urban scale, it would be interesting to further explore how this development influences job security and the future economic direction of Groningen especially as its dominant agricultural sector competes for

Reflection

resources with AI infrastructure.

For further research, it would also be relevant to develop the participatory structures of the strategy, including actually testing the stewardship game that was created.

Additionally, hydrogen innovation could become a significant driver for the region, particularly in powering large industries such as AI infrastructure.

Lastly, the proposed strategy of energy communities, in combination with the job-prioritisation of decentralised data centres (e.g. temporally switching AI systems on and off), requires further refinement in close collaboration with engineers to develop a feasible temporal system.

Reflection

Throughout this research it was difficult to define a clear position on the development of AI data centres in Groningen. It seemed as though the further we learned about AI, the more ethical concerns arose. The expansion of the technology seems rapid and unstoppable, positioning urbanists in a role where they have to mitigate harm rather than resist or redefine the system. Within this project, we sought to do both.

We continuously questioned whether our approach was radical enough. Because our proposed strategy still operates within the framework of continuous growth. Our decision to engage with the AI development in Groningen was partly justified by its perceived societal/national value. However, by accommodating such developments, we may inadvertently justify the many more to come.

Personal reflections

Cody

I really enjoyed this quarter and working at this scale. It was exciting to engage with such a pertinent issue, with impacts on the city, landscape, politics, and the planet. The multidisciplinary nature of the project allowed me to explore the topic across different scales and stakeholder perspectives. At times, the breadth of the subject made it challenging to keep the project grounded in Groningen and the energy transition, but this also reflects the complexity of the issue.

In this regard, the group dynamic was a real strength. Working collaboratively allowed us to approach the project from different angles, creating greater depth and a richer outcome. I learned a great deal from my teammates, particularly in experiencing a Dutch approach to working, characterised by strong communication and mutual respect. Personally, coming from a different background, I found it especially valuable to engage deeply with the analytical and storytelling aspects of the project. In hindsight, I would have liked to be more involved in the design process to ensure stronger alignment between the argumentation and spatial proposals.

A key takeaway from this project is understanding how to construct a counter-narrative, particularly through governance structures and decision-making processes. This has highlighted the importance of incorporating plural voices and perspectives, and learning how to negotiate based on shared values and approaches. Meaningful participation depends on this, as well as the ability to communicate, negotiate, and propose designs at this scale while navigating complex political frameworks.

It is really valuable to be building an academic perspective on a topic that will have such an impact on our planet, lives and careers. Given its urgency, I am curious to keep exploring finding hope in work with and against AI – but I equally find it completely overwhelming and existential.

Ytke

I enjoyed working in a group this quarter, mainly because it kept the topic light. It was insightful to be part of a process that was consistent from beginning to end. There was a nice balance between realism and idealism. Similarly there was a nice balance between reflective periods where there was a lot of discussion, and productive periods where we had to deliver.

Furthermore, the Q3 assignment taught me to form a more educated opinion on the growth of AI instead of avoiding the problem all together. Another key take away is that there is no one-size-fits-all approach to regional scale urbanism; it is not about a grand design idea that will tackle all issues, but more about coming to a solution together. More importantly leaving room - in form of time - for discussion. Due to the urgency of the topic this is all the more important, but perhaps unrealistic.

Designing a vision and strategy this rapidly seemed disconnected from actual communities, which made me question my role as a future designer/researcher. In the group reflection we wrote: "the expansion of the technology seems rapid and unstoppable, positioning urbanists in a role where they have to mitigate harm rather than resist or redefine the system." This sentence best captures what made this project particularly difficult because it shows why it did not align with my values. Throughout the course, I felt very detached from the abstract language and large, visionary statements. It makes me wonder, if I already feel that distance, how accessible or meaningful are these strategies to communities themselves?

If I were to do the assignment again, I would steer the project towards a more activist approach; how to give communities and municipalities the tools to resist the construction of AI data centers.

Eva

I experienced this quarter as a very positive and valuable learning process. I really enjoyed working in this group setting, where the collaboration felt natural. I enjoyed our dynamic, we were not always overly serious and could definitely have a laugh, but at the same time we were motivated to deliver a thoughtful and overall good project. The many discussions and conversations within the group were really meaningful as all perspective helped to get to deepen and direct the project, even though at times they felt never ending. I learned a lot from these exchanges, in terms of knowledge about energy and ai, but also in how to approach complex topics together.

Although AI was not initially a topic that strongly interested me, I feel that we were able to give it real value through our focus on governance and a bottom-up approach. By connecting it to real communities this development got a face. Through this, I gained substantial knowledge about both energy systems and AI infrastructure, which before this project I knew little about.

At times, I found it challenging to organise time for production moments. The schedule was quite full with lectures, studio sessions and group meetings, which made it difficult to balance learning and producing. For the next project I will try to manage this better, by scheduling specific time blocks for production with my teammates

Overall I learned a lot from the lectures and studio sessions, but I think I have learned the most from working with my team mates. This I really enjoyed.

Lara

At the start of this course, I perceived regional design as largely top-down. However this shifted throughout the course, recognising the importance of communities effected by spatial interventions. A key insight was that no solution satisfies all stakeholders. Designing within overlapping systems requires prioritisation, often favouring certain interests. This became clear when addressing tensions between AI developments, economic growth, and regional independence. While these design goals served a larger goal, they did not align with local or ecological interest. To work with this complexity, I proposed discussions, scenario building, and mapped out ideas. I also recognised how differing theoretical perspectives in the group influenced the decision-making. In the future would I make everyone's position more explicit to improve collaboration.

Collaboration was collective, with all members actively contributing. My role developed as an initiator, structuring discussions and encouraging decision making. Contributing mainly to the spatial design, including plans, maps, diagrams, and local policymaking. My role as municipal actor informed a policy-oriented perspective. While roles were not assigned, they emerged naturally. I focused on practical aspects, while also engaging more with theory to strengthen arguments and my own skills. I was critical in discussions by representing the municipality's perspectives, improving both content and argumentation. The project highlighted the complexity of regional design, involving multiple systems and stakeholders. The lack of fixed roles created for new insights, but also made decisions more challenging. I learned that valuing different working styles strengthens the outcome.

This project also thought me to design for the user and navigate with conflicting interests. Designers play a key role as mediators between systems and stakeholders.

While our resource was strong, I feel like we could have dived deeper in research by design. Also was our engagement with the community limited and weakened the validation of this project. In future projects, I would prioritise earlier stakeholder involvement and a more iterative process. This experience strengthened my ability to collaborate in complex context and take active responsibility in a team.



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Figurelist

Appendix 1

Appendix 2

Appendix 3

Appendix 4

Appendix 5

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Figure 82. Made by authors

The cloud is not in the sky, but in Groningen

AI used in this research
and its enviromental
impact

documented as
transparently as possible

This research aims to explore ethics of the development of ai supercomputer; therefore, we have been conscious around our use of ai while acknowledging its potential as a tool.

In trying to understand and position ourselves on this issue - we wanted to know the impact of our use of ai through our research and design. This means calculating the resources consumed, and trying to discover where these data centres were located.

Aiming to hold ourselves accountable.

