ENERGIZING CHANGE

A Roadmap to emission free energy, production & distribution in North-West Europe

Regional Planning

Q3_Studio
Spatial Strategies for the Global Metropolis

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“Despite all the efforts that the European Union has taken, most countries won’t reach the CO2 reduction goal by 2030.”

This project rethinks the way that the countries of NorthWest Europe approach the energy transition by focusing their efforts on the energy potentials, locally and regionally, in a sustainable and collaborative way. This can be done by generating renewable energy in a centralized manner, for instance by using the potential of the North Sea with a big wind farm. Next to that the fossil fuel industry has to switch to a hydrogen based economy. In this way, Northwest Europe can be independent in energy production. Individuals and local parties will also contribute to the transition, by giving them the means to locally produce their own electricity. We believe that the solution is just a matter of collaboration and an integrated approach.”

Preface

In this report, a spatial vision for the energy transition in Northwest Europe is proposed, together with a strategic framework for this transition in the area of the Port of Rotterdam. This strategy accelerates the energy transition from a fossil fuel reliant society towards a sustainable, collaborative and socially just future.

The report is structured in three parts: the analysis, the spatial vision and the strategic framework, each divided with their own chapters (which can be found in the content table). In the analysis part, the context of the current situation with the challenges and opportunities regarding the energy transition will be set out. The findings are put together in a synthesis map that forms the base layer for the development of the spatial vision. The spatial vision itself is divided into three scenarios: the centralised approach, the decentralised approach, and the integrated vision. The latter is the final vision, which combines an ideal set of qualities from both scenarios. This vision is made spatial in the case of the area of the Port of Rotterdam, the focus location of this research and design. The last part of the report, the strategic framework, focusses on the spatial projects, policies and implementations needed in the area of the Port of Rotterdam to facilitate this transition. The strategic framework is built up according to the phasing of different interventions, related to four main projects that are set out earlier.

With special thanks to Lei Qu and Robbert Jan van der Veen as tutors of the design course for continued guidance and stimulation, and Roberto Rocco and Marcin Dabrowski as lecturers for their inspiring discussions and workshops, we present this report for a sustainable and socially just energy transition of Northwest Europe.

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Abstract

With the current emissions and disasters due to climate change, the energy transition towards a sustainable and climate resilient future of Northwest Europe is now more important than ever. The first steps have been made, but this transition is happening too slow and in an insufficient and uncollaborative manner. This research studies the spatial implications of the energy transition and aims to construct a framework that helps to accelerate the process and make it more efficient and socially just. The methods used for this are data analysis and research by design, combined with scenario building, by investigating and designing the case study of the province of South-Holland within the context frame of Northwest Europe. The results of this report show an integrated spatial vision on the energy transition on multiple scales. Additionally, it provides a strategic framework that consists of policies, organizational structures and physical interventions, both in space and time, that are structured in a catalog. This proposal helps accelerate the process of the energy transition, to be able to build on a sustainable future for energy production and distribution.

Keywords

energy transition, renewable energy, Northwest Europe, South-Holland, social justice, CO2 emissions, spatial vision

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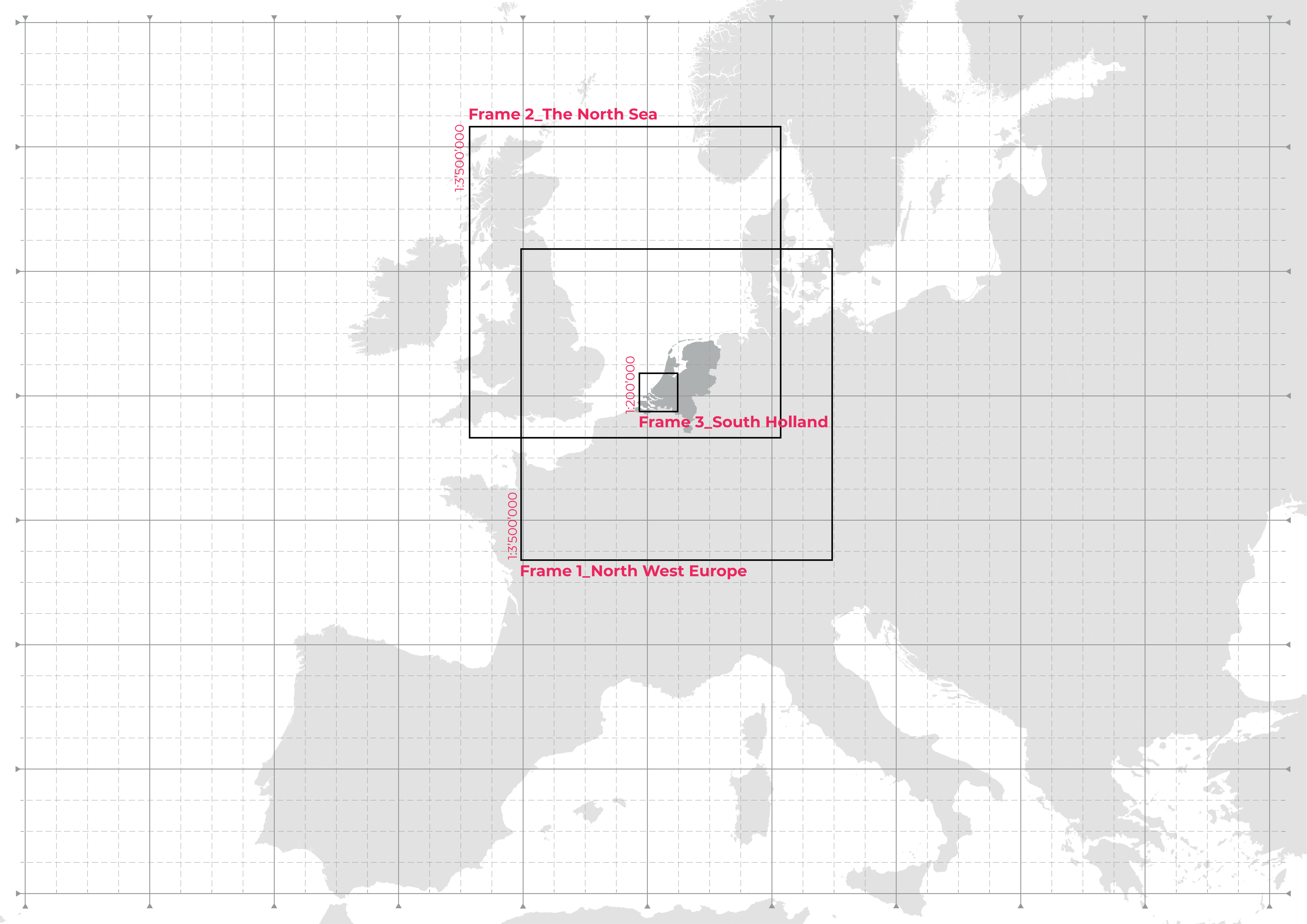
Frame 2_The North Sea
1:3'500'000
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Frame 3_South Holland
1:3'500'000
Frame 1_North West Europe

1 Intro-duction

I _Introduction
CO2 & The Global Warming

1.1 Problem Statement

Tackling carbon dioxide levels in the atmosphere has been a global pressing issue since 1988 (Weart, 2008). That is most prominently due to the emissions that are generated when burning fossil fuels such as coal, oil and gas. This mainly happens for the production of energy. Northwest Europe is one of the most problematic regions, as it is highly industrialized and densely populated. Transforming to renewable energy production is one of the known solutions to the carbon dioxide problem. Various renewable energy production methods are known, each with their vown potentials and limitations. However, even though the energy transition has started, it is not happening fast enough (Gielen, Boshell et. al., 2019). Furthermore, the energy transition is not efficient, because each country sets goals and operates for itself, separated from each other. In addition to this, many decision-making processes within the energy transition are happening in a socially unjust way, such as imposing top-down policies that affect local people's lives (Wiseman, 2017).

1.2 Vision Statement

In our vision, Northwest Europe has reached a fully emission-free energy production and distribution system in the near future, in a socially just way. With smart use of known and upcoming potentials and technical solutions, fair and efficient energy production and distribution can be realized. The energy demand in the future will be fulfilled in a sustainable way. Firstly because a paradigm shift will take place that changes the way of producing energy from a fully centralized to an integrated system that builds up in scales. This new system emphasizes on reducing the energy demand by promoting local energy production and storage. This also prevents unnecessary energy losses, for instance with transportation.

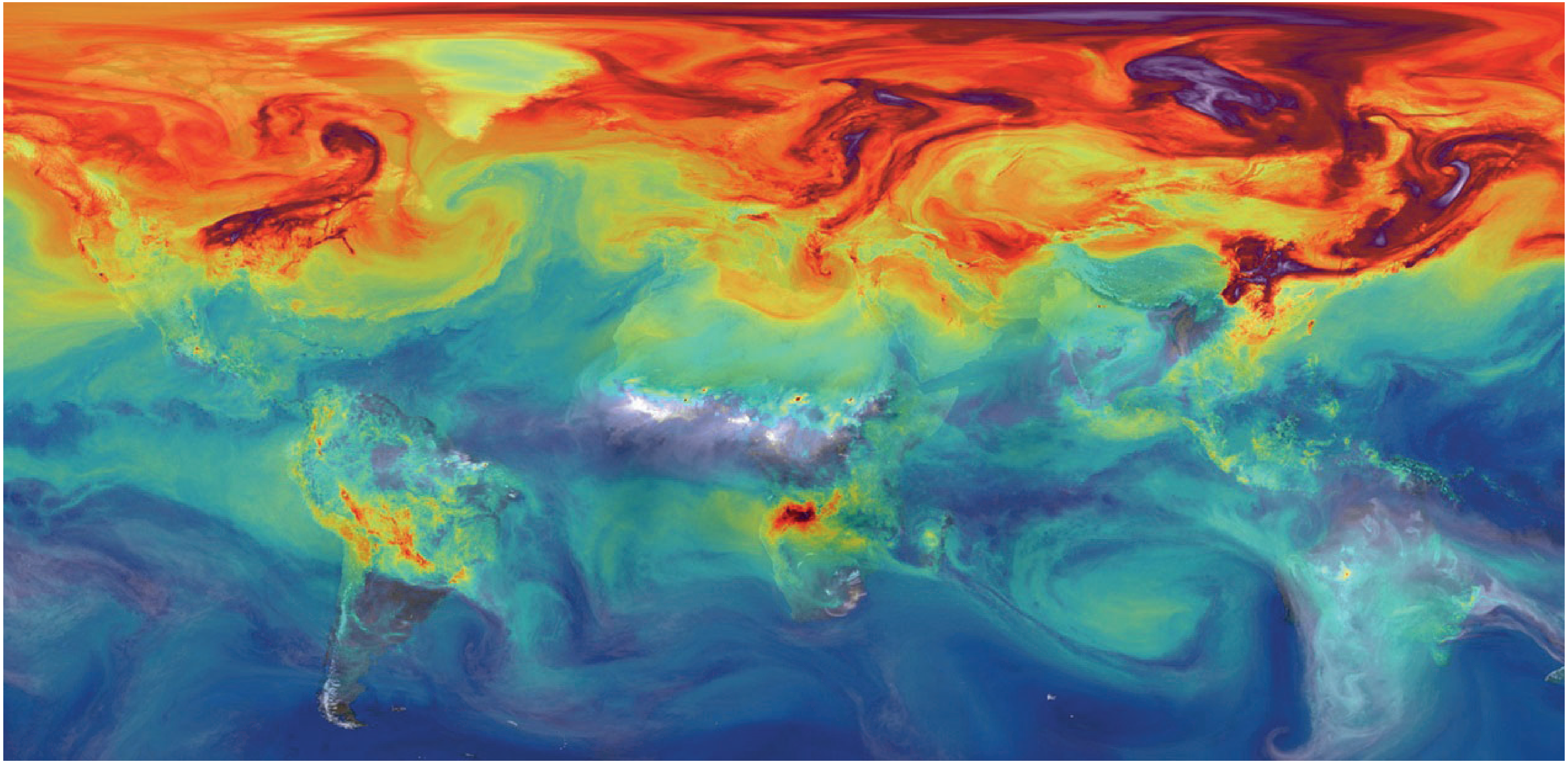
Furthermore, the future will be socially just in terms of energy production and distribution, by providing individuals and communities with choices and opportunities to be energy independent. Another just aspect is making energy availability a common good that is accessible and affordable for all.

More collaborative approaches of co-creation are needed in order to make the energy transition efficient (Sillak, Sperling, 2021 & Andrews-Speed, Van der Linde & Keramidas, 2014). Collaboration is about working together on all scales and with all stakeholders. Therefore, a participatory design approach across different scales is needed to ensure a just process (Fraser et al., 2006). Next to this, organizational structures need to be rethought to fit the local context better, and to incorporate the interests of all stakeholders, including minorities.

The aim of this project is to add to the acceleration of the energy transition of Northwest Europe from a fossil fuel reliant society towards a sustainable, collaborative and socially just future, by rethinking the transition towards a renewable energy production and distribution systems. The collaboration process of the energy transition is firstly addressed by creating a framework, including a collaborative cross-border organizational approach for the energy production and distribution systems. Since CO2 emissions and global warming consequences will not distinguish country borders, the approach to tackle them should not as well. Second, the efficiency of the transition is improved by analyzing the most efficient ways of producing renewable energy per location and combining a centralized and a decentralized system of energy production into an integrated approach across multiple scales.

Furthermore, a strategic framework that incorporates interventions both in space and time, will contribute to an efficient phasing of interventions. Different disciplines are combined and indications for milestones and guidelines are proposed to provide structure to policy makers and designers. Lastly, a clear guideline of design principles that lays an emphasis on maintaining spatial quality locally and incorporating the views and interests of local stakeholders needs to be implemented. Stakeholder benefits and interests need to be analyzed to compensate for losses and to avoid conflicts.

In the current context it is important to address the problems of the current energy production and distribution system in Northwest Europe, because the transition towards renewable energies needs to accelerate.



1.3 Research Question

The main question that this research aims to answer is:

How can a spatial vision for Northwest Europe help to accelerate the energy transition and make is socially just?

A strategy for an integrated energy production and distribution system in South Holland.

This will be done by answering the following sub questions per chapter:

Chapter 2 _ Analysis:

What is the current state of the systems and processes related to energy production and distribution in Northwest Europe?
What are known solutions for renewable energy production and what potential do they show within Northwest Europe?

Chapter 3 _ Spatial Vision:

How can a spatial vision for the energy transition of Northwest Europe be created?
What could a centralized renewable energy production and distribution system that uses potentials on the Northwest Europe scale to the maximum to produce enough energy in the future look like?
What could a decentralized renewable energy production and distribution system that produces energy locally in Northwest Europe in the future look like?
How could the centralized and the decentralized system be combined into an integrated vision for renewable energy production and distribution in Northwest Europe in the future?

Chapter 4 _ Analysis:

How can the created integrated vision for the energy production and distribution in Northwest Europe be translated into a strategic framework that shows implementations both in space and time for the case study of South-Holland?
What policies are needed to support this strategic framework?
How can the spatial interventions and policies related to the integrated vision for the energy transition in South-Holland be phased over time?
How can policy-makers and other organizations be assisted to use the possible spatial interventions in the case of South-Holland regarding the energy transition?
What are organizational structures that can be used for the implementation of the spatial interventions related to the energy transition?
How can it be made sure that all stakeholders are represented in the approach?
What are possible ways of implementing the catalog of different possible spatial interventions, together with its guidelines, in specific zoom-in locations (with different spatial qualities, landscapes and land uses) within the context frame of South-Holland, and what are the spatial consequences?
How can the organizational matrix with indications for organizational structures be used for the specific zoom-in locations within the context frame of South-Holland and what are the assumed opinions of involved stakeholders?

1.4 Methodology:

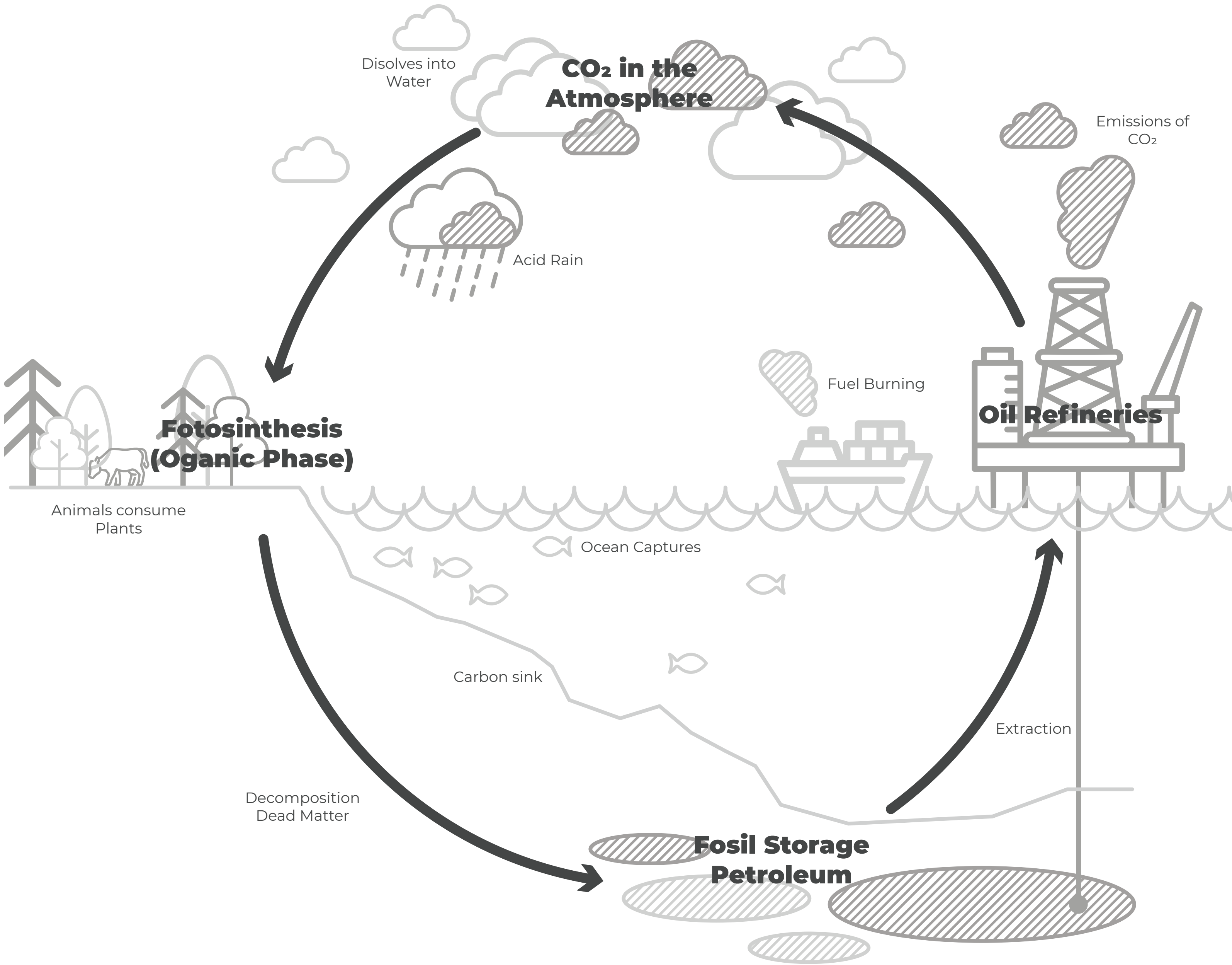
The overview of the methods used in this report is structured per chapter:

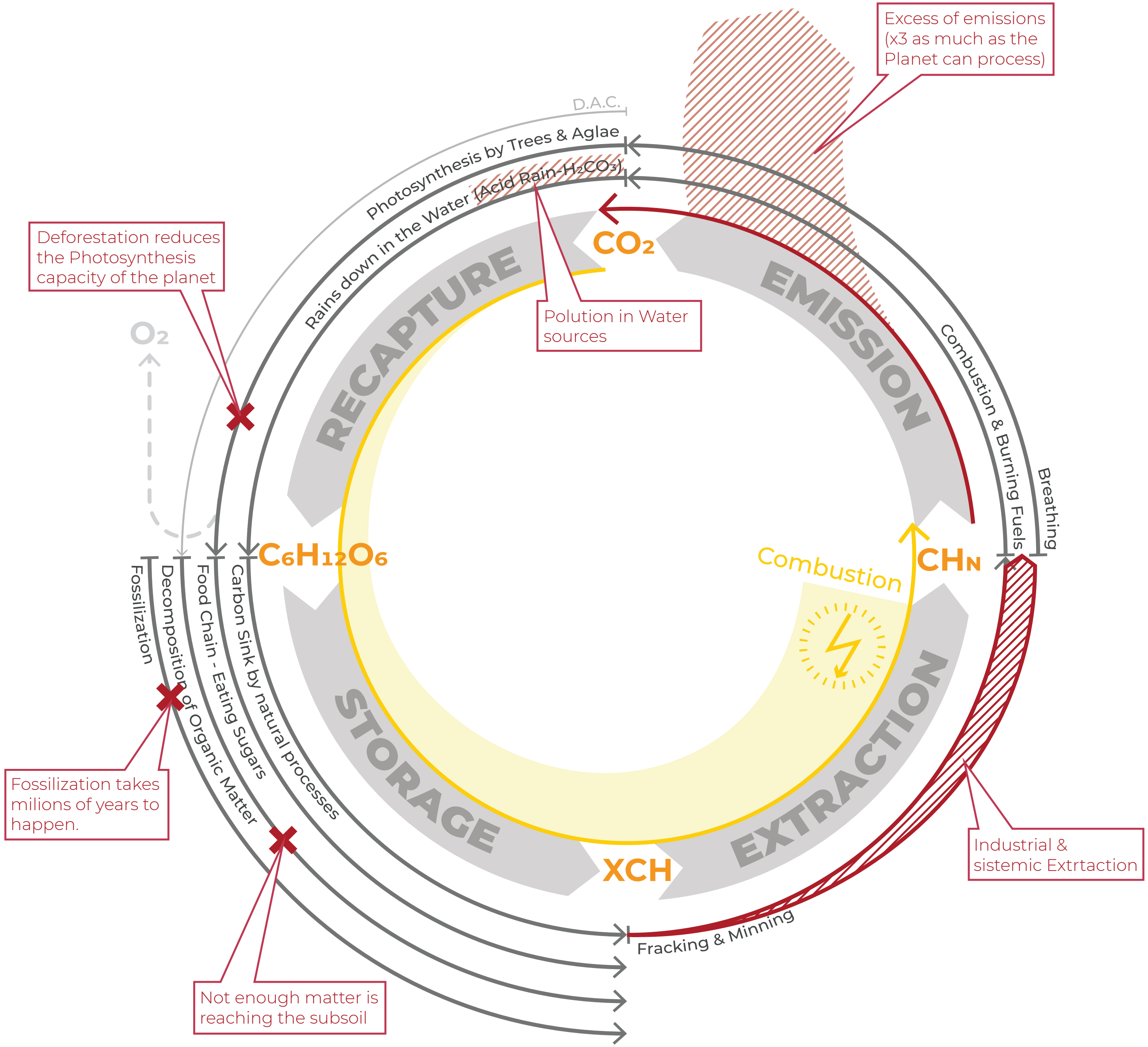
In the Analysis, academic research and data analysis are used to analyze the context of the current situation with the challenges and opportunities regarding the energy transition. In the Spatial Vision, research by design, combined with scenario building, comparing pros and cons, and shifting through different scales together form the methods used to create an integrated spatial design vision. This vision is supported by a theoretic framework. In the last chapter, the strategic framework is created by investigating the case study of South-Holland. First, specific zoom-in locations within the case study are designed by using a catalog, which forms a structured scheme of possible spatial interventions on different locations. Afterwards, a stakeholder analysis and a matrix on organizational structures, based on academic research, are applied to the same locations within the case study.

Carbon Cycle

Function

Carbon is the sixth element of the table and its the main component in the organic molecules that make life possible. Its ability to easily bound to most of the other elements makes it a very versatile element and it can be found in many states and places in the planet. Because of that it also has many important roles in the way the planet functions, for example: CO2 is one of the most important temperature regulators in earths atmosphere; C6H12O6 (glucose) it carries energy from plants to animals and CH4 (Methane) does the same for the inorganic processes that Humans preform.





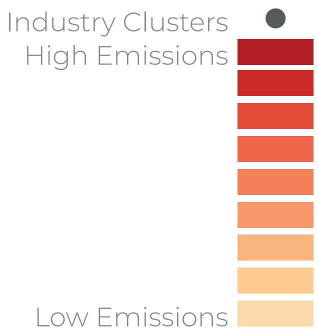
Problems

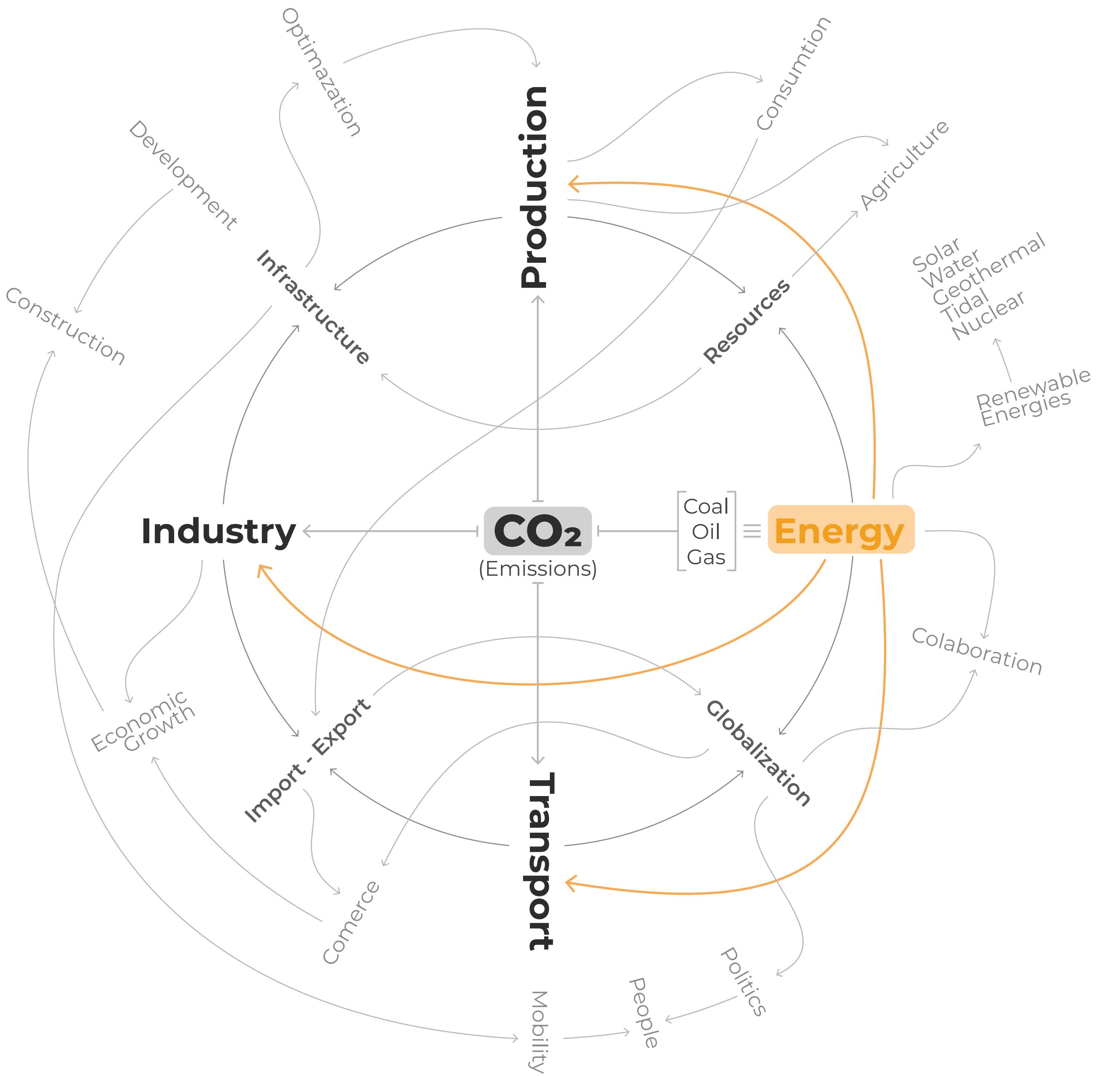
Human intervention in the way carbon flows through the cycle has generated a historic spike on the amount of CO2 found in the atmosphere. The main cause for this is the excessive amount of CO2 emission generated by the burning of fossil fuels as Natural Gas, Oil and Coal All of which are different forms of carbon compounds, that have been accumulating in Earths mantle for million of years. The extraction of these resources also frees up an insane amount of carbon that was bound to the soil and rocks in the ground. But thats not all. On the other side of the cycle we are also deforesting the planet, which decreases the amount of CO2 that the planet can naturally process. Nowadays Humans are emitting 3 times the amount of CO2 that the planet can recapture through plants and trees.

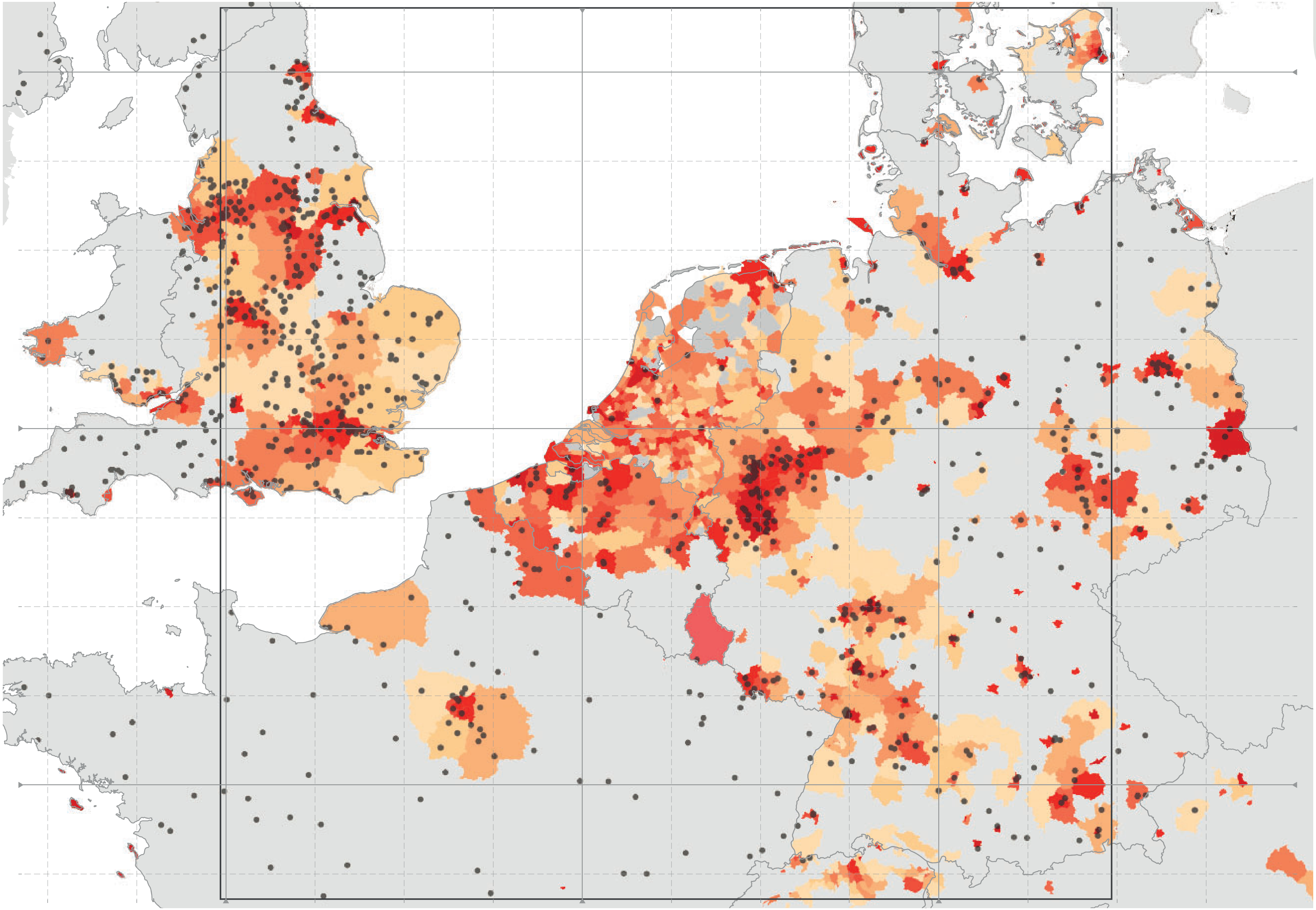
CO_2 Emissions

Atmosphere Concentration

The CO2 emission problem has a lot of contributing factors. In order to analyze them, specific questions were asked. starting from how we produce what we consume, how it gets shipped to us, and what is the role of industry in this cycle. More importantly, where does the energy that is needed to operate this system come from?
The answer was that the source of the energy mainly comes from fossil fuel sources. Furthermore, this led us to research the concentration percentage of CO2 emissions in fossil-based energy production sites. The result was rather expected. These sites are highly polluted and have the highest percentage of CO2 emissions. Thus, the energy production sector is one of the main contributors to the CO2 problem. This is the conclusion that has led this report to be mainly focused on the energy production sector.



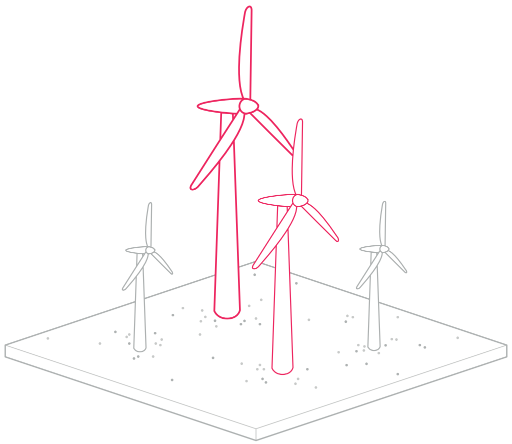


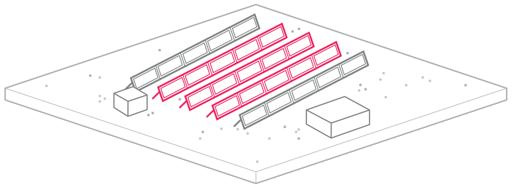


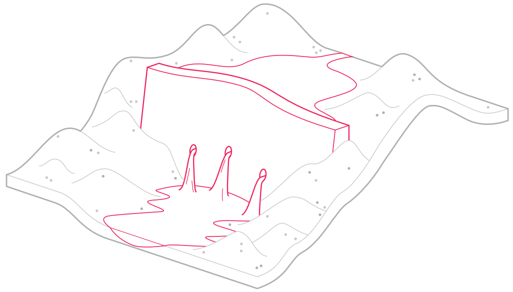
2 Analysis

II _The Energy Transition

Renewables







Eolic Energy

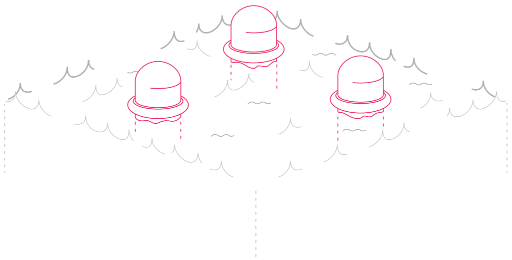
A wind turbine (4 to 6 MW) has a foundation base of approximately 50 m². A 5.6 MW wind turbine has a hub height of 105 to 166 meters. Moreover, between wind turbines, a mutual distance of about five times the rotor diameter applies in connection with interference. This means that a wind farm of 10 turbines of 5 MW covers approximately 50 hectares. In addition, safety zones apply around wind turbines where there are limited development opportunities for homes, infrastructure and other functions. These distances depend on the height and the rotor.

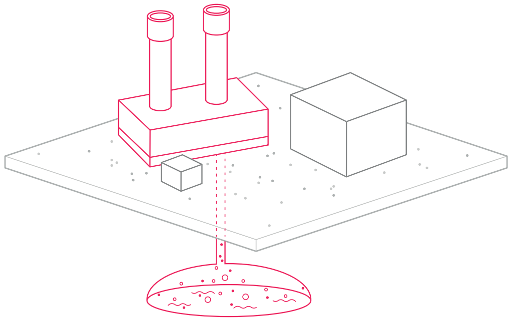
Solar Energy

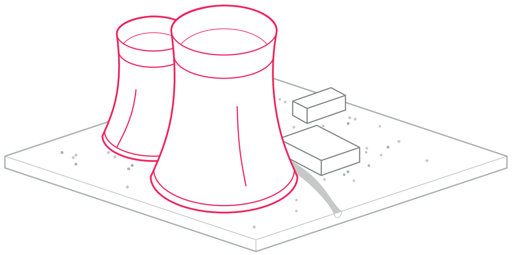
Photovoltaic panels convert energy from the sun into electricity. Above 2 MW capacity (approx. 2 hectares), a solar field can no longer be connected to the medium-voltage ring via a district station. These larger farms are connected to the high-voltage grid via a medium-voltage or high-voltage substation. Furthermore, the total surface area of a solar field is currently approximately 1 hectare per MW capacity.

Hydrolic Energy

Hydroelectric power plants work with turbines that convert the flow of water into electricity. The yield is relatively high because they are in operation almost continuously. Moreover, If the installations are located in existing locks and dams, no additional direct space requirement for hydropower applies. However, the additional spatial effects mainly consist of the necessary measures for ecology, such as fish ladders and the like.







Tidal Energy

Tidal power stations work with turbines that convert the flow of water into electricity. The installation of 5 turbines in the Oosterscheldekering is about fifty meters long and twenty meters wide. The use of space here is very limited, as this takes place in the existing flood defense. However, when the natural flow changes due to tides, this has consequences for flora and fauna. Ecological measures are needed around tidal power stations, such as fish ladders, etc.

Geothermal Energy

Geothermal energy extracts heat from deep underground. At a depth of 500m, the temperature is about 20 degrees. At depths of 6 km and more, the temperature rises above 200 degrees. The availability strongly depends on the location, and it can heat greenhouses, homes and non-residential buildings, directly or via a heating network. Furthermore, 5,000m² of paved area is required per geothermal well, of which 500m² is built-up.

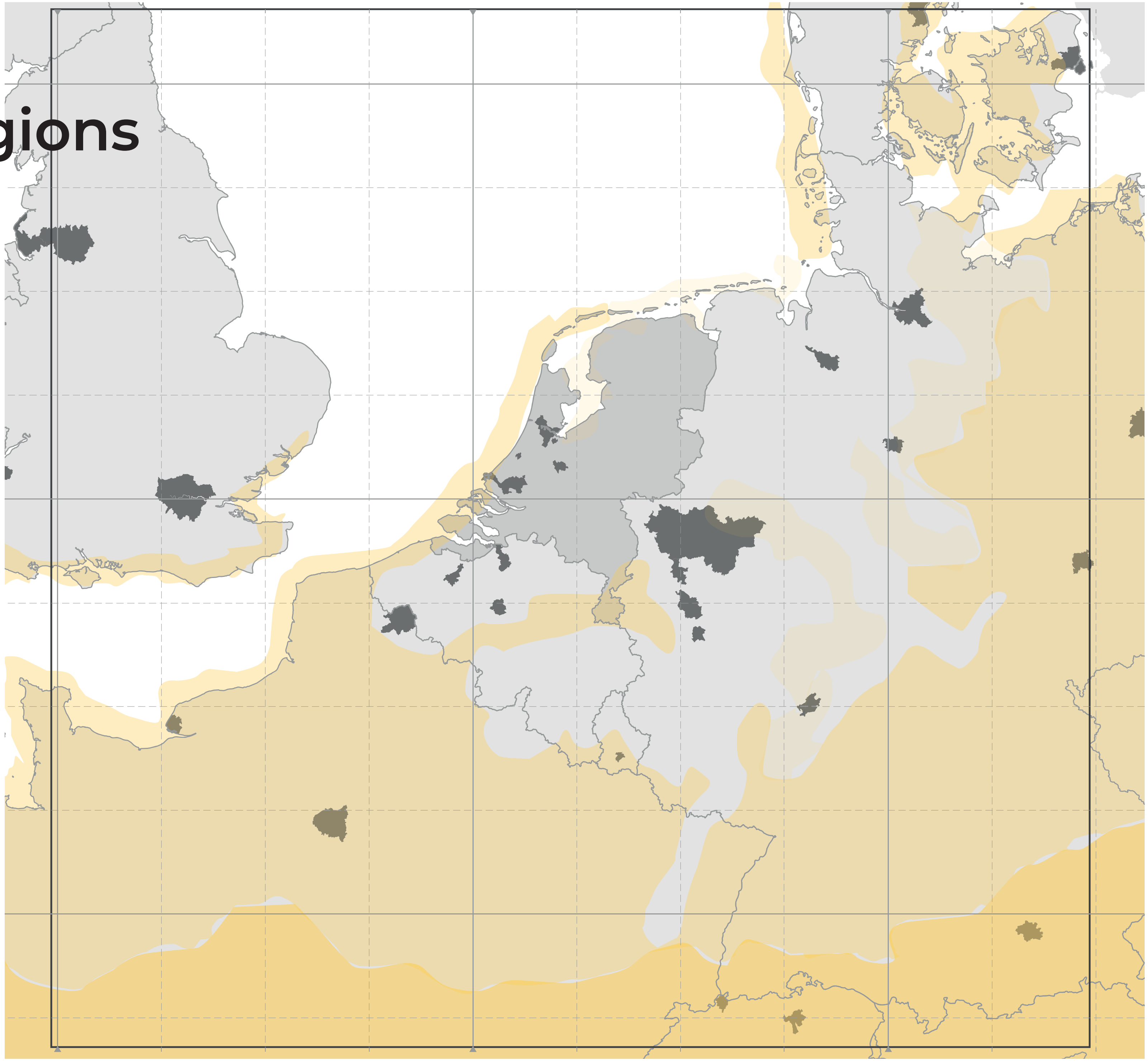
Nuclear Energy

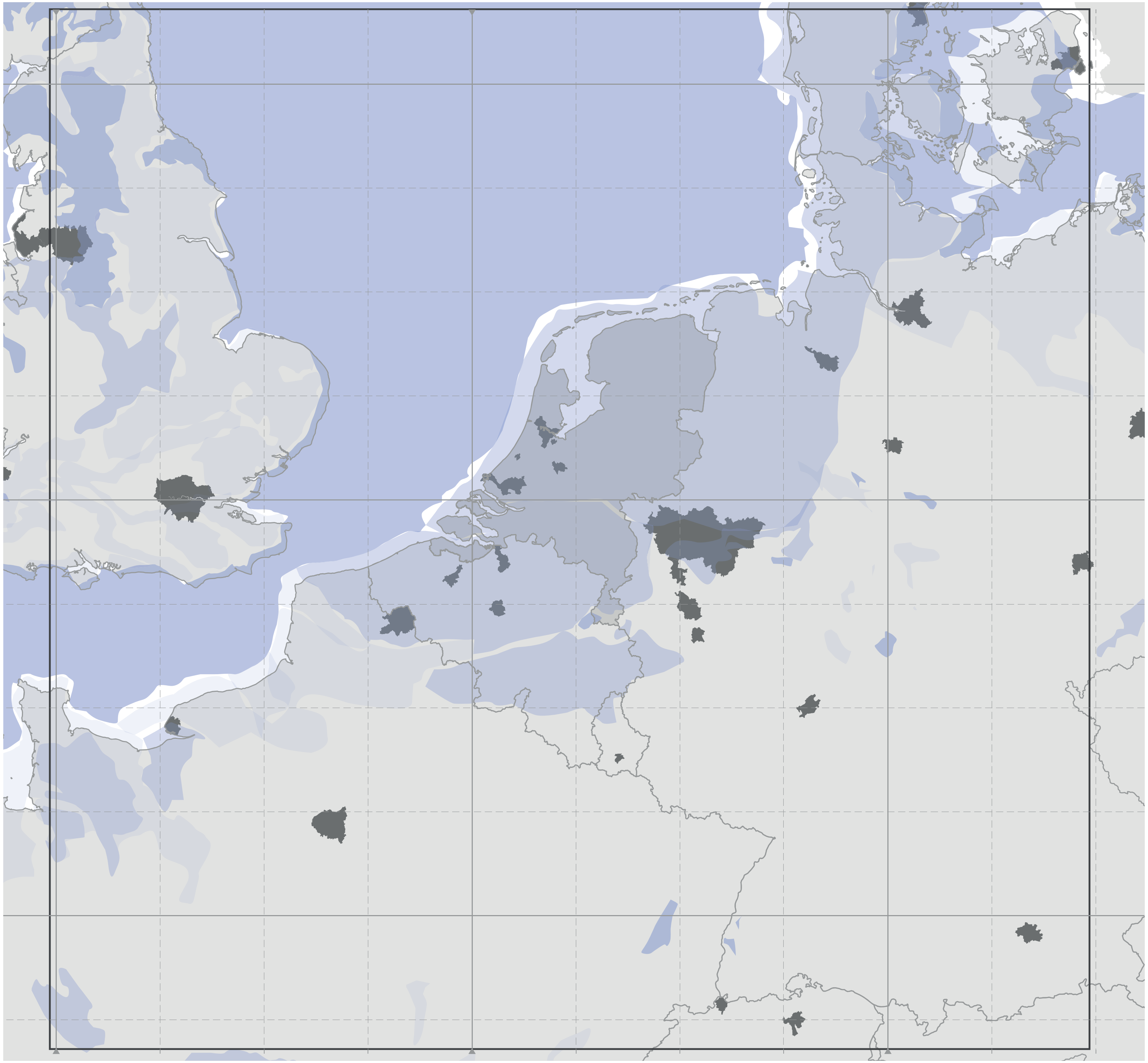
In a nuclear power plant, the heat released during nuclear reactions is converted into electricity via steam, turbines and generators. A nuclear power station needs cooling water and must therefore be located on a river or the sea. The Borssele nuclear power station has an area of approximately 6.4 hectares and a capacity of 480 MW. Moreover, In an area of 0 to 5 kilometers around a (planned) nuclear power plant, the policy is aimed at maintaining favorable low population densities and avoiding the establishment of facilities that could lead to the presence of large numbers of people who are difficult to move. However, the environmental and safety risks associated with nuclear power make it less sustainable, thus it will not be used as a renewable energy source nor promoted in this report.

