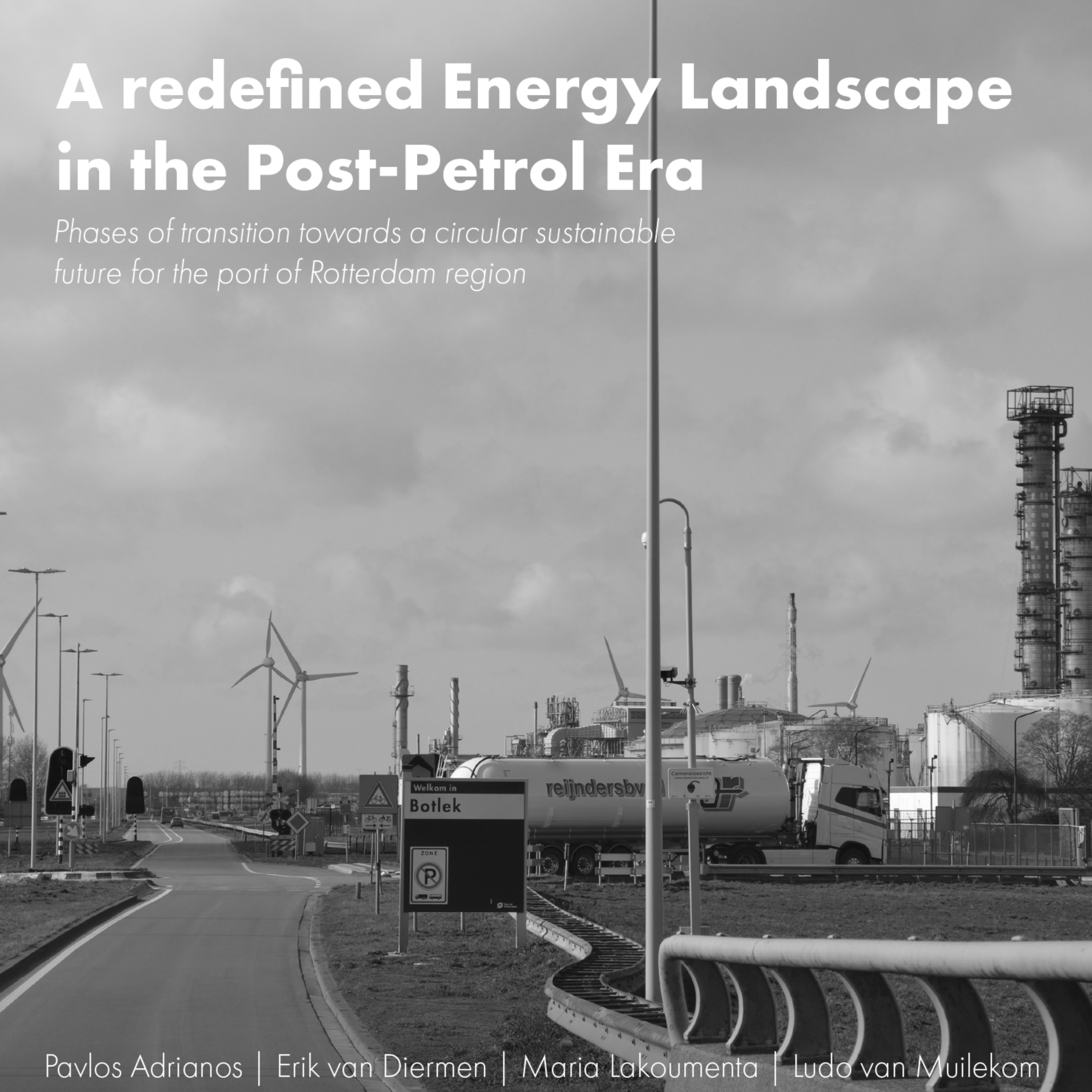
A redefined Energy Landscape in the Post-Petrol Era

Phases of transition towards a circular sustainable future for the port of Rotterdam region



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ABSTRACT

Keywords | Circular economy, spatial justice, energy transition, decentralized energy network, renewable energy, the Post-Petrol era, port of Rotterdam

The importance of the energy transition is an emergent issue on a global scale. The United Nations, the European Union, the Dutch National government and the Province of South-Holland all have set clear and urgent goals. But still, it seems very hard to find the right strategy to tackle this challenge, together with a desired circular economy and without letting people behind.

The Province of South Holland envisions sustaining the region with the port of Rotterdam as an important energy node for Europe and the region itself. Now, the port still relies heavily on petrol, which will become obsolete in this transition. Therefore, the petrol dependency endangers a sustainable and secure future for the port of Rotterdam region.

The energy transition will be achieved through three phases from 2020, to 2030 and 2050 in an aim to gradually phase-out fossil fuels and phase-in renewable alternatives, together with increasing levels of circularity and social inclusion. Hence, this process revolves around the integration and intertwining of three main pillars that shape the framework of this project: Energy transition, Spatial justice, Circular economy.

In the post-petrol era of 2050, the region of Zuid Holland will embody a dynamic and adaptive energy landscape. This new energy landscape will become more resilient and autonomous. The landscape will consist of an interdependent and just network of actors and relies entirely on renewable energy sources.