AR2U086 R and D Studio

AR2U088 Research and Design
Methodology for Urbanism

2025–2026 (Q3)

Lara Brouwer – 5507413
Eva Cocu – 6346960
Ytke Feijen – 5539773
Cody Knight – 6488242

**Here we aim to be
radically honest.**

**Confronting every time
we used AI throughout
Q3, and its enviromental
impact.**

AI Use Statement

This report may include the use of artificial intelligence (AI) tools (such as large language models) to support specific tasks, including language editing, structuring of text, and preliminary idea exploration.

The authors understand that all TU Delft produced publications are subject to AI scanning and that all use of AI must be transparently disclosed in this report.

All substantive content, including research design, analysis, interpretation, and project development, was produced by the authors. AI tools were used as assistive instruments and not as a substitute for critical thinking, academic judgement, or original work.

All sources have been independently verified by the authors. Any content generated with the assistance of AI has been reviewed, edited, and validated to ensure accuracy, relevance, and compliance with academic standards.

The authors remain fully responsible for the content, integrity, and originality of this report.

NOTES



The Stargate data center campus in Abilene Texas is expected to host OpenAI's largest compute cluster from the second half of 2025 through 2026. This is the first of several sites in the Stargate project, spanning the US and the globe. We have a variety of sources to estimate the capacity of this data center, from company announcements, to permit documents, to satellite imagery of air-cooled chillers.

View our calculations [here](#).

Sources

- [Crusoe 2024 Impact Report, with details on Abilene](#)
- [Air Permit Application for buildings 1-2, featuring blueprints on p.157](#)
- [Mortensen's profile of the project, with details of substations](#)

Read more about our methodology.

Construction status

The 1 GW substation looks close to completion. Building 3 appears to have all power and cooling equipment installed, but there are still signs of construction work. This seems on track for operation in 3 months. Building 4 has about 80% of chillers installed. Other buildings have few or no chillers installed.



Power 295 MW Compute 5.0×10^{20} FLOP/s Cost 8.1 billion USD

Image © 2026 Vantor Copernicus Sentinel data 202

Most of the chat gpt servers are in the United States, their exact locations are not made public, however most are distributed through Microsoft Azure data centers. We can take the Abilene Texas data centre as one example of where our prompts could be being processed.

This data centre runs at 295MW, 87% of which is natural gas, and 13% is from renewable sources.

Date	Software	Prompt	no. of follow up prompts
13.02	chatgpt	if they are going to build a new ai data center in groningen what is the most likely location for it from a technical and a practical/political perspective?	
17.02	happy scribe	transcribe interviews from field work	6 interviews
17.02	powerpoint	remove background	1 image
17.02	chatgpt	Translate interviews from fieldwork accurately to english	6 interviews
16.02	google ai	zijn ai datacenters aangesloten op het energienet?	
18.02	atlast.ti	summarize articles	8 articles
18.02	atlas.ti	ai coding to catagorize concepts	
20.02	chatgpt	hoe kan ik een afbeelding in qgis krijgen, verplaatsen en schalen	

Date	Software	Prompt	no. of follow up prompts
23.02	atlas.ti	summarise articles	
23.02	gemini	waar kan ik een kaart vinden van alle datacenters in nl en die ik kan gebruiken voor qgis	6 interviews
24.02	chatgpt	can you give me a few examples of large ai supercomputers in china to choose from as a case study. I want to know how much space they require (both for energy production and for the data center themselves). I want to know what the public response to their introduction was - was there any participation of citizens in the development and construction? what do people in china generally think about its implementation? how much energy does it use and where does this energy come from? how much water does it use? where does this water come from? how much did it cost? where did this funding come from?	

Date	Software	Prompt	no. of follow up prompts
24.02	chatgpt	can you give me a few examples of large ai supercomputers in the usa to choose from as a case study. I want to know how much space they require (both for energy production and for the data center themselves). I want to know what the public response to their introduction was - was there any participation of citizens in the development and construction? what do people in china generally think about its implementation? how much energy does it use and where does this energy come from? how much water does it use? where does this water come from? how much did it cost? where did this funding come from?	6 interviews
25.02	atlas.ti	What are the main concerns of the residents surrounding Eemshaven and if relevant about the concerns of the ai factory that is being build in groningen?	
25.02	atlast.ti	Do they have specific opinions?	
25.02	atlas.ti	Wie zijn de dominante stakeholders / communities binnen de stad groningen?	

Date	Software	Prompt	no. of follow up prompts
24.02	chatgpt	prompt given: AI supercomputer estimate in power and space according to given case studies	10
06.03	chatgpt	what is the space requirements for a factory that recycles rare earth minerals and magnets - what are the energy requirements and the water requirements for this sort of process	0
11.03	chatgpt	i am trying to compare liquid and evaporative cooling methods for a 12mw data centre in a temperate climate (north netherlands) how much water would each of these cooling methods require	0
18.03	google ai	protected nature areas groningen	
	chatgpt	can you give me feedback on the structure of this presentation script:	0

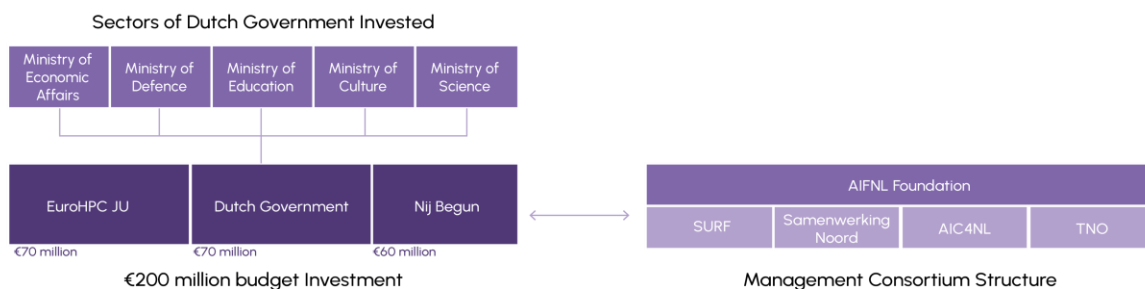
Date	Software	Prompt	no. of follow up prompts
	chatgpt	i am looking to write a position paper from the perspective of Chairman of the EuroHPC JU Governing Board, i am wanting to write on the development of a ai factory in groningen and the associated data centre - can you help suggest relevant papers and policies on eu's position on energy generation, on the spatial repercussions and impact on the local community, or on the potential to scale up the project	0
	chatgpt	can you help reduce this text (1200 words) into an 800 word format	1
	chatgpt	I am reading donna haraways the cyborg manifesto - with particular emphasis on how it relates to ai - are there any thinkers who have written on this connection	0
	chatgpt	can you help cut this first draft into 800 words	1
	chatgpt	can you give feedback on this abstract, checking for grammar and keeping it within 300 words	2

Date	Software	Prompt	no. of follow up prompts
	chatgpt	can you give feedback on the structure of this theoretical framework - it should be academically rigorous and link together each of the thinkers, i would also like to keep the structure moving from the cloud to the critical zone to the subsurface but would appreciate feedback on how best to bring all of the ideas together beyond this structure	3
04.04.26	chatgpt	i am looking to calculate how much water and electricity is used per search of chat gpt - can you give me some numbers of approximate use of resources per prompt that i can then make calculations with?	2

Position of the EuroHPC Joint Undertaking on the Groningen AI Factory Vision

The EuroHPC Joint Undertaking (EuroHPC JU) is mandated to fund, procure, and operate a federated network of supercomputing and AI infrastructure across Europe. Since its establishment in 2018, it has deployed projects, supporting applications ranging from climate modelling and drug discovery to advanced manufacturing and energy system optimization (Office of the European Union L-, 2026). In parallel, EuroHPC JU manages and coordinates public-private investment instruments designed to mobilize the substantial capital required for next-generation AI infrastructure.

