

Where Industry Meets the Tides

Anchoring Sustainable Spatial Circularity
in the Wadden Sea Region

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P5 Presentation

24 June 2025

First Mentor
Second Mentor
Delegate

Alexander Wandl
Teake Bouma
Marcel Bilow



Foundation

Framing the challenge

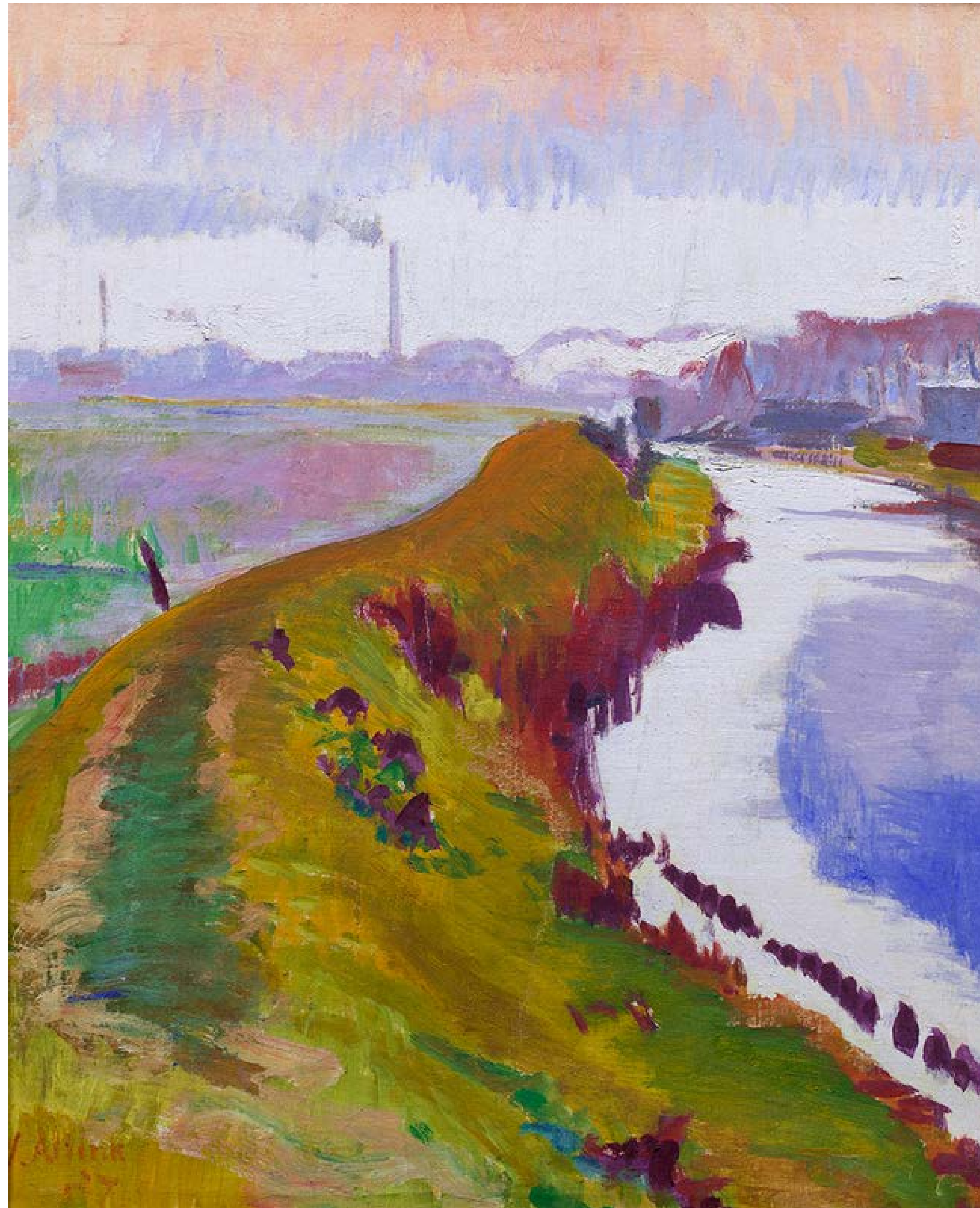
Inventarisation

Understanding the region

Projection

Envisioning circular futures

What kind of
landscape
moves me?



Jan Altink, 1927
Dijk langs het Reitdiep
Oil on canvas
Groninger Museum Collectie

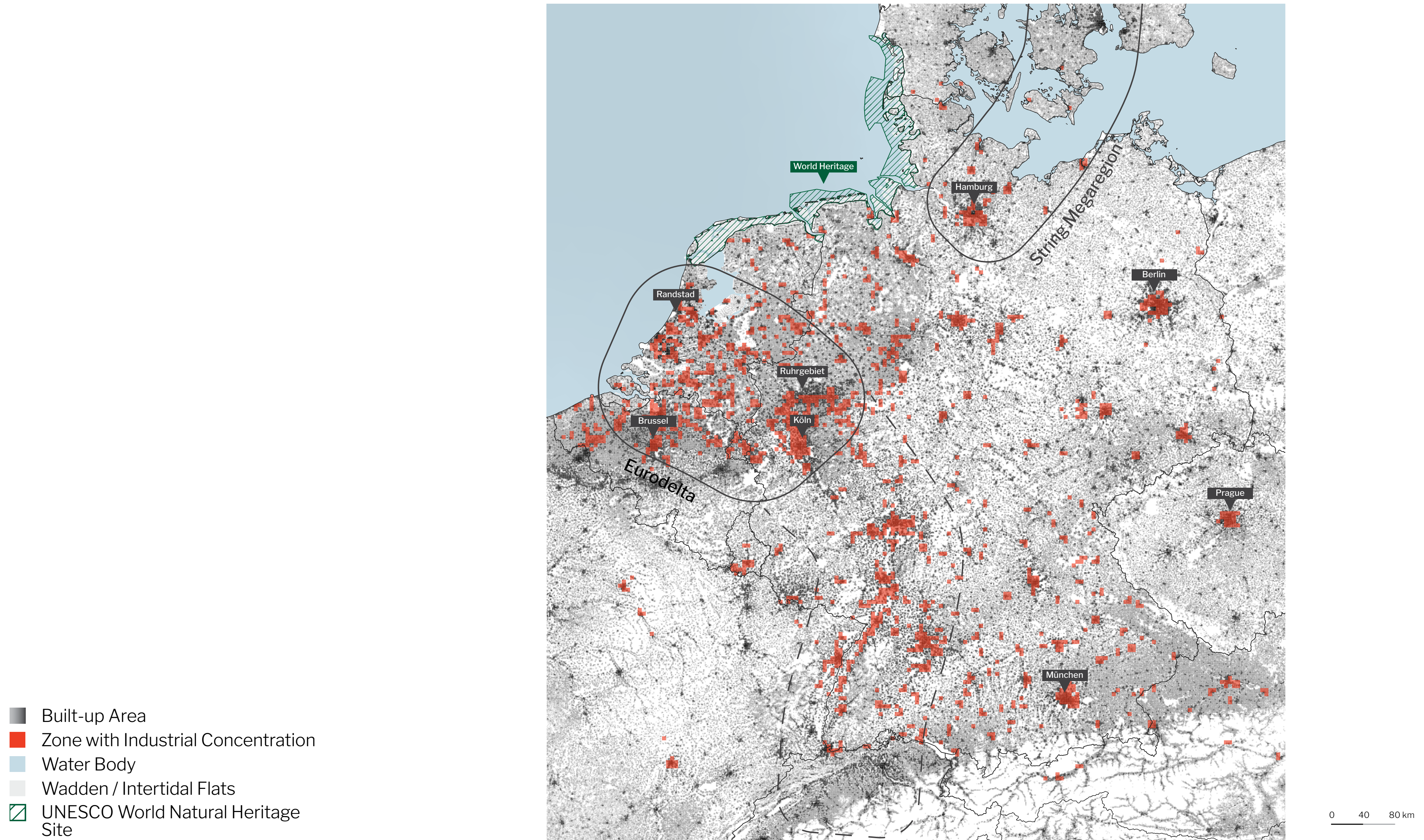
What kind of
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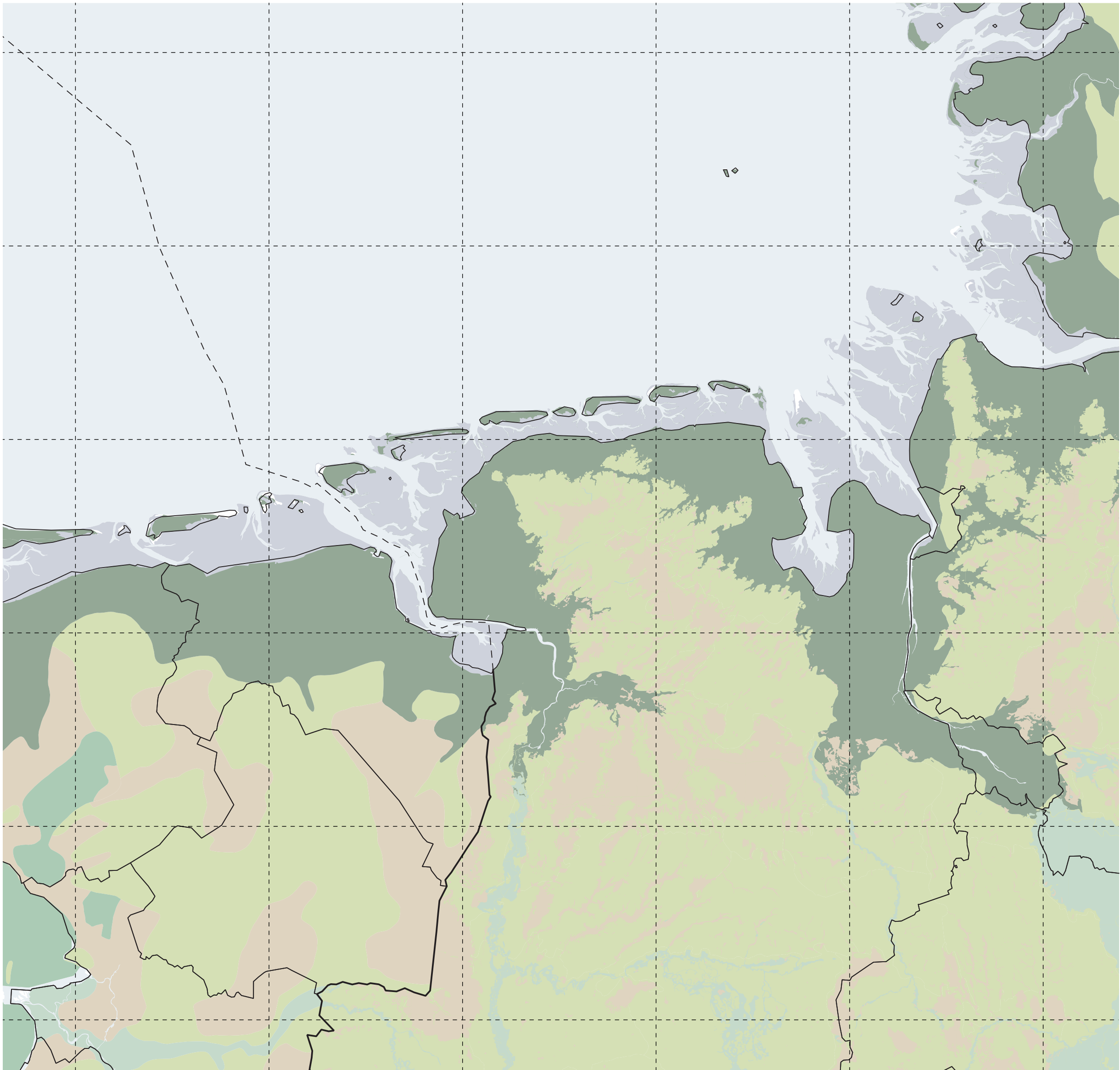
Industrial System

Landscape System

Why the Wadden Sea region?

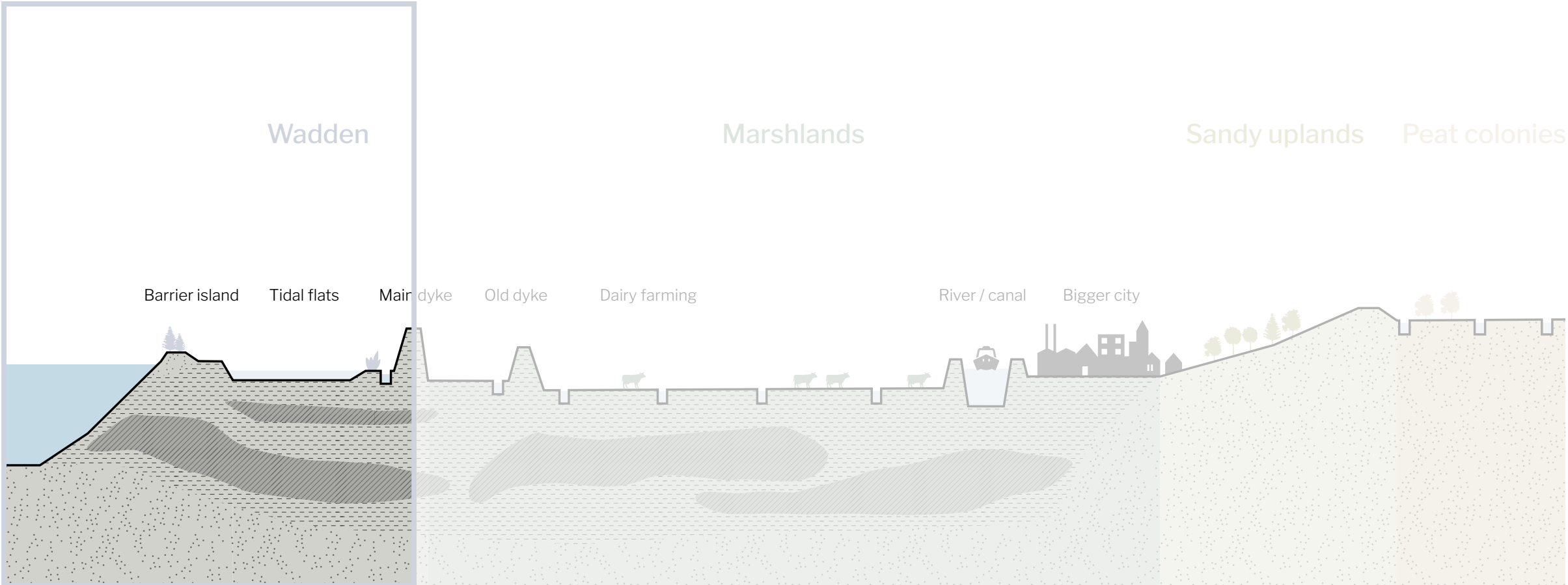


At which landscape types are we looking?

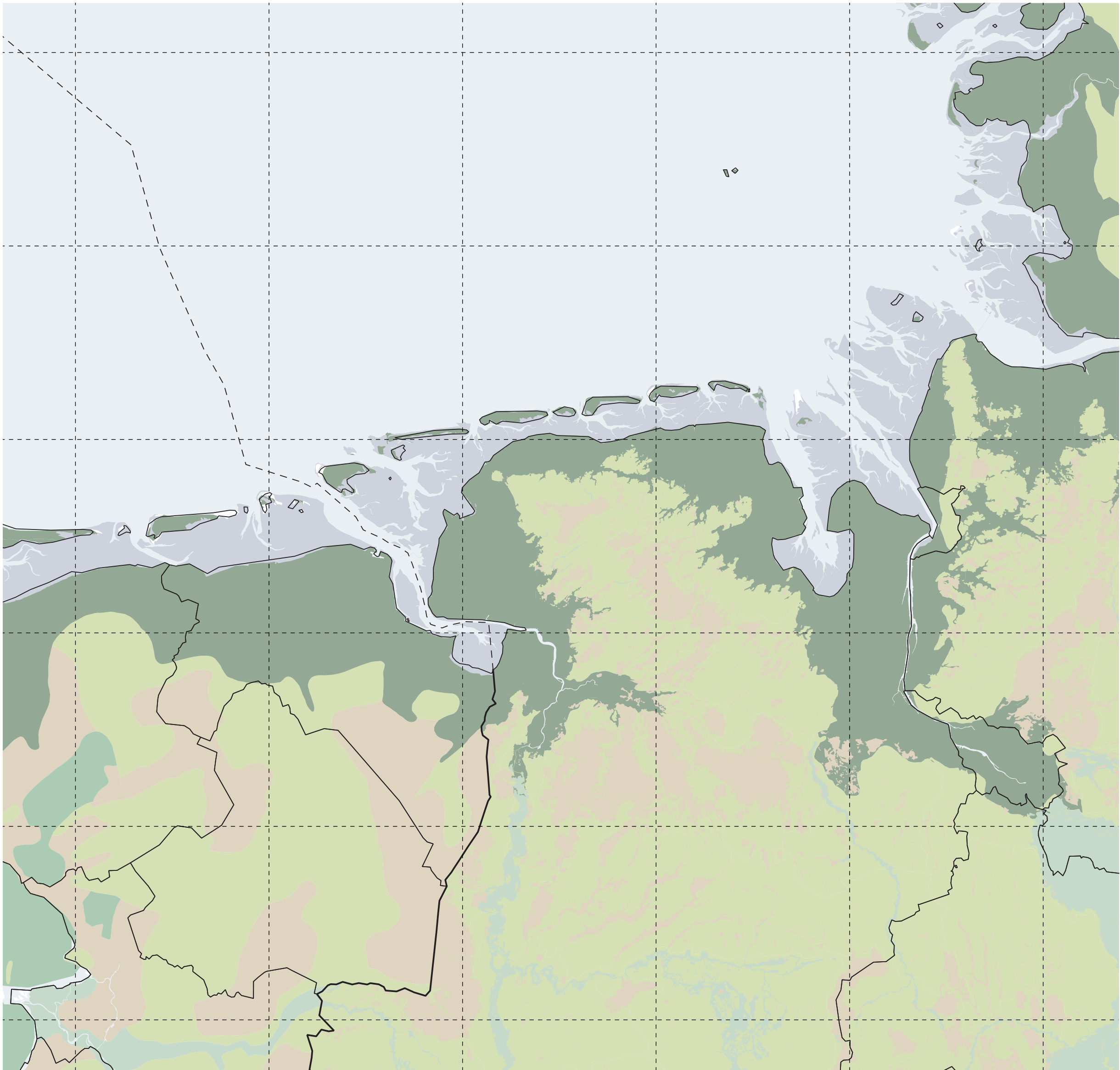


0 10 20 km N

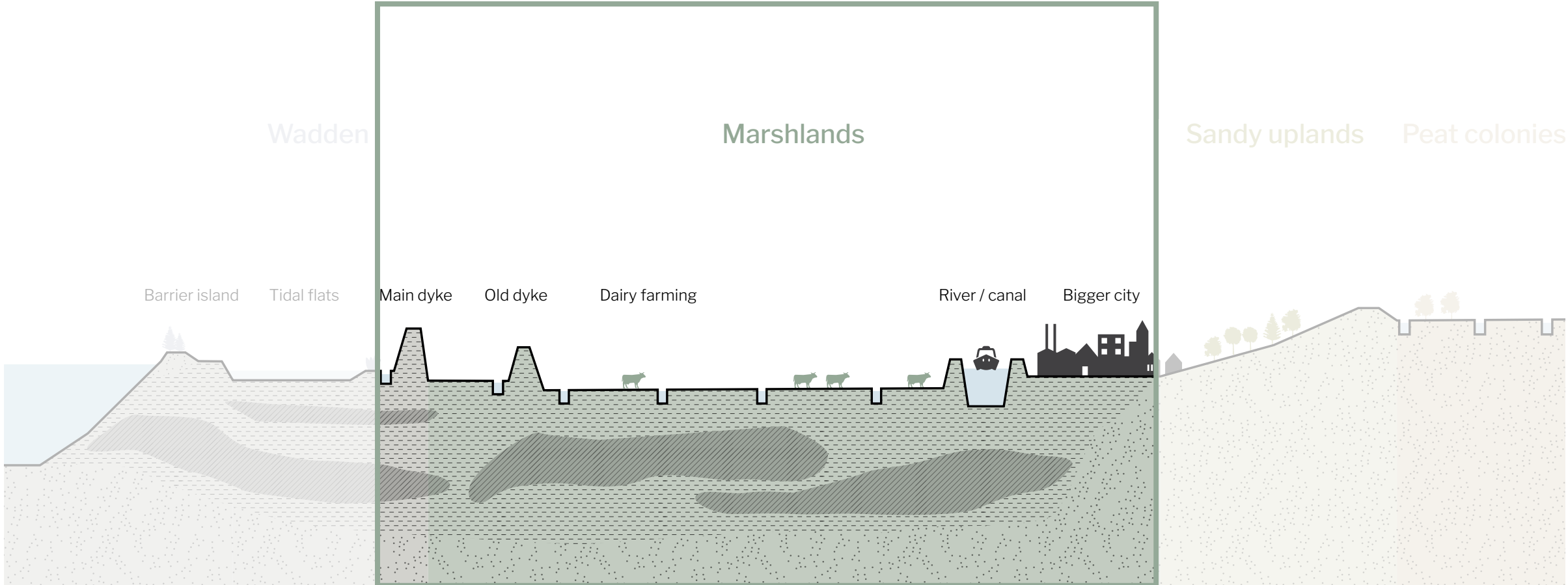
Wadden Sea



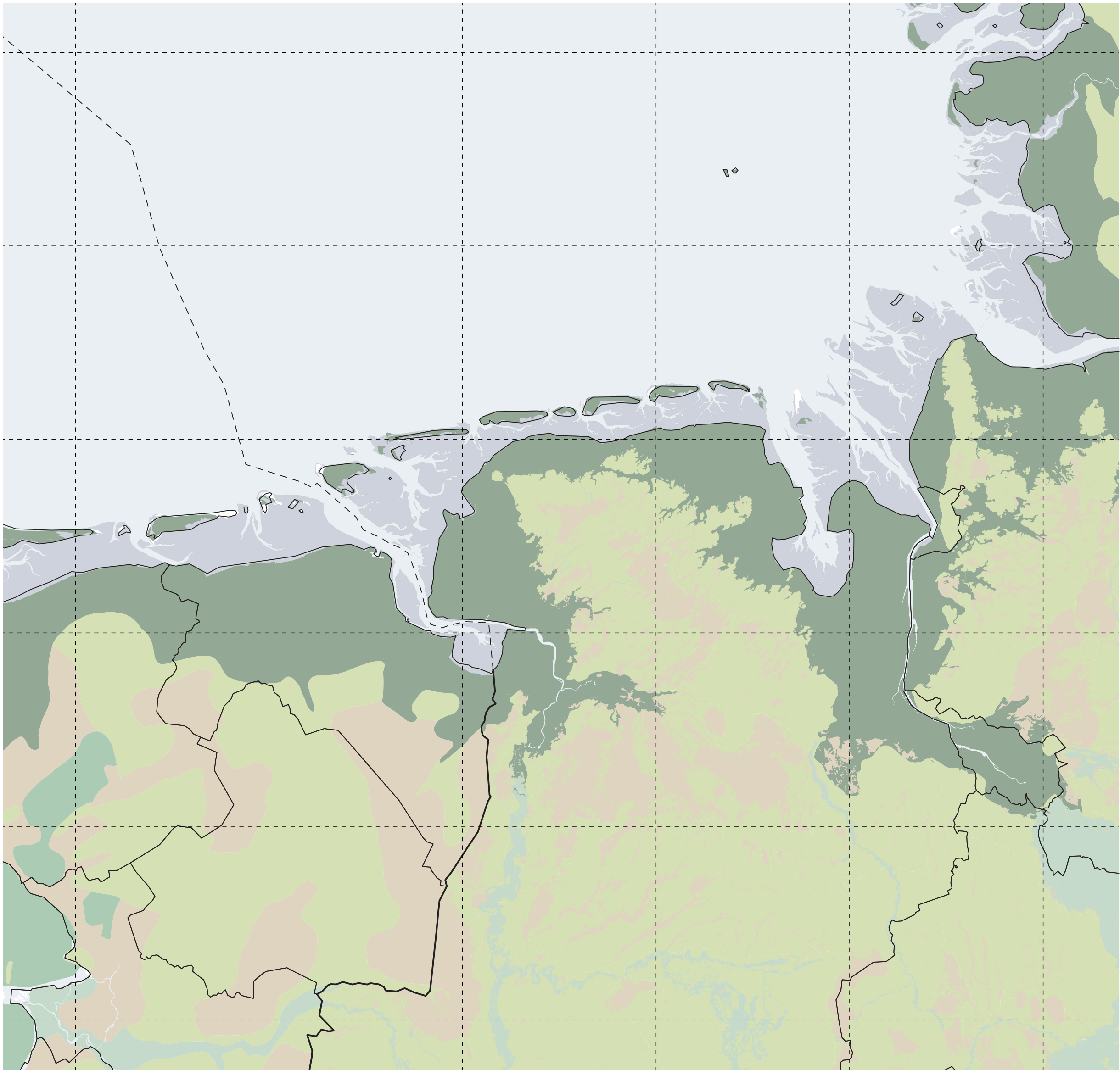
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Marshlands

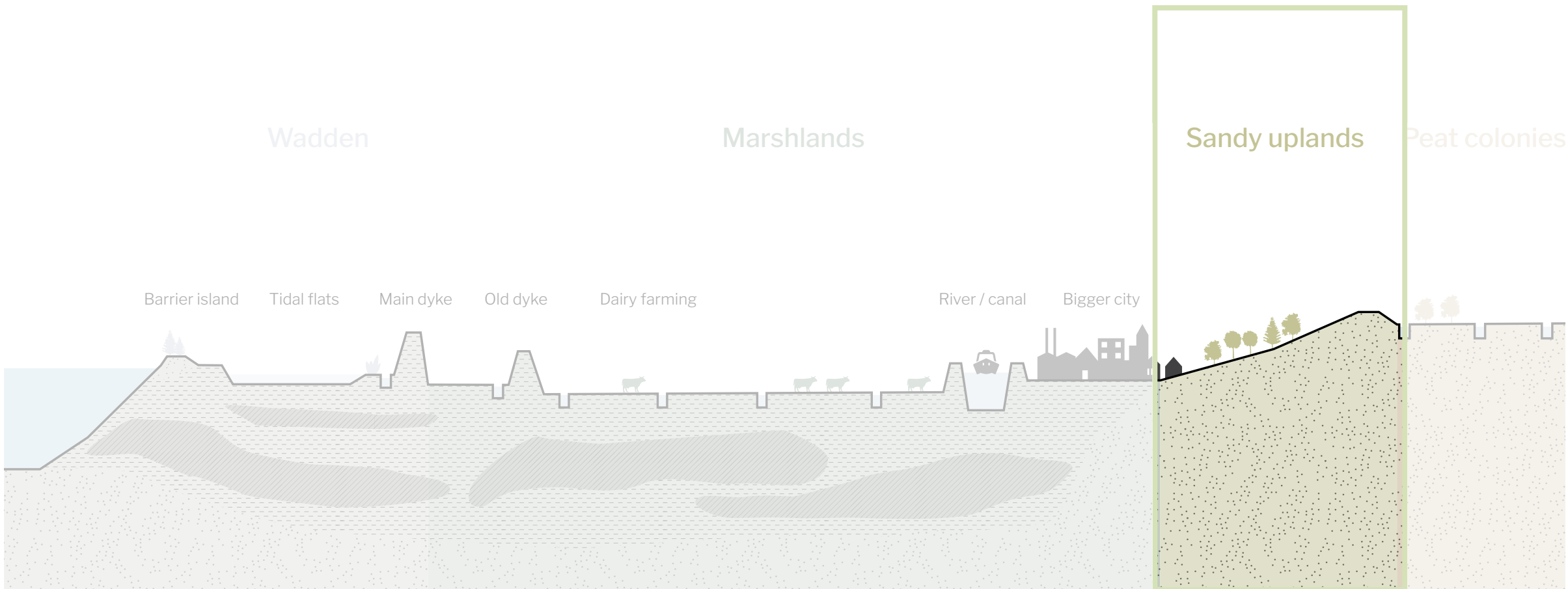


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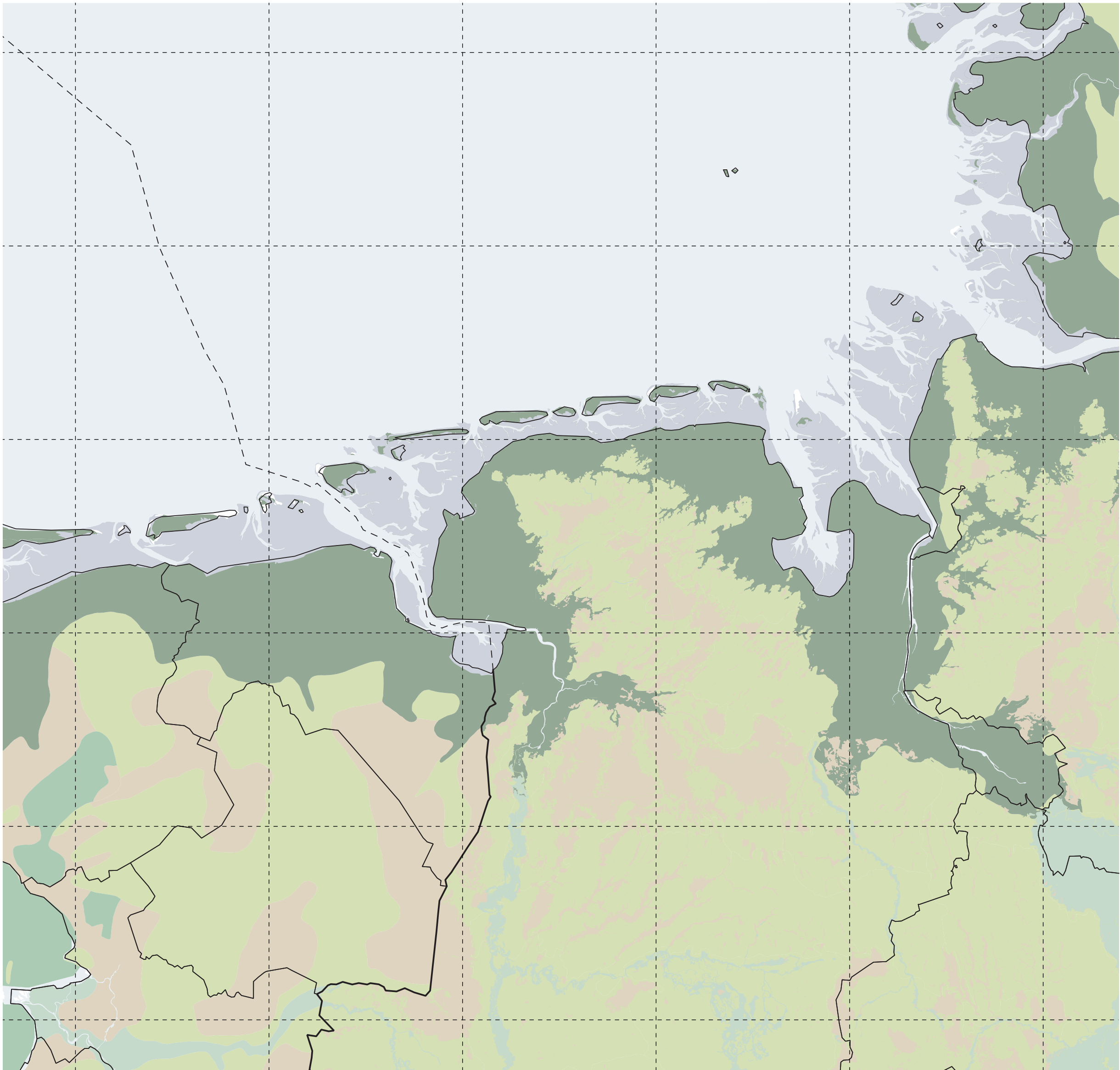


0 10 20 km N

Sandy uplands (geest)

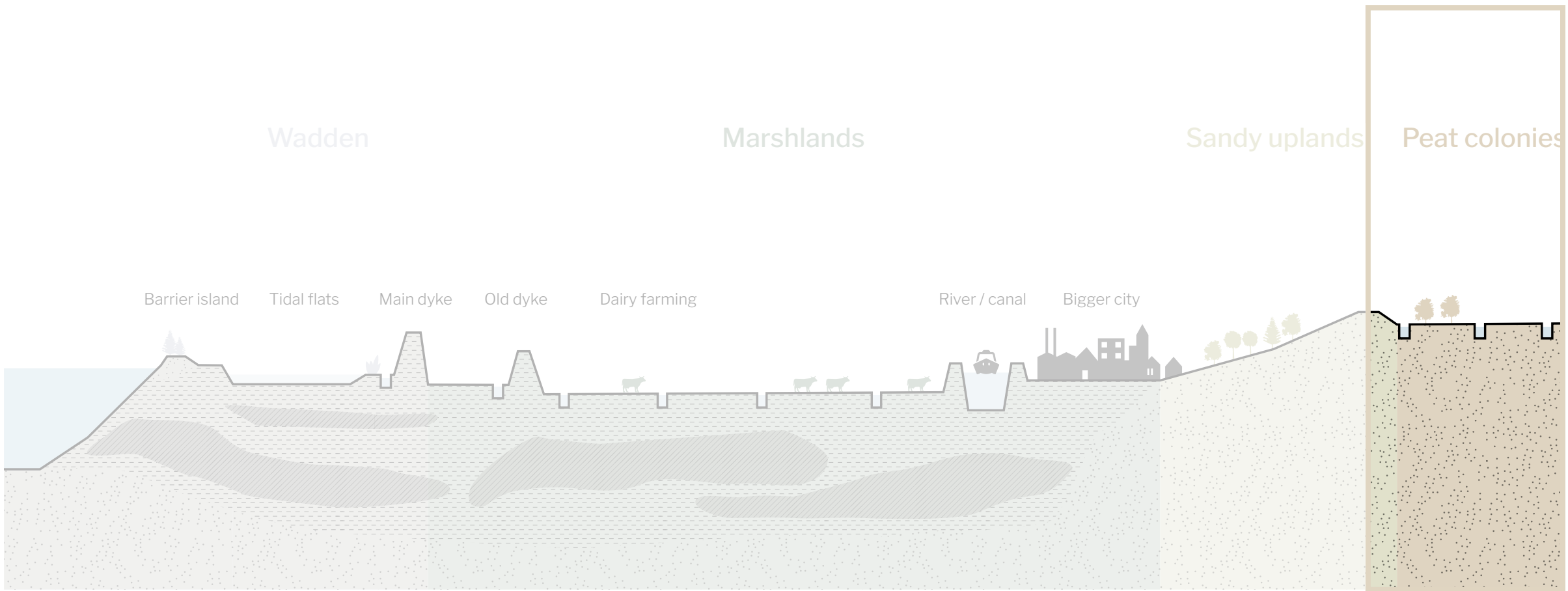


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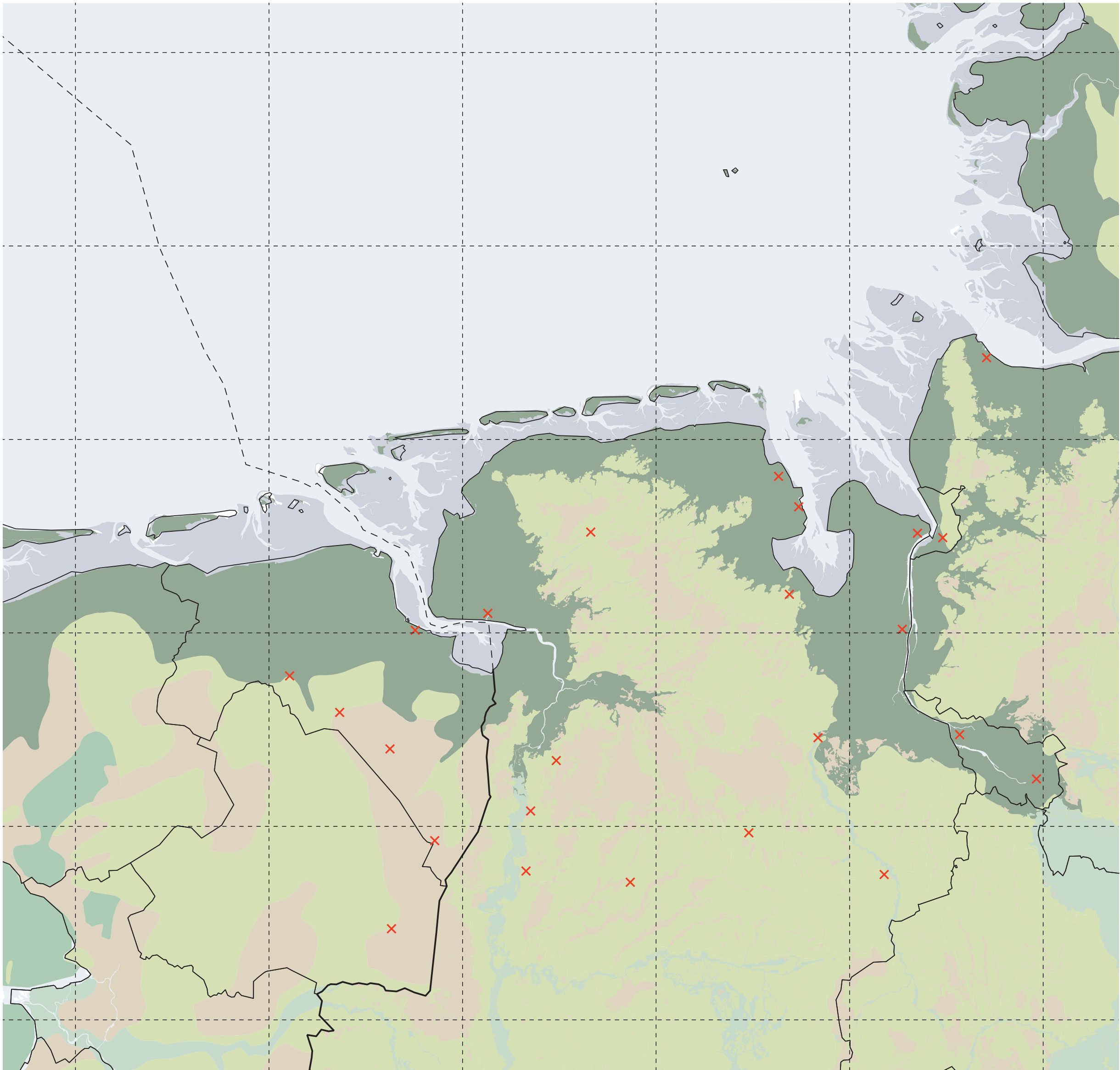


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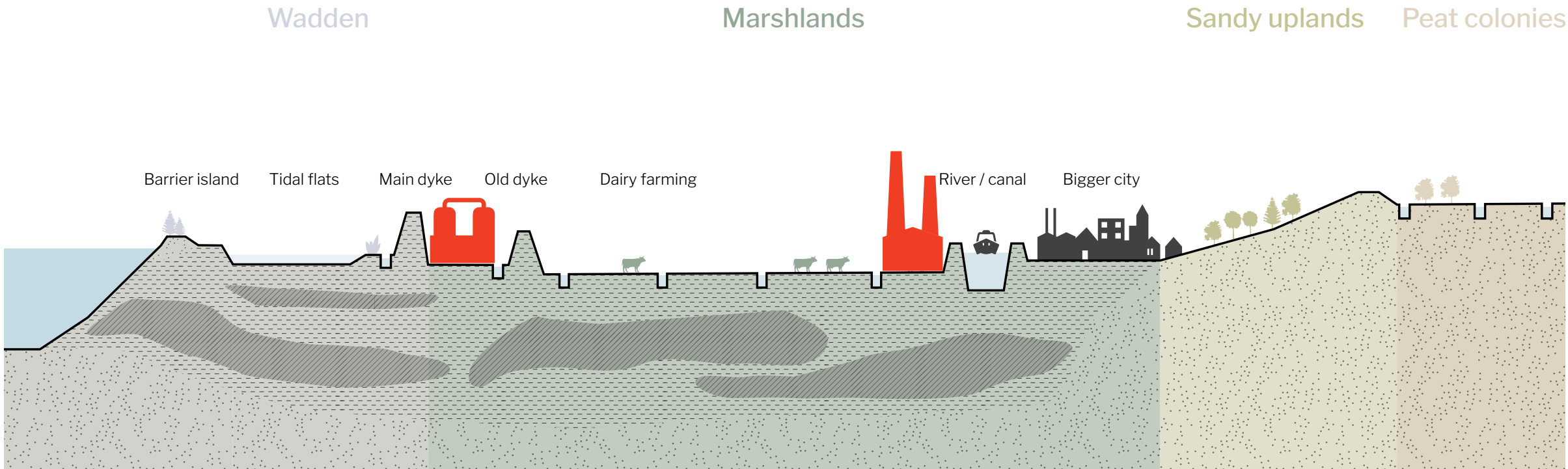
Peat bogs



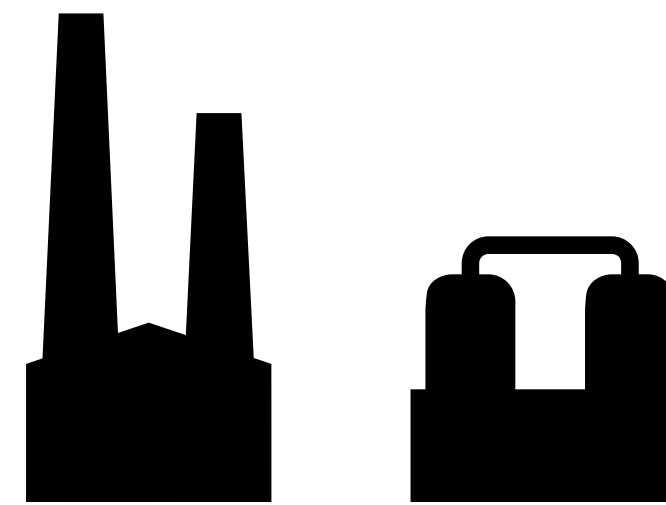
How is industry positioned in this landscape?



Industry

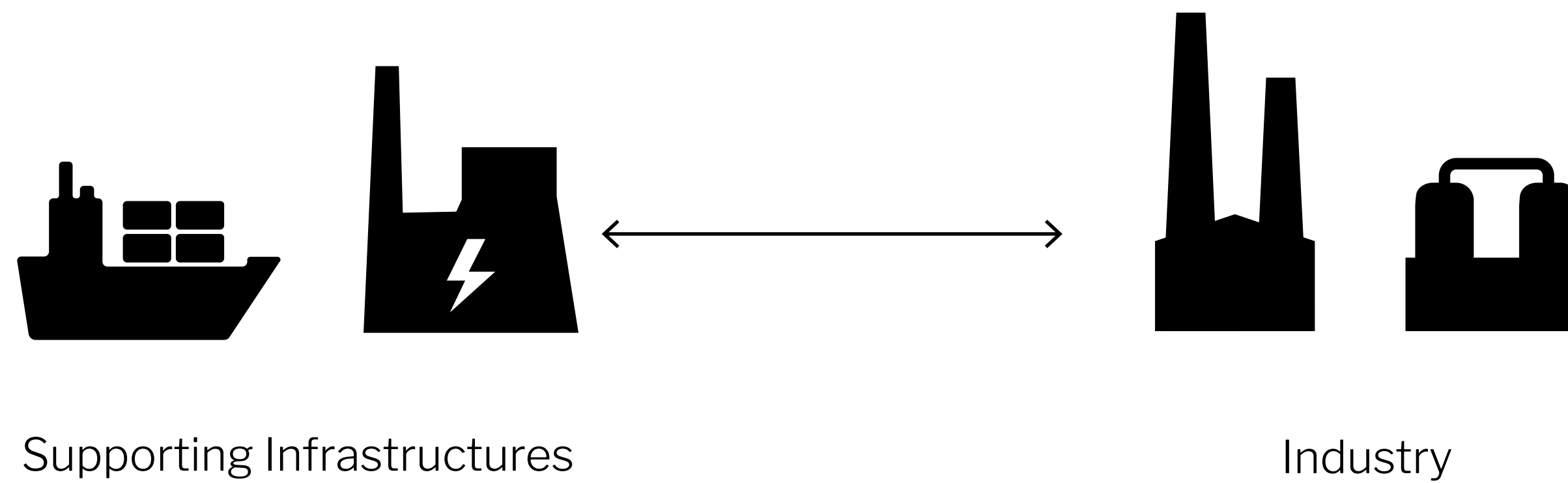


But first, how do you understand an Industrial System?