Potential Regions

Solar

The data shows that the southern region of North-West Europe has the most potential in terms of solar power.



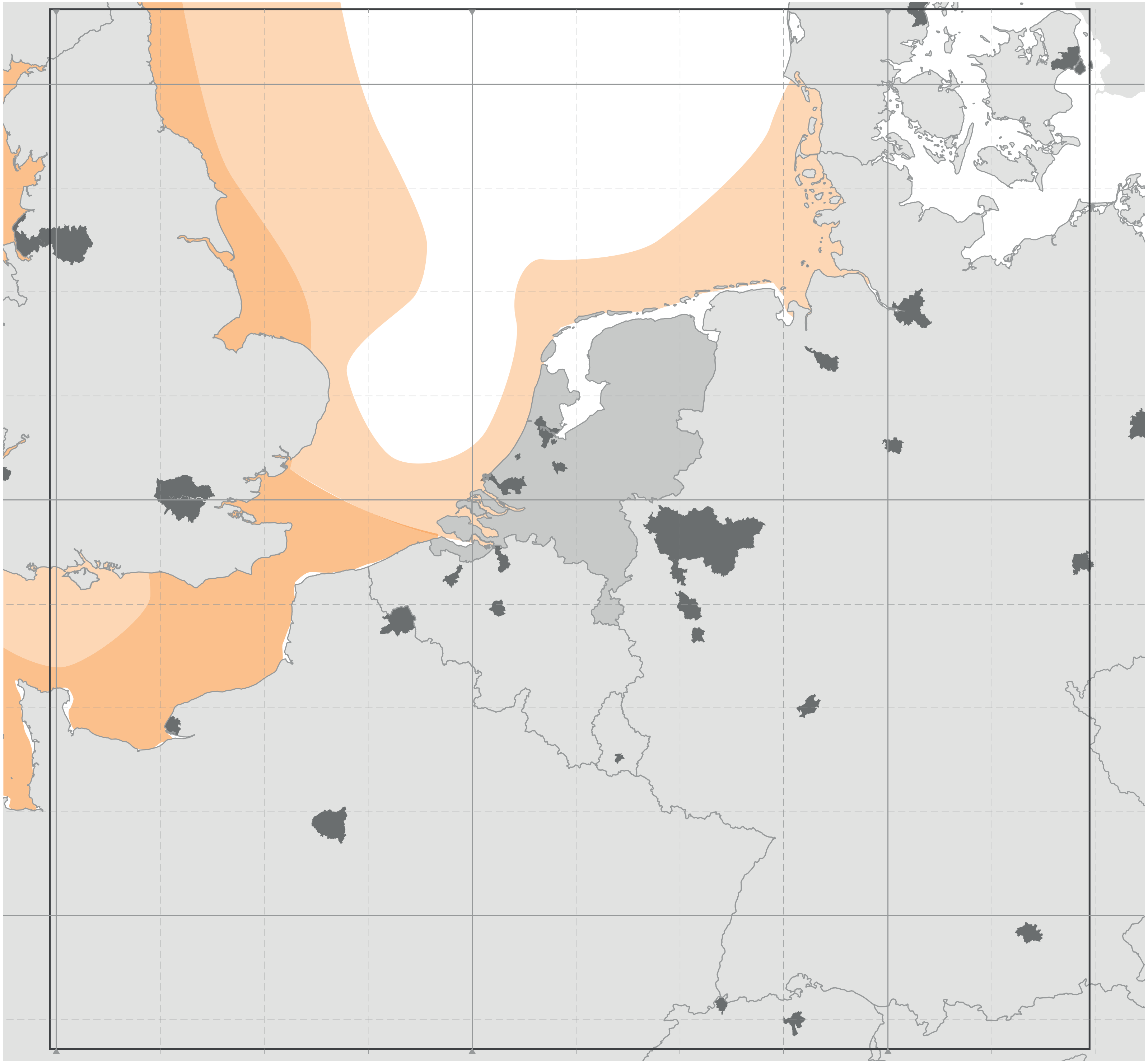


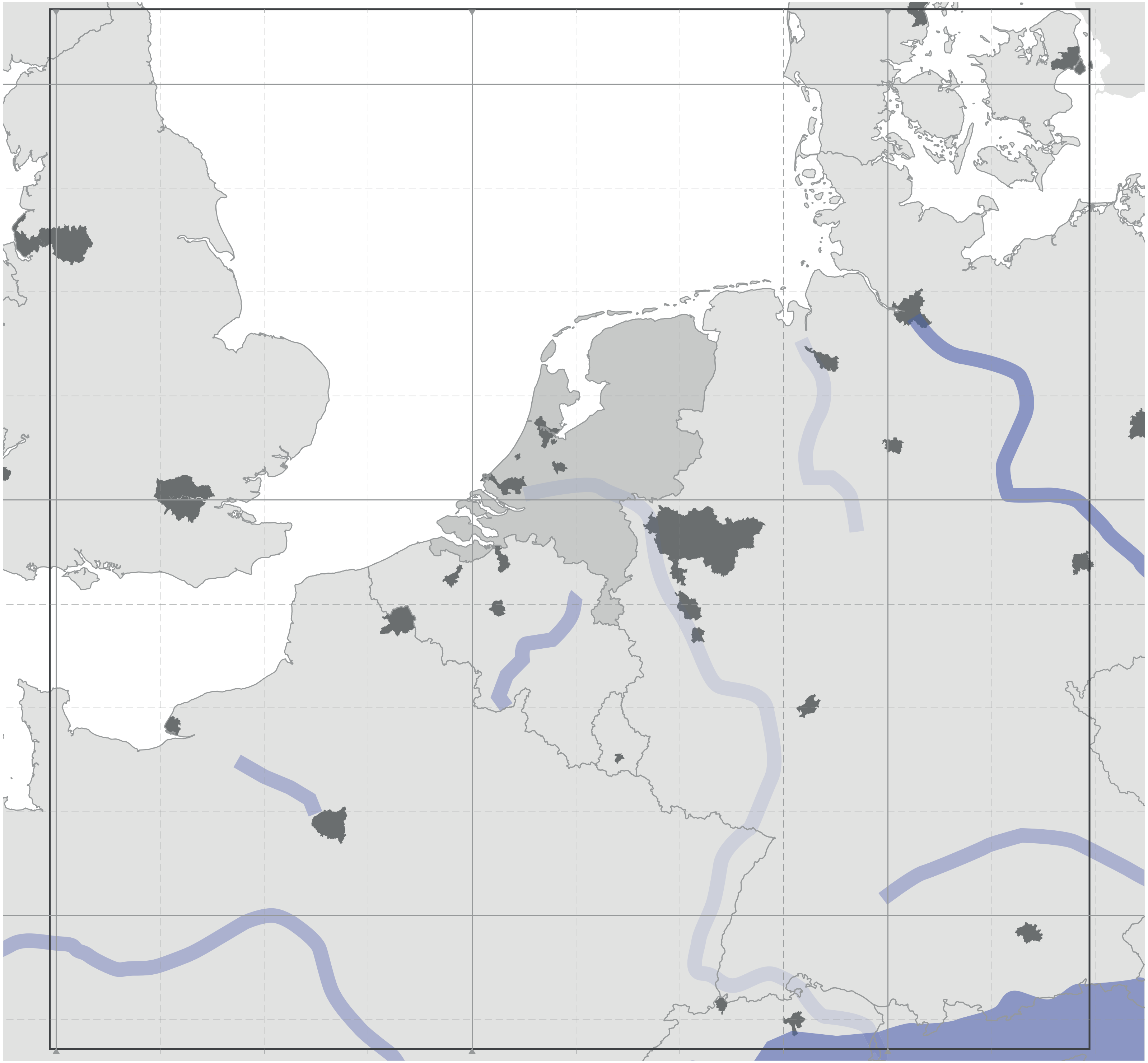
Wind

It is clear from the map that the North Sea has significant potential in terms of wind power.

Tidal

Most of the coasts in the North Sea have tidal energy potentials, especially the coast of France, Belgium, and the UK.

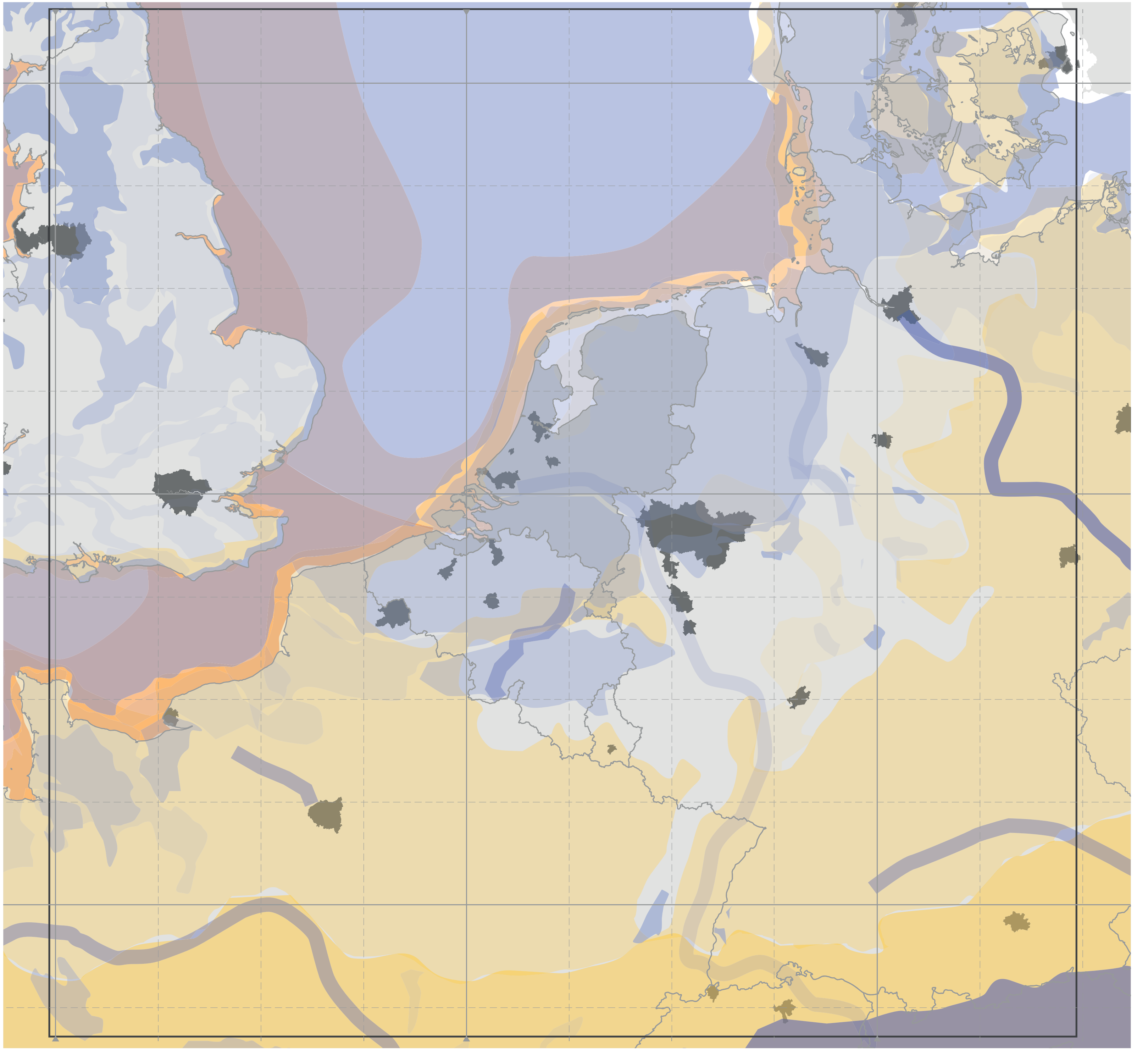




Hydrolic

Hydro energy potential is primarily concentrated in the river basins.

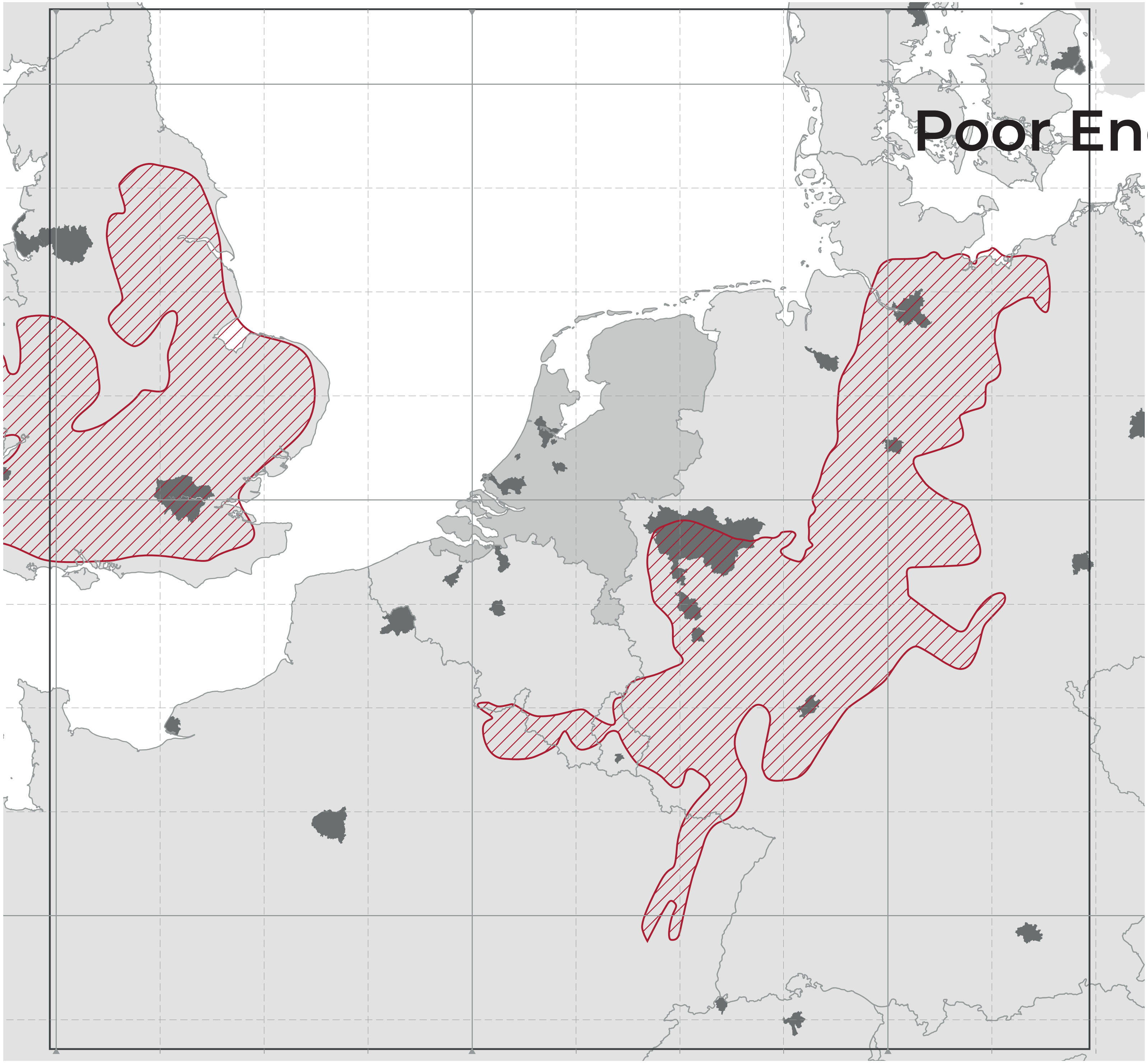
Overall



Poor Energy Regions

No Potential

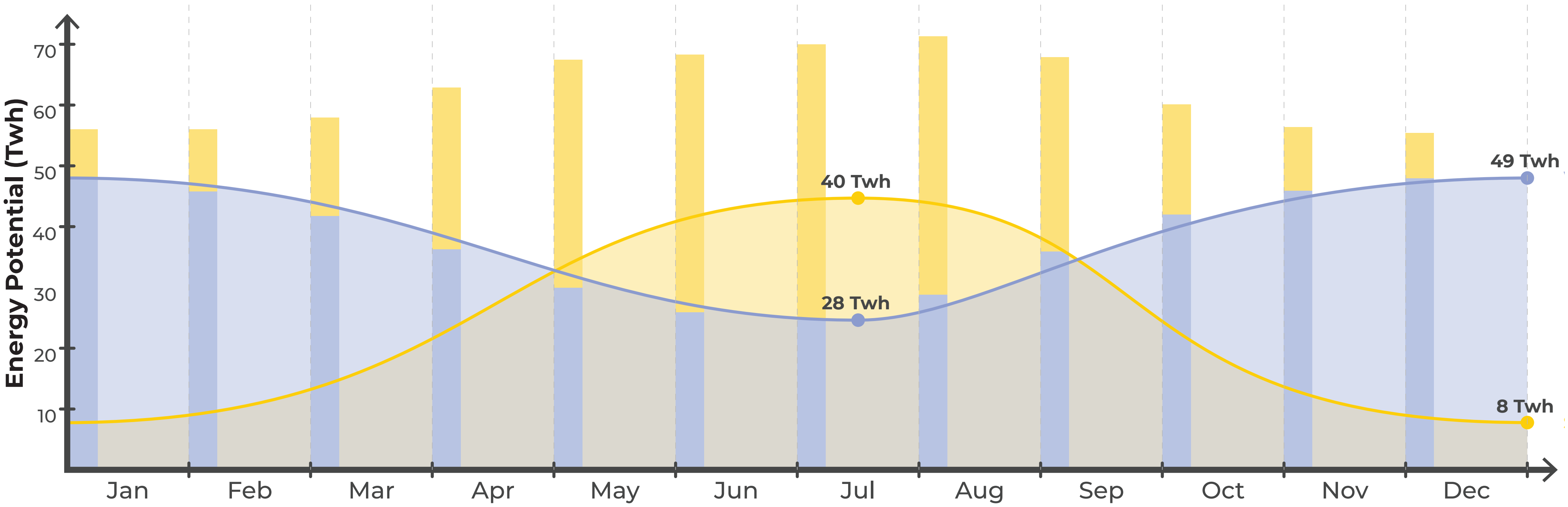
After assessing all the available sources of energy, it can be concluded that the majority of the North-West European regions have some sort of potential for renewable energy production. However, there is a significant part of the continent that due to its location and geográficas conditions don't count with any type of energy potential, like the Eastern part of Germany and a significant portion of the UK. These areas are also hard to determine in a fixed map, since they depend mostly on the season of the year and the fluctuations on the sun activity and the winds.

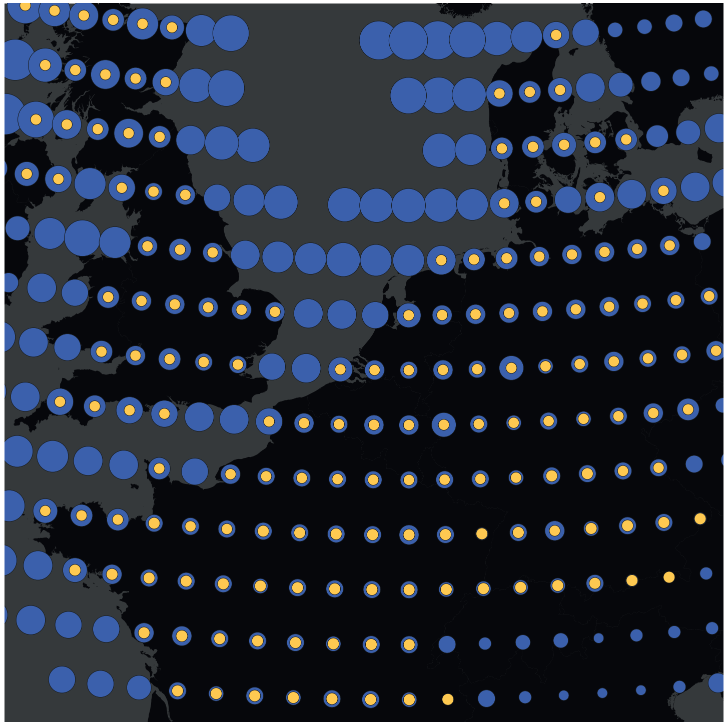


Poor Energy Potential

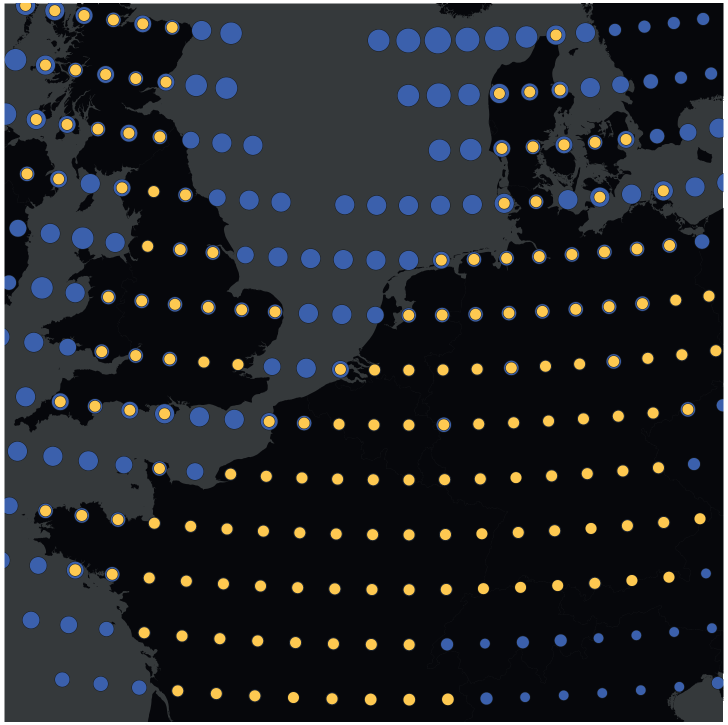
Time Fluctuations

Solar potential depends on the strength of the sun, while wind potential depends on the strength of the wind, resulting in considerable variability in their efficiency throughout the year. In addition, the period from May to December is when solar potential is at its peak efficiency, while wind potential is at its lowest. The opposite is true during the remainder of the year. As a conclusion, effective energy management systems and diversified energy sources are critical for ensuring a reliable and sustainable energy supply.





March



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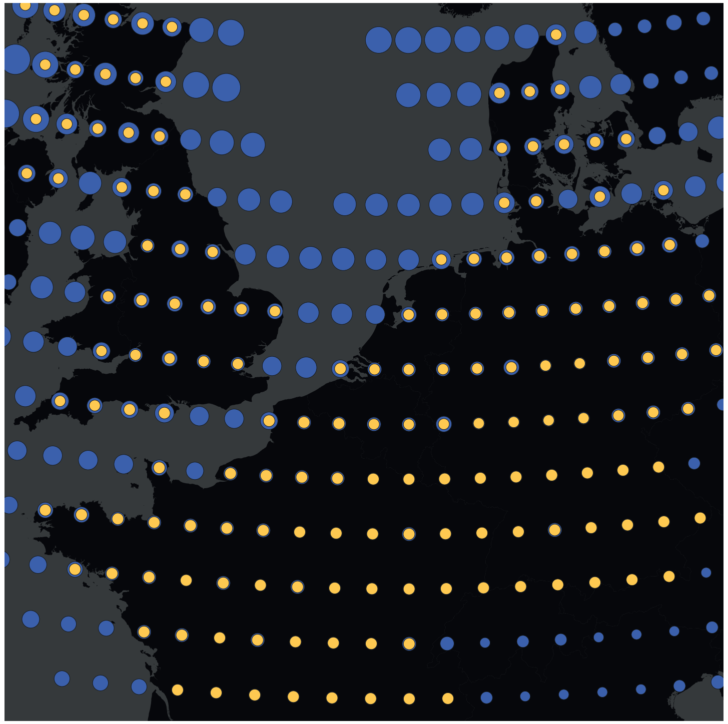

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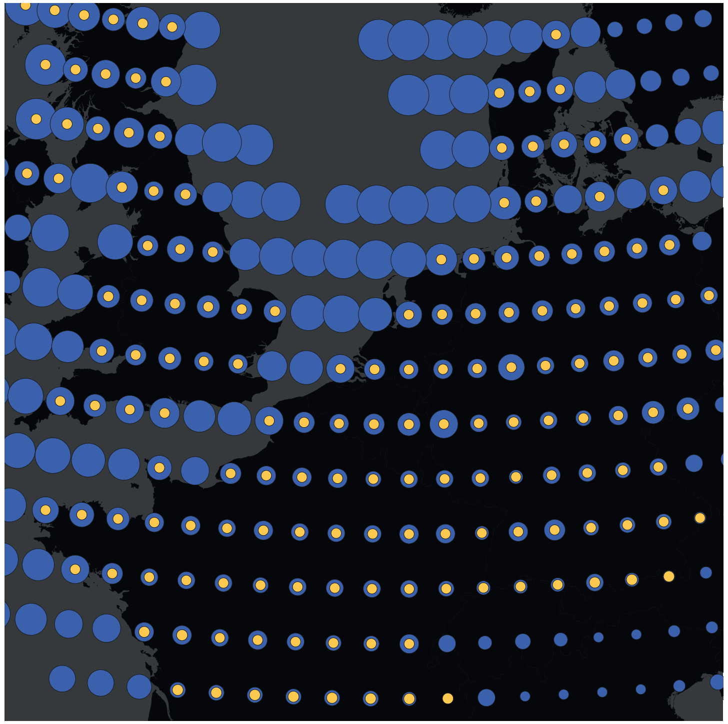


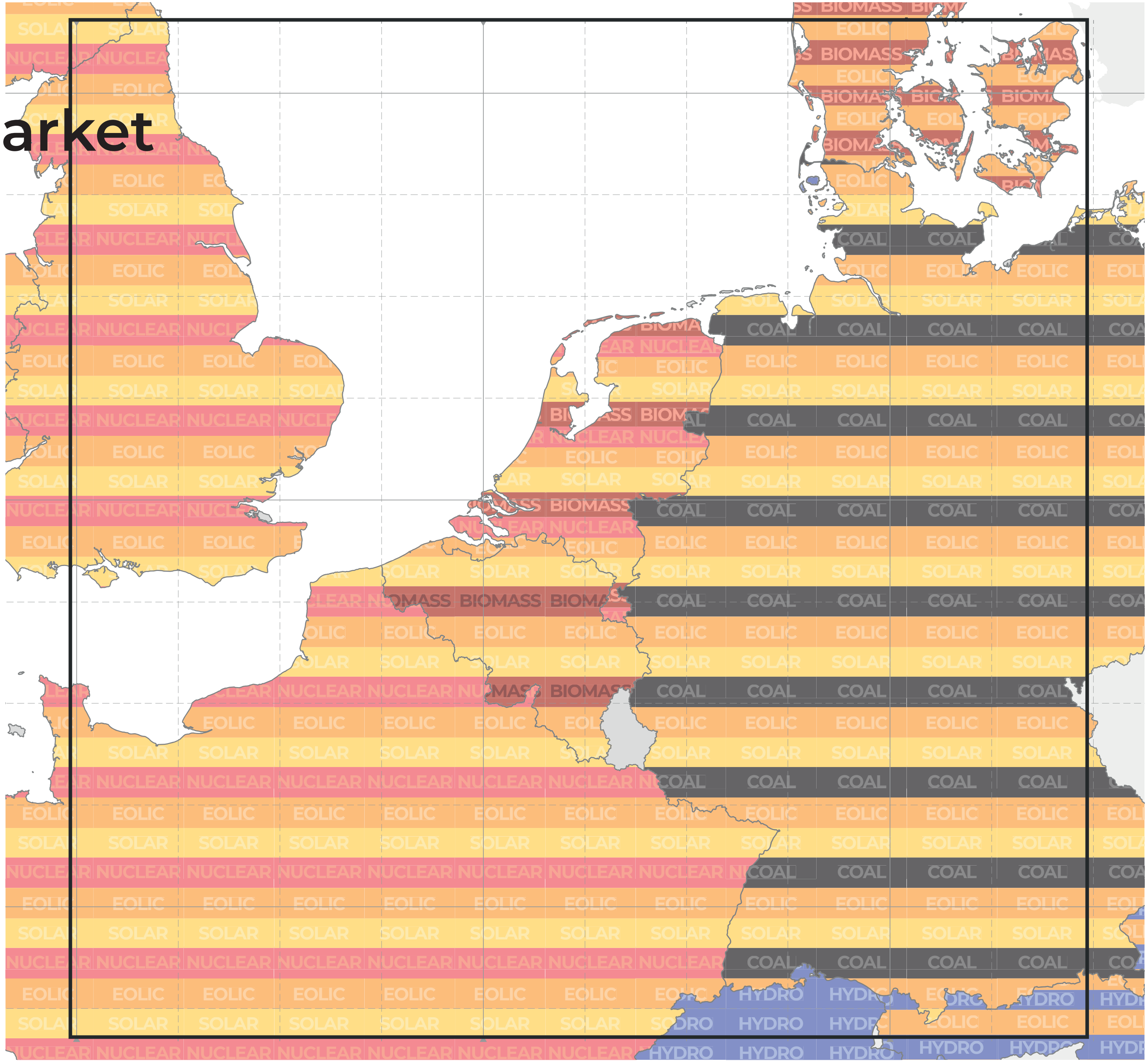
December

The Global Market

Policies

To accelerate the energy transition, it is necessary to evaluate the green energy policies of each North-West European country. When it comes to utilizing various sources for renewable energy production, France and the Netherlands have exhibited the greatest resilience. In contrast, Switzerland and Austria have displayed the least resilience, as they rely primarily on hydro power. Furthermore, Germany, Belgium, and the Netherlands are leaders in wind power production, while the UK is primarily focused on solar energy production, which does not have as much potential for energy generation. Moreover, France currently leads in nuclear energy production with 56 nuclear reactors and has plans for further expansion in this area.

In conclusion, North-West European countries have implemented policies promoting renewable energy sources. However, these policies may not be sufficient to meet the 2030 transition deadline. One contributing factor is that countries are planning in isolation from one another, without fully considering the collective potential of the region's land for renewable energy production. Collaborative planning and policy implementation is necessary to achieve a successful energy transition. (Sillak, Sperling, 2021 & Andrews-Speed, Van der Linde & Keramidas, 2014).



Import - Export

The nations of North-West Europe have established significant energy trading relationships as a result of numerous nations importing and exporting energy to and from their neighbors. For instance, nuclear power reactors in France, Belgium, and the Netherlands generate extra electricity that is sent to neighboring nations like Germany and the United Kingdom. Germany is the region's leading generator of renewable energy and sells a significant amount of electricity to its neighbors. Despite the fact that it isn't officially an EU country, Norway is a major energy exporter to the area and supplies hydropower to the UK and the Netherlands. Moreover, It is evident that the Northern nations of the region are the primary suppliers, whereas the Southern nations heavily rely on energy imports.

As a conclusion, the interconnectivity of the energy systems of the nations of North-West Europe has resulted in the development of a pan-European energy market, making it possible for nations to trade power. However, this may also result in issues with the availability of energy, as nations may become reliant on their neighbors for electricity supply during peak demand.

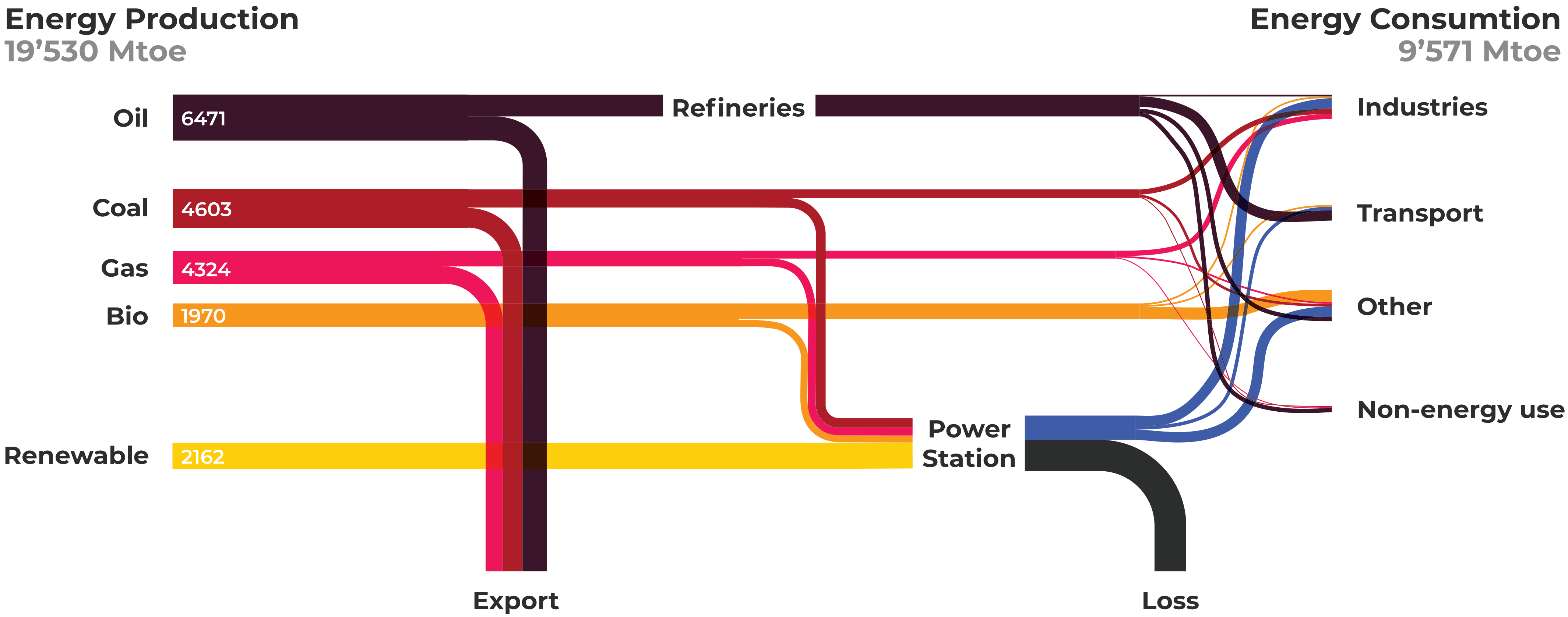
Exporter

Importer

The Flow of Energy

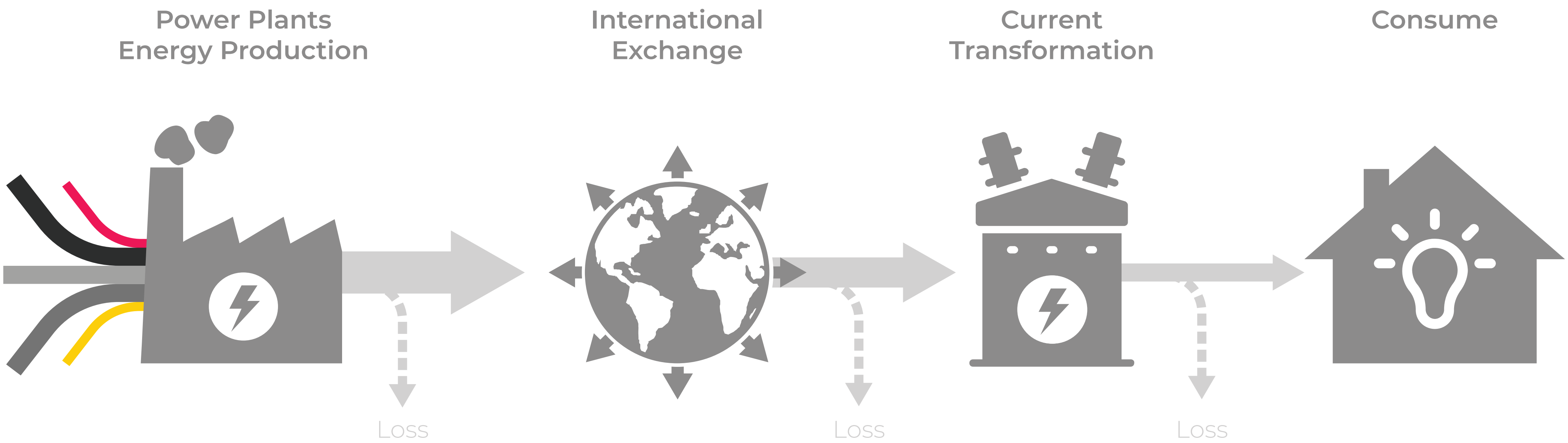
The Current of energy

Since the energy production sector is still highly reliant on globally imported/exported fossil fuel as a main source, it is important to assess energy flows on a global scale. This diagram is based on the International Energy Agency (IEA) comprehensive energy flow diagram which is based on data from 2019. It is clear from the graph that the global energy flow is a sophisticated network of interconnected pathways, involving the production, transportation, and consumption of different forms of energy. The majority of the world's energy is derived from fossil fuels, with only a small proportion coming from renewable sources.