In the future, we envision the port of Rotterdam to be an important node on the global and regional scale. The futural port will be the core of the decentralized energy network in the region, consisting of several energy nodes that connect autonomous energy regions that will be self-sufficient in the production of energy. Besides, these nodes are serving as hubs for energy storage, raising awareness, education and other social activities. This is how we want to open up the port and the energy network to the public and establish a new cultural relation with the use and production of energy. The development strategy will reveal how individuals from all origins and walks of life will be included and can adapt to this change. Since, not only public actors have high interest to make this transition happen, private actors and citizens that have to change their business models and daily activities have to be considered. Therefore, the strategy also reveals how different stakeholders can work collaboratively and what actions are needed to combat the energy transition together. On the global scale, we propose an invert of global energy flows, from the import of Petrol to the export of hydrogen, to maintain the level of economic importance in the energy sector.

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30
km/h
30

1
INTRODUCTION

1.1 Context

On the European and global scale, the region of South-Holland with the port of Rotterdam is an important node with accessibility for the largest vessels and extensive intermodal connections, consisting of railways, inland shipping, roads and pipelines with the rest of Europe. Moreover, the port has a global significance as one of the largest fuel hubs, with a top 3 global position as a bunkering port, diversifying from oil to biofuels (Port of Rotterdam Authority, n.d.-a). Besides, with 192 Mt Rotterdam is the largest port of Europe and is covering nearly half of the cargo transshipments annually. Within the context of Rotterdam, 44% of these wet bulk transshipments of up to 100 million tonnes of crude oil, predominantly coming from the Middle East, the North Sea region and Russia, enters the port. Subsequently, it is transported to refineries in the Netherlands, Belgium and Germany through an extensive pipeline network (Port of Rotterdam Authority, n.d.-b; Facts and Figures Port of Rotterdam, 2021, p. 2).

On the national and regional scale, the Port of Rotterdam is an important economic force as 385 thousand people work in and around it every day (Facts and Figures Port of Rotterdam, 2021, p. 12). In order to meet national climate goals, the Province of South-Holland needs to balance the repurpose of this important regional energy node with renewable alternatives and maintain its economic strength by getting private actors aligned to change their activities. At the same time, the daily activities and the living and working environment for the people in the province will change; this will also create a social challenge of acceptance and inclusion.

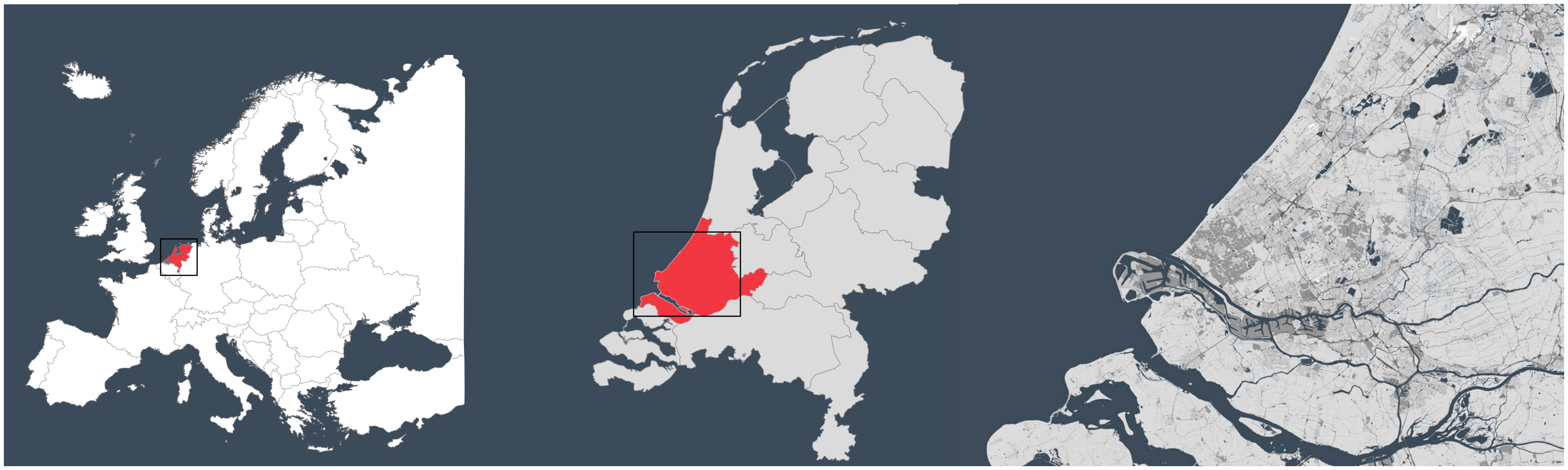


Figure 1 Location region in Europe and the Netherlands

Figure 2 Route Fieldtrip

Fieldtrip Results

On February 14th, a field trip was organized to study the region surrounding Rotterdam's harbor. Schiedam was the starting point. This is where the group gathered and the field trip began. We traveled from Schiedam to Pernis. We selected Pernis because we figured it would be fascinating to see how the port activities in the area effect the town's atmosphere. We observed that the port's activities were both visible and audible. However, we discovered that a green buffer between the port activities and the town helped to reduce the town's visual and auditory pollution. We traveled along the south side of the Botlek Harbour Basins from Pernis to Rozenburg.