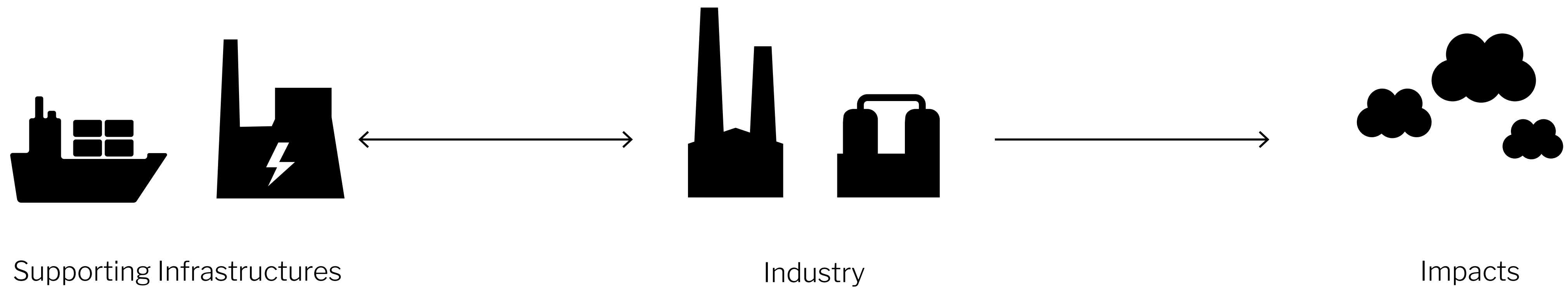


Industry

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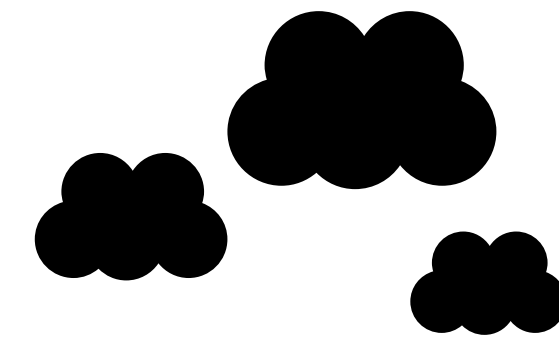
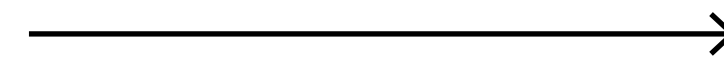
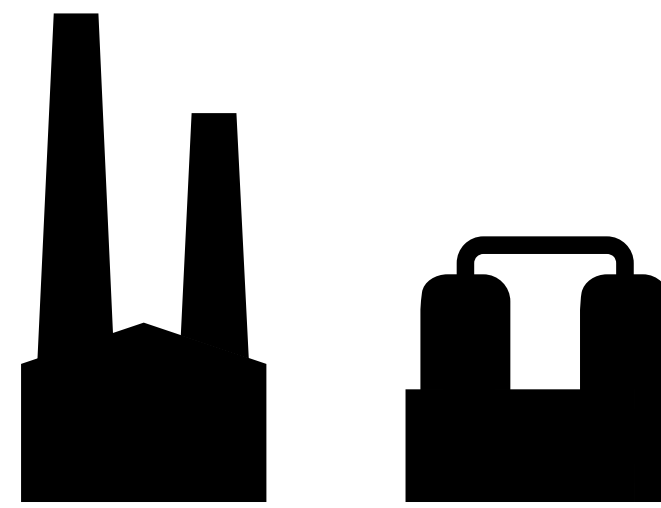
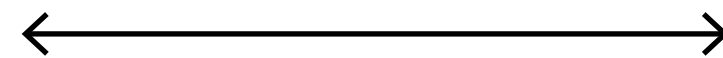
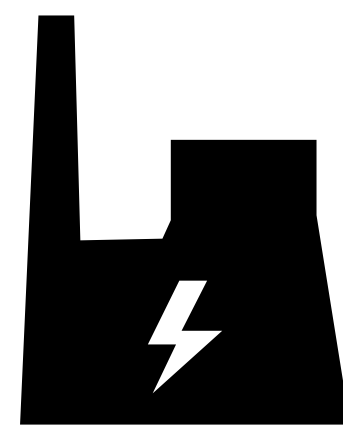
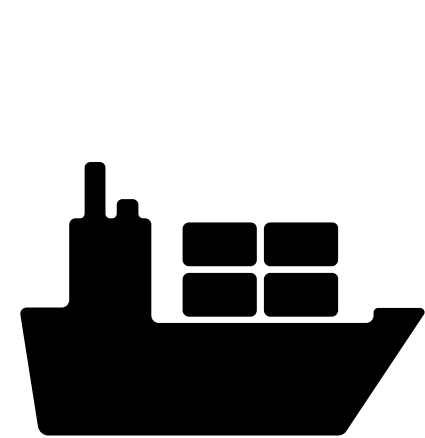


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Industrial System



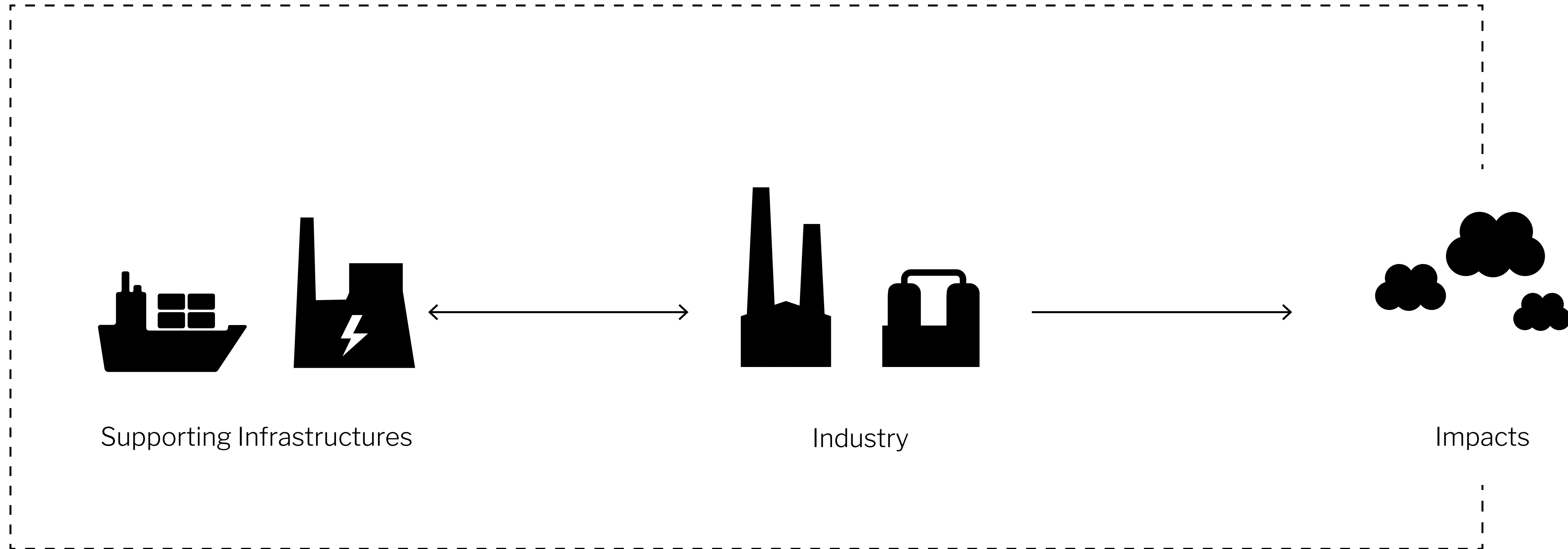
Supporting Infrastructures

Industry

Impacts

But first, how do you understand an Industrial System?

Industrial System



Supporting Infrastructures

Industry

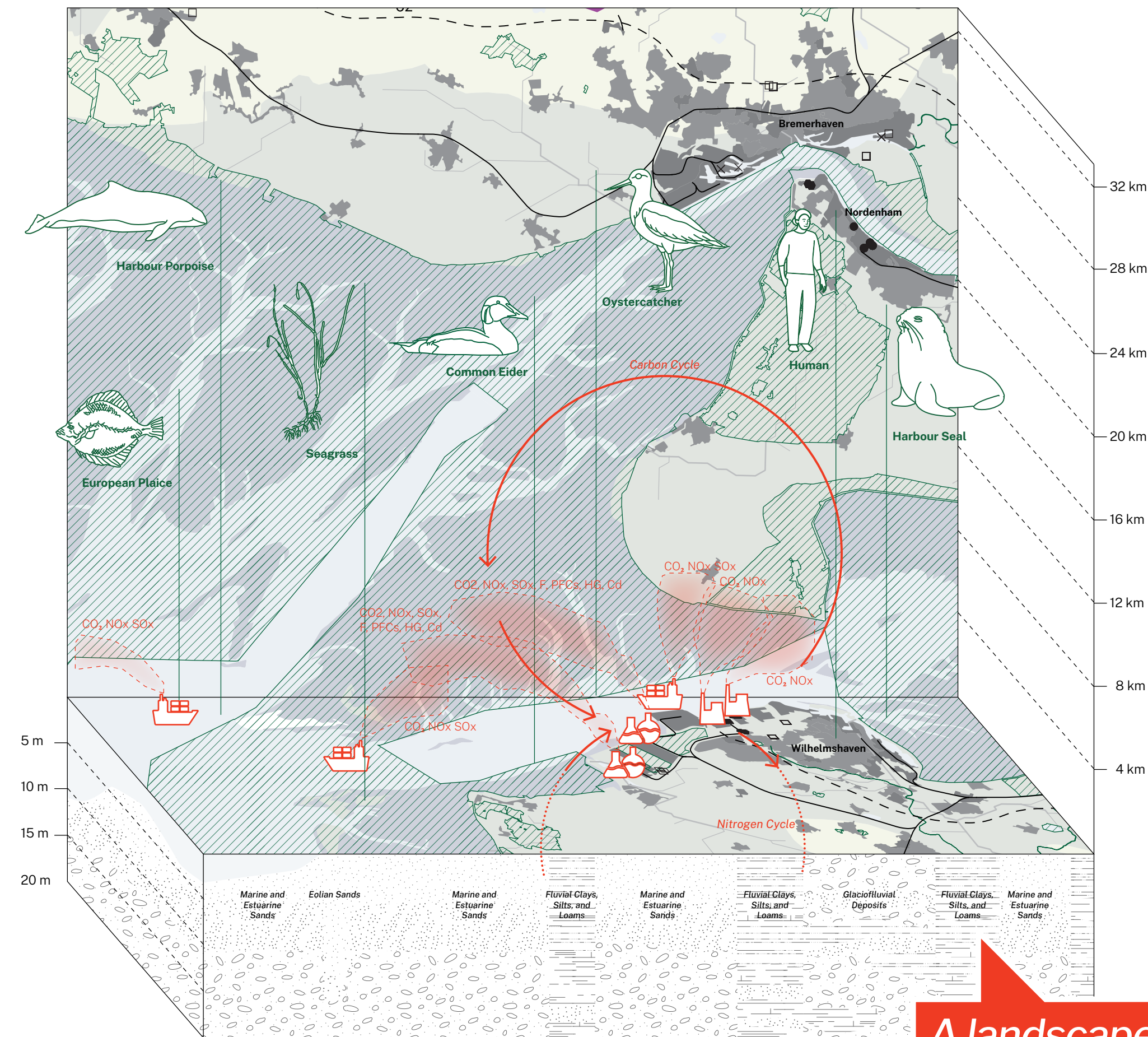
Impacts

Ecosystems
Society

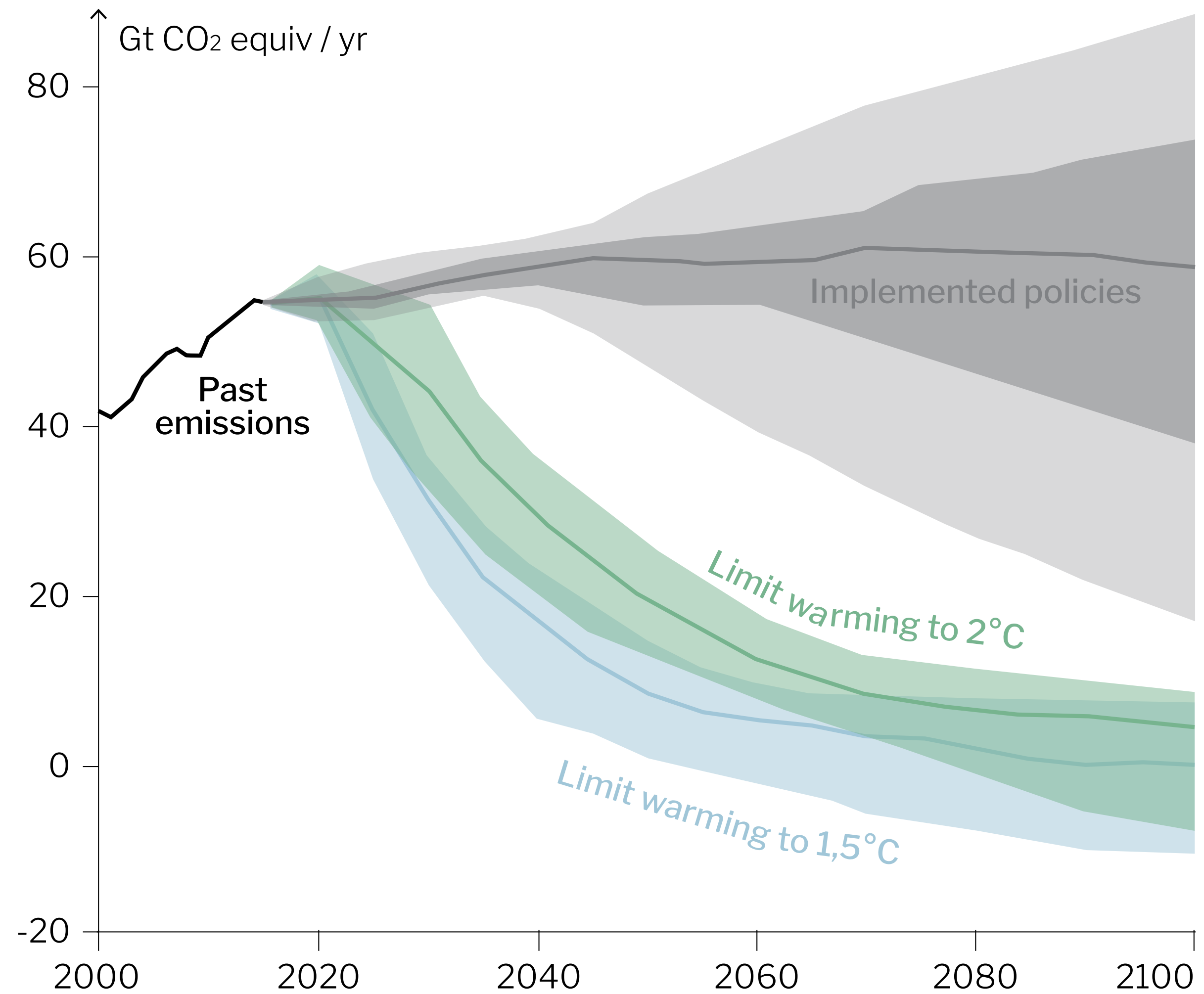
Functions
Morphology

Landscape

Where does this coexistence lead to?



Why now?

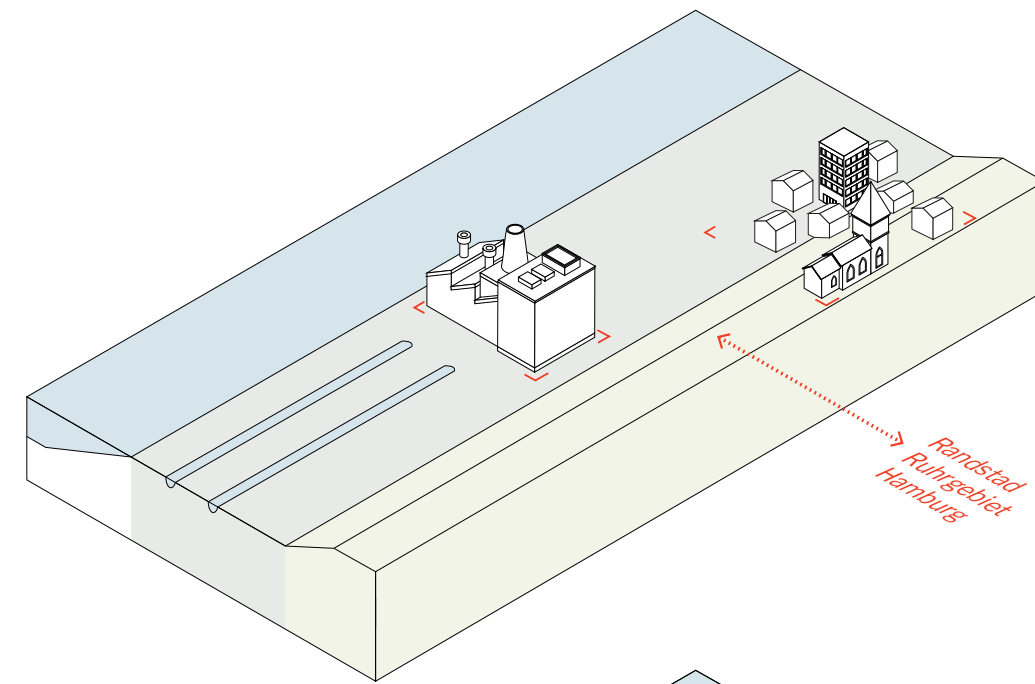
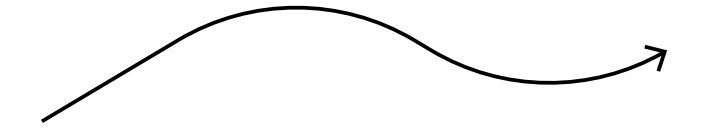


Global CO₂ mitigation paths (Source: IPCC, 2023)

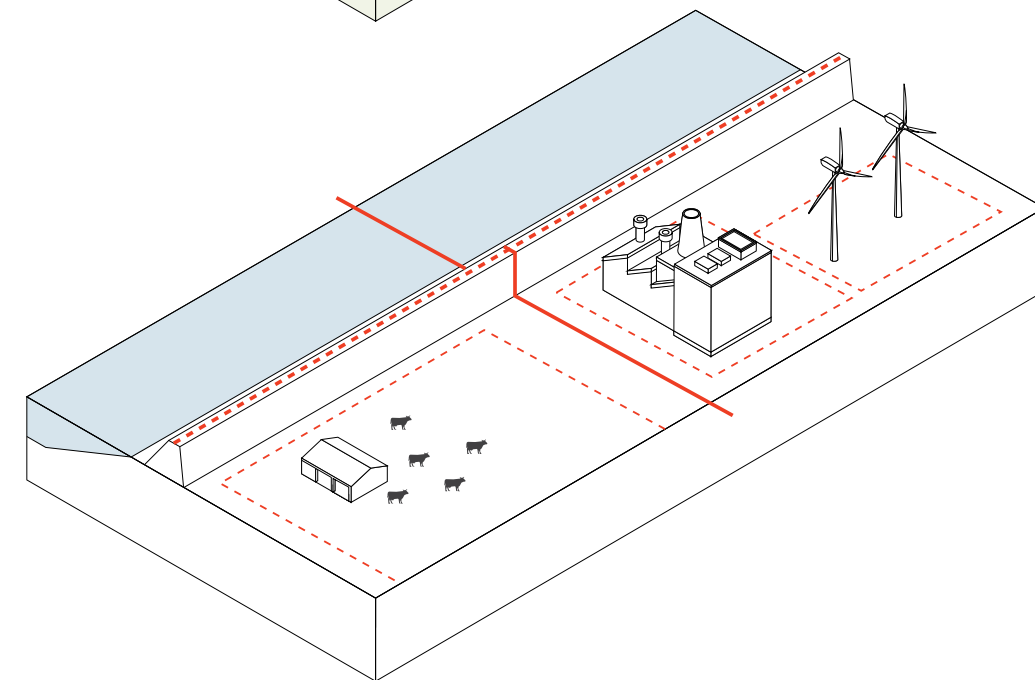
Why now?



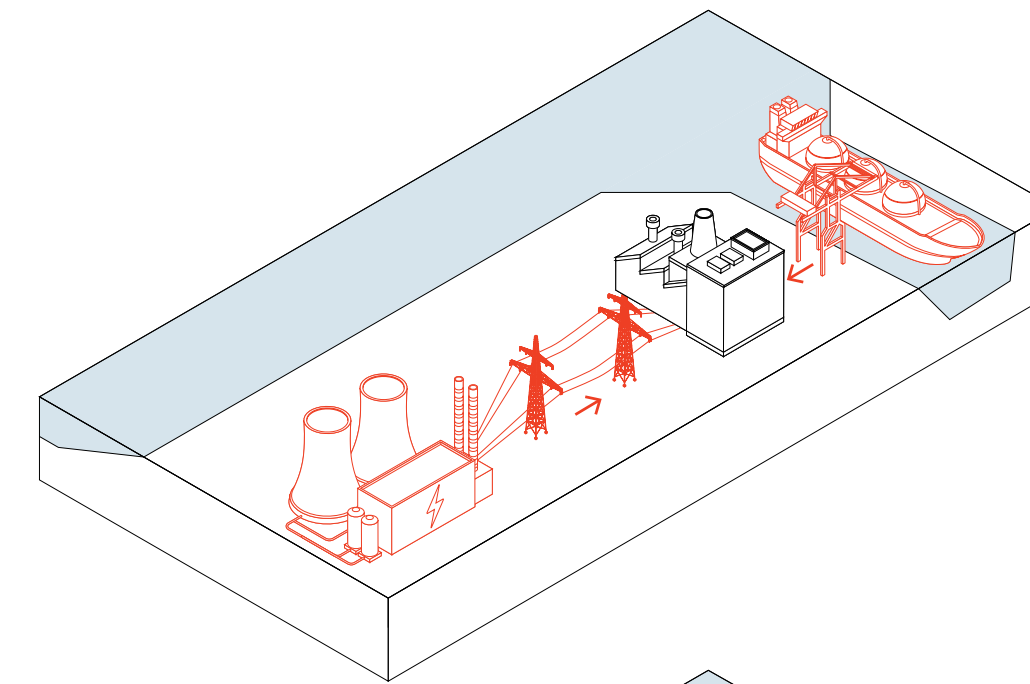
How to frame the problem here?



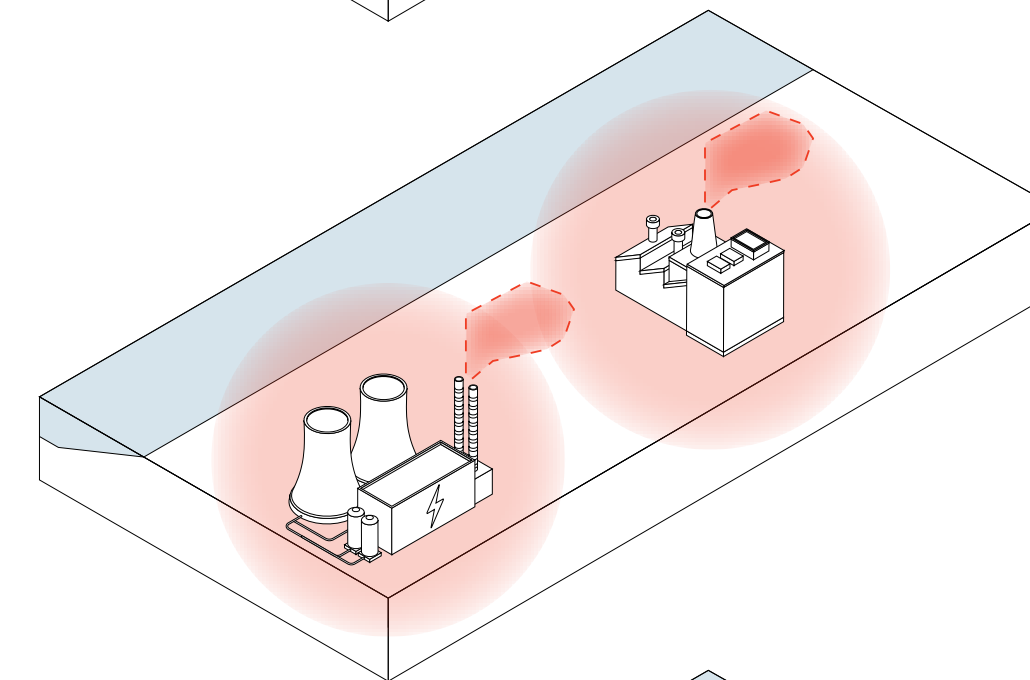
Man-Made Semi-Peripheral
Landscapes



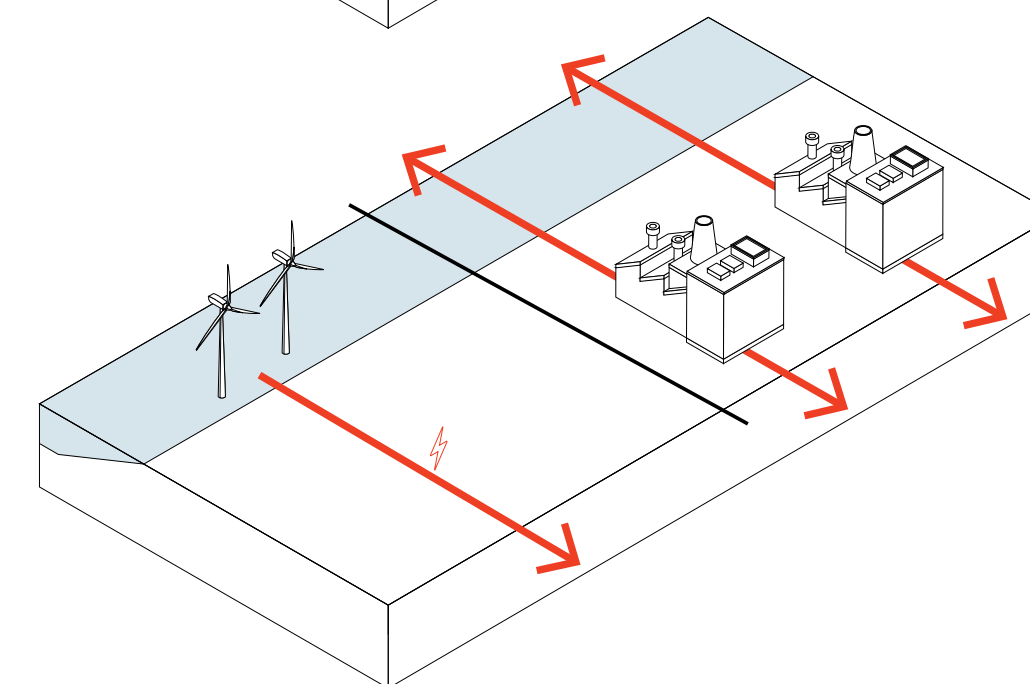
A Region Shaped by
Borders



Industry's Infrastructural
Footprint

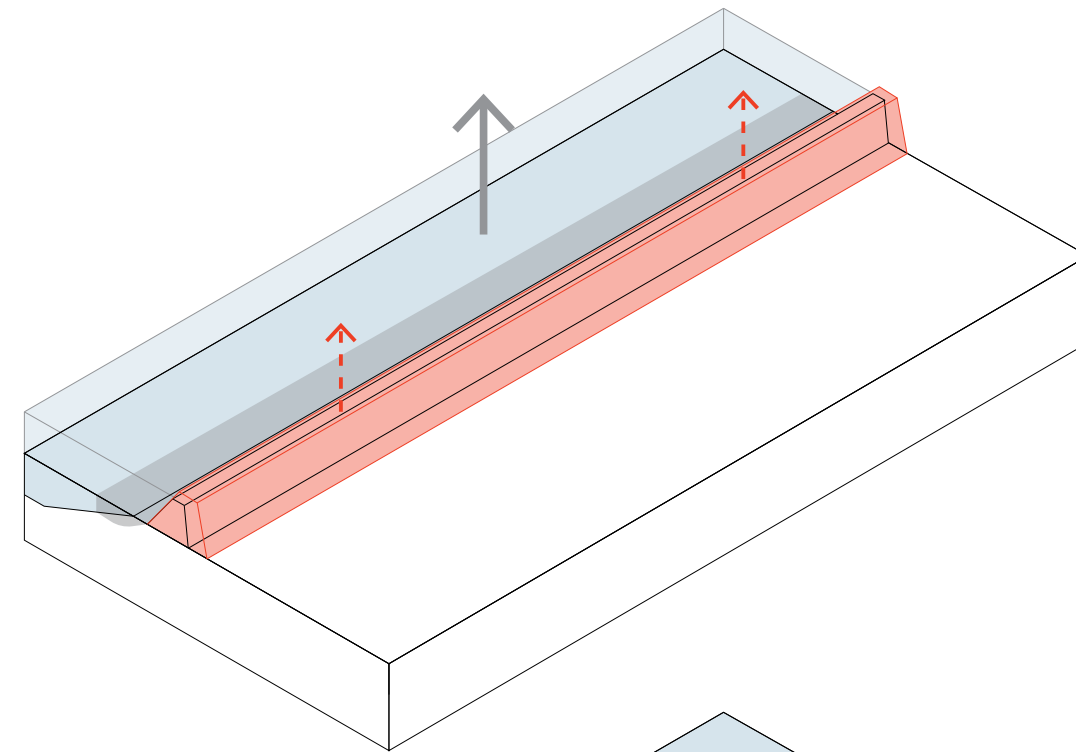
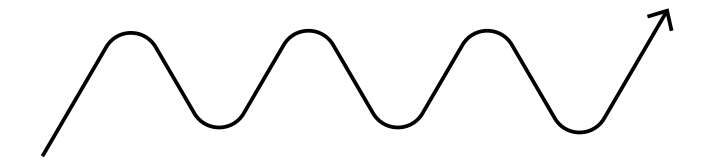


Pollution in a Fragile
Landscape

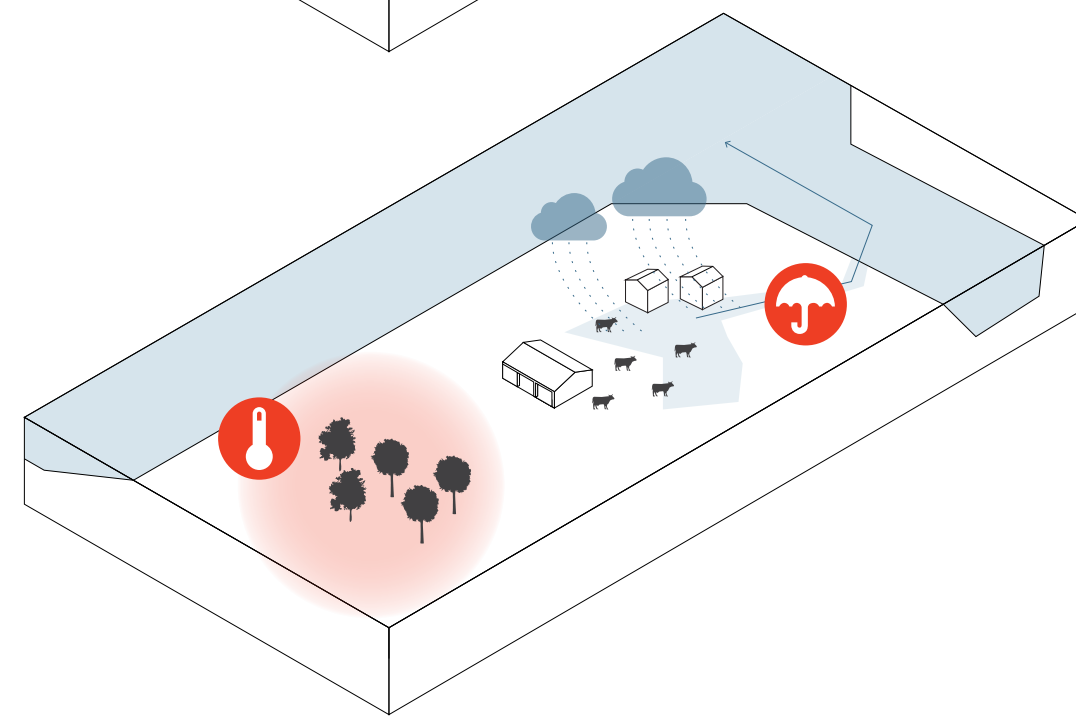


The Throughput Nature of
Flows

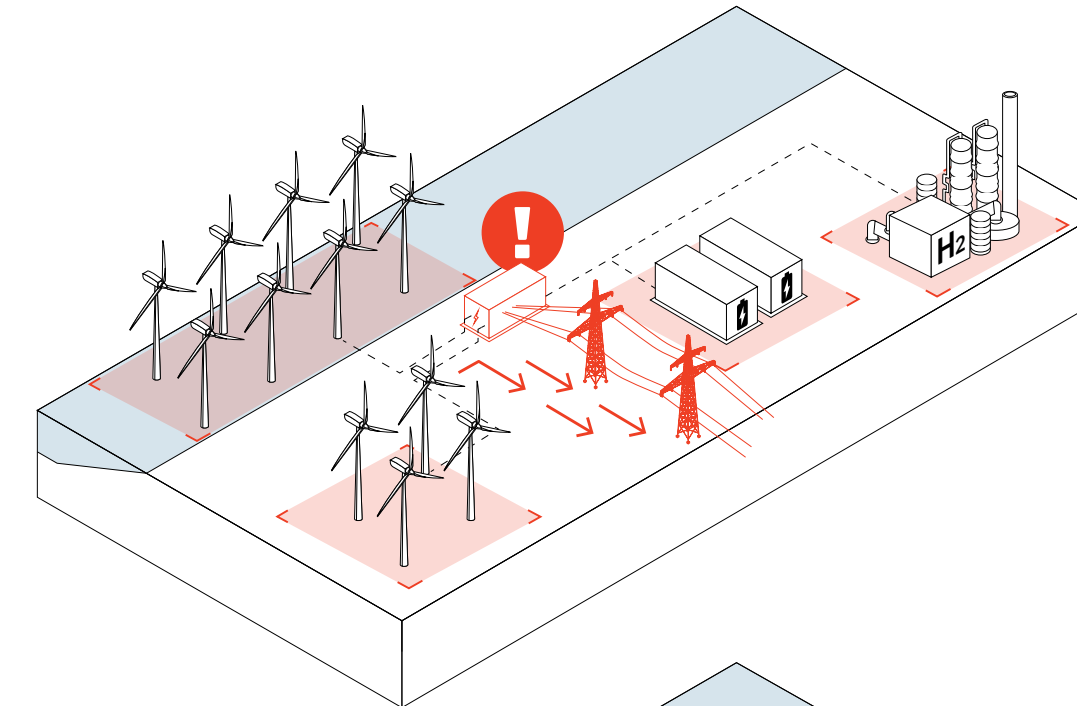
How to frame the problem here?



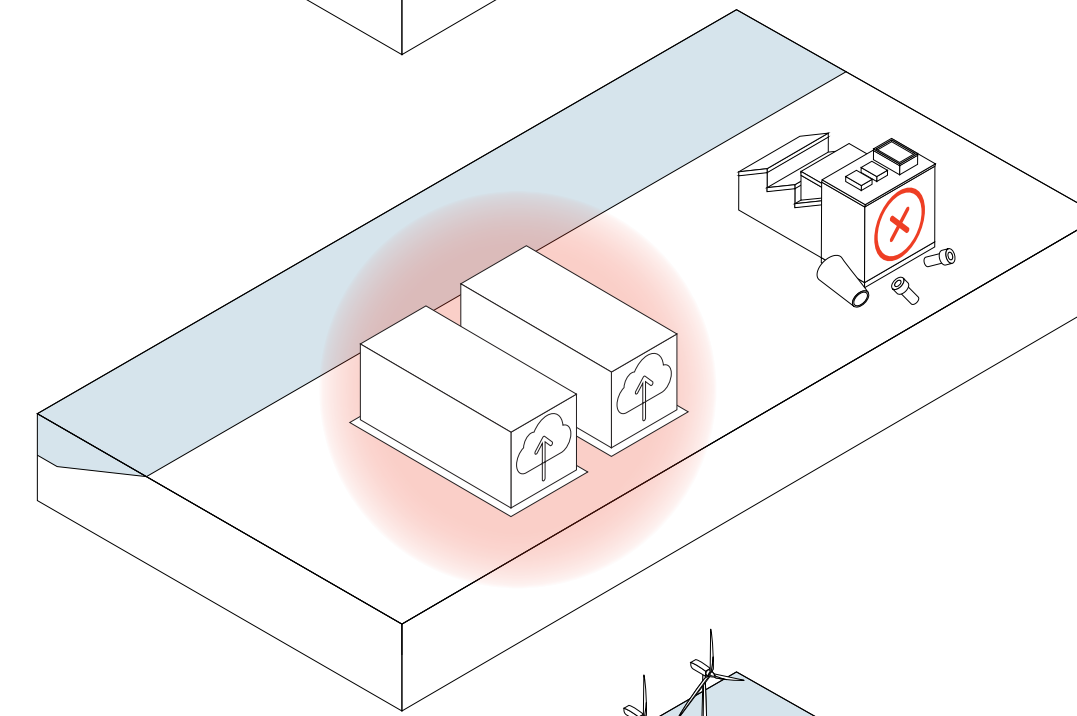
Effects of Rising Sea Levels



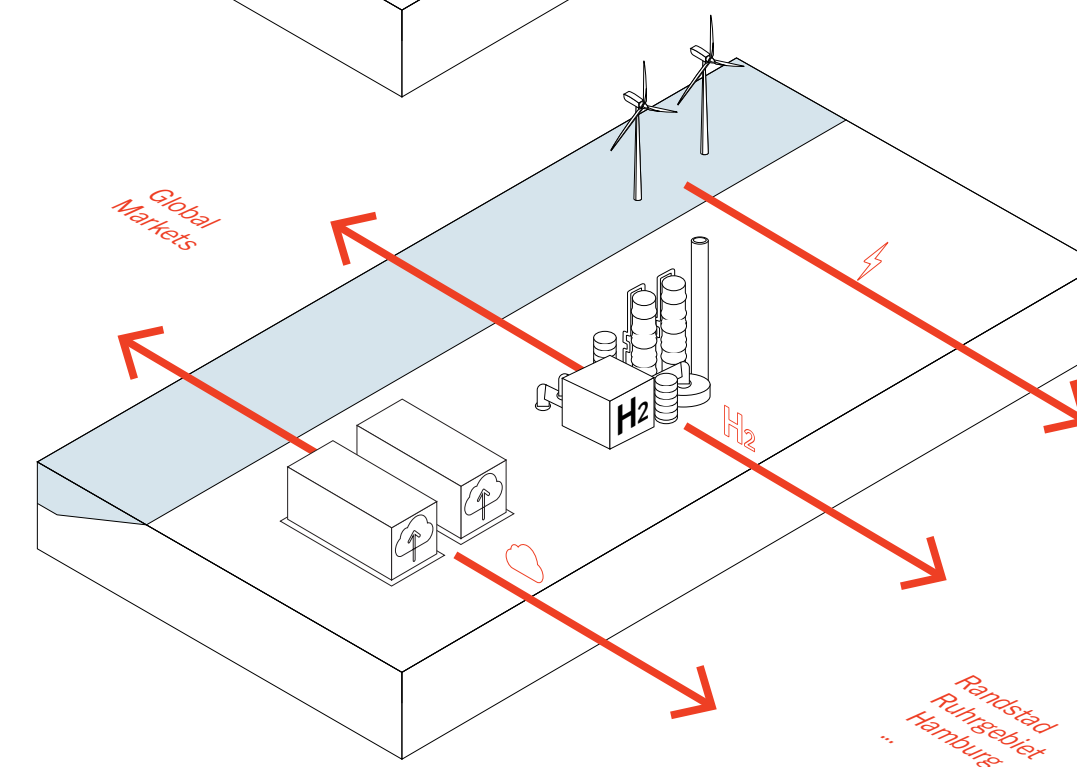
Climate Change in the Hinterland



New Dependencies of Renewables

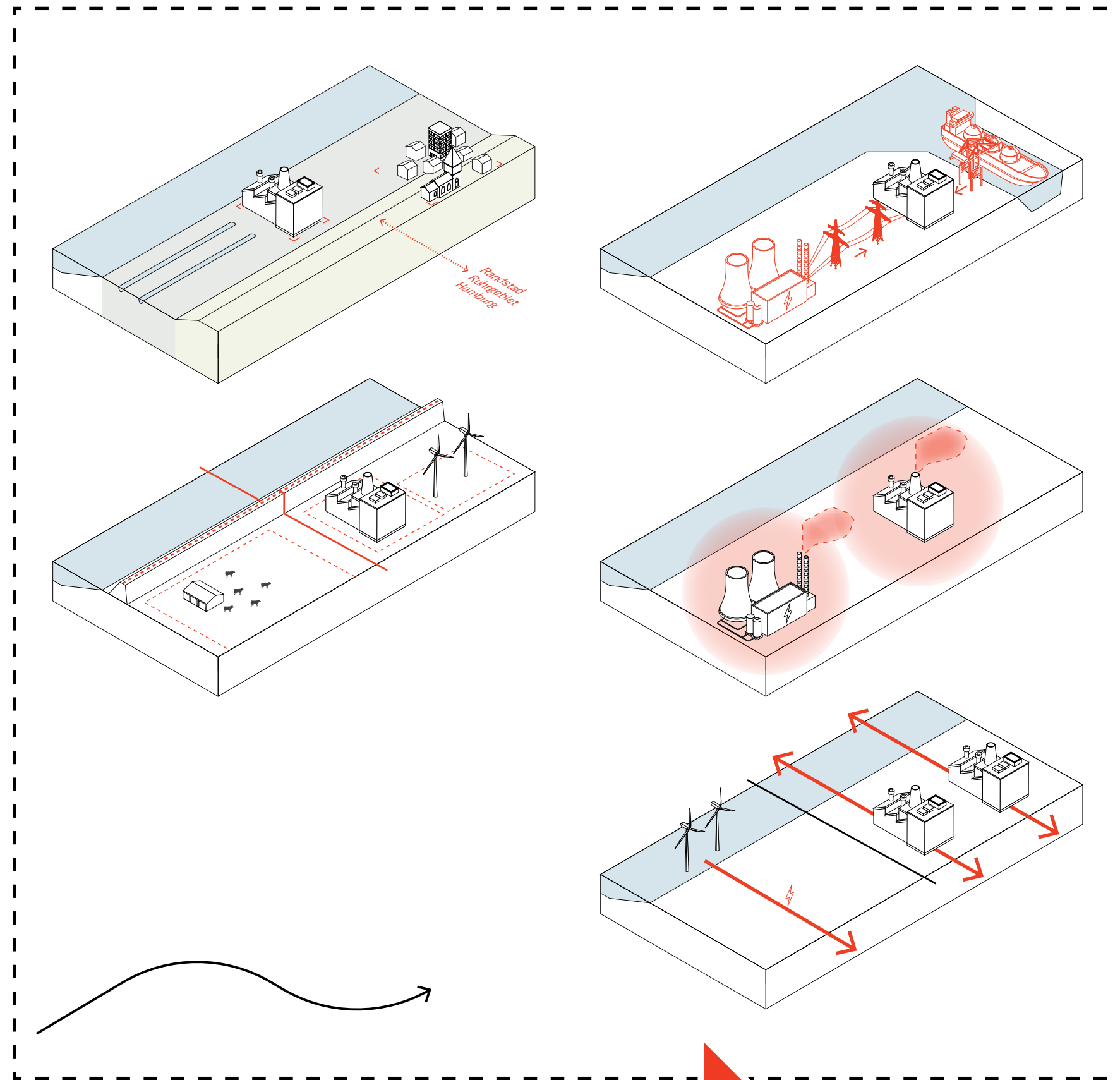


Changed Pattern of Manufacturing

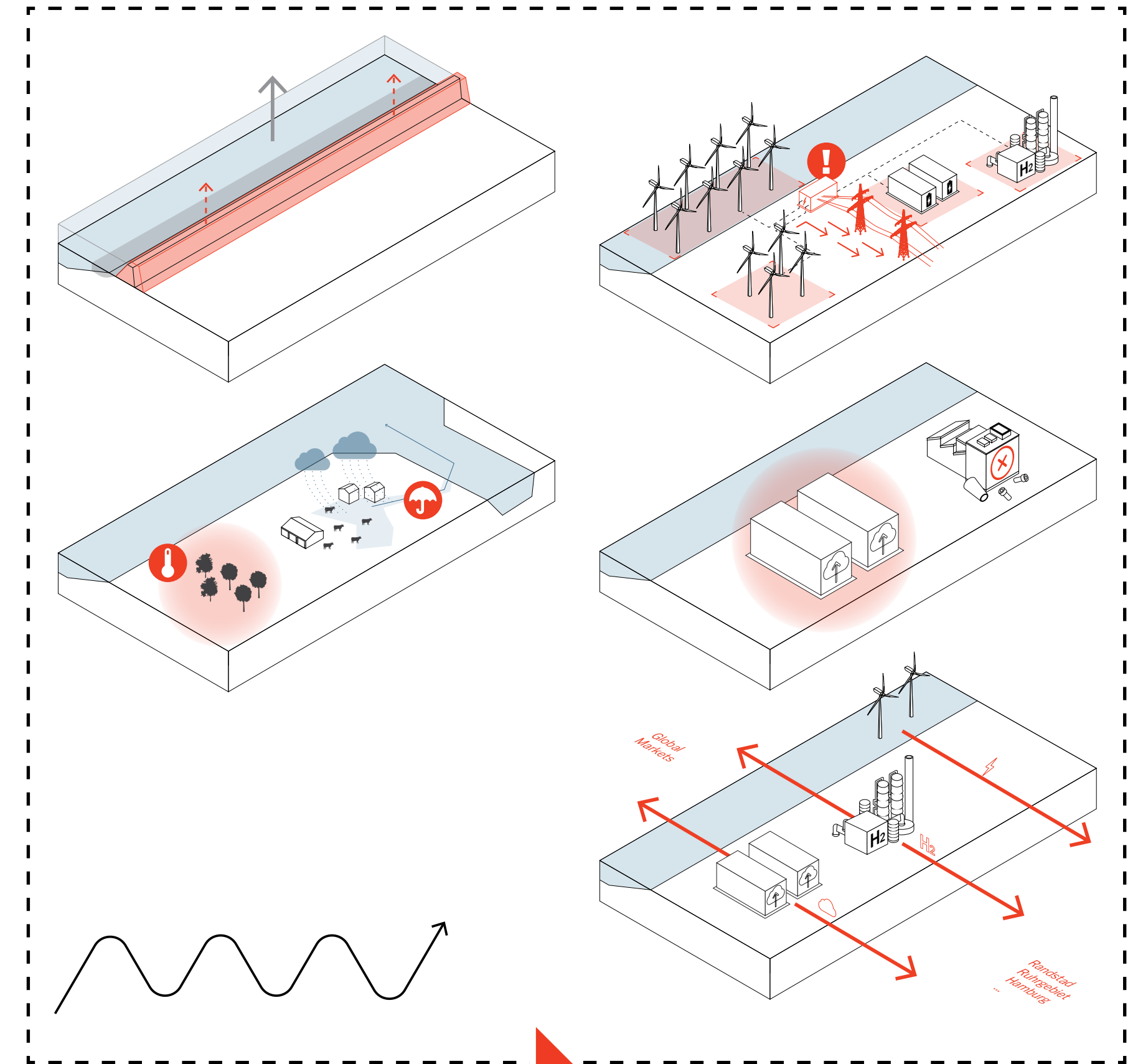
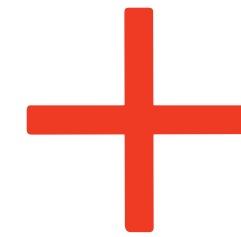


Semi-Periphery, but Rethought

How to frame the problem here?