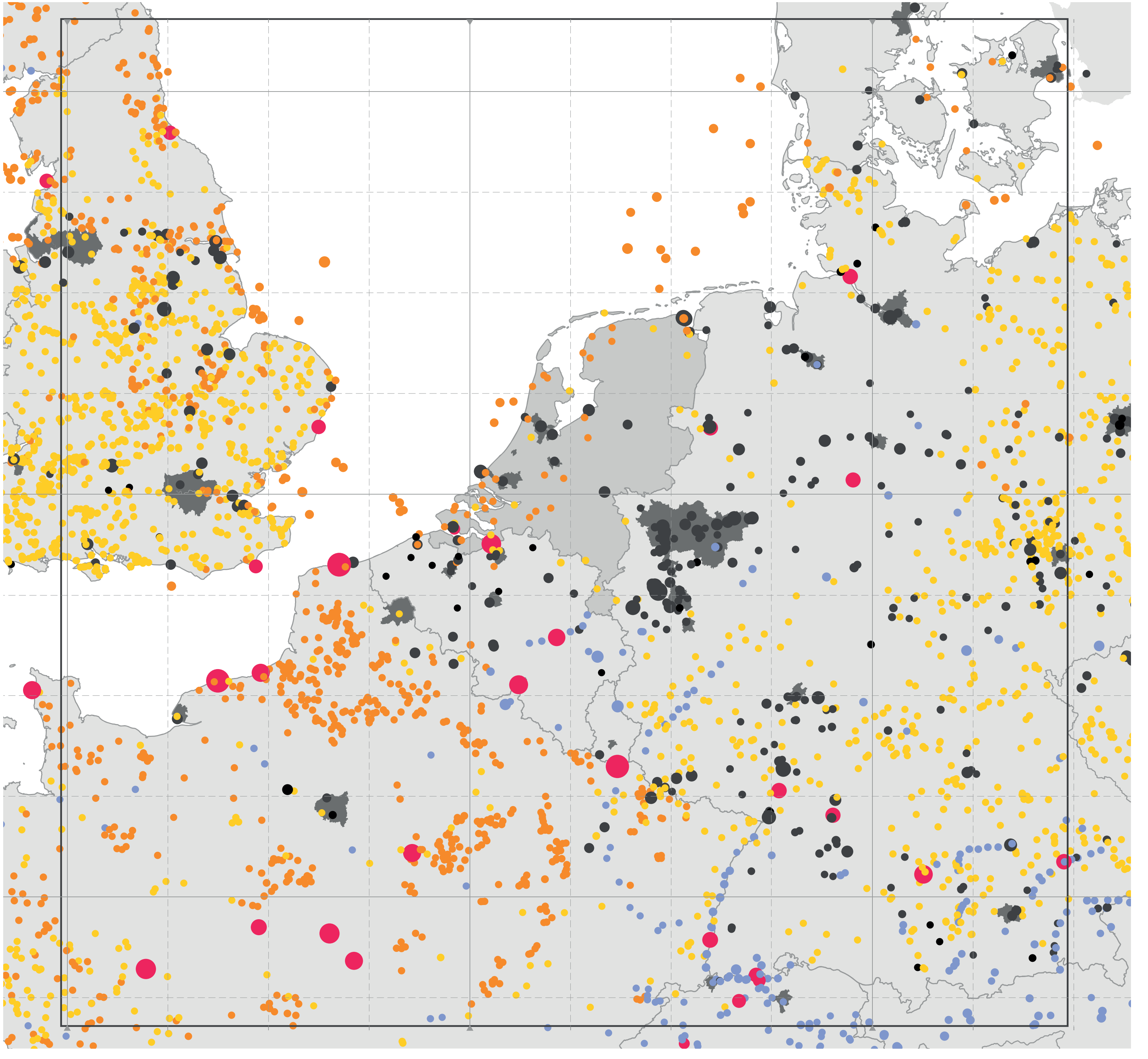
Energy loss

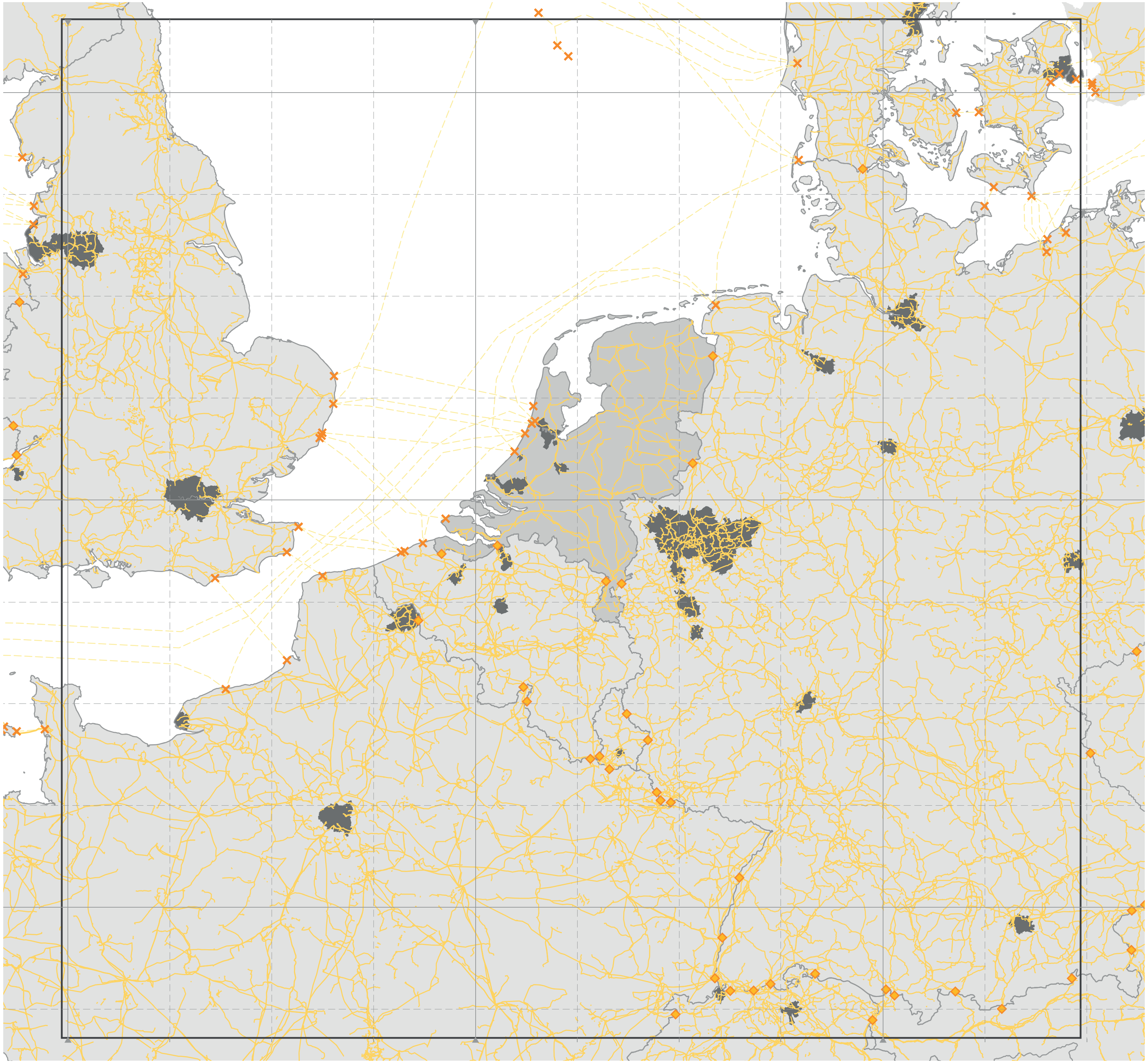
However, a significant amount of this energy is lost during transportation and exportation. Once the energy reaches refineries or power stations, a considerable portion is lost due to inefficiencies in the conversion process. Despite this loss, the remaining energy is directed towards consumption, primarily in the industrial and transportation sectors, with the majority of the remaining energy being consumed in domestic use. Alarmingly, despite producing a significant 19.530 Mtoe of energy, the world only consumes roughly half of it (9.571 Mtoe), indicating a critical problem in our energy usage. and waste management.



Plants

The map shows the current distribution of fossil-based energy plants and renewable energy production sites. It is obvious that the majority of fossil-based energy plants are concentrated around large European cities with significant heavy industries. In contrast, renewable energy production sites are more dispersed across the region and do not necessarily align with the optimal energy potential of the location. This indicates that there is room for improvement in terms of cross-country collaboration and strategic planning to ensure that renewable energy production sites are strategically located to fully harness the region's energy potential.





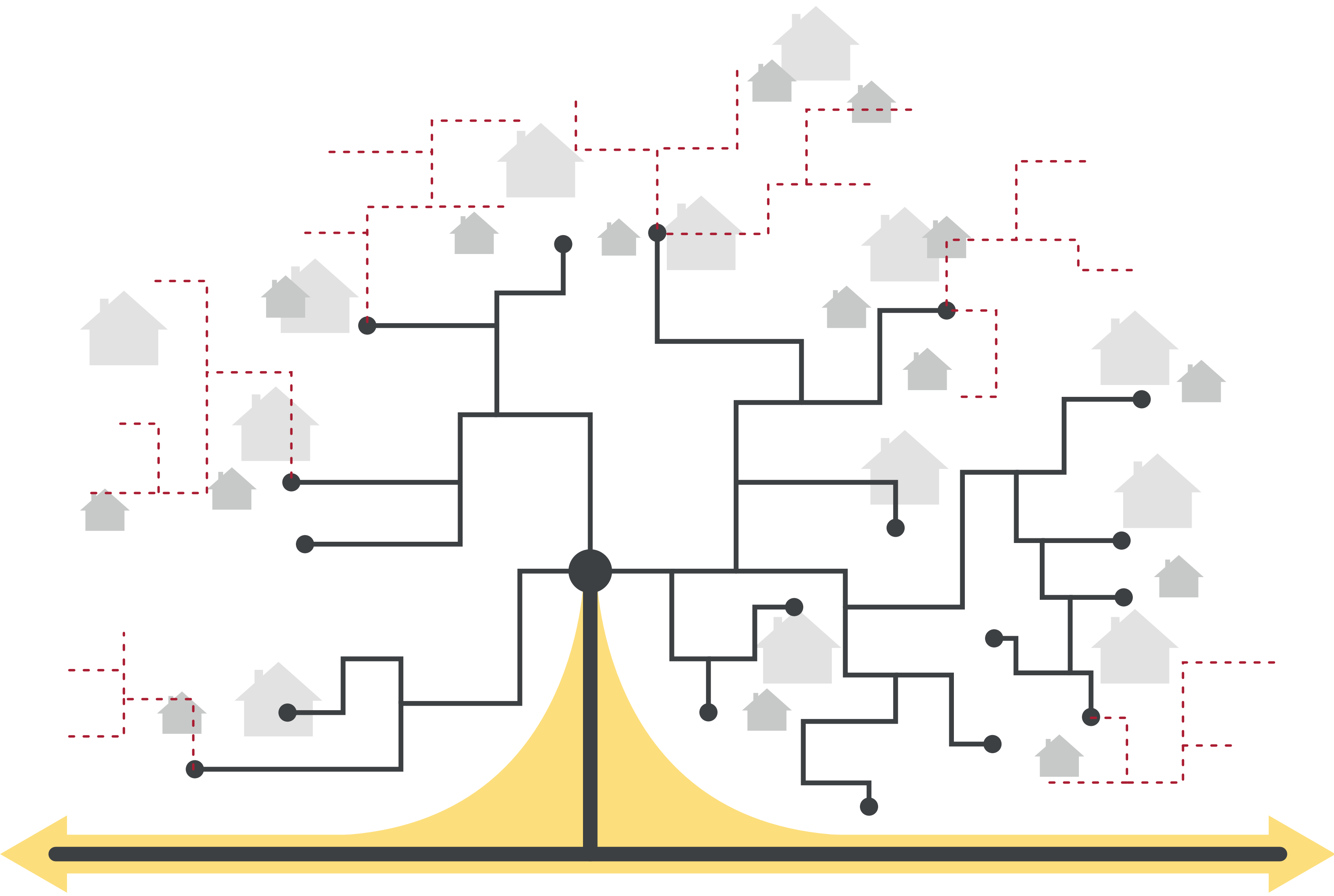
The Electricity Grid

The electricity grid in the region of North-West Europe is a vast and complex network that serves millions of people across several countries. The grid comprises of power plants, transmission lines, substations, and distribution networks, in addition to landing points towards the North sea and exchange points along countries borders. Due to the high demand for electricity, the electricity grid in the region has undergone significant upgrades and expansions to ensure that it can handle the growing energy demands of the region. (ENTSOE, 2010). One of the significant challenges faced by the electricity grid in North-West Europe is the integration of renewable energy sources into the existing infrastructure. However, the interconnected network spanning across the region presents a crucial opportunity to accelerate the transition towards sustainable energy.

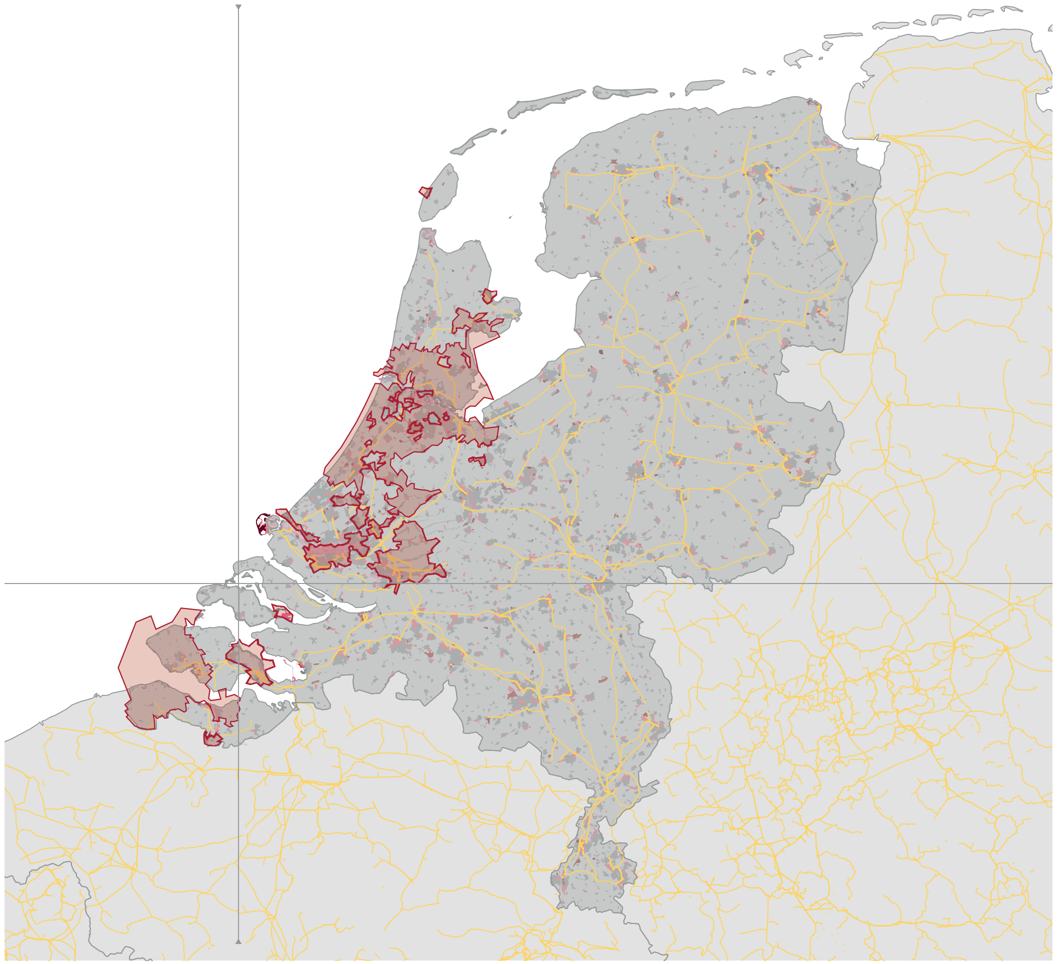
The Net-Congestion problem

The Electricity Grid

The Netherlands is a densely populated country with a highly developed economy, which has resulted in a significant strain on its electricity infrastructure. In recent years, the country has been suffering from a growing problem of net congestion, which occurs when either the demand for electricity in a particular area exceeds the capacity of the local grid, or when the grid is unable to handle an excessive supply of electricity. The bottleneck problem is a key issue related to net congestion, which occurs when the flow of electricity through a particular point in the grid becomes restricted, leading to a reduction in the overall capacity of the grid. This bottleneck issue can cause significant problems for electricity distribution companies and grid operators, making it difficult to maintain a stable and reliable supply of electricity to customers, or to add more renewable energy sources to the grid. Consequently, this issue imposes a critical challenge on the Dutch electricity grid which has to be dealt with as soon as possible. "To continue to provide everyone with energy in the future, the electricity grid must be strengthened. Building additional distribution stations and laying thousands of miles of cables is a monster job." (PAO, 2021)

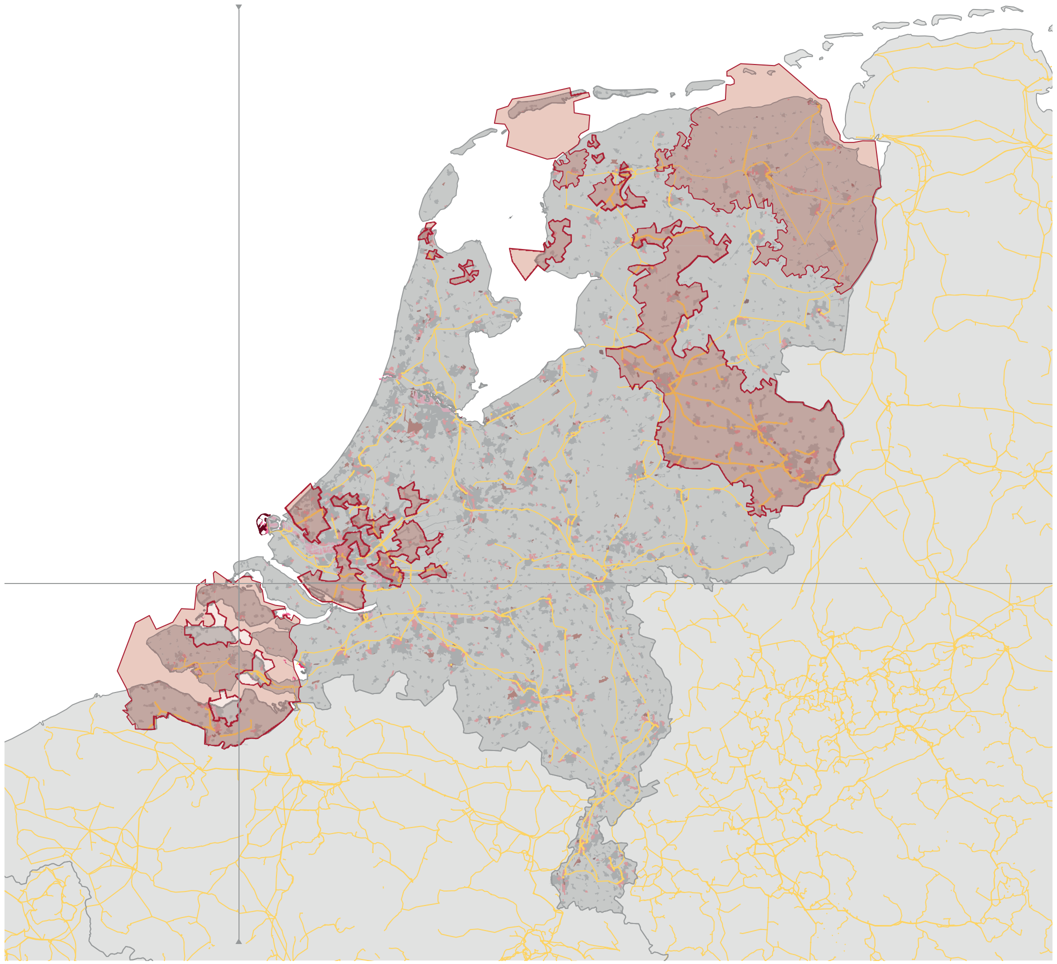


More Production



The map shows the specific areas in the Netherlands where there is more demand for electricity than the grid is able to cope with.

More Consumtion

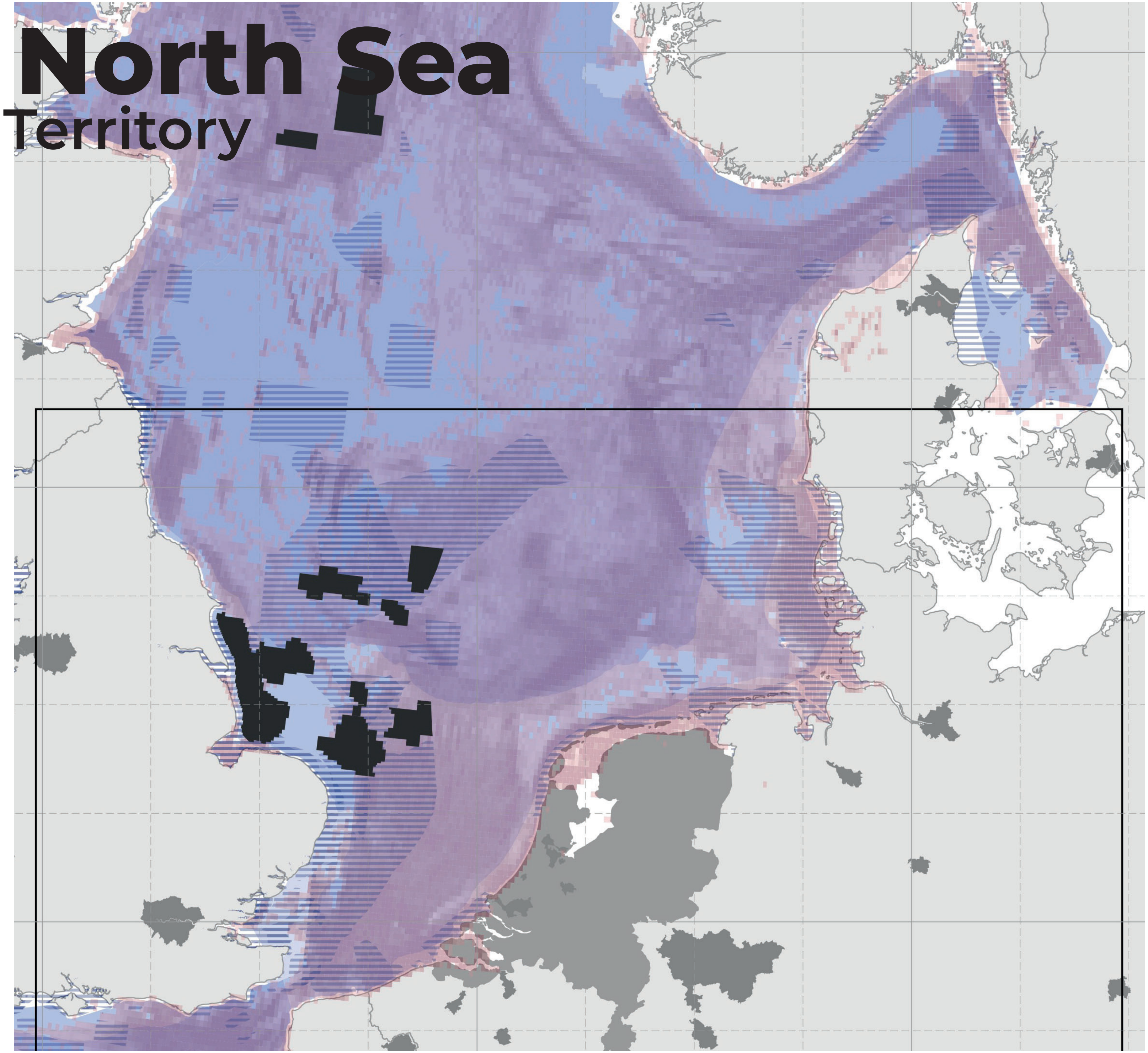


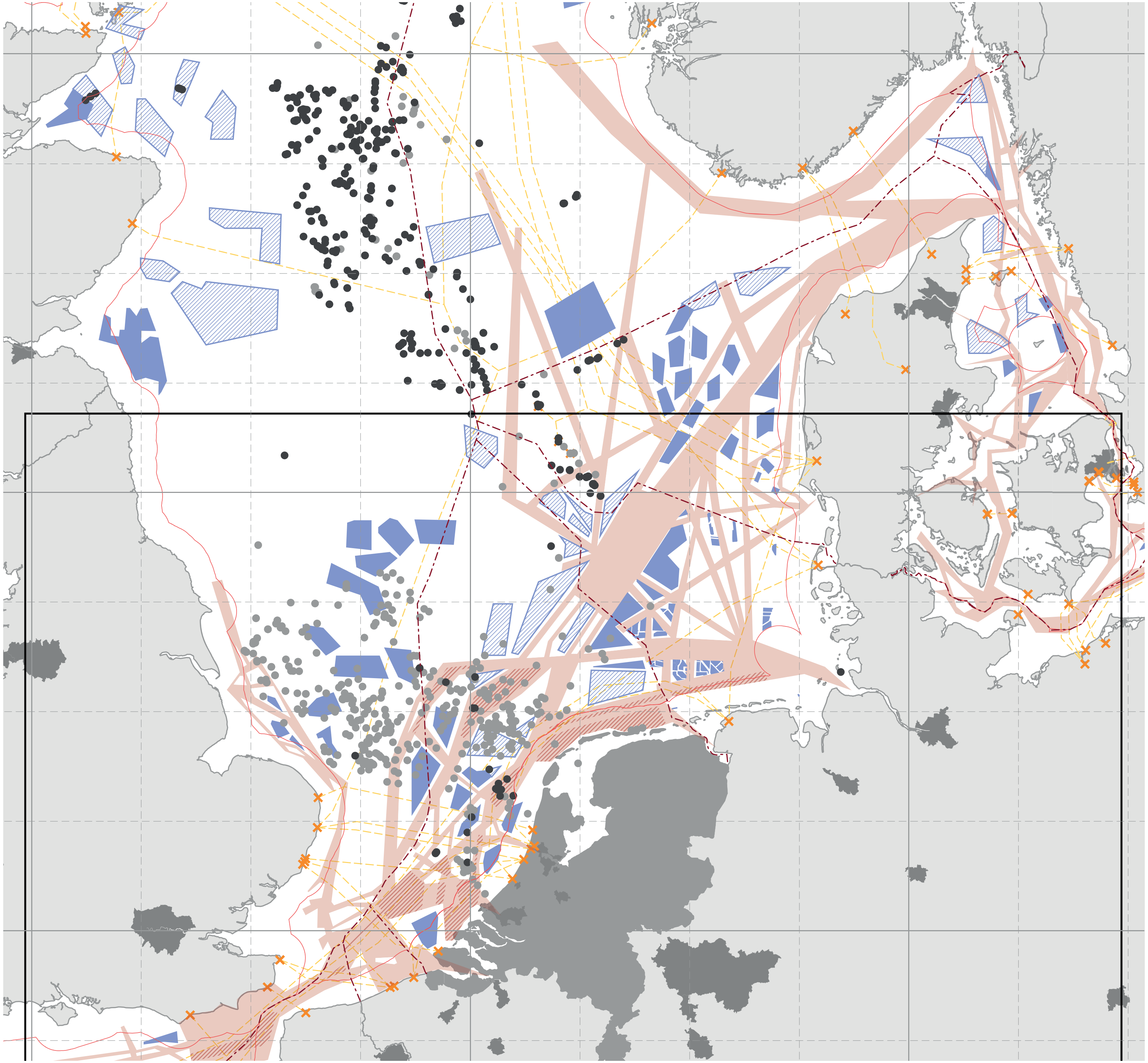
The map displays the locations in the Netherlands where net congestion is happening as a result of an excess supply of electricity that cannot be accommodated within the grid.

III _The North Sea
The Sea as a Territory

Natural Environtment

the North sea is a complex geographical condition that has defined the development of the North-West of Europe throughout human history. Archeological evidence shows that it holded a high number of settlements al around the southern half and nowadays it holds the highest density in the european country with cities like Hamburg, Amsterdam and London. In the middle ages it permitted communities to exchange and migration to happen, generating an identity rich region of the globe, where cities were deeplly related to one another and towards the sea. Throughout this period there were no borders to hold on to. The entire region function as one single space that included different folks to collaborate and trade. Result of this are the Hanseatic cities (Hamburg, Amsterdam, Antwerp, Bergen,...) that reflect a similar Identity in their architecture and hold a very close relation to the sea, more than towards inland. Nowadays societies have been alienated from the sea and the imaginary territory that the waters hold, has been forgotten and replaced by a blanck space.





Urban Landscape

Contrary to this, the Sea holds a vast amount of infrastructure, physical and imaginary (Borders, shipping routes...) that allow governments to exploit the resources that the sea holds such as natural gas and crude oil. But the way this infrastructure has ben put in place respons only to the political and economical aspect of how companies extract those raw materials. This leed to a chaotic state whit high concentration of oil rigs along the middle of the sea, and an excessive amount of shipping routes that cut through the entirety of the sea, leaving just residual spaces for natural ecosystems and ecological reservoirs. Until Modernity the value of the sea laid on only two aspects of it: maritime transport, and fossil fuels extraction. But due to the recent raise of renewable energy market, and the high potential of the sea to place offshore wind farms, the question has been risen: how should this territory be further develop in an integral way?

Landing Platform
Oil Extraction Rig
Gas Extraction Rig
Intercontinental Cables
Soverign Waters (200NM)
Nacional Waters (12NM)
Functional Windfarms
Proyected Windfarms (2030)
Shipping Routes
Ships Parking Sites

IV _H2: The Fuel of the Future

Why...?

As Europe moves towards a more ecological and low-carbon energy system, hydrogen is becoming more widely acknowledged as a key energy carrier, which makes it a crucial link in the global energy transition. These are the opportunities that hydrogen provides:

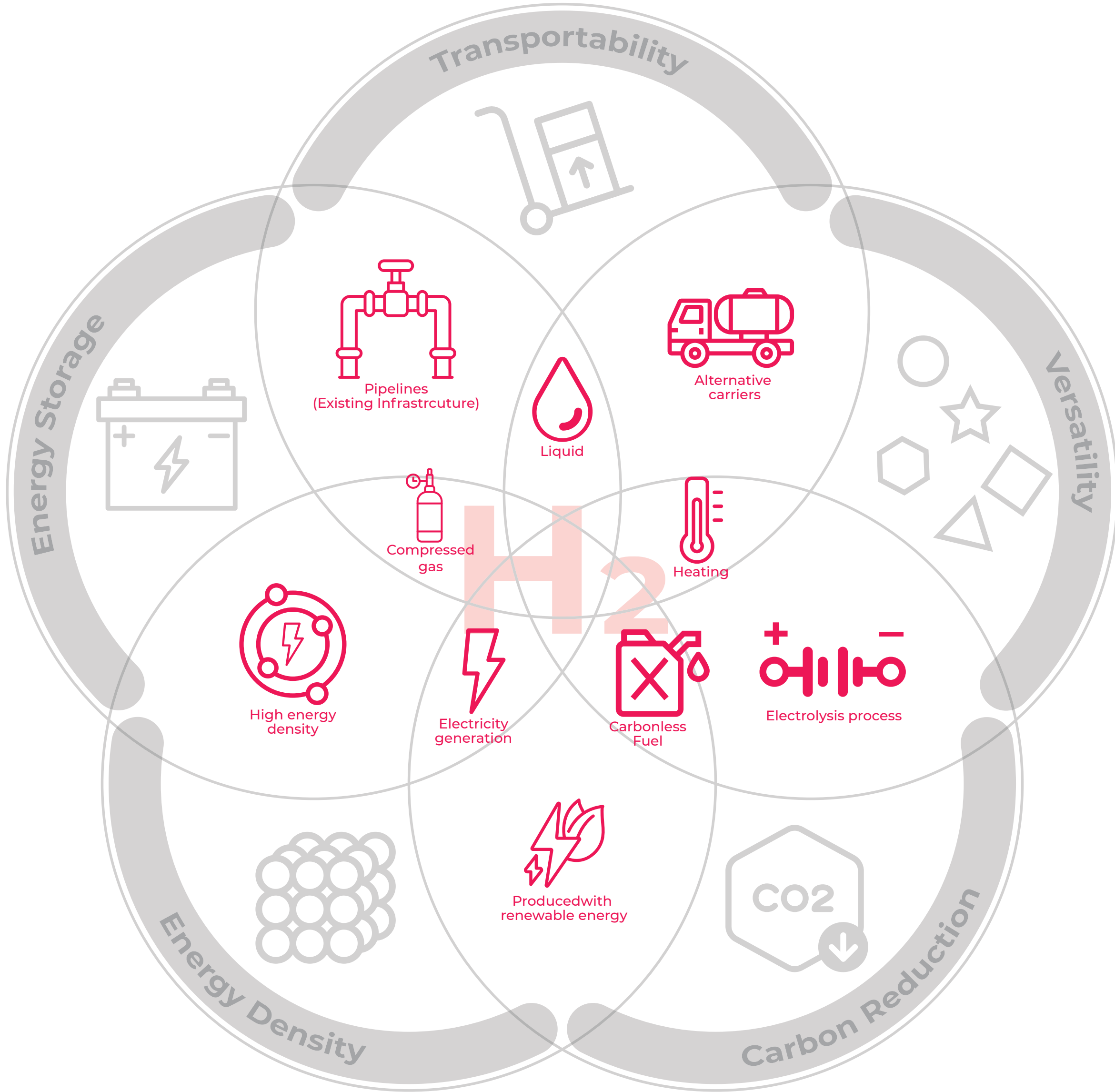
Carbon reduction: Since hydrogen can be generated using renewable energy sources such as wind, solar, or water power, it is a fuel with no emissions. Its use in industry, heating, and transportation may significantly reduce greenhouse gas emissions and aid in the decarbonization process.

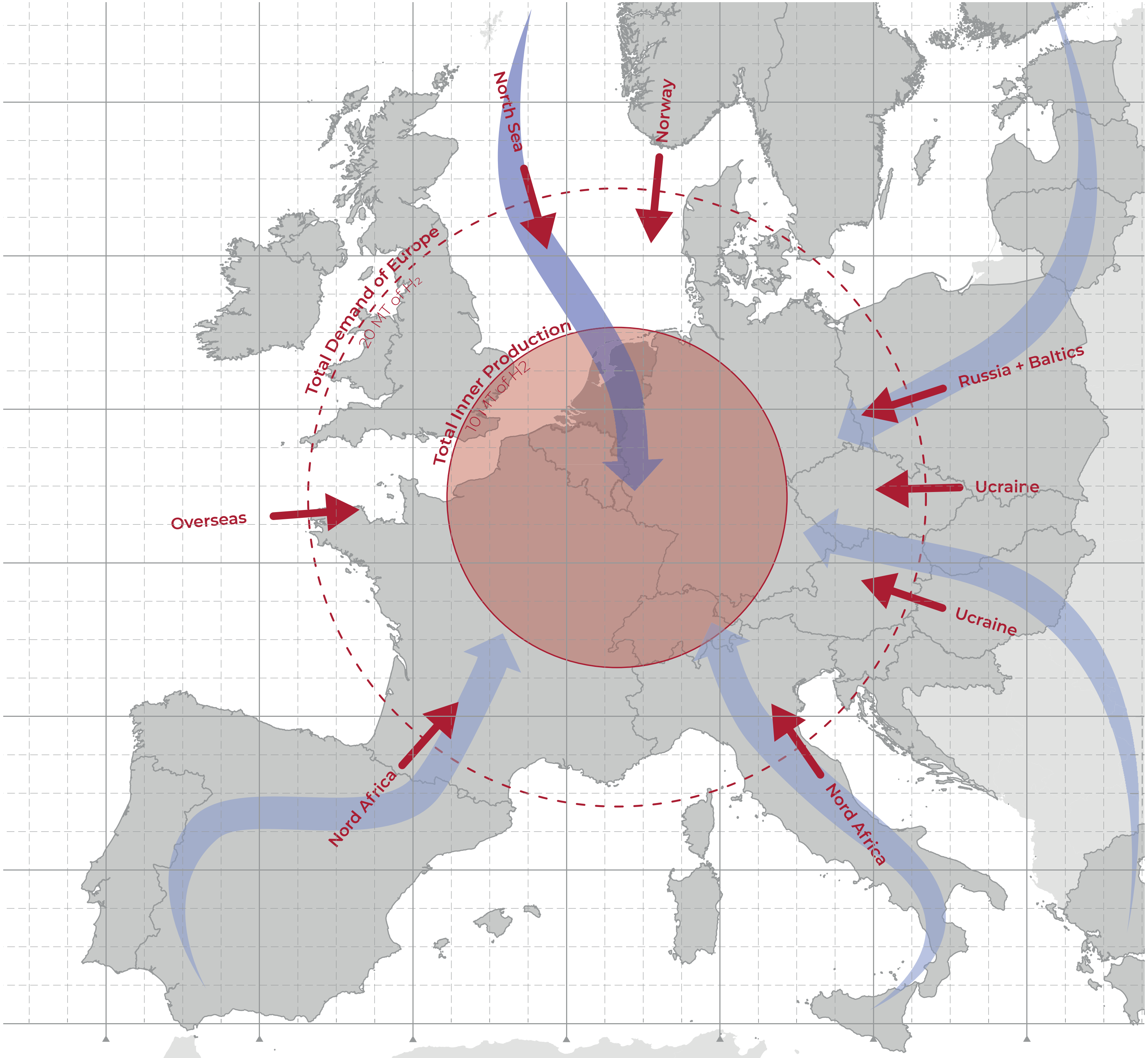
Energy storage: Hydrogen can be used as a form of energy storage, which is essential for balancing the irregular nature of renewable energy sources. Energy generated from renewables can be used to produce hydrogen, which can be stored and used later to generate electricity or heat.

Versatility: Hydrogen can be used for many energy applications, such as transportation, heating and cooling, and electricity generation. This versatility makes it a vital energy form for many sectors.

Transportability: Hydrogen has a transportation ability over long distances through pipelines or by tanker trucks or ships, which makes it easier to transport renewable energy from high production locations to low production ones.

Energy density: Hydrogen has a high energy density, which translates to the ability to deliver a lot of energy per unit of weight or volume. This makes it beneficial for applications where energy density is crucial, like fuel cells or hydrogen-powered vehicles. (Fischedick et al., 2005)





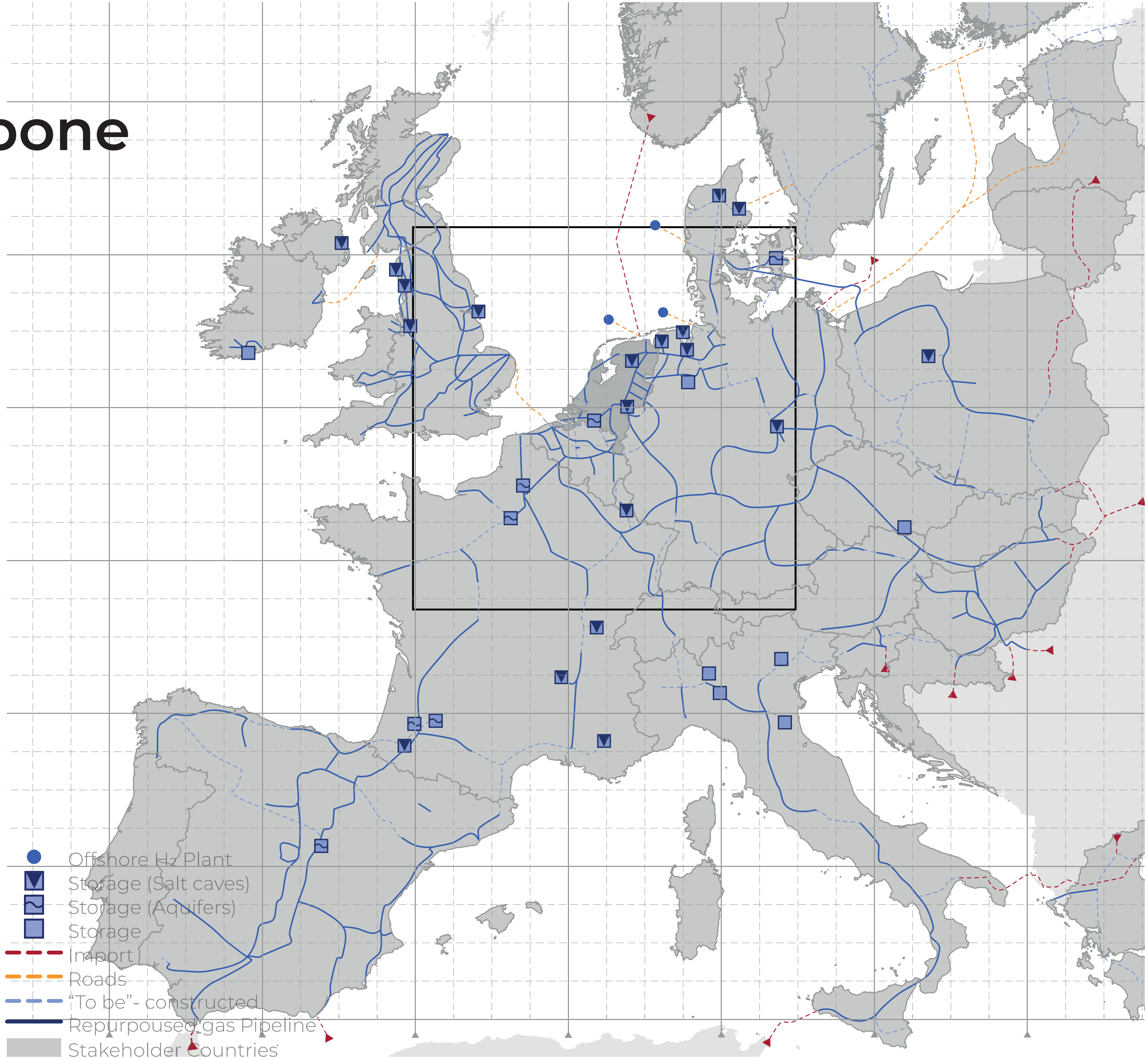
The EHB

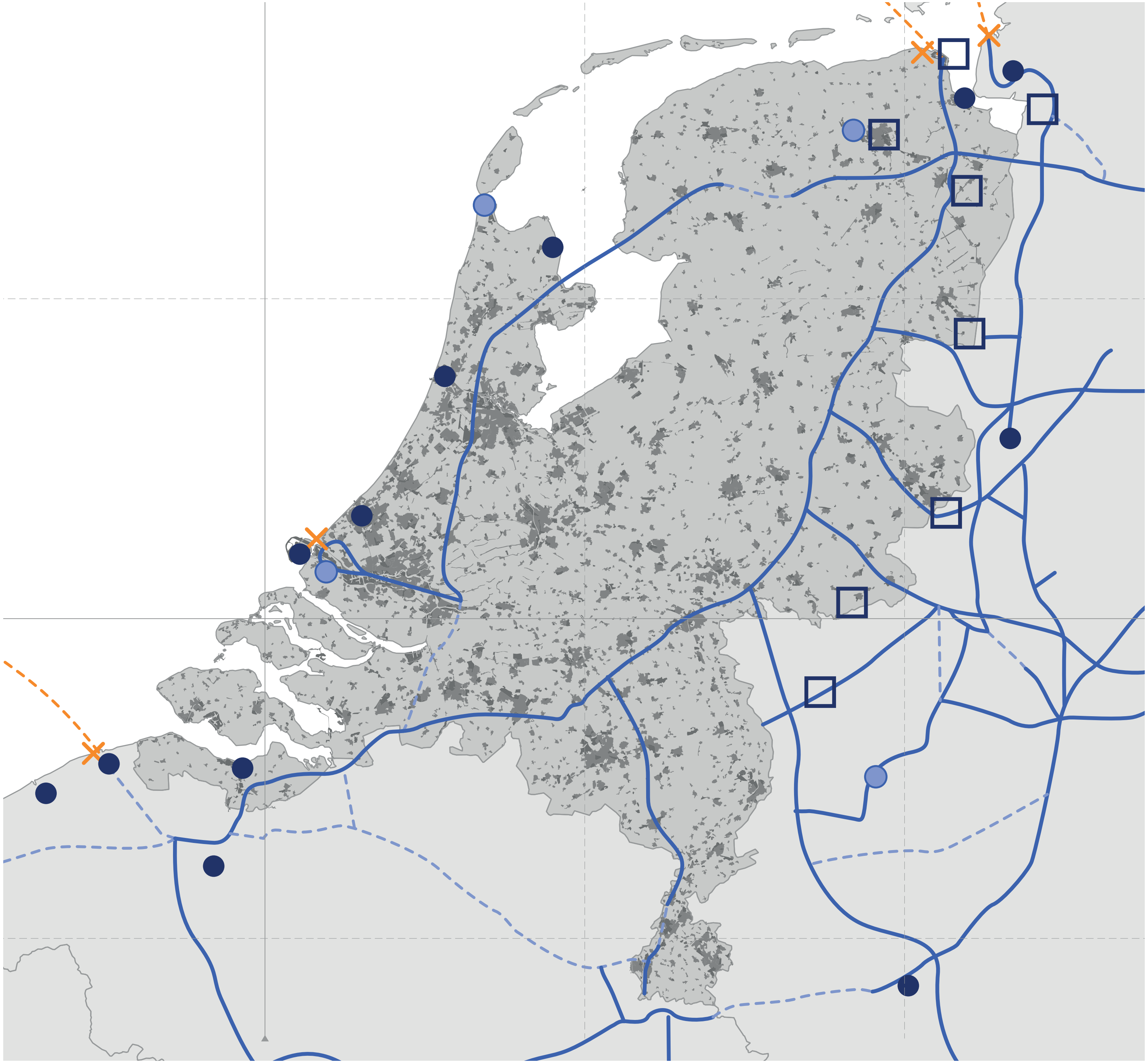
The European Hydrogen Backbone (EHB) is an ongoing project aimed at developing a hydrogen infrastructure network across Europe to support the decarbonization of various sectors, such as transport, industry, and heating. The Backbone will connect hydrogen production sites with demand centers across Europe, including industrial clusters, ports, and urban areas. The project identifies five priority corridors for the development of the EHB network, which cover countries from Portugal to Poland and from Denmark to Italy. These corridors have been selected based on their potential for the development of hydrogen supply and demand, as well as their strategic location and existing infrastructure. The study discusses the spatial implications for the development of the EHB network, including pipeline and transport infrastructure, storage facilities, and hydrogen refueling stations.
The target is to provide 20 m/t (million ton) of Hydrogen each year to different sectors across Europe. However, 10 m/t of the Hydrogen is locally produced, and the other half is imported from outside Europe. (European Hydrogen Backbone, 2022)