This is where we first noticed and felt the port's real size. Rozenburg was a long way from the port compared to Pernis. There was less noise, and the port appeared to be a long distance away. We came upon a building site where a new tunnel was being built below the Nieuwe Waterweg. This tunnel would connect the port's south side to the Westland greenhouses, cutting travel time from an hour to twenty minutes. We took a ferry from Rozenburg to Maasluis. Maasluis was the first city we discovered that was no longer connected to the port. The field trip came to a close at Vlaardingen.

1.2 Problem Statement

"The petrol dependency endangers a sustainable and secure future for the port of Rotterdam region."

Fossil fuels, and more specifically petrol, are still dominating as the primary sources for the global energy network. Until recently, they have been fundamental drivers of change in many aspects of human activities including the technological, social and economical sectors. However, except that they are finite and non-renewable, they bring a significant amount of negative externalities. Amongst them, they contribute significantly to climate change due to carbon dioxide emissions that come as a result of the processes of extraction and use (Ritchie, 2020). According to research, we can only keep on emitting the same amount of carbon dioxide as 2019 for 13 more years in order to maintain a 50% chance of staying below 1.5°C of global temperature rise. (Cambridge Econometrics, 2020). These effects are also apparent on a local scale in terms of air pollution, which especially in urban agglomerations can be linked to fatal health diseases per year globally (Ritchie, 2020).

Oil dependency negatively affects the economic sustainability of Europe and consequently the region of South Holland, which relies heavily on petrol-related activities. Since 80% of crude oil and 95% of refined oil that is imported in the European Union comes from non-European companies, we can clearly understand the relatively small and not equally distributed economic benefits that originate from petrol related activities (Cambridge Econometrics, 2020).
Inequality of distribution is also evident spatially, as a large amount of space is dedicated to petrol related activities. Only the refineries in Rotterdam port take up to 2200 acres of spaces, while pipelines dedicated for fossil fuel distribution span up to 1500 km (Hein, 2018). If we also consider the terminals, road infrastructure and all fossil-fuel related activities we end up with a large share of space within the region of South Holland. This space is mostly privately owned while benefits for the people as well as accessibility are limited.

In conclusion, petrol dependency has negative implications on all three pillars of sustainability, environmental, economical and social. Hence, transition to other forms of energy keeping in mind sustainability and circularity, is imperative.

PRODUCTS AND SERVICES	Number of sites	Site (x1000 m2)	Number of employees
OIL AND OIL PRODUCTS			
Oil Refining	6	8970	3271
Refinery Terminals	6	3680	142
Tank Terminals for Oil Products	9	3842	535
CHEMICALS, BIOFUELS AND EDIBLE OILS			
Chemical Manufacturing and Products	42	9289	6167
Biofuels Manufacturing and Products	4	553	260
Edible Oil Refineries	5	411	477
Tank Terminals for Chemicals, Biofuels and Edible Oils	16	2908	843
GAS AND POWER, COAL AND BIOMASS			
Gas Fired Power Plants	9	250	107
Coal and Biomass Fired Power Plants	5	1325	594
Wind turbines	-	-	-
Natural Gas Terminals	2	530	-
Coal and Biomass Terminals	8	2307	-
PIPELINES AND UTILITIES			
Industrial Gases and Water Plants	7	483	634
Pipelines	3	50	40
Total Industrial Cluster	122	34598	13070

Figure 3 Industrial Cluster of the Port of Rotterdam (Havenbedrijf Rotterdam, 2020)

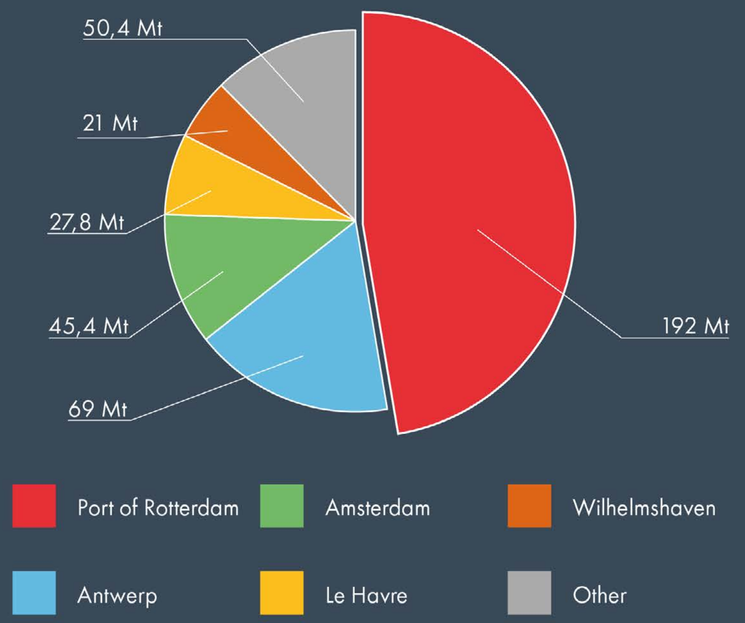


Figure 4 Cargo Transhipment of 10 largest port of Europe (Havenbedrijf Rotterdam, 2020)