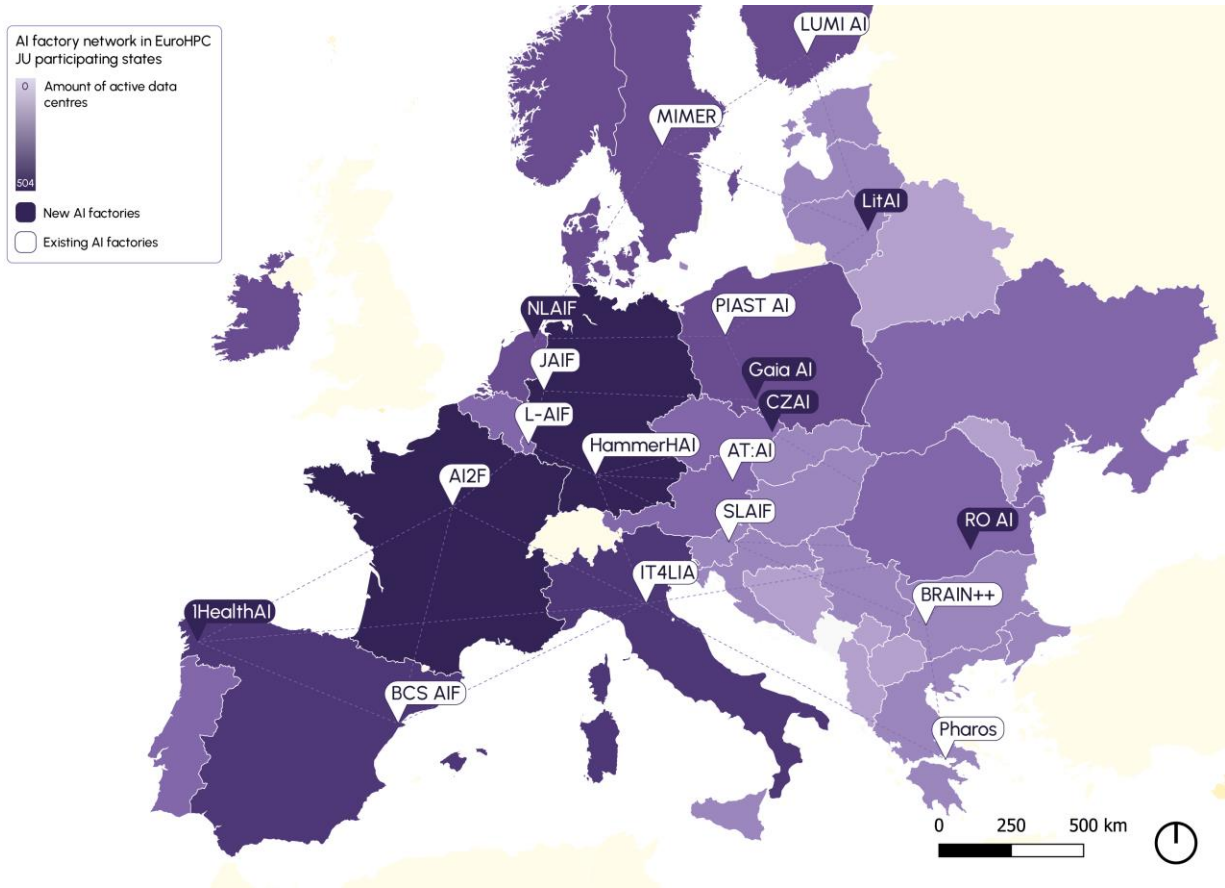
Its operational model is based on co-investment and shared governance. EuroHPC JU matches funding from Member States and associated partners while enabling private sector participation in both infrastructure development and service provision. This blended financing structure is critical given the scale of capital expenditure required for AI factories, which increasingly operate at hundreds of megawatts globally. The proposed Groningen facility reflects this model, with a multi-level governance structure in which European, national, and regional actors jointly finance and manage the system. As such, it should be understood not as a standalone national asset, but as a functional node within a coordinated European HPC ecosystem.



Investment and management consortia structure for the AI Factory in Groningen

This role is guided by three interdependent strategic priorities: digital sovereignty, sustainability, and material resilience.

Digital sovereignty requires that Europe maintains autonomous capabilities in AI development, training, and deployment. Current global dynamics indicate a rapid concentration of compute capacity in the United States and China, with hyperscale AI facilities reaching gigawatt-scale planning horizons. In this context, Europe faces a structural risk of falling into a “middle technology trap,” whereby it lacks both the scale of investment and the frontier capabilities required to remain competitive and secure (Draghi, 2024). The proposed 12 MW capacity of the Groningen AI factory, while a relevant starting point, remains limited in comparison to global benchmarks (AIC4NL, 2025). Without a clear pathway toward scaling, such facilities risk underperforming in both research and industrial applications. EuroHPC JU therefore emphasizes the need for modular, scalable infrastructure design and sustained capital mobilization to ensure long-term competitiveness.



Network of AI factories in EuroHPC JU participating states and the density of data centre computing power

Sustainability constitutes a second core pillar. AI and HPC workloads are driving exponential increases in electricity demand, often outpacing grid expansion and contributing to congestion challenges - particularly in Member States such as the Netherlands. At present, there is a lack of binding, EU-wide standards for energy efficiency and transparency in AI infrastructure, yet the EU aims to be a worldwide leader in the energy transition. EuroHPC JU supports the development of harmonized reporting frameworks and minimum performance standards to ensure that all facilities contribute to climate objectives under the European Green Deal (EuroHPC JU, 2024). This includes requirements for renewable energy integration, energy reuse, and system-level efficiency. The concept of “energy-positive AI facilities,” in which data centres actively support grid stability, district heating, and local energy systems, should be further operationalized.

Material sovereignty represents a third, increasingly critical dimension. AI infrastructure is highly resource-intensive, relying on semiconductors, copper, rare earth elements, lithium, and cobalt. The European Union remains significantly dependent on external suppliers, particularly for rare earth processing. Despite policy recognition under the Critical Raw Materials (European Parliament, 2024) framework, recycling rates remain extremely low, with less than 1% of rare earth materials currently recovered. This creates both economic and geopolitical vulnerabilities. EuroHPC JU therefore considers the integration of material recovery and recycling systems into AI infrastructure planning to be essential, rather than optional.

In addition, EuroHPC JU promotes an “AI social infrastructure” approach, ensuring that investments in computing capacity translate into broader societal and economic value. This includes structured stakeholder engagement, targeted job creation, and the development of advanced technical skills. The ability to attract and retain highly skilled talent, particularly in AI engineering, system architecture, and applied research, remains a key determinant of long-term success.

Within this strategic context, the spatial vision for the Groningen AI factory demonstrates several important strengths.