The H_2 Backbone

Europe comes Together

The EHB project is reflected on land by a Hydrogen pipeline network that will gradually grow to its full extent by 2040.
The extensive portfolio of ongoing and planned hydrogen infrastructure projects in the area, such as the large-scale offshore wind developments, the large-scale integrated hydrogen projects, and an expanding list of anticipated import terminals for hydrogen and hydrogen derivatives in the Netherlands, Belgium, Germany, and France, present a significant opportunity for this corridor.
This corridor appears as a highly-integrated supply corridor that can take advantage of substantial offshore gas infrastructure in the North Sea, planned national and regional hydrogen backbones in the Netherlands (by 2027), in Belgium and Germany by 2030—connecting all major demand clusters in north-western Europe—as well as possible hydrogen storage at salt cavern locations in northwest Europe.
By 2030, the corridor would be established, spanning 12,000 km of substantial hydrogen pipes through all of the participating nations, with about 70% of those pipelines being repurposed. Because of the corridor's high potential for repurposing already-built infrastructure, there is a chance to keep the price of transporting hydrogen comparatively low. By 2050, all of the nations along the corridors will have adopted hydrogen, resulting in an emissions reduction of about 360 MtCO2/year, or 29% less emissions overall. (European Hydrogen Backbone, 2022)





Local Scale

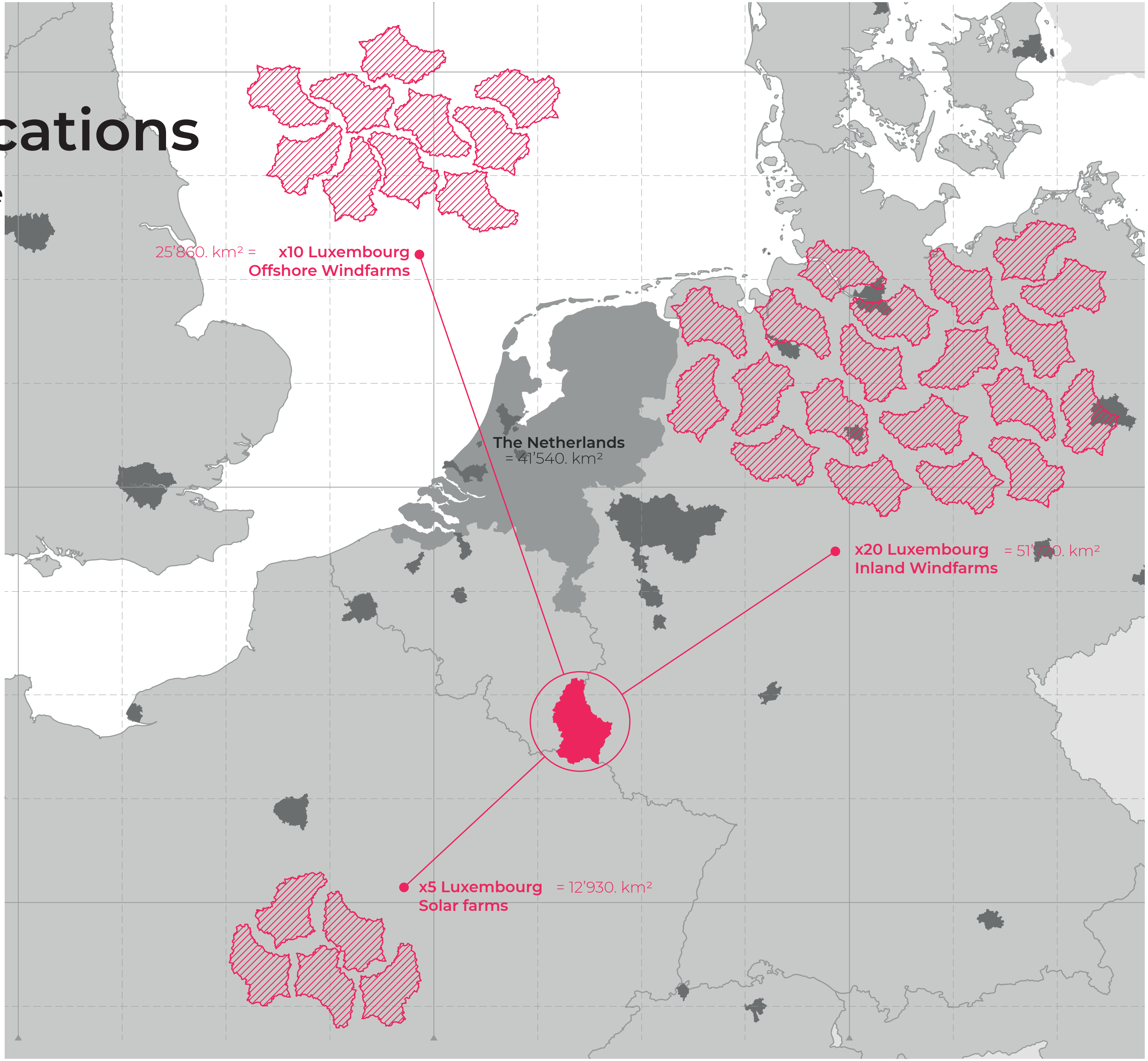
The Netherlands is creating a national hydrogen backbone that, by 2030, will have 1,400 km of pipeline network. The network will link regional backbones, sizable industrial consumer groups, port facilities, storage facilities, and grids located outside of the Netherlands. The backbone is anticipated to contain repurposed gas infrastructure to a degree of 85%. Being strategically located in the heart of the European H2 infrastructure, "The Netherlands has a large potential of reducing carbon emissions by transitioning from being Europe's second largest hydrogen producer, with an annual production of over 9 million m3 of (fossil based) hydrogen, to becoming a hub for clean hydrogen." (NL Hydrogen Guide, 2022)
More importantly, The Netherlands will play a vital role in the EHB because of its strategic location at the heart of the European hydrogen infrastructure proposed by 11 European grid operators.

Spatial Implications

Luxenbourg as a reference

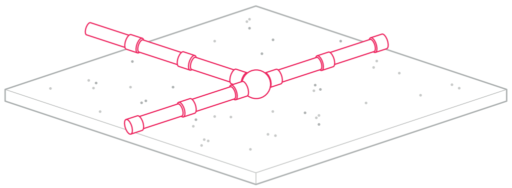
When analyzing the EHB project, it seemed flawless in most of the aspects. However, making a new economic paradigm and calling it the “Hydrogen ecosystem” (NL Hydrogen Guide, 2022), while heavily relying on importing half of this hydrogen from outside Europe, is a huge problem regarding resilience. Consequently, a question was raised: What would it take for Europe to be able to generate all of the green hydrogen locally?

As a result, a quantitative research was done to clarify the efficiency in energy production per renewable type (windmills and solar panels). That is to answer the question: What is the area needed to locally produce the 20 million ton of Hydrogen? The outcomes were unexpected. To help understand and compare the results on a European scale, we compared the area needed with the size of Luxembourg. The result was that we would need five times the area of Luxemburg filled with solar panels to produce the 20 m/t of H2, or ten times the area of Luxemburg filled with offshore windmills in the North sea, or twenty times the area of Luxemburg filled with onshore windmills. In conclusion, the goal of achieving self-sufficiency in renewable energy supply in Europe has notable spatial implications when relying only on centralized energy production.



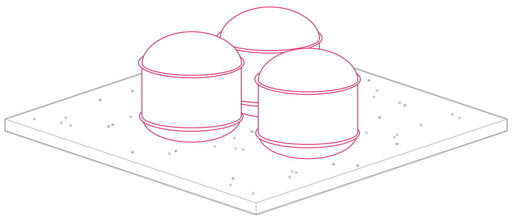
Luxembourg = 2'586 km²

Infrastructure



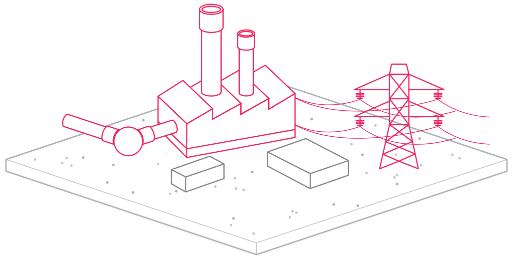
Pipelines

The Hydrogen backbone is expected to connect hydrogen production facilities with demand centers across Europe, covering a distance of approximately 23,000 km. 80% of the pipelines are repurposed from the European gas grid.



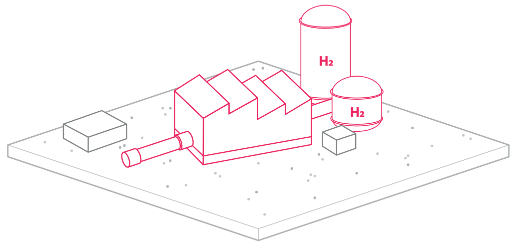
Storage

Storage facilities need to be provided across Europe to store the over-produced hydrogen. The storage can be provided in the form of tanks or empty gas fields.



Power Plants

As the conversion of hydrogen to electricity for feeding into the grid becomes more widespread, there will be a growing demand for additional power plants to handle the increased capacity.



Electrolyzer

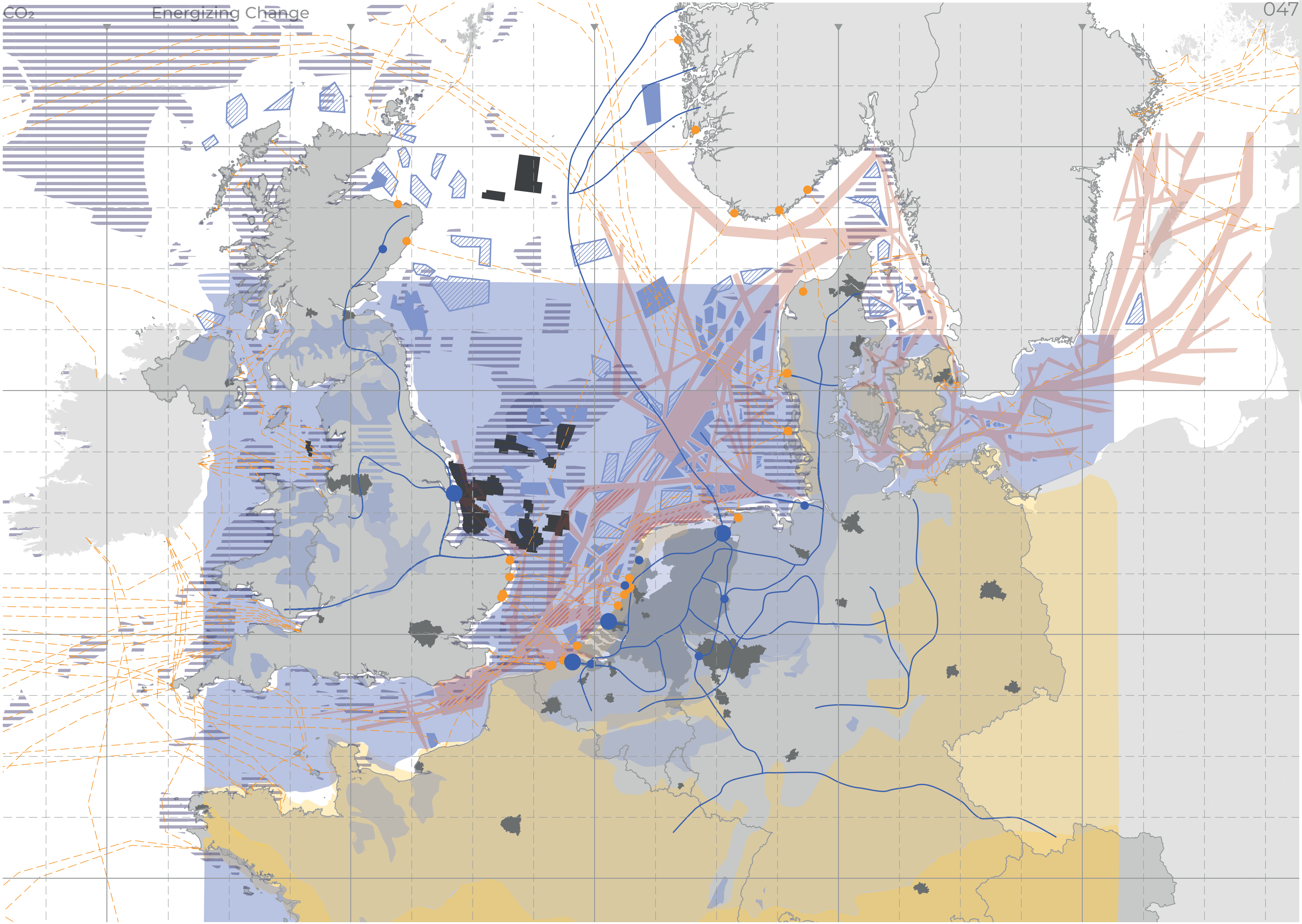
One of the most critical spatial implications of the hydrogen economy is the need to establish electrolyzers, which are facilities that utilize renewable energy sources to extract hydrogen from water.

V _Quick Synthesis

The Synthesis of it All

By overlaying all the data that was researched, the complexity of the North-West European context becomes clear. each one of these potentials/problems has its own embedded system on land, which in its tern overlap with other complix systems. This makes the mission of energy transition more challenging.

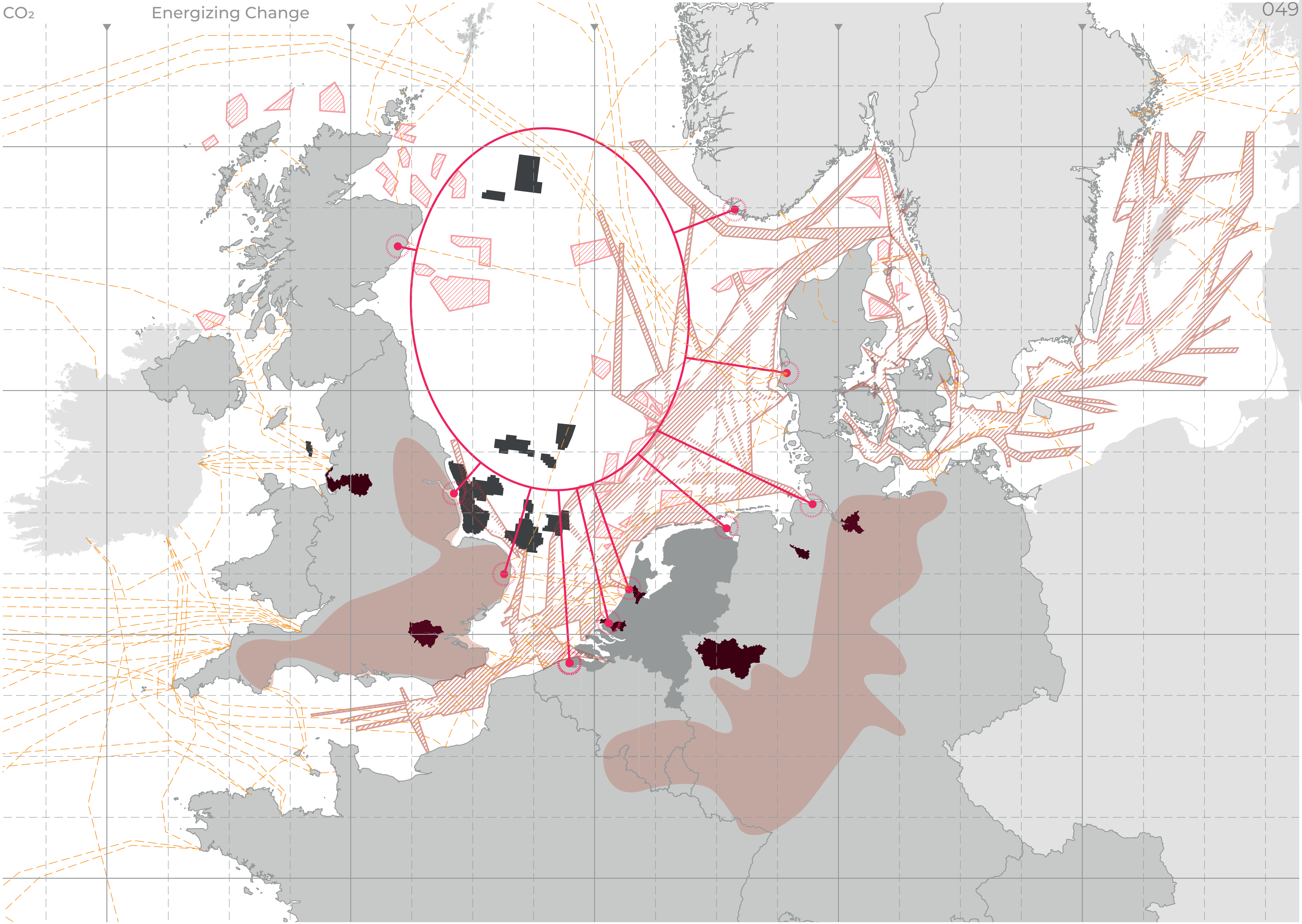
Landing Points
H2 Hub
H2 Backbone
Intercontinental Cables
Protected Areas
Wind Potential
Solar Potential
Wind farms
Proyected Windfarms (2030)
Shipping Routes
Ships Parking Sites
Carbon Storage Sites
Cities



Posibilities and Opportunities

Upon examining the existing conditions of the region with respect to its renewable energy potential and the policies in place to support the transition, as well as considering the challenges that may hinder progress, it becomes clear that accelerating the transition towards a sustainable energy system will require regional collaboration to harness the available potential and address the obstacles.

Key Landing Point
North Sea Wind Circle
Electricity Grid
Shipping Routes
Proyected Windfarms (2030)
Construction Site
High Energy Consimtion
Airports



What Can We Do...?

Possible Solutions

While the solution to the issue of transitioning from fossil fuels to renewables may appear straightforward -- simply remove the fossils and install renewable energy sources -- it is in fact a complex matter. The existing fossil fuel infrastructure, which has been in place for decades and is closely tied to our daily lives, is a significant source of CO2 emissions. Furthermore, numerous stakeholders are involved in this transition, and each is primarily focused on their own interests. This raises the question: what steps can we take to address this challenge?

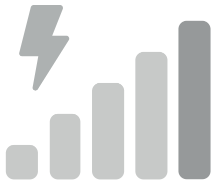
3 Spatial Vision

VI _Two Main Scenarios

Centralized

Maximum use of Potential areas

By exploiting the renewable energy production potentials to the extreme, the energy production system becomes sustainable in terms of land use.

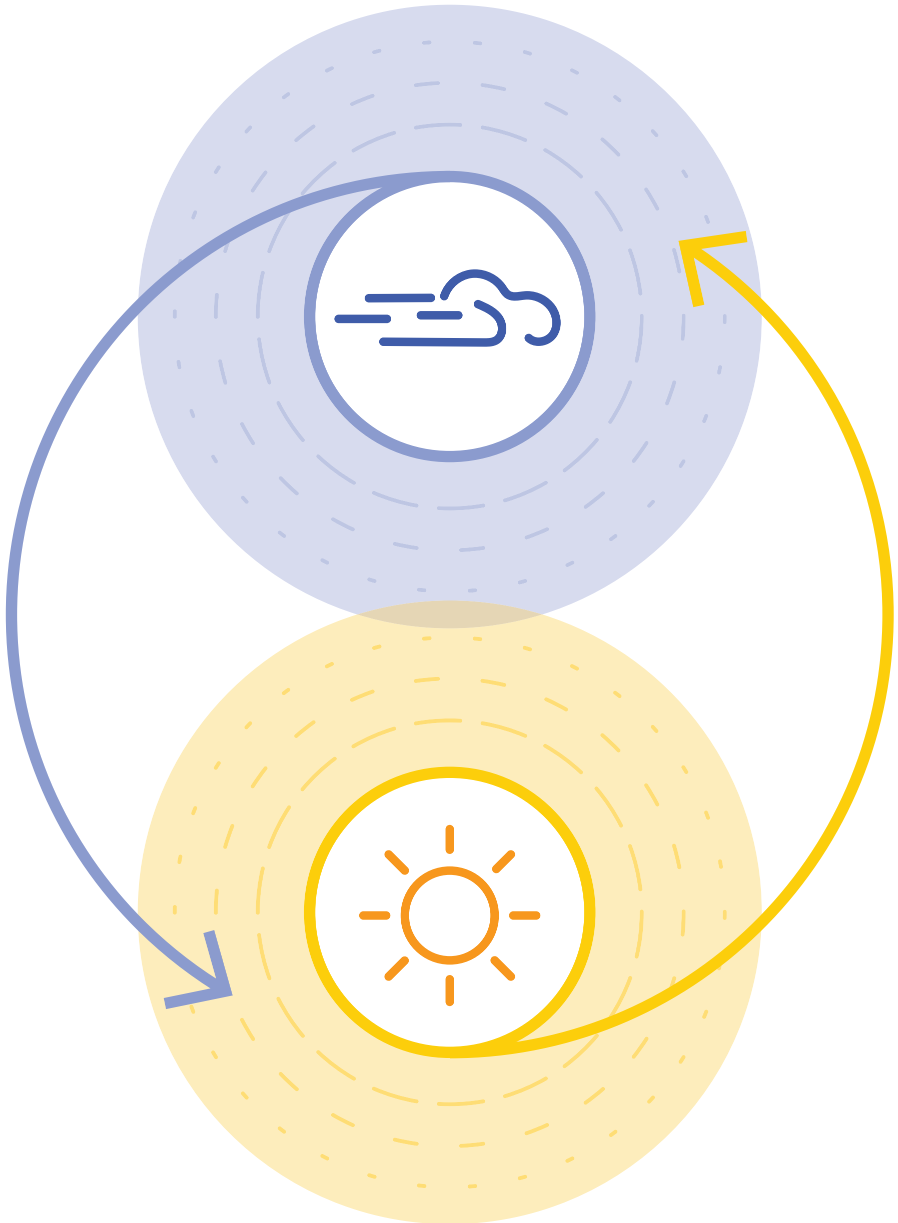


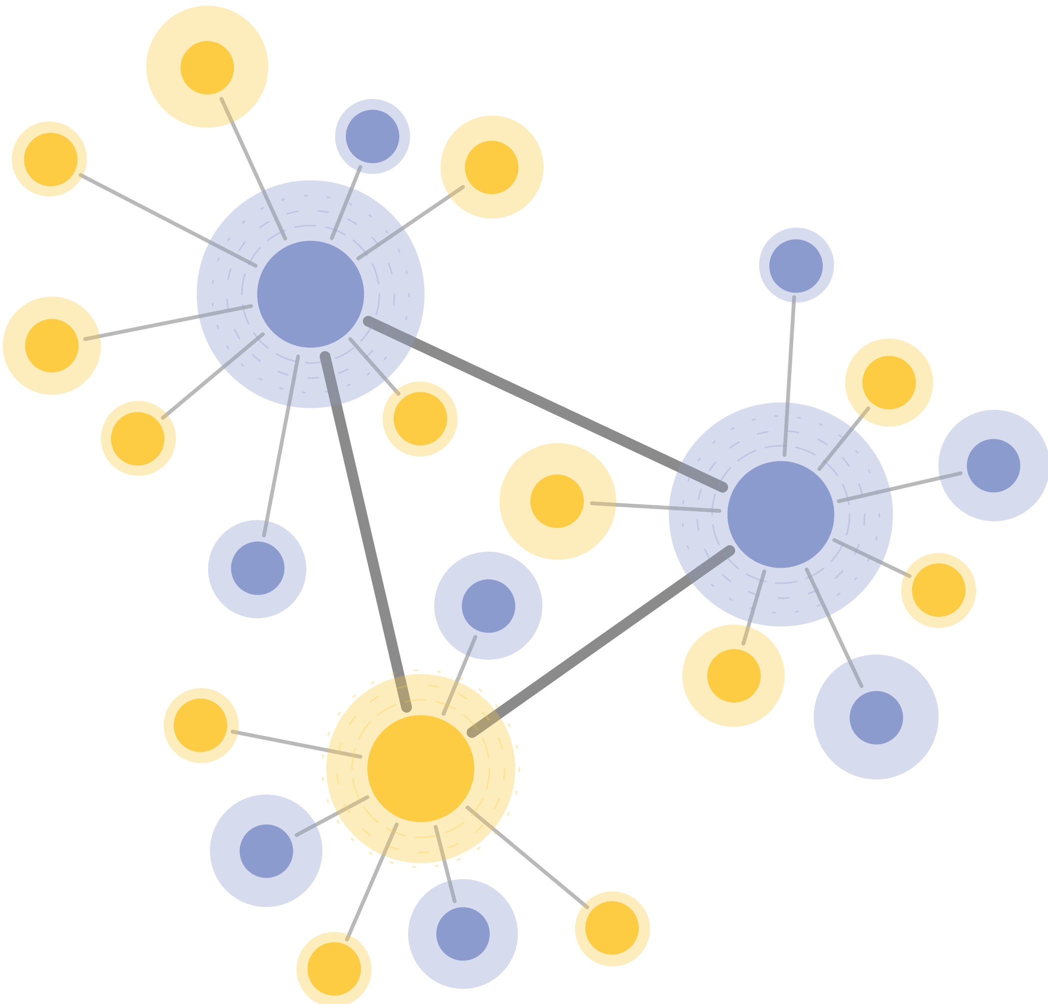
Regional & Technological Development

By redesigning the now inefficiently used North Sea for wind energy production because it poses great potential, the energy production system will become more efficient.

Cross-border Planning

International collaboration regarding the energy transition is retrieved by using cross-border planning to create the centralized system.

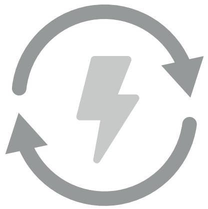




De-Centralized

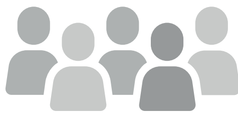
Risk Management

Because of local and efficient energy production and distribution, energy security is achieved. Centralized systems are risky, because minor crashes could have big consequences. With the decentralized system, this is not the case because multiple energy production points are connected to the same grid.



Circularity

By producing and consuming energy locally, citizens are independent of big companies in terms of energy. A system that supports and promotes individual energy production thus allows for independence.



Citizen Participation

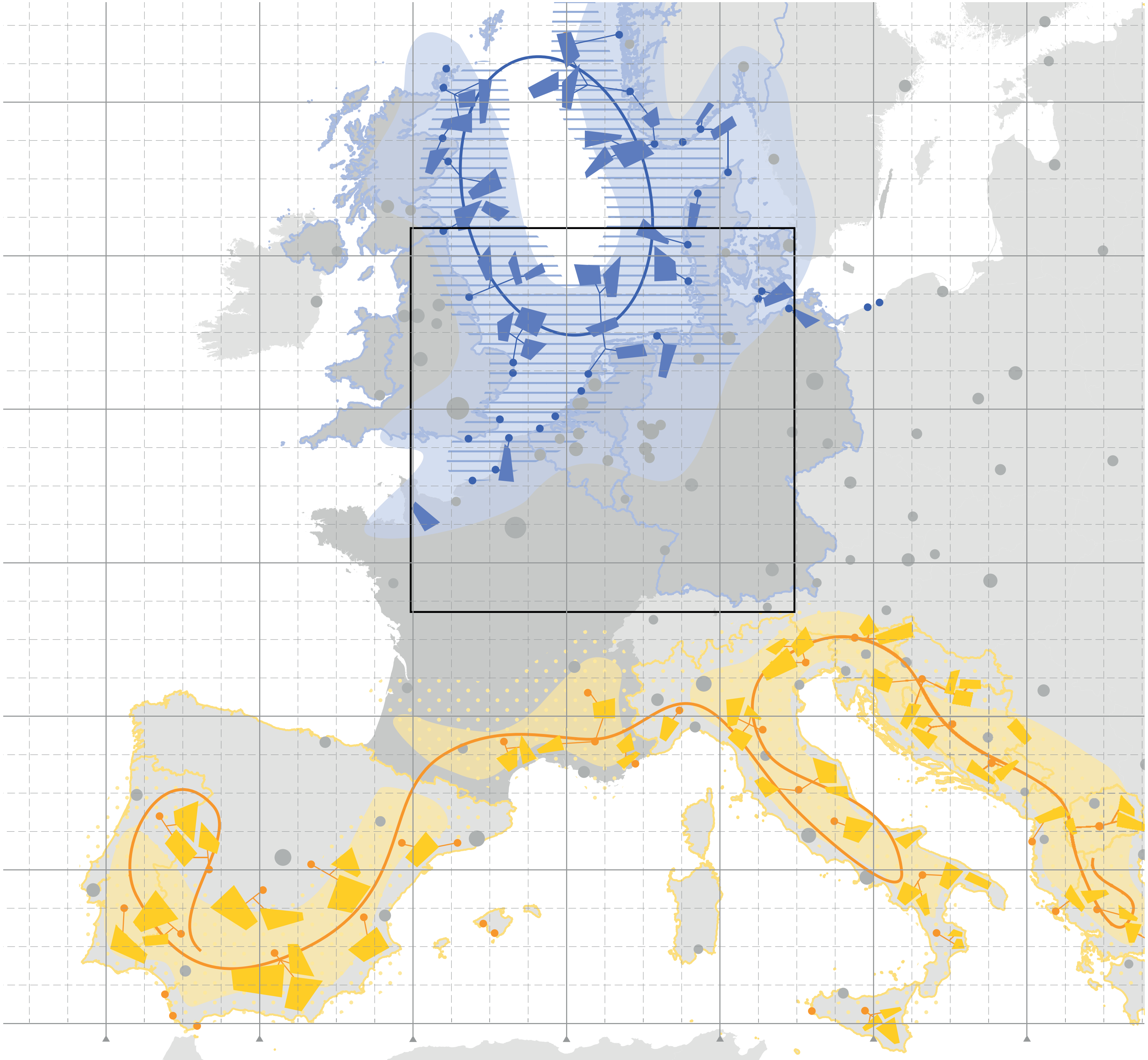
By implementing local strategies, collaboration practices and stakeholder analysis into the design process, citizen participation can be achieved, which adds social justice to the energy transition.

Centralized

Energy Centers

With the centralized scenario, the renewable energy production potentials are explored to the extreme. Combining the wind potential in the North Sea and the solar potential in the southern regions of Europe, results in a centralized system that provides the whole of Europe with renewable energy. To distribute this energy, it is transported in the form of hydrogen. Big wind farms will be installed along a ring in the North Sea and solar fields will be implemented in the southern regions. Cities in Europe are provided with a connected electricity and hydrogen pipeline network, storage facilities and electrolyzers, forming a continuous grid. This scenario builds upon the ongoing European Hydrogen collaboration deal (EHB) that is explained earlier in this report. Thus, 80% of this network is repurposed from the existing gas pipeline network and only 20% of its infrastructure will be constructed. The energy production per potential fluctuates through the year. To compensate for a lack of wind energy in the summer, the excess solar energy of the south is exported to the northern regions and vice versa.

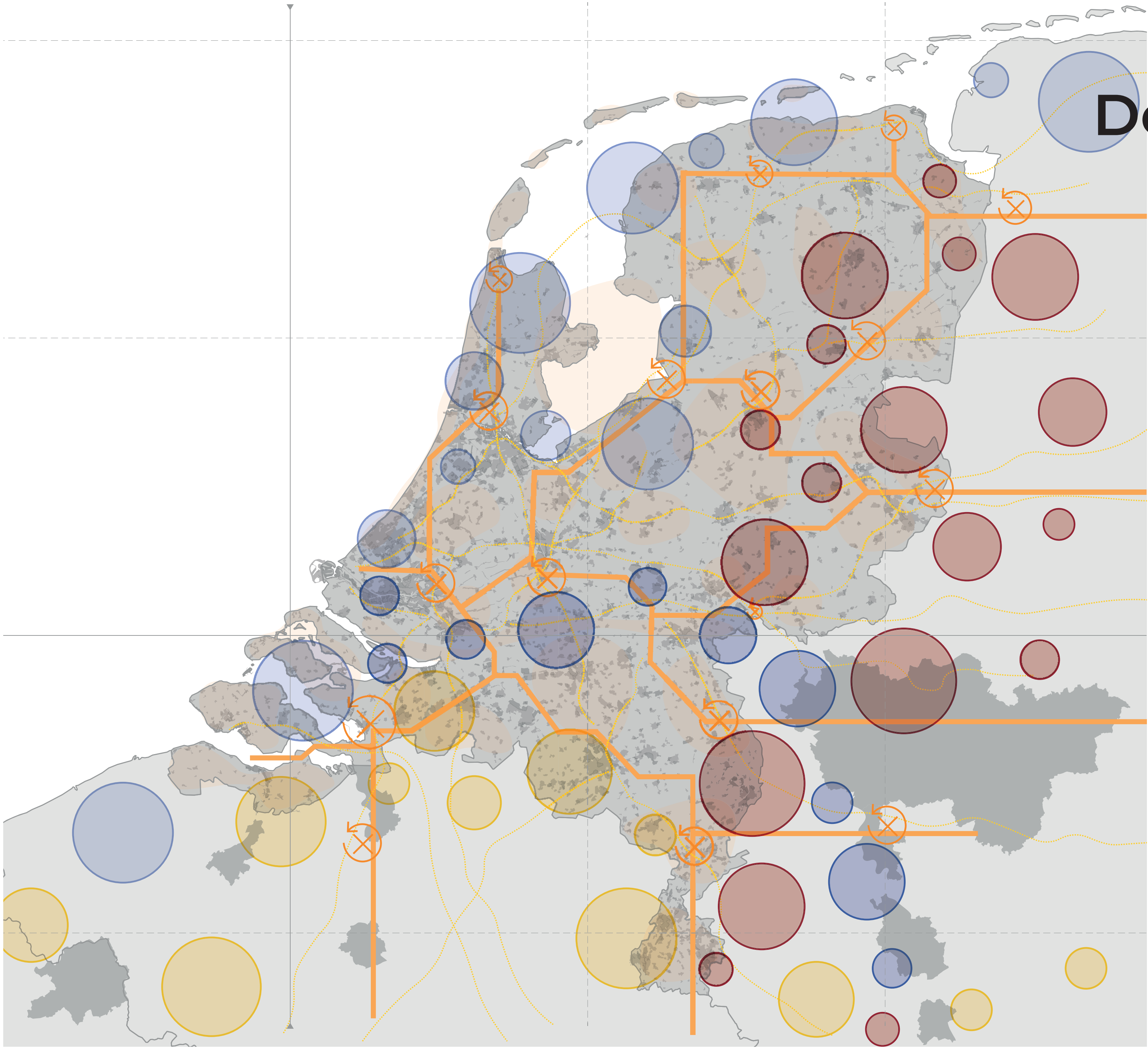
Cities
Landing Points
Colectors
Main infrastructure Line
Main infrastructure Line
Wind Potential Area
Wind farms
Solar potential Area
Solar farms



De-Centralized

Distributed Network

With the decentralized scenario, the energy production system is redesigned. Instead of a centralized system with high energy loss due to import and export, the decentralized system focuses on local energy production and distribution.

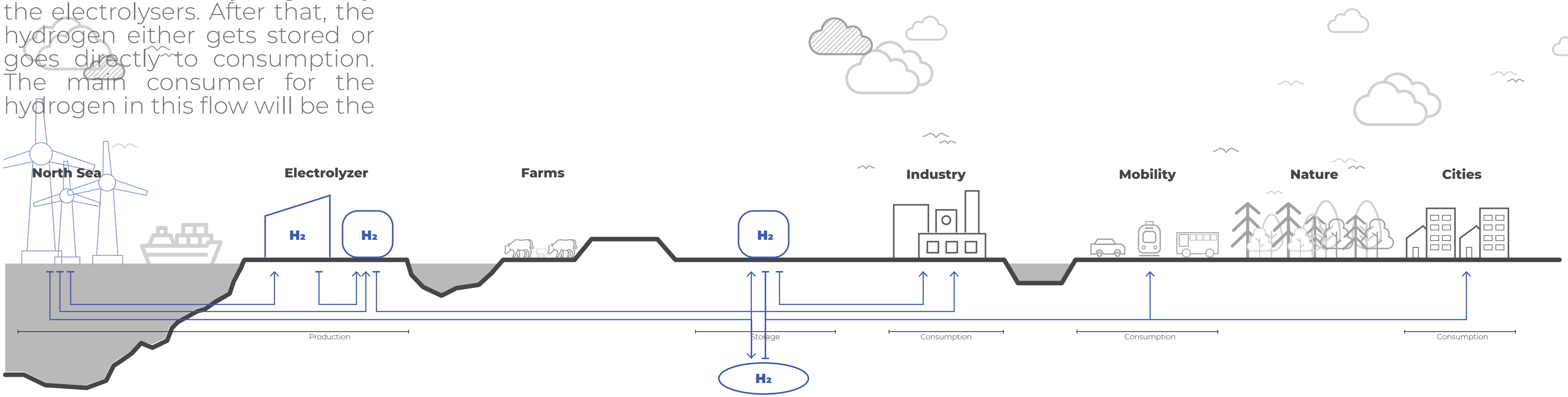


Transformers
Wind Focused Clusters
Hydro Focused Clusters
Geothermal Focused Clusters
Solar Focused Clusters
Main Electricity Highway
Electrcity Grid
Cities

Centralized

Long Distribution Line

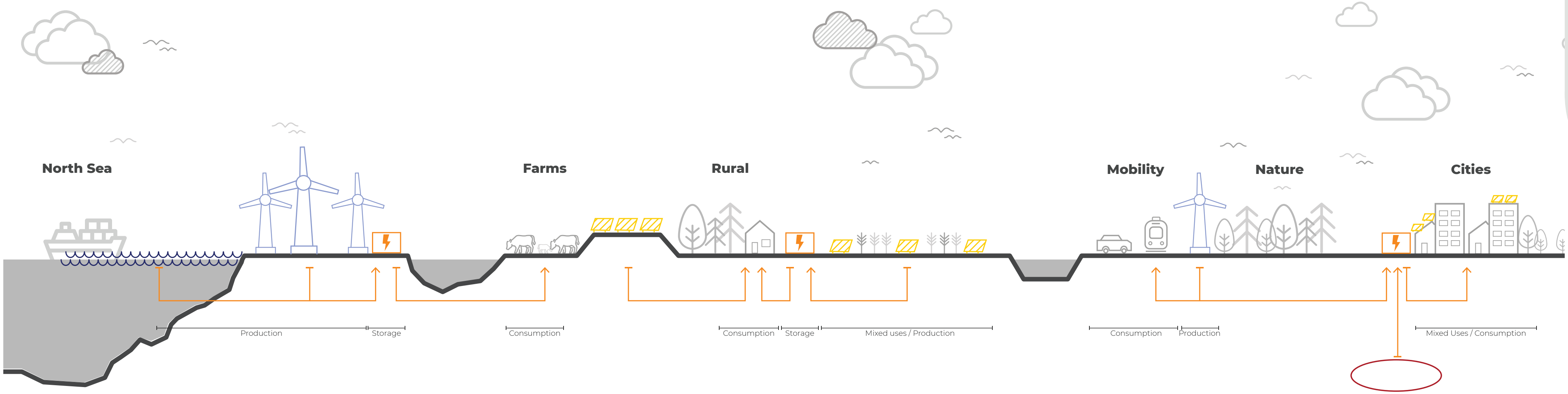
We can see from the energy flow section of the centralized energy production scenario, that the flow chain is quite long, and it is mainly provided from the offshore wind ring in the North Sea. The energy arrives to landing points and gets transformed to Hydrogen by the electrolysers. After that, the hydrogen either gets stored or goes directly to consumption. The main consumer for the hydrogen in this flow will be the industry. In this scenario each city has its own power plant that transforms the Hydrogen to electricity.