*The region is a semi-peripheral
"Operational Hinterland"*

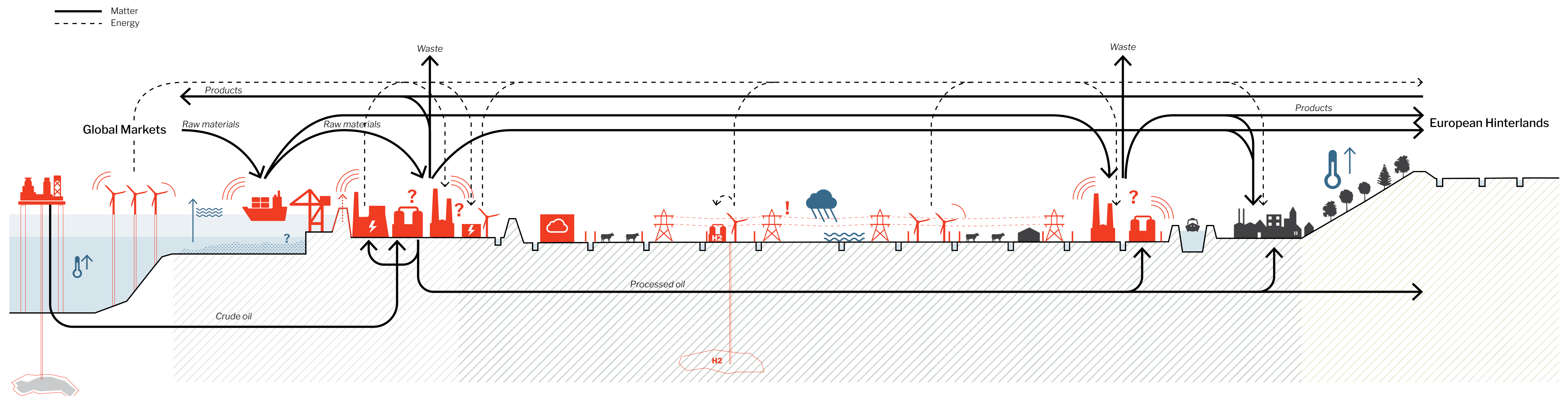


*Climate change and deep
changes in production*

How to frame the problem here?

→ Synthesised Problem Statement

Situated in a unique and ecologically vulnerable zone, the Wadden Sea region functions as an operational hinterland defined by infrastructural throughput and industrial extraction. As climate breakdown intensifies and supply chains shift, its spatial logic is reaching its limits, demanding a new imagination of regional development.

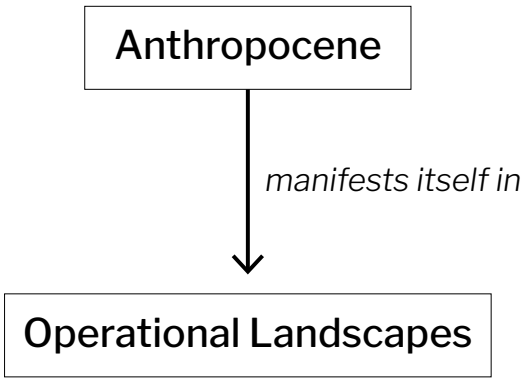


There is a Need to

Transform

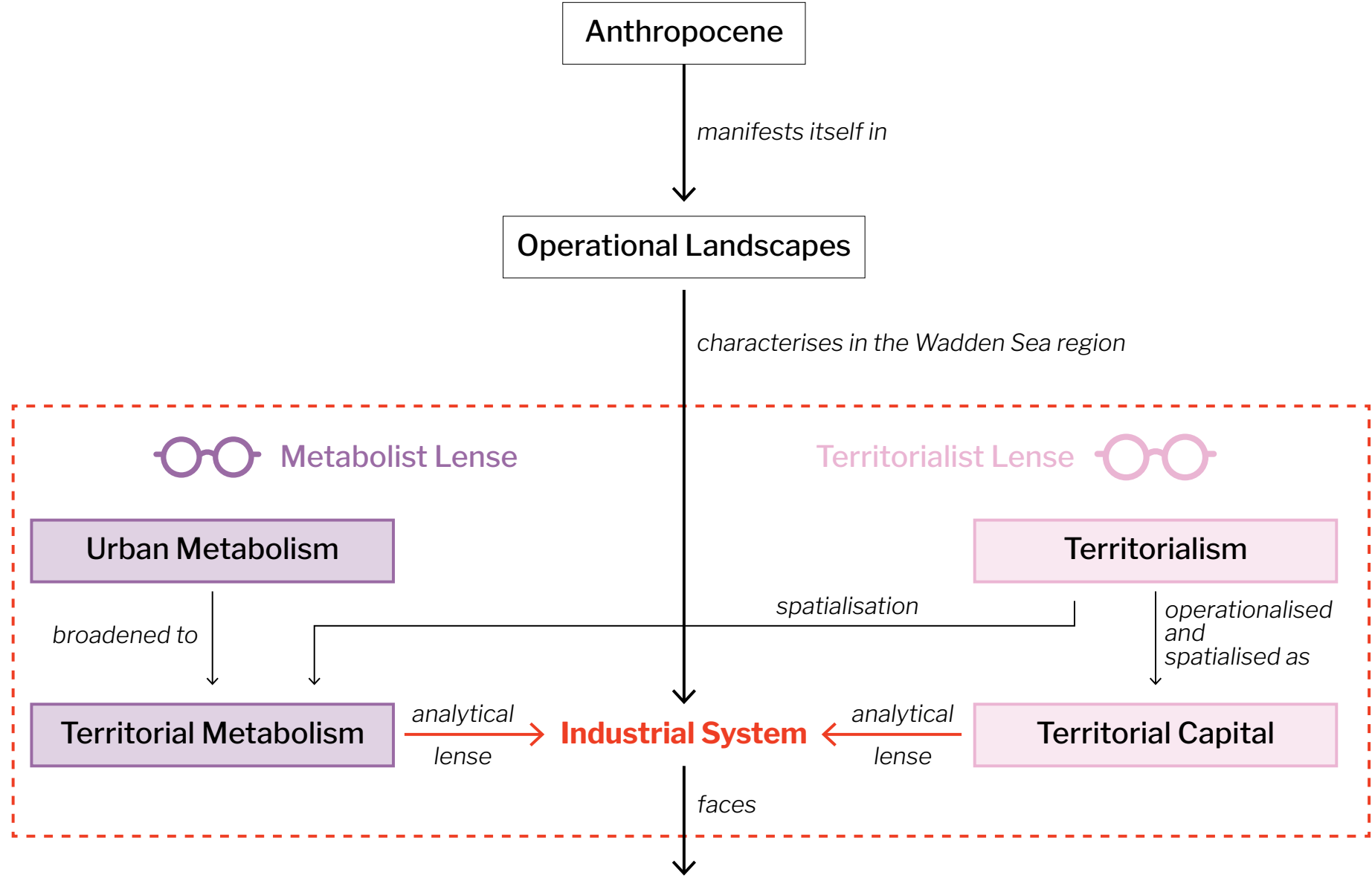
the Industrial System of the Wadden Sea Region

What concepts help to frame this issue?



Context

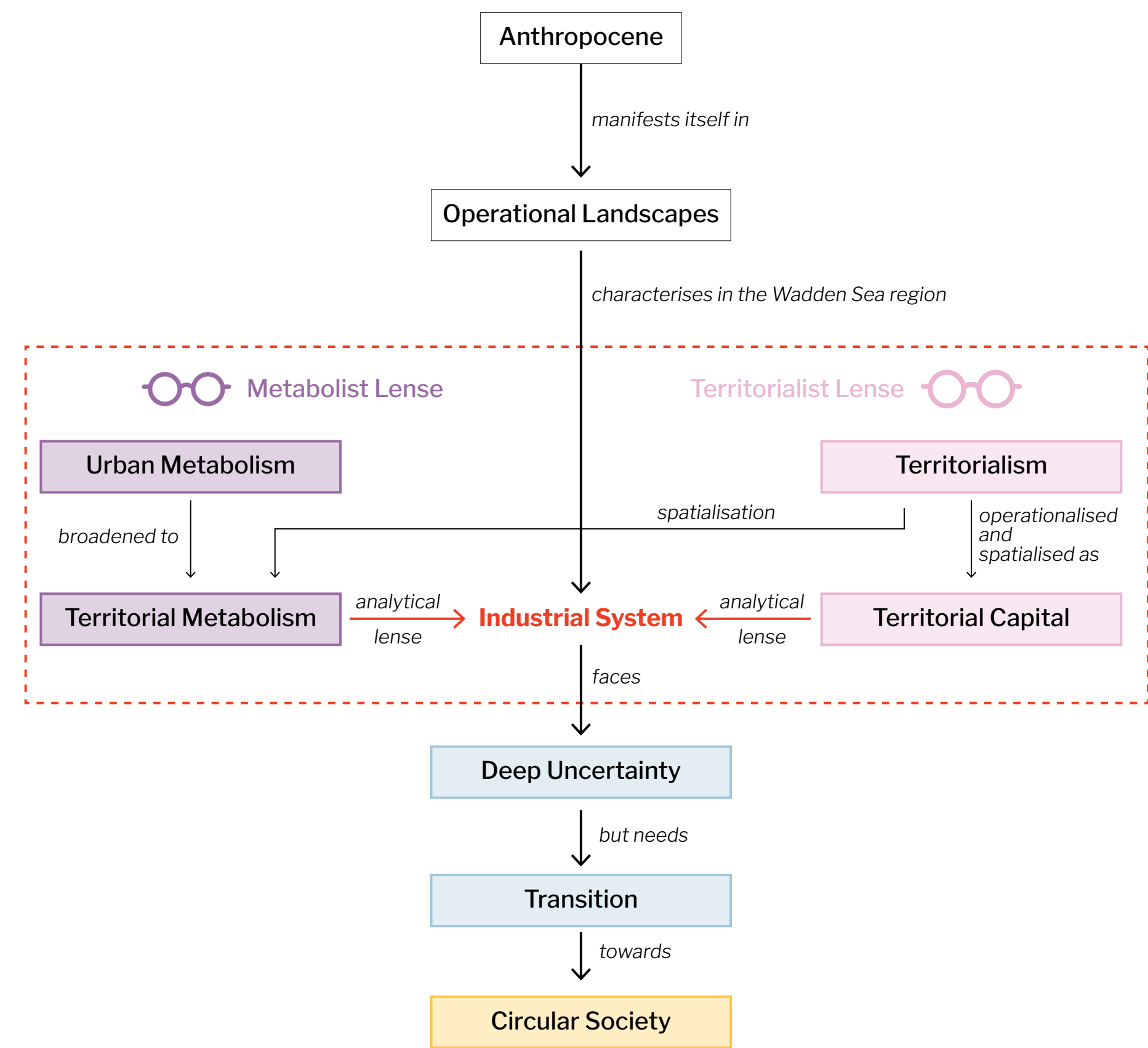
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Context

System in Focus

What concepts help to frame this issue?



Context

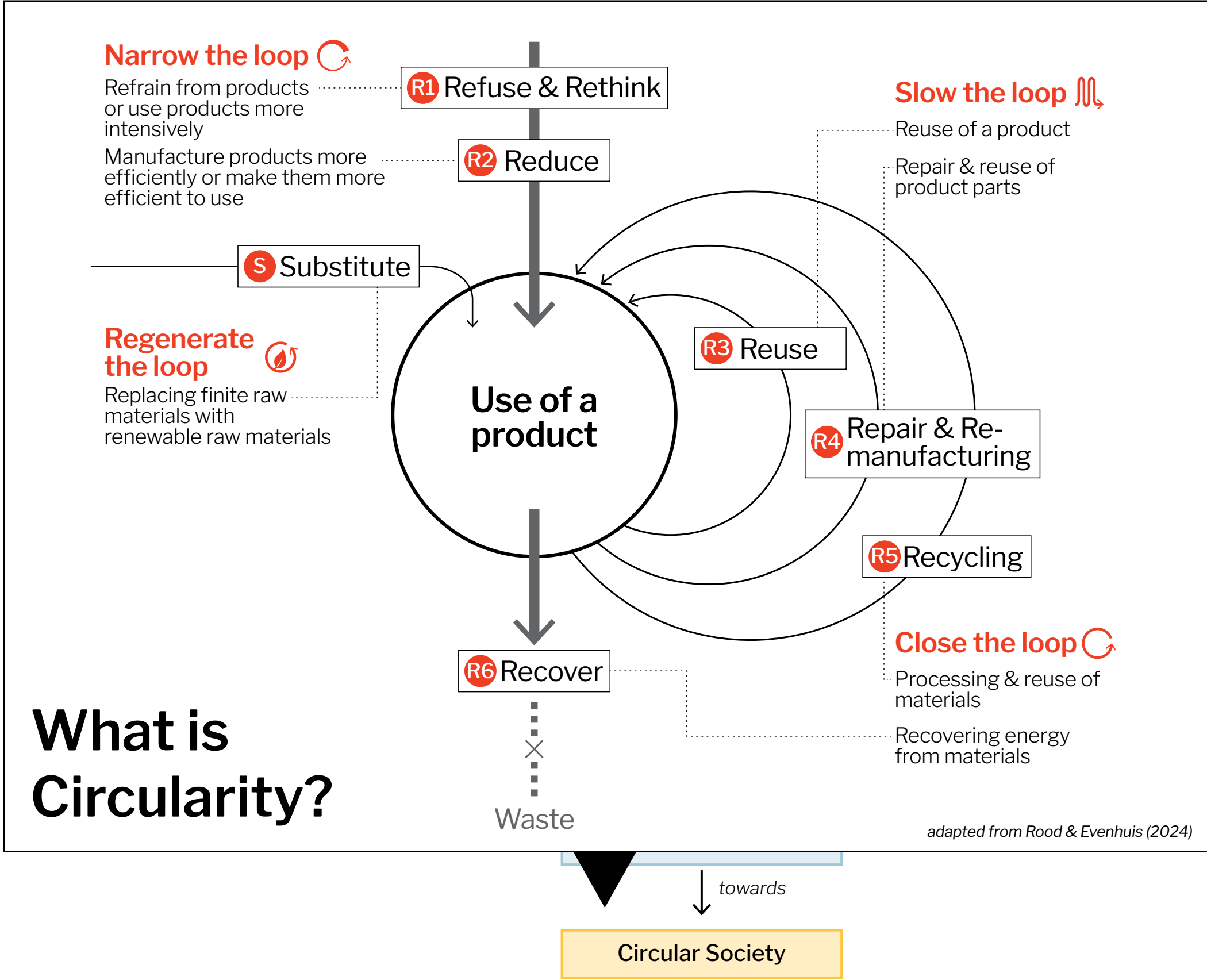
System in Focus

Process

Means

Goal

What concepts help to frame this issue?



Context

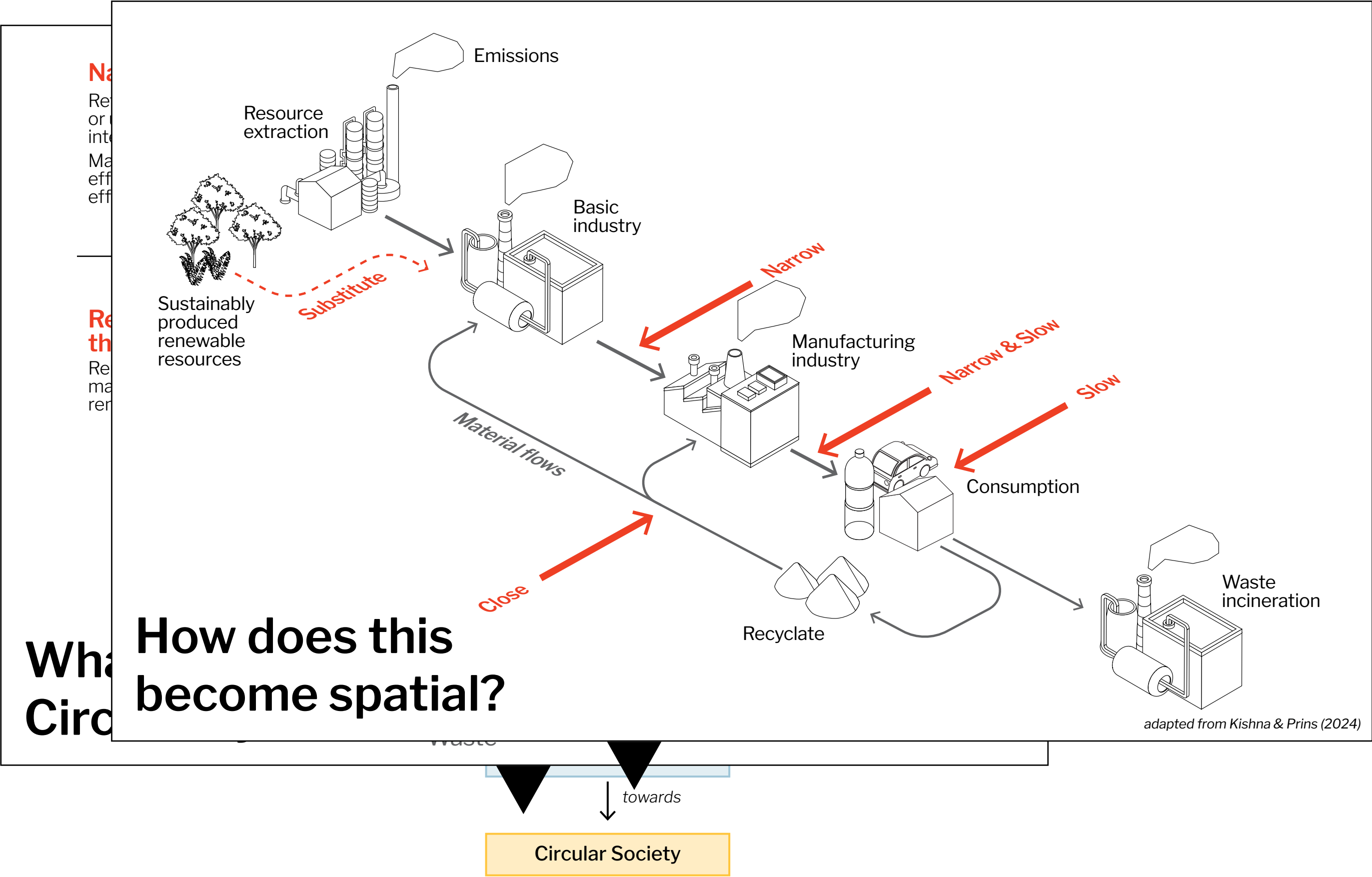
System in Focus

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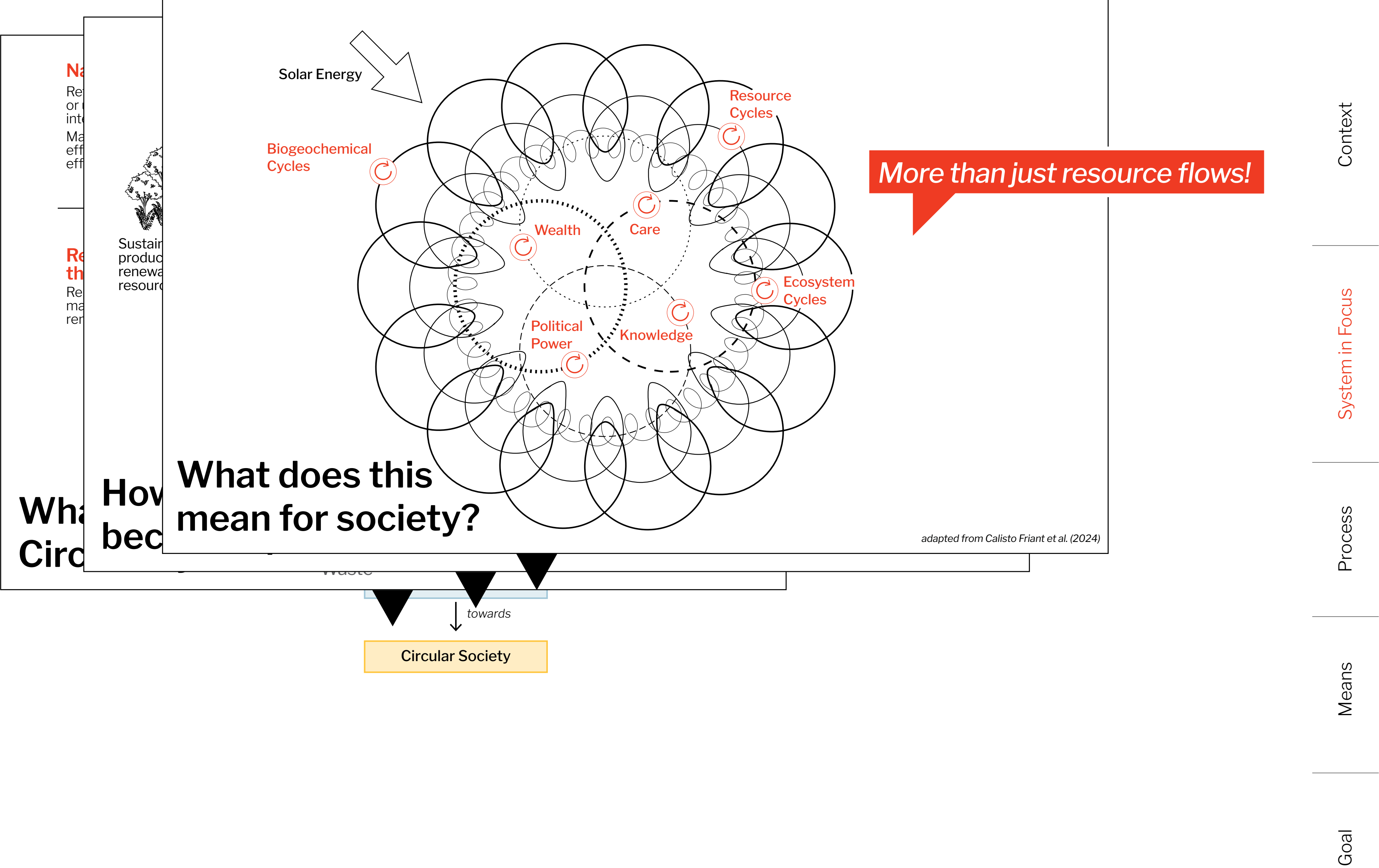
System in Focus

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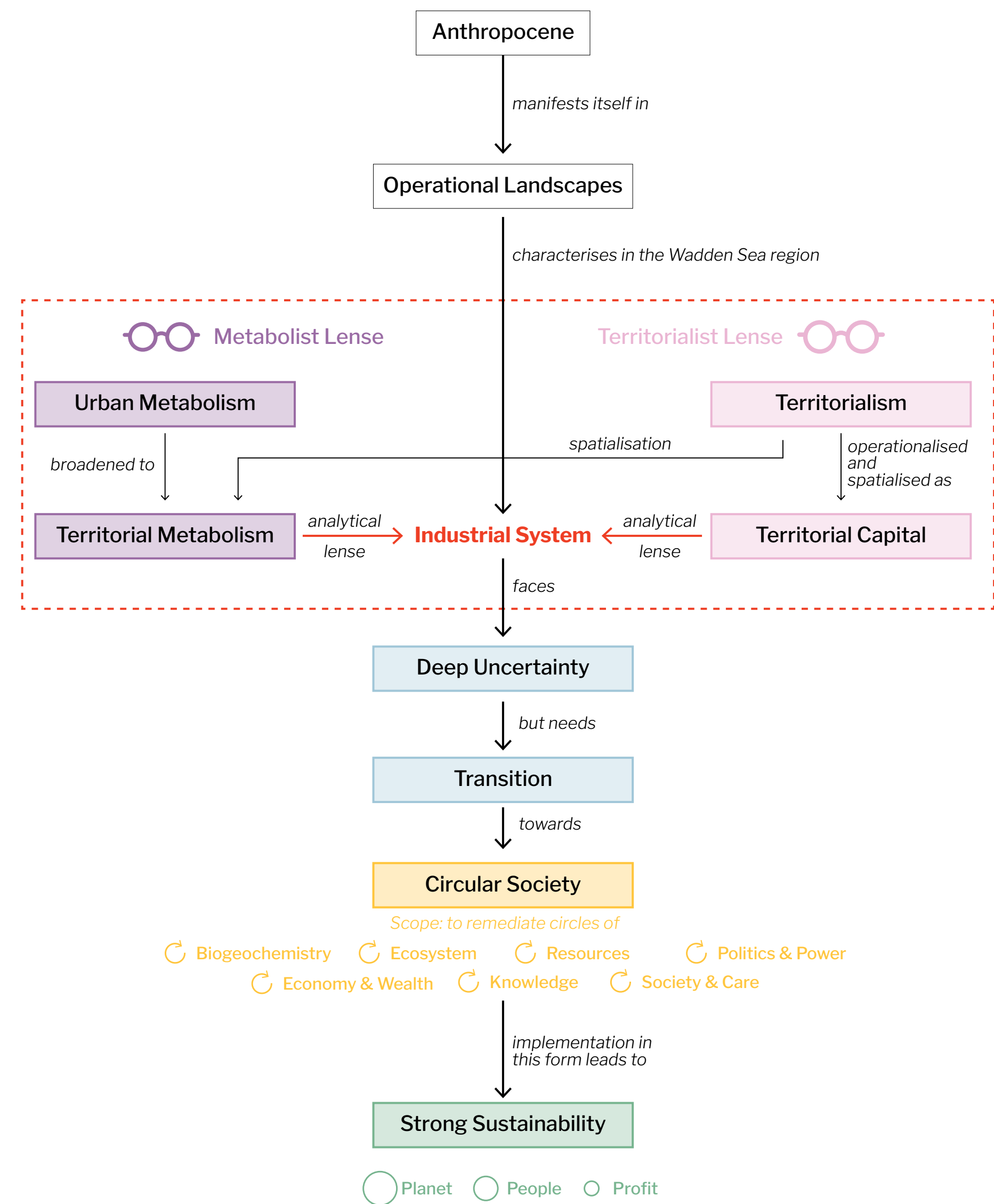
Means

Goal

What concepts help to frame this issue?



What concepts help to frame this issue?



What do I want to find out – and how?

Research Question

How can the industrial production system in the Wadden Sea region be spatially transformed into a circular and sustainable model, considering its role as an operational hinterland and its impact on functions, morphology, society and ecosystems?

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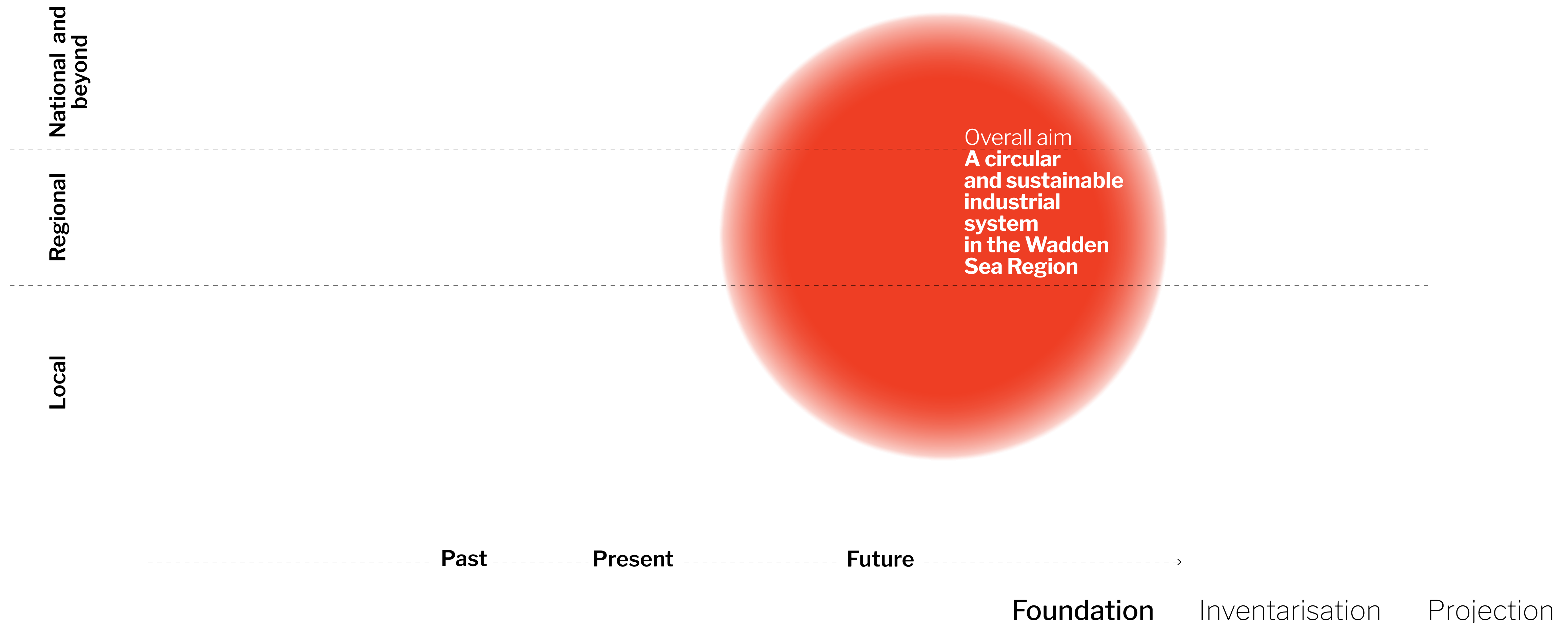


Overall aim
**A circular
and sustainable
industrial
system
in the Wadden
Sea Region**

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Research Question

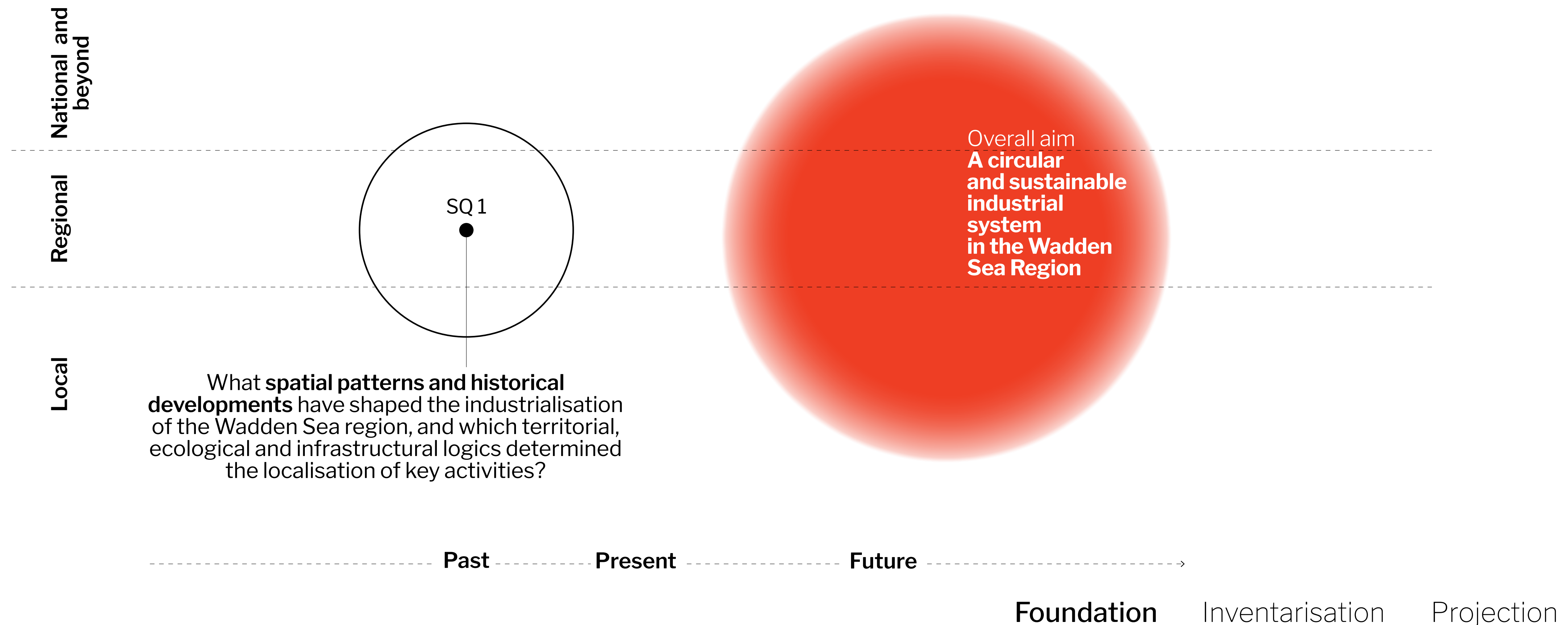
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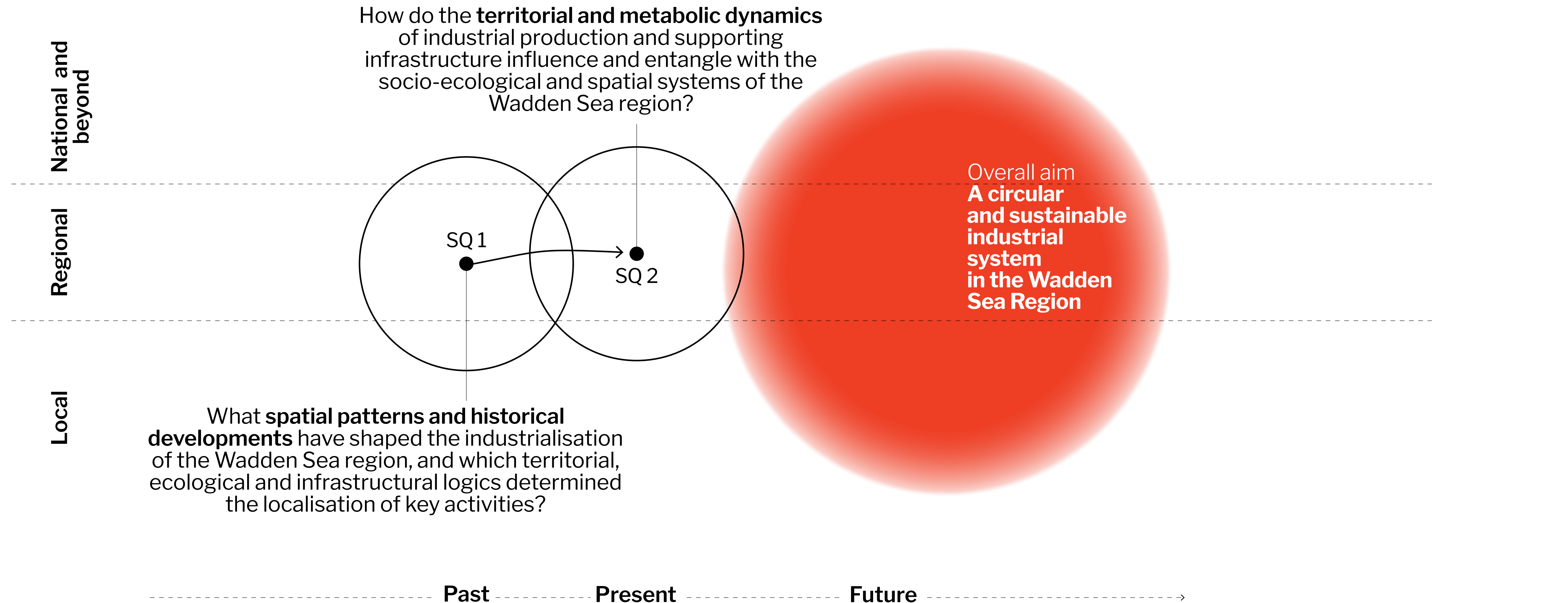
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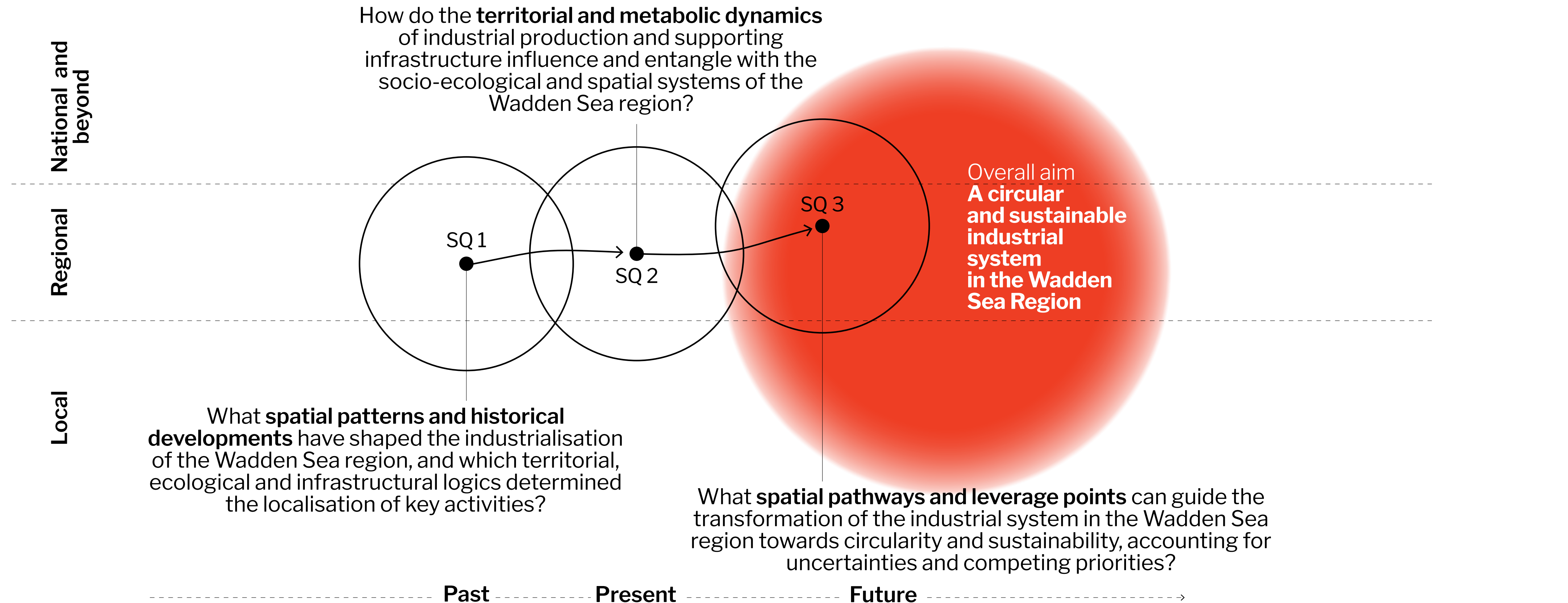
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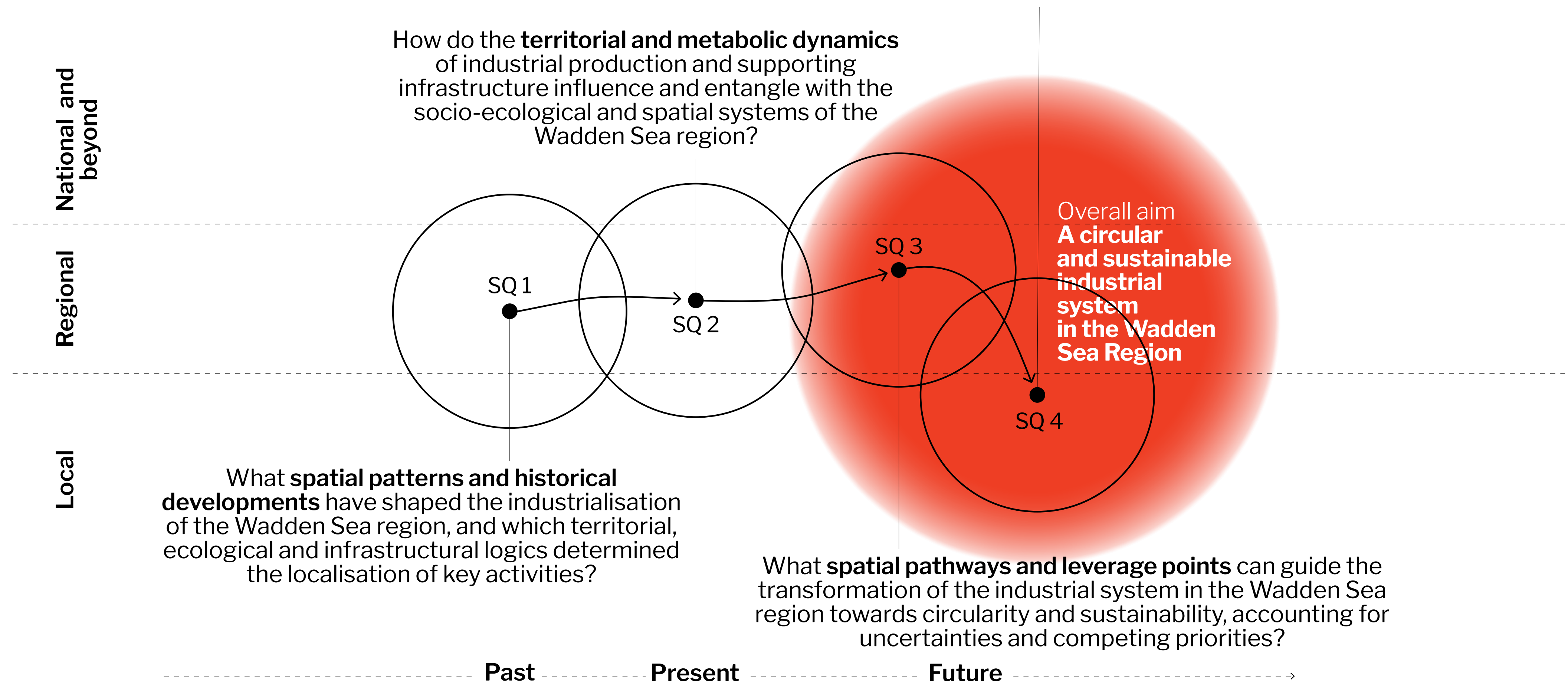


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Which **strategic measures** ensure actionable outcomes for functions, morphology, society and ecosystems and how can the approach be spatially translated into local design elaborations?



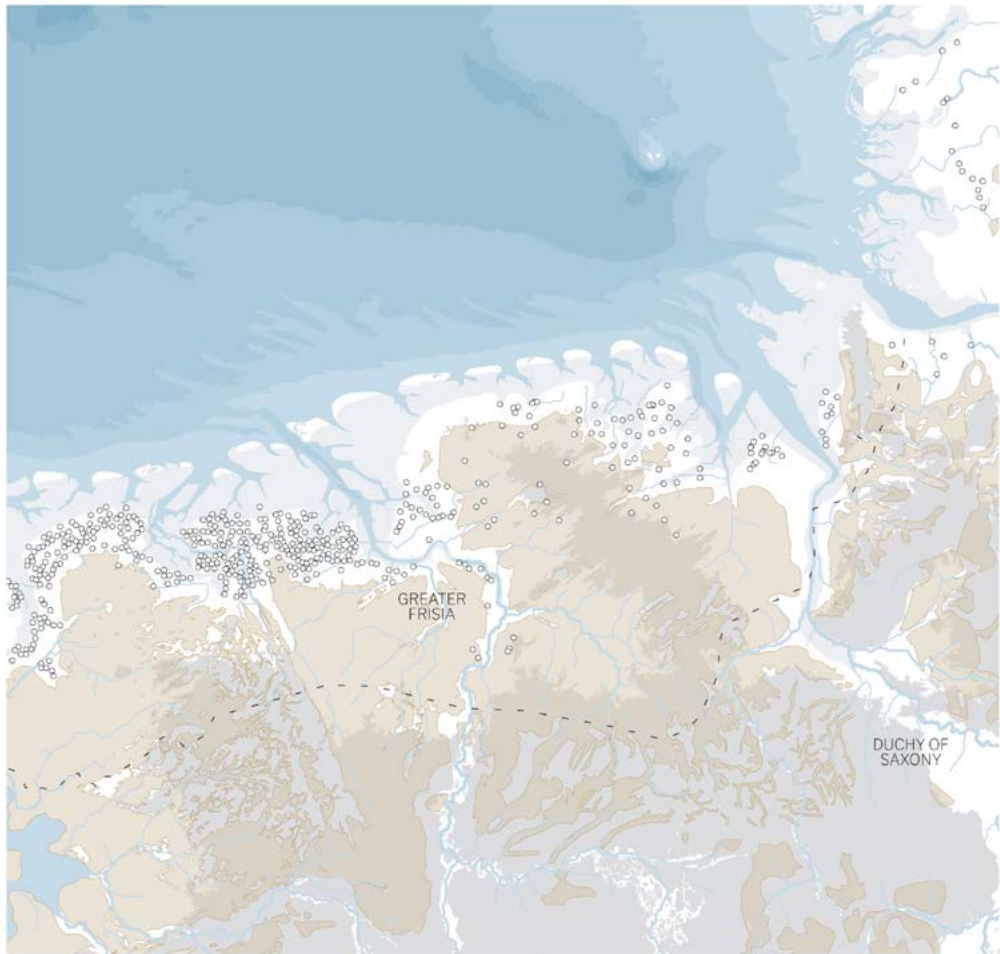


Inventarisaton

- **SQ1: Spatial Patterns and Historical Developments**
- **SQ2: Territorial and Metabolic Dynamics**

How did this region become what it is?

800



1500



1850



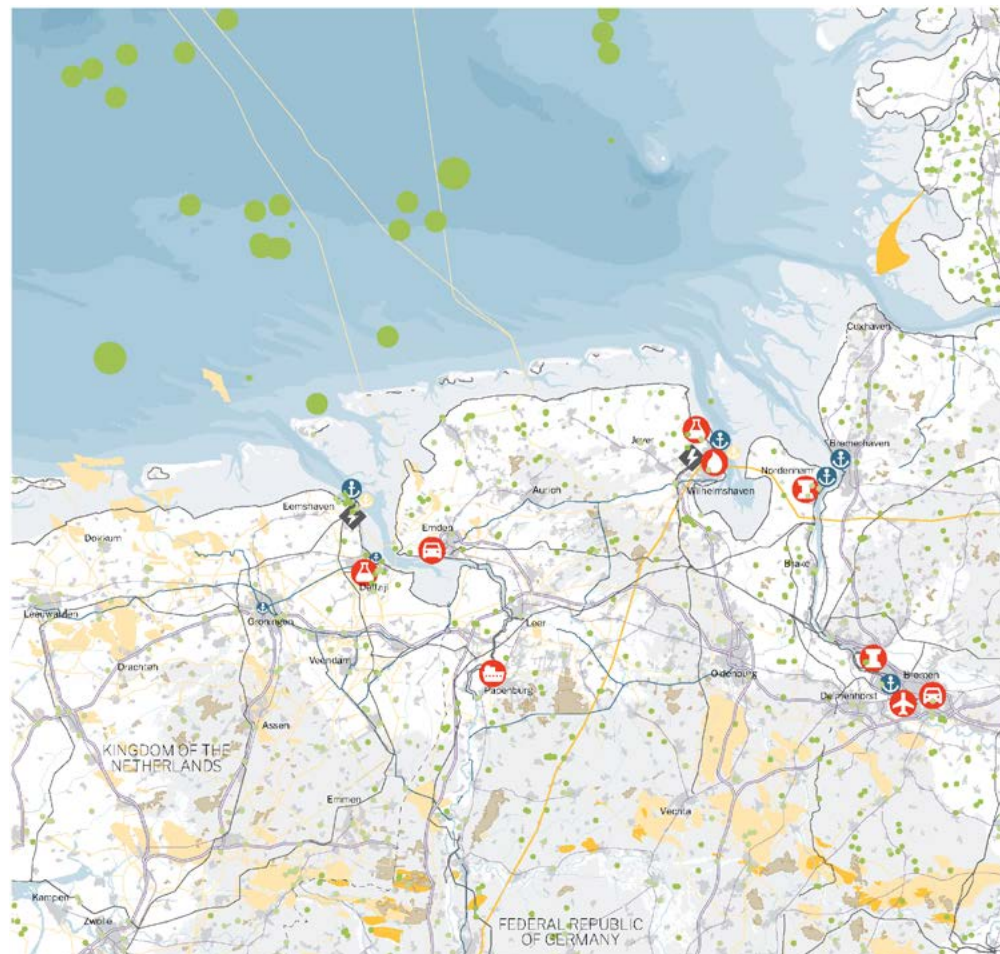
1910



1980



2025



How did this region become what it is?