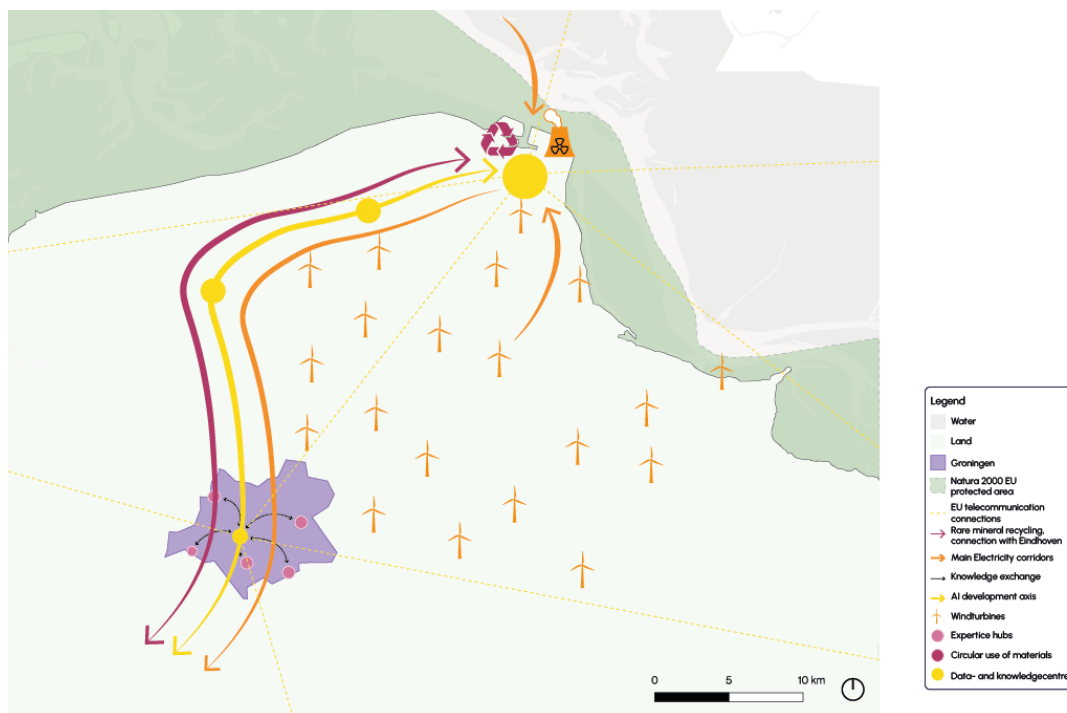
First, the location in the Eemshaven energy cluster provides a strong foundation for integrating large-scale computing with diversified energy supply. The proximity to offshore wind generation, solar fields, existing gas infrastructure, and potential future nuclear capacity creates the conditions for a hybrid energy model capable of supporting both reliability and decarbonization (IEA, 2025). Given the increasing mismatch between AI-driven electricity demand and grid availability, such co-location is not only

advantageous but necessary, particularly in synergies such as the integration of district heating. It enables direct coupling between energy production and consumption, reducing transmission constraints, and enhancing system resilience.

Second, the proposed integration of circular material flows is a notable and forward-looking component of the vision. The co-location of e-waste processing and rare material recovery facilities alongside computing infrastructure reflects a systemic understanding of AI as both a digital and material system. When linked to semiconductor manufacturing developments in the Eindhoven region, this creates the potential for a geographically distributed circular value chain within the Netherlands. Such configurations are highly aligned with European objectives to reduce import dependency and strengthen internal industrial ecosystems.

Finally, the spatial design acknowledges the need for scalability. While the initial 12 MW capacity is modest, the site's physical characteristics appear to support phased expansion through modular and stackable infrastructure. This is a critical requirement, as future competitiveness will depend on the ability to rapidly scale compute capacity in response to technological and market developments. EuroHPC JU would therefore strongly encourage maintaining spatial flexibility and reserving capacity for future public and private investment.

In conclusion, the Groningen AI factory aligns with key EuroHPC JU priorities, but its long-term impact will depend on the extent to which it is embedded within a broader European strategy of scaling, integration, and coordination. AI infrastructure must be understood as a coupled system; linking compute capacity, energy availability, and material supply chains. The Groningen project offers a strong spatial foundation for this approach. To fully realize its potential, it must evolve beyond its initial scale and function as a fully integrated node within Europe's federated, sustainable, and sovereign AI ecosystem.



Groningen AI factory map from EuroHPC JU perspective; emphasis on the interconnected technology within the EU network, the circular recycling of e-waste and rare minerals, and the scaling up of the technology and renewable energy facilities.

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Not our Burdens for their gains: Towards a fair distribution in energy and landscape

Groningen's proposed AI factory, announced in May 2025, is framed as a drive of innovation, economic growth, and secure data use (Nij Begun, 2026). However, this narrative overlooks a critical spatial and social imbalance. While the plan prioritizes urban and larger-scale benefits, the environmental and social costs will largely affect Eemshaven and Het Hogeland. Eemshaven risks becoming a 'sacrifice zone', where national transitions are spatially concentrated at the expense of local liveability and landscape quality. As a peripheral region with relatively low population density and strong existing energy infrastructure, Het Hogeland is often seen as a suitable location for large-scale developments like the supercomputer, reinforcing this imbalance (Van der Veen, 2025). This raises the question of whether the benefits outweigh the concerns of local residents (Dagblad van het Noorden, 2026).

The European Union and Dutch government aim to reduce reliance on other countries in AI with this project, making it strategically important (Verhagen, 2025). The province of Groningen sees it as an opportunity for economic growth aligned with its *Omgevingsvisie* (translated as *Environmental Resilience Vision*) (Provincie Groningen, 2025).

To address potential conflicts, decision making involves collaboration between the national government, province, and stakeholders, including residents and businesses. Municipalities can voice concerns when plans are made at the province scale. Likewise holds the province the municipality accountable for local plans, and is able to intervene if this serves a general interest (Gemeentewet, art. 112-115, art. 118-120, 2026).

When making policy decisions, shown in Figure 1, are municipalities, provinces, and waterboards collaborating with expert who provide advice on the environment, nature, and water management (Ministerie van Infrastructuur en Waterstaat, 2026). While European agreements influence the process indirectly via the national and provincial legislation (VNG, 2025).