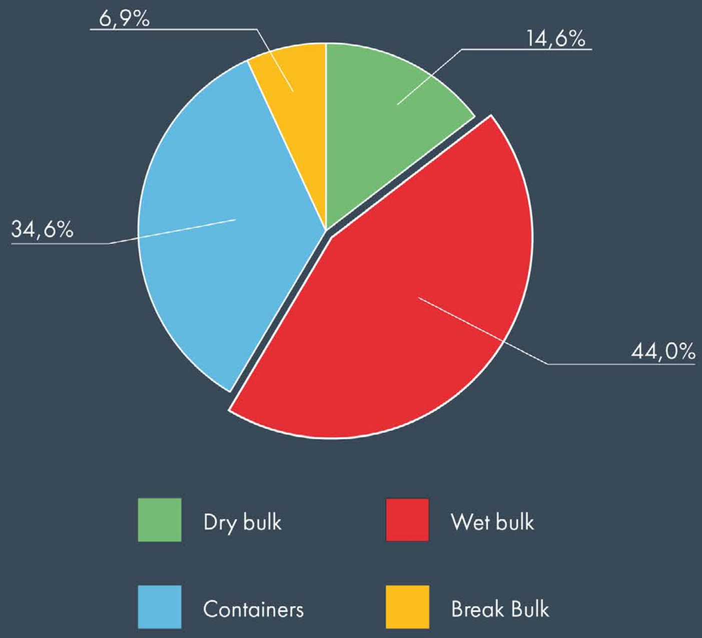


Figure 5 Cargo Transhipment in Rotterdam (Havenbedrijf Rotterdam, 2020)

1.3 Goals

Significance of the Project

The United Nations Sustainable Development Goals helps to structure the goals and aims of this vision. Therefore, we ordered the SDG's to identify how the assignment is structured. Ten SDG's identify the significance of the assignment.
First and foremost **Climate Action**, the main goal of this assignment is to decrease climate change by implementing a new energy landscape that uses renewable energy sources rather than fossil fuels. As a result, **Renewable Energy** is the second strategy in this assignment. The use of renewable energy sources will lead to the third strategy which is **Sustainable Cities and Communities**. In order to attain these objectives, optimization is required. The essential instruments to employ for the new terrain are **Innovation and Infrastructure**.
The redefinition of the Energy Landscape needs to lead to **Good Jobs and Economic Growth.** Climate action is the primary driver of this redefinition. As a result, good jobs and economic growth will aid in the improvement of **Life on Land**, as the new Energy Landscape promotes **Responsible Consumption of energy** and R**educed inequalities**. The utilization of **Quality Education** to educate people is a crucial pillar in achieving all of this. This will assist individuals in understanding the reasons for the changed Energy Landscape and how to effectively implement it. Last but not least, new **Partnerships for the Goals** must be formed in order to realize them. (United Nations, 2022)

Figure 6 Sustainable Development Goals (United Nations, 2022)

Figure 7 Collage energy landscape Pernis-Botlek 2050

Vision statement

In the post-petrol era of 2050, the region of Zuid Holland will embody a dynamic and adaptive energy landscape. This new energy landscape will become more resilient and autonomous,. The landscape will consist of an interdependent and just network of actors and relies entirely on renewable energy sources.

The redefinition of the energy landscape will be achieved by focusing on three main pillars: the gradual energy transition, spatial justice and circular economy.

Activities / relation - spatial justice
By changing industrial activities, the identity of the port of Rotterdam region will be preserved and reinvented as an renewable energy node. Hereby, an energy paradigm shift is realised: a new cultural relation with energy use and production.

Resilient
By establishing a diverse composition of renewable energy sources, the region will become more robust. In this way, the region will be less dependent on one source of energy.

Because of this the new energy landscape will be adaptable to change which also contributes to the resilience of the energy landscape.

Autonomous / interdependent
Simultaneously, the energy network will be more efficient and energy consumption will be reduced. This will be achieved by implementing small-scale solutions in a decentralized energy network, as it will reorganize power structures, improve energy efficiency as well as decrease energy demand.

Just
This will result in a healthier, safer and less polluting port where activities for the people will take place, thus creating a new cultural relation with the port of Rotterdam. The accountability and responsibility of the

Renewable
The new energy landscape facilitates a phase out of fossil fuels and a phase in of alternative energy sources. This transition will happen gradually. Taking into account different interests and investments of different stakeholders.

Policies of Governments

In order to set goals for the new Energy Landscape of 2050, it is necessary to investigate policies and goals of the main stakeholders in the Port of Rotterdam region. In this region, the municipality of Rotterdam and the Port of Rotterdam Authority are the governments of the local level. The South-Holland Province governs on a regional level, while the National Government governs on a national level.

Municipality of Rotterdam
In the coming years the municipality is aiming to generate energy in a different way and cleaner, distribute differently and reduce demand (Trias Energetica). In addition, the municipality will start to close material chains. This means other electrification of processes and use of hydrogen as an energy carrier in the industrial complex of the port. Residual heat is used to heat the urban area to make our housing stock more sustainable together with the urban mobility and transport to/in the port. (Municipality of Rotterdam, 2021)

Ambitions:
Solar: Majority of energy generation in the Built Environment with use of solar panels, as much as possible. This can be combined with infrastructure. Not in the landscape because of the effect of green space.