800

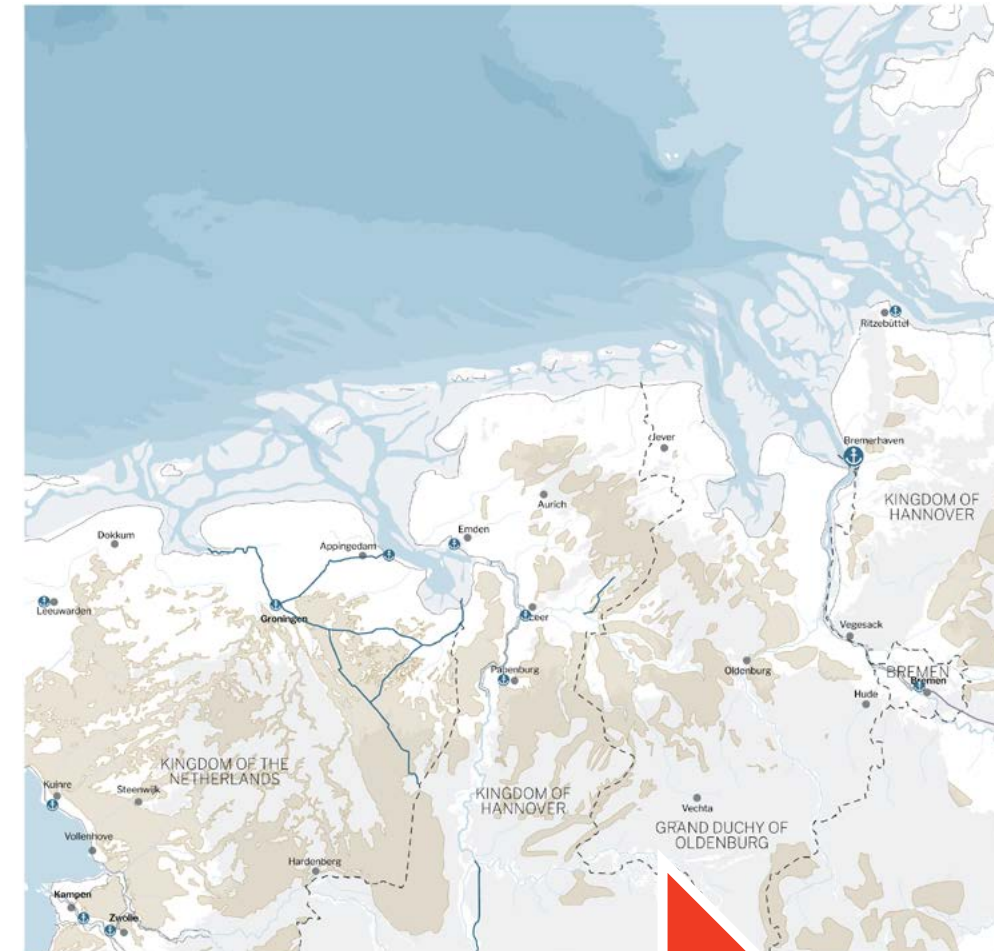


Adaptive occupation

1500



1850



Engineered control

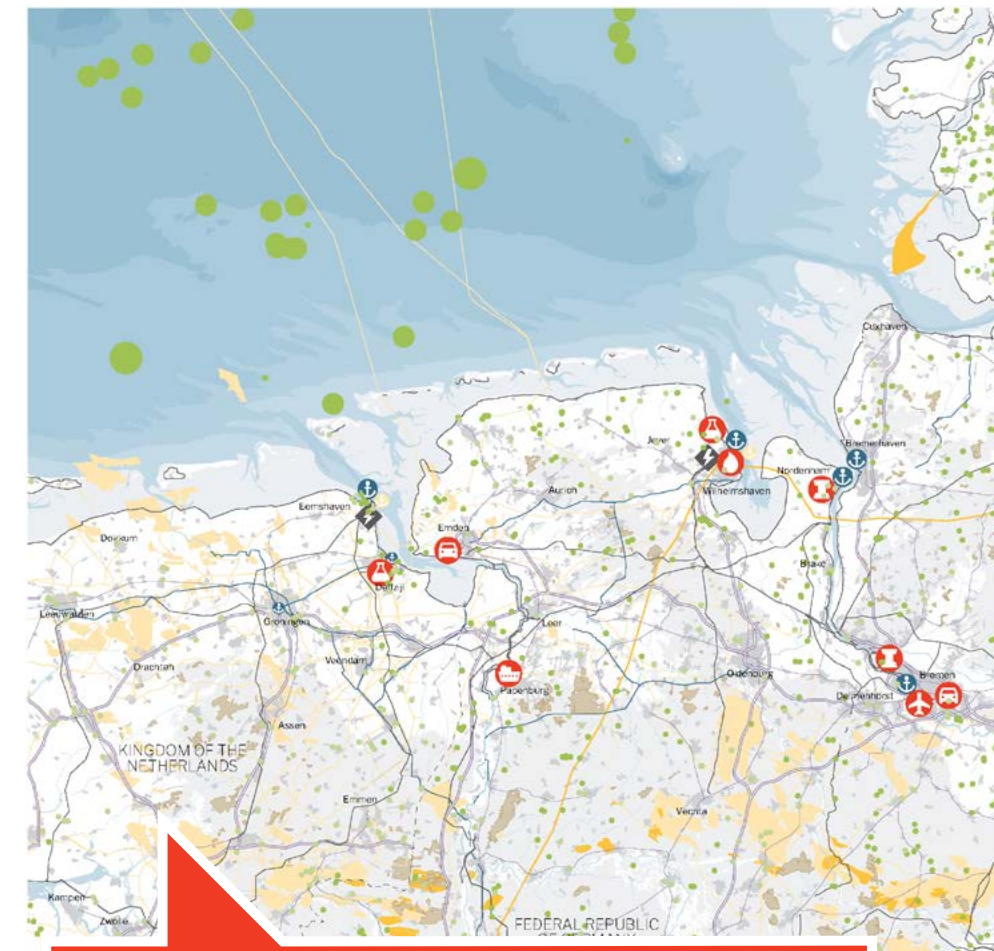
1910



1980



2025

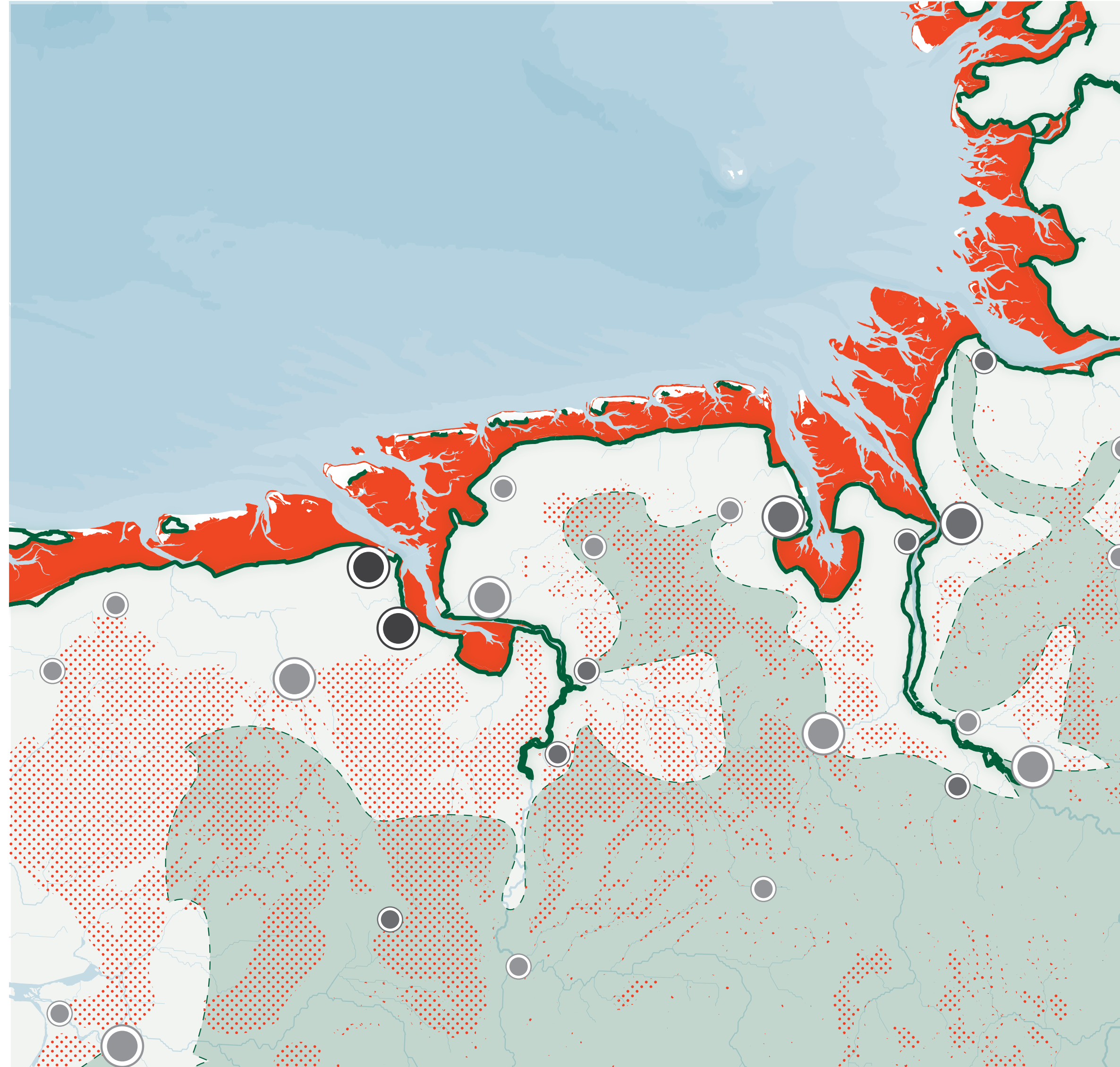


Infrastructural override

Inventarisation

Projection

How did this region become what it is?



Sea
Wadden
Dynamic
Intermediate
Stable

1:1,250,000
0 10 20 km N
|

What strengths can we build on here?

Category of Territorial Capital (Orsi et al., 2024, modified)

Mapped Territorial Capital

Natural Capital

Soil Types

Freshwater and Terrain

Wildlife and Biotopes

Human Capital

Education and Workforce

Settlement Capital

Population Distribution

Economic Capital

Land Use

Industrial Activity

Infrastructural Capital

Coastal Protection

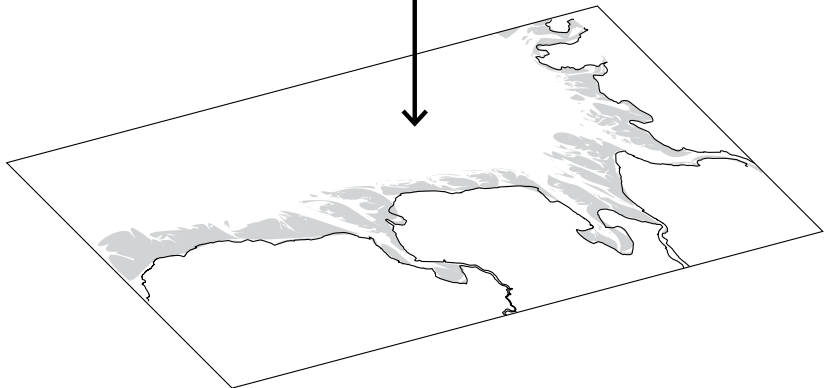
Land Transport Networks

Water Transport Networks

Fossil Energy Generation and Distribution

Renewable Energy Generation and Distribution

Application to and inventarisation of the
Wadden Sea Region



What strengths can we build on here?

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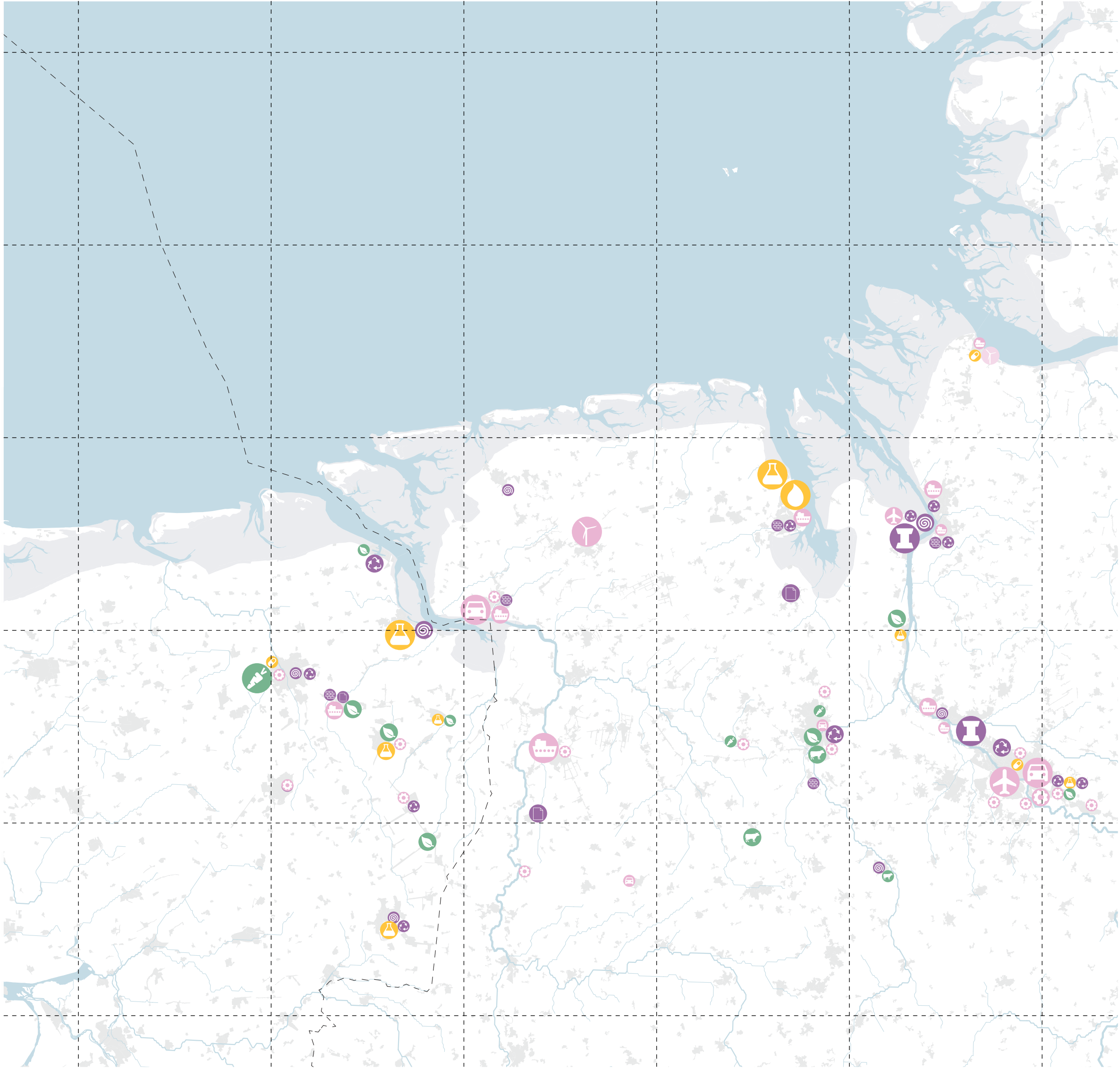
Fossil Energy Generation and Distribution

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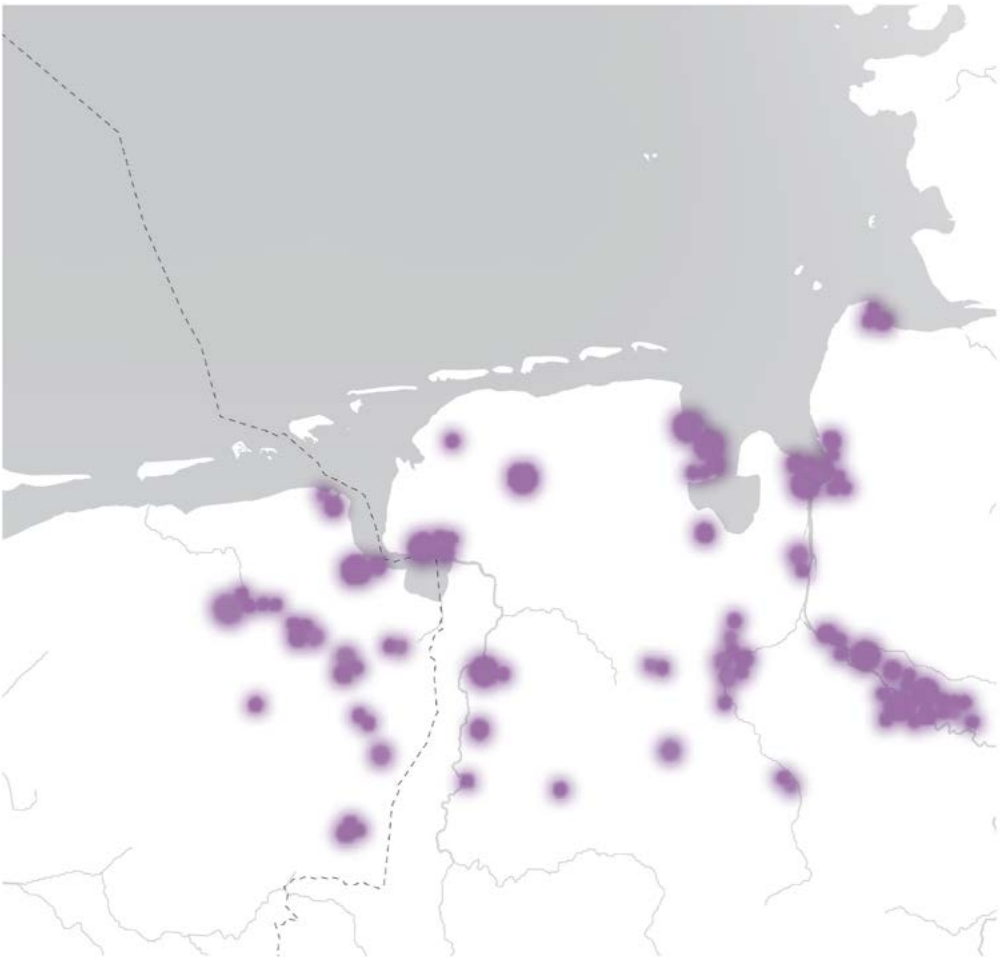
- Sea
- Wadden
- Heavy Industry**
 - Manufacture of basic metals
 - Fabricated metal products
 - Cement and construction materials
 - Paper industry
 - Recycling

- Settlement
- Industrial Location
- Light Industry**
 - Manufacture of motor vehicles
 - Shipbuilding
 - Aerospace industry
 - Manufacture ren. energy appliances
 - Manufacture machinery/ electronics

- Chemical Industry**
 - Manufacture of basic chemicals
 - Oil refinery
 - Pharmaceutical industry

- Manufacture of bioproducts
- Food industry
- Livestock plants

0 10 20 km N
1:1.250.000



What strengths can we build on here?



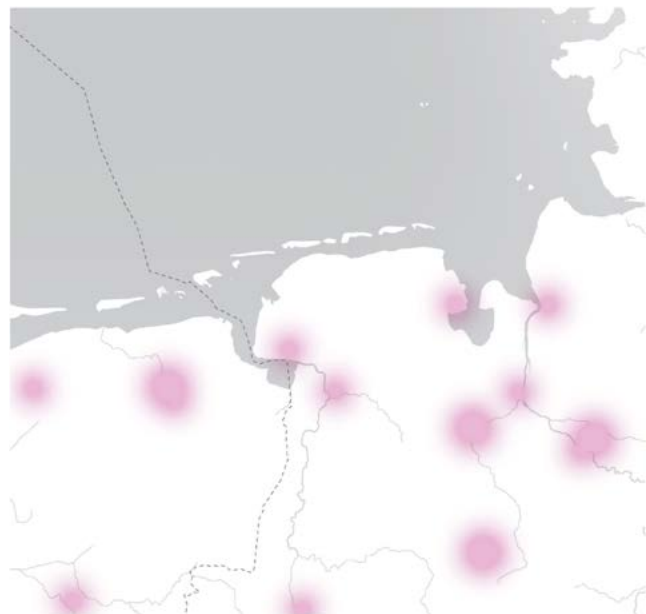
Soil



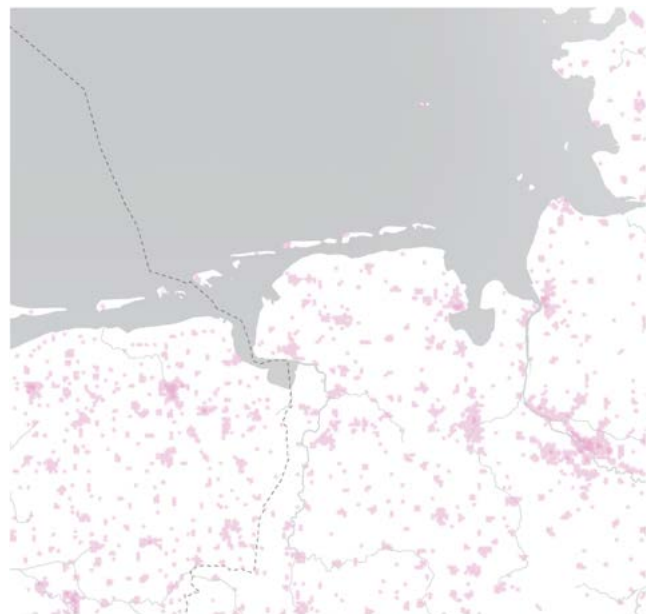
Water & Terrain



Biotopes



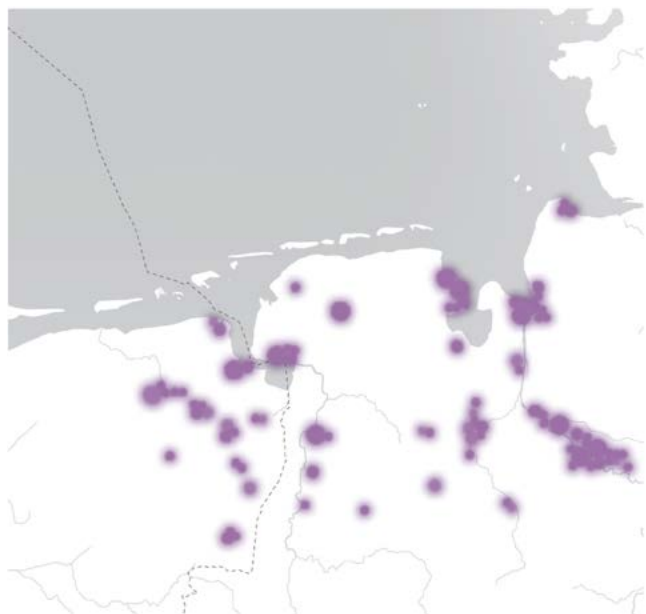
Education



Settlements



Land Use



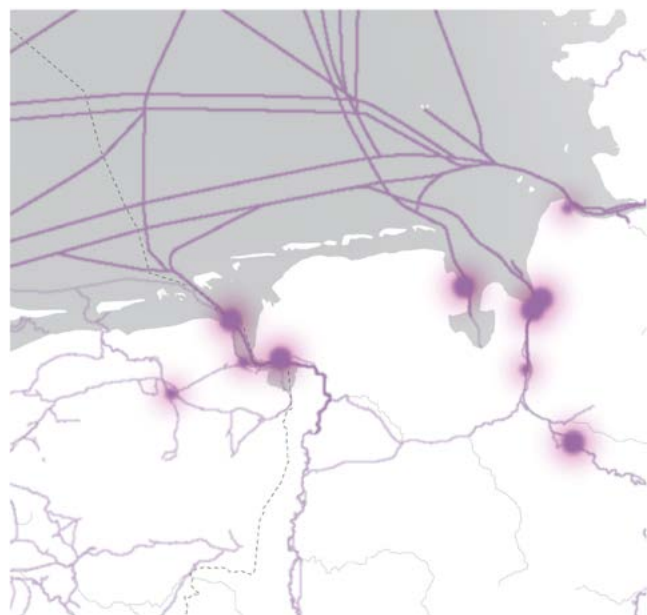
Industrial Type



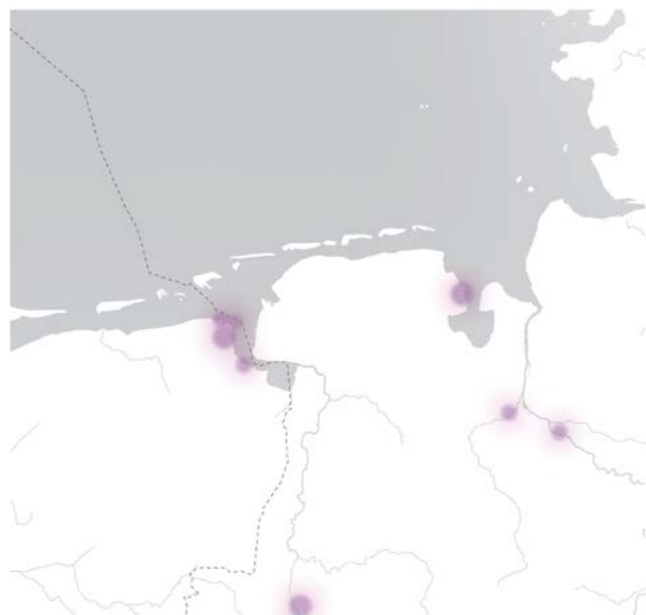
Dikes



Land Transport



Water Transport

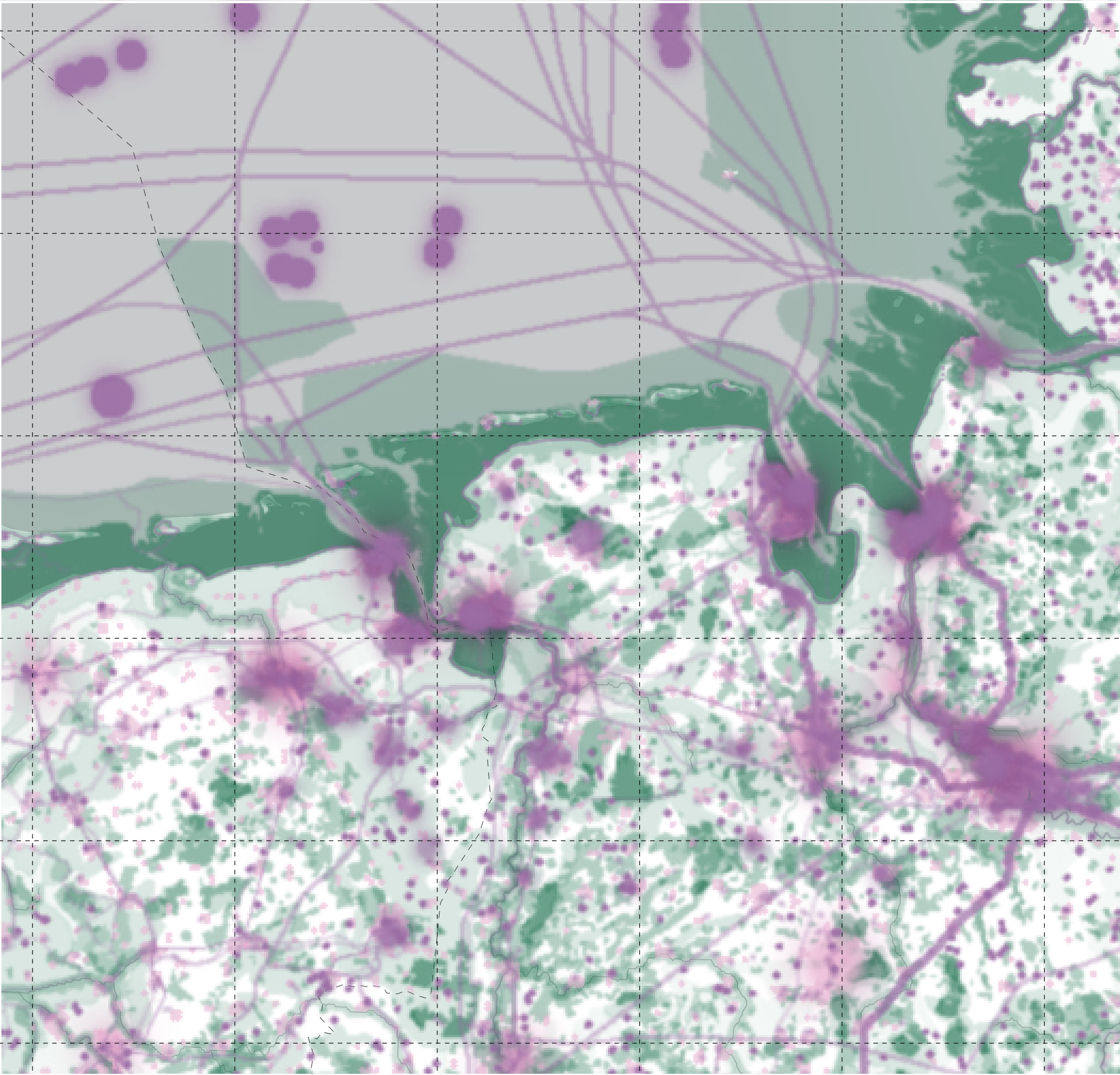


Fossil Energy



Renewable Energy

What strengths can we build on here?



Capital Overlay

Category of Territorial Capital (Orsi et al., 2024, modified)

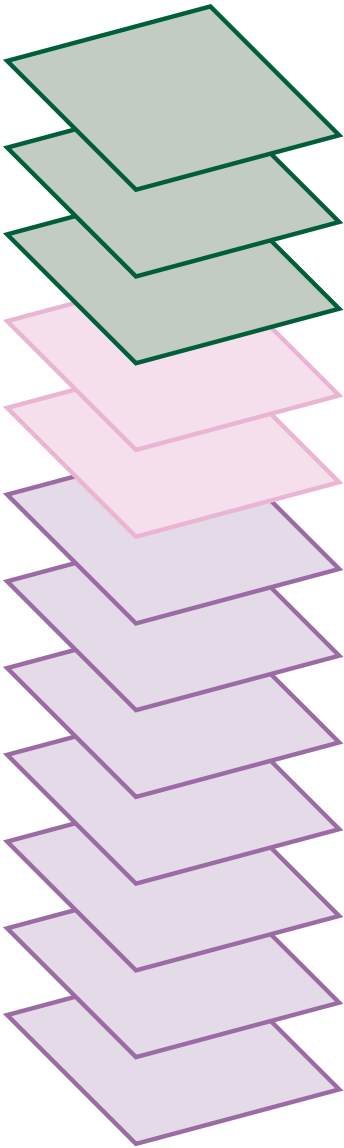
Natural Capital

Human Capital

Settlement Capital

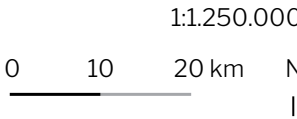
Economic Capital

Infrastructural Capital



Mapped Territorial Capital

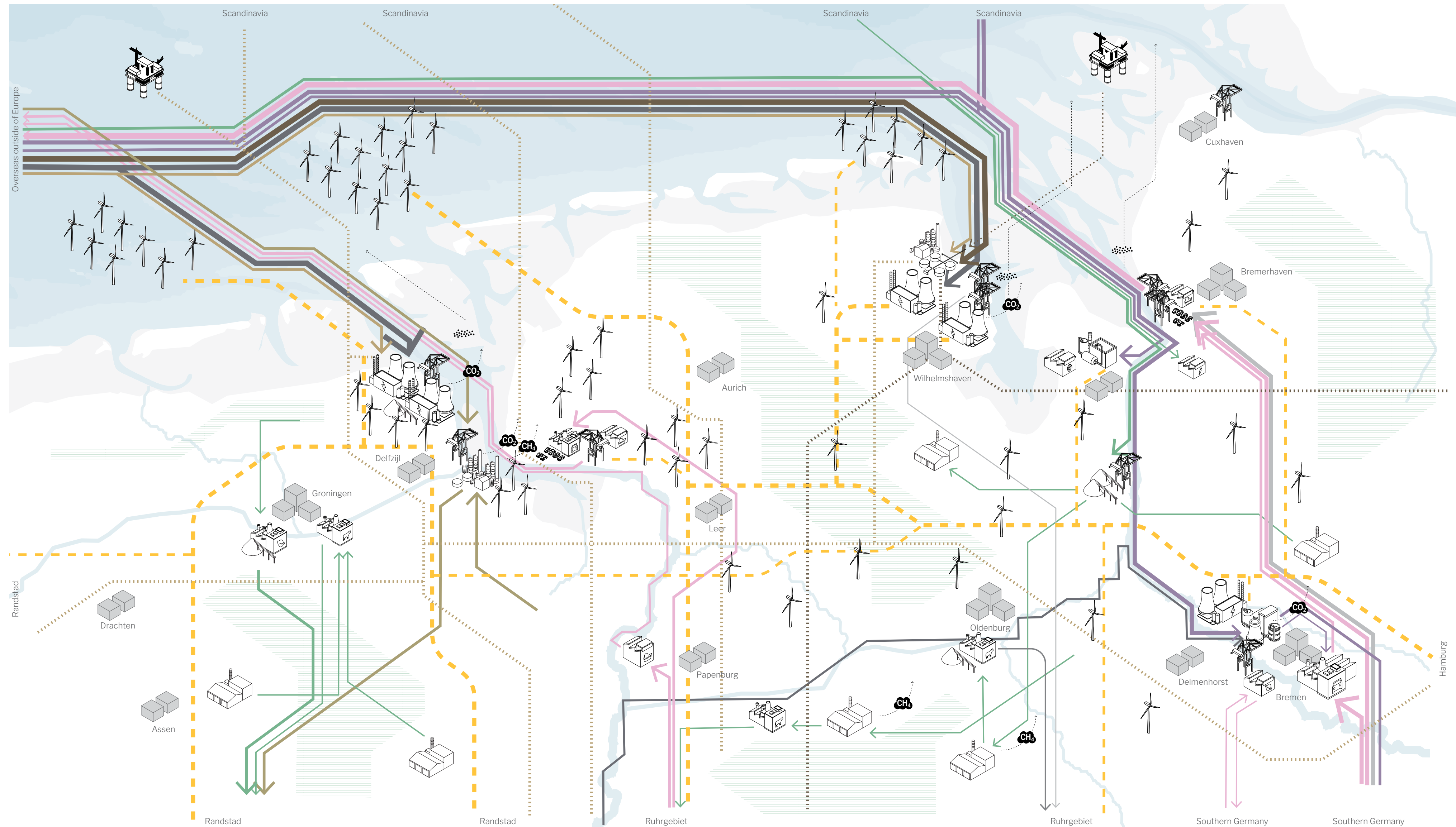
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- Land Use
- Industrial Activity
- Coastal Protection
- Land Transport Networks
- Water Transport Networks
- Fossil Energy Generation and Distribution
- Renewable Energy Generation and Distribution



Energy Flows Germany 2022

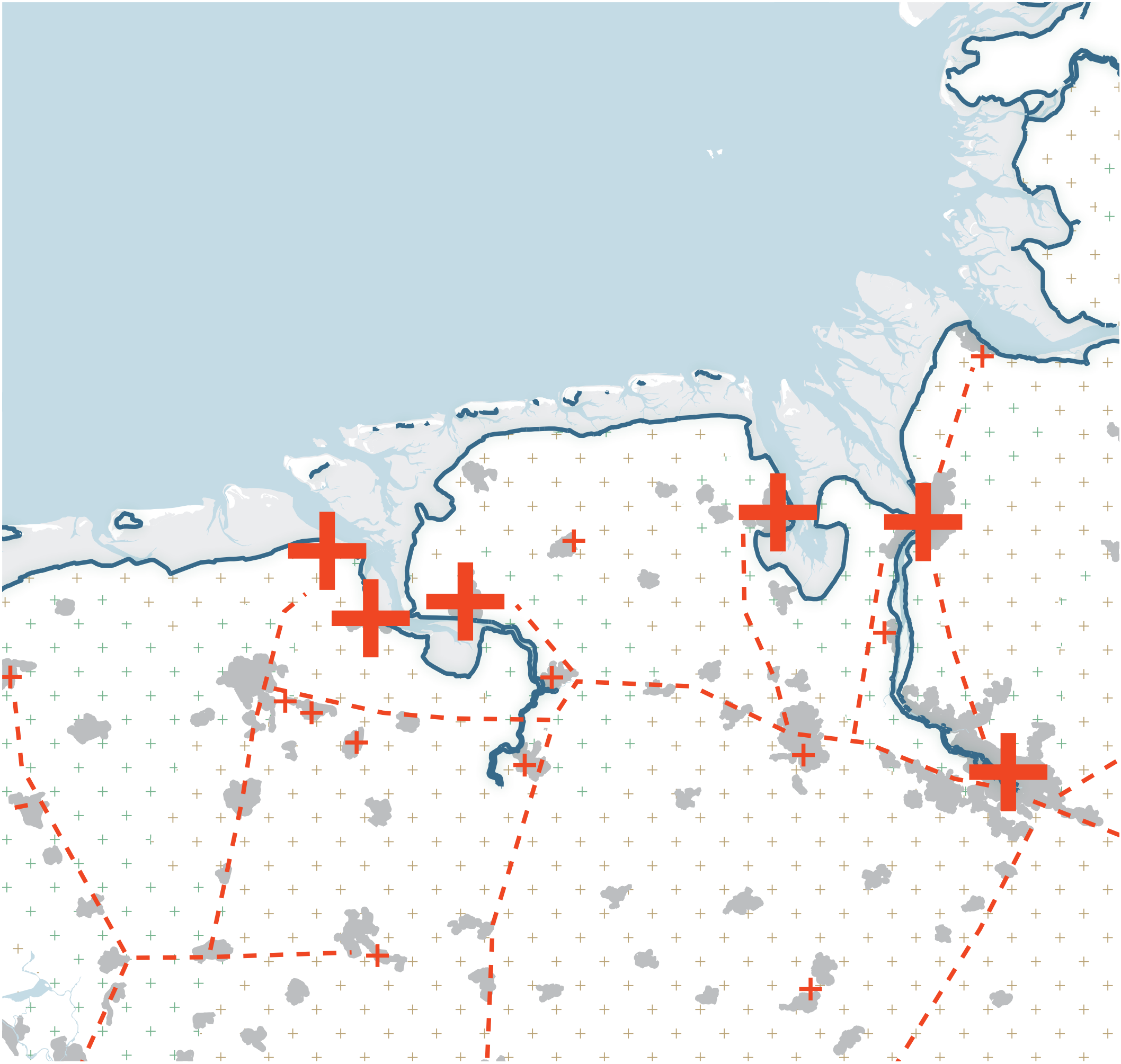
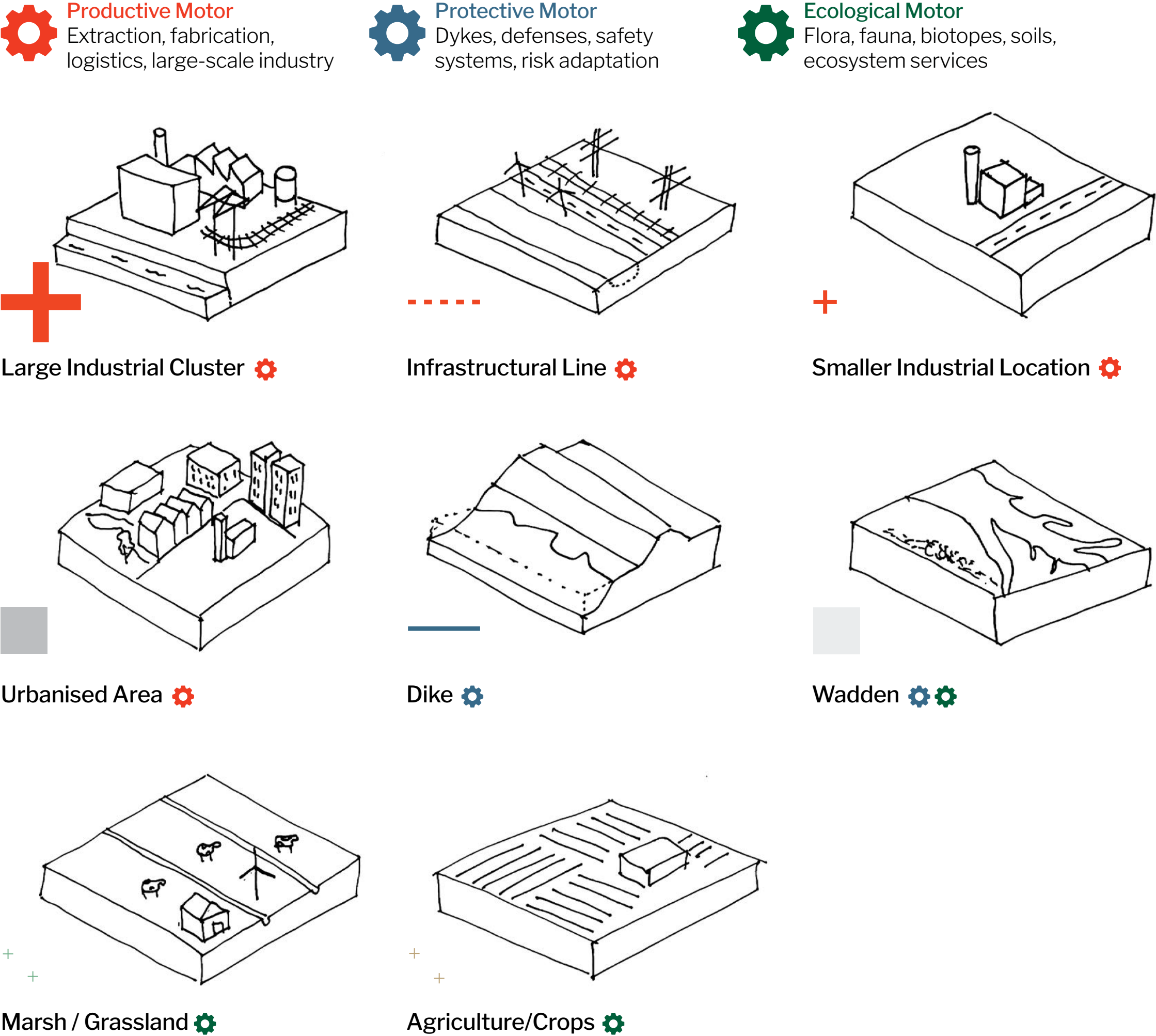


How do materials and energy flow through this system?