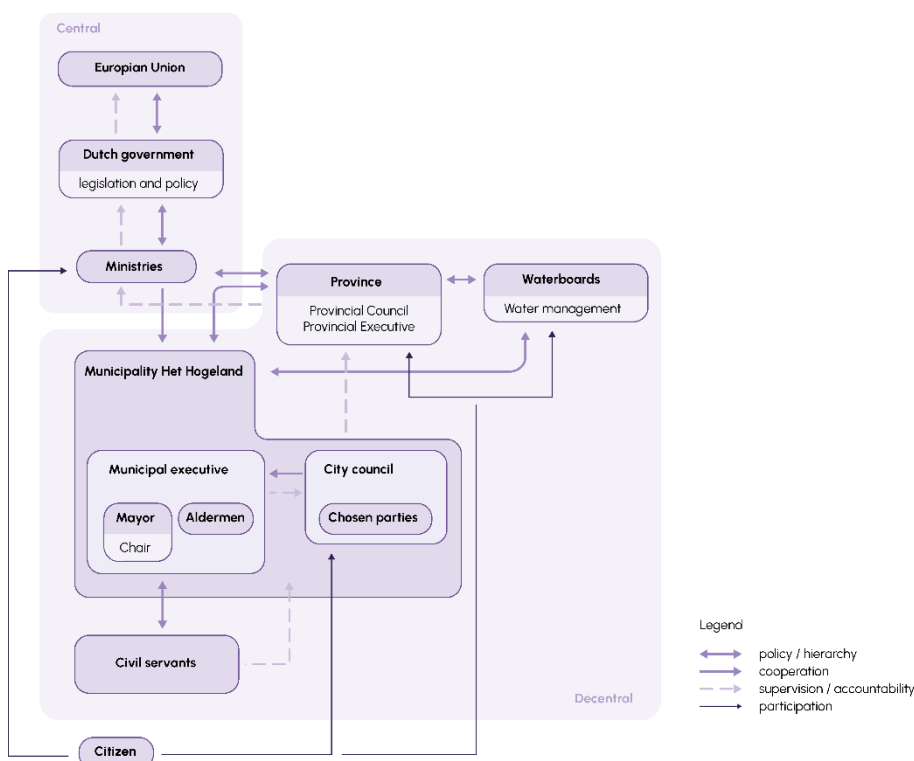


Figure 1 Diagram of local government (own illustration)

As the local government, the residents' interests are represented through municipal elections (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2026). The most recent elections saw nearly 60% turnout, with GroenLinks/PvdA (7 seats), Gemeentebelangen Het Hogeland (6 seats) and CDA (4 seats) as largest parties (Stemmen Tellen En Uitslag - Gemeente Het Hogeland, 2026; NU, 2026). Their election programs and the municipal environmental vision shows how the AI-factory is being perceived by the residents.

When looking at the given vision, village expansion is promoted, but this requires clear prioritising. As in current municipal policy, Winsum, Uithuizen, and Bedum remain designated as growth centres. Expanding all villages is not feasible, as it would involve building on private agricultural land before all space in the villages is fully used. (GroenLinks/PvdA Het Hogeland, 2026). Additionally, function clustering is necessary to ensure financial feasibility and accessibility.

Regarding economic development, including datacentres and the expansion of Eemshaven, a clear boundary condition applies. Further growth of Eemshaven is inevitable due to national and provincial objectives. However, the municipality does not support additional datacentres, as they conflict with the vision of Eemshaven as a green industrial area (Von Hebel, 2025). These developments primarily serve national interests, such as the energy-, AI-, and economic transitions. But if they proceed, datacentres should be confined to existing industrial clusters and must not compromise the openness of the landscape by decentralisation.

Additionally, local residents are expressing concerns towards the noise pollution from the expanding industry of Eemshaven. Following protest, noise limits were only reduced by 1 decibel, making residents feel unheard. (Van der Veen, 2025). Developments must provide local benefits, like residual heat, and introduce better participation to build trust between residents and the municipality (*Stemhulp MijnStem Het Hogeland | Gemeenteraadsverkiezingen*, 2026).

In the field of energy, upscaling is necessary for the increasing use of electricity and the planned datacentres. Residents fear for the already strained energy network (Von Hebel, 2025). Therefore, approval should only be granted if the energy grid can remain independent of, or be upgraded for, datacentres. Large-scale energy needs can be met through wind energy and hydrogen use, but integration must be suitable. Solar energy is preferred on rooftops, while applications on agricultural land are only acceptable if ecologically and visually responsible. An example is the nature-inclusive solar parks (as in Assen) (GroenLinks/PvdA Het Hogeland, 2026). Large interventions that impact the open landscape are not appropriate.



Figure 2 *Energietuinen in Assen (Energietuinen, n.d.)*

Proposed transitions in agriculture require realistic and careful implementation. Innovation and functional mixing are necessary and align with provincial ambitions (Provincie Groningen, 2025). However, it is unacceptable to use agricultural land for purposes like water storage or energy production without a clear framework. Such measures will face resistance and should only occur within defined regulations that provide farmers with perspectives and opportunities. They also want to move towards an ecological agriculture, but only if it is feasible and profitable.

Preserving the historic coastal landscape is considered an important quality, widely supported by residents. Developments in this area are only appropriate if they enhance these landscape and cultural-historical values. Combinations with other functions may be feasible, provided they are carefully designed and integrated.

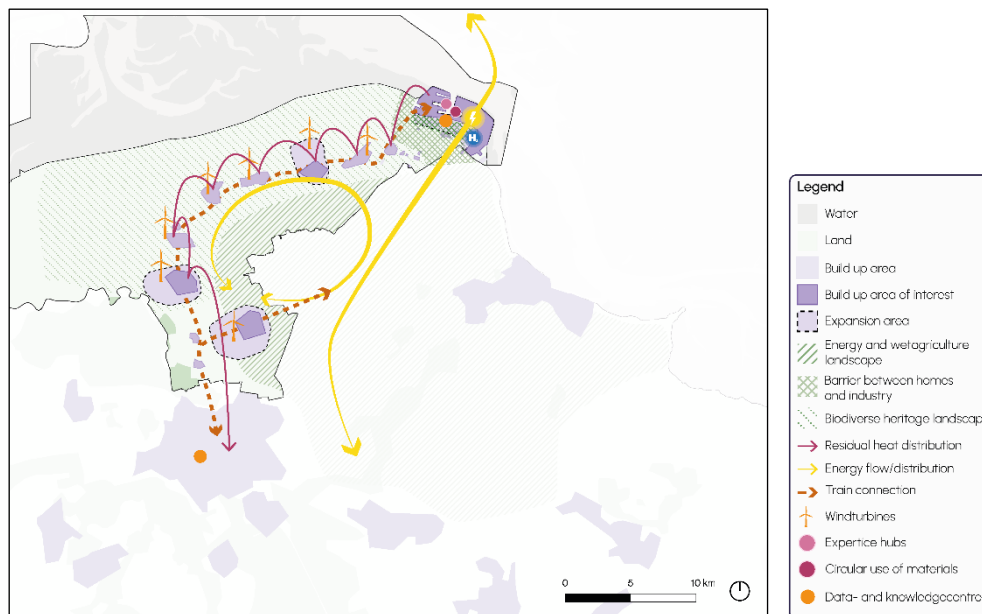


Figure 3 Suggested vision from Het Hogeland (own illustration)

As a reaction on the given vision, a new suggested vision is provided (Figure 3). The municipality recognizes both the opportunities and challenges of the AI factory, Eemshaven expansion, and regional development. While these projects can drive economic growth and innovation, they must not compromise residents' interests, regional identity, or ecological and cultural values. Development should be concentrated in designated areas, with local benefits like residual heat use and sustainable opportunities to build trust.

Our position is clear: developments are only acceptable if they fit within spatial quality and provide direct added value for residents. Without guarantees on energy, liveability, and compensation, expansion is not desirable. The municipality has the capacity to coordinate with national and provincial authorities, experts, and stakeholders to ensure responsible planning, and has to be held accountable to do so. Not our burdens for their gains, but a fair balance between national ambitions and the local living environment.