Wind:
The municipality will investigate new locations for wind parks. The municipality will keep in mind the impact of wind parks in the landscape.

Heat:
The municipality aims to a more efficient use of residual heat from port activities and industries. Also, more use of geothermal, aquathermal and other small scale sources.

Infrastructure energy system:
A reinforcement of the electricity grid is necessary. More cables and pipes for the landing of wind energy from wind farms in the North Sea, expansion of the heat infrastructure, facilitating geothermal facilities and more energy storage and charging points are needed to balance supply and demand.
(Municipality of Rotterdam, 2021)

Port of Rotterdam Authority
The electrification of various industry processes is anticipated to be one of the primary topics to which the Port of Rotterdam authority responds. As a result, several investments must be made in order to begin this shift. In addition, this electrification has a significant impact on the mobility industry. The government must adjust to autonomous and electric modes of transportation. The capacity to store electricity rather than consuming it directly is an essential piece of the jigsaw in making this all happen. Another crucial step is to transform them to molecules rather than electrones. Like other government agencies, the Port of Rotterdam Authority aspires to be CO_2 neutral by 2050.

The port has set goals in their vision to be more circular in 2050:
1. The Rotterdam factor, of European importance;
2. Global Hub, digital and efficient
3. Europe's Industrial Cluster, competitive and in transition.
4. Connection Port, City and Region
5. Space for Development
6. Human Capital

Innovative-Ecosystem

The first three point can be combined. As 'Global Hub' and 'Europe's Industrial Cluster', the harbor of Rotterdam is of great economic importance for Europe and the Netherlands. Therefore, Rotterdam should play a leading role in the transition towards new economic standards. Therefore, Rotterdam should adapt to digitalization and automatization, strive for implementing the use of alternative fuels and enable electrification and high efficiency of all transportation modes.

The final four points can also be combined. The coming changes should lead to the economic activities of the harbor and the city to become more synergized and intertwined. New possibilities for attracting urban economic activities (innovation). An attractive high quality environment for new companies and future residents.
This requires high quality education, encouraging entrepreneurship, attracting new talent, boosting research facilities, support for start-ups and scale-ups and regulations that enable innovation, workspaces and meeting places for innovative entrepreneurs.
(Havenbedrijf Rotterdam, 2019, p. 22-23)

Province of South Holland
In addition to the National Government's policy goals, the province of South Holland has defined it's own policy goals for the energy transition. In the policy document Watt Anders (Provincie Zuid-Holland, 2016), the province is aiming for a 1.5% reduction of energy consumption per year. Goals for CO2 emissions are also included in the document. These objectives were interpreted as fossil-free goals. The reduction in CO2 emissions is defined as the percentage reduction in fossil fuel consumption. (Provincie Zuid-Holland, 2019).

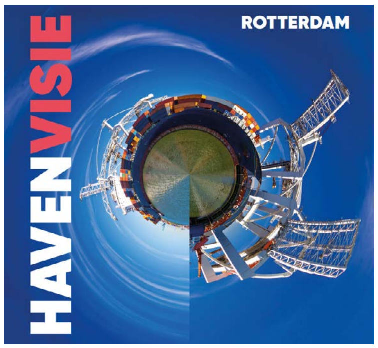
Ambitions:
Build Environment: CO2 neutral in 2035
Industry: Work with innovations to facilitate transition to renewable energy
Greenhouses;CO2 neutral in 2050, most amount of heat-use is generated with geothermal energy or residual heat.
Mobility & Infrastructure:CO2 neutral in 2050

National Government
The Dutch national government does not have any energy usage or energy transition targets, according to the coalition agreement (VVD et al, 2021). Instead, they've set CO2 reduction targets. This can be linked to the use of fossil fuels. This provides insight into the future reduction of emissions. The government aims for:

- 55% reduction in 2030
- 70% reduction in 2035
- 80% reduction in 2040.
- The latest aims are a 100% reduction in CO2 emissions in 2050 (Jetten, 2022).

The national government also has a variety of funding available to assist citizens, companies, and other stakeholders in the transition. The Dutch government worked in 2019 on a law that forbids the use of coal for the production of electricity from 2030 (Wet verbod op kolen bij elektriciteitsproductie (35.167), 2019)

Conclusions
In addition to the policy goals of various governments and public groups, a table was created to make the vision's goals more understandable. Some of our goals contradict those of other governments and organizations, as we learned. In this table, we compile and select goals that, in our opinion, simplify the transition. This will be the key guiding principle for the transition's development strategy.



Omzien naar elkaar, vooruitkijken naar de toekomst

Coalitieakkoord 2021 – 2025

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15 december 2021

1.4 Research Methodology

The vision for project adresses the energy transition of South Holland, integrated with the establishment of a circular economy and an equal distribution of benefits and burdens for all concerned.

The strategy explains how this should be organised, in a phased construction, together with all stakeholders from civil society, the public and private sector.