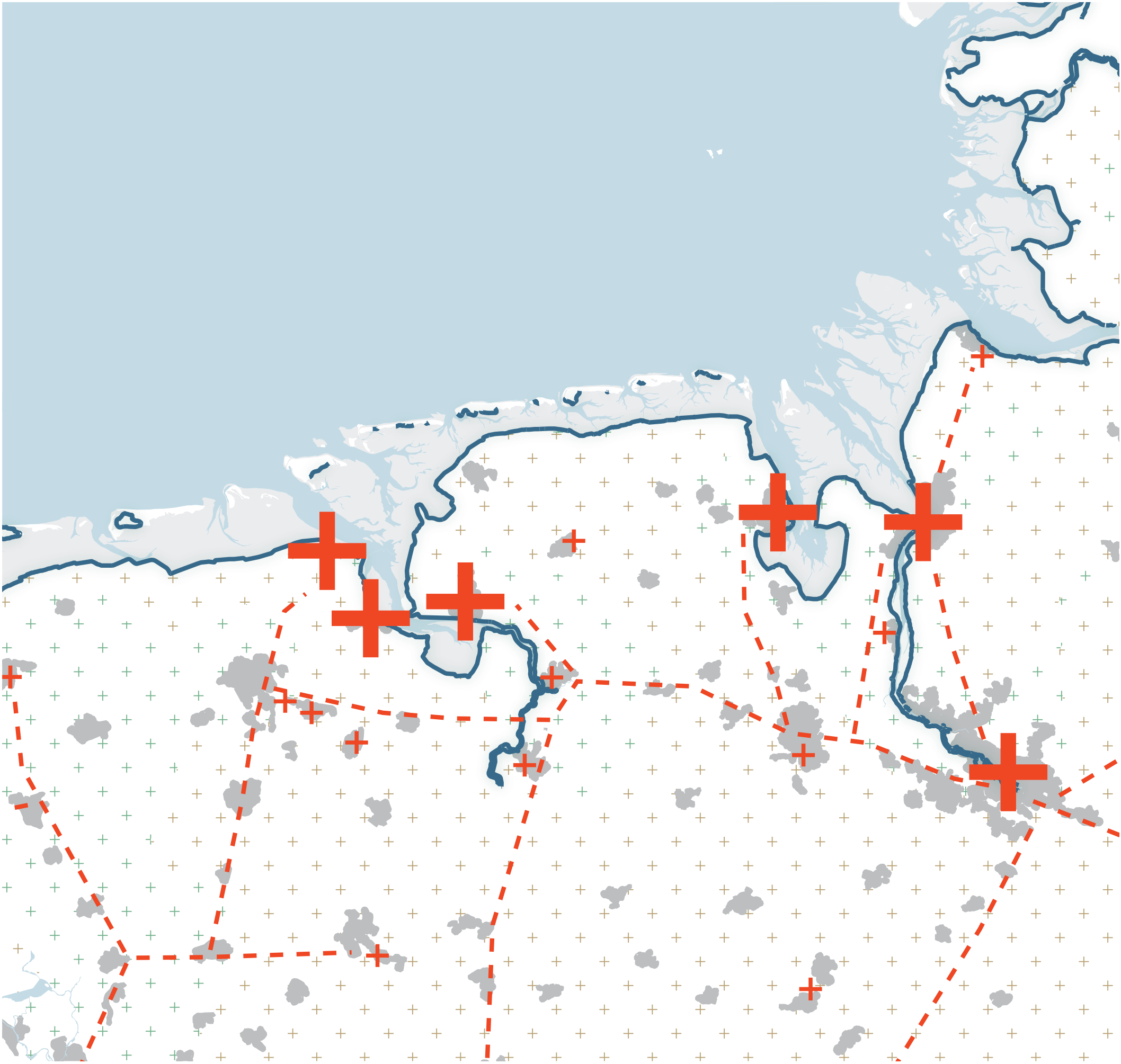
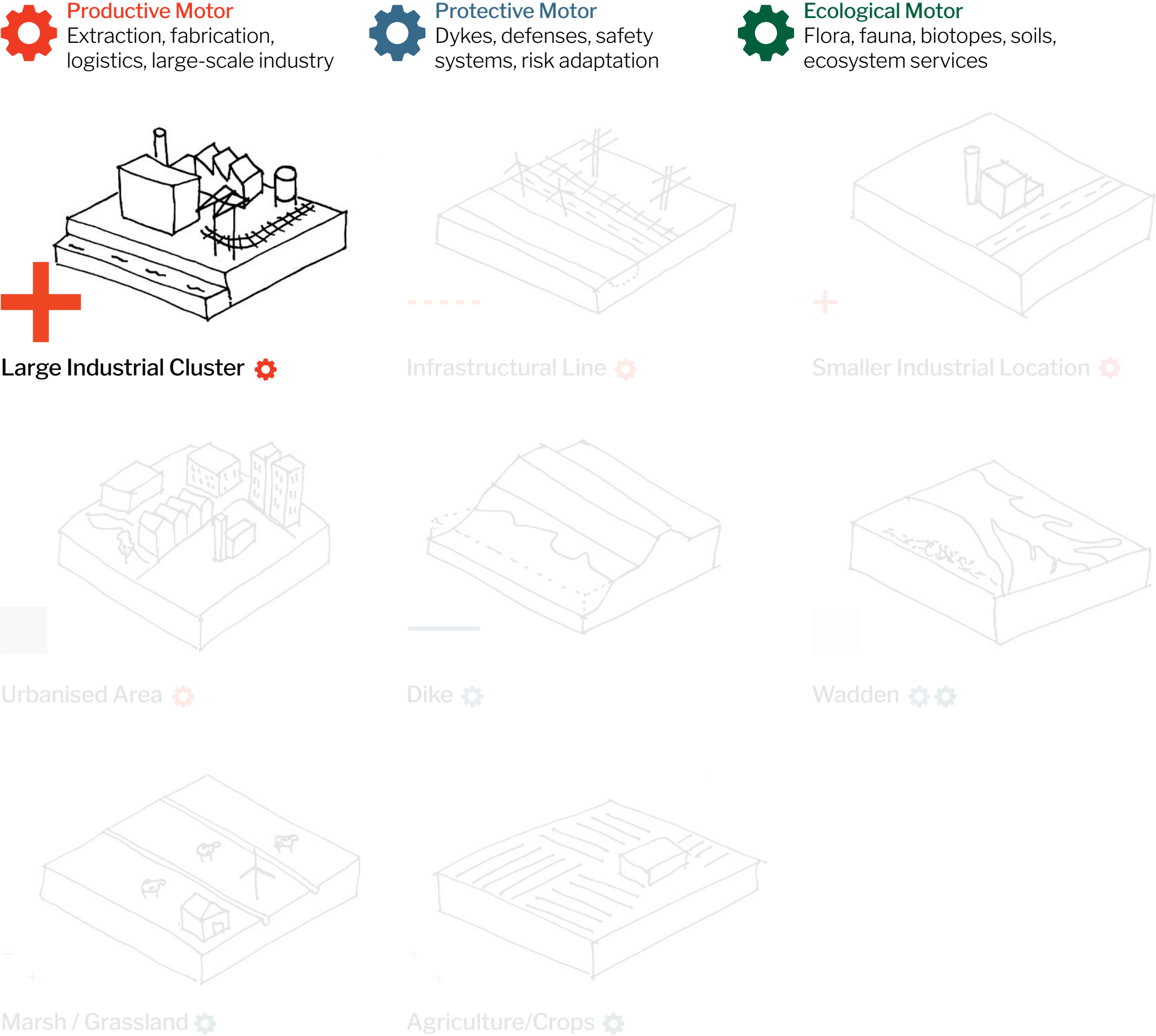
What space types structure this industrial landscape?

The Three Motors of the Region



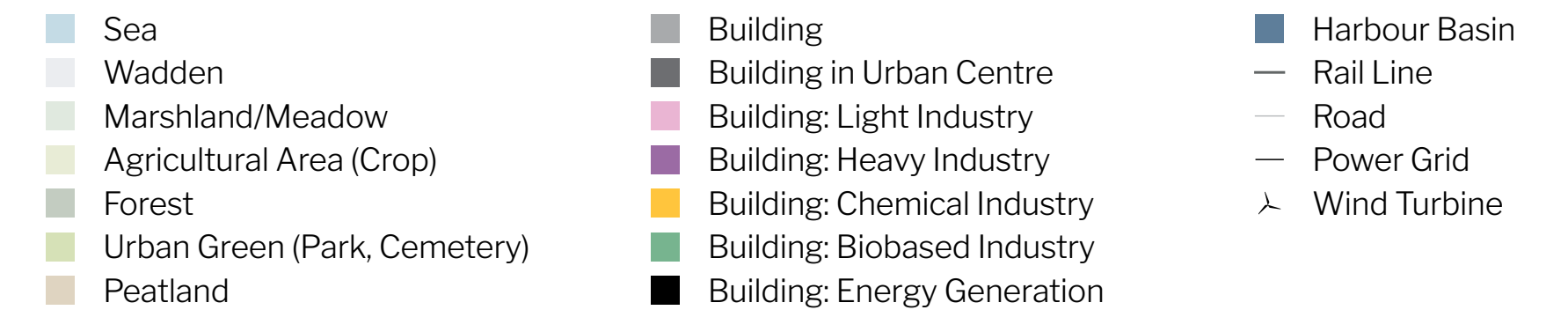
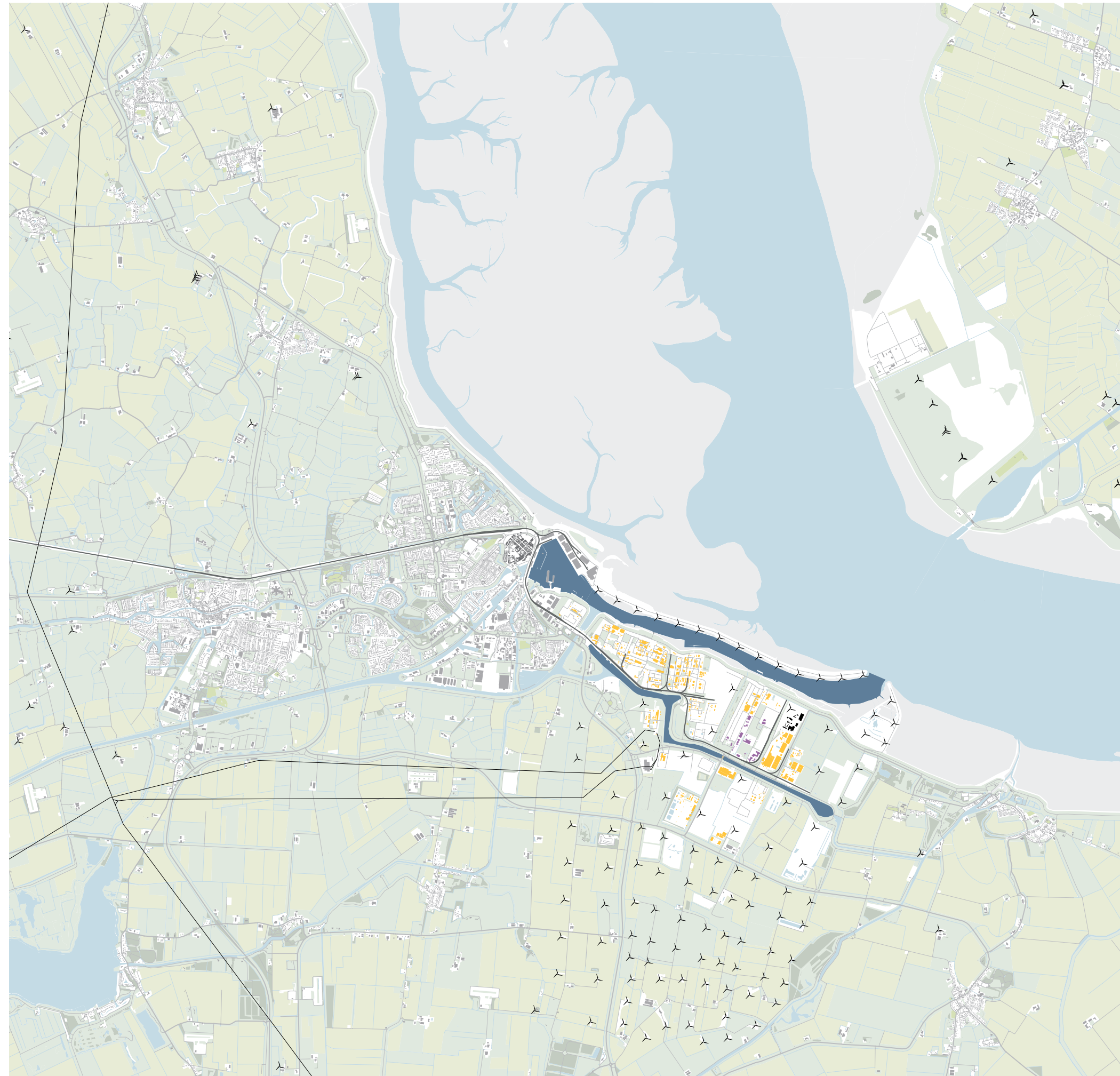
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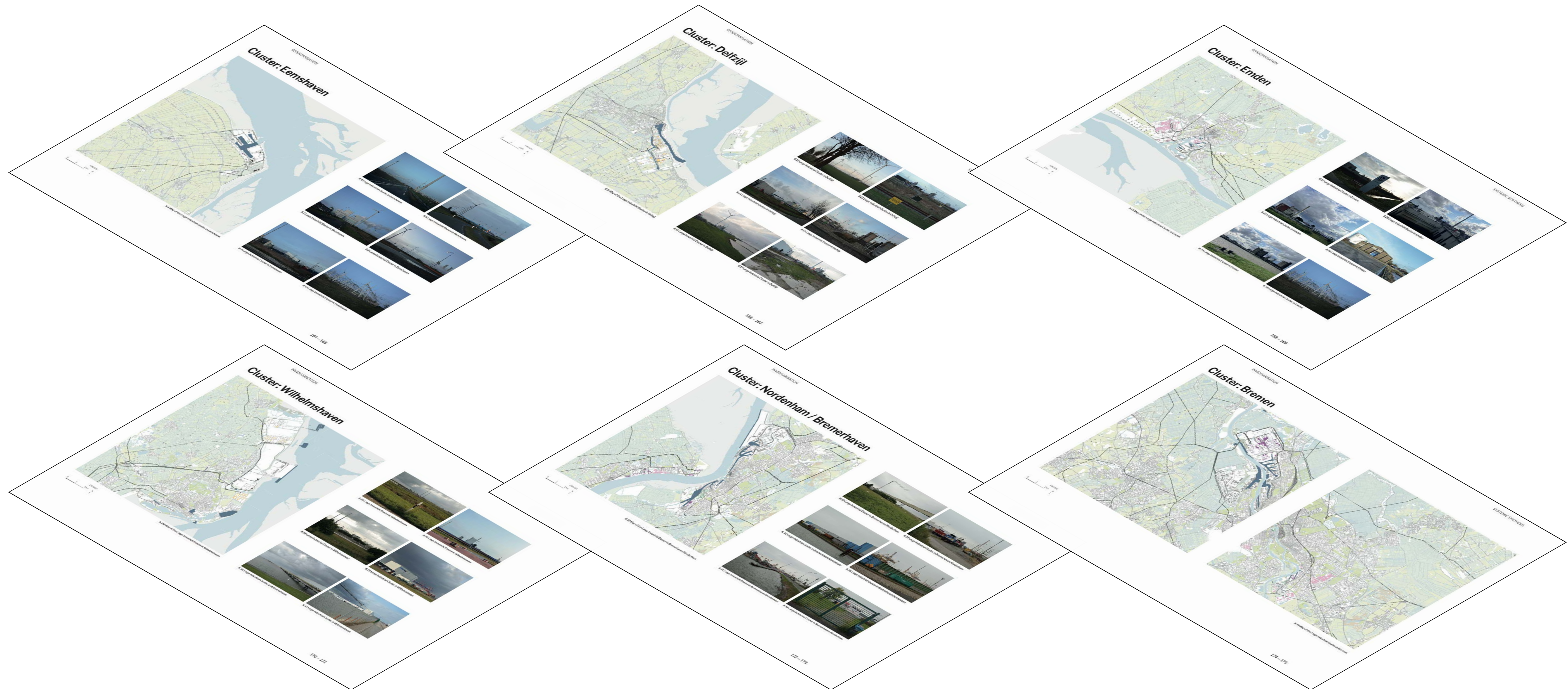


What can we learn from that key space type?

Cluster: Delfzijl



What can we learn from that key space type?



What logics shape industrial localisation?

Infrastructural Logic

Infrastructure binds and breaks



- Infrastructure enables scale, but cuts through urban/ecosystems
- Deepwater ports, rail and grids spatially isolate clusters
- Renewables offer a new layer, but not always in sync

Ecological Logic

Overwriting Nature



- Industry overlays ecological and older water systems: Dikes, marshes, tidal zones, ditches

Typological Logic

Planned and Patch-worked



- Some clusters were developed planned, others grew more messily
- Typologies reflect legacy, functions and planning culture
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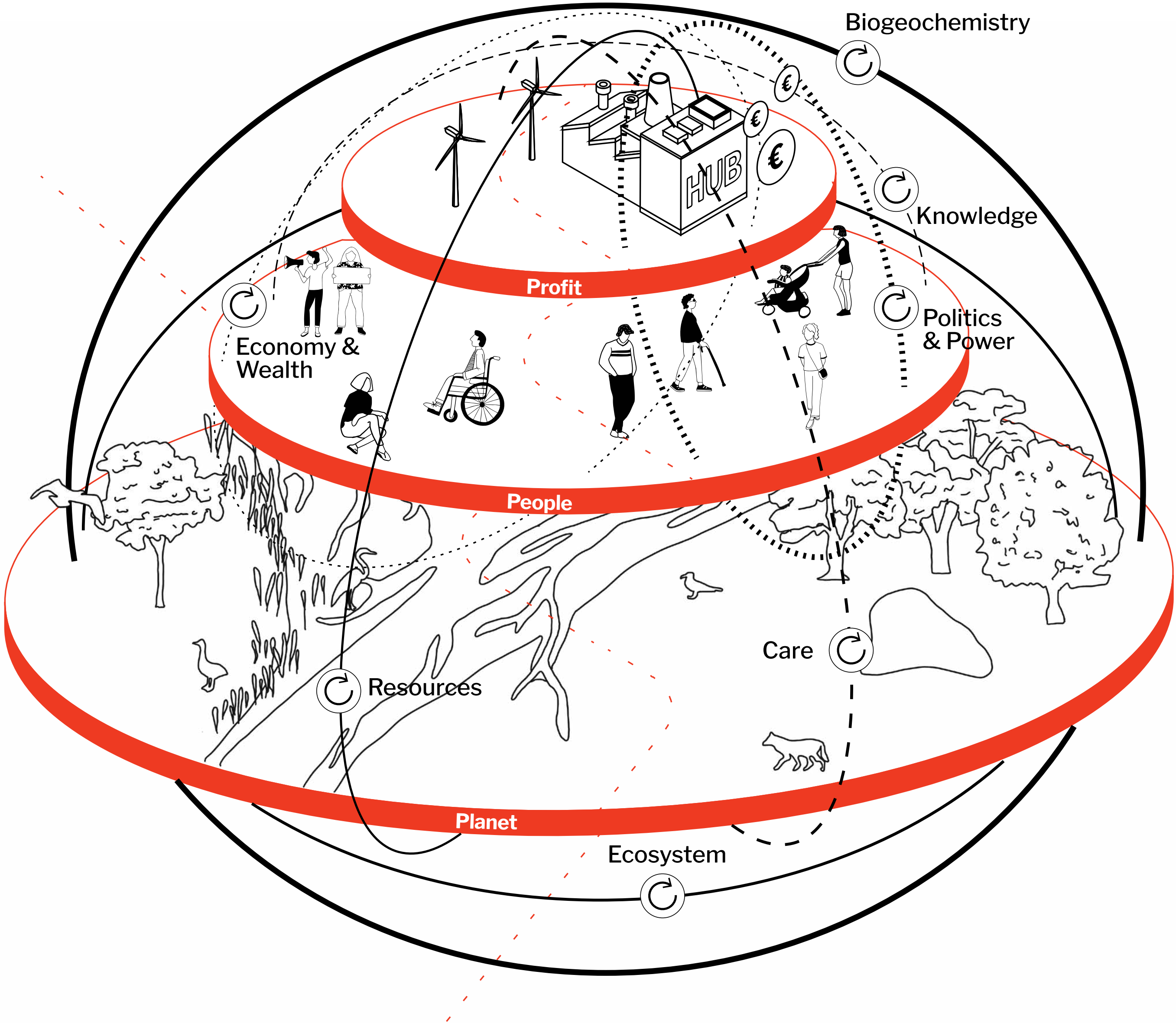
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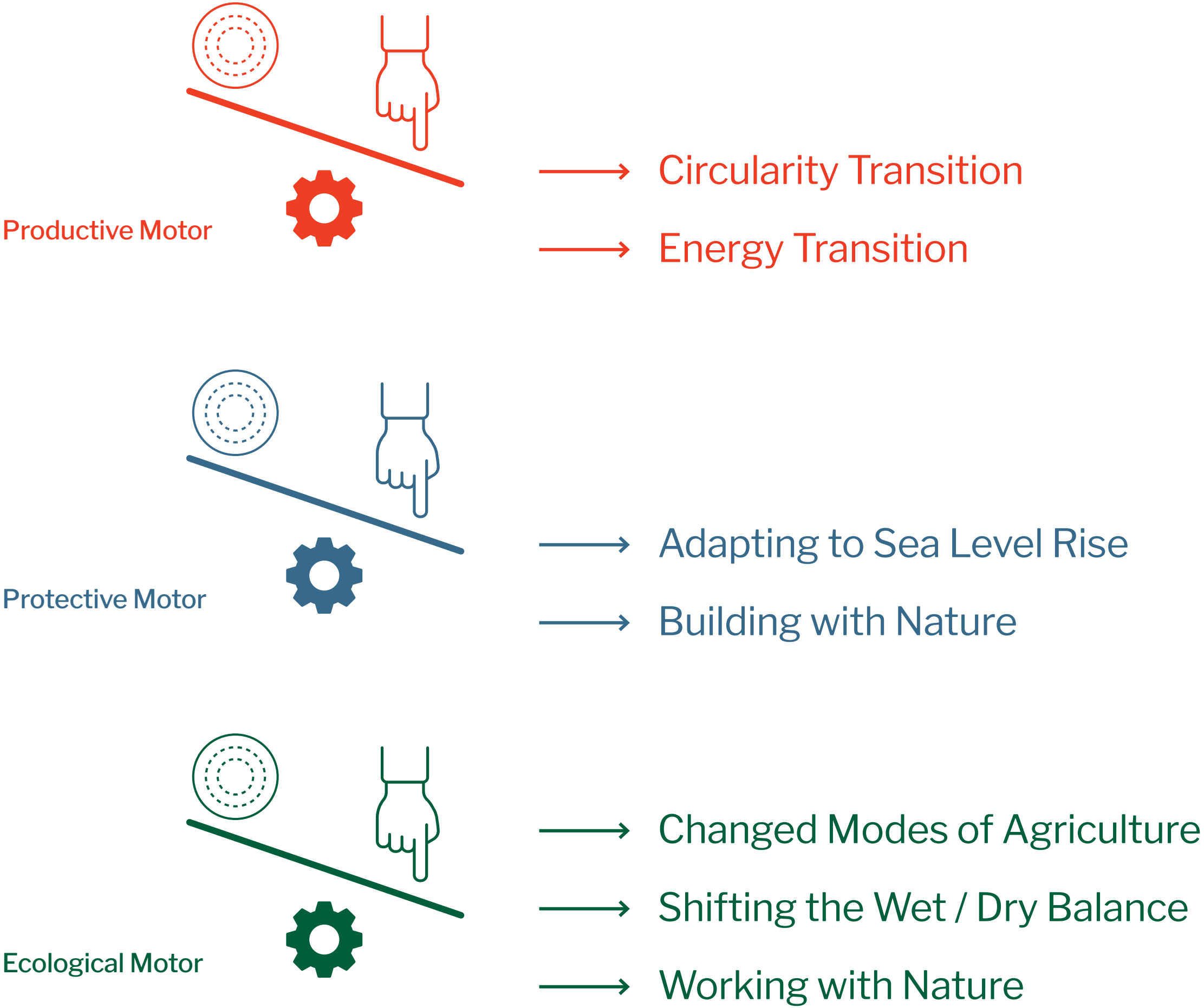
Projection

- **SQ3: Leverage Points and Spatial Pathways**
- **SQ4: Actionable Measures and Local Design Elaborations**

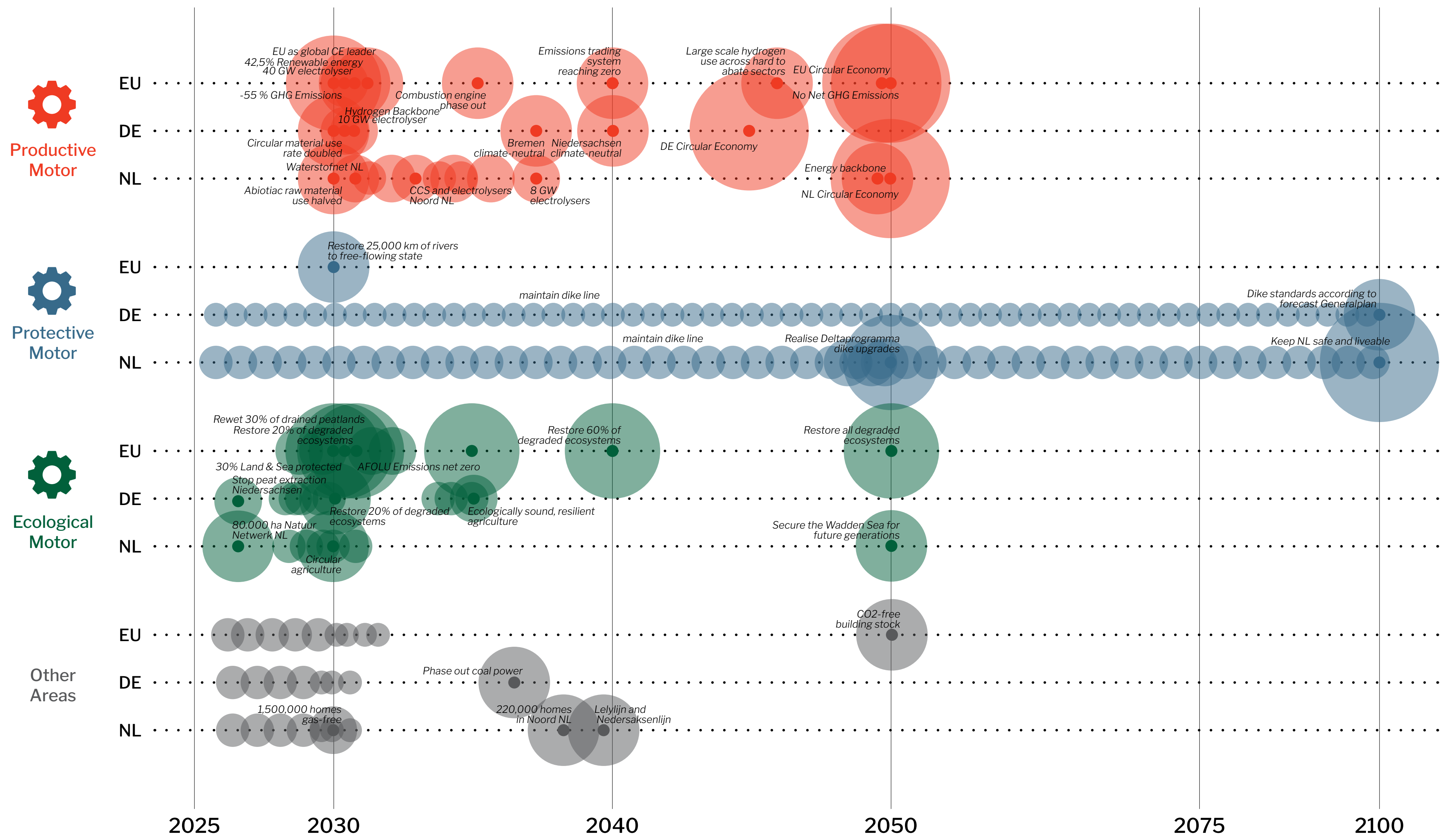
How would a desirable future look like?



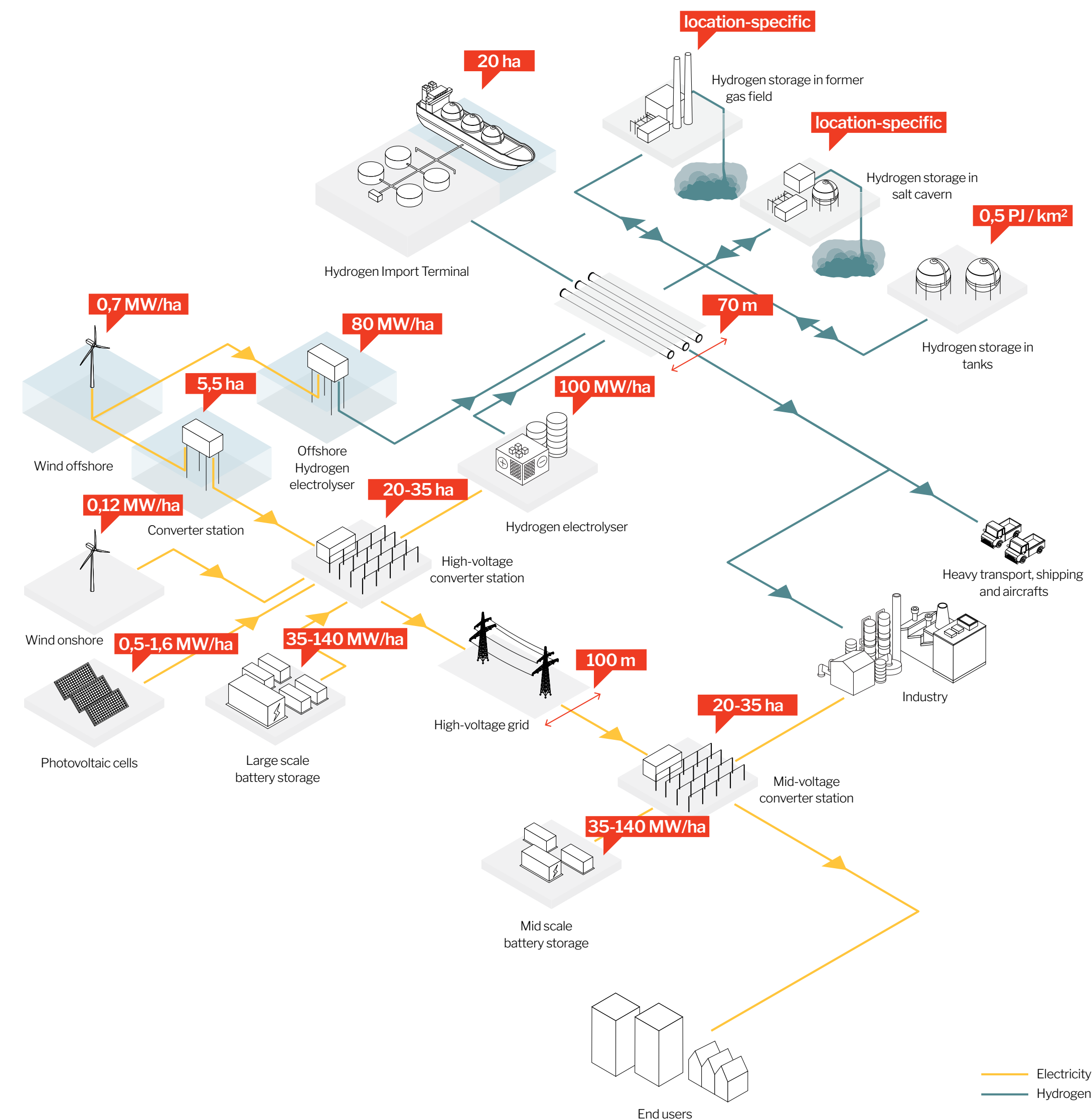
What can be leverage points for a sustainable circular metabolism?



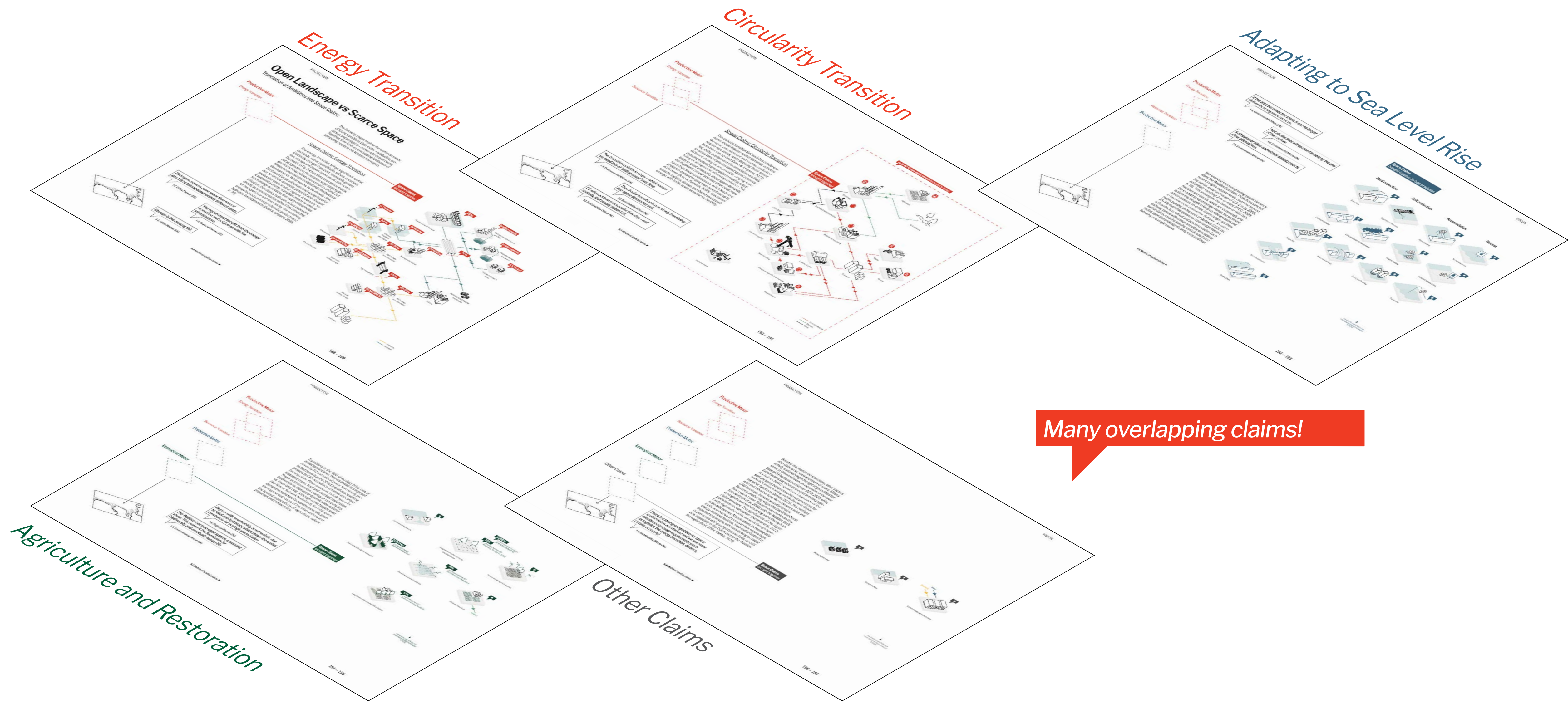
What can be leverage points for a sustainable circular metabolism?



How do they translate into space claims?



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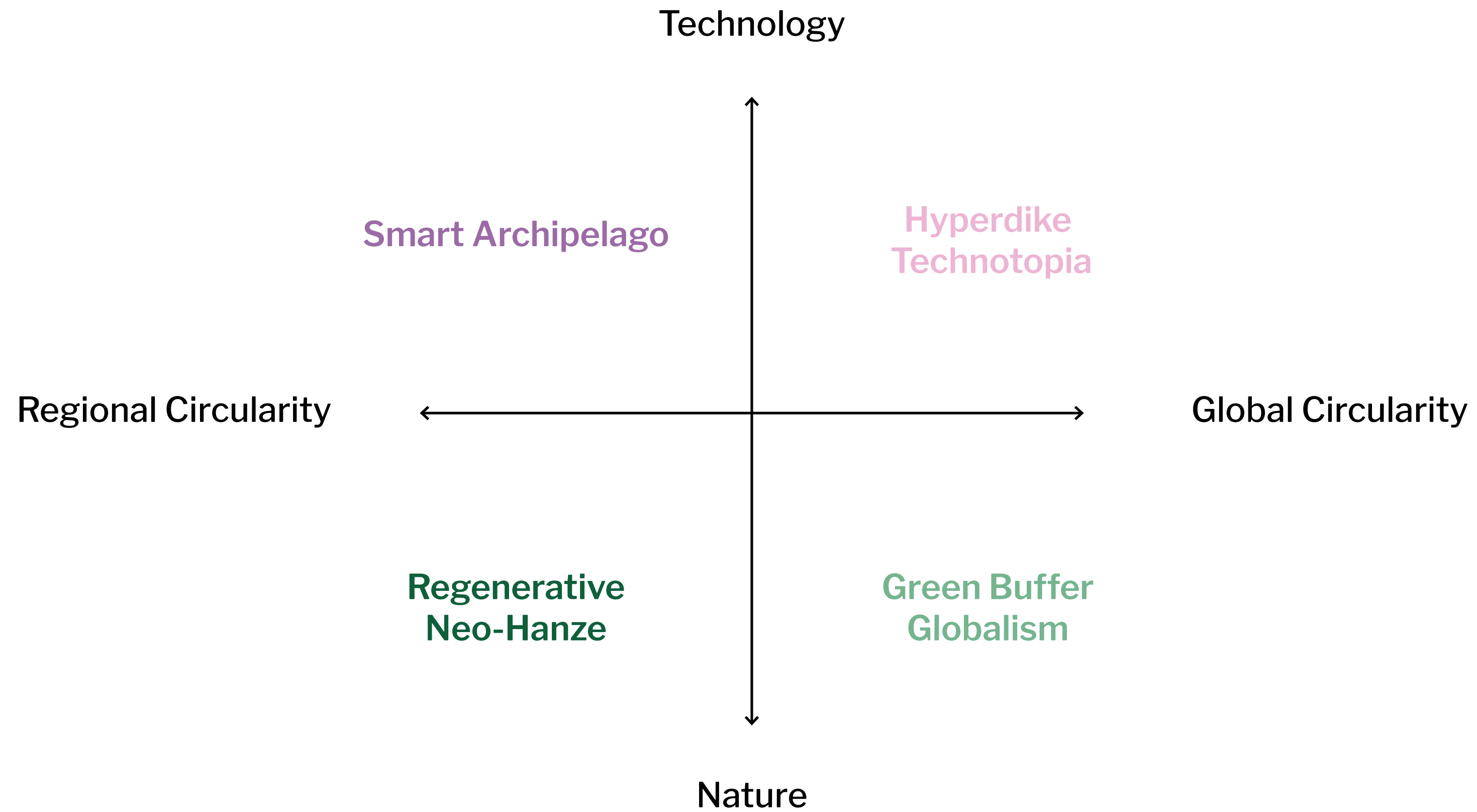
There is a strong competition for space: spatial claims are stacked and we see many simultaneous usage requirements (such as logistics, the energy transition, defence, circular economy)

I-1, Sustainability Officer (NL)

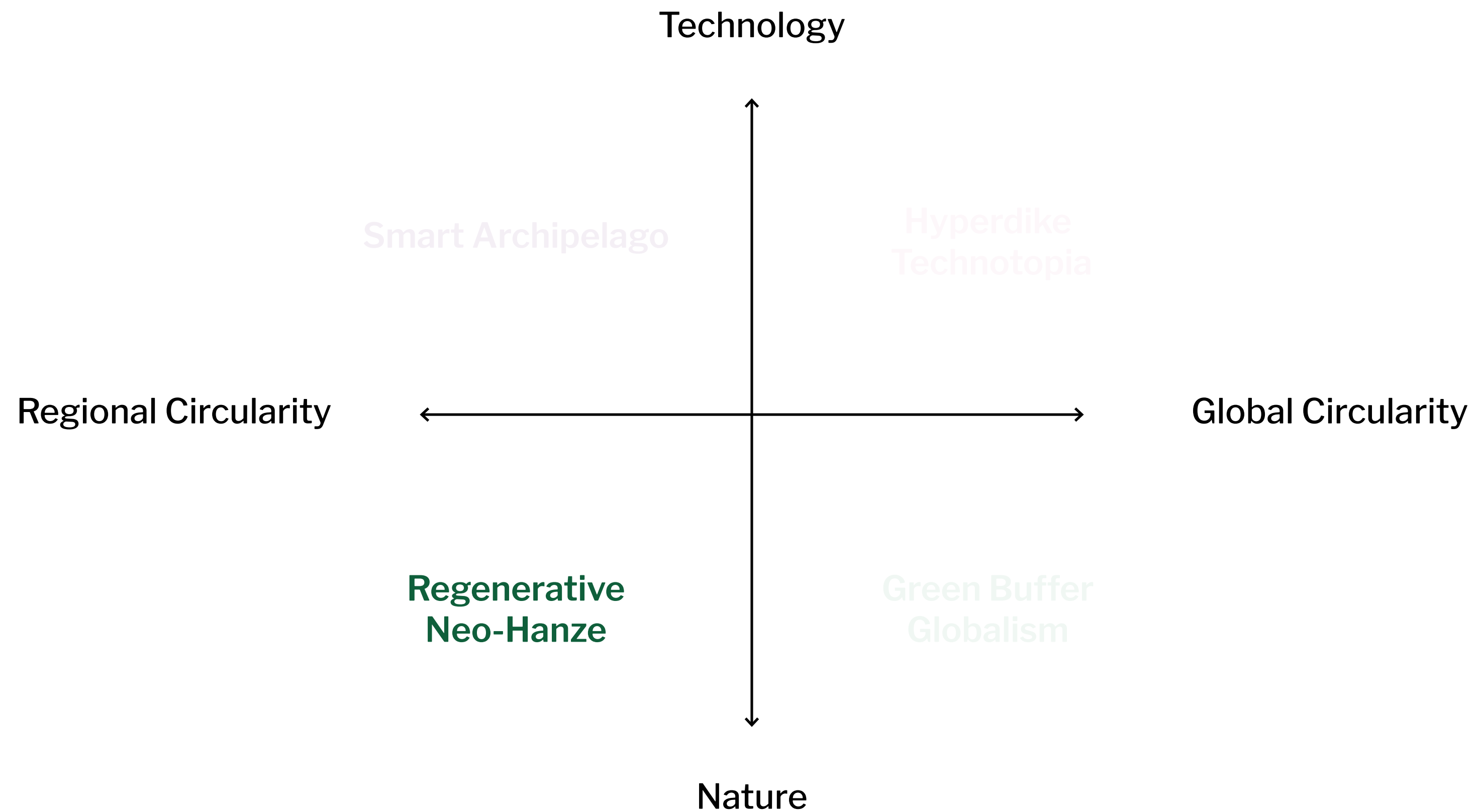
Perhaps the urgency just isn't high enough yet – which is why people avoid tough decisions.

I-4, Business Representative (NL)

Which future do we build for, then?



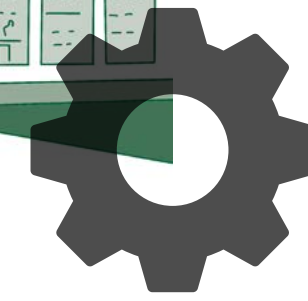
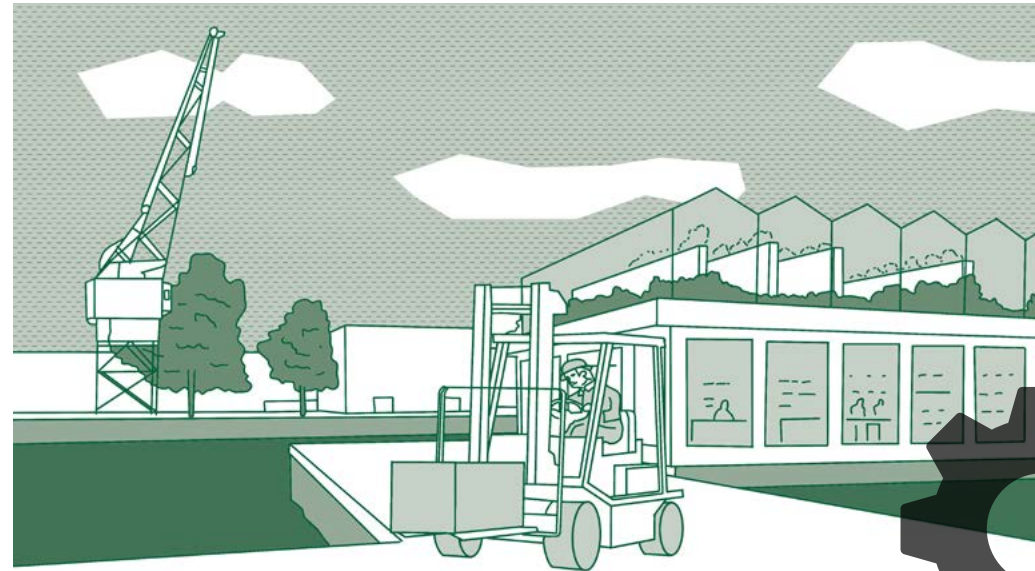
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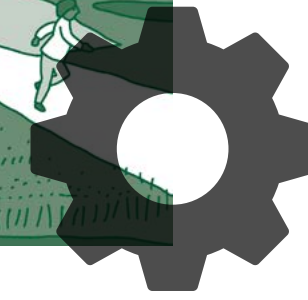
Which future scenarios emerge?



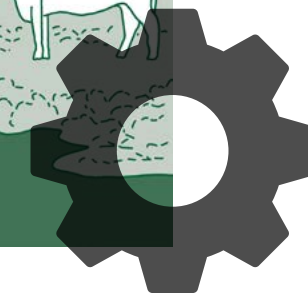
Which future scenarios emerge?



Productive Motor

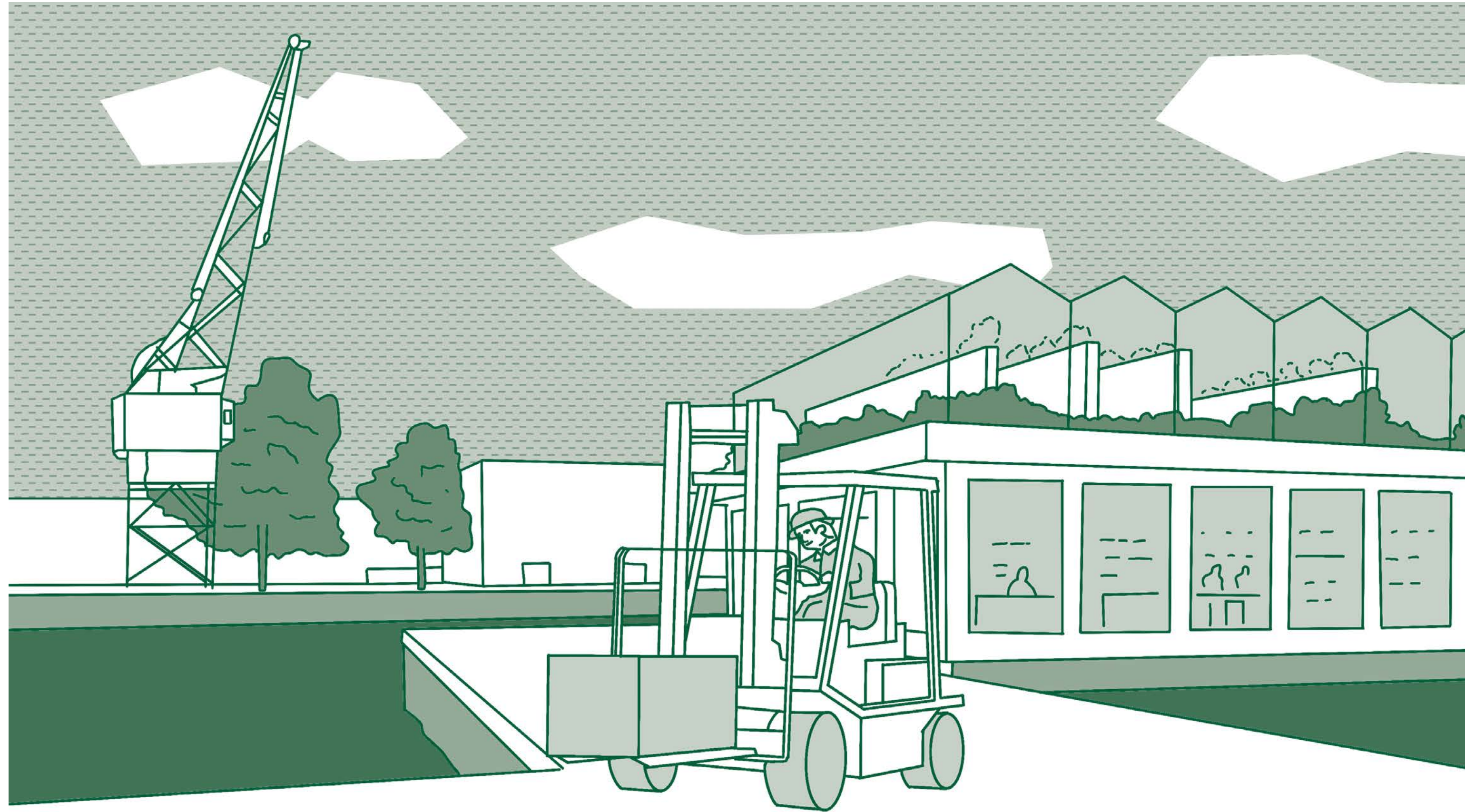


Protective Motor



Ecological Motor

Which future scenarios emerge?