De-Centralized

Short Independent Grids

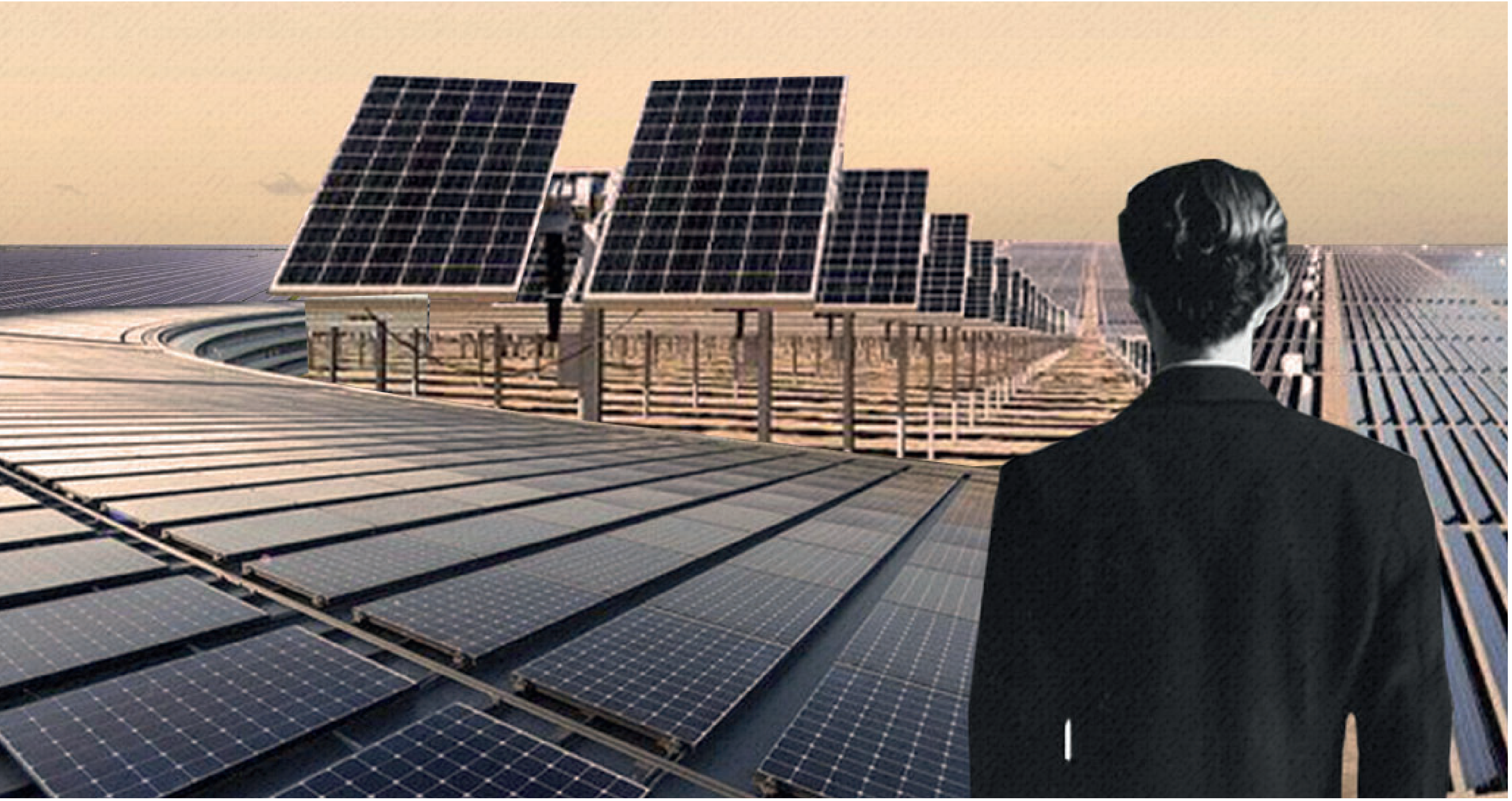
In the de-centralized energy production scenario, the energy chains are shortened. Each one of the consumers is producing their own energy in the form of electricity, and based on the local potential of the location. The over-produced energy can also be stored.



Centralized

Pros

In order to come to an efficient energy transition, international collaboration is needed. Cross-border planning of a collaborative centralized system stimulates this collaboration and provides the economical and political means to realize the transition. By working collaboratively, the produced energy can be distributed equally, which is socially just. Second, in order to be really efficient in energy production, the potentials of each region should be used to the maximum, so that no potential is lost. Lastly, because the centralized system is so extreme and works on the full scale of Northwest Europe, the future energy demand would be met. The constant production and distribution flows of energy would be enough to facilitate the needs of the full region.



Cons

On the big scale, from a top-down and analytic point of view, the centralized scenario seems very promising. With a centralized energy production and distribution system, the future energy demand of Northwest Europe can be met solely with the use of renewable energy. Energy production efficiency is maximized in this way. Energy distribution efficiency however, is not. Big import and export flows are needed, where a lot of energy losses happen. For this transportation system, huge cables, pipes, electrolyzers, transformers and distribution centers are needed. When looking at the implementation on the smaller scale, the scenario shows even more flaws and implications. Grand areas of land and sea would have to be filled with wind turbines or solar fields. Spatial quality on the local scale would be lost and countless people would lose their land, which causes injustice. Nature would suffer from the construction sites as well. The same accounts for the space that is needed for the infrastructure that needs to be built for the electricity and the hydrogen grid.

De-Centralized

Pros

In the decentralized approach, the energy flow is shortened because the production, distribution and consumption of energy happen locally. This represents circularity and efficiency, which is considered sustainable. Because the risk of a system collapse is low when there are more energy production points connected to the same grid, energy security and independence is achieved. Citizens can produce their own energy without relying on corporate companies. Because each implementation of a renewable energy production site is designed for the specific location where it is built, interests of local stakeholders are represented in the decentralized vision. This, together with citizen participation in a collaborative design process, adds to the social justice of the energy transition. In this way, spatial quality on the local scale can be maintained and natural areas can be preserved.

Cons

When looking at the local scale, the decentralized scenario shows great potential. The only downside is that the decentralized system might cause net congestion and a bottleneck issue already exists in the network, because the current electricity network cannot cope with this extra supply of energy. Therefore, the network would need to be expanded. When zooming out however, the system becomes less favorable. Firstly, the system would not support the full energy demand. Some areas pose less potential for renewable energy production or use more energy than they can possibly produce. Furthermore, on a bigger scale the system becomes chaotic. Because a collaborative bigger system is absent, organizational structures are difficult to establish. Next to this, the system relies a lot on subsidies from the government, since the big market with investing companies is not involved anymore.

4 Road-map

VII _The Social Aspect

Social Goals

Social Goals

This paragraph is to extensively emphasize the social aspects that are accomplished while combining the two scenarios. Firstly, by collaborating to produce energy at a North-West European scale, each country will have the opportunity to transition to green energy, even if it lacks the resources to do so independently. Furthermore, allowing for people's participation in the transition dialogue provides an opportunity for their voices to be heard, thus democratizing the transition process. Lastly, a bottom-up approach to transitioning is ensured, enabling individuals to take ownership of the process and achieve energy independence. This approach also provides them with the opportunity to secure their energy supply without relying solely on the electricity grid

Public Goods

In order to ensure a just transition, an integration between the social pros of each one of the scenarios is needed. By combining them, a list of public goods is created that ensures and promotes citizens' rights. The most vital one is "the right to clear air", which is ensured by decreasing the CO2 levels in the atmosphere by cutting off the use of fossils. Second, reducing the CO2 emissions would directly diminish the consequences of climate change, thus promoting "the right to a resilient climate". Additionally, making citizens feel secure in terms of energy availability, ensures the third public good which is "the right to an accessible energy system".

SDGs Goals

The SDGs stand for Sustainable Development Goals, which are a set of 17 goals established by the United Nations General Assembly in 2015 as part of the 2030 Agenda for Sustainable Development. The SDGs aim to address global challenges such as poverty, inequality, climate change, environmental degradation, and injustice. (UN, 2022). This integrated vision relates to several goals of the SDGs, and supports the global sustainable development through.

3_ Health & Well Being

3.9_ Reduce the number of deaths and illnesses from air, water and soil pollution

16_ Peace, Justice and Strong Institutions

16.3_ Promote the rule of law at the national and international levels and ensure equal access to justice for all.

17_ Partnership for the Goals

17.13_ Enhance global macroeconomic stability, including through policy coordination and policy coherence.
17.14_ policy coherence for sustainable development
17.16_ Global Partnership for Sustainable Development, complemented by multi-stakeholder partnerships that mobilize and share knowledge.
17.17_ promote effective public, public-private and civil society partnerships.
17.19_ build on existing initiatives to develop measurements of progress on sustainable development.

6_ Clean Water & Sanitation

6.3_ Improve water quality by reducing pollution, eliminating dumping release of hazardous chemicals.
6.6_ protect and restore water-related ecosystems.

7_ Affordable & Clean Energy

7.1_ Universal access to affordable, reliable energy services.
7.2_ increase substantially the share of renewable energy.
7.3_ double the global rate of improvement in energy efficiency.
7.a_ international cooperation to facilitate access to clean energy research and technology.
7.b_ expand infrastructure and upgrade technology for supplying modern and sustainable energy services.

13_ Climate Action

13.1_ Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters.
13.2_ Integrate climate change measures into national policies, strategies and planning.

8_ Decent work & Economic Growth

8.2_ Achieve higher levels of economic productivity through diversification, technological upgrading and innovation.
8.3_ Promote development-oriented policies that support productive activities, decent job creation.

9_ Industry, Innovation & Infrastructure

9.1_ Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure.
9.4_ By 2030, upgrade infrastructure and retrofit industries to make them sustainable.

11_ Sustainable Cities & Communities

11.4_ Strengthen efforts to protect and safeguard the world's cultural and natural heritage.
11.6_ reduce the adverse per capita environmental impact of cities, including air quality.
11.a_ Support positive economic, social and environmental links between urban, peri-urban and rural areas.
11.b_ substantially increase the number of cities adopting and implementing integrated policies towards inclusion, mitigation and adaptation to climate change.

12_ Responsible consumption & Production

12.2_ achieve the sustainable management and use of natural resources.
12.5_ substantially reduce waste generation through prevention, reduction, recycling and reuse.
12.6_ Encourage companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.
12.8_ ensure that people everywhere have the relevant information for sustainable development.
12.c_ Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption.

Stakeholders

Ecology Advocators

Industry

The Port of Rotterdam is one of the biggest industry sites in Northwest Europe. Different companies with their production and distribution sites are located here, the most prominent of which is the oil industry that produces energy in the refineries. Some of those companies (such as Shell) are interested in the renewable energy transition, because they have already invested in hydrogen production sites. Others are against the transition, because it would mean that the business would have to invest a lot of money into the transition, would have to move to another location or would have to close. Some of those companies have a lot of power, because they play a big role in the economic welfare of the country. Those companies need to be convinced to contribute and invest in the energy transition via policies, restrictions and subsidies.

Farmers

The agriculture sector plays an important role in the renewable energy transition, because of its historical involvement in managing key resources, particularly land (Sutherland et al., 2015). Therefore, farmers are probably not interested in the energy transition because they do not want to give up their land for renewable energy production sites. They also do not want to invest in it, if it is not profitable enough (in the short term). The farmers need to be convinced to cooperate, because of the power they have by owning large plots of land. This can be done by means of providing subsidies and setting new restrictions and rules for the use of fossil fuel energy in the farming sector.

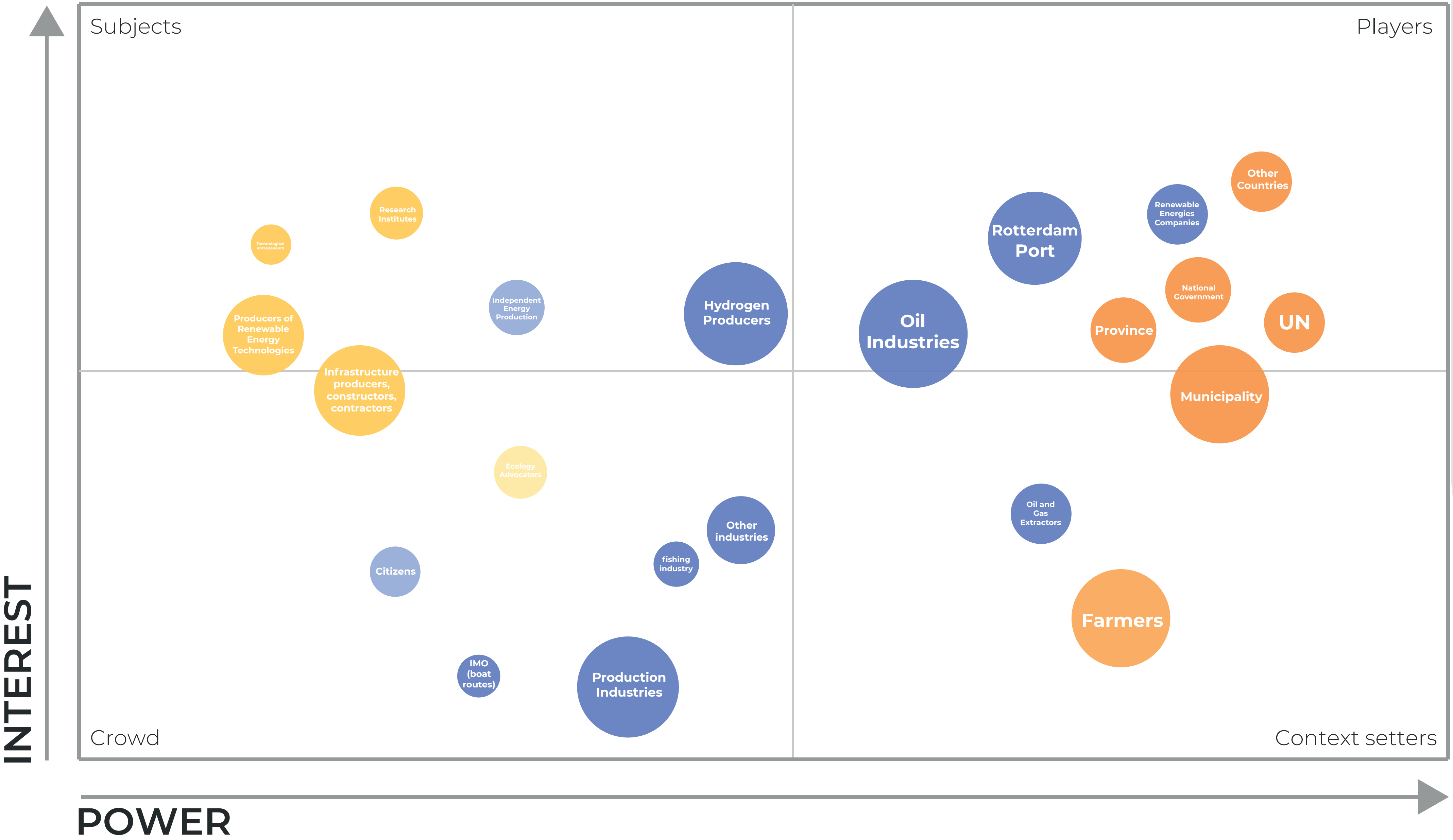
Governance

The government of the Netherlands with its institutions is one of the vital stakeholders regarding the transition. The Dutch government has set ambitious goals for energy transition, with the aim of achieving a fully carbon-neutral economy by 2050. To achieve this, it has implemented a range of policies and initiatives aimed at promoting renewable energy, reducing carbon emissions, and improving energy efficiency. (Schone energie voor iedereen, 2020). Due to their ability to pose financial and political means to set policies, hand out funds, fines and set restrictions, the government has a lot of power. In this project, the already existing policies and the new established ones will be used as a shaping instrument to support the transition.

Citizens

Individual energy production can lower the energy bill, which could be a reason for citizens to be interested in the energy transition. However, because investing in renewable energy production is expensive and little is possible on the small scale of a single house, some citizens may not be interested to contribute. Citizens possess little power on their own, but they can be convinced to contribute to the energy transition via subsidies.

Companies


Subjects
Players
Crowd
Context setters
INTEREST
POWER
Research Institutes
Producers of Renewable Energy Technologies
Infrastructure producers, constructors, contractors
Independent Energy Production
Hydrogen Producers
Ecology Advocators
Citizens
IMO (boat routes)
Production Industries
fishing industry
Other industries
Oil Industries
Rotterdam Port
Renewable Energies Companies
Other Countries
National Government
Province
UN
Municipality
Oil and Gas Extractors
Farmers

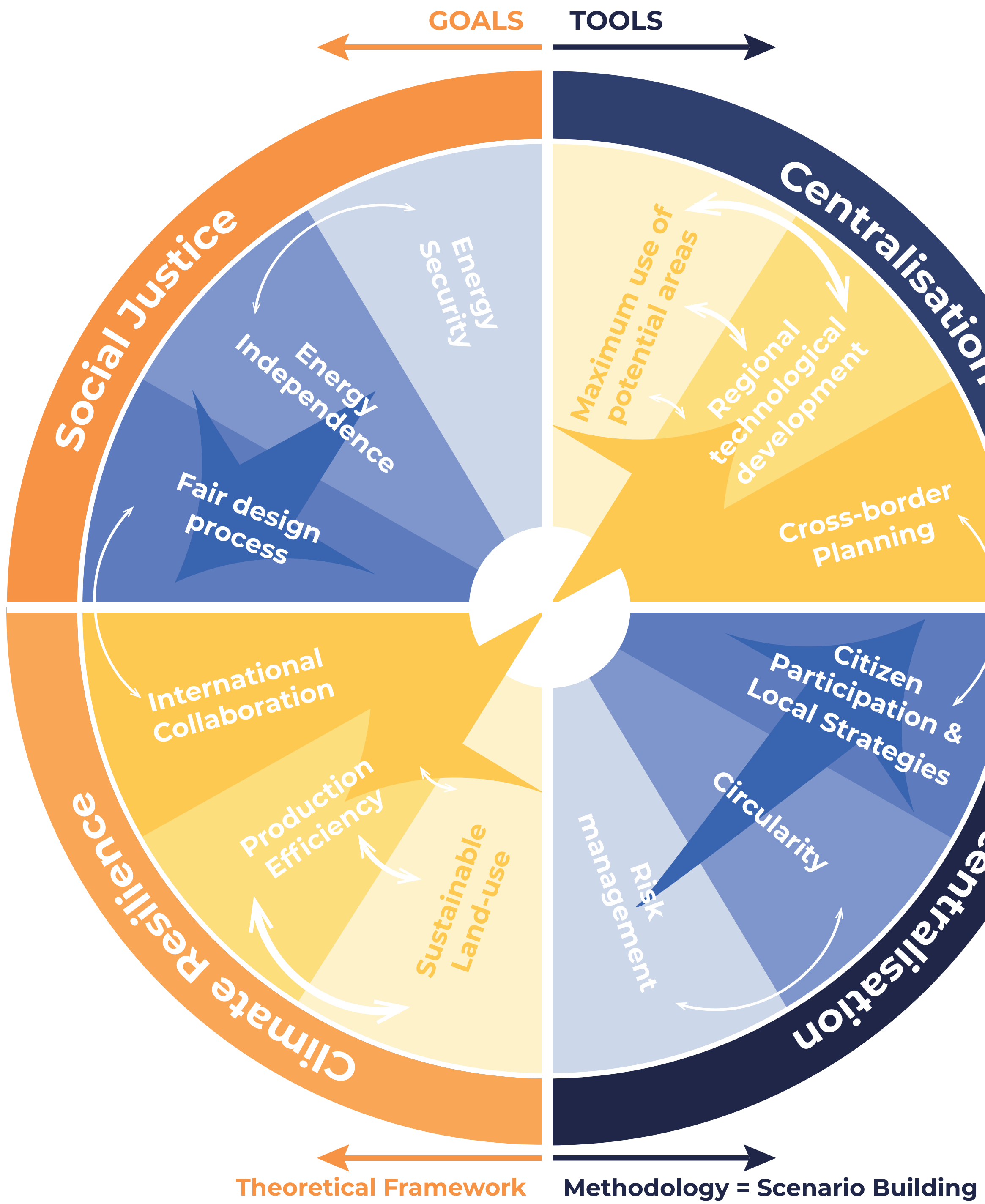
Finding a Middle Ground

Each scenario has its qualities and implications, that also differ per scale. This leads to a spiraled design process when trying to find the best balance between the two in a third scenario: the integrated vision. This integrated scenario is envisioned on both the scale of Northwest Europe and the South-Holland scale of the focus area, to represent implementations on the bigger and the smaller scale.

The implemented centralized system contains solar fields in southern regions, a ring of wind turbine farms in the North Sea and a hydrogen network between big cities in Northwest Europe. Harbors surrounding the North Sea contain landing points for the wind energy and thus form hydrogen hubs that feed the system that provides energy to big consumers like industry sites and big cities.

The decentralized system is implemented locally, to reduce the energy demand, use local potentials and prevent energy losses due to transportation. Spatial quality on the local scale is maintained and social justice is achieved by using local strategies and citizen participation processes.

The goals and tools used for the integrated vision are visualized in the conceptual framework.

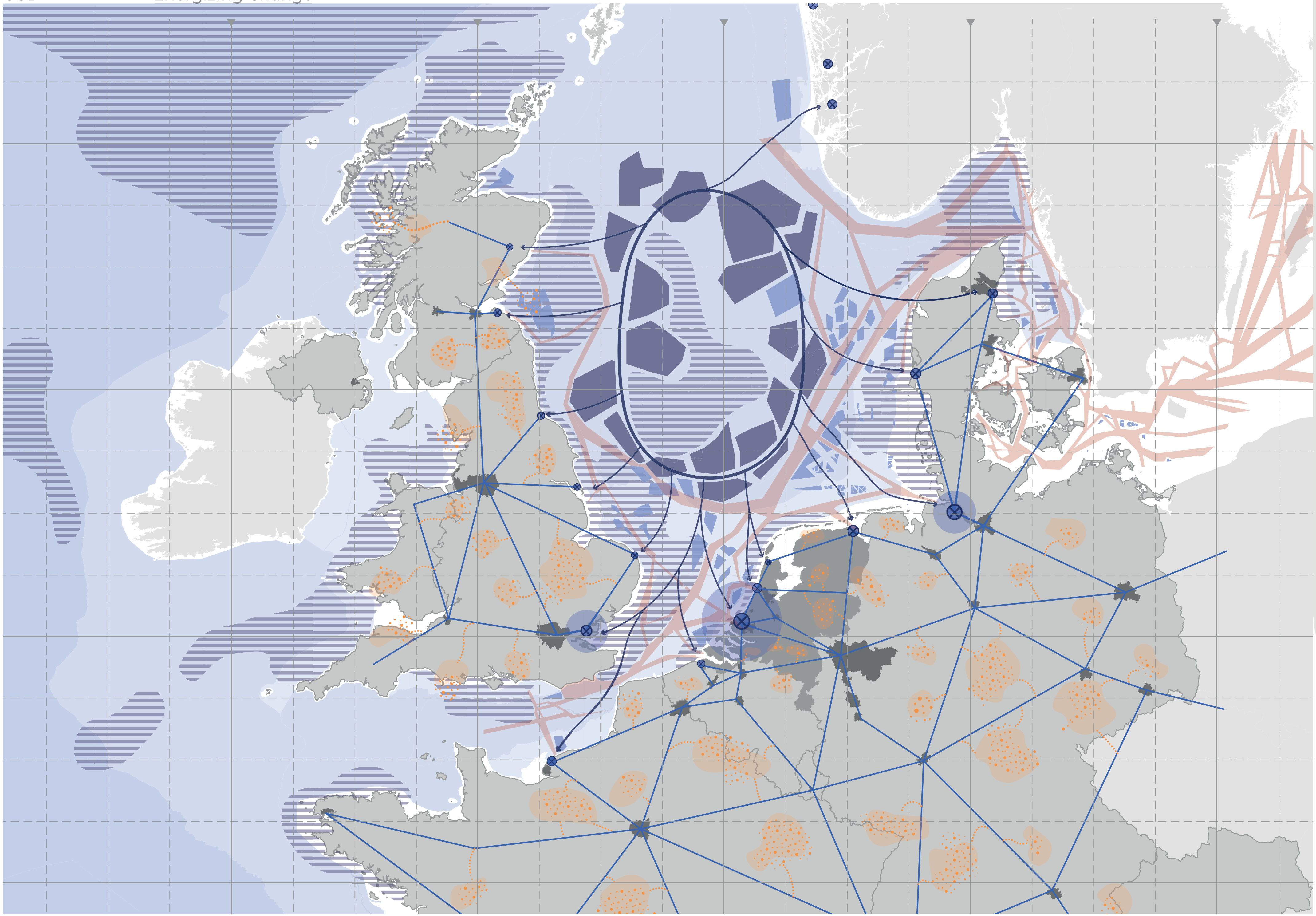


Tools & Goals

The conceptual framework companies both the theoretical framework and the methodology that was used. The Theoretical framework represents the two main aims and pillars of this project which are climate resilience and social justice. Each of these aims is reached by accomplishing three main goals. Furthermore, The methodology part represents the tools that were used in order to reach the desired goals. These tools were the two main scenarios that were experimented with in this report. The centralized scenario contributes to the aim of climate resilience, while the decentralized scenario helps to reach the goal of social justice.

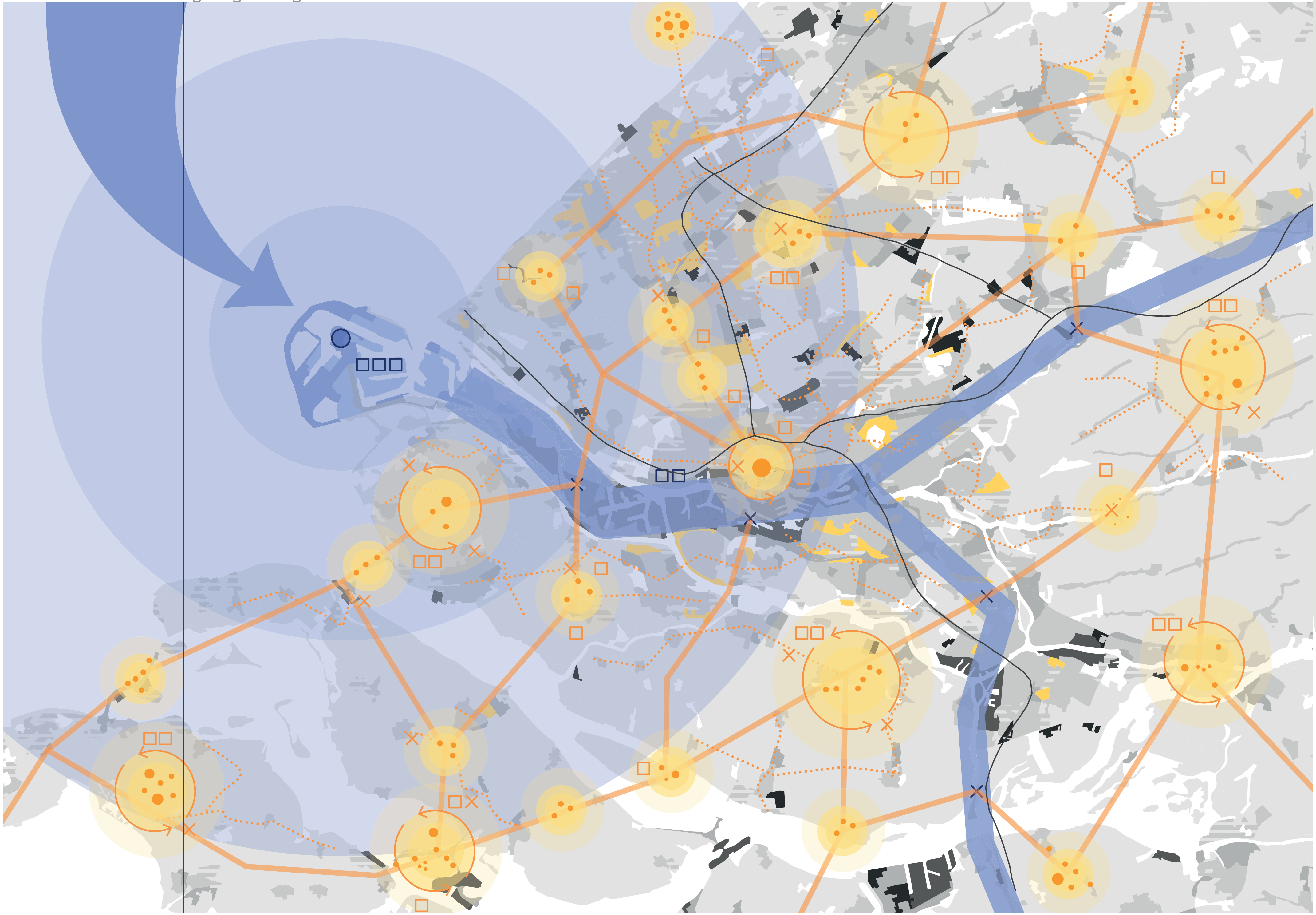
VIII _A Vision
...For North West Europe

Landing Point
Mid-voltage Cabeling
H_2 Backbone
Wind Circle Cabeling
Decentralized Clusters
Shipping Routes
Wind farms
North Sea Wind Circle
Maritime Protected Areas
River plumes
Coastal
Shelf
Oceanic
Cities



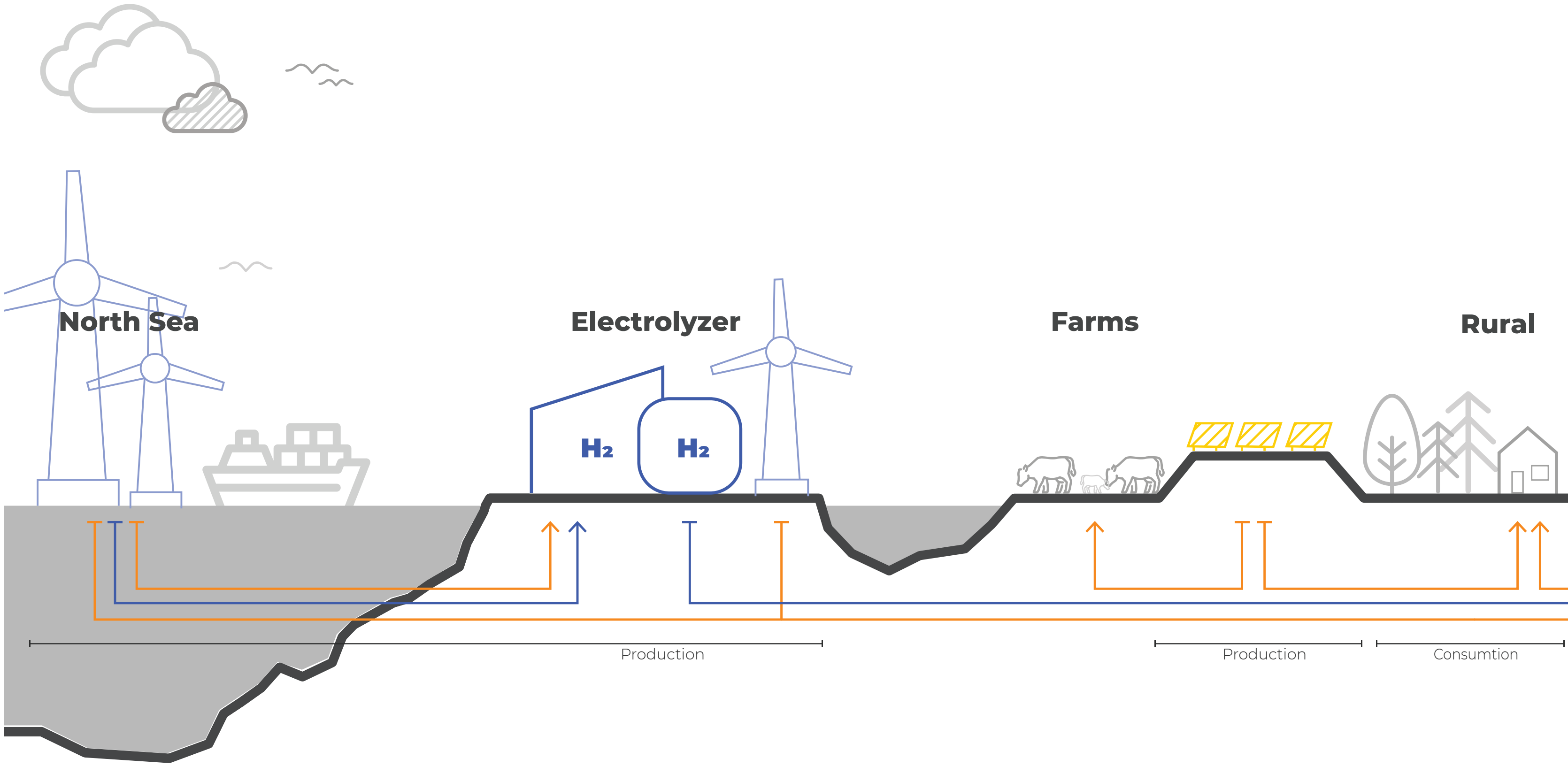
...For South Holland

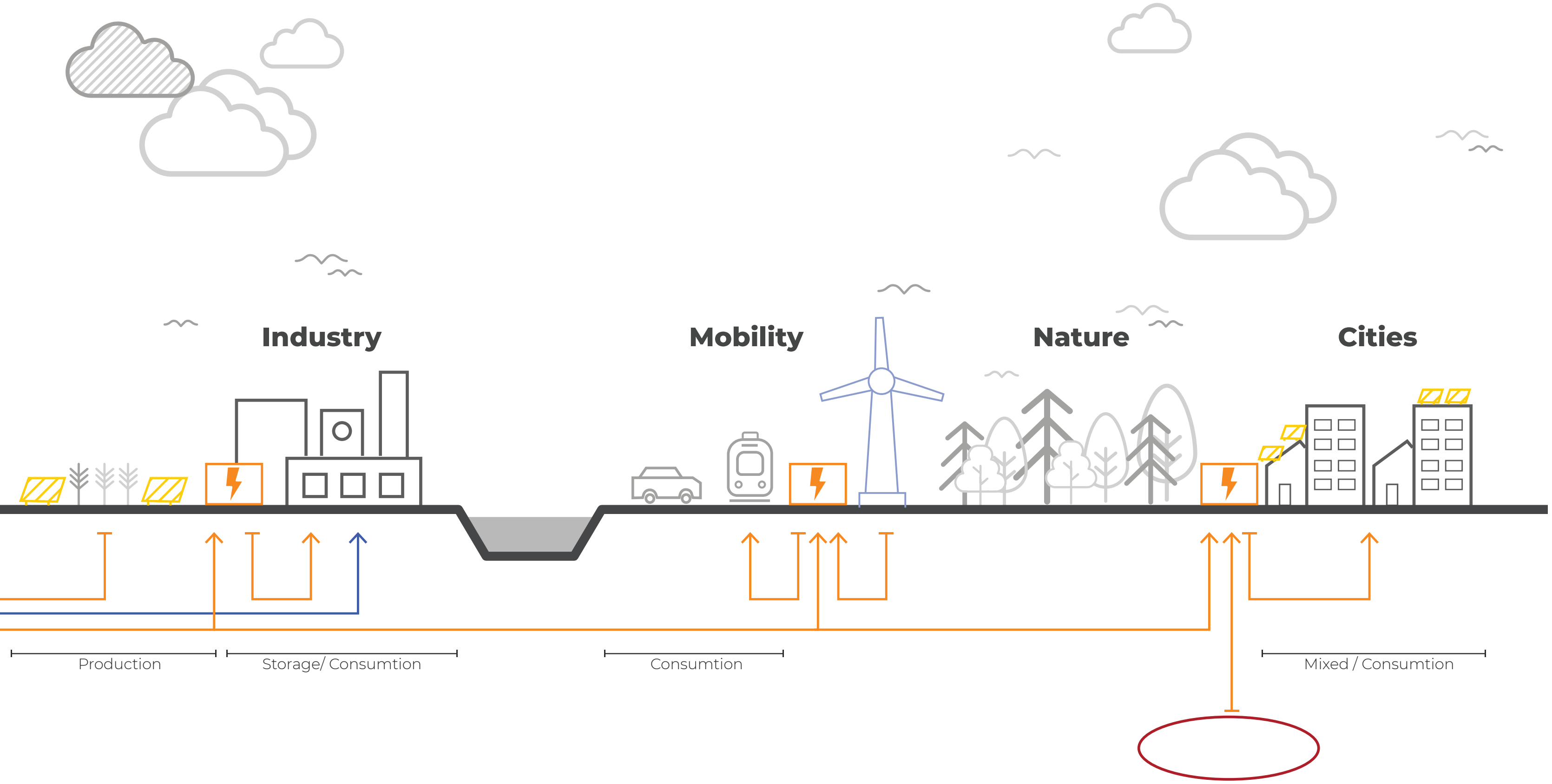
Power Plant
H_2 Storage
Bateries
Transformers
Railways
Electricity Grid
Clusters
H_2 Backbone
Urban Parks
Urban Landscapes
Intense Urban Landscapes
Port
Building Sites



...For North West Europe

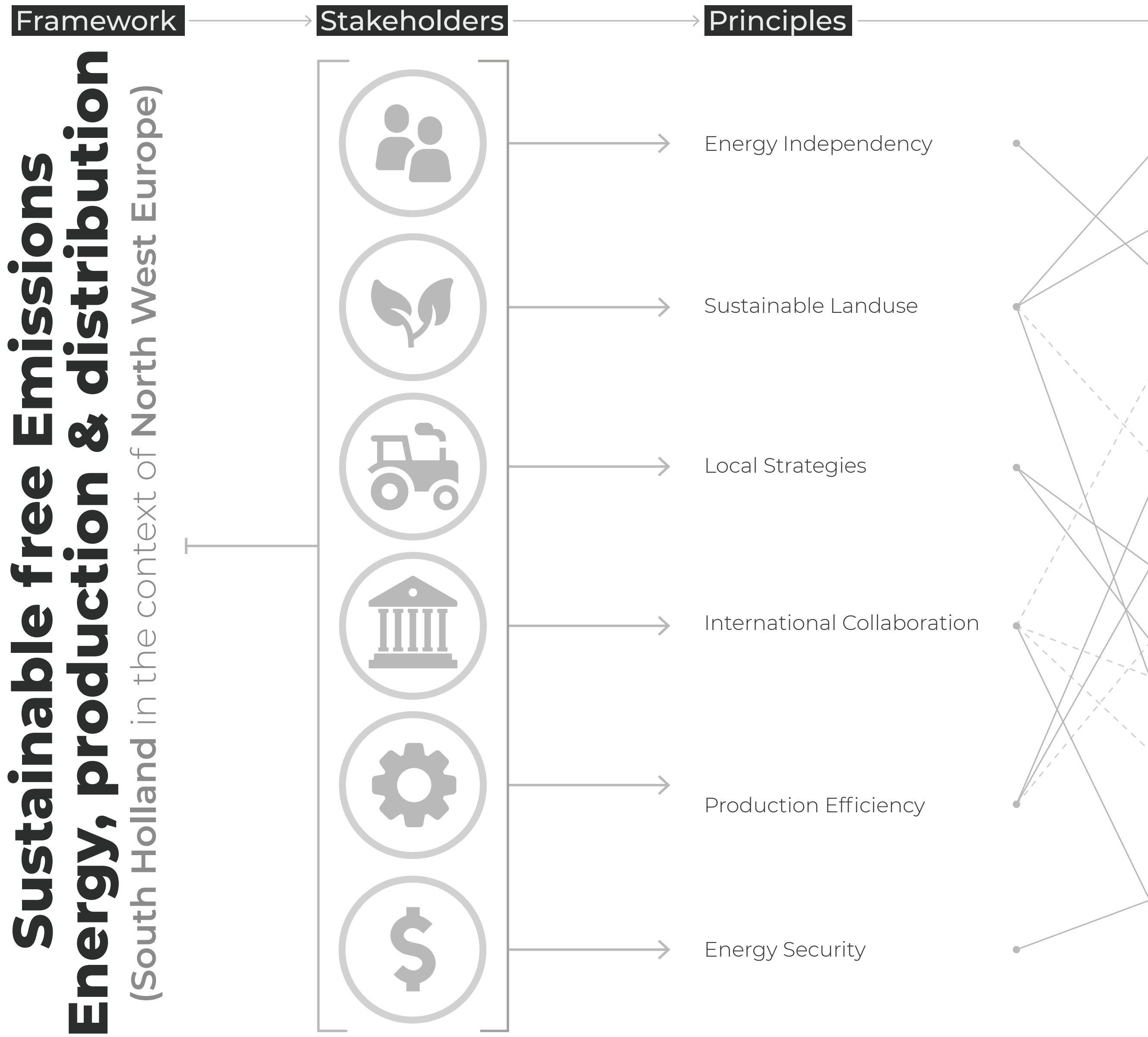
When integrating the two energy production scenarios, the main energy flow of hydrogen gets supported by the secondary energy flow of electricity. The supportive network can give back energy to the main network.