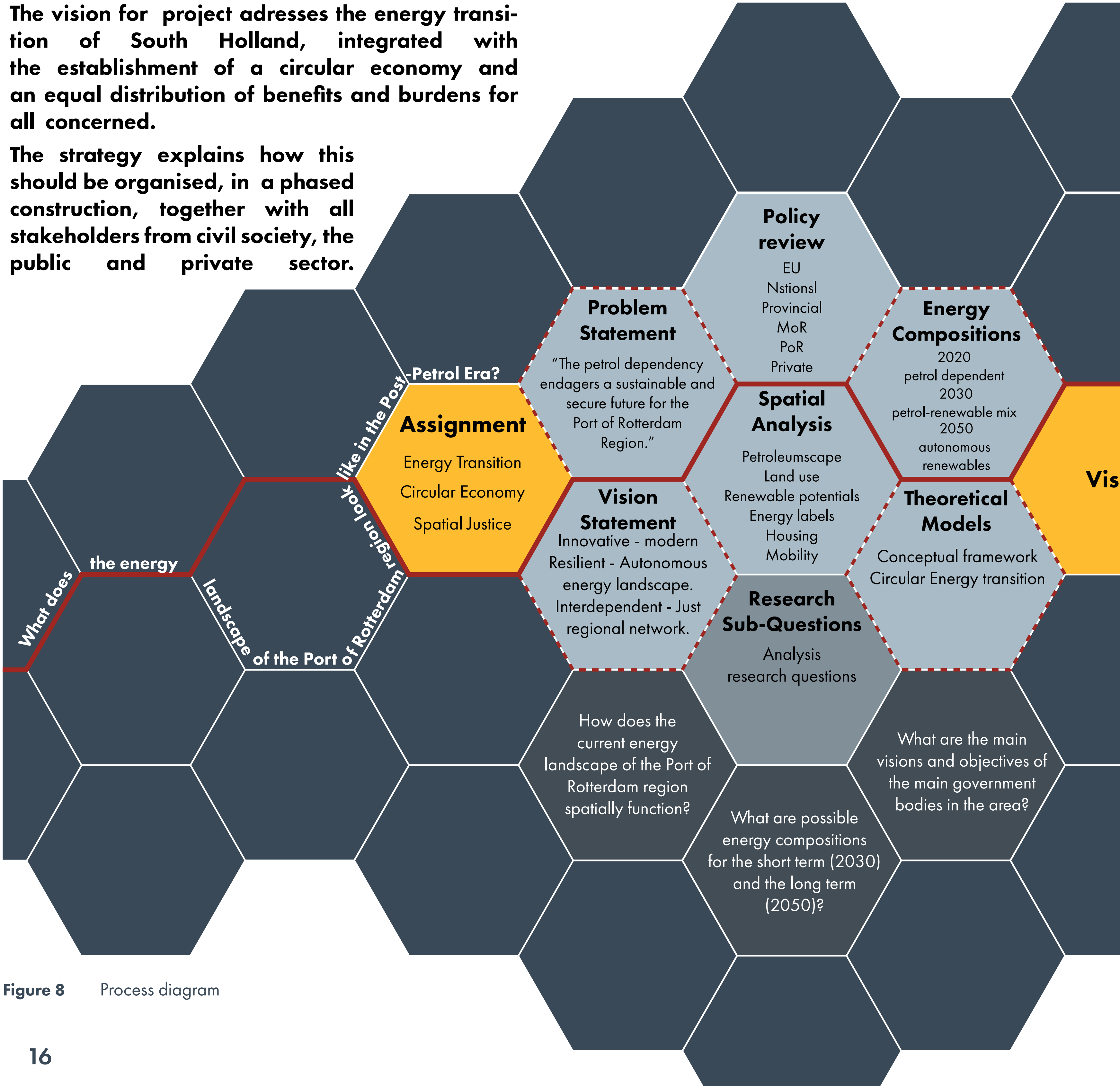
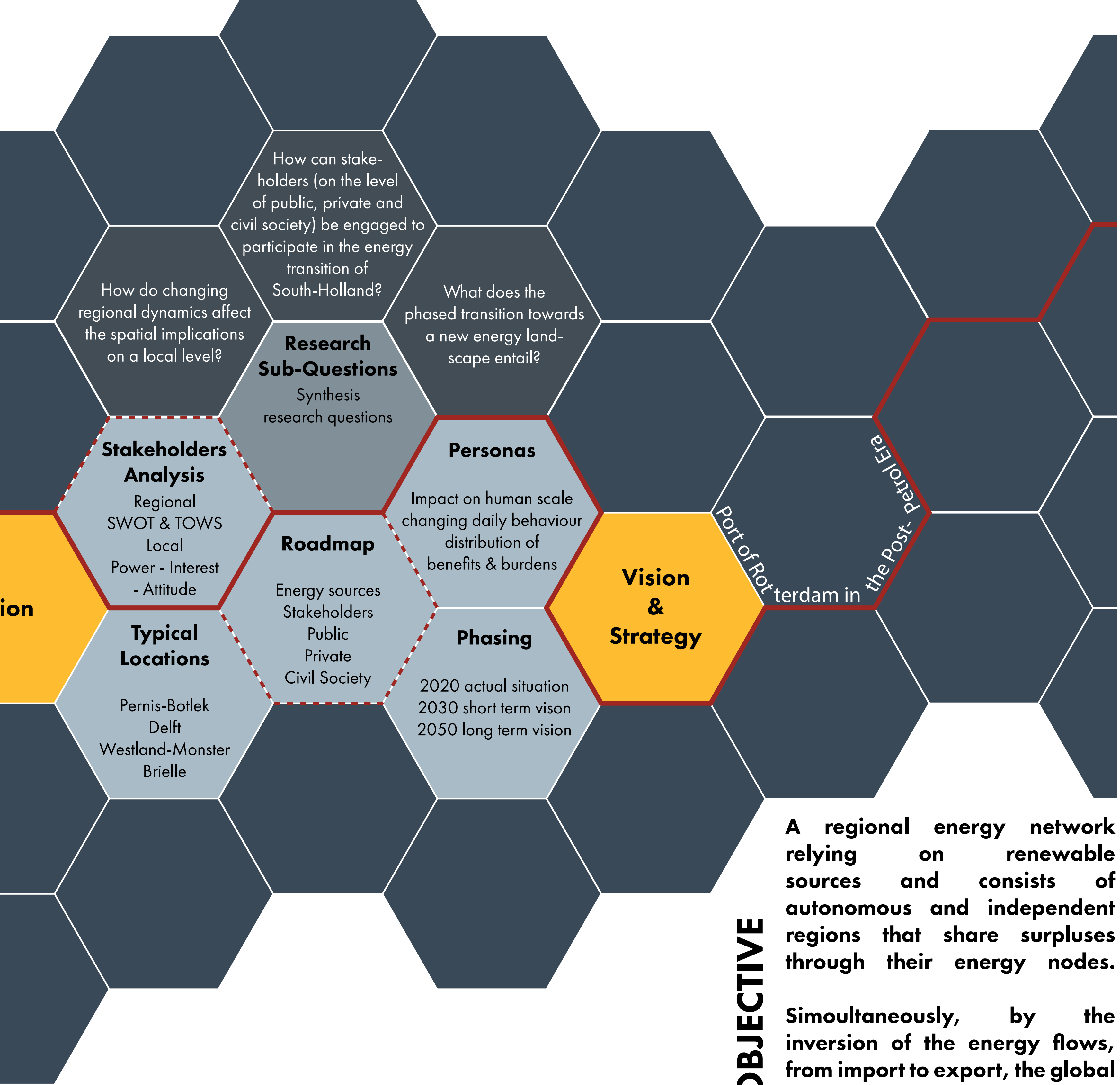