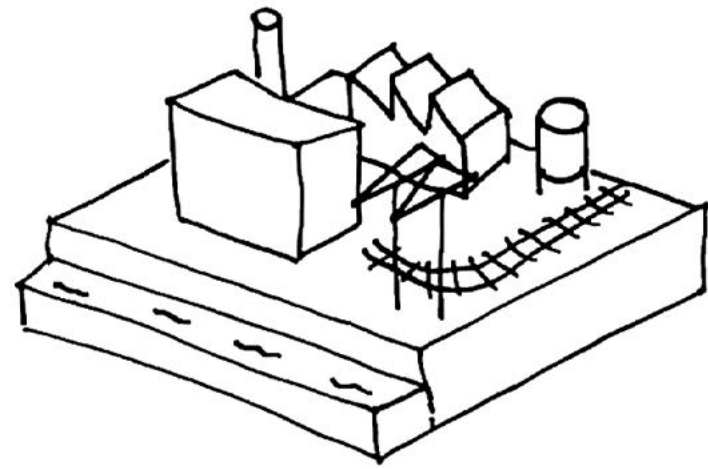
Which future scenarios emerge?



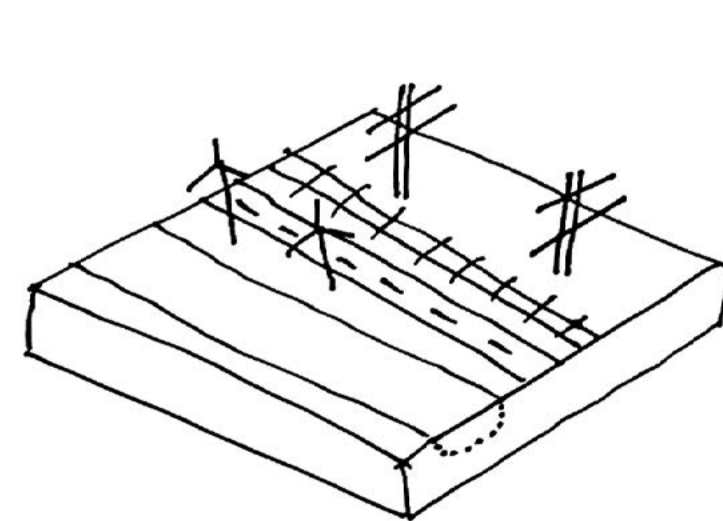
Which future scenarios emerge?



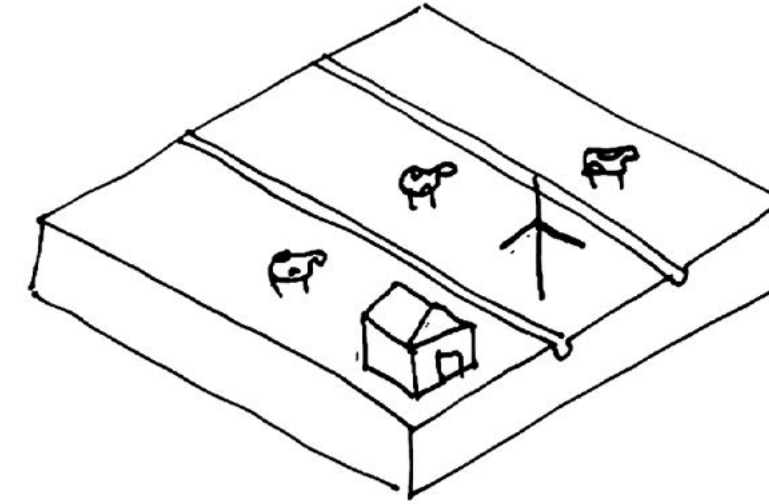
Which future scenarios emerge?



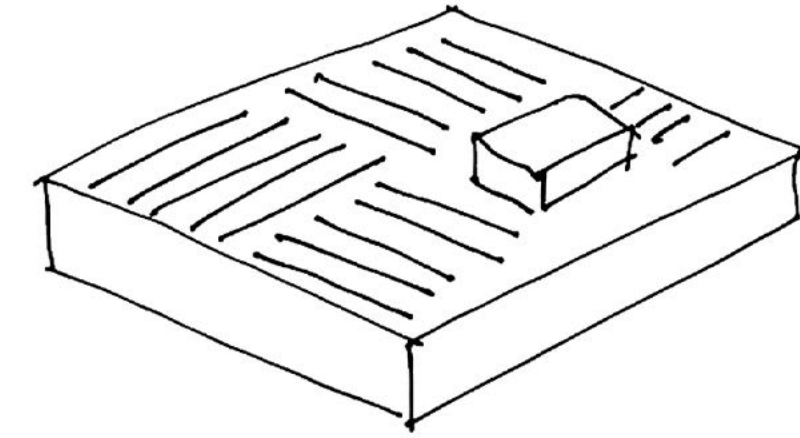
Large Industrial Clusters 



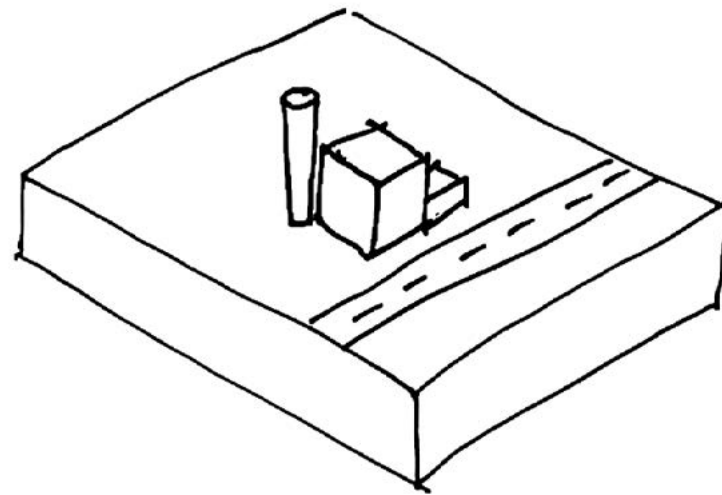
Infrastructure Lines  



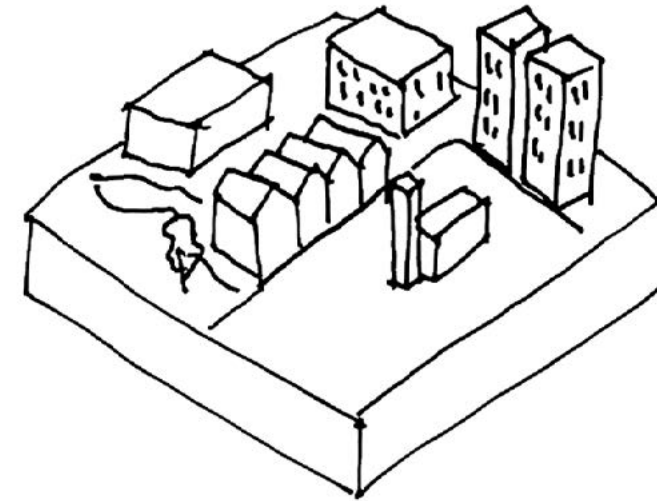
Marshlands  



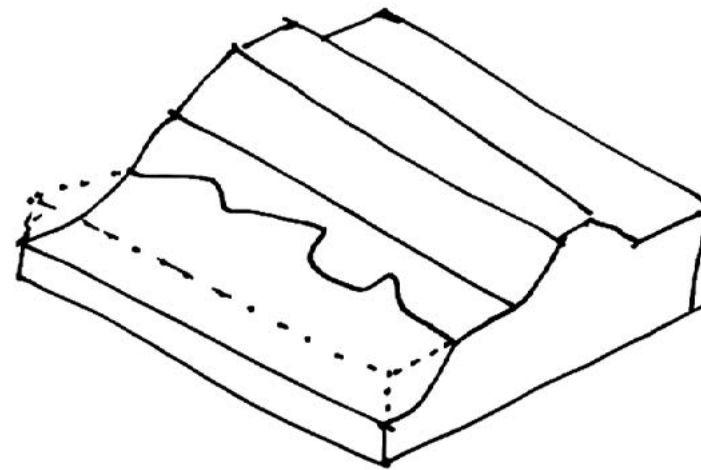
Crop Agriculture 



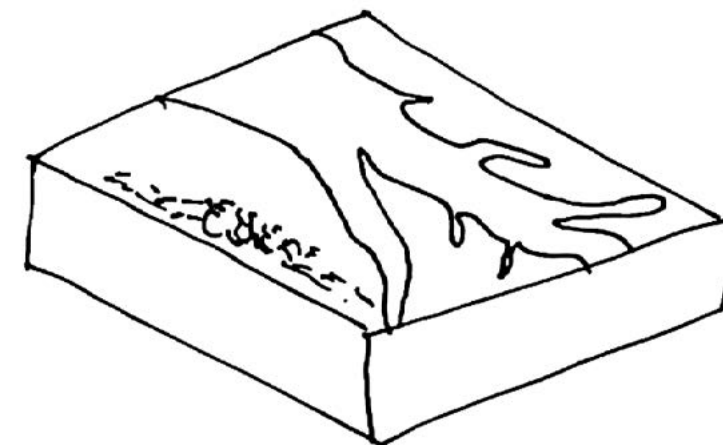
Smaller Industrial Locations 



Urbanised Areas 

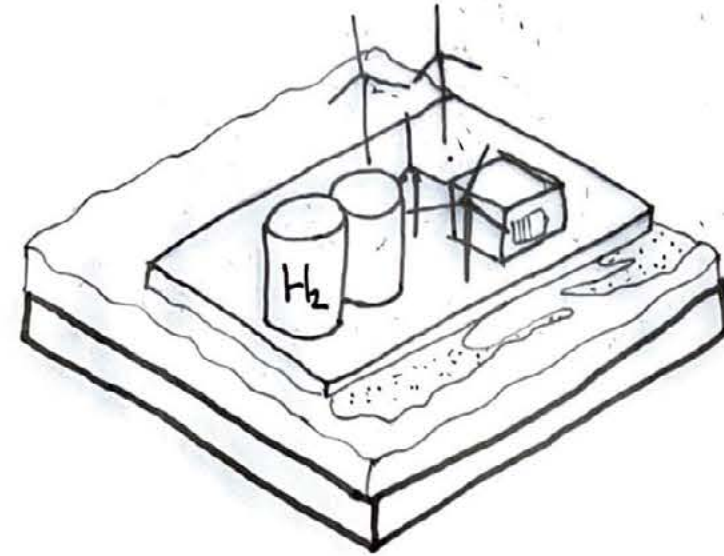


Dykes  

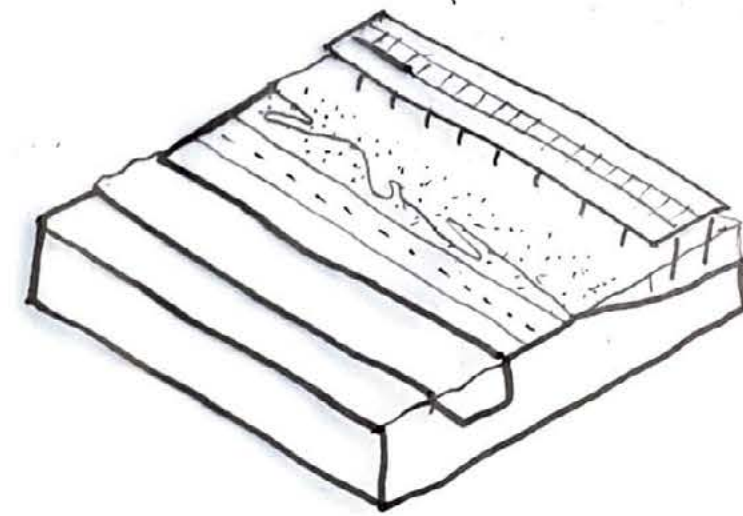


Wadden Sea (Tidal Flats)  

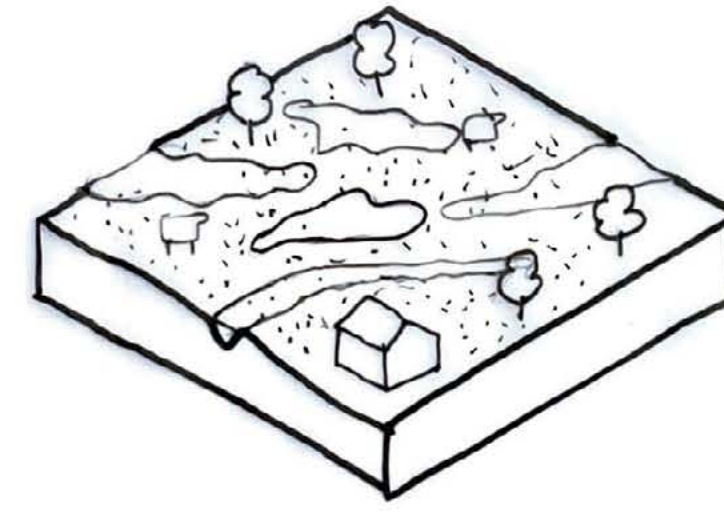
Which future scenarios emerge?



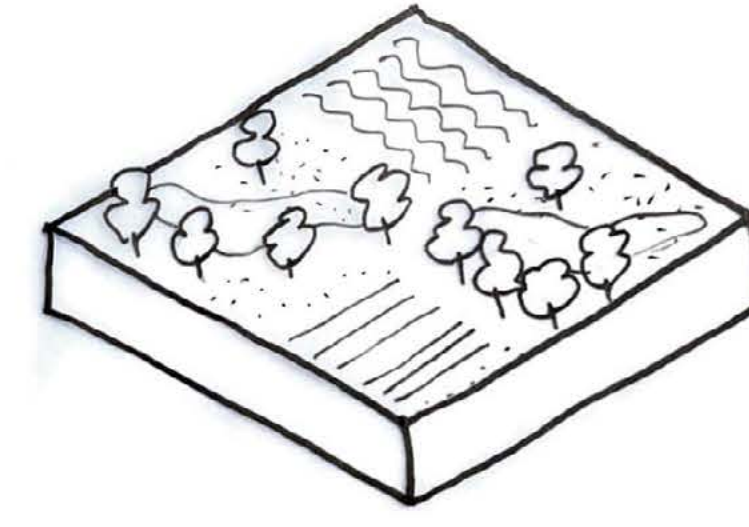
Large Industrial Clusters ⚙️
Energy Islands



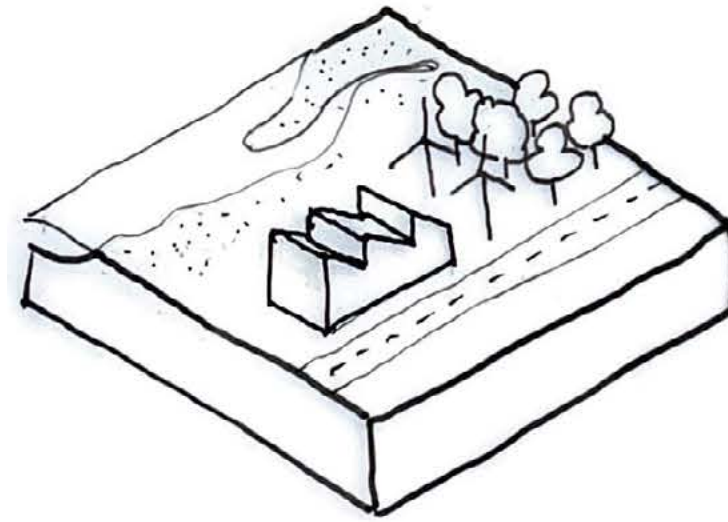
Infrastructure Lines ⚙️ ⚙️
Scaled back and partly rewilded



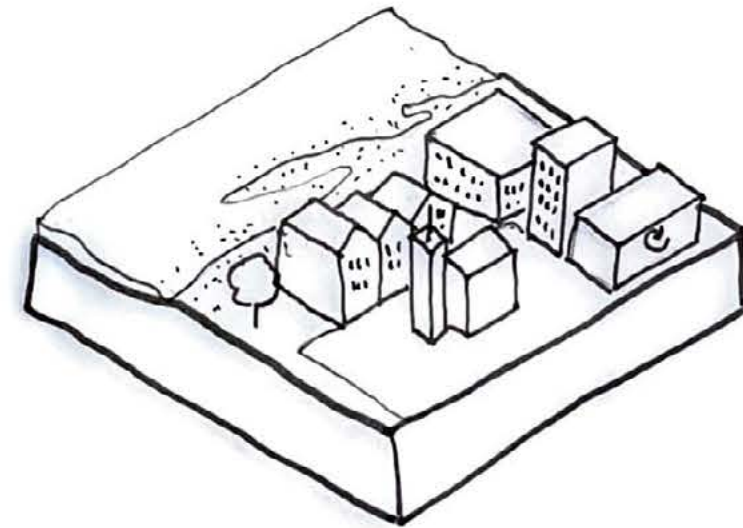
Marshlands ⚙️ ⚙️
Rewetted, rewilded, extensive agriculture



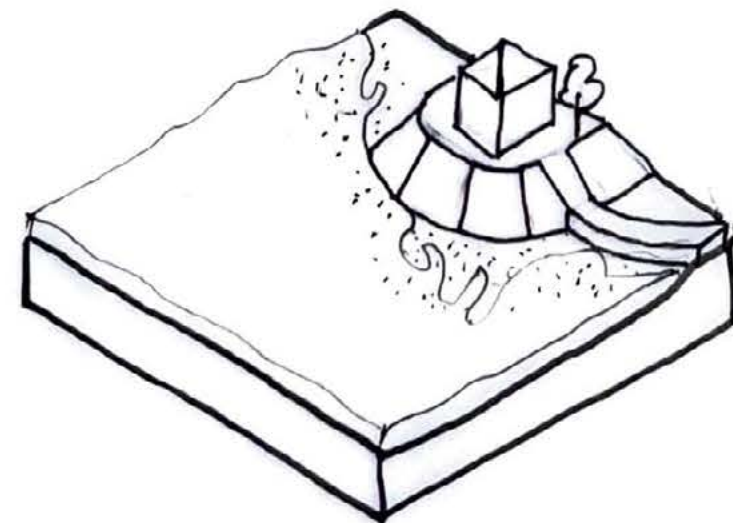
Crop Agriculture ⚙️
Remaining higher areas used for ecological corridors and crop production incl. biobased feedstock



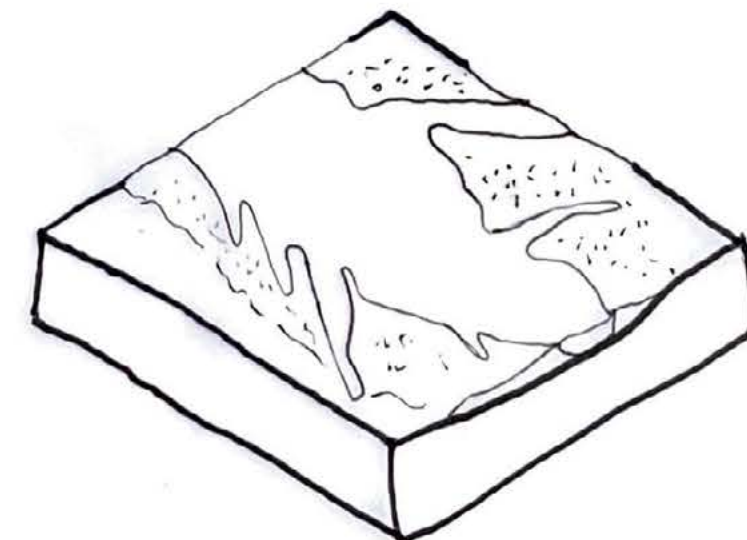
Smaller Industrial Locations ⚙️
Backbone of regional economy, waste = input



Urbanised Areas ⚙️
Now often close to water, circular facilities

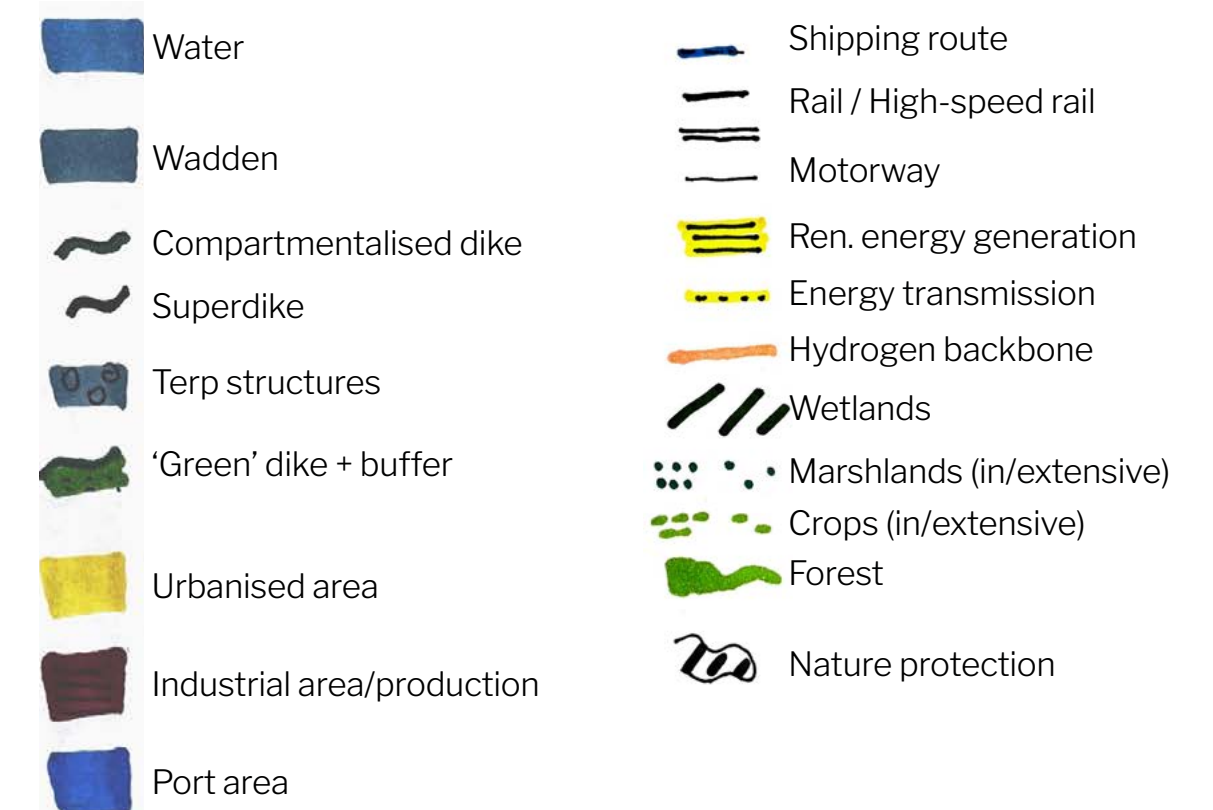
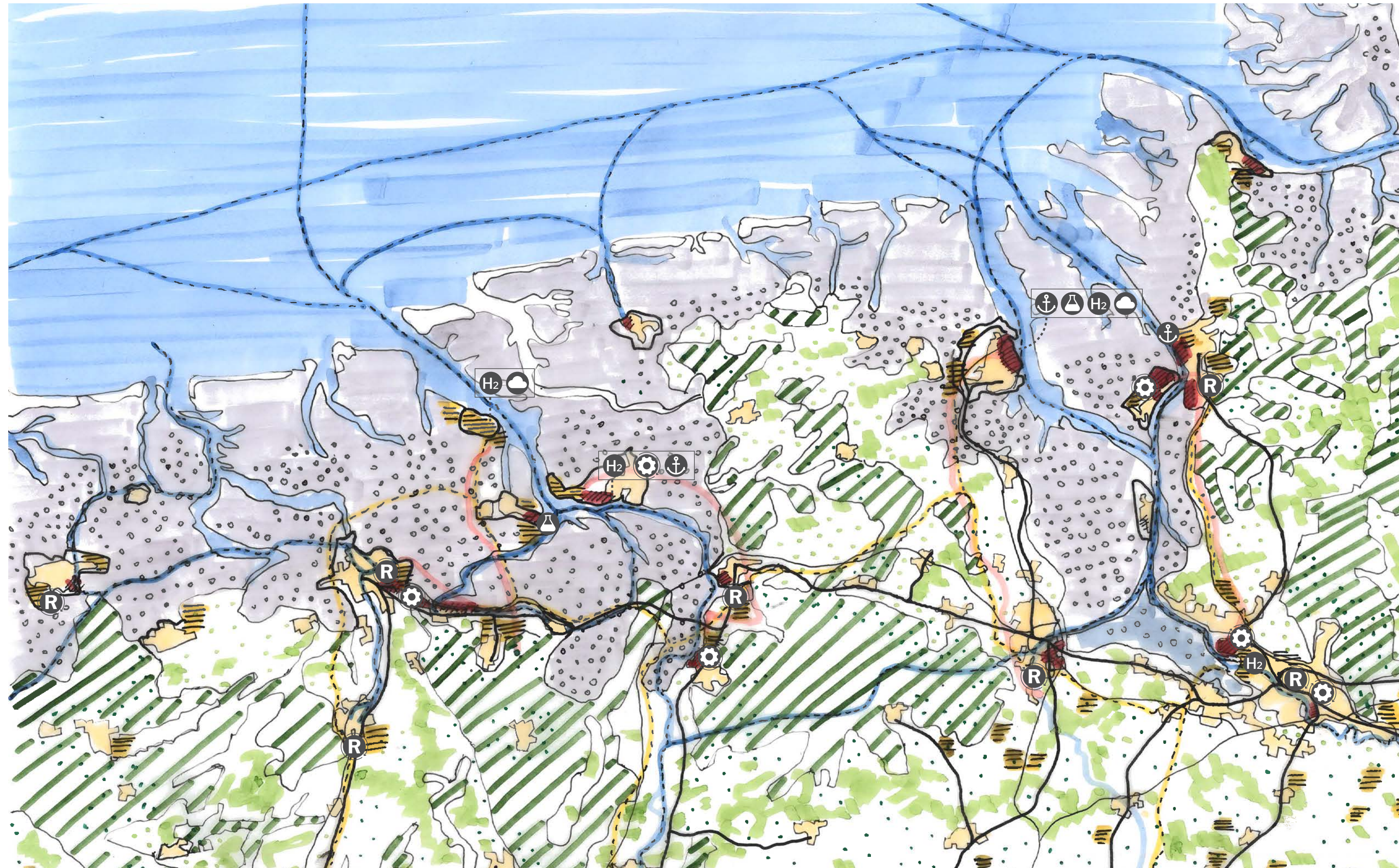


Dykes ⚙️ ⚙️
Removed/out of use, replaced by terps

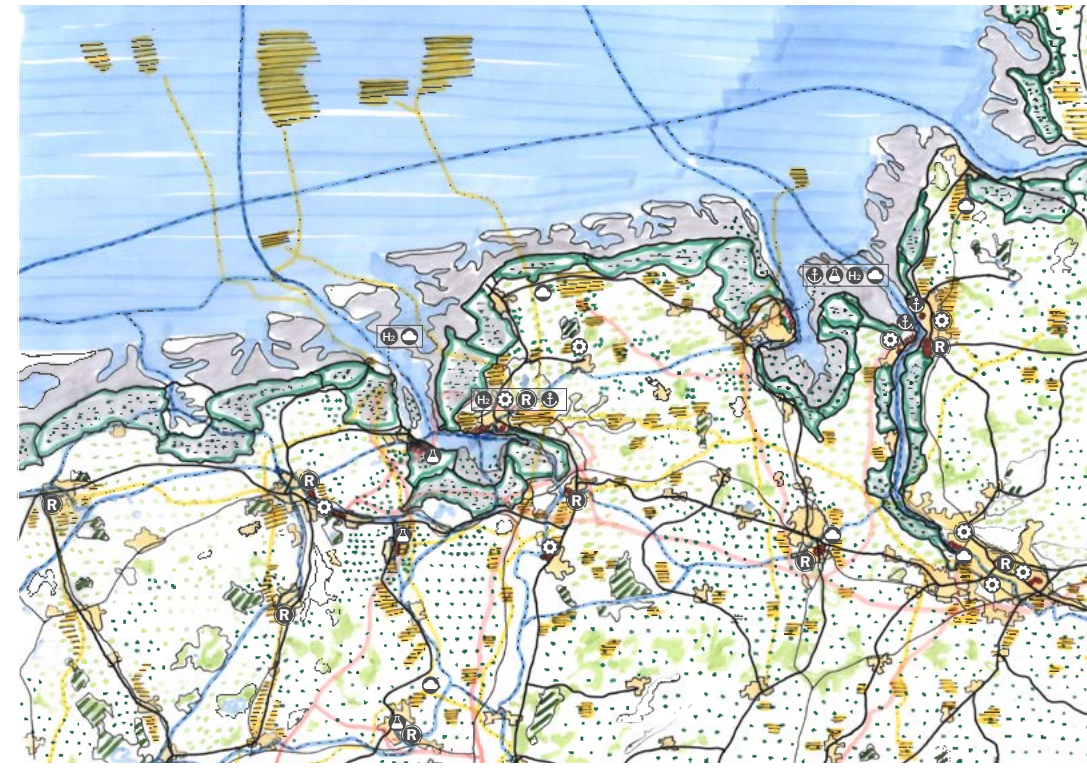


Wadden Sea (Tidal Flats) ⚙️ ⚙️
Remains in place and expands, sedimentation

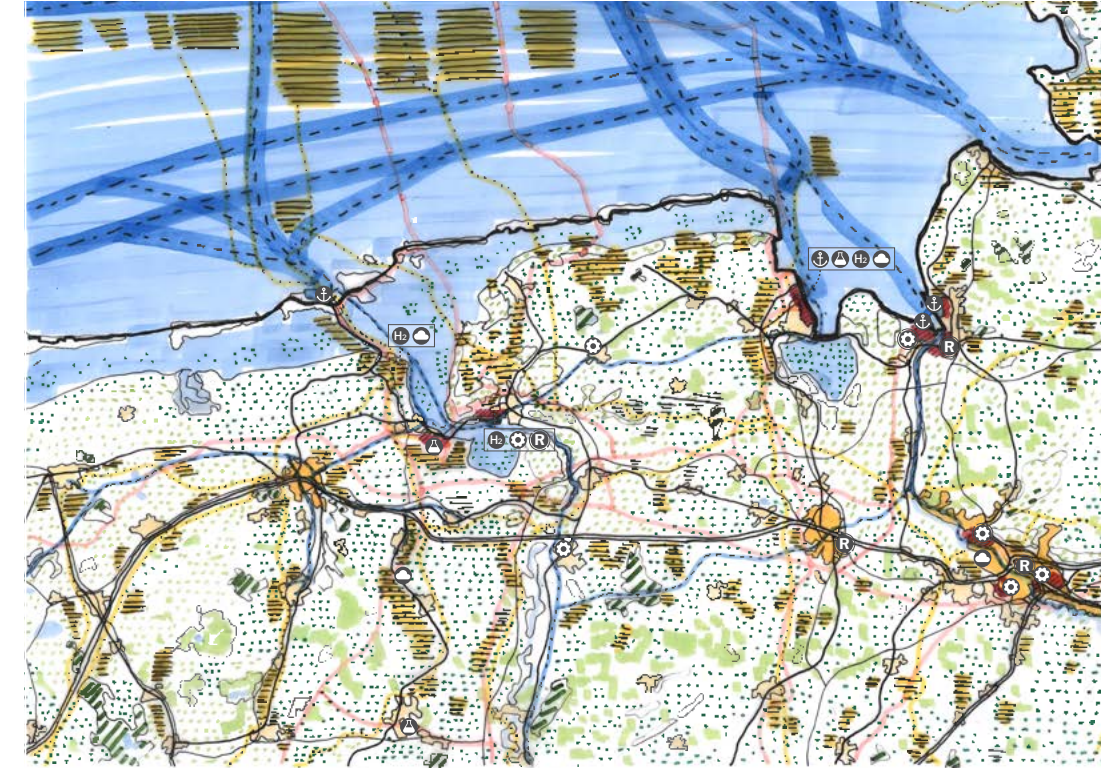
Which future scenarios emerge?



Which future scenarios emerge?



Technology-based



Smart Archipelago

Circular hubs spread across the area, defined by technical infrastructure serving the region itself and not other areas.

Hyperdike Technotopia

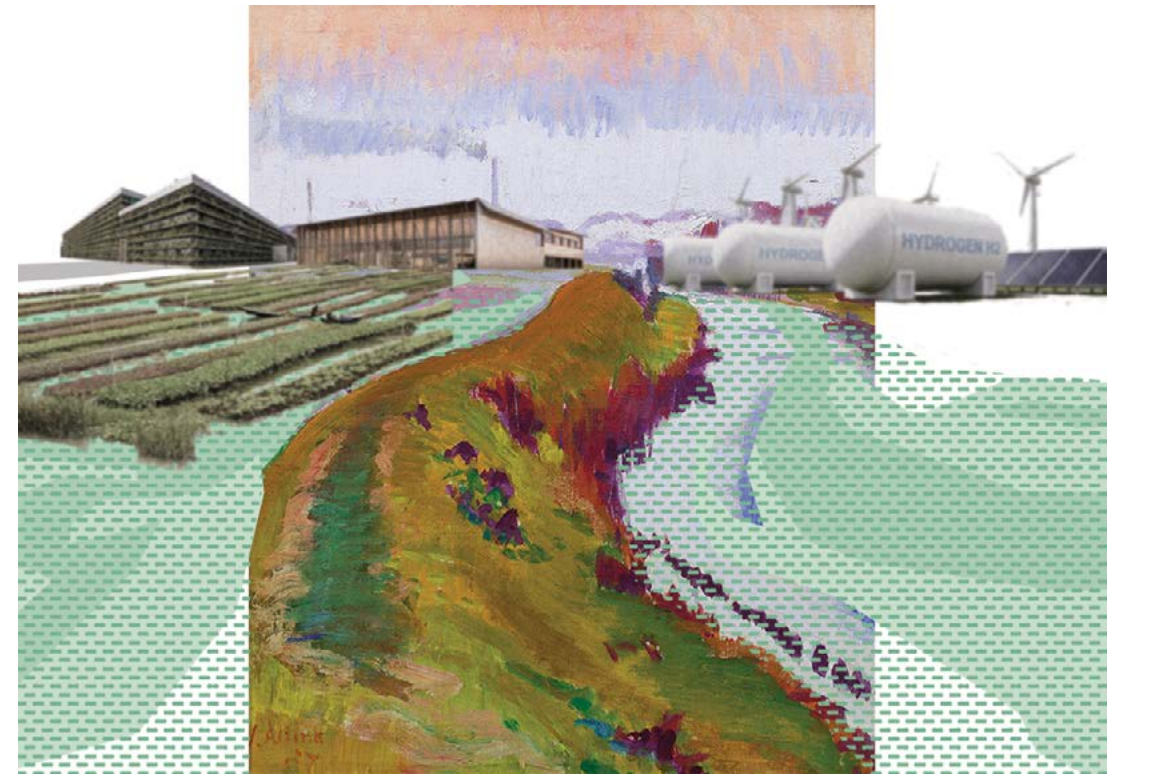
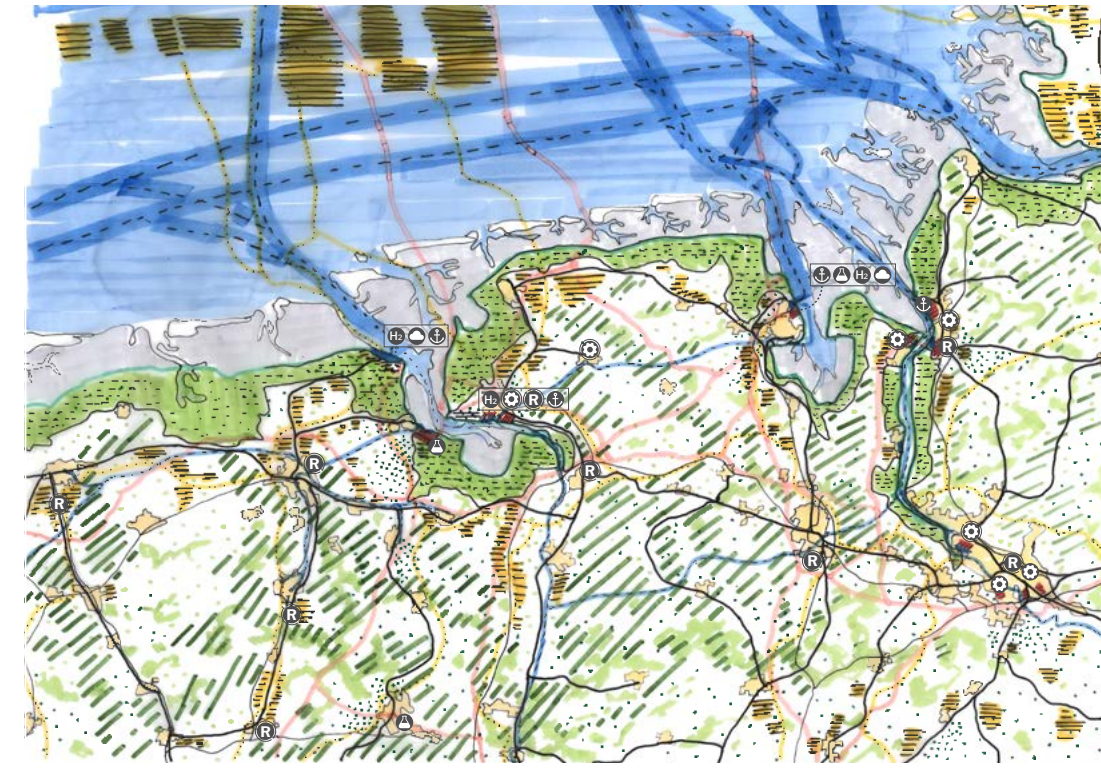
Fixed coastline with a massive sea closure, export-driven hubs dominate, hinterlands linked to the global ports via strengthened corridors.

← Regional Circularity

Global Circularity →



Nature-based



Regenerative Neo-Hanze

Territorial retreat with compact cities and restored wetlands, port cities become peripheral outposts in a decentralised bioregional network.

Green Buffer Globalism

Green buffer development with integration of ecology and productivity. Economic activity remains concentrated in existing hubs, but done differently.

How to assess these scenarios?

Smart Archipelago

- “Technology will always be central.” (I-5)
- Modular but too controlling**
- “Natural functions are assumed to be controllable here, but this requires immense ecological knowledge.” (I-6)
- “Strong conditions for vertically layered land use, which is positive” (I-9)

- + Valued for innovation and modularity
- ⚠ Concerns about oversimplified control logic, upscaling and ecological blind spots

Hyperdike Technotopia

- “The Delta Works cost 20% of Dutch GDP. That is just not affordable in a region like this.” (I-8)
- “What happens when a dike fails? One breach and the system collapses, from the 1960s” (I-6)
- Unaffordable and unecological**
- “The dike is a massive shipping bottleneck.” (I-9)
- “Technically interesting, politically unfeasible in Germany’s federal governance system” (I-5)
- “However, such a large joint project could also bring the region closer together” (I-8)

- + Might appeal to high-growth sectors
- ⚠ Socially and ecologically fragile tech-utopia

Regenerative Neo-Hanze

- “Ecologically sound, but somewhat naive for the next 50 years.” (I-5)
- “Would require a return to the flexible way of living with water of centuries ago.” (I-6)
- Restorative, socially fragile**
- “Social drive is missing for such ecological prioritisation.” (I-8)
- “Seen as implying a loss of prosperity.” (I-3, 8)
- “Once you start, you can’t just step back – this is a one-way path.” (I-9)

- + Praised (by some) as visionary and restorative
- ⚠ Feasibility, economic viability and societal impacts are all fundamentally questioned

Green Buffer Globalism

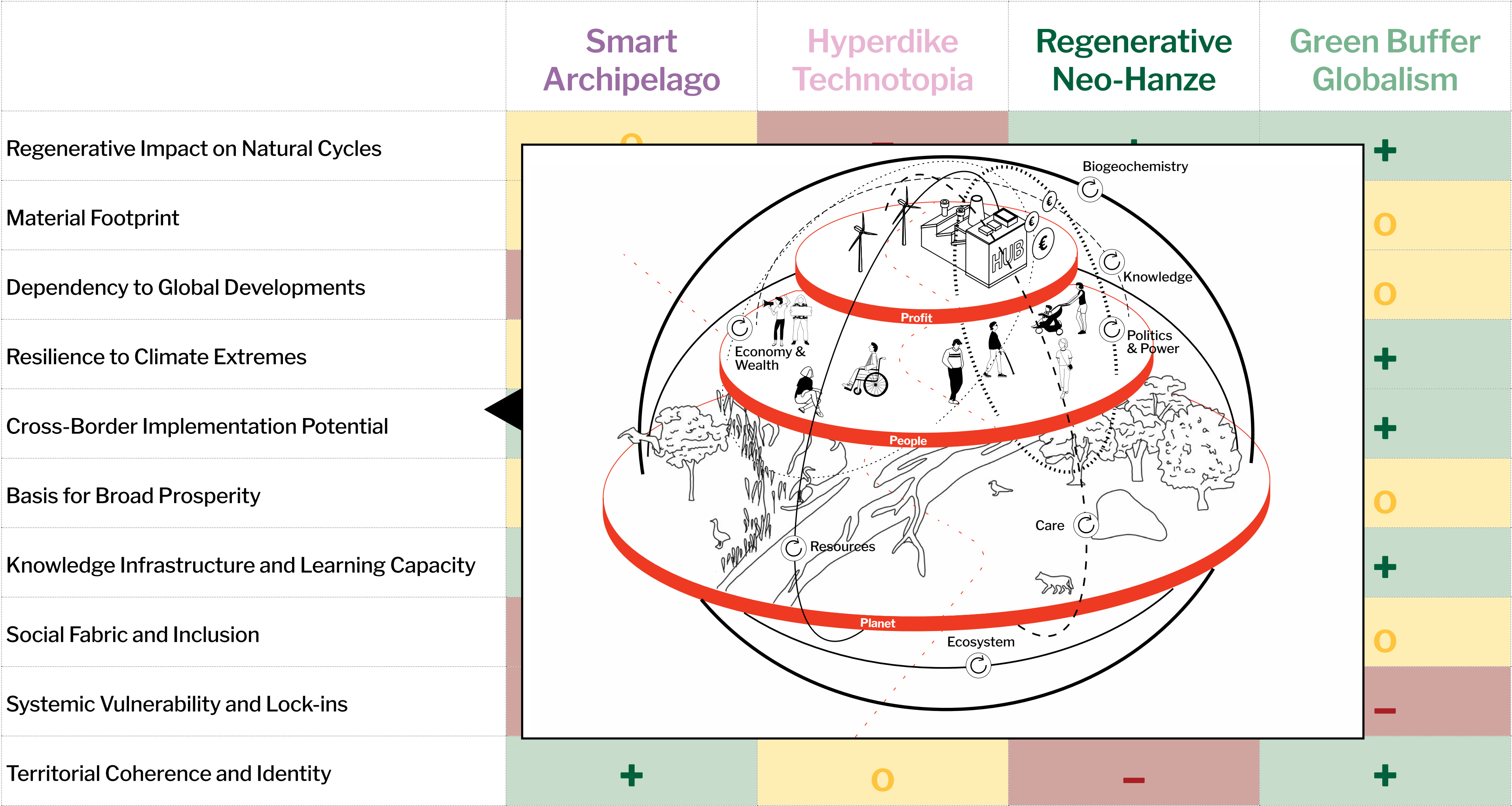
- “Eventually the most realistic.” (I-3, 4, 8)
- “Agriculture and nature can regain space here: this is a welcome direction.” (I-9)
- “Post-crisis realism: this comes after climate crisis and the following biodiversity shocks.” (I-9)
- “Desirable, but I expect this only by 2150.” (I-9)
- “The current barriers”
- Desirable but very distant**
- “Scenario approach with nature/global logic seen as promising, but slow.” (I-2)

- + Seen as a desirable long-term systemic transformation
- ⚠ Requires structural shifts in governance, societal mindset, culture and business

Which future scenarios emerge?