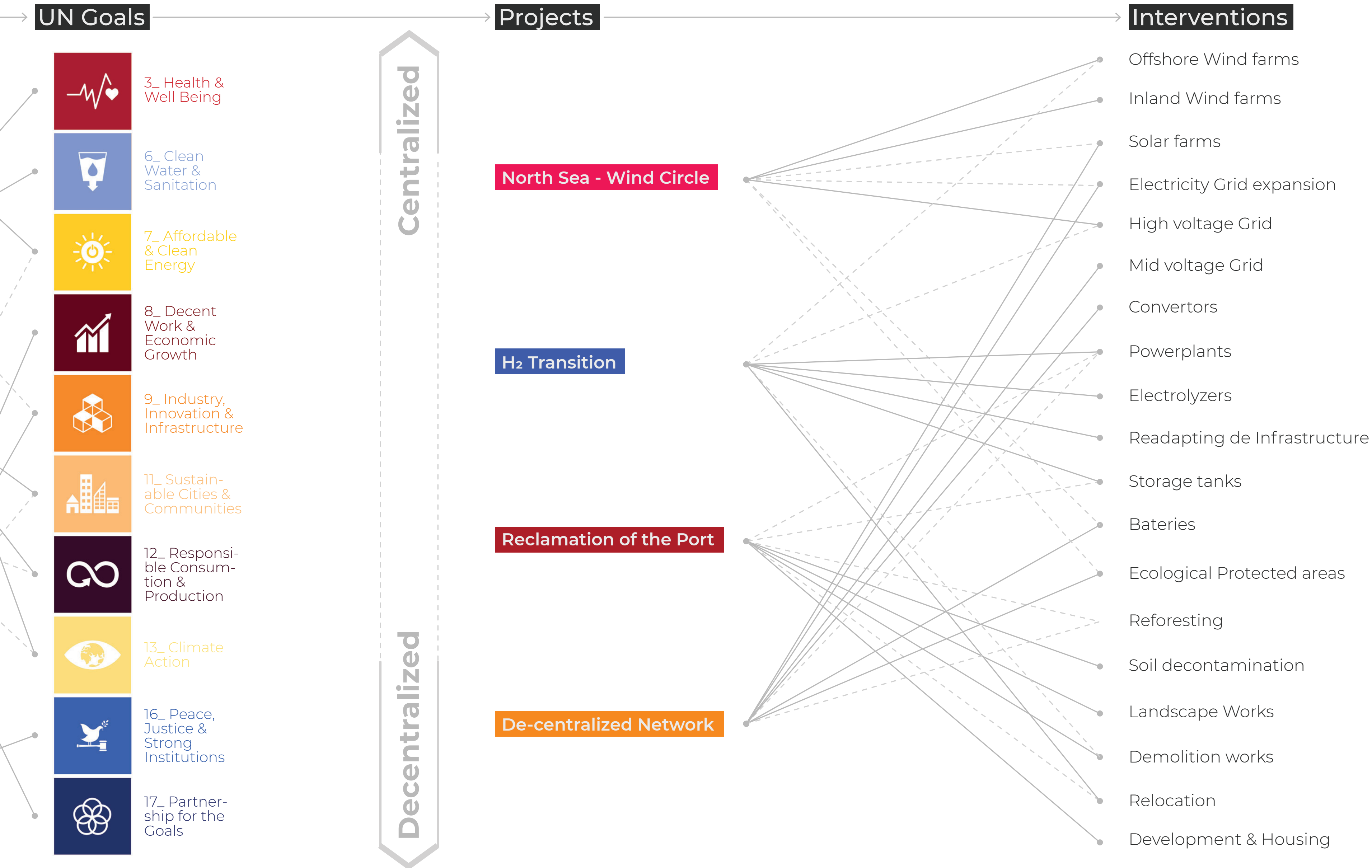




Industry
Mobility
Nature
Cities
Production
Storage/ Consumtion
Consumtion
Mixed / Consumtion

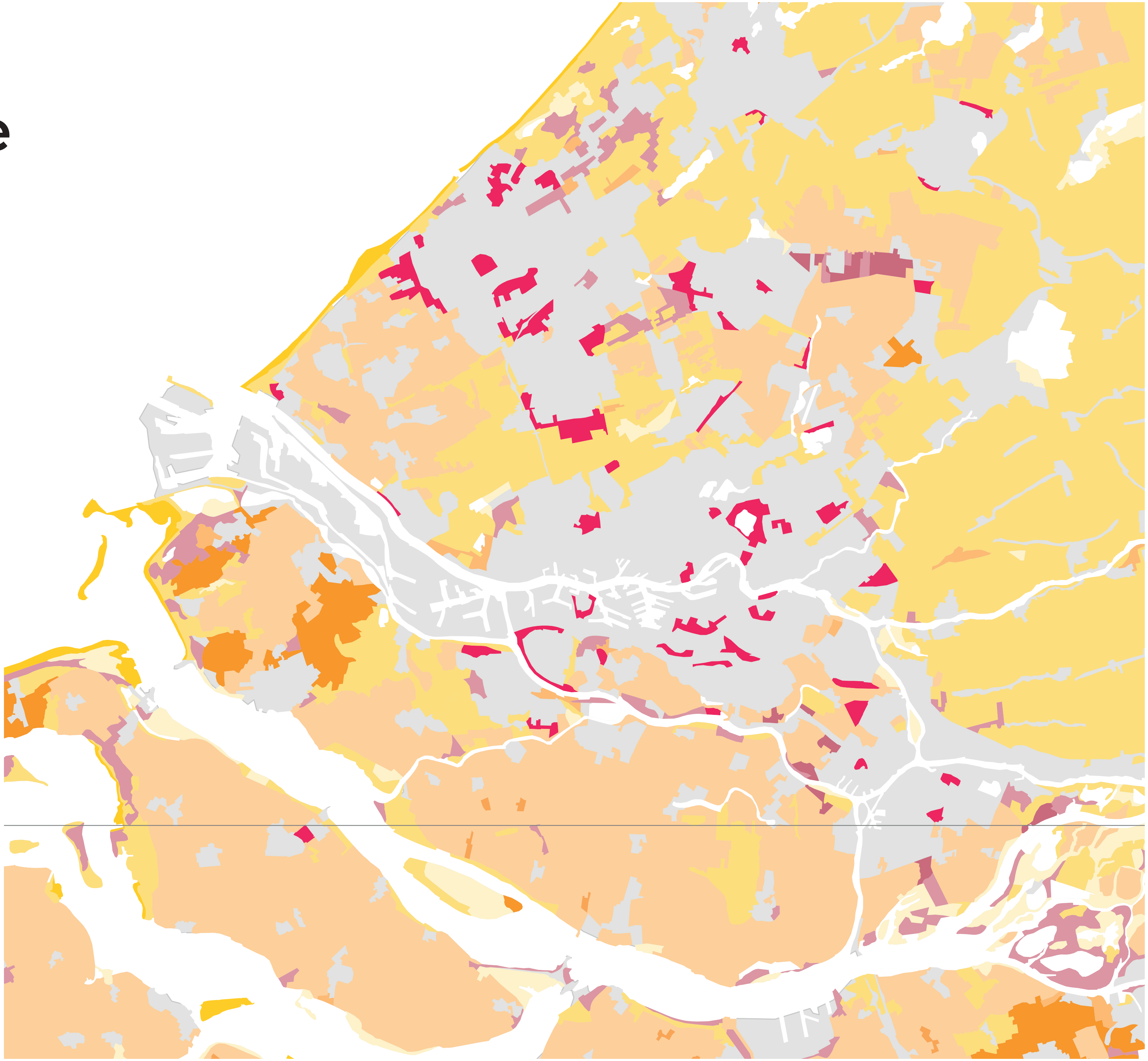
IX _Strategy of Action
Logic Structure




UN Goals
Projects
Interventions
3_ Health & Well Being
6_ Clean Water & Sanitation
7_ Affordable & Clean Energy
8_ Decent Work & Economic Growth
9_ Industry, Innovation & Infrastructure
11_ Sustain-able Cities & Communities
12_ Responsi-ble Consum-tion & Production
13_ Climate Action
16_ Peace, Justice & Strong Institutions
17_ Partner-ship for the Goals
Centralized
Decentralized
North Sea - Wind Circle
H2 Transition
Reclamation of the Port
De-centralized Network
Offshore Wind farms
Inland Wind farms
Solar farms
Electricity Grid expansion
High voltage Grid
Mid voltage Grid
Convertors
Powerplants
Electrolyzers
Readapting de Infrastructure
Storage tanks
Bateries
Ecological Protected areas
Reforesting
Soil decontamination
Landscape Works
Demolition works
Relocation
Development & Housing

Current State

Natural Environtment



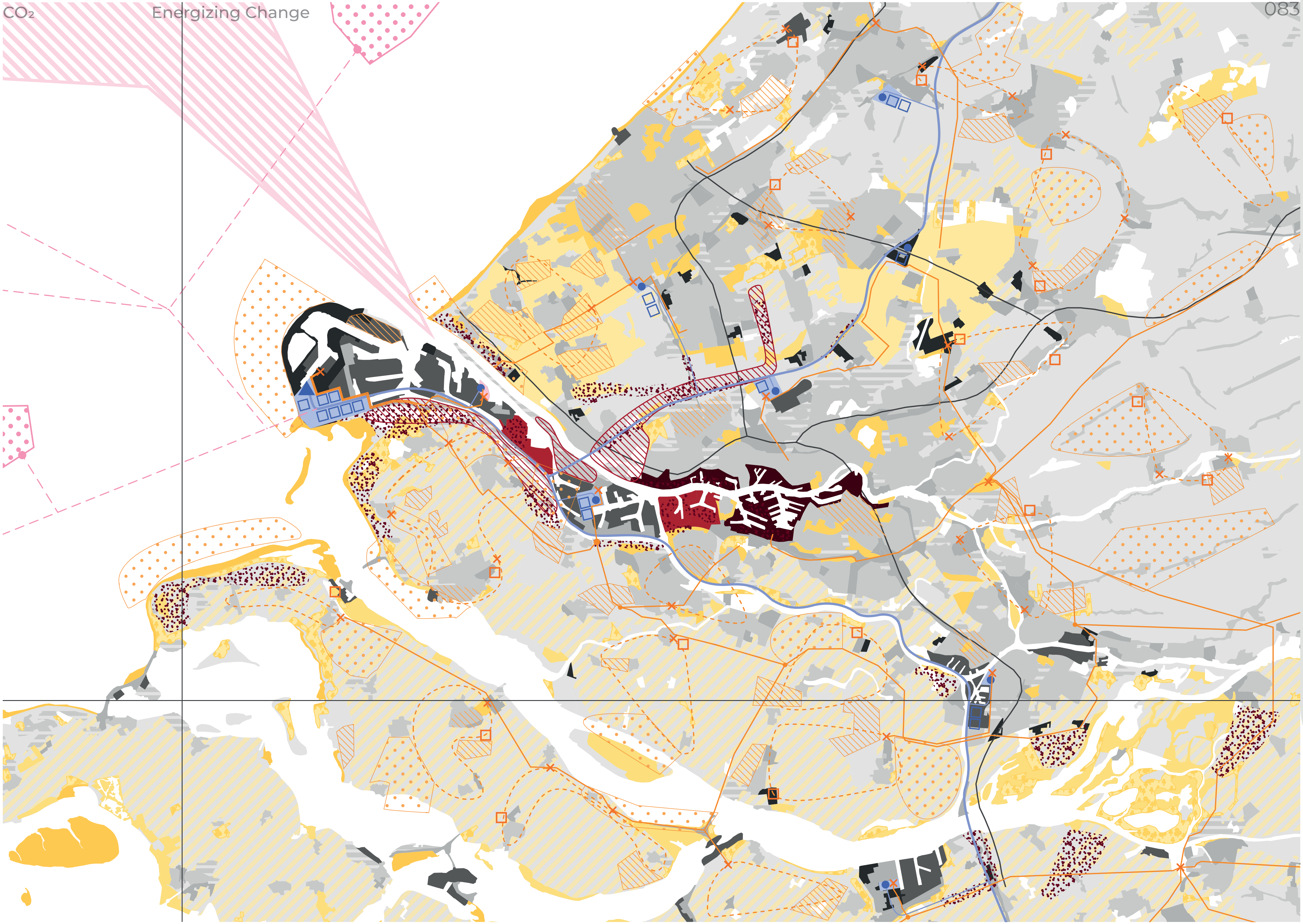
Marshes, Moors
Grasslands
Beaches, Dunes
Arable Lands
Fruit Trees
Comples Cultivation
Woods
Wild Vegetation
Urban Green Areas

Urban Landscape

Strategy Map

By overlapping the projects in the strategy map, it becomes clear how the interventions are highly interconnected in terms of space and time. Each project consists of several steps that are reliant on other steps, even in other projects. For instance, constructing the housing part of the Port can not be done before moving the industries and starting on the implementation of the green corridor. This map paved the way for starting the phasing and the timeline. The sequence of these interventions related to the projects is visualized in the timeline of the phasing. The spatial consequences of these interventions are visible in the strategy map that combines the interventions of the different projects over time.

Power Plant
Electrolyzer
H_2 Storage
Bateries
Transformers
Railways
H_2 Pipeline
Mid-voltage Cable
High-voltage Cable
Railway
Shipping Routes
Offshore Wind farms
Energy Hubs
Greening
Landscape Works
Planting Trees
Housing and Development
Wind farms
Solar farms
Leisure Spaces
Urban Landscape
Infrastructure
Port
Building Sites
Agriculture
Greenhouses
Airports
Natural (Protected) Areas
Dunes & Beaches



Main Projects & Policies

Wind Circle

The first project represents the offshore wind farm ring in the North Sea from the centralized scenario. The project is about creating an international collaborative system of renewable energy production on the North Sea that provides energy in the form of hydrogen to an international network that connects big cities and industrial areas.

In order to start the centralized energy production in the North-Sea, a policy is needed to organize the current state of the sea. That is done by reorienting the shipping routes, and widening the coastal area while emphasizing on protecting the preserved natural areas. A policy for a framework with a specified timeline is required to coordinate the construction of the wind farm and establishment of new landing points. This policy should determine the respective contributions from each country involved. Finally, an administrative community is needed to manage this energy production site, and to make sure that the energy is equally distributed between all the countries.

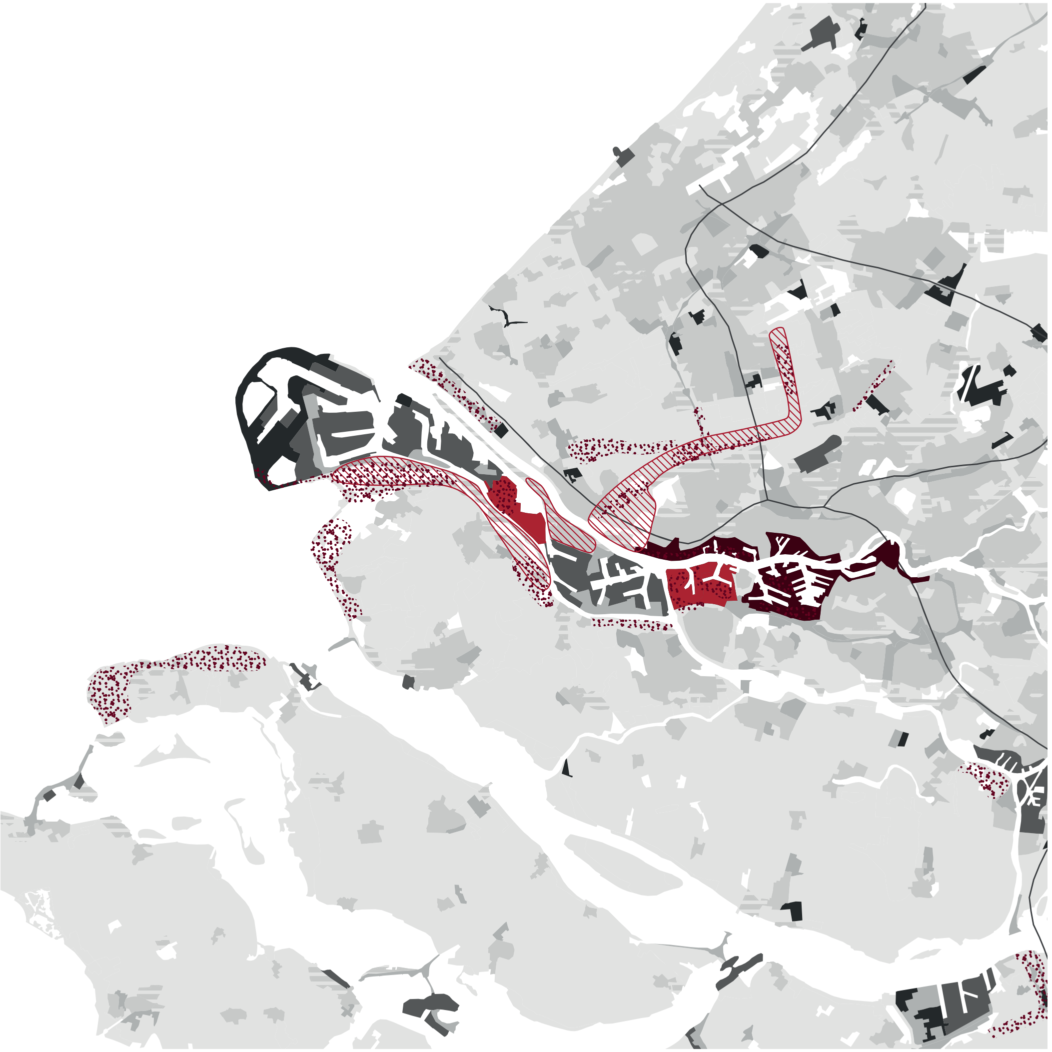
Because the interventions that this project requires are too broad to explore in this research, the further investigation of this project is not included in this report. The (expected) stakeholder relations towards this project however, are represented in the power-interest matrix.

The second project refers to the centralized energy distribution system that is created in the form of a cross-border hydrogen backbone. The hydrogen from the offshore wind farm reaches the Port of Rotterdam as one of the landing points from the sea, keeping the current important status of the Port in terms of energy production and distribution. The Port and the government are main actors in this project, because they both possess great power in the area. Existing oil and gas extractors are conflicting stakeholders that need to be stimulated to contribute to the transition.

The national Dutch policies regarding the Dutch Hydrogen backbone will be endorsed by new shaping instruments such as the project integrated vision, which target various stakeholders in order to accelerate the repurposing and the construction process of the H2 pipeline network.

H2 Backbone

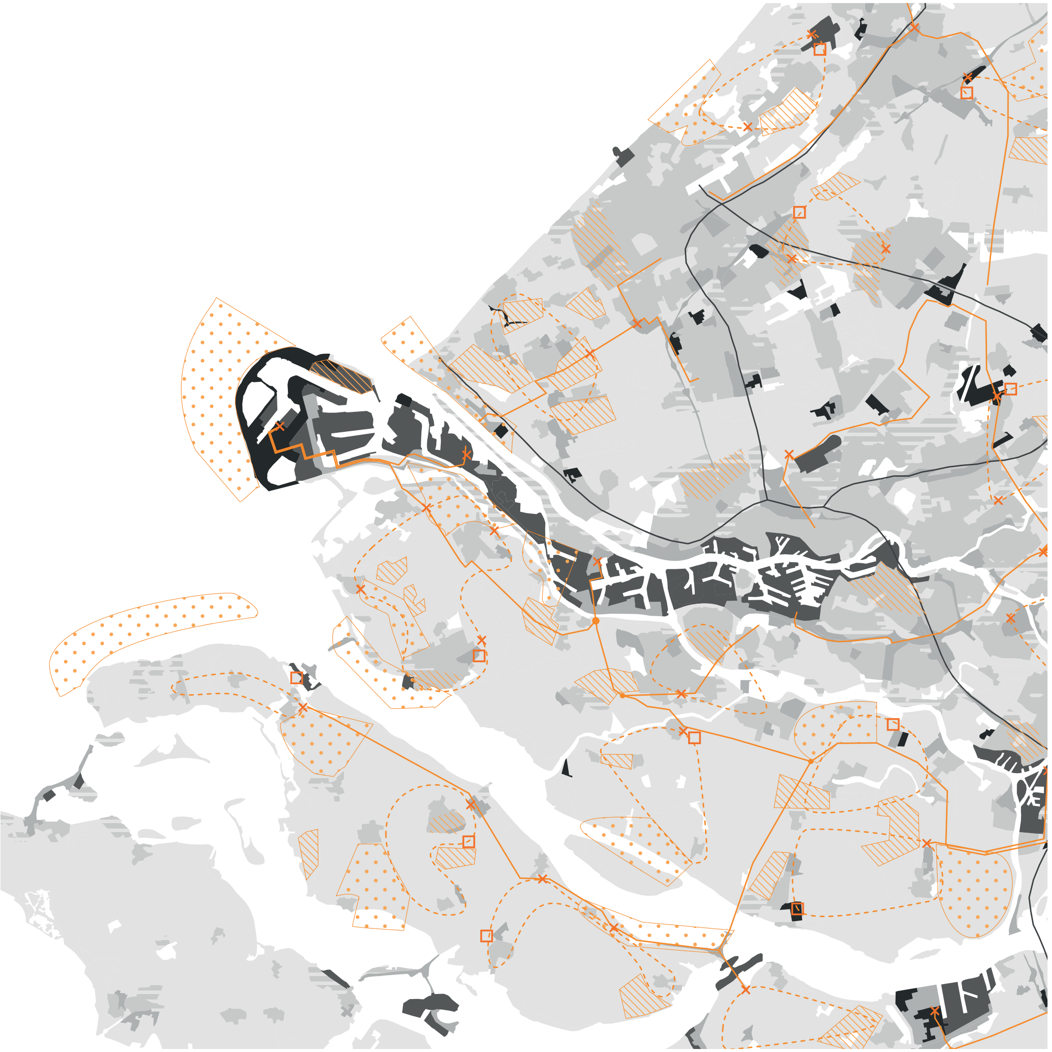
Main Projects & Policies



Reclaim of the Port

The third project is related to the transformation of the Port and refers to the reclamation of the leftover areas from the transition.

Because the fossil fuel industry needs to transition, a lot of space will become free for new development. A new policy that uses stimulating and regulating instruments will target the oil companies in the Port. The policy aims to relocate them to the far west part of the port by giving them subsidies and lowering their taxes if they transition to renewable energy production. The leftover space allows for the greening of the Port to create a green corridor and a public park that connects two ecological zones on the both ends of the river. A policy will take place by exploiting the relocated industrial sites. Finally, new housing developments will be encouraged by new policies of reclaiming part of the Port that is the closest to Rotterdam city. They will be developed in a sustainable way, by making them self-sufficient in terms of energy.



Decentralized Network

The last project indicates the implementations and systems that are needed to realize spatial interventions for the decentralized energy production system in clusters.

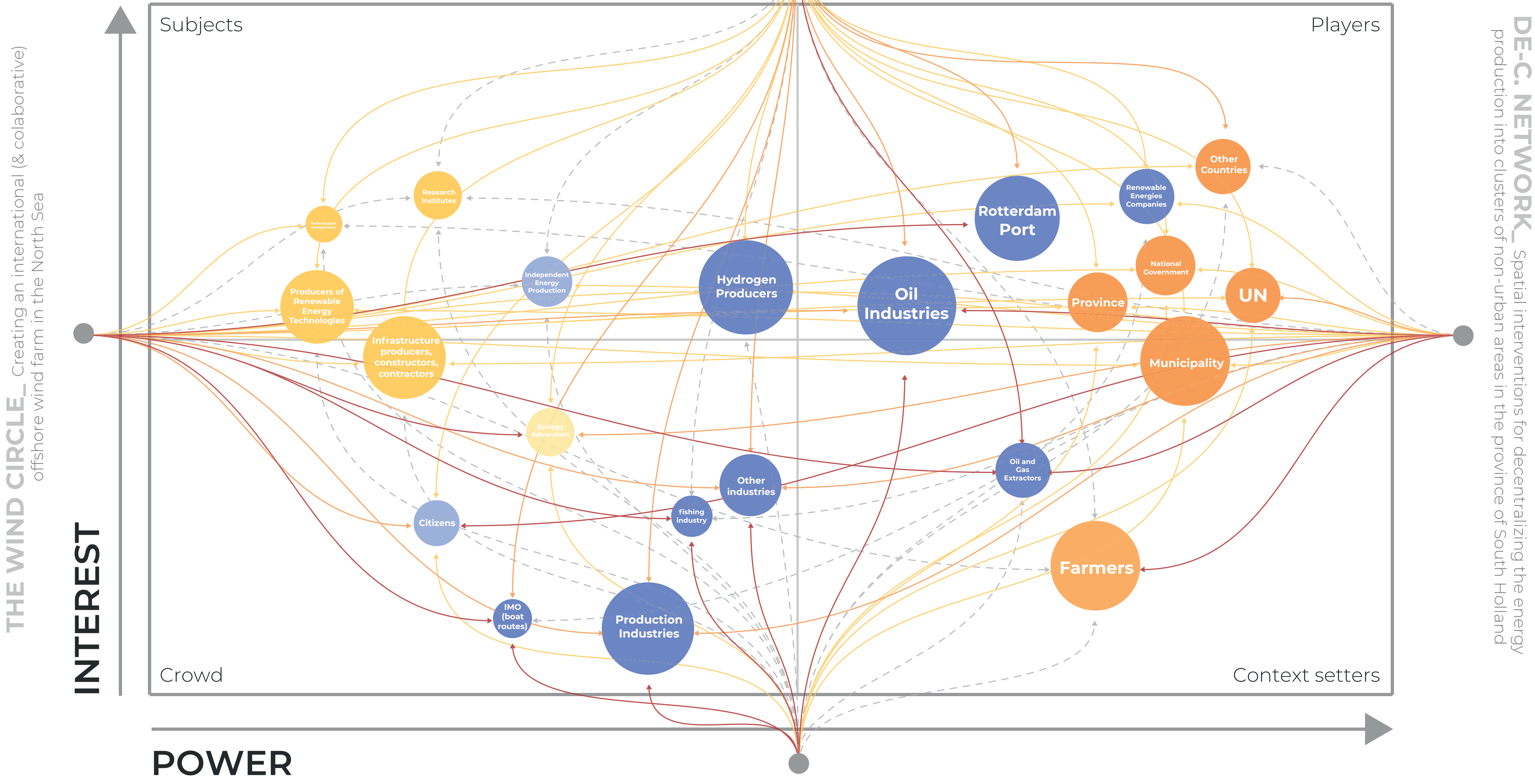
Because the decentralized network does not only apply to the Port of Rotterdam, but the whole region, this project is explored more in this report. Each location has its own spatial characteristics and qualities and there are a lot of different possibilities in terms of renewable energy production sites. Therefore, a catalog of spatial interventions for the case of South-Holland is created in this report. This catalog consists of possible spatial interventions per type of land use, to help policy makers, urban designers and regional or spatial planners with a set of tools to use in the decision making process. Furthermore, an organizational matrix is created, to help determine the best organizational structures for each type of intervention per location and context. Both the catalog and the organizational matrix are used in this report for three specific zoom-in locations within the frame of the province of South-Holland. This is done to give a proof of concept for both of the toolsets and to give an indication of possible implementations in the context of the decentralized system.

Farmers are the biggest opponents of the decentralized energy production project and need to be stimulated to contribute via regulations, policies and bottom-up systems. Furthermore, the electricity network in the province needs to be improved in order to combat net congestion. A new policy that is aligned with the existing Dutch policy (NL Hydrogen Guide, 2022) of supporting and empowering the electricity network will be suggested. The policy aims to stimulate the citizens by providing them with sufficient infrastructure that supports local energy production, such as providing places for storage and batteries, as well as transformers. More policies for the decentralized system are suggested with the zoom-ins.

Interests

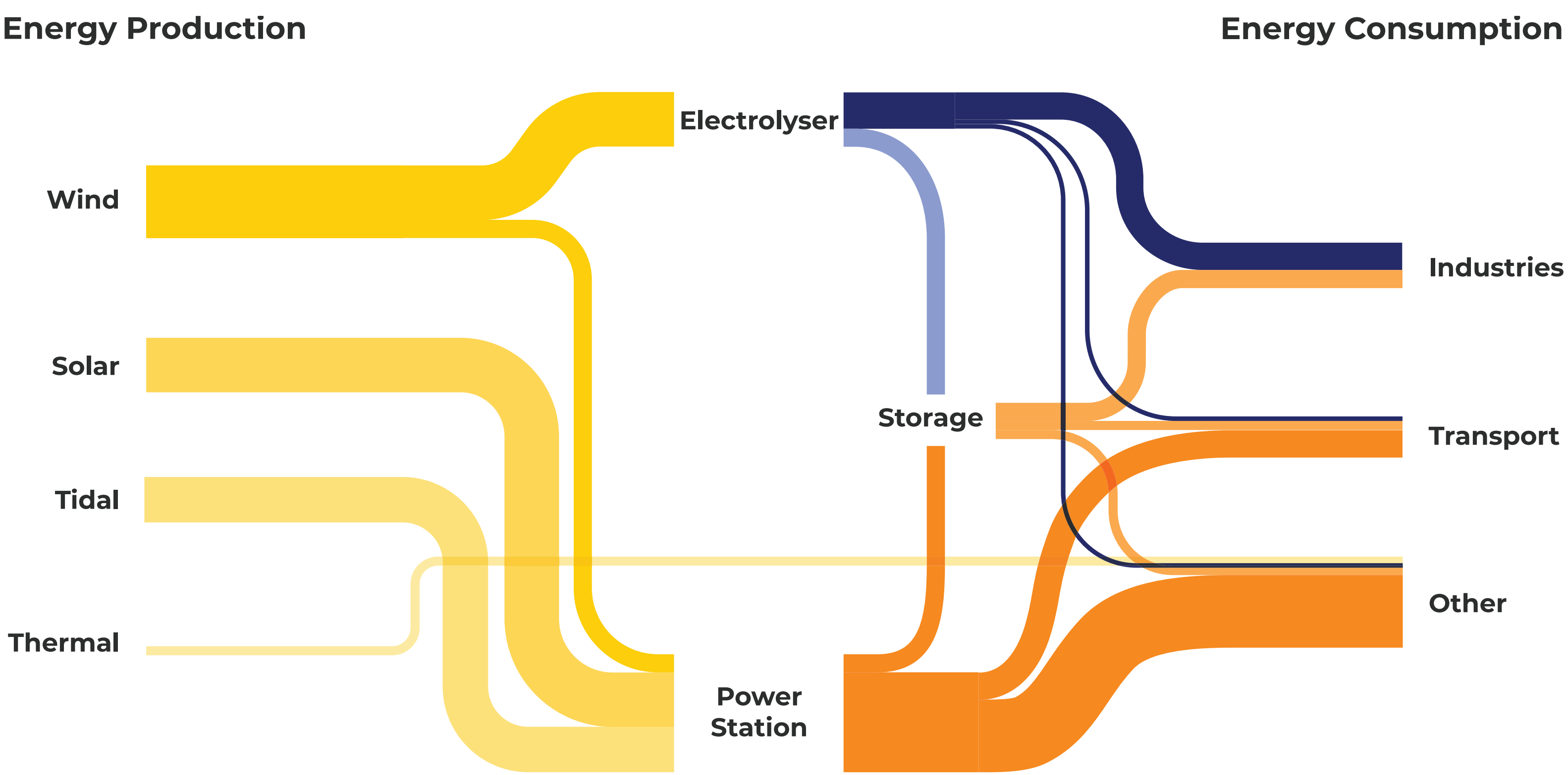
The previously explained stakeholder analysis is compared to the four different projects, by means of filling in the power-interest matrix.

H2 Transition_ Creating a Hydrogen hub (as one of the main landing points) in the Port of Rotterdam

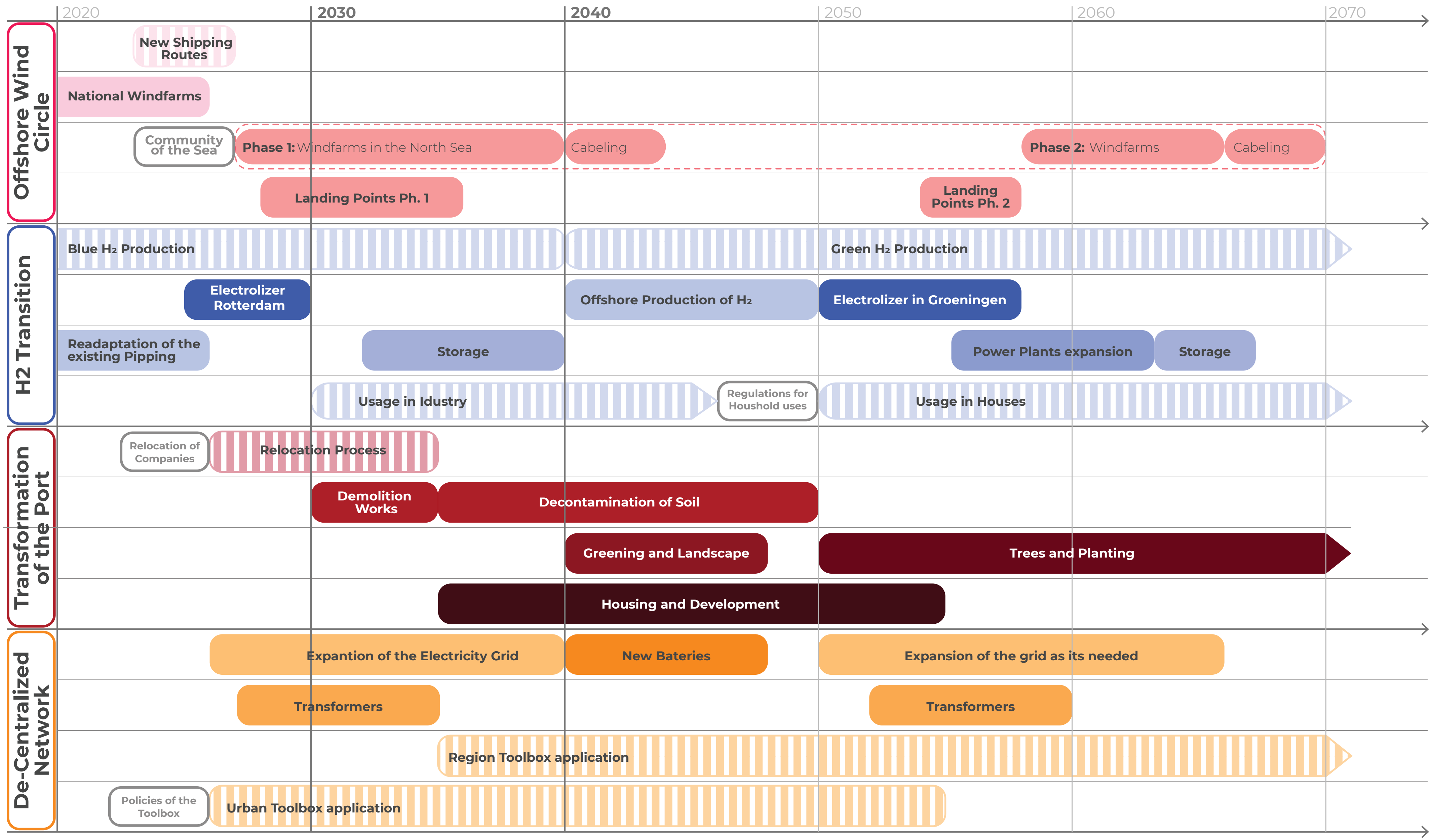


RECLAIMING THE PORT_ Greening the Port and reclaiming space for housing & further develop the city sustainably

The New Flow



The new energy flow in the province of South-Holland shows that the energy production sector is mainly reliant on renewable energy sources that are based on the local energy potentials of the area. Each one of the renewables will be contributing to the flow based on its own efficiency. Since the energy is locally produced and distributed, no energy losses will happen due to exporting/importing processes. Moreover, even when the Hydrogen has to be transported in the region, no energy losses will occur. Thus, 100 percent of the produced green energy will be consumed. After production, the energy either goes to electrolysers or power stations based on its wanted form of consumption. The Hydrogen gets produced in the electrolysers, and the electricity gets processed in the power plants. Then the energy either gets stored or gets directly consumed.


2020
2030
2040
2050
2060
2070
Offshore Wind Circle
New Shipping Routes
National Windfarms
Community of the Sea
Phase 1: Windfarms in the North Sea
Cabeling
Phase 2: Windfarms
Cabeling
Landing Points Ph. 1
Landing Points Ph. 2
H2 Transition
Blue H₂ Production
Green H₂ Production
Electrolizer Rotterdam
Offshore Production of H₂
Electrolizer in Groeningen
Readaptation of the existing Pipping
Storage
Power Plants expansion
Storage
Usage in Idustry
Regulations for Houshold uses
Usage in Houses
Transformation of the Port
Relocation of Companies
Relocation Process
Demolition Works
Decontamination of Soil
Greening and Landscape
Trees and Planting
Housing and Development
De-Centralized Network
Expantion of the Electricity Grid
New Bateries
Expansion of the grid as its needed
Transformers
Transformers
Region Toolbox application
Policies of the Toolbox
Urban Toolbox application

Timeline

In the timeline, the four main projects are set out over time, in relation to each other. These are not independent processes that happen all at once, one after the other, but they are interrelated to one another. The different steps that each of the projects follows, have an effect on the other ones. For example, the housing and development of the Port can only start happening once the infrastructure of the hydrogen transition and the first phase of the North Sea wind circle is already in place, since it happens in the spaces where there used to be oil and coal factories.

On the other hand, it also shows that the decentralized network can happen independent of the big infrastructure projects. Since it is composed of small independent interventions all around the periphery and in the countryside, it does not depend on the processes that are going in the port. What it does get aligned with, are the expansions on the electrical grid, the transformers and the batteries that then link the two main actions, the port and the region.

In the timeline, various milestones are set as a guideline for projects and interventions to be finished. These milestones indicate important years where certain projects need to be finished, in order for other ones to be able to start. These milestones also set guidelines for policy makers to motivate them to start early on in the process.

Milestones

Milestone 1 _2030

In the first period of time, the gas pipelines are repurposed for the now working hydrogen network that gets fed by the first wind farms of the North Sea wind circle.
Part of the decentralized network starts appearing too, mostly in the cities and urban areas, and the relocation of the companies in the Port starts to happen.

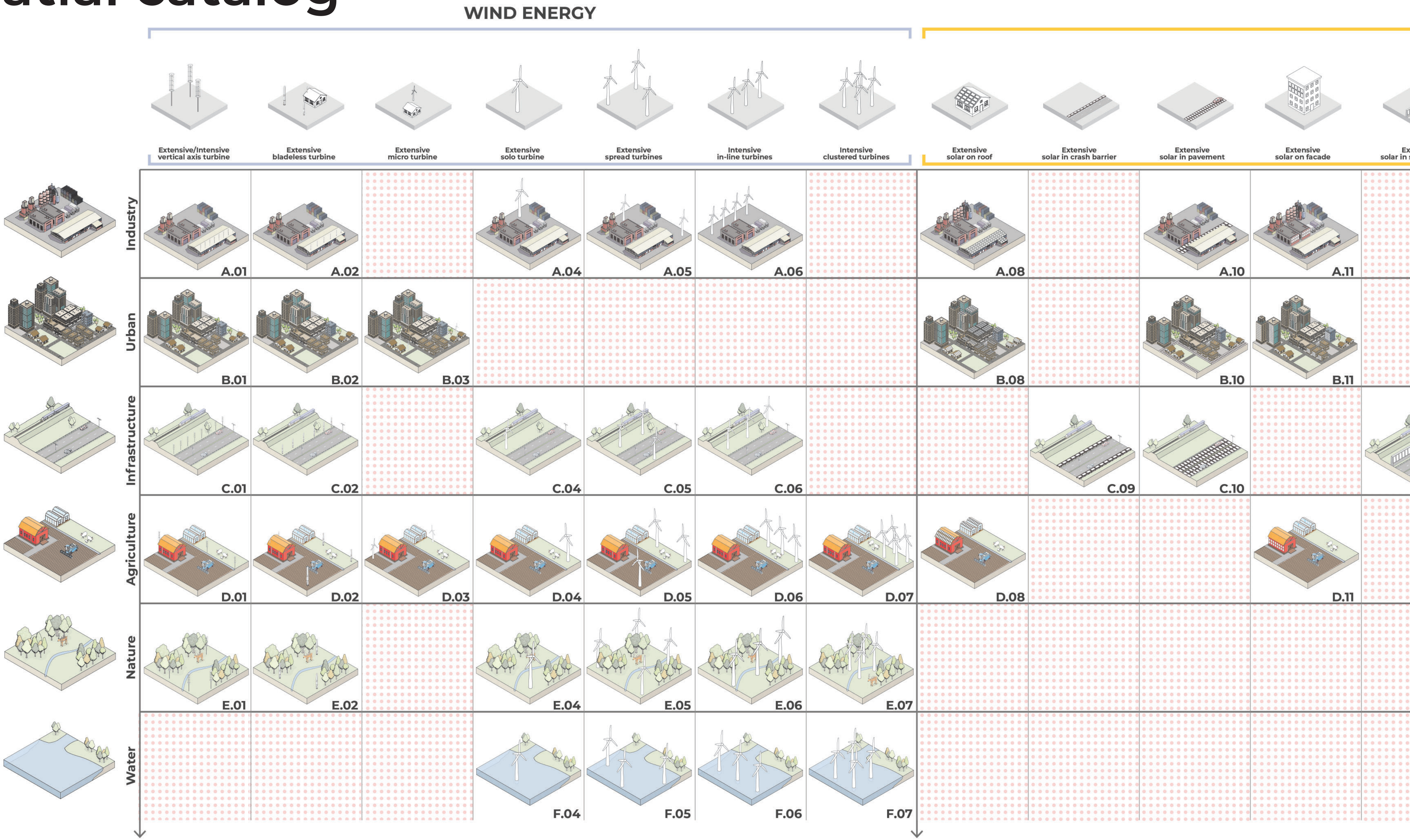
Milestone 2 _2040

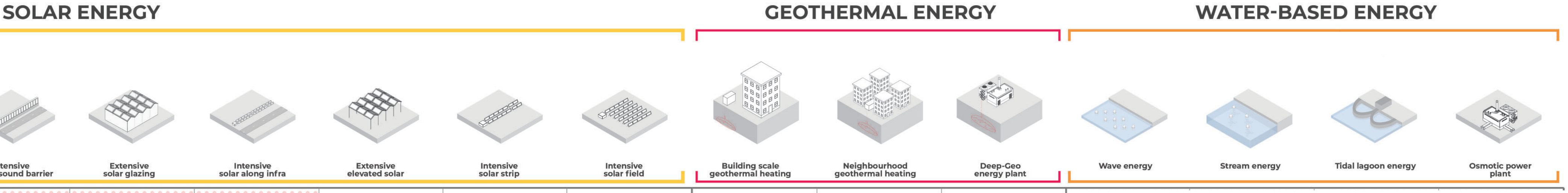
At this point, the Port starts changing more drastically and the landscape works in the new freed up spaces, such as decontamination of the soil and the design of the public park start occurring next to the first housing and development projects.
The power plants and the storage of hydrogen gets further expanded, which now completely supports the energy system.
Further, the decentralized network expands and the region keeps on developing new wind farms and solar fields along the agriculture plots and small sized towns.

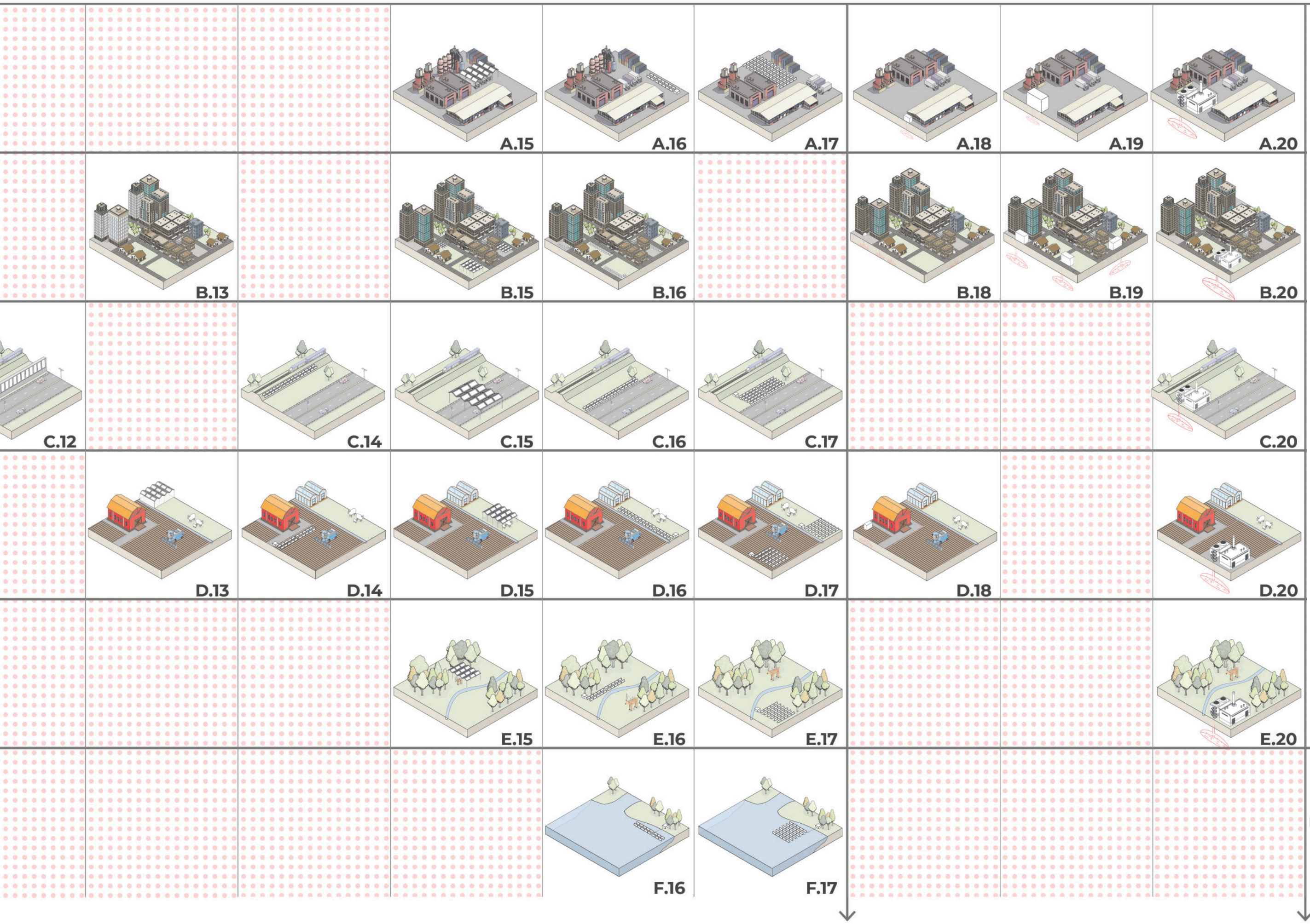
Milestone 3 _2070

At this point, the whole transformation of the Port is finished and the hydrogen based industry is fully in place. What keeps on growing is the decentralized network, making the region more independent in their electricity production and developing the outskirts of the city in a sustainable way.