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AI Development Within the Limits of the Water System

positioning the waterboards

Waterboard Noorderzijlvest is one of the 21 waterboards in the Netherlands. In the north of Groningen, part of Drenthe and a part of Fryslân we are responsible for ensuring safe, sufficient and clean water. Our focus lies on remaining climate-proof and developing a more natural and sustainable water management. Major challenges we are dealing with are preventing drought and salinization, stimulating biodiversity and the circular reuse of energy and raw materials from wastewater. These are issues we face together with the region and we therefore explicitly seek collaboration with the region and partners (Waterschap Noorderzijlvest, 2021).

The position on behalf of waterboard Noorderzijlvest considering the development of the AI factory and accompanying infrastructure in North Groningen is as follows: the AI factory, in principle is welcome, on the condition that it fits within the limits of the soil and water system.

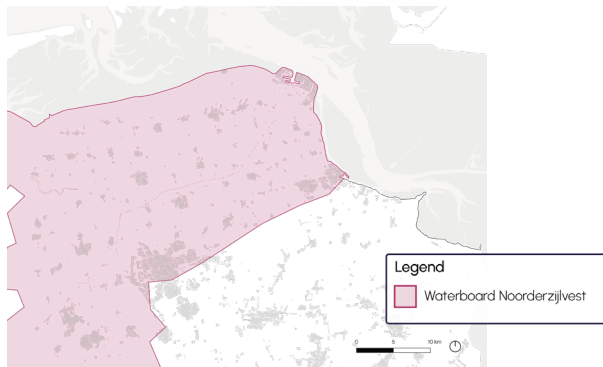


Fig 1. Map of the synergies

Decision-making capacity and legal authority

Waterboards are functional, decentralized governments with their own administration and tax system. The general board establishes policy and rules and is largely democratically elected, supplemented with representatives of specific interests such as nature and agriculture. The executive board is responsible for implementation and enforcement (Havekes et al., 2019).

This structure and also the capacity in decision-making are legally established in the Waterschapswet, the Waterwet and the

Omgevingswet. In this, the waterboard is designated as part of the Dutch governmental organization and can therefore take binding decisions, establish regulations, impose orders or prohibitions and grant or refuse permits, and levy taxes. It is also stated that the waterboard is territorially bounded and thus part of the territorial decentralized government, just like municipalities and provinces. Furthermore, it is established that the tasks of the waterboard are exclusively related to water management, which contrasts with municipalities and provinces. The waterboard is also obliged to guarantee water safety, quality and quantity (Havekes et al., 2019).

Institutionally, the waterboard is therefore hierarchically equal to municipalities, both being decentralized governments with their own tasks and agenda, but differ in focus as waterboards are exclusively responsible for water management. The province fulfils a framework setting and supervisory role and is responsible for regulating the waterboards as can be seen in figure 2 (Havekes et al., 2019).

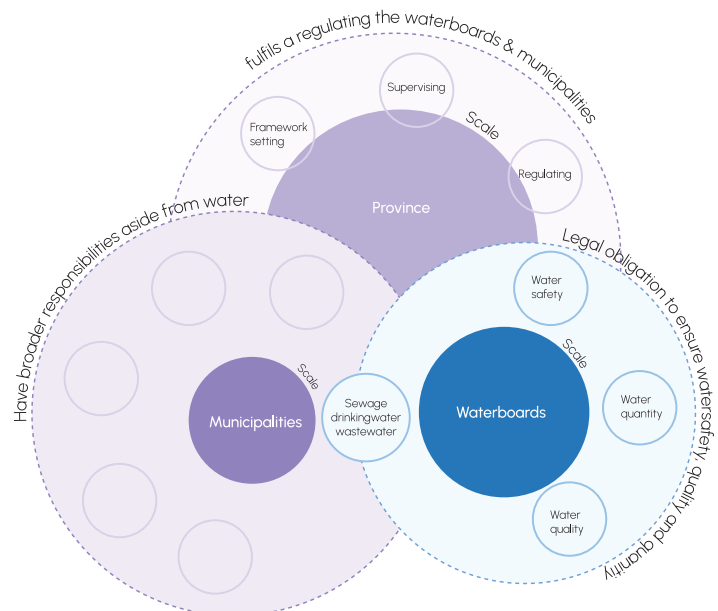


Fig 2. Diagram of partnership between province, municipalities and waterboards (made by author)

The Arena: Partners and Forces

Within the governance arena we move between different actors with varying interests and scales. Dutch water management and thus the

waterboards are strongly influenced by European legislation, for example through the Water Framework Directive and flood risk management. There are also European directives for, for example drinking water, bathing water and wastewater, these rules take precedence over national legal rules (Havekes et al., 2019).

Municipalities and waterboards are hierarchically equal and form a direct partnership (Havekes et al., 2019). Our agendas however inherently differ: where municipalities focus on broader welfare and liveability, waterboards only safeguards the soil and water systems of the region in question (Noorderzijlvest, 2025). In line with the Environment and Planning Act we act as one government, which means that in the exploration phase we proactively advise on (im)possibilities instead of afterwards (Waterschap Noorderzijlvest, 2021).

Nature is not a formal actor, but does form an essential interest for which we are the legal

representative (Werkgroep Omgevingsagenda Noord-Nederland, 2020). Our role is to ensure that the blue network in the landscape is preserved, therefore we require that large industrial developments do not disturb the ecological balance, for example through water extraction, discharge, etc. (Werkgroep Omgevingsagenda Noord-Nederland, 2020).

Community vision: opportunities for blue synergy

Based on the vision of the communities for the AI factory in North Groningen, Noorderzijlvest sees clear overlaps that offer opportunities for synergy. We support the stated ambition for a circular economy and see the AI factory as an active link in the energy and water chain. A major coupling opportunity lies in the use of residual heat for aquathermy, where heat is extracted from water in order to reduce the energy footprint of the region shown in figure 3 (Noorderzijlvest, 2025).