	Smart Archipelago	Hyperdike Technotopia	Regenerative Neo-Hanze	Green Buffer Globalism
Regenerative Impact on Natural Cycles	O	—	+	+
Material Footprint	O	—	+	O
Dependency to Global Developments	—	—	+	O
Resilience to Climate Extremes	O	O	+	+
Cross-Border Implementation Potential	+	—	O	+
Basis for Broad Prosperity	O	+	—	O
Knowledge Infrastructure and Learning Capacity	+	+	—	+
Social Fabric and Inclusion	—	—	+	O
Systemic Vulnerability and Lock-ins	—	—	+	—
Territorial Coherence and Identity	+	O	—	+

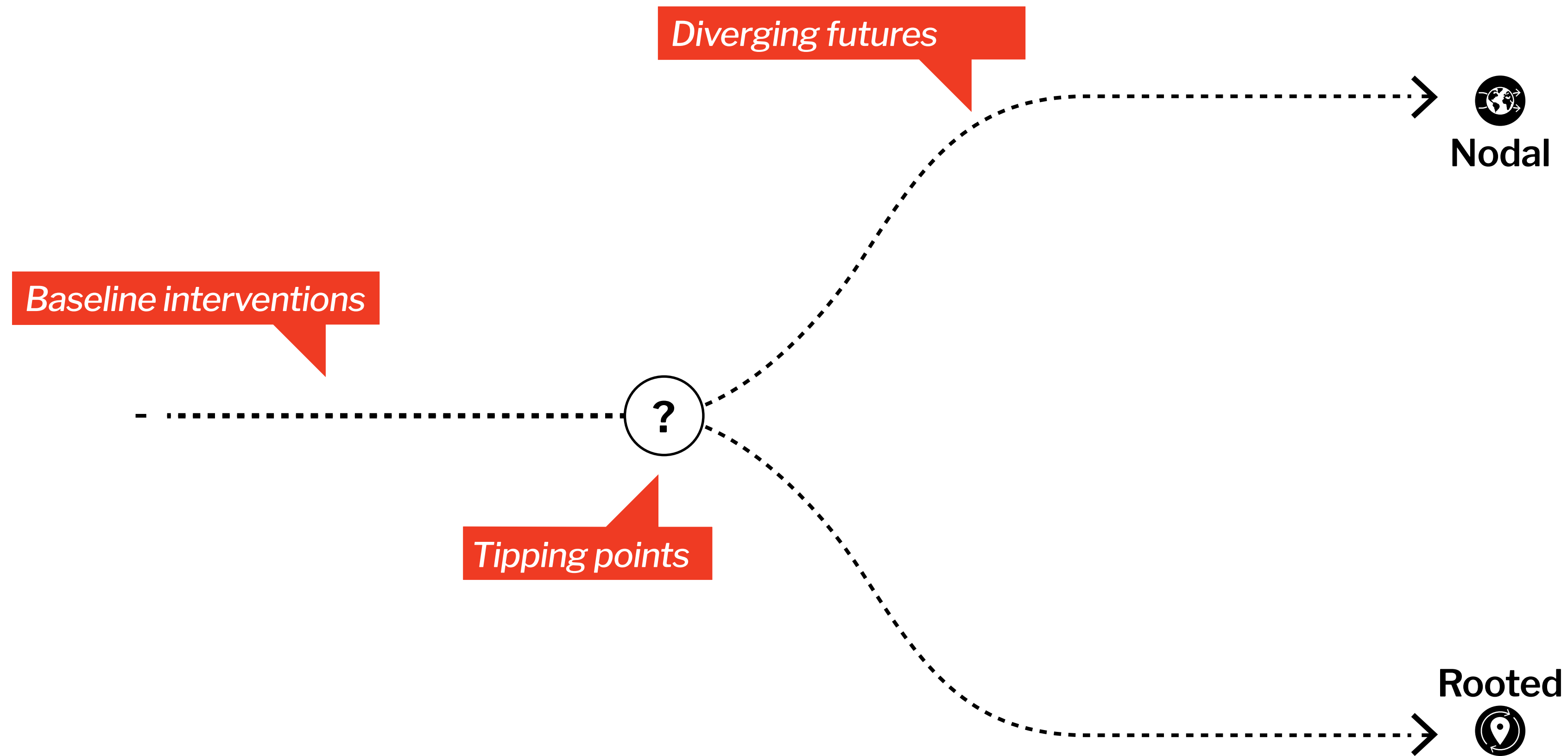
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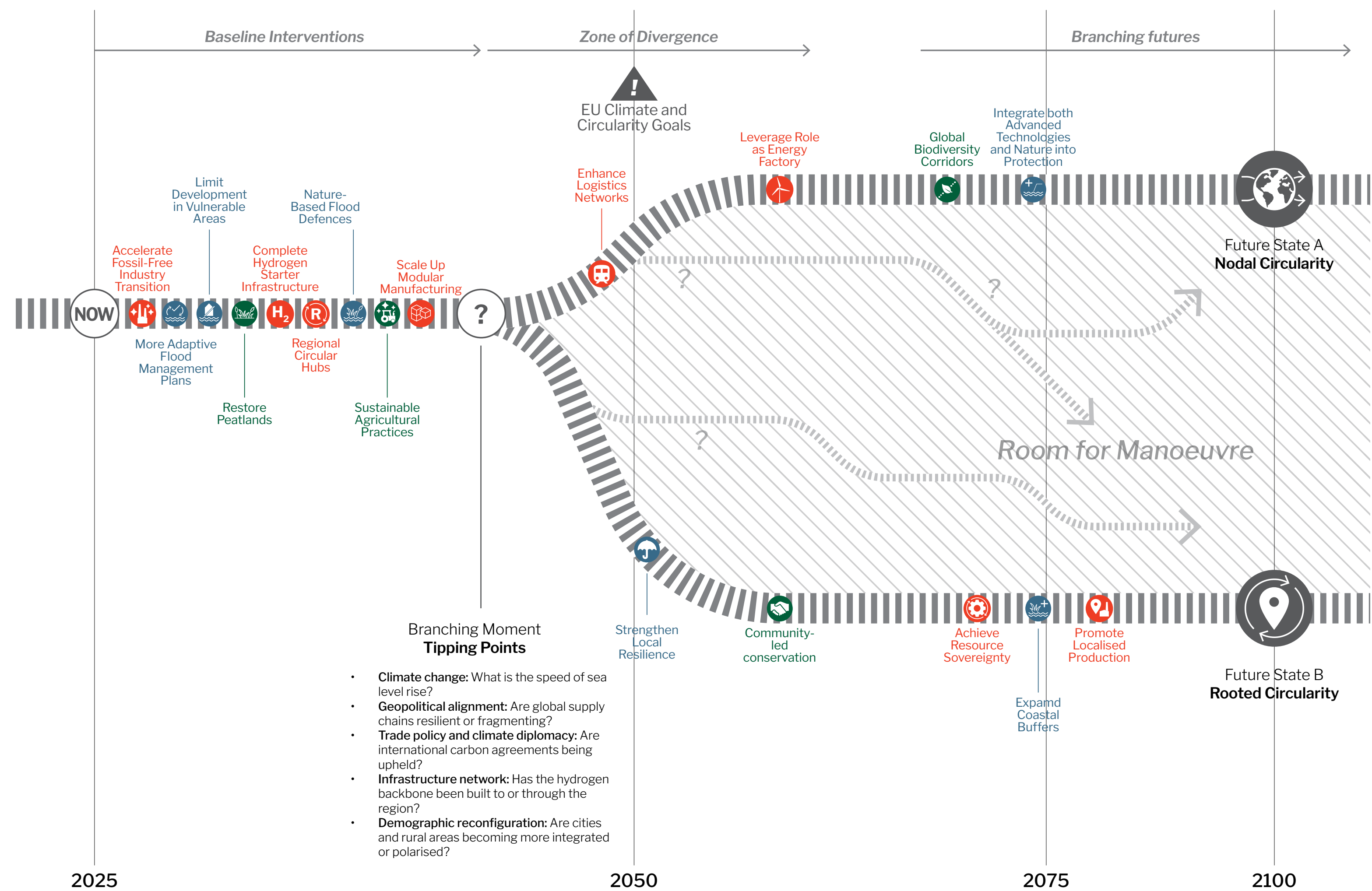
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Territorial Coherence and Identity	+	O	—	+

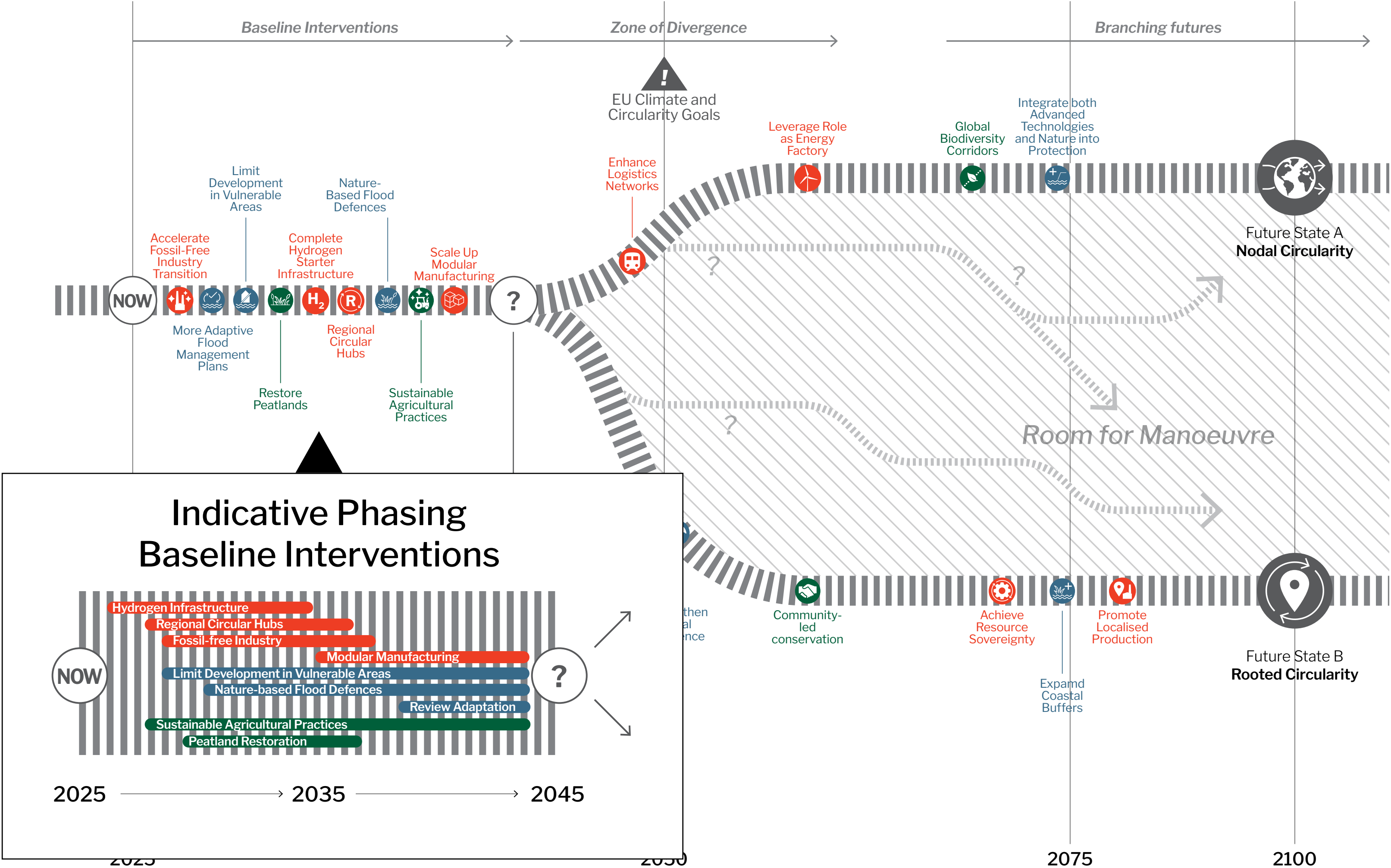
What pathways can guide us forward?



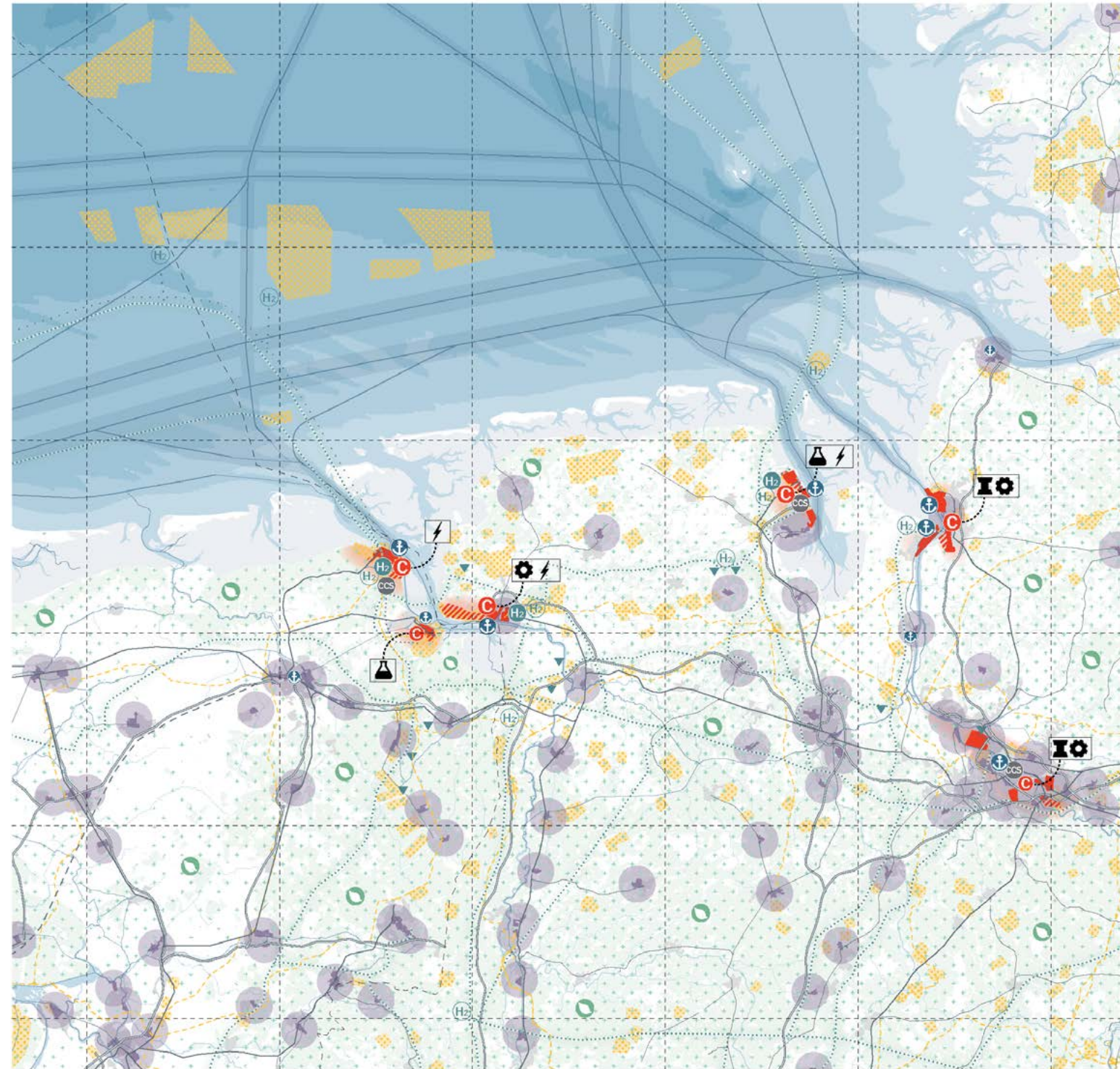
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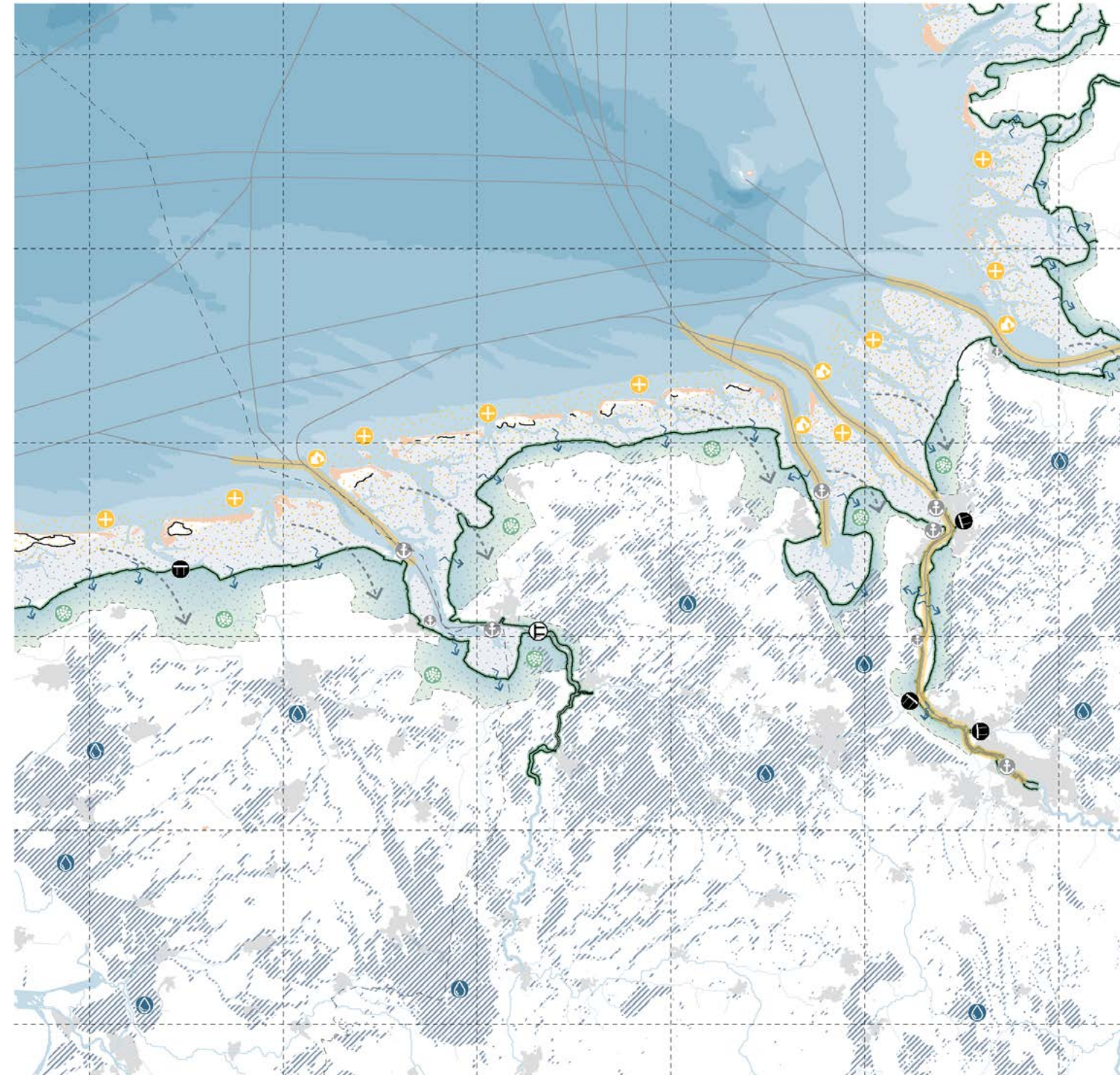
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How does this Strategic Framework become spatial?



 Productive Motor

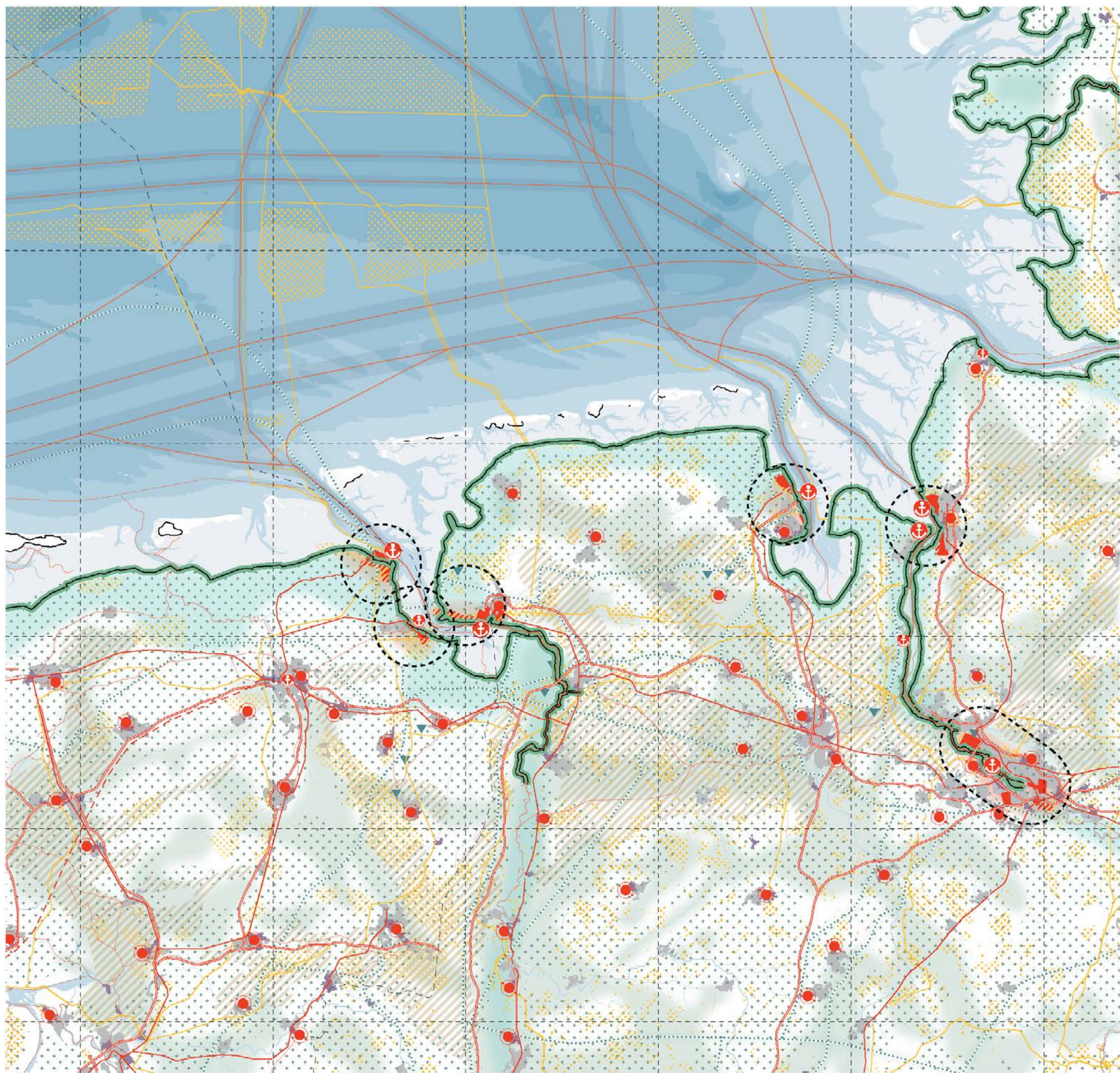


 Protective Motor



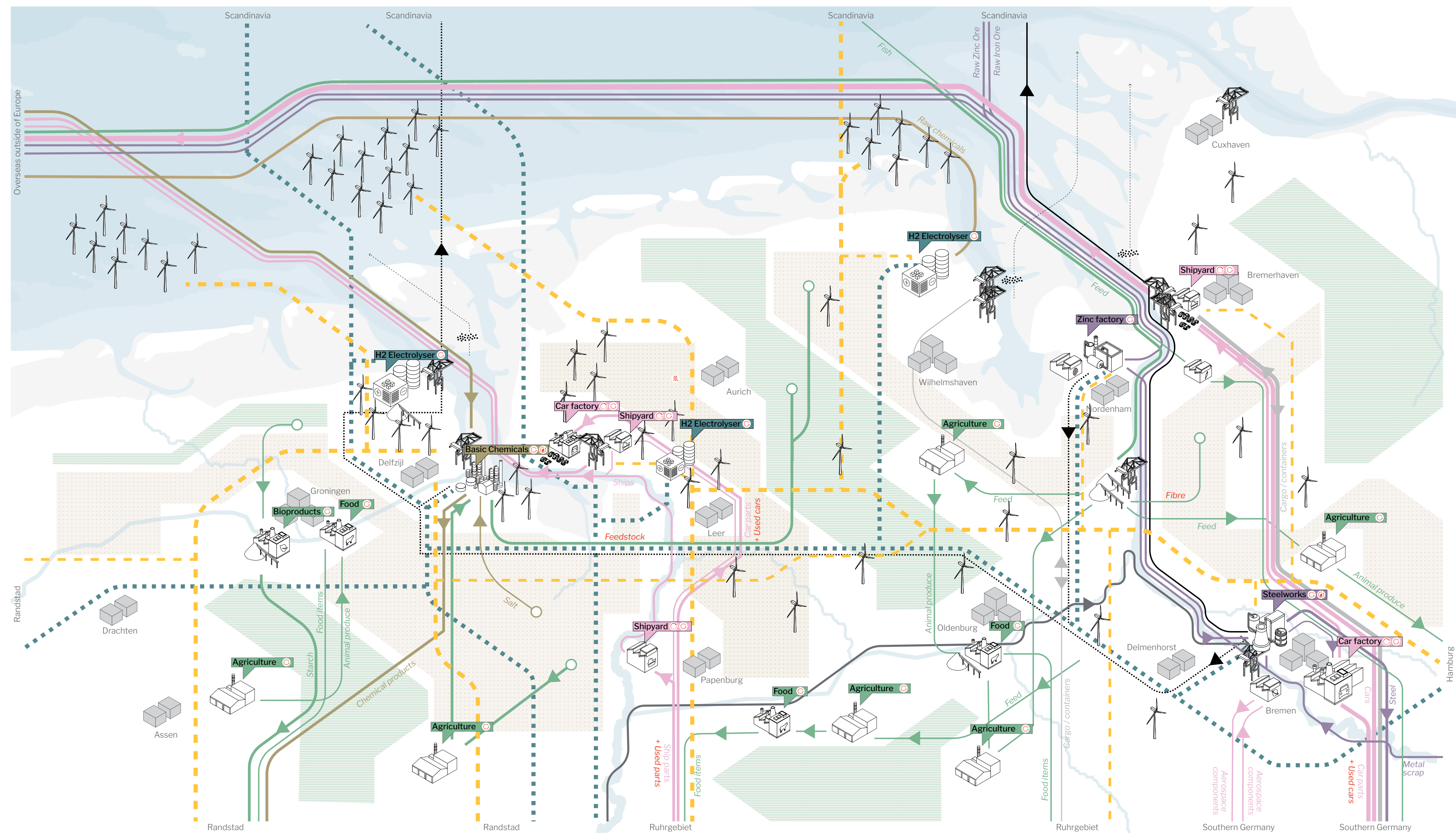
 Ecological Motor

How does this Strategic Framework become spatial?



- Sea
- Wadden
- Settlement
- Large Industrial Cluster area
- Potential Cluster expansion
- Large Cluster
- Local Circular Hub
- Energy area
- Mobility network
- Energy grid
- Broad green dike (Raising as long as possible)
- Green spine
- New water landscapes
- Potential rewetting

How could materials and energy flow through this system?



Zooming in: What happens in Emden?



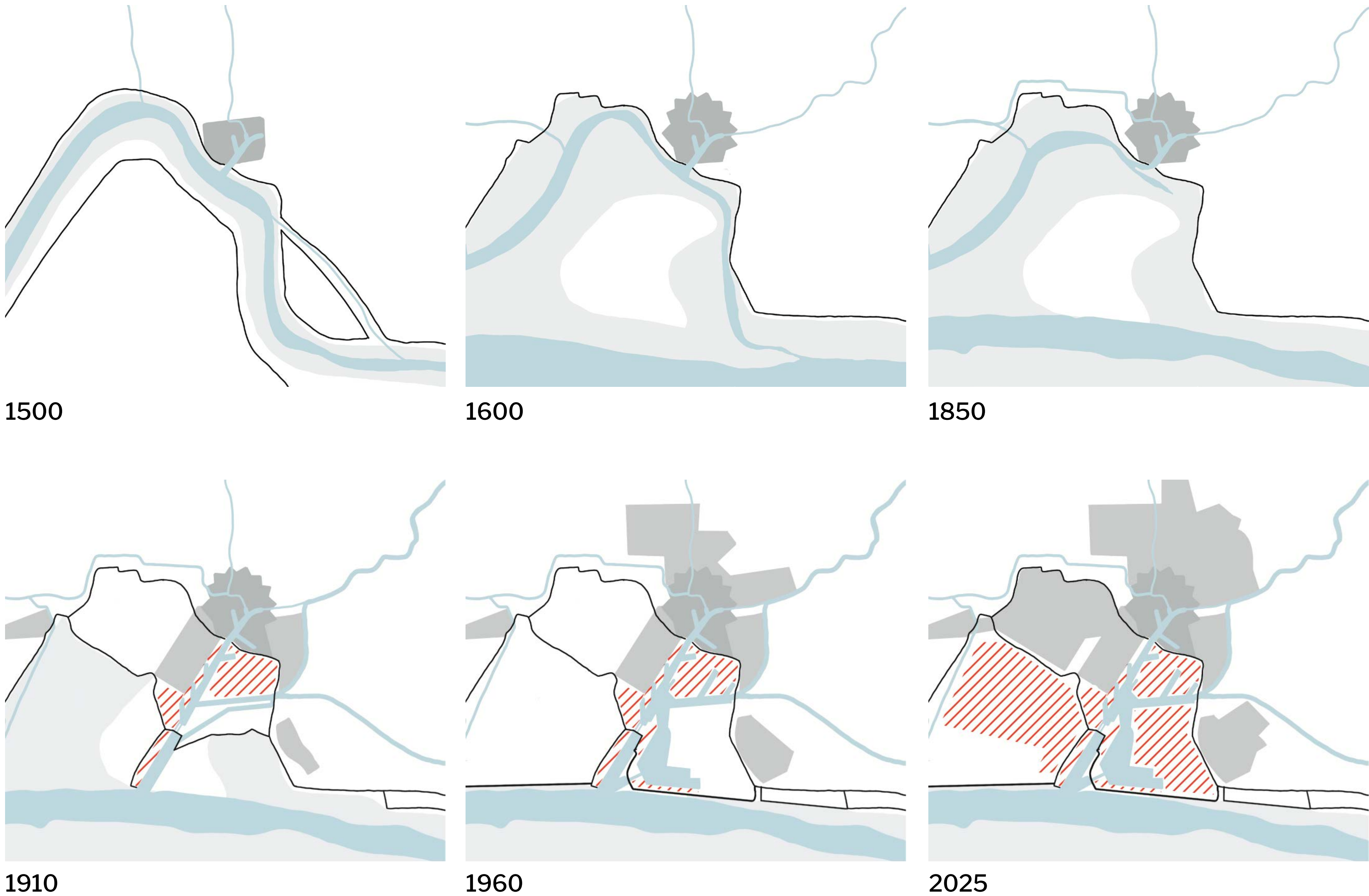
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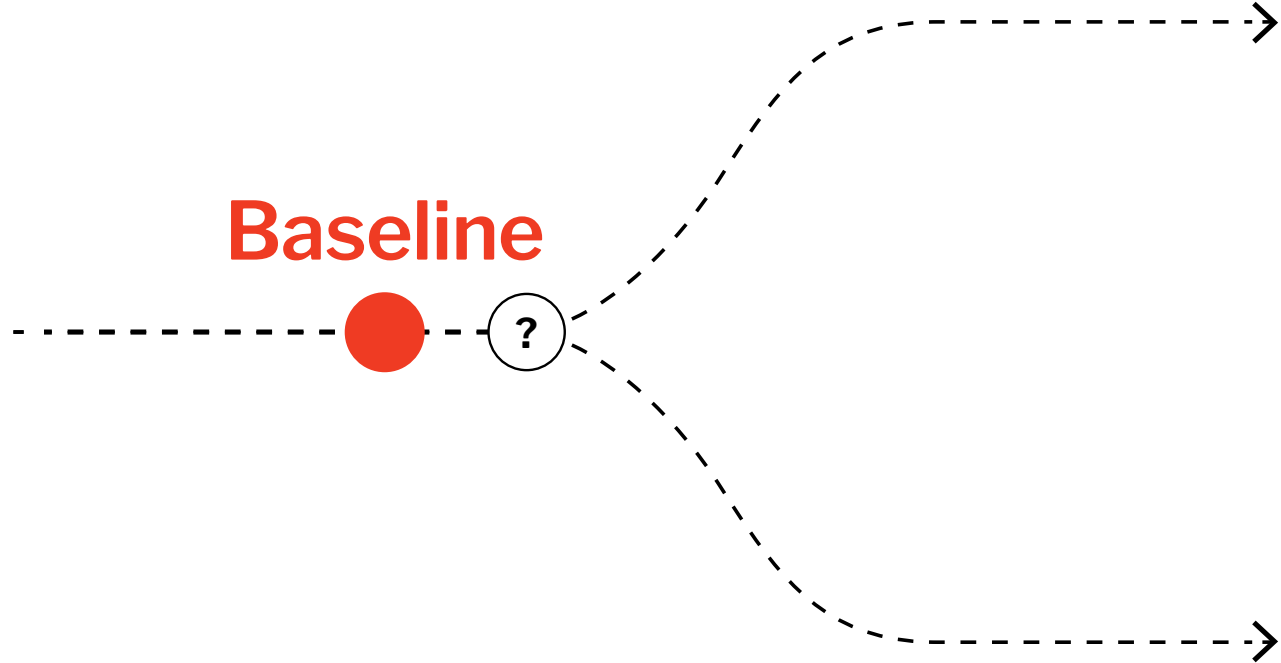
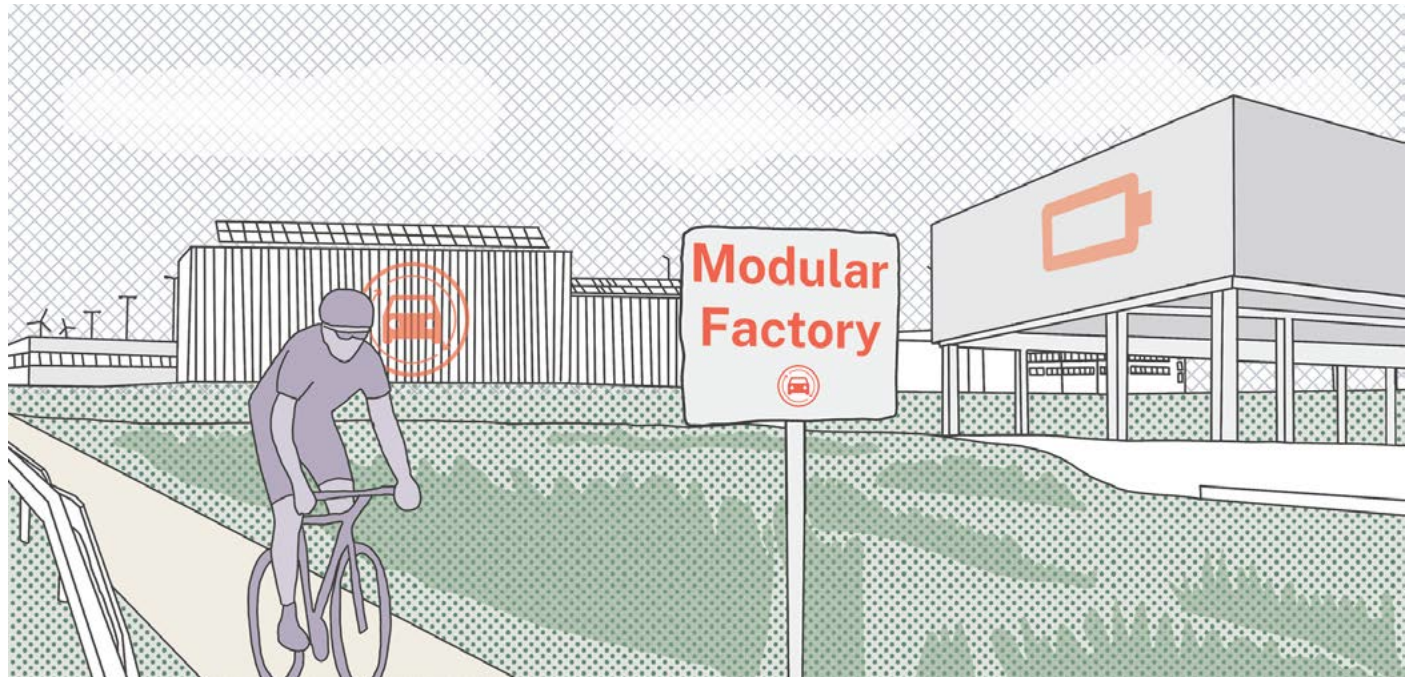
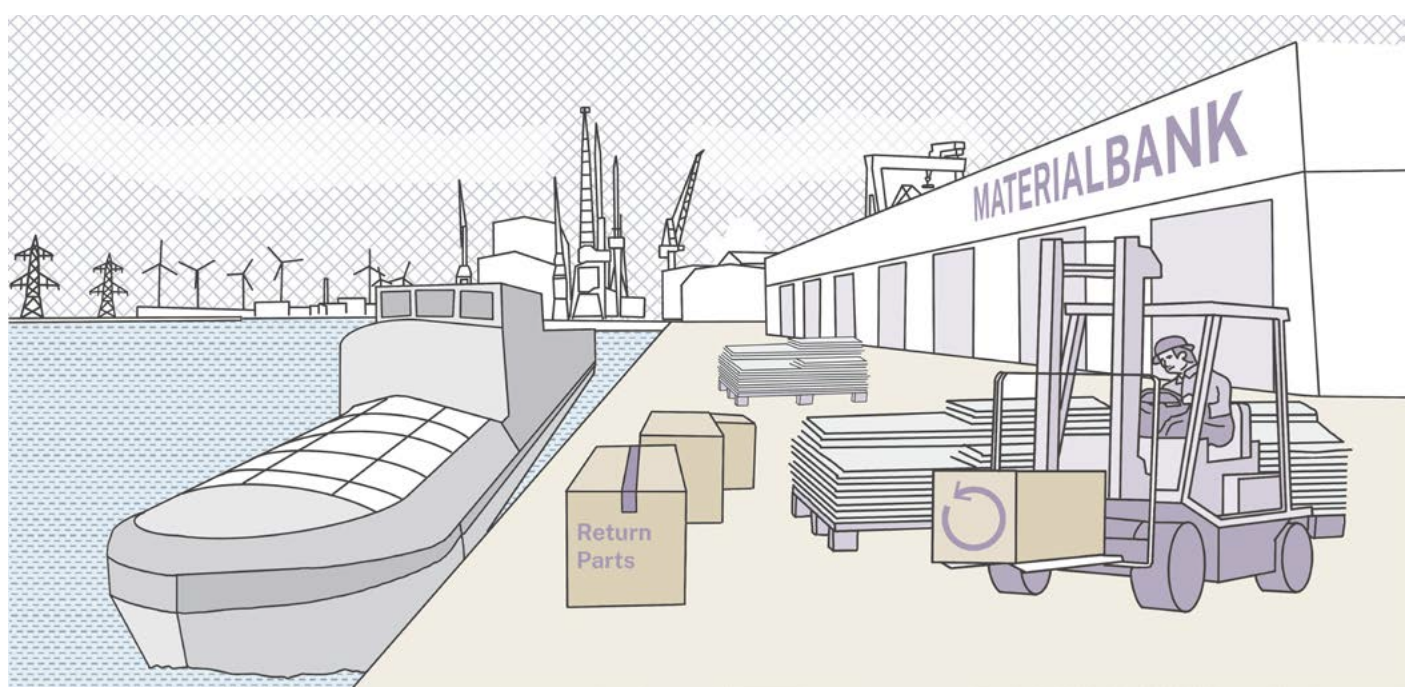