Spatial catalog

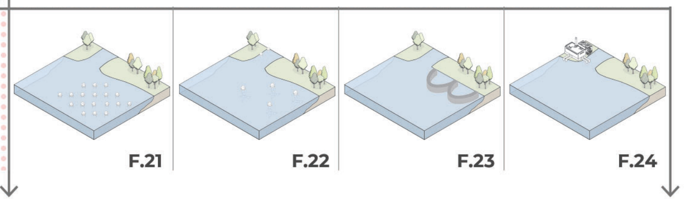






Since the actual interventions are based on the local potentials, the implementation of the decentralized energy system is extremely space bound. To be able to make substantiated design choices and assist the design process of the individual cluster, a spatial catalog is created. This catalog exists out of 75 tiles, categorized in terms of landscape type (vertical axis) and energy production source (horizontal axis).

When designing the decentralized energy system for a cluster the local potential and landscape types determine the possible interventions for that energy system. Together with the organizational matrix, which will be introduced in the next page, the toolbox can be used to create a fitting design solution based on the spatial and social context.



Organizational matrix

In order to find an organizational method that can structure the decentralized renewable energy production system, intensive research done by (Cities4PEDs), which addresses good practices of successful energy transition across Europe was adopted. The investigated research began by taking a comprehensive global inventory based on the knowledge already in existence and desk study, which included cases in Belgium, the Netherlands, Austria, France, Sweden, Ireland, and Finland, as well as in Italy, Spain, Germany, and the Czech Republic. Seven districts were chosen as promising candidates for a PED (Positive Energy District) after considering various factors including stakeholder cooperation, citizen involvement, municipal instruments, legislation and regulations, business case, building typologies and urban development, digital tools, and mapping. They were chosen to include a wide variety of focus topics. The cases involve both new and existing districts, as well as districts of various sizes, stages of growth, and time frames (Cities4PEDs, 2021).

After studying the seven cases that were extensively explained in the research, an organizational matrix for the decentralized approach was created by us. This matrix categorizes the chosen location based on 7 criteria: spatial context, typology, ownership, energy system, and management. Each of these criteria provides several options that can be chosen based on the specific context of the location. For instance, the management system of renewables is highly reliant on the type of ownership of the properties and the available energy system. If the district is owned by the city (such as a city-owned brownfield), then the management of the transition will be provided by the city. Whilst if the district is a compensation between old and newly built buildings with dispersed ownerships, then a special purpose company that takes charge of the transition would be the best choice for managing it. "... Here, relationships are made between the spatial context, the energy system transition that is being aspired to, and the organizational model that is required to achieve this" (Cities4PEDs, 2021).

This organizational matrix is then applied to specific zoom-in locations that represent examples of implementations of the strategy to the focus location of South Holland, to find the most suitable organizational structure per location that fits the interests of the stakeholders.

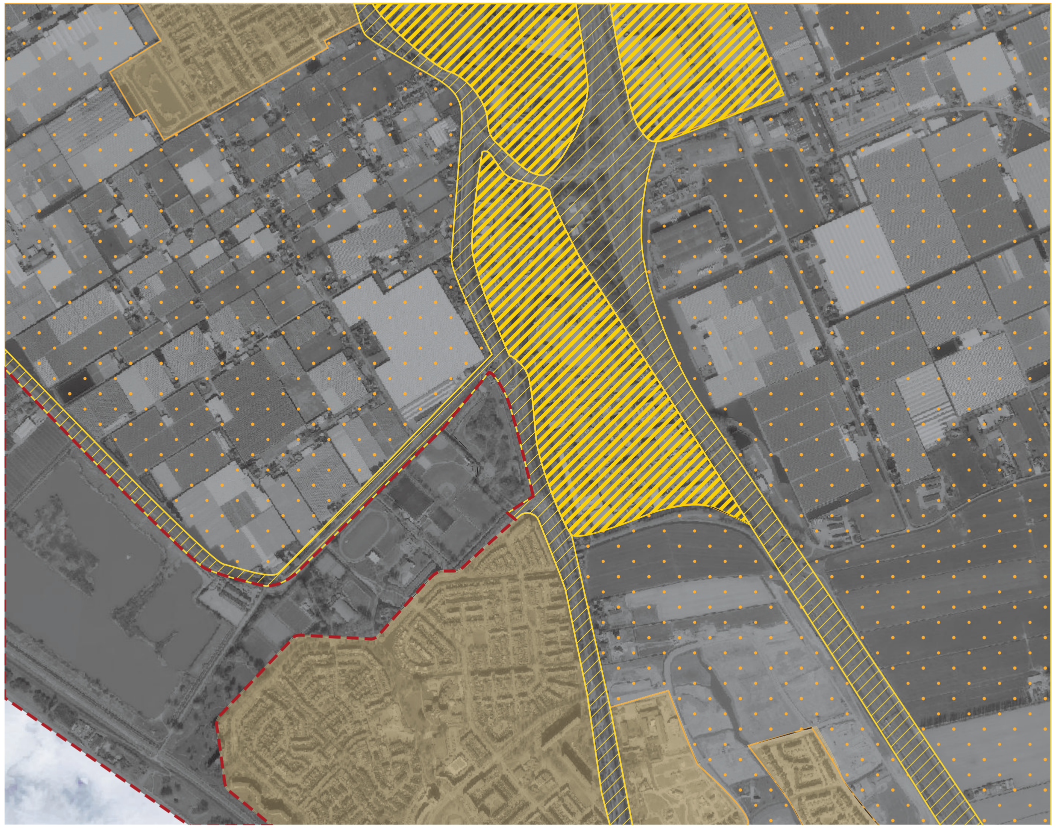

Organizational matrix
Spatial context
existing location
new location
Typology
mixed use
industry/brownfield
residential
agriculture
nature
Ownership
(local) governmetn
private ownership
housing corporations
dispersed
Energy system
changing the energy source
clustered energy production
individual energy production
connected to industry
Management
(local) government
citizen owned production
self-organized group
special purpose comp.
in between platform

Zoom-in: Maasdijk

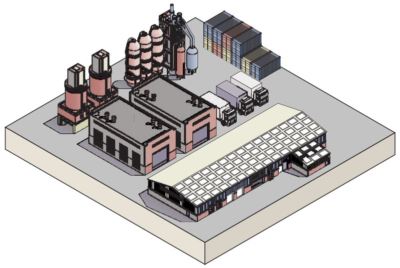
Spatial interventions

Maasdijk, a Dutch town in the Westland municipality, is known for its greenhouses that are used to grow a variety of plants and flowers. Situated in the heart of Westland, which is referred to as the "Greenhouse Capital" of the Netherlands, the town benefits from its location near the A20 highway, providing easy access to Rotterdam and The Hague, making it an ideal location for businesses that require efficient transportation and logistics. In addition to the greenhouses, Maasdijk has an industrial site that provides employment opportunities for the town's residents. Situated along the Nieuwe Waterweg, a major shipping channel that connects Rotterdam to the North Sea, the town has excellent access to international trade routes.

Despite its industrial and commercial activities, Maasdijk has maintained its rural charm, with a small population of just over 5,000 inhabitants, and a close-knit community that is proud of its agricultural heritage. Maasdijk is also home to an "ecologisch natte zone," an ecological wetland area dedicated to preserving and promoting biodiversity in the region, attracting nature enthusiasts and birdwatchers, and adding to the town's reputation as a green and sustainable community.



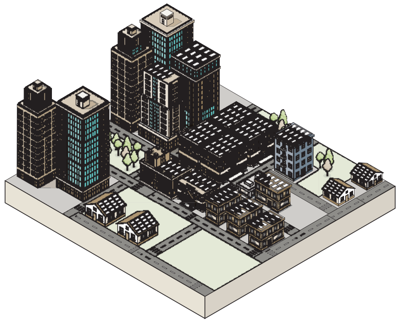
Landscape types in area



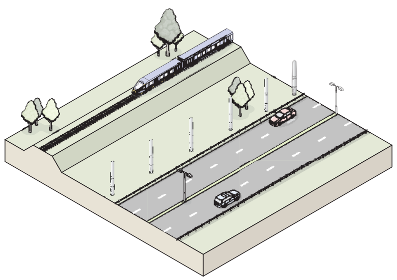
A.08

B.02

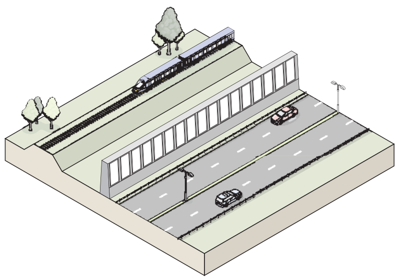
B.03



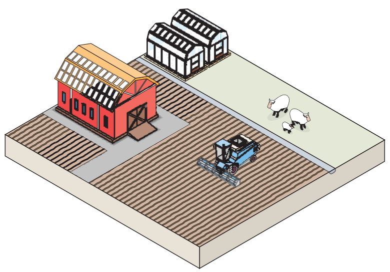
B.08



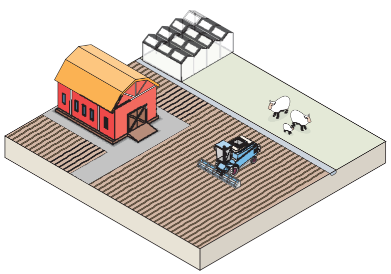
C.02



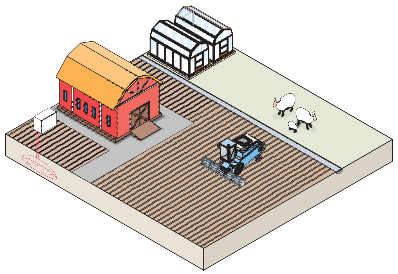
C.12



D.08



D.13



D.18

Interventions

A.08: Extensive solar on roof in industrial landscapes

B.02: Extensive bladeless turbine in urban landscapes

B.03: Extensive micro turbine in urban landscapes

B.08: Extensive solar on roof in urban landscapes

C.02: Extensive bladeless turbine in infrastructural landscapes

C.12: Extensive solar in noise barrier in infrastructural landscapes

D.08: Extensive solar on roof in agricultural landscapes

D.13: Extensive solar glazing in agricultural landscapes

D.18: Building scale geothermal heating in agricultural landscapes

Zoom-in: Maasdijk

Spational interventions

In preparing Maasdijk to be part of an emmission free future, the goal is to keep the local landscape as intact as possible. The different landscape types that make up the village of Maasdijk offer a variety of possibilities in terms of energy production. By utilizing the A20-highway for extensive solar energy production and applying small-scale interventions in the urban landscape, the local character stays in place. In the urban areas, there is a focus on small-scale solar and wind energy. By placing solar panels on roofs, transforming regular bicycle paths into solar pavement and placing sleek, bladeless wind turbines at the building facades, the appearance of the urban would stay fairly the same.

The greenhouses will host more intensive types of energy production. The large roofscapes can easily be utilized for the placement of solar panels, while transforming the regular greenhouse glass for solar glazing allows for even more solar energy production. The newly planned village extensions grant the possibility of using geothermal energy for heating the new neighourhoods. In that way a stable and balanced energy production is created, utilizing different types of energy sources, while still maintain the existing local character and steering away of developing in (protected) natural areas.

B.02

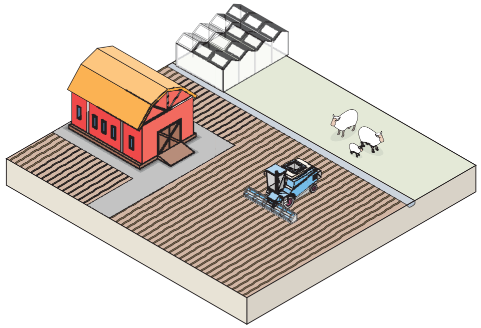
Extensive bladeless wind turbines
in urban landscapes

Energy prod.
30kWh - 50kWh *
per year per m2

Implications
- Available in sizes between 0.8m and 16m high
- Applicable on roofs and/or building facades
- Slim design, reduced horizon pollution
- Low material costs
- Almost no noise pollution

Guidelines
- Apply only 0.8-1.6m turbines in village core
- Apply only 0.8-6.0m turbines at village borders
- Apply only on roofs/eaves in desne populated areas

References
- See appendix



D.13

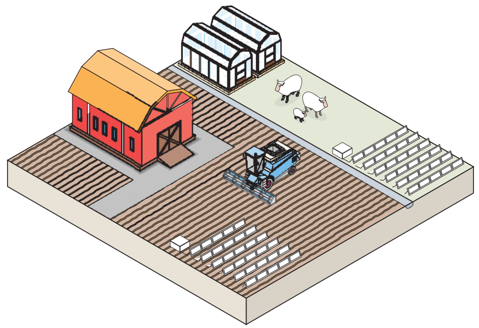
Extensive solar glazing
in agricultural landscapes

Energy prod.
45kWh - 50kWh
per year per m2

Implications
- No aesthetic compromises compared to traditional glazing
- Uses earth abundant construction materials
- Relatively new technology, resulting in increased costs

Guidelines
- Apply only in large glass surfaces, due to relatively low production efficiency

References
- See appendix



D.17

Intensive solar fields
in agricultural landscapes

Energy prod.
130kWh - 180kWh
per year per m2

Implications
- Quite space demanding
- Medium high production efficiency
- Non-balanced energy production
- High material costs
- No noise pollution

Guidelines
- Apply only on former pastures
- Minimum area of 3 hectare

References
- See appendix

Zoom-in: Maasdijk

Current situation

Zoom-in: Maasdijk

Possible situation


ZERO
CO2

Zoom-in: Maasdijk

Organizational structure

The various landscapes and interventions also come with a variety of stakeholders and actors that are active in the zoom-in area. In this paragraph, the organizational structure of the transformation of Maasdijk is set out.

The way of organizing the renewed energy system can be derived from five different branches: spatial context, ownership, management, energy system and typology. On the basis of the various previously proposed interventions, a division is made in five different zones, each with their own combination of characteristics from the five branches. These zones are:

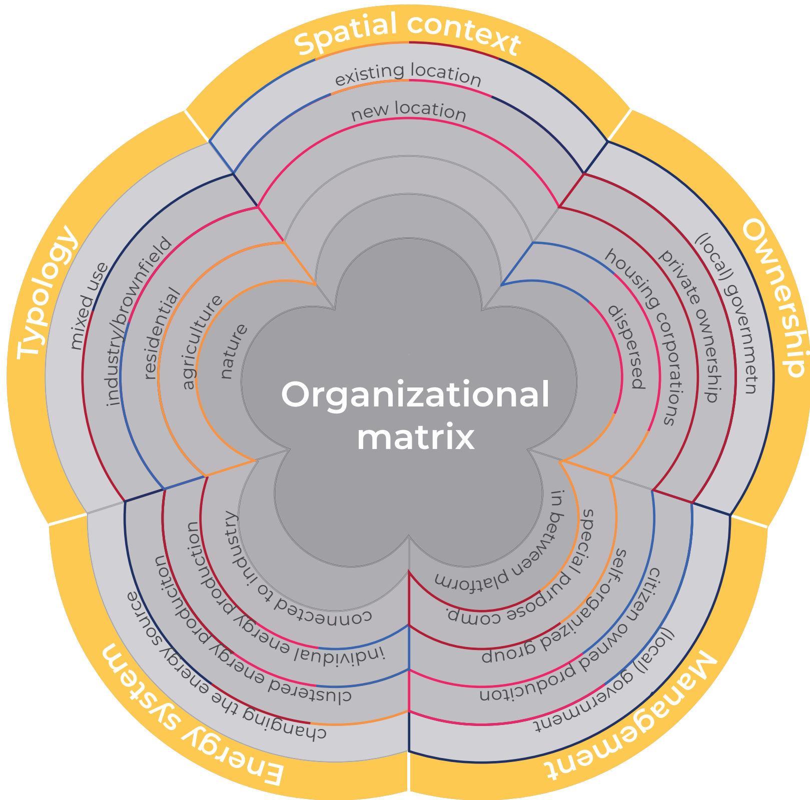
1. Private existing residents
2. Private new residents
3. Greenhouse collaboration
4. Organized industries
5. High Tech Government

The private residents (1,2) represent small scale energy production systems within residential areas. Installing, managing, maintaining and the ownership of the energy production system is the responsibility of the private homeowner or the housing association. Stimulating these interventions can be done by governmental institutions by handing out subsidies for the placement of private energy production systems, for instance by implementing the “salderingsregeling”.

In the greenhouse sector (3), another approach is used. Here, the aim is to create collaborative partnership between individual greenhouse owners, to produce energy together. The management is handled by an external party that uses the roofs (against payment) provided by the greenhouse owners for renewable energy production.

Within the industry and business premises (4), a collaboration between landowners is sought-after. Because individual lots are often bigger within these terrains and the amount of stakeholders limited, a collaboration between these stakeholders is feasible. In this way, it is possible to produce energy regardless of the presence of lot- or country borders.

The energy production in the infrastructure (5), lies in the hands of the government. She is the landowner and responsible for building and maintaining roads and civil constructions. Because there is almost no energy production along highways at the moment, the infrastructure needed for this must be placed as well (e.g. cables, pipes, transformators, etc.). The complexity of this type of project matches the best with an organizational structure where the (local) government is the owner and the manager of the energy production system.



A Private existing residents

- Ownership is dispersed over many different actors with small plots
- Individual energy production and consumption
- Individual management and maintenance of energy system
- Stimulated by salderingsarrangement and subsidies

B Private new residents

- Ownership is dispersed over many different actors with small plots
- Individual energy production and consumption
- Individual management and maintenance of energy system
- Stimulated by salderingsarrangement, subsidies and integrative sustainable design

C Greenhouse collaboration

- Few different actors and land owners with relatively large plots
- Collaborative clustered energy production
- External party acts as manager, owner and maintainer of energy production system
- Stimulating by financial compensation for use of building/land for energy production

D Organized industries

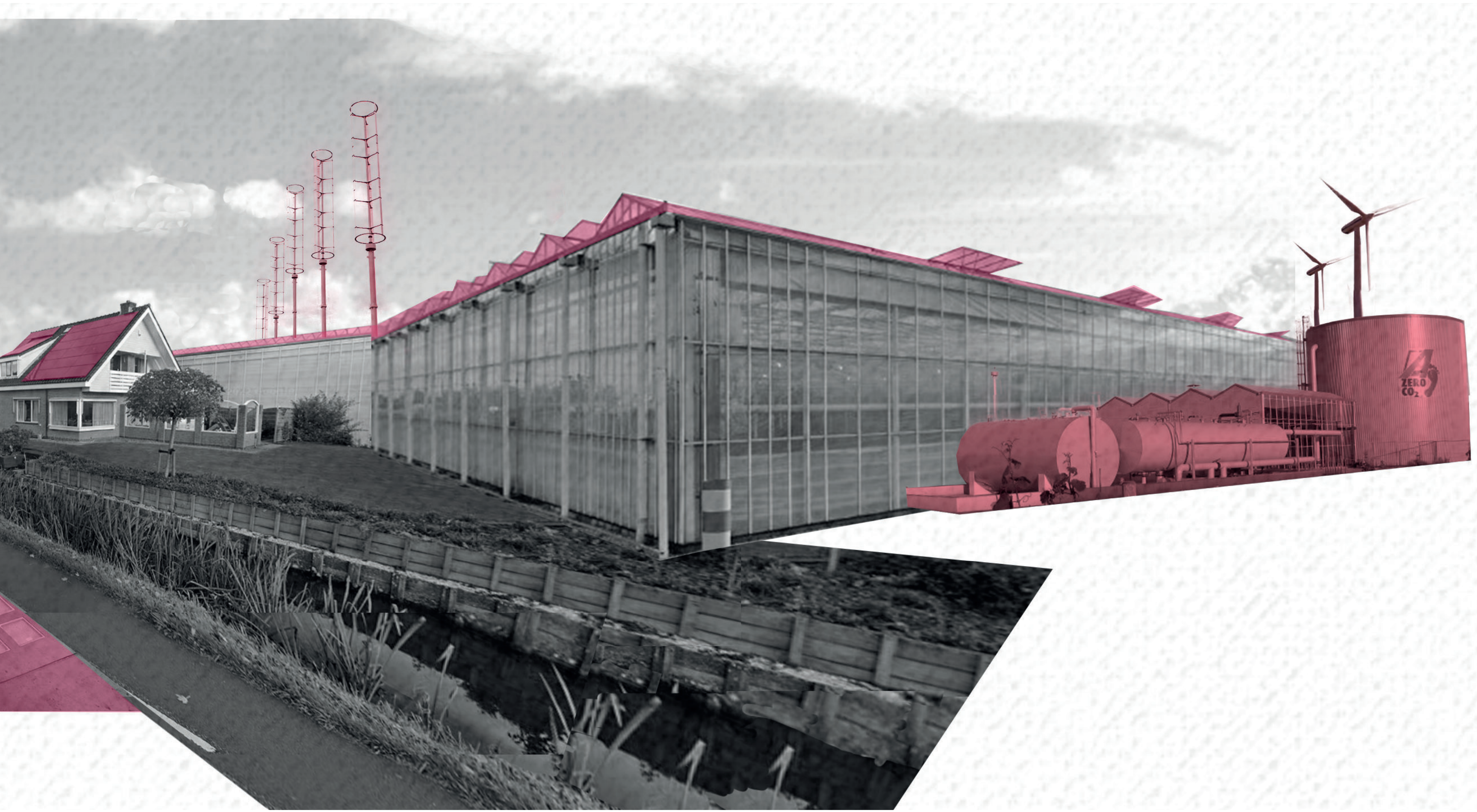
- Few actors with relatively large plots
- Collaborative clustered energy production
- Self-organized group for maintenance and management of energy production system
- Subsidies for individual energy production of (larger) commercial sites

E Governmental infrastructure

- Only one land/infrastructure owner in form of government
- Clustered energy production
- Management and ownership in hands of (local) government

Zoom-in: Maasdijk

Spatial interventions


ZERO
CO2

Zoom-in: Maasdijk

Stakeholders and actors

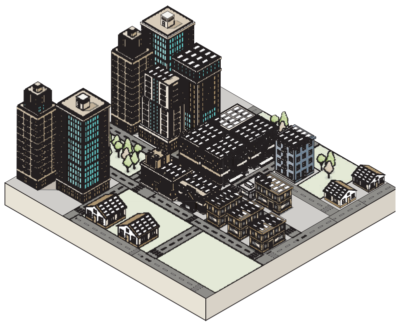

"I am happy to contribute in the energy production for the neighborhood!
Ideal, because I do not have to worry about it, I just offer my roof. And with a small investment, I get a share of the overall produced energy for my business."
ZERO CO2

Zoom-in: Ooltgensplaat

Spatial interventions

The village of Ooltgensplaat is located in a rural area with a mix of agricultural, residential, and industrial land uses. Large fields of crops like potatoes, sugar beets, wheat, and onions are grown on a large portion of the land surrounding the village. The village is small and has a vibrant commercial district with a variety of stores, eateries, and cafes. A few small industrial sites can be found in Ooltgensplaat as well, which offer locals opportunities for employment. These locations house production and processing plants that create goods like metal products, building supplies, and agricultural machinery.

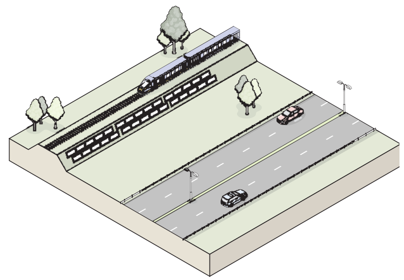
The marina is a another significant land use in Ooltgensplaat and is located on the eastern side of the town. The marina serves as a focal point for recreational boating and fishing, drawing tourists from all over the area. Ooltgensplaat, where the Haringvliet and Volkerak rivers converge, is a great place for water sports and other outdoor activities. Finally, the surrounding area of Ooltgensplaat is home to a number of parks and nature reserves. These areas serve as crucial habitats for a variety of plant and animal species.



B.08

B.10

B.18



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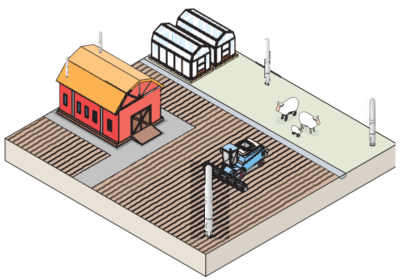

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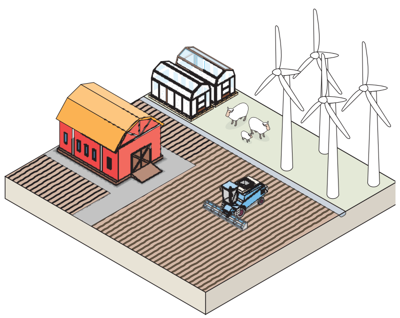

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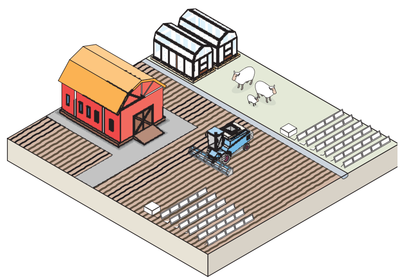
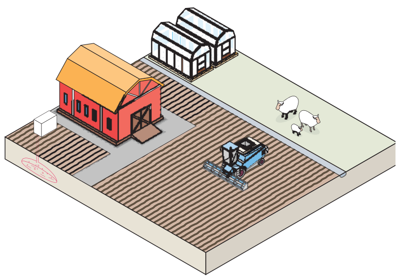


D.17



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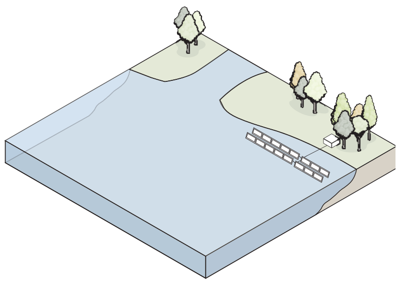
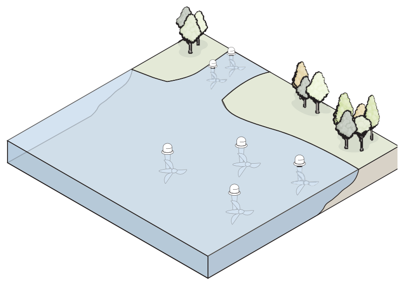


F.16



F.22

Interventions

B.08: Extensive solar on roof in urban landscapes

B.10: Extensive solar in pavement in urban landscapes

B.18: Building scale geothermal heat in urban landscapes

C.14: Intensive solar along infrastructure

D.02: Extensive bladeless turbine in agricultural landscapes

D.07: Intensive clustered wind turbines in agricultural landscapes

D.17: Intensive solar fields in agricultural landscapes

D.18: Building scale geothermal heat in agricultural landscapes

F.16: Intensive solar strips in waterscapes

F.22: Intensive stream energy in waterscapes

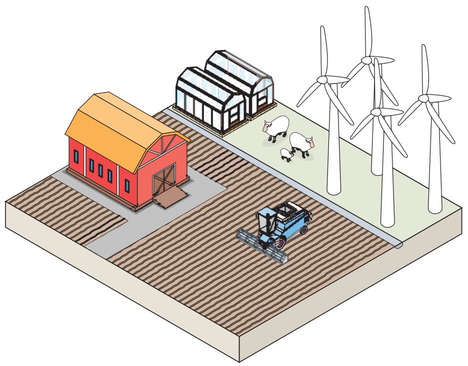
Zoom-in: Ooltgensplaat

Spational interventions

The objective is to preserve as much of the local landscape as possible in order to get Ooltgensplaat ready for an emission-free future, with an emphasis on preserving the natural reserves that surround the village. Ooltgensplaat's immediate surroundings are primarily used for agriculture, leaving plenty of open land for larger-scale interventions like wind and solar farms. There are some guidelines that must be adhered to so as not to infringe upon the villagers in any way. Solar farms can only be located in places with limited views and away from protected natural areas. The wind turbines are placed at least 1,5km out of the village borders and are no higher than 50m.

Small-scale interventions are installed within the village's boundaries. All of the roofs will have solar panels installed, and the village's touristic, pedestrian-only center will have solar pavement, making a high-tech attraction for visitors and locals without the risk of parked cars deflecting the sunlight. Geothermal heating and small, bladeless wind turbines of various sizes will be installed in the new housing areas without obstructing the view of the surrounding scenery.

The waterscape is another area used for energy production. The border areas of the river are filled with floating strips of solar panels, while closer to the center of the fairway stream energy turbines are placed. The Volerak is ideal for this type of intervention due to the sufficient flowing speed of the water and the fact that it's relatively little used by ships and boats.



D.07

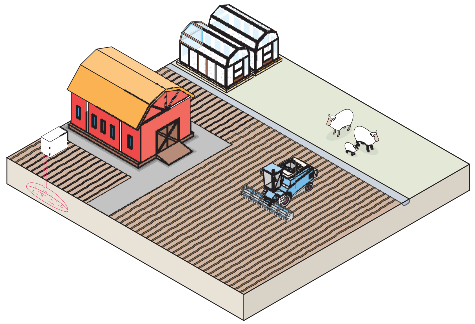
Intensive clustered wind turbines in agricultural landscapes

Energy prod. 1.050kWh per year per m2

Implications
- High horizon and noise pollution
- Unstable energy production due to high cut-in wind speeds
- High material costs
- Can be dangerous for birds and animals.

Guidelines
- >30m from roads
- >1.5km from housing
- >80m from power lines
- >60m from pipes

References
- See appendix



D.13

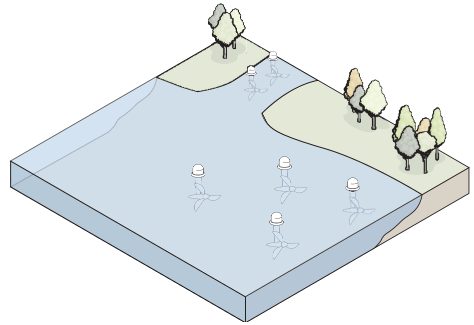
Building scale geothermal heating in agricultural landscapes

Energy prod. +-8.800kWh* per year

Implications
- Improved electricity demand but removes need for gas-use
- Always place in combination with other energy production interventions
- Difficult to install in densely built areas

Guidelines
- Apply only with other energy production sources
- Apply only in newly built areas or areas with lots of open space

References
- See appendix



F.22

Intensive stream energy in waterscapes

Energy prod. 1.100.000kWh - 1.500.000kWh per year per turbine

Implications
- Relatively high cut-in stream speeds (0.4 m/s)
- Reduced possibility of recreation and transport on water
- Quite expensive solution

Guidelines
- Apply only in streams with at least avg speed > 1.3m/s
- Do not obstruct trading routes or water recreation

References
- See appendix

Zoom-in: Ooltgensplaat

Current situation

Zoom-in: Ooltgensplaat

Possible situation

Zoom-in: Ooltgensplaat

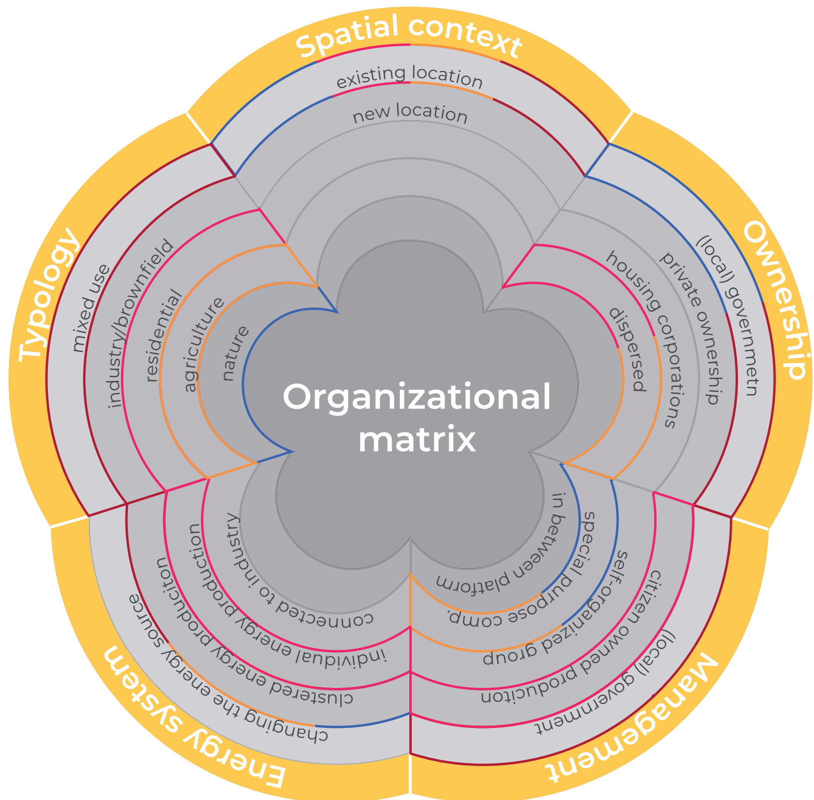
Organizational structure

The biggest land use within Ooltgensplaat is agriculture. Farmers, local residents and the local government are the biggest actors and stakeholders in the realisation of the energy transition. By making use of the organizational matrix, four organizational structures that relate to the interventions in and around Ooltgensplaat are created:

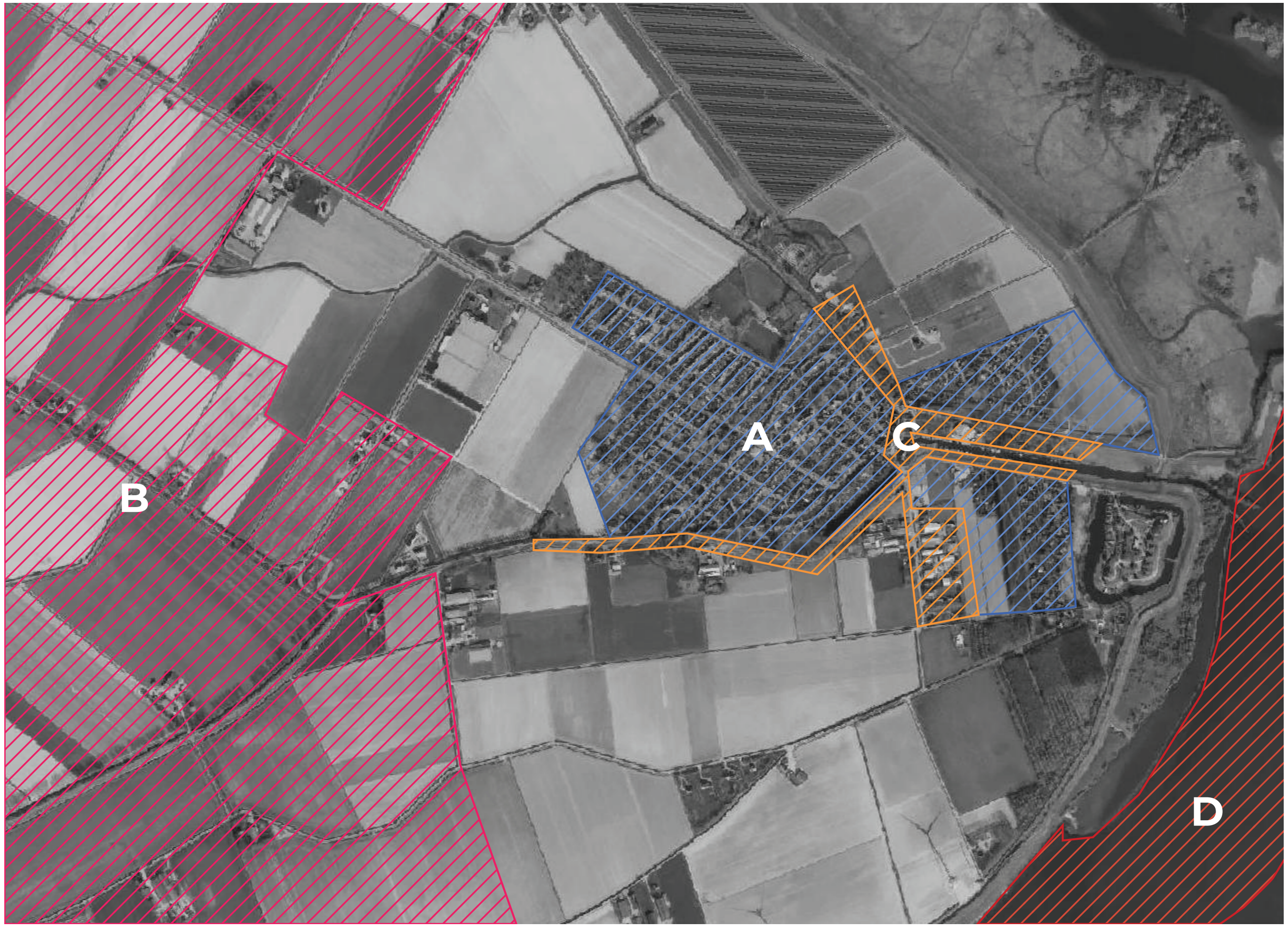
1. Independent residents
2. Collaborative agriculture
3. High-tech municipality
4. State's stream turbines

The first and least complex organizational structure for the energy transition in Ooltgensplaat is related to the local residents (1). By means of handing out subsidies and salderingsarrangements for the return delivery of energy, homeowners are stimulated and motivated to invest in solar panels or micro (bladeless or vertical-axis) wind turbines. Installing, maintaining and financing these systems happens by the residents themselves.
Next to this, the extended agricultural landscape provides options for grand scale energy production in the form of wind turbine parks and solar fields. To ensure that the placement of these energy production systems is supported by the local population, an extensive and more complex organizational structure is adopted. The aim is to retrieve a partnership between the landowners (farmers) and the residents of the village. This collaboration is created in the form of a coöperation, where both residents and agrarian landowners can become shareholders, either by providing land, or by investing. Each shareholder has a say in the decision making process, leading to a fair system. The cooperation provides residents and farmers with the chance to contribute to the energy transition and ensures support from the residents for the implementation of renewable energy production systems in the area. Next to this, the investment in renewable energy production sites contributes to the awareness of energy consumption. During the development of a project, the cooperation will be supported by advisors, appointed by the local government, in the field of energy production and infrastructure.

Public spaces within the built area provide space for the energy transition as well. By implementing high-tech solutions in infrastructure areas, such as solar roads, solar coating on safety barriers and solar panel-infused sound barriers, the province is provided with the opportunity to present itself as high-tech and sustainable. Although the redevelopment and placement of these techniques is mostly executed by private companies, the maintenance and management can be done by the municipality.
Next to the land, also the water



provides chances for emission-free energy production. This landscape is within the management of Rijkswaterstaat, meaning that it has only one owner. Still there are several actors and stakeholders active because of the use of the river. Because the implementation of stream turbines is a relatively new technology, it is important that experts in the field are appointed to maintain, install and manage the turbines. The local government and Rijkswaterstaat, however, need to direct their attentions on renewable energy production in and on the water. By means of spatial visions, as well as investing in sustainable and long-term relationships with companies in the sustainable energy production sector, this development can be stimulated.