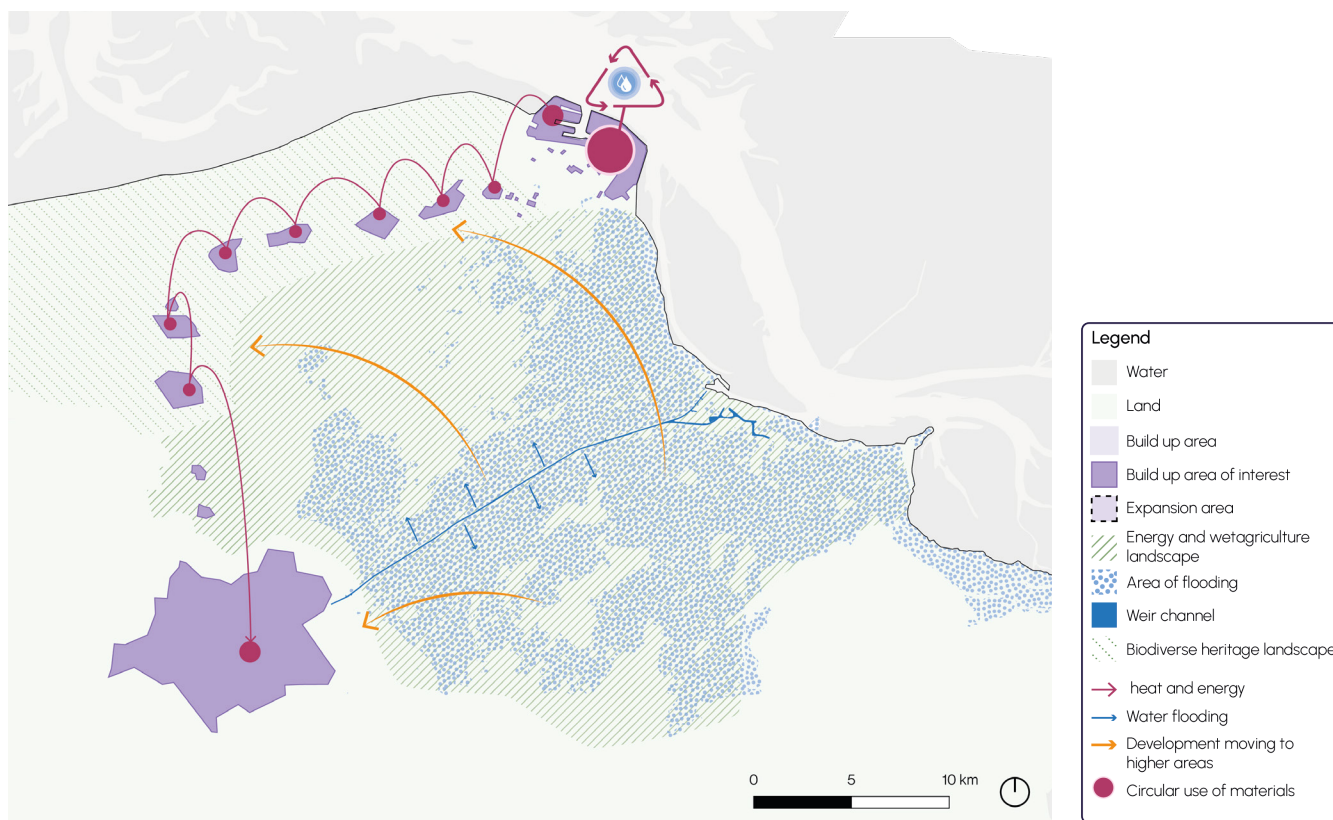


Fig 3. Map of the synergies

Furthermore, the plans for the reuse of effluent as cooling water for the factory overlap with the vision we have for industrial development. We also support the plans to make agricultural land more wet, as this is crucial to counter peat oxidation and land subsidence, although this must take place in close consultation with current users, to jointly determine how this can be done precisely (Waterschap Noorderzijlvest, 2021).

The bottom line

Despite these opportunities within this development, we set a number of hard and non-negotiable requirements that form the lower boundary of our cooperation.

First, under no condition may infrastructure be placed that affects the integrity of our primary flood defences or regional dikes, or that obstructs future developments of the broader coastal zone and dike reinforcements. Water safety ranks hierarchically above any other function (Havekes et al., 2019).

Second, we require full transparency regarding the cooling water demand of the AI factory. If this demand exceeds the limits of regional freshwater availability, we will refuse the necessary permits in accordance with our water management program (Middel et al., 2021).

Third, the choice of location must follow the principle of 'soil-following development', vital AI components may not be planned in crucial water storage areas or in low-lying areas with a high risk of flooding (Waterschap Noorderzijlvest, 2021).

Risks related to AI development

The vision speaks about wanting to control and slow down the "fast-paced growth" of the AI industry, this fast-paced growth brings significant risks, which makes this point very important. Data centres are in our view defined as "new large water demanders" (Middel et al., 2021). In times of increasing drought we apply a legal priority ranking in which water for safety and nature takes precedence over industrial parties (Havekes et al., 2019). Noorderzijlvest does not accept developments that confiscate freshwater availability for other vital functions and residents, therefore moderated growth is essential (Waterschap Noorderzijlvest, 2021).

Conclusion

In conclusion, water authority Noorderzijlvest positions itself as a critical cooperative partner within the development of the AI factory. The arrival of the factory is in principle accepted, but only when it fits within the limits of the soil and water system. Where there are clear opportunities in the field of circular energy use and water reuse, water safety, freshwater availability and ecological balance remain leading. From its legal tasks and authorities, we have a clear role in safeguarding these interests and setting conditions. In this broader context, this means that economic development does not stand on its own, but must always be weighed against the carrying capacity of the water system and the interests of nature and the surrounding environment.

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Position Paper

by: Ytke Feijen

The Q3 assignment asks us to reflect on a shared spatial vision through the perspectives of different stakeholders within a governance arena. In this case, the stakeholders include the European Union, the municipality, the waterboard, and nature. This position paper represents the voice of nature in the Groningen region, articulated through the Natuur en Milieu Federatie Groningen (NMG).

The NMG is a federation of approximately 50 organizations working on nature and sustainability. While partly funded by the province, it operates as an independent advocate for ecological systems and sustainable development. (Verantwoording NMG, 2025)

The proposed vision imagines a synergy between AI infrastructure and natural landscapes. However, this vision raises the question: can technological growth truly align with ecological limits, or does it risk repeating Groningen's extractive past at nature's cost?

What ambitions does Natuur en Milieu Federatie Groningen have?

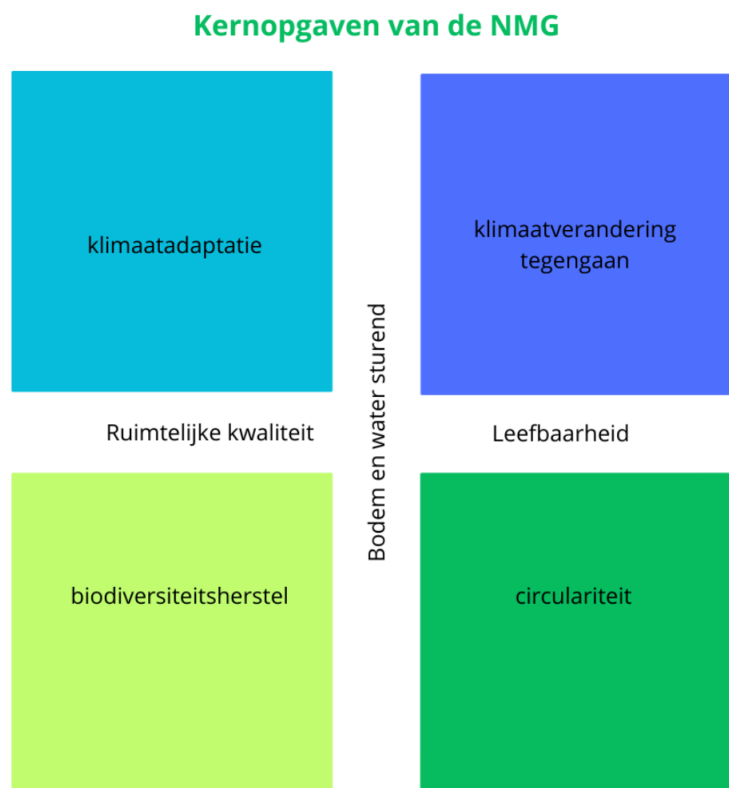


figure 1: Key Objectives NWG (2023)

Our mission focuses on four goals: mitigating the climate crisis, adapting to the climate crisis restoring ecological systems, and adopting circular resource use (Meerjaren Programma 2024-2027). Achieving these goals requires spatial transformations and in a region like Groningen where space is already under pressure, choices must be made about how land is

distributed. In our opinion, nature is not a passive element within spatial planning, but a system upon which all human activity depends. Therefore it has the urgency to be prioritised in spatial planning.