Figure 8 Process diagram



OBJECTIVE

A regional energy network relying on renewable sources and consists of autonomous and independent regions that share surpluses through their energy nodes.

Simoultaneously, by the inversion of the energy flows, from import to export, the global importance for the Port of Rotterdam is maintained in the transition to the Post-Petrol era.

Conceptual Framework & Circular model

This conceptual framework is designed to achieve the goal of a 'Post-petrol region of South-Holland'. As the Port of Rotterdam is known as an important energy node for Europe, the energy transition of this region is of high significance as well. Especially, considering concurrent transitions like the one to the circular economy and the achievement of broader climate goals, it comprehends a complex challenge. However, on the regional level it will also mean it will cause a huge impact on the human scale. It will change the way we live, work and move around. Therefore, it is crucial to make sure the distribution of benefits and burdens associated with the transition are equally divided. In order to make sure all important aspects are considered, the three tree pillars 'Energy Transition', 'Circular Economy' and 'Spatial Justice' were chosen and integrated. Every pillar consists of two hexagons, both with a stronger relation with the adjacent pillar.

Spatial Justice
Energy poverty is already a daily struggle for people in the less affluent parts of the urban environment. As mentioned by the European Commission (2020) 8% of the people in Europe have difficulties with keeping their home warm enough. When the energy transition is demanding changes, for instance in terms of retrofitting, this will cause additional challenges.

The way how the energy transition will be spatially organized will have an effect on who will be able to live in the city. The concept of the 'right to the City' is coined by Lefebvre (1968) as one of the first and more recently covered by Harvey (2008; 2012) who argues that citizens should be able to get more involved in the management of their cities. For instance, when former industrial areas are solely developed by the market, prices will be unaffordable for lower-income groups. Within the philosophical debate, this way of inclusion leads to a more people-centred approach where the process of working is shared with different layers in society, and moving away from a paternalistic traditional to a more participatory democracy (Fisher, 1990; Held, 1987) or discursive democracy (Dryzek, 1990). Therefore, participatory governance could be an important concept to make sure the voices of all stakeholders are represented in the ongoing debates about (spatial) developments (Fischer, 2012).