A Independent residents

- Ownership is dispersed over many different actors with small plot
- Individual energy production and consumption
- Individual management and maintenance of energy system
- Stimulated by salderingsarrangement and subsidies

B Collaborative agriculture

- Collaboration between agricultural land-owners and local residents
- Clustered energy production in spacious agricultural sites
- Management and ownership in hands of a cooperation of locals
- Changes and criteria in procurement procedure are needed to ensure that only cooperations with >50% locals can join the tender

C High-tech municipality

- Few actors with relatively large plots
- Collaborative clustered energy production
- Self-organized group for maintenance and management of energy production system
- Subsidies for individual energy production of (larger) commercial sites

D State's stream turbines

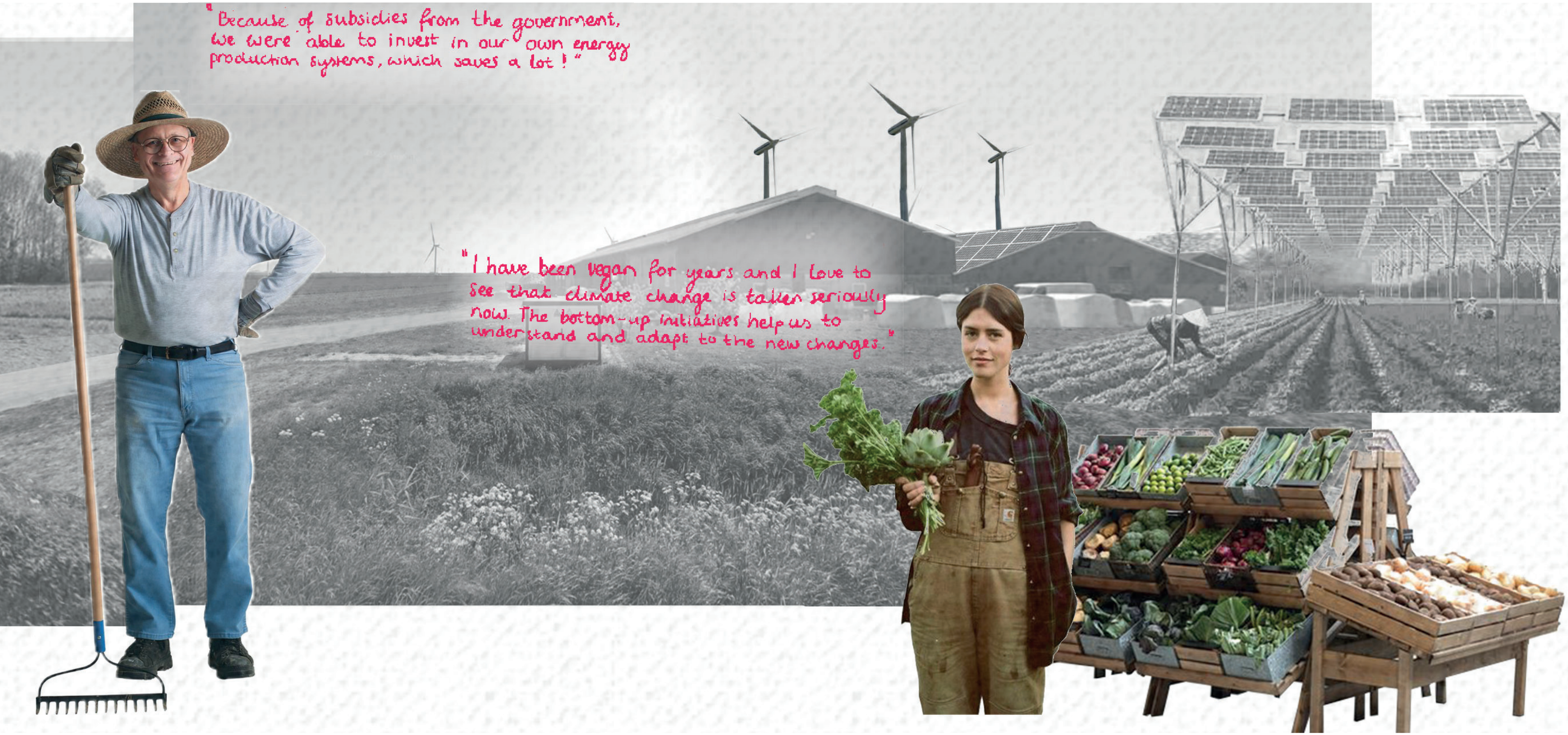
- Only one land/infrastructure owner in form of government
- Clustered energy production
- Management and ownership in hands of (local) government

Zoom-in: Ooltgensplaat

Spatial interventions

Zoom-in: Ooltgensplaat

Stakeholders and actors

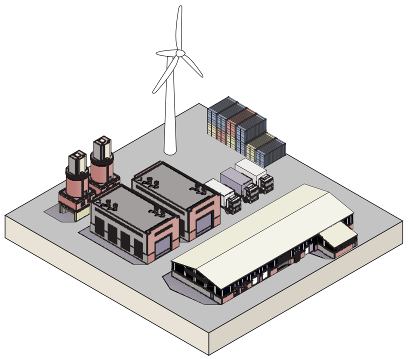

"Because of subsidies from the government, we were able to invest in our own energy production systems, which saves a lot!"
"I have been vegan for years and I love to see that climate change is taken seriously now. The bottom-up initiatives help us to understand and adapt to the new changes."

Zoom-in: Pernis

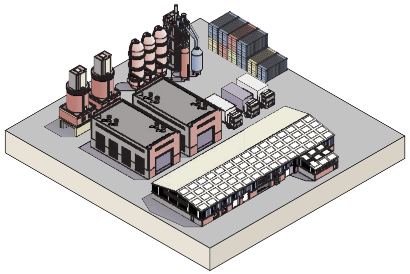
Spatial interventions

Pernis is a small town in the municipality of Rotterdam in province of South Holland. The town is located on the Nieuwe Maas river's southern bank, which divides it from the Rotterdam city center. The immediate surroundings of Pernis are predominantly industrial in nature, with the town being surrounded by oil refineries and chemical plants.

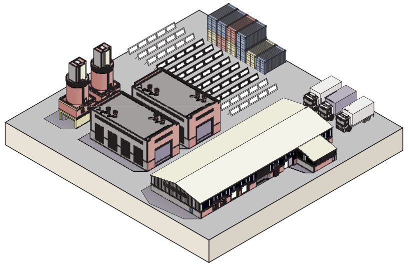
Despite its proximity to industrial activity, Pernis has maintained its green town borders, which are designated green zones that protect the town from further industrial development. Besides that, these green zones serve as a border between the town and the A15 and A4 highways in the south and west of the town. Green spaces, parks, and nature preserves make up this zone and serve as habitats for numerous plant and animal species, protect the town from the noise of the highways and additionally function as a recreational area for inhabitants of Pernis and the neighboring areas.



A.04



A.08



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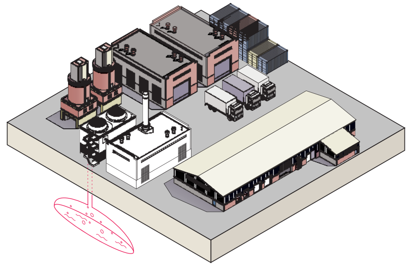

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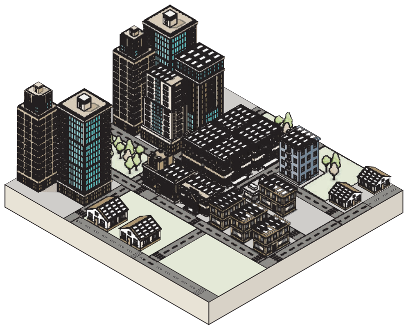
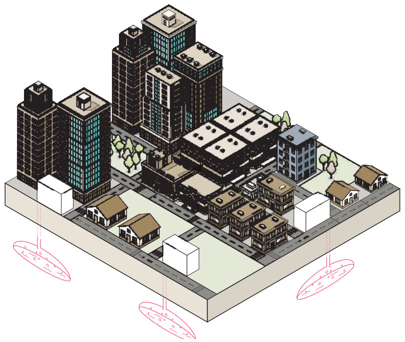


B.08



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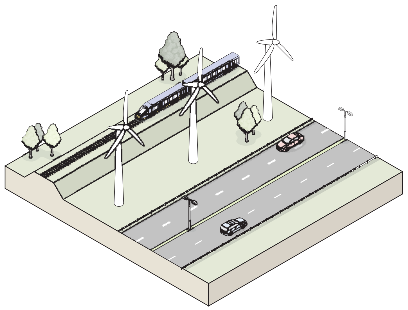
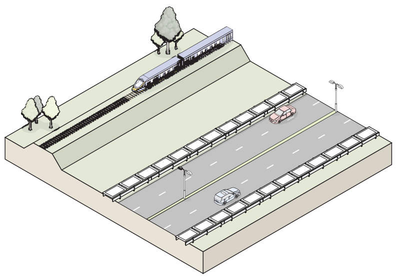
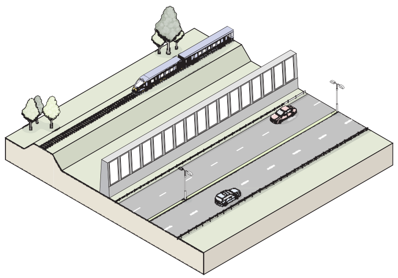


C.06



C.09



C.12

E.02

A.04: Extensive solo wind turbine in industrial landscapes

A.08: Extensive solar on roofs in industrial landscapes

A.17: Intensive solar field in industrial landscapes

A.20: Deep-geothermal power in industrial landscapes

B.08: Extensive solar on roofs in urban landscapes

B.19: Clustered geothermal heat in urban landscapes

C.06: In-line wind turbines in infastructural landscapes

C.09: Extensive solar in crash barriers in infrastructural landscapes

C.12: Extensive solar in noise barriers in infrastructural landscapes

E.02: Extensive bladeless wind turbines in natural landscapes

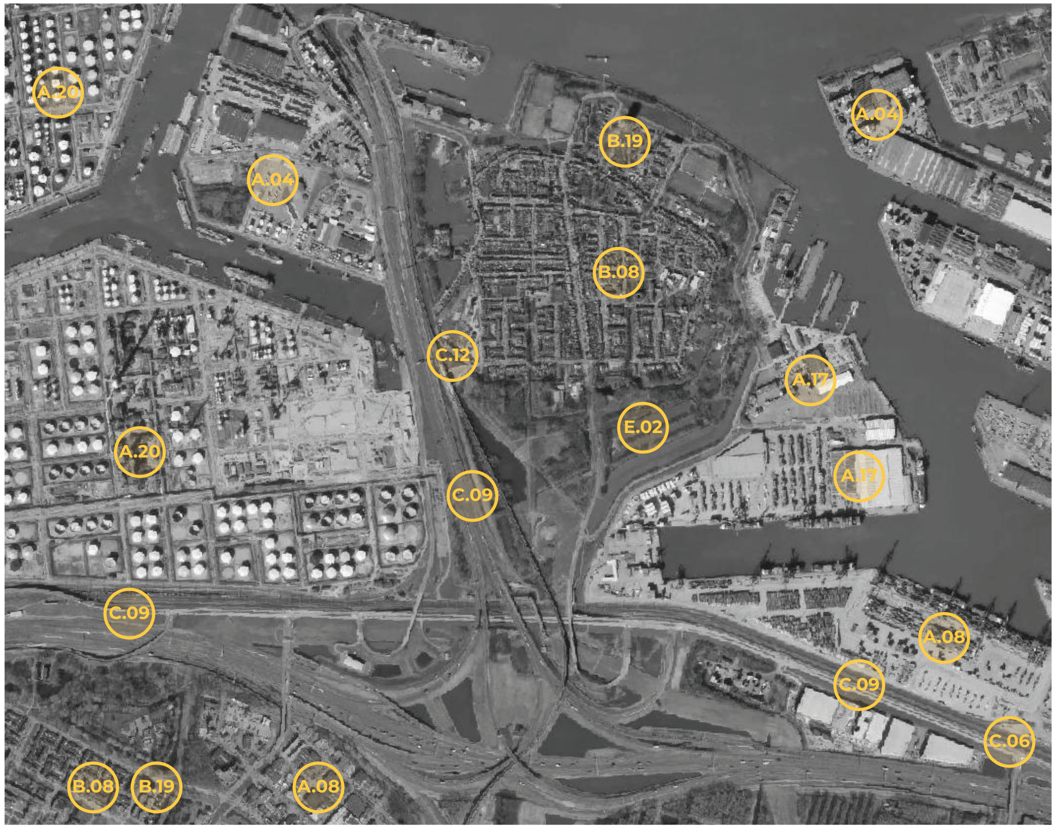
Zoom-in: Pernis

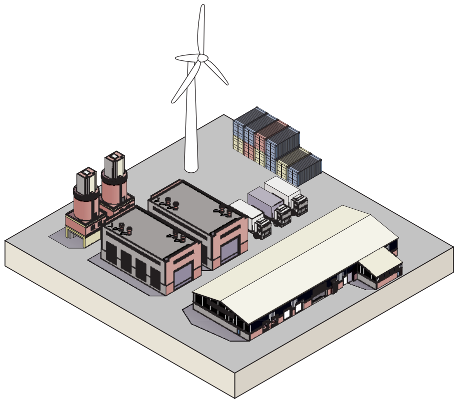
Spational interventions

The extensive industrial areas surrounding Pernis are mainly focused on storing and processing oil and chemicals (in the west) and transhipping containers (east). Because we're moving to an zero-emission future, the oil industry will shrink immensely, therefore areas that are curently used will become available for redevelopment. These large plots allow for larger transformations regarding energy production and are capable of housing intensive wind turbines and solar fields. By utilizing solar energy as well as wind energy a balanced energy produciton throughout the year is secured. The industries that still have a place in a sustainable future will be intensively equipped with solar panels on roofs and/or facades. The waterscapes are too intensly used for transport to accommodate for tidal or stream energy. The harbours themself could be used for floating solar strips once the industries are relocated.

The village of Pernis itself houses approximately 4.500 inhabitants. This small-scale of the village is one of the aspects which is to be preserved, as well as the green borders which protect the village from the noise and pollution of the A4 and A15 highway. In these two landscape types only small-scale interventions will be made in the form of bladeless/micro wind turbines, solar panels on roofs and solar paving. New village extensions will be designed in an integrative manner and make use of geothermal energy as well as solar glazing and solar facades.

The infrastructure can be utilized for energy production as well. The presence of the highways allow for solar panels in the crash barriers, as well as in the noise barrier between the A4 and the village itself.





A.04

Extensive solo wind turbine
in industrial landscapes

Energy prod. 800kWh - 1.400kWh per year per m2

Implications

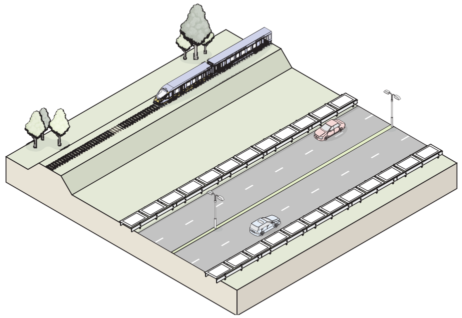
- High horizon and noise pollution
- Unstable energy production due to high cut-in wind speeds
- High material costs
- Can be dangerous for birds and animals.

Guidelines

- >30m from roads
- >1.5km from housing
- >80m from power lines
- >60m from pipes
- Not higher than 60m
- Not next to chemical-industries

References

- See appendix



C.09

Extensive solar in crash barriers
in infrastructural landscapes

Energy prod. +-3.200kWh* per m per year

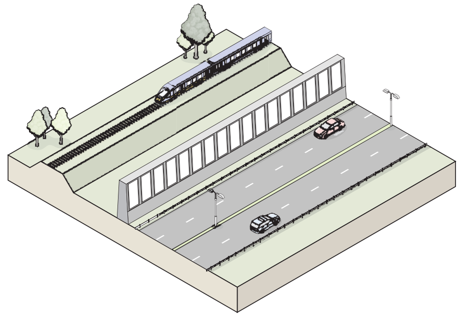
Implications

- Relatively low production efficiency
- No impact on horizon or noise pollution
- Expensive in maintenance
- High material costs
- Scarce production materials

Guidelines

- Apply only on longer distances to be profitable

- See appendix



C.12

Extensive solar in noise barriers
in infrastructural landscapes

Energy prod. 280kWh - 420kWh per m per year

Implications

- No extra horizon pollution compared to tranditional noise barriers
- Medium high production efficiency
- High material costs
- Scarce production materials

Guidelines

- Apply only if noise barriers is neccessary
- Apply only along highways
- Don’t apply next to train tracks to due filth and dust

- See appendix

Pernis

Current situation


CONTINENTAL
NAUTA

Pernis

Possible situation


CMA CGM

Zoom-in: Pernis

Organizational structure

The organizational structures in Pernis are a bit more complex than those in Maasdijk. Within this design area, there are a lot more and more powerful actors. With the organizational matrix, a distinctions is made in six organizational zones:

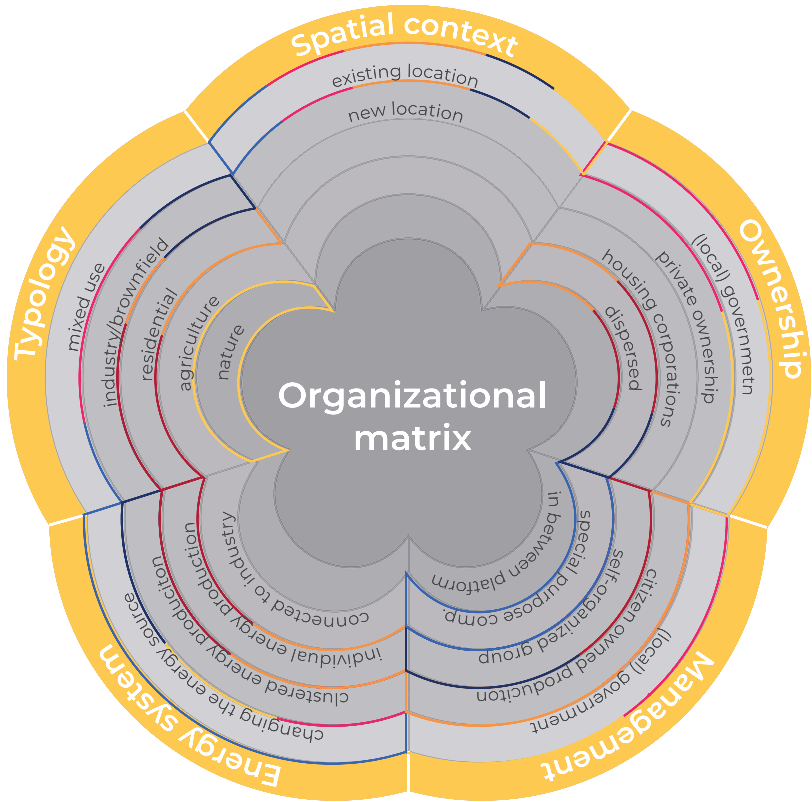
1. Commercial port redevelopment
2. Governmental highway adaptation
3. Transition of existing neighborhoods
4. Self-organized new residential developments
5. Organized industries
6. Natural interventions

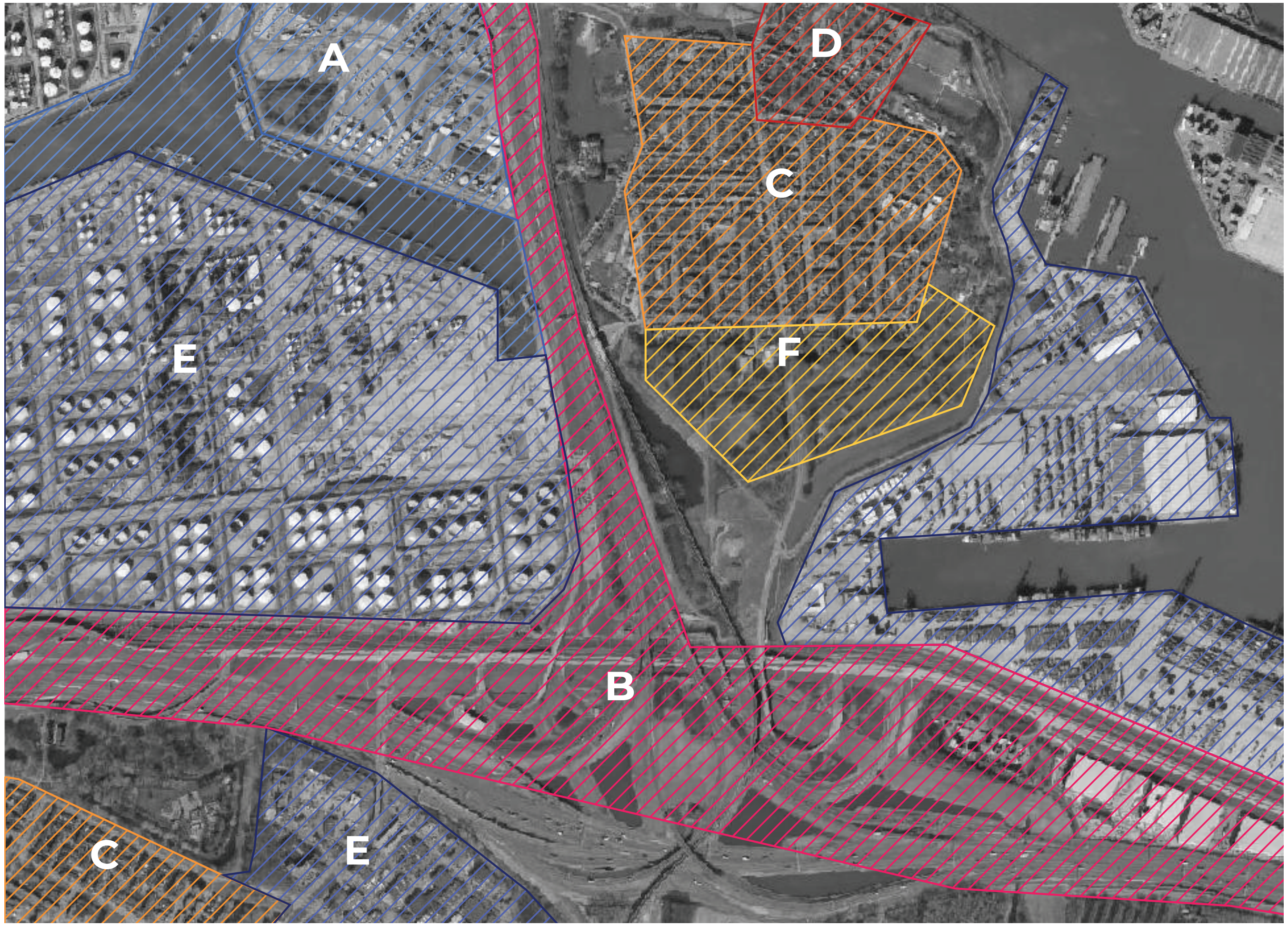
The most striking thing about Pernis is its location in the middle of the harbor (1). A big area of the Port is now being used for the storage and processing of chemicals, oil and gas, and will be made available for redevelopment. By buying out the fossil industry by the government, space becomes available for greening, housing development and renewable energy production. The redevelopment of the Port can be outsourced to commercial parties.

Next to the transformation of the industry, action is needed from the government for making the highways (2) more sustainable. Rijkswaterstaat is responsible for the building and maintenance of the infrastructure and thus for making it sustainable. By means of goals, regulations and milestones that are contractually set, the implementation of energy production systems in and around the highways can be enforced.

Existing residents (3) should be taken along in the energy transition. This happens by means of individual energy production and consumption. Homeowners are stimulated via subsidies and salderingsregulations to invest in renewable energy production themselves. By handing out energy discounts when at least 40% of the used energy is produced by themselves, individuals are stimulated to contribute to the energy transition.

Residents of the newly developed neighborhoods (4) fall under a different regulation. The new houses in Pernis are already being built with the aim of being self-sufficient in terms of energy production. This energy is produced in clusters of multiple houses that share a battery for storage together. Maintaining the system will be done by a cooperation between these residents themselves.
The leftover, non-fossil industries (5) are provided with an option to stay in the area. In this case, they need to comply with strict rules. The industry either needs to contribute to the production or distribution of hydrogen, or needs to produce 80% of her energy herself, in an emission-free manner.
In natural areas (6), several small interventions are done to support the energy transition. Important is that these interventions have minimal to no impact on biodiversity. To ensure this, these interventions are placed and maintained by the local government, together with Natuurbeheer.





A

Commercial port redevelopment

- Government buying out exiting actors and reselling the plot to commercial developers
- Re-using existing electricity infrastructure for renewable energy production
- Management en redevelopment in hands of external party

B

Governmental highway adaptation

- Ownership already in hands of governmental body
- Clustered energy production
- Energy production and maintenance
- Stimulated by contracts, goals and regulations

D

Private existing residential

- Few different actors and land owners with relatively large plots
- Collaborative clustered energy production
- External party acts as manager, owner and maintainer of energy production system
- Stimulating by financial compensation for use of building/land for energy production

E

Organized new residential

- Few actors with relatively large plots
- Collaborative clustered energy production
- Self-organized group for maintenance and management of energy production system
- Subsidies for individual energy production of (larger) commercial sites

E

Organized industries

- Only one land/infrastructure owner in form of government
- Clustered energy production
- Management and ownership in hands of (local) government

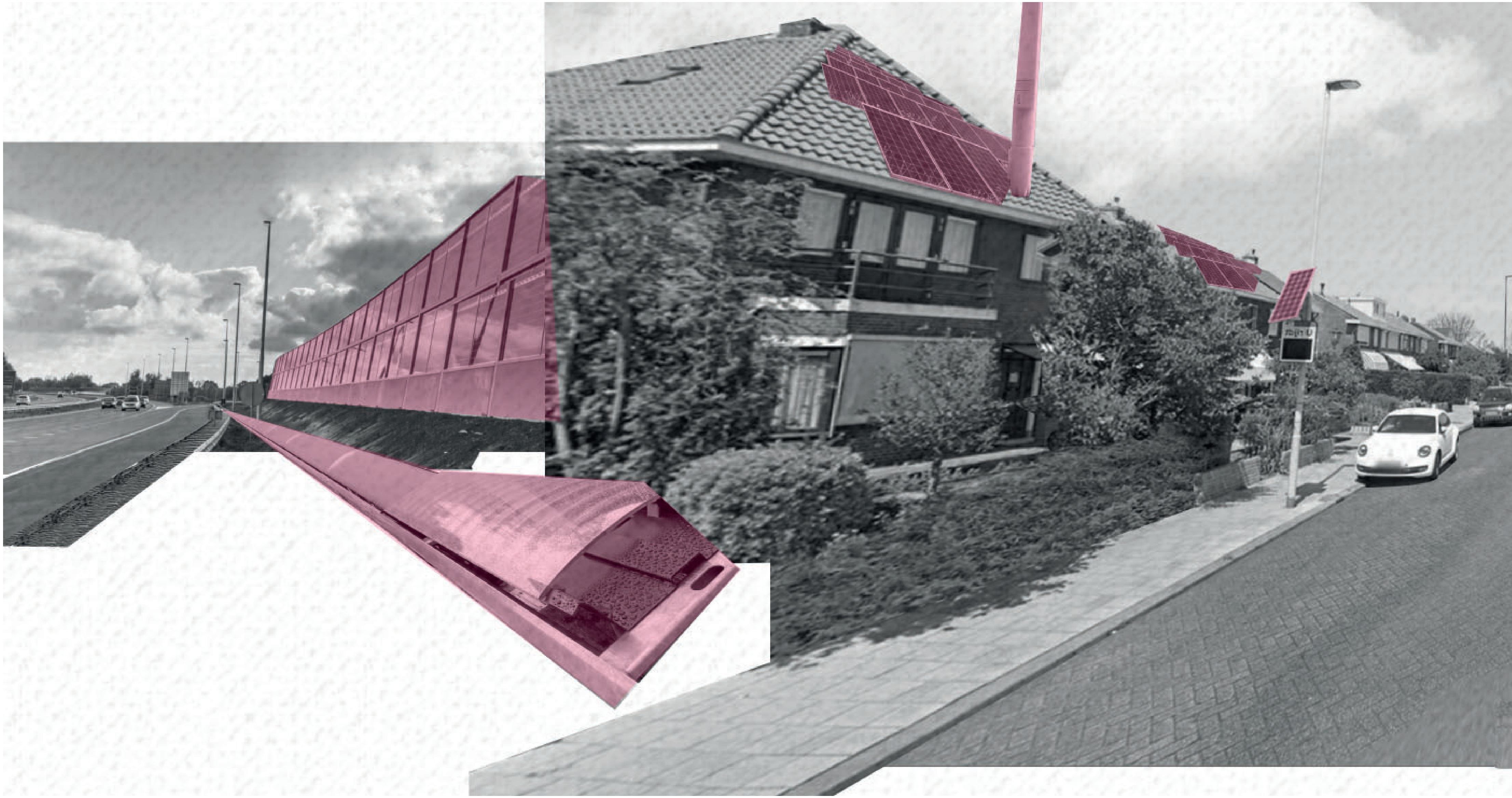
E

Natural interventions

- Only one land/infrastructure owner in form of government
- Clustered energy production
- Management and ownership in hands of (local) government

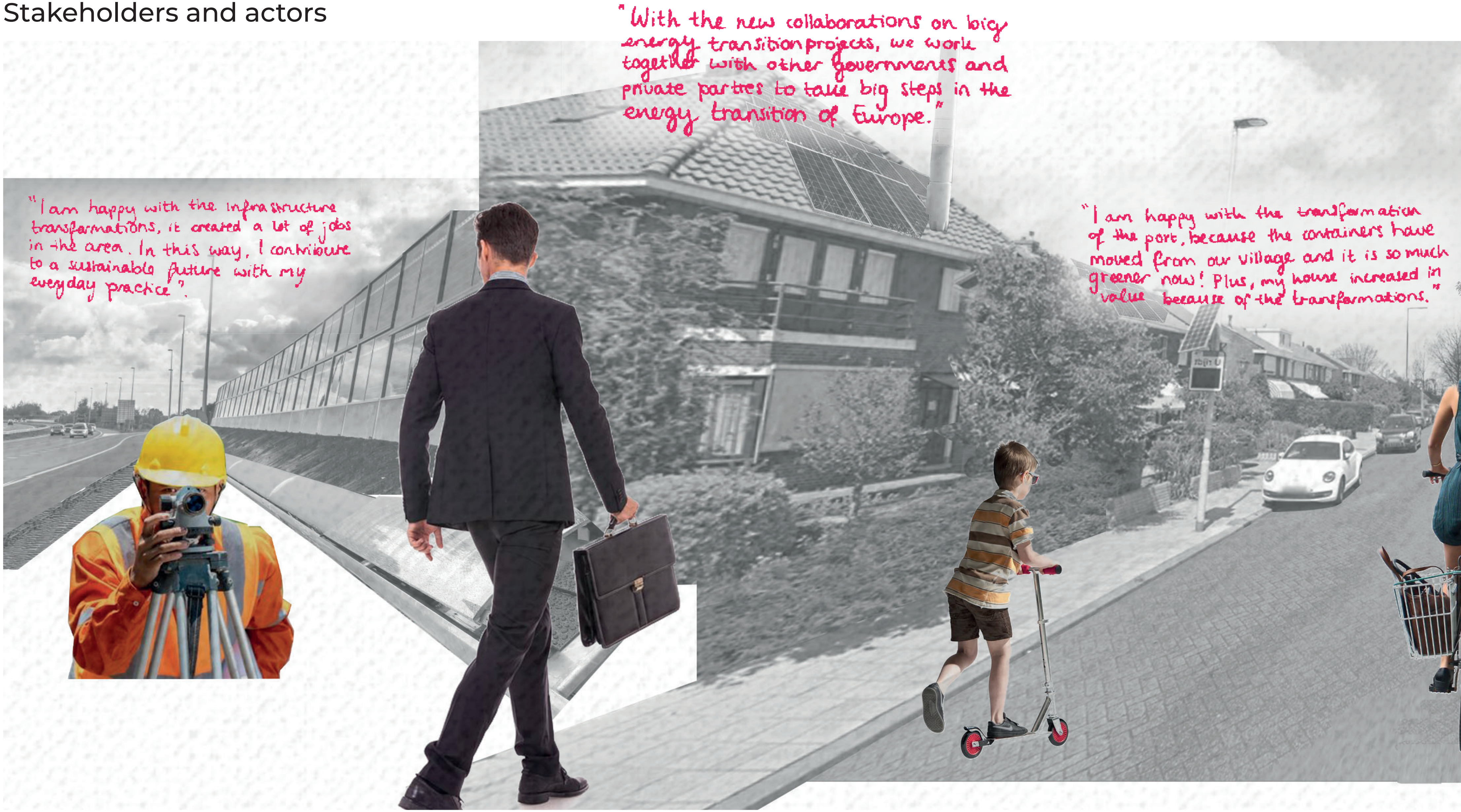
Zoom-in: Pernis

Spatial interventions



Zoom-in: Pernis

Stakeholders and actors




"We were looking for a quiet place to live, close to the city and then we found this new neighborhood in Pernis."
"With the subsidies from the government I was able to move my business to the other side of the Port for a fair price."
"Quack. quack".
CMA CGM

X _Conclusion

Tackling the CO2 emission problem is highly reliant on the energy transition. Although the energy transition in Northwest Europe has already started, we seem far away from reaching the goals that have been set. The main aim of this project was to contribute to the energy transition with the proposed integrated vision of both centralized and decentralized energy production systems. The use of hydrogen as a form of energy was a crucial way of accomplishing this vision. The production of this hydrogen was realised by encouraging all the countries of the region to work collaboratively together. The vision was then translated into a strategic framework with policies and projects with spatial interventions for the province of South-Holland as a case study. The new suggested policies were highly aligned with existing European policies and had built upon them. Moreover, the projects were highly interconnected to each other in terms of space and time. An extensive stakeholder research was done in order to accommodate and study the needs of all the stakeholders while aiming towards a just transition. After that, a deep zoom-in was done towards three different locations, where a toolbox for the decentralized system got extensively experimented. Finally, this report has provided a holistic approach of the energy transition, in which sustainable development and a just transition were the main two pillars, while at the same time it focused on improving the spatial quality of the studied locations.

XI _Discussion

The aim of this report is to contribute to these sustainability targets and show the way to a completely emission-free energy production by 2030. However, to achieve the sustainability goals, other sectors like transport, manufacturing industries, and agriculture also need to contribute to the transition.

The report investigates large-scale interventions, such as the creation of the North Sea ring with wind farms, and small-scale distributed energy sources, resulting in an innovative and integrated approach to the research subject. The actual spatial design for these large-scale interventions did not fit into the scope of this project. The created vision is transformed into a strategy for the province of South-Holland, the Netherlands, consisting of concrete interventions contributing to achieving the integrated vision. However, the tools and strategy used in this report can be adapted to the local context of the research area and used as a foundation or inspiration for other areas.

To improve the proposed strategies in this report, more research is necessary to evaluate the state-of-art energy production technologies, organizational structures, policies, and potentials of local contexts. Moreover, further research is needed to determine the climate footprint of the proposed interventions, as the production and material mining have a significant impact on the greenhouse effect. Due to the flexibility in the design options proposed in this project, no statements are made on the envisioned energy mix and the ratio between centralized and decentralized energy production. The same accounts for the calculations of the net energy production in the integrative system. Furthermore, deeper stakeholder analysis can be executed to create a more socially just and inclusive strategy. Before implementing the strategy, more research is needed on the effects of the implementations on, for instance, biodiversity, social justice, or the economy.

XII _Reflection

Sanne van Rees

"What is the role of a vision in the planning and design proposal of your group project and how has it influenced your development strategy?"

We have been aware about climate change for quite some time now, and yet it seems as though little action is being taken to tackle CO2 emissions and transform the fossil fuel industry. With energy production as one of the main polluters, the relevance of exploring renewable energy production systems is clear.

From the lecture by Carola Hein in the first week, we learned that our society stopped being circular when oil came around, because of the import and export flows for energy production and distribution (Hein, 2023). That is why we decided to focus on redesigning the system for energy production and distribution for our vision.

Governments like the United Nations are gathering and radical goals are being set, such as the SDG's and the aim of the European Union to become climate neutral before 2050, which is stated in the climate agreement from the Conference of Parties in Paris (UN, 2022 & Ministerie van Infrastructuur en Waterstaat, 2023). The same goal is set by the Dutch government (Ministry of Economic Affairs, 2016). That raises the question: How come that these goals are not yet enough translated into spatial interventions? During this quarter, we investigated this question.

Our research pointed out that to achieve these goals, action must take place as soon and as quickly as possible and the approach to do so must be made more efficient. The same collaborative agreement on acknowledging the problem should therefore be used for tackling it. We believe that integral and collaborative systems and processes are needed to translate the goals into real interventions (Sillak, Sperling, 2021 & Andrews-Speed, Van der Linde & Keramidas, 2014).

These interventions take place within different domains and locations, but also differ in sequence over time. Furthermore, the systems needed for these interventions flow across different scales and many stakeholders are involved in the process, some of which have conflicting interests. In order to be efficient and sufficient, the interventions needed for the energy transition need to be coordinated collaboratively across domains, but also be specific per location. Therefore, we decided early on in the design phase that because the topic of the energy transition contains problems and interventions across a large domain, the analysis of the topic and the vision for a solution should be investigated in two extreme scenarios (Rocco, 2023b). One (the centralized) representing the collaborative, almost top-down organizational structures and the possibilities on the big scale of Northwest Europe, and the other (the decentralized) representing the local spatial implications and the social justice aspect through a more bottom-up approach.

Methods for how to translate the vision into a strategic framework with interventions, such as creating a conceptual framework, exploring organizational structures, and theories about stakeholder engagement, we learned from the methodology lectures by Roberto Rocco and Marcin Dabrowski and then we implemented them in our strategy (Rocco, 2023a&b).

From the lecture by Roberto Rocco about social justice, I learned that social justice is both spatial and political. Distributive justice is about the creation and allocation of and access to public goods, where procedural justice talks about the decision-making process and the distribution of these public goods (Rocco, 2023c). In our research, we implemented distributive justice by creating an integrated energy production system that provides equal access to electricity as the public good. The procedural justice is implemented in the strategy, where we focus on bottom-up design and organizational processes with the decentralized energy production and distribution system.

Marah Echtai

Having worked as a social justice advocate for over five years, I was struck by the undeniable links between climate justice and social justice that I discovered in this course. The complementary approach between the Methodology course and the studio was the reason behind this. Additionally, this new understanding made me realize that we need to take a more holistic approach to be able to solve climate problems in a just way. This approach can be embedded in Networked Governance that allows constructive conflict to occur between the governing parties. In other words, democratizing the transition by giving space for public, civil, and private sectors to participate while also thinking about the interest of future generations. This was reflected in our project by using the organizational matrix which provided "management options" that reflected the governing type. Allowing different governing bodies with different governing types to take place would contribute to making the transition more just.

As a group, after researching the CO2 emission problem, we quickly agreed to focus our project on the energy transition. We had inspiring discussions about it, and each one in our group was a special asset. The Capita Selecta lectures gave us the needed push to be able to start. It broadened our perception of the problem and all the interconnected aspects of it. The circular economy lecture by Alex Wandl helped us to better understand the complex term of circularity, and thus we were later able to define how our project is contributing to it. Moreover, the energy flows are a global complex puzzle, changing any part of it in the province of South Holland will have consequences all around the world. This is what Carola Hein helped us to be aware of in her Energy Landscape lecture.

As we worked to resolve complex issues, the project was both ambitious and challenging, testing our limits. We were persistent despite the difficulties, and the experience proved to be extremely enlightening, providing us with valuable new skills and insights that will undoubtedly benefit us in the future. Furthermore, after making the vision on the North-West European scale and zooming in towards the province scale, the mission seemed to become harder. We became more aware of the stakeholders and how the big-scale vision would affect them. However, we were able to come up with methods that helped us tackle this problem such as the policy transfer method that was learned from good practices around Europe.

Having to link all the interventions and the policies to a timeframe, taught us by hard how complex our subject is. Designing for the future is challenging as we do not have the power to control, change, or even predict it. Dealing with uncertainties means proposing solutions that would provide resilient realities that fit the specific context of the project despite future challenges. What helped us to overcome this issue was Verena Balz's SDS lecture about (Strategic spatial planning & design) as we were able to link the policies to the physical interventions and define the vital milestones that are highly relevant to our vision.
As I continue to deepen my understanding of urbanism, I believe that Q3 was a significant addition to this matter. This quarter has helped me to realize the connections between sustainable urban development and social justice while emphasizing spatial qualities. Moving forward, I am excited and ready to explore these ideas further.

Max van der Waal

“What is the relation between research and design in your group project?”

The energy transition is a complex spatial planning and design challenge that requires extensive research about a variety of technological aspects. This project aimed to understand the current state of energy production and distribution technologies, state-of-the-art technological solutions, the goals that are set to reach an emission-free energy system, the different stakeholders involved in the area and how they relate to each other in a spatial context.

At the start of the project, an elaborate analysis was conducted on the current state of energy production in Northwest Europe, providing insight into the extent of the CO2 problem and the biggest emitters in the area. It was concluded that energy production takes a major stake in the problem (IEA, 2022). Therefore an analysis of the current state of the energy production system was necessary. This analysis involved questions regarding the current energy mix, types of renewable energy production, requirements for efficient utilization of energy sources, balance between energy demand and production, and the infrastructure that is needed for the energy grid to work efficiently.

Despite the technological nature of the research, the project team had to keep in mind the spatial implications of these technologies. Every bit of research had to start with the question, “How can this contribute to the spatial quality of Northwest Europe?” It was a challenge not to get lost in the (technological) research and ensure that all technological solutions were integrated into a spatial design that could enhance the quality of life in the intervention area.

Another essential aspect of the research involved identifying and understanding the different stakeholders in the area. This included analyzing the policies of individual countries and local governmental bodies, as well as the way they interact with each other (Rocco, 2023a). The project team had to determine the ways in which spatial interventions would be stimulated and planned, and investigate forms of regulations, stimulatory tools, and connection building (Rocco, 2023a) to ensure that proposals could be realized while remaining just and fair to all stakeholders.

This project was not just about understanding technological solutions, the current state of energy production, and its stakeholders. It was also a big exploration of design interventions that could contribute to accelerating the energy transition. The solutions and spatial interventions designed during the project form a foundation for future development in different intervention areas. Our team explored ways in which technologies can be implemented in spatial development projects without compromising on the local character and existing structures. In this way, the project was both a research for design and research by design, combined in one project.

IEA (October 19, 2022), Defying expectations, CO2 emissions from global fossil fuel combustion are set to grow in 2022 by only a fraction of last year’s big increase. Retrieved from

Stephan Hosie

I think the vision for our group was more or less clear, of what the end result should look like. Naturally and without having to discuss too much, we knew already from the start what the general picture was.

When we started researching the topic, and looking up the current state of things, we came across things that we hadn't considered beforehand which also reshaped the vision and tweaked details here and there. Some of it, made us go back and reconsider what we were envisioning, sometimes it was too ambitious, unrealistic, or maybe even not part of the problem. The research process, though, was very enriching and positive for the whole project (and the group itself, much of what we found out was completely new for us and it taught us a lot about the topic. For example, the hydrogen story we really didn't know much about and it made us reconsider the focus of the wind farms in the North Sea, including the infrastructure for the hydrogen backbone, and direct the project in that direction) and only made the argument stronger for what we were cooking up with. It was a very smooth process all and all.

It wasn't until we dived in depth and started drawing and putting our ideas over the paper that we realized that for the same general vision, there were many ways of getting there, different variants and focuses that the actual design process could follow. Each of us had different interests and preoccupations that influenced the way we were coming up with the design solutions. By the end of this process the four of us had each their own variant of the same picture, some were more socially oriented, others had more of a spatial preoccupation, or even a functional aspect of the whole. The two main scenarios approach allowed then us to condensate the ideas and interests into the models that then we merged to get to the conjoint solution for the main design.

I liked the way the course was thought out. The broad topics of water, nitrogen, and co2 are not, at first glance, things that can be spatially addressed but by landing it and contextualizing them into the territory we realized that there is nothing that doesn't have spatial implications, or functional processes embedded in them. Just like the carbon cycle already implies a function and a space where it occurs and how it does so. Also, being so broad meant that we could link them to different problems and have different approaches between the groups, address the same topic and still come up with different research questions about it.

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