Additionally, the organisation emphasises inclusive governance. It believes that all residents should have influence over their living environment, fostering a shared responsibility for sustainable development and therefore preserving cultural identity.

And finally, the organisation critically questions the focus on economic growth. Growth cannot be infinite within a system of finite resources, society and power structures remain to be very oriented towards continuous growth. The NMG therefore advocates for a rethinking of what “growth” means.

How are NMG's ambitions represented in the vision?

To realize its ambitions, the NMG focuses on five key transitions: nature-inclusive energy, nature-inclusive agriculture, natural climate buffers, a future-proof built environment, and reducing overall resource use. Together, these aim to balance ecological restoration with spatial development.

Many of these ambitions are reflected in the vision. It proposes three landscapes: a biodiverse energy landscape, a biodiverse heritage landscape, and an urban spine toward Eemshaven. It also recognises flood-prone areas as future buffer zones and includes circular systems such as e-waste recycling. The emphasis on collective governance aligns with NMG's values of participation and shared responsibility.

However, the vision assumes that large-scale AI infrastructure can coexist with ecological restoration, which remains highly problematic. Data centres require vast amounts of energy and water, potentially competing with other sustainable land uses and harming sensitive coastal ecosystems. In addition, the industrialisation of landscapes leads to land sealing, heat and light emissions, and greenhouse gases. The short lifecycle of hardware further generates significant electronic waste, often exported elsewhere, shifting environmental burdens globally.

From nature's perspective, several principles are non-negotiable. First, strict limits must be placed on resource use, with data centres operating only on renewable energy. Second, land must be reserved for climate adaptation, such as buffering against flooding, drought, and heat. Third, biodiversity must not decline; instead, ecosystems should be actively restored and protected. Finally, true circularity requires full lifecycle thinking, including infrastructure and energy systems.

Concluding from this, the construction of AI data centres appears to be incompatible with nature's non-negotiables. The consumption of resources for this development will always exceed planetary and ecological limits if not in Groningen, then elsewhere. This once again returns to the core issue of growth.

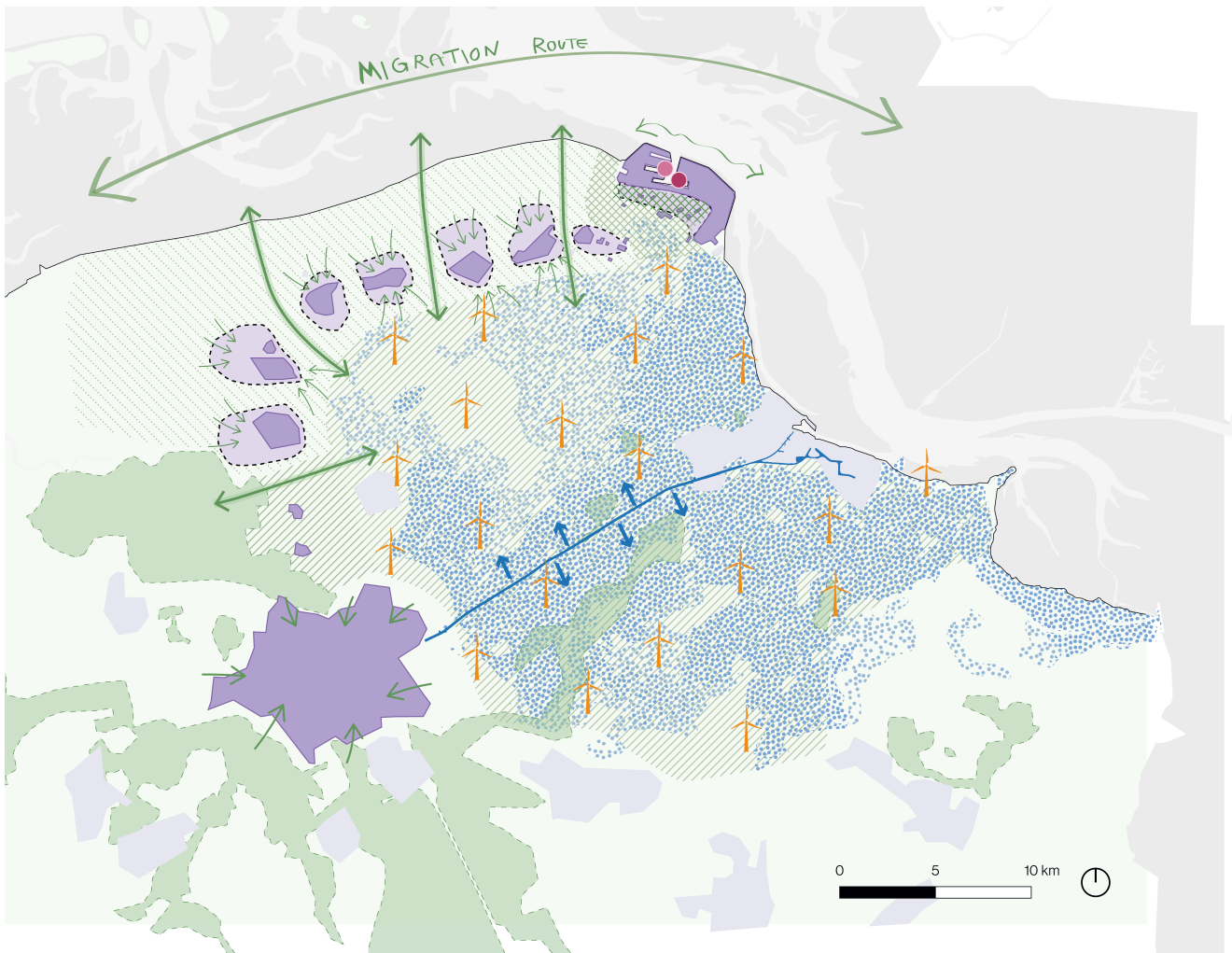


figure 2: vision map according to NWG (author's image)

How does NMG relate to other stakeholders?

From the perspective of the NMG, the positions of other stakeholders reveal important tensions between economic, technological, and ecological priorities.

The municipality presents itself as an actor investing in regional growth. However, from an ecological standpoint, this strategy is problematic. The use of public funds, which were originally intended to compensate citizens for the impacts of extractive gas practices, are now put toward a new form of extractive development in the form of AI infrastructure. While framed as innovation, this model risks repeating historical patterns, where economic gains are prioritized while citizens and non-human habitats bear the long-term costs.

The EU promotes ambitious goals for digital sovereignty and green transition, which, in principle, align with sustainability ambitions. However, these objectives have the risk of contradicting other EU policies such as the EU Birds Directive (2009) the EU Habitat Directive (1992) as well as EU Green Deal, Circular Economy Act and the ambition to operate data centres fully on renewable energy by 2030. This reflects a policy contradiction where ecological protection is treated as a parallel goal rather than a limiting condition.

The waterboard represents a stakeholder with partially aligned concerns. Its responsibility for water management and safety connects directly to ecological systems. However, it also operates within a framework that accommodates industrial demand for water as a resource.

From the perspective of nature, water and soil are not merely resources to be managed, but living systems and habitats in themselves.

The NMG advocates for an ecocentric approach. Rather than asking how nature can fit into technological growth, the question should be how technology can fit within ecological and planetary limits.

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