Energy transition
Renewable energy is the energy of the future. Today these forms of energy are already present, however, in some times still limited. In order to be ready for tomorrow, a lot of research, investment and experimenting have to be carried out. When leaving fossil fuels to the past, we move away from a strong dependency, in phases to gradually adapt. Since there is a strong power imbalance with large influential actors in the energy landscape of today, change is going slow. On one hand, large private and public actors are profiting our common finite resources and using oil as a geo-political tool. On the other hand, other (smaller) players and individuals are keen to change faster, but are held back, since their level of power is limited and the existing energy landscape and governance is obsolete. Therefore, a new and more just decentralized energy network is envisioned, with new role divisions between energy users and producers.
Next to a challenging technological aspect of the energy transition, there is the challenge of social acceptance. With the changing energy system, the daily lives of people will face changes as well. In the scientific debate this is understood as a Socio-technical system. For instance, Norman (1993) & Goguen (1993) state that techno-centric approaches do not integrate the complex interaction between social, environmental and technical factors. Lawhon & Murphy (2012) emphasize geographers are increasingly becoming aware they need to consider frameworks, where not only elite actors are included to prevent tensions, are necessary to achieve successful implementation. At the moment the port becomes more and more dominated by large machinery. People are also physically excluded from energy this way. When the energy transition goes in synergy with opening up port with its energy activities, possibilities arise for a new cultural relation with energy production and consumption.

Synergies between pillars
For instance, the decentralization of the regional energy network is incentivized by the emerging need for a demonopolized network. The transition to renewable energy sources has to be organized in different phases to give actors and systems time to participate in this change. Both the circular economy and energy transition demand adaptations in the built environment, and therefore, new investments have to be done; to make sure these changes are accessible for everyone.

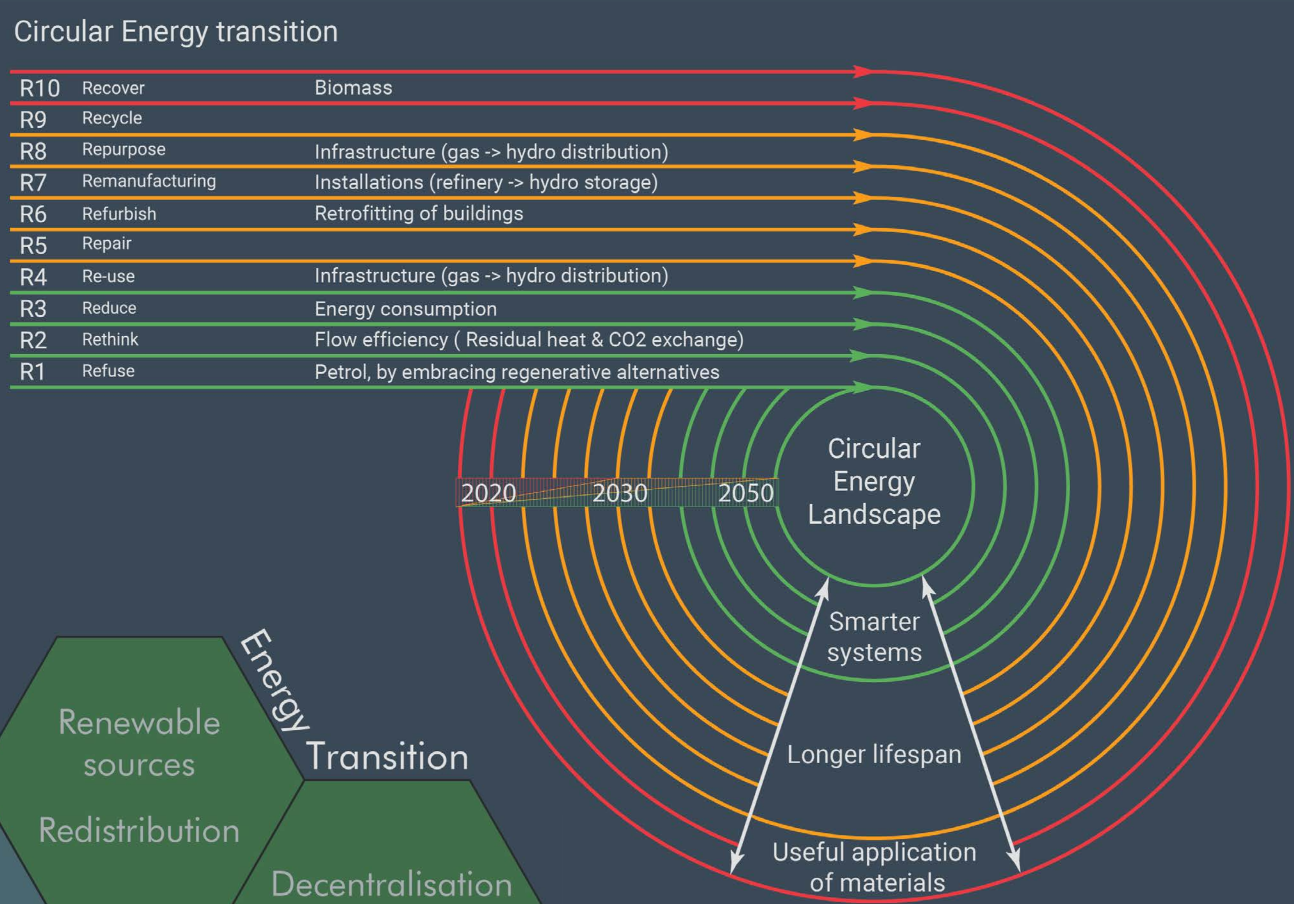


Figure 9 Circularity Diagram