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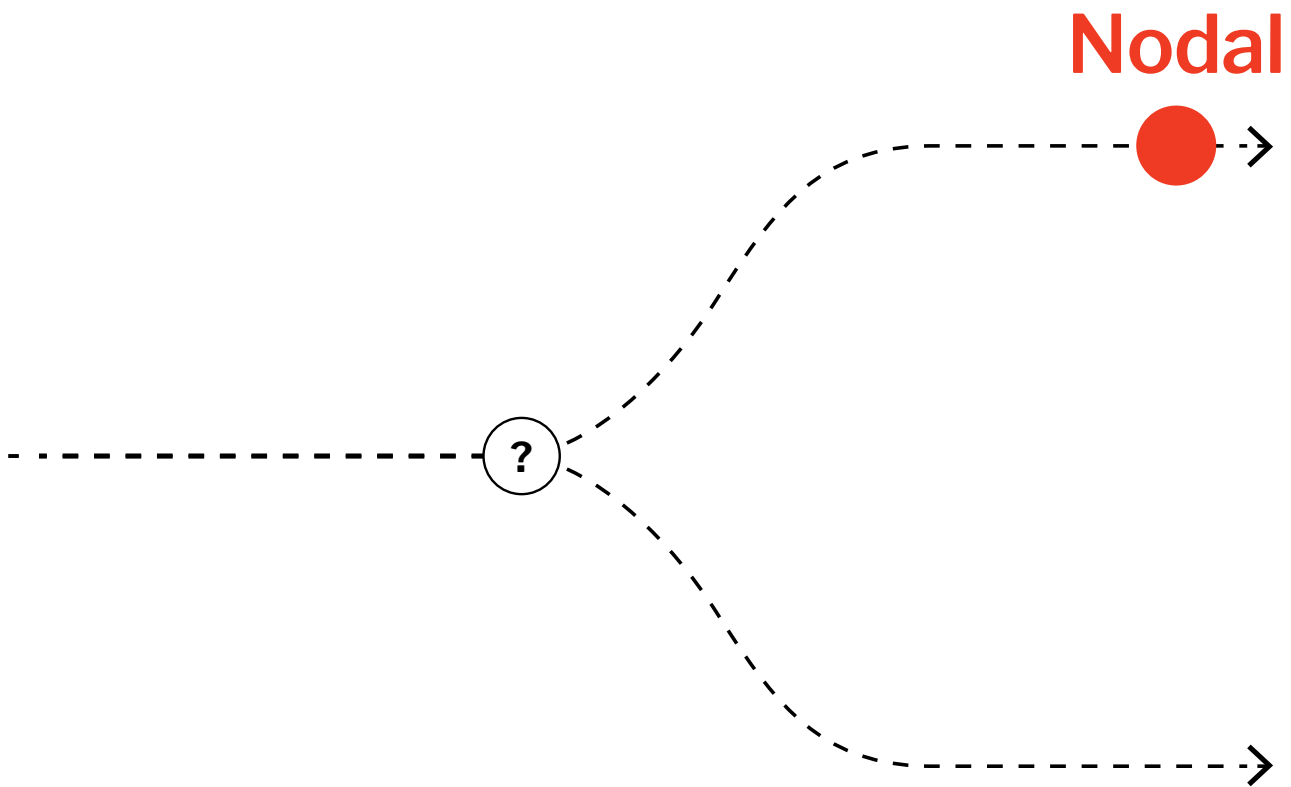
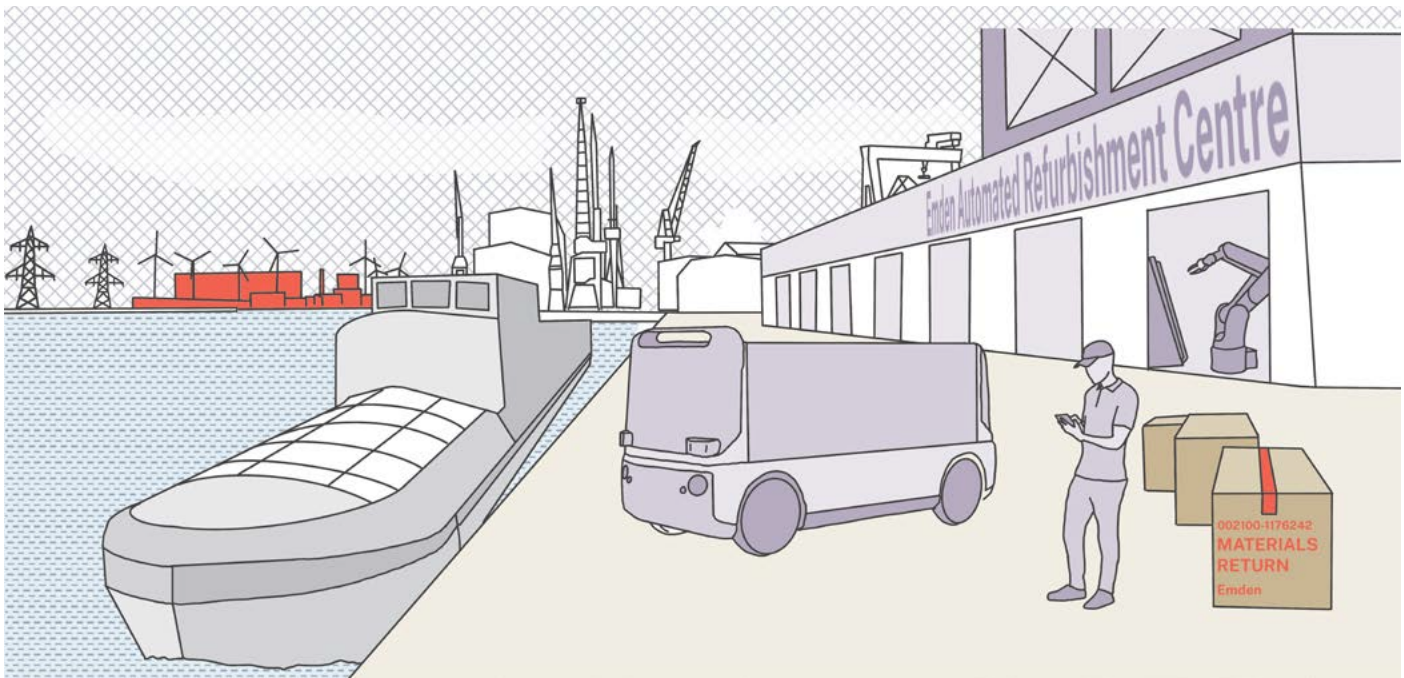
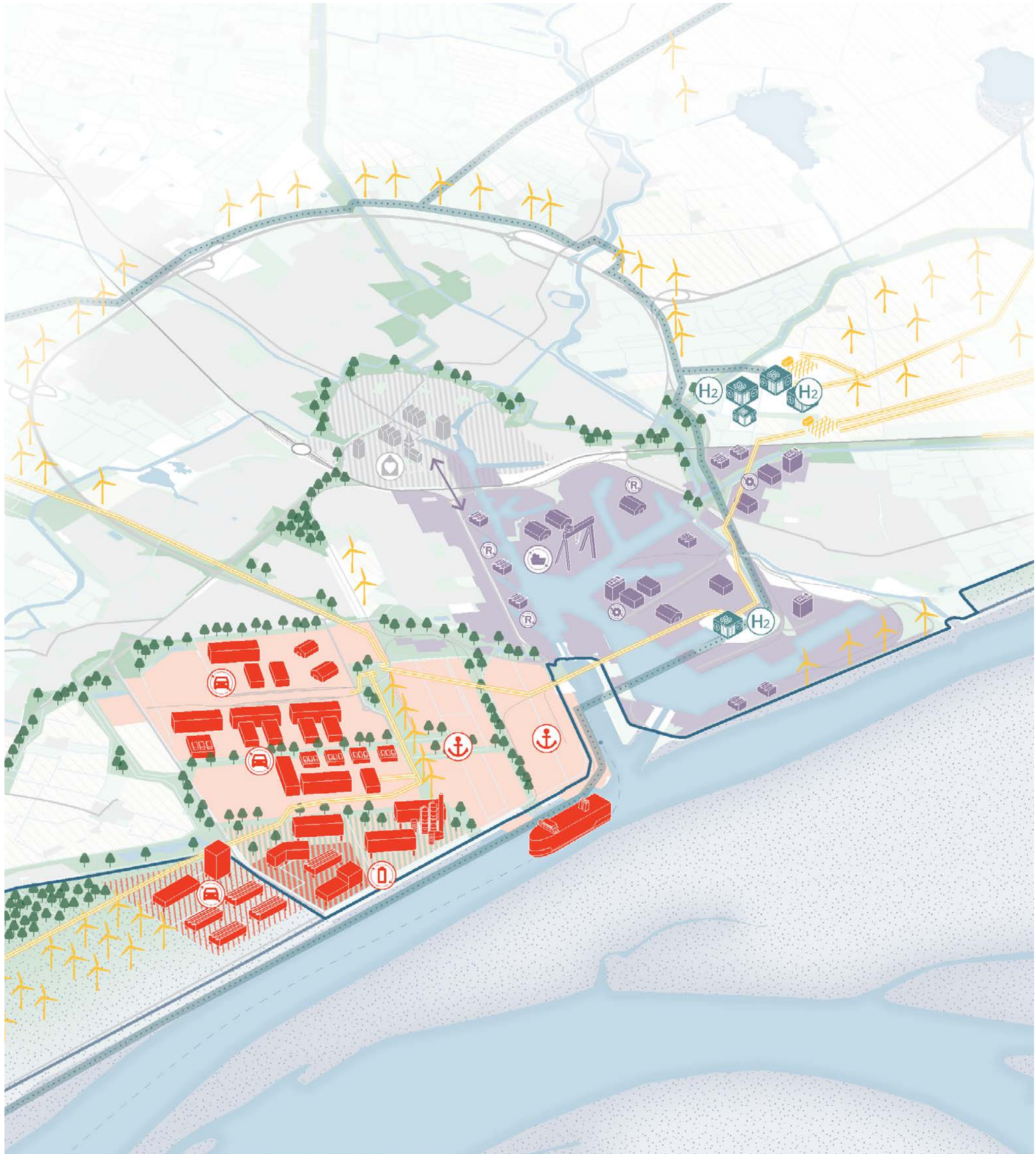
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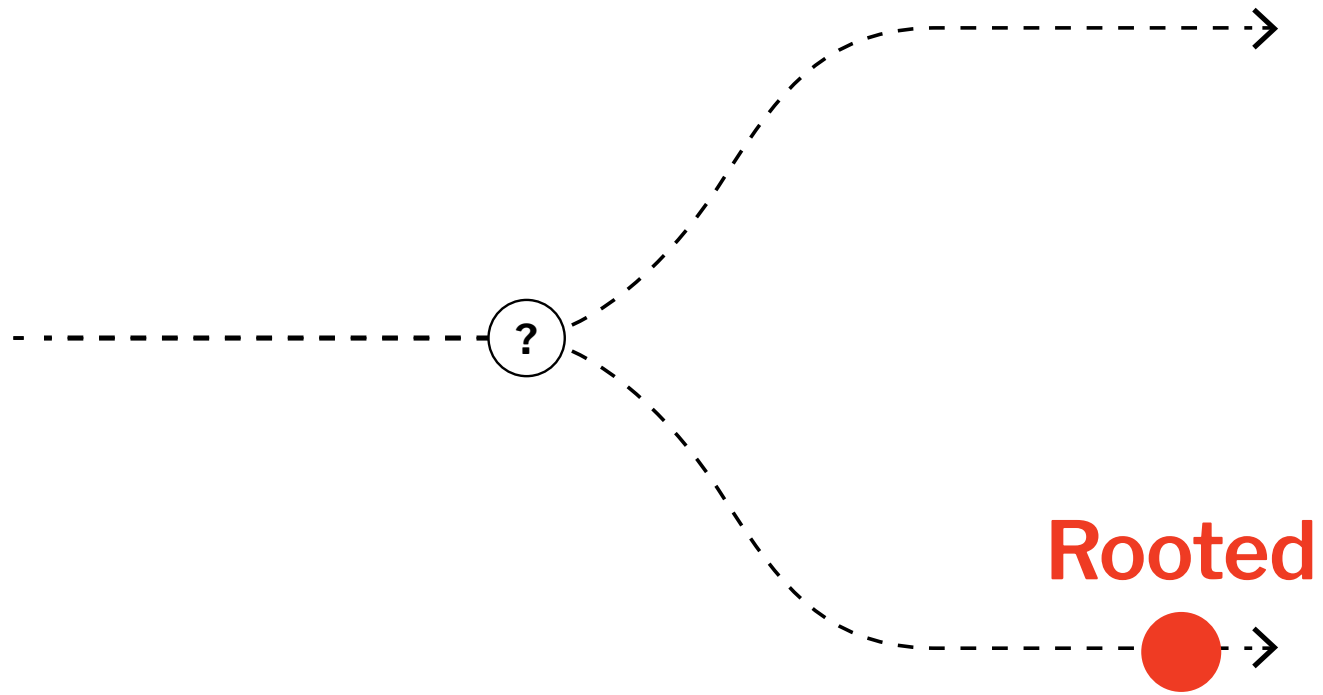
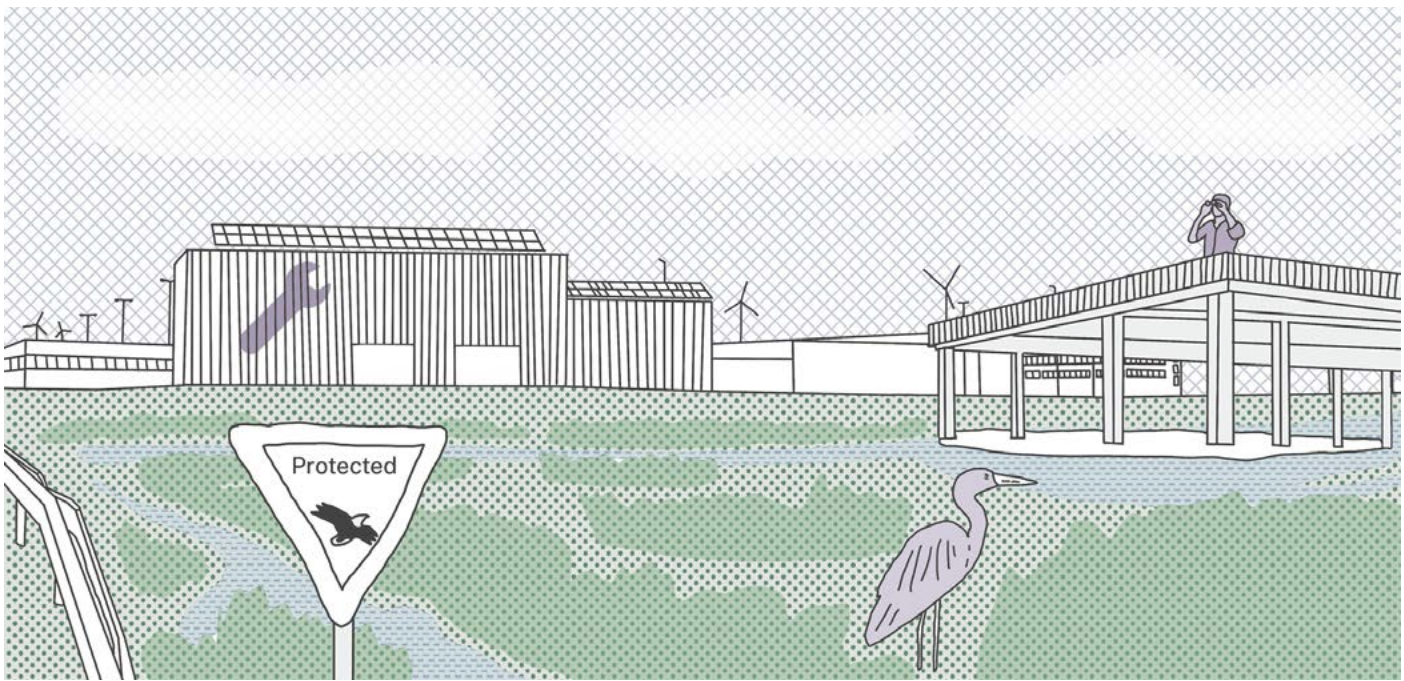
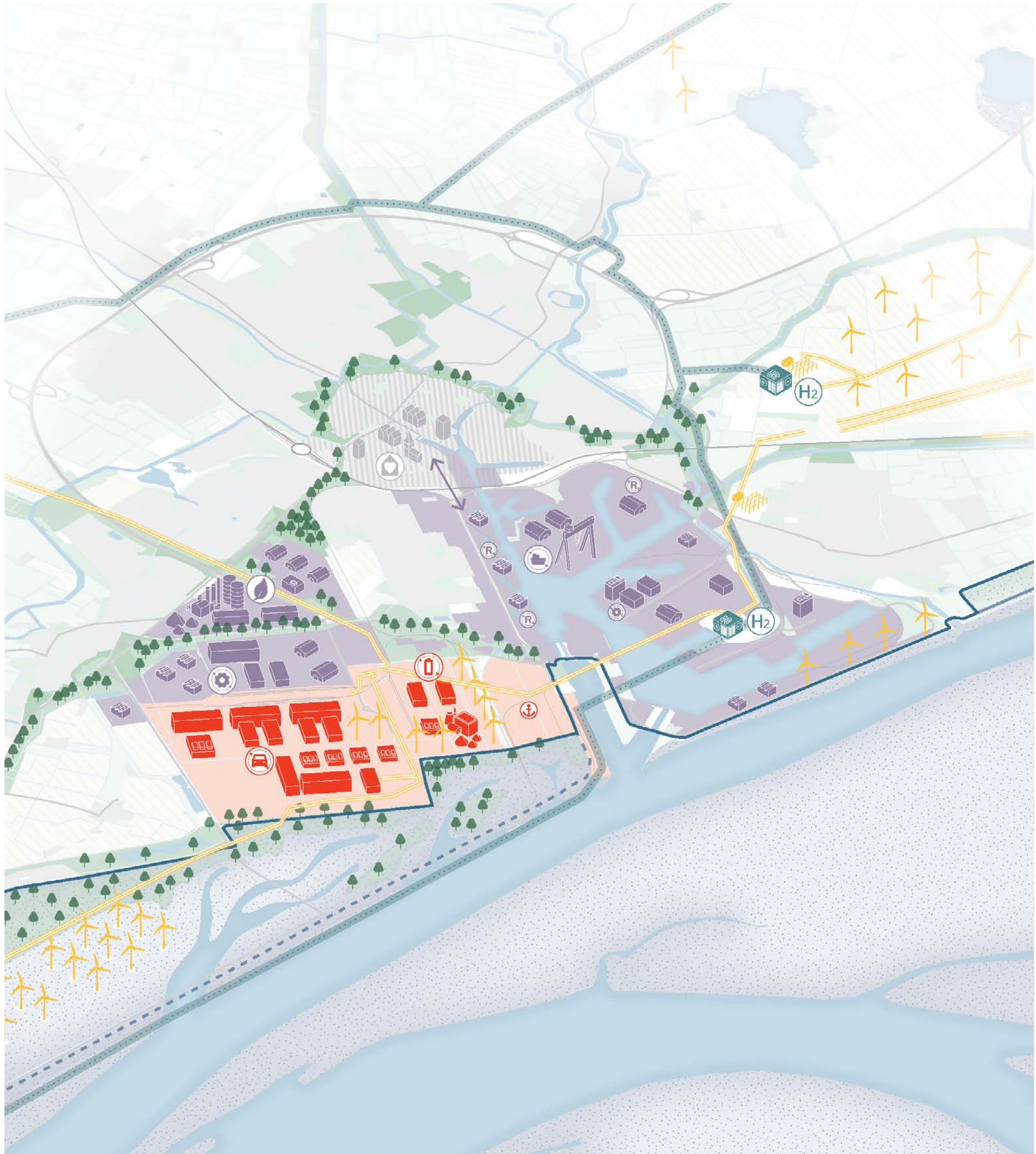
Zooming in: What happens in Emden?



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Zooming in: What happens in Emden?



What have we learned about shaping circular futures?

Research Question
How can the industrial production system in the Wadden Sea region be spatially transformed into a circular and sustainable model, considering its role as an operational hinterland and its impact on functions, morphology, society and ecosystems?

National and beyond

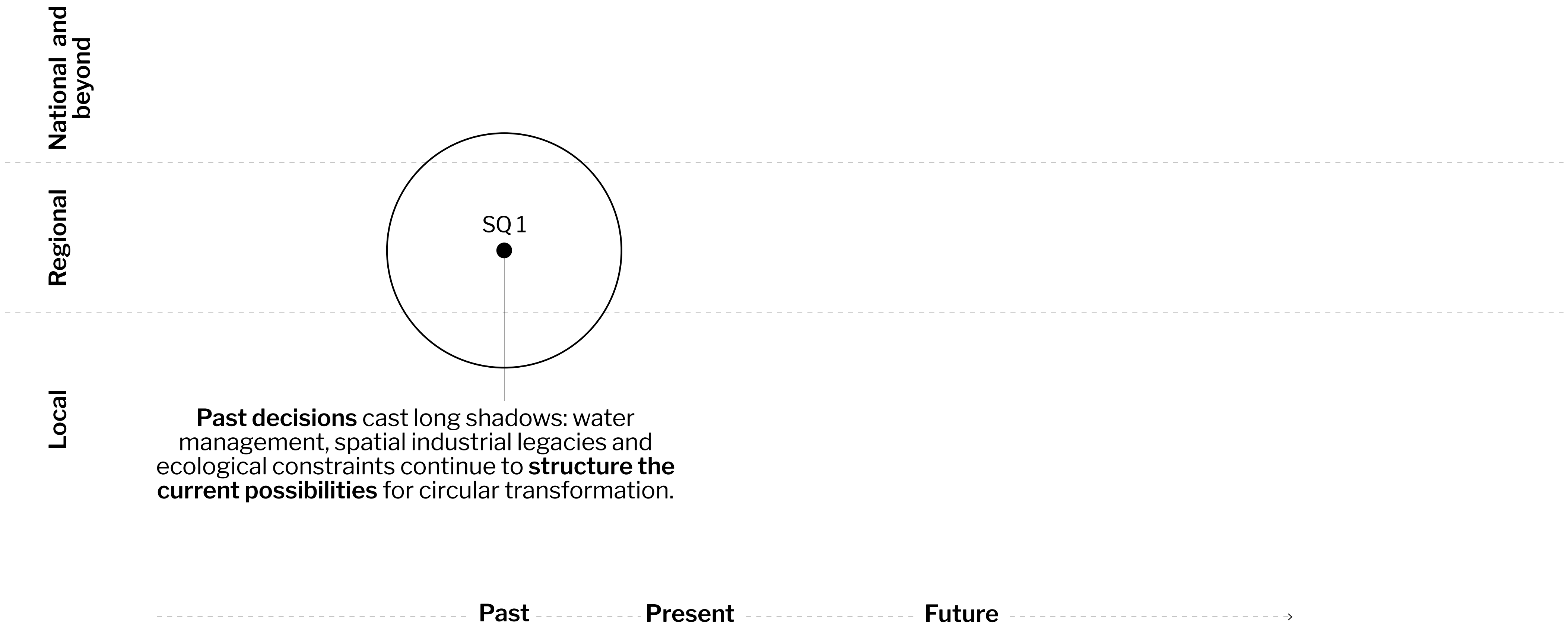
Regional

Local

Past Present Future →

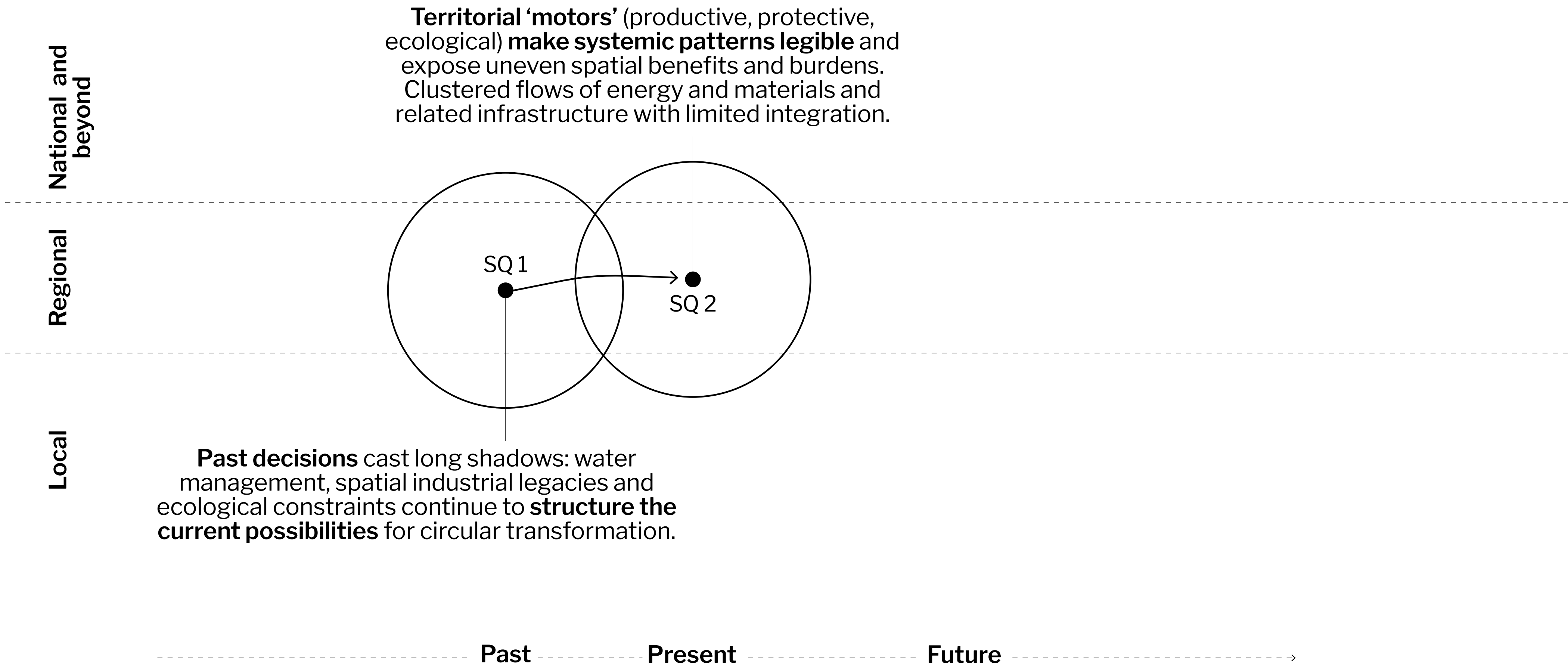
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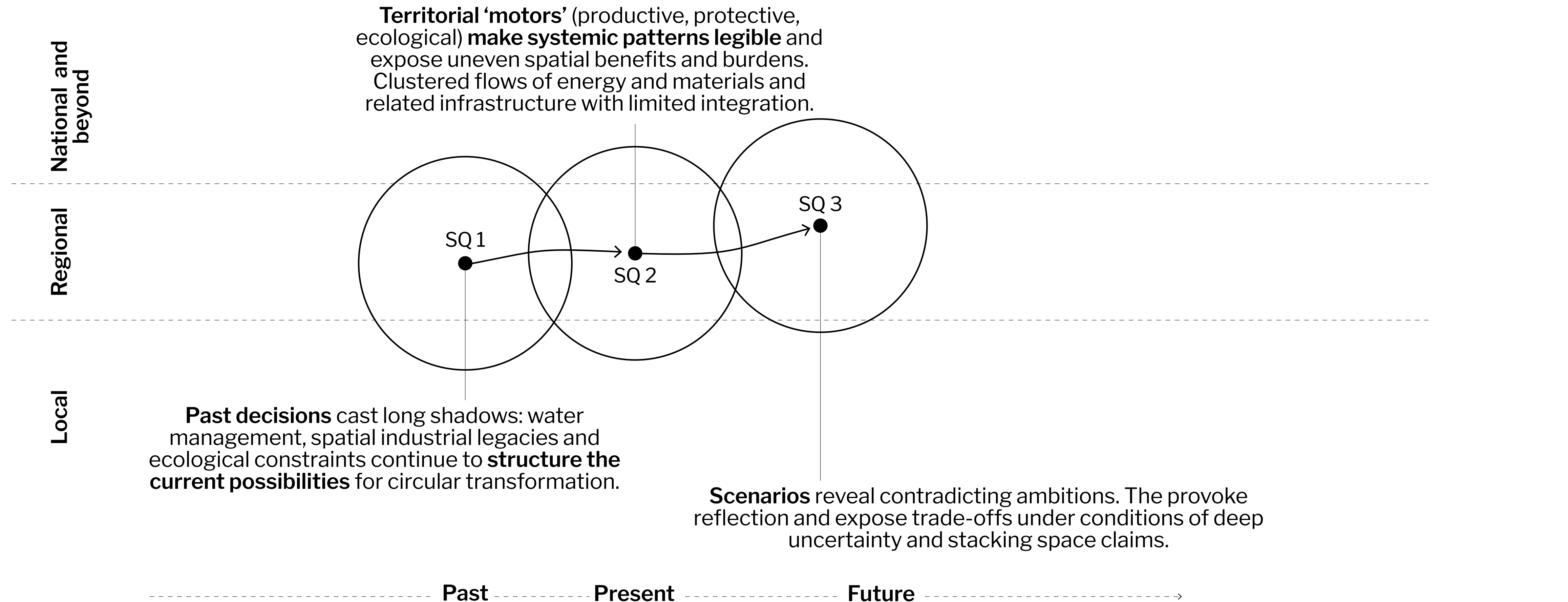
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A circular future lies in the **process**. The Y-shape of the strategy shows adaptivity and robustness. Emden is a test on city and eye level: reversible morphologies, infrastructural modularity, ecological integration

Territorial ‘motors’ (productive, protective, ecological) **make systemic patterns legible** and expose uneven spatial benefits and burdens. Clustered flows of energy and materials and related infrastructure with limited integration.

National and beyond

Regional

Local

Past decisions cast long shadows: water management, spatial industrial legacies and ecological constraints continue to **structure the current possibilities** for circular transformation.

Scenarios reveal contradicting ambitions. The provoke reflection and expose trade-offs under conditions of deep uncertainty and stacking space claims.

----- Past ----- Present ----- Future ----->

What have we learned about shaping circular futures?

Research Question
How can the industrial production system in the Wadden Sea region be spatially transformed into a circular and sustainable model, considering its role as an operational hinterland and its impact on functions, morphology, society and ecosystems?

A circular future lies in the **process**. The Y-shape of the strategy shows adaptivity and robustness.
Emden is a test on city and eye level: reversible morphologies, infrastructural modularity, ecological integration

Territorial ‘motors’ (productive, protective, ecological) **make systemic patterns legible** and expose uneven spatial benefits and burdens. Clustered flows of energy and materials and related infrastructure with limited integration.

National and beyond

Regional

Local

Past decisions cast long shadows: water management, spatial industrial legacies and ecological constraints continue to **structure the current possibilities** for circular transformation.

Overall aim
A circular and sustainable industrial system in the Wadden Sea Region

Scenarios reveal contradicting ambitions. The provoke reflection and expose trade-offs under conditions of deep uncertainty and stacking space claims.

Past Present Future



Thank you

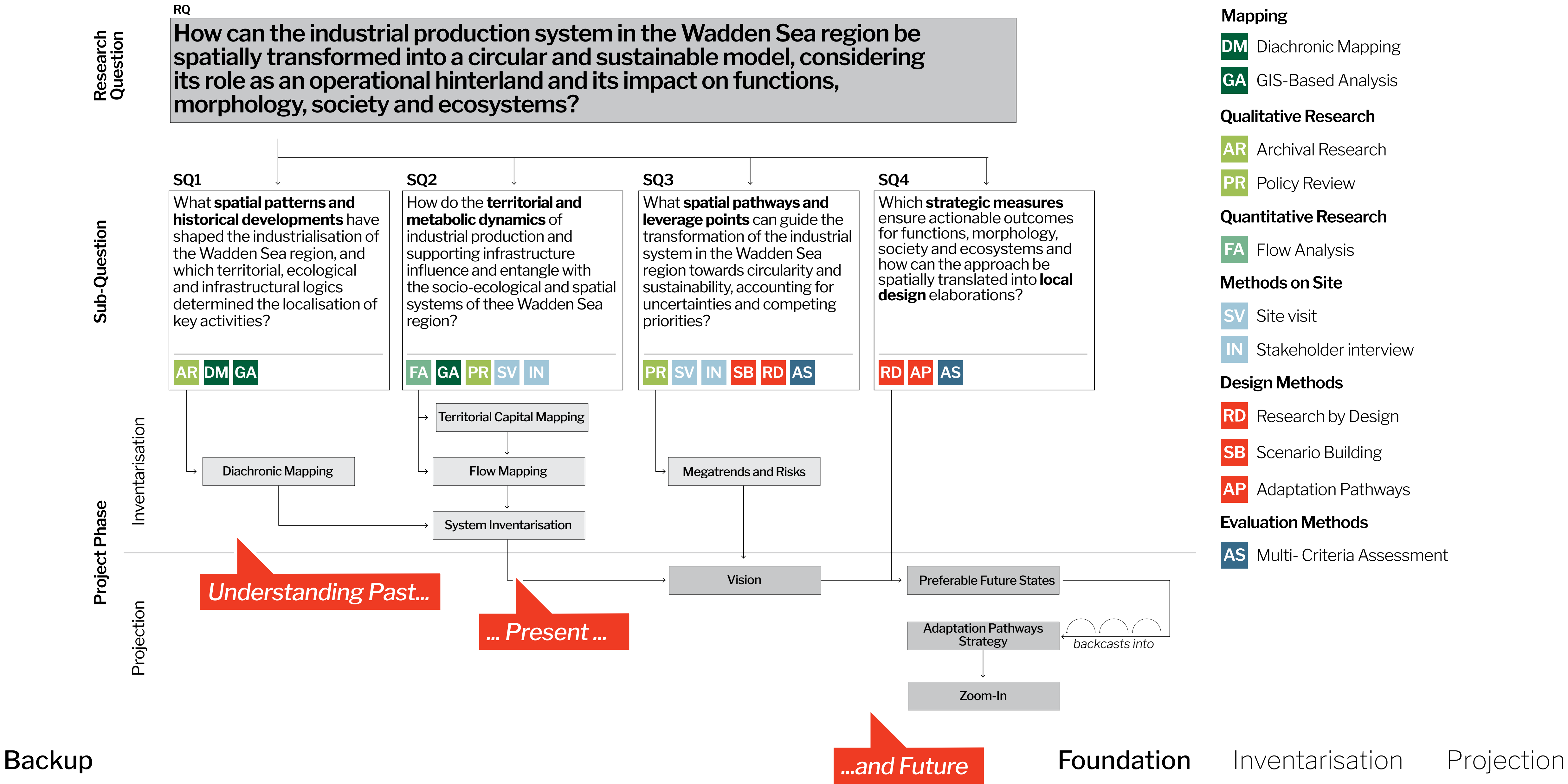
for Listening!

Where Industry Meets the Tides
Anchoring Sustainable Spatial Circularity in the Wadden Sea Region

Maximilian Theye
P5 Presentation
24 June 2025



Methodological Approach

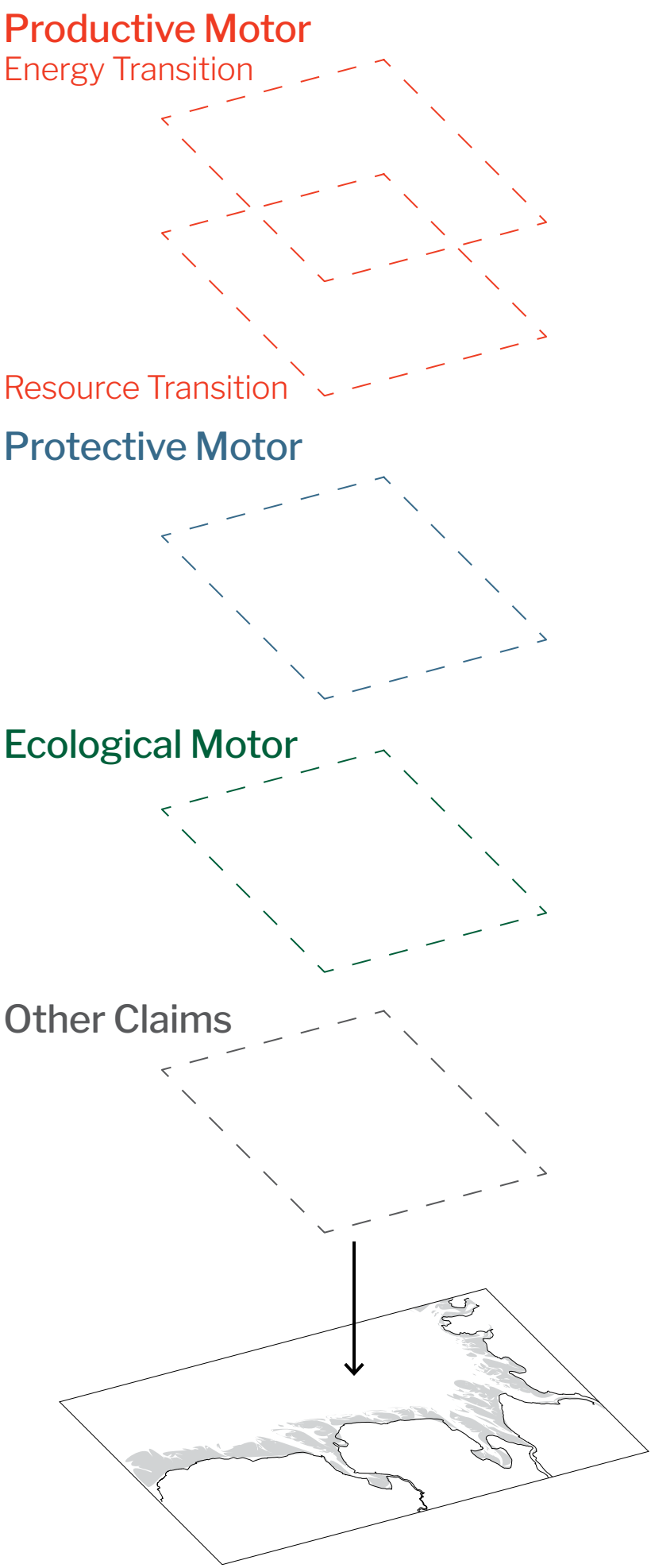


Which tensions shape the future?

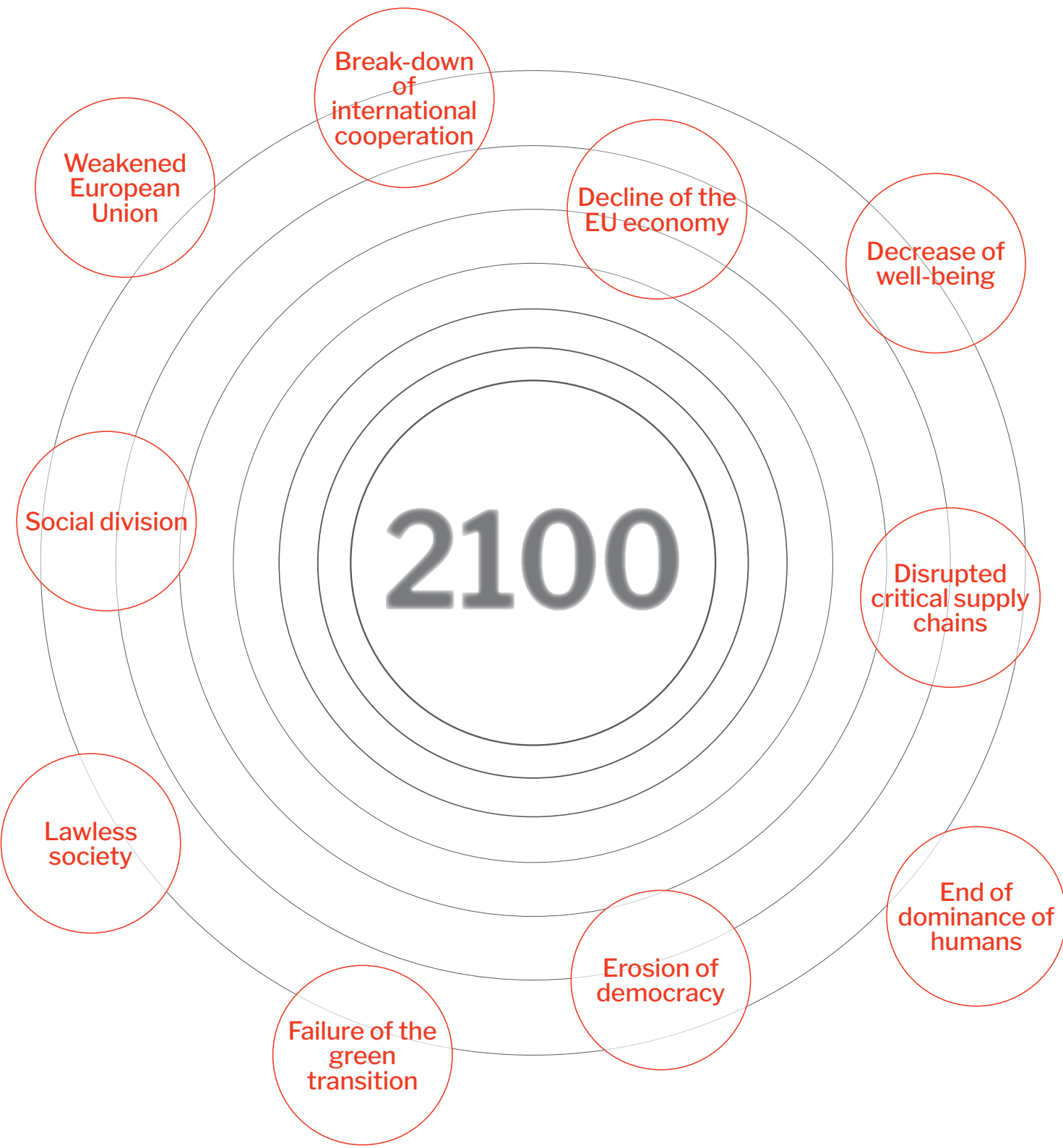
Political Goals



Spatial Claims

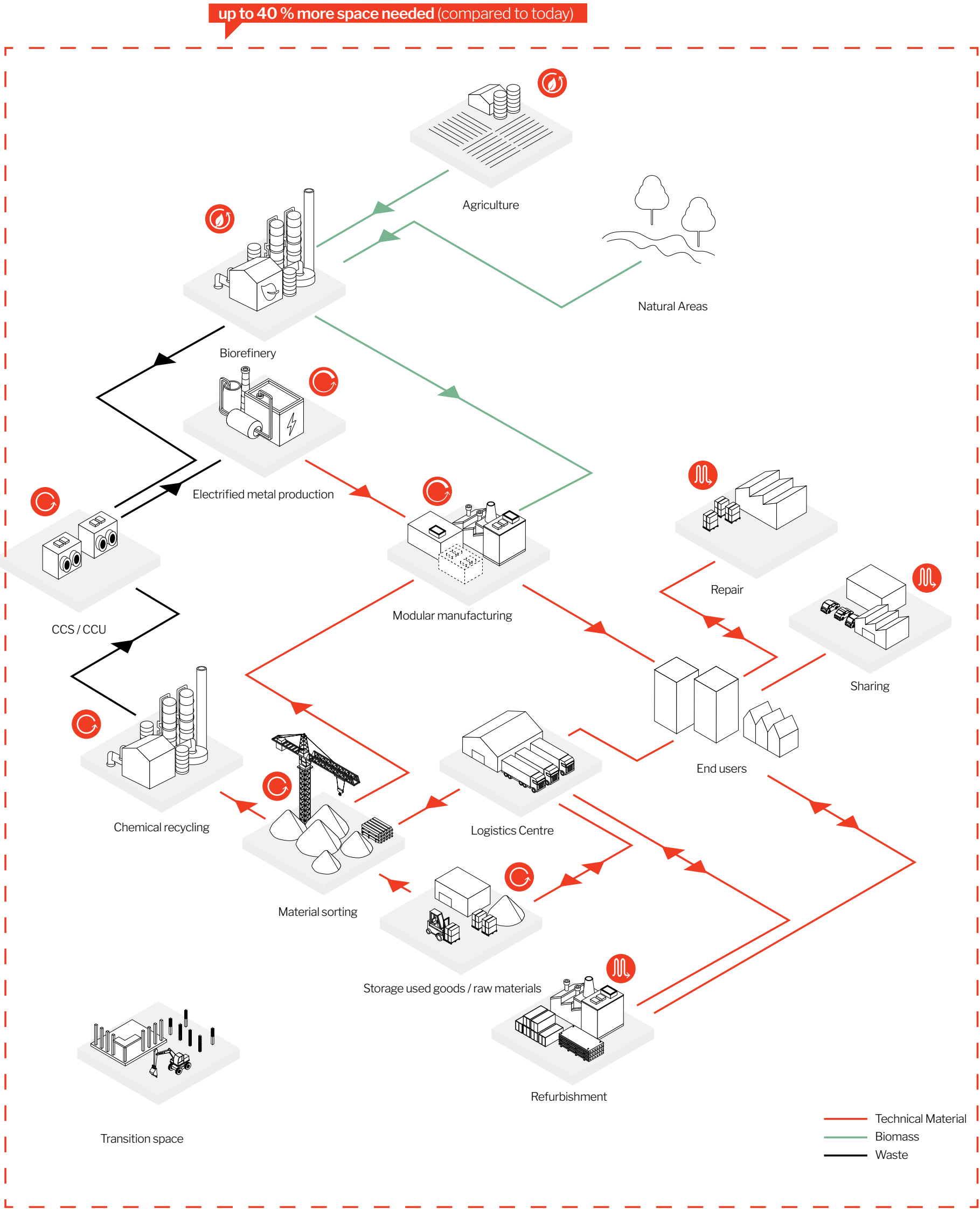


Deep Uncertainty

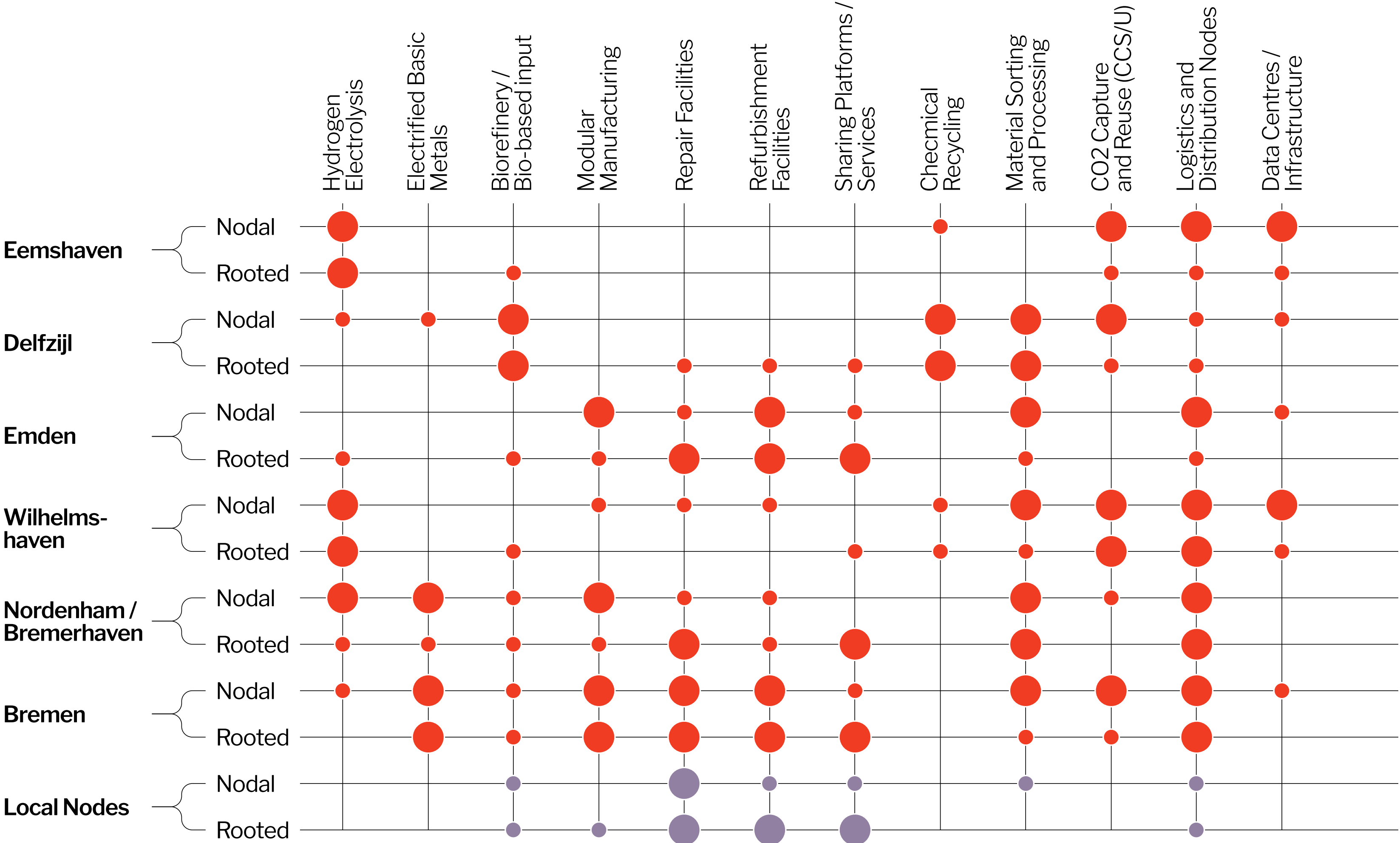


Major Risks defined by EU JRC (2024)

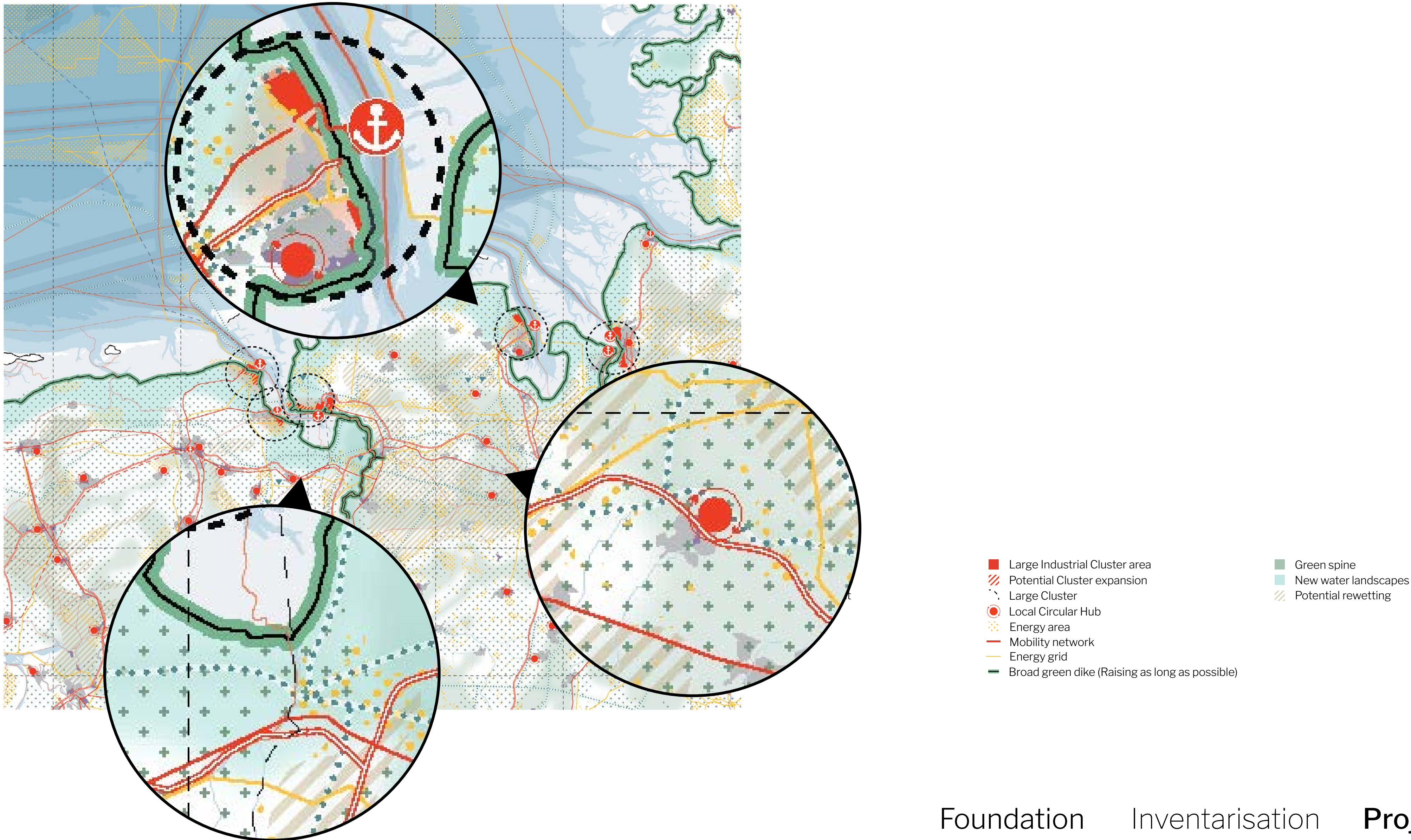
Space Claims – Circular Economy



Strategy Matrix – Productive Motor



Motor Overlap – Strategic Framework



Seven Circle Assessment

	Not addressed	Touched upon	Covered	Substantially engaged
Biogeochemical Cycles Key cycles like water and carbon were addressed through historical, present, and future lenses, particularly in relation to resource flows and decarbonisation strategies.			x	
Ecosystem Cycles The historical degradation and contemporary revaluation of ecosystems (e.g., peatlands, wetlands) featured prominently, including their role in proposed leverage points				x
Resource Cycles The R-ladder formed a foundational framework for scenario development and strategy, anchoring material and energy flows within circular transitions.				x
Political Cycles of Power Power asymmetries surfaced in flow mappings and branching moments, though governance and corporate roles require further elaboration in implementation.		x		
Economic Cycles of Wealth Uneven regional development was problematised as a key issue, addressed through rooted pathways aiming to redistribute productivity and benefit.			x	
Knowledge Cycles Education and skill-building were seen as vital enablers of transition, from regional human capital to localised workshop hubs and global linkages.			x	
Social Cycles of Care The care dimension emerged indirectly through health and equity impacts of pollution and labour conditions, but remains underdeveloped conceptually.		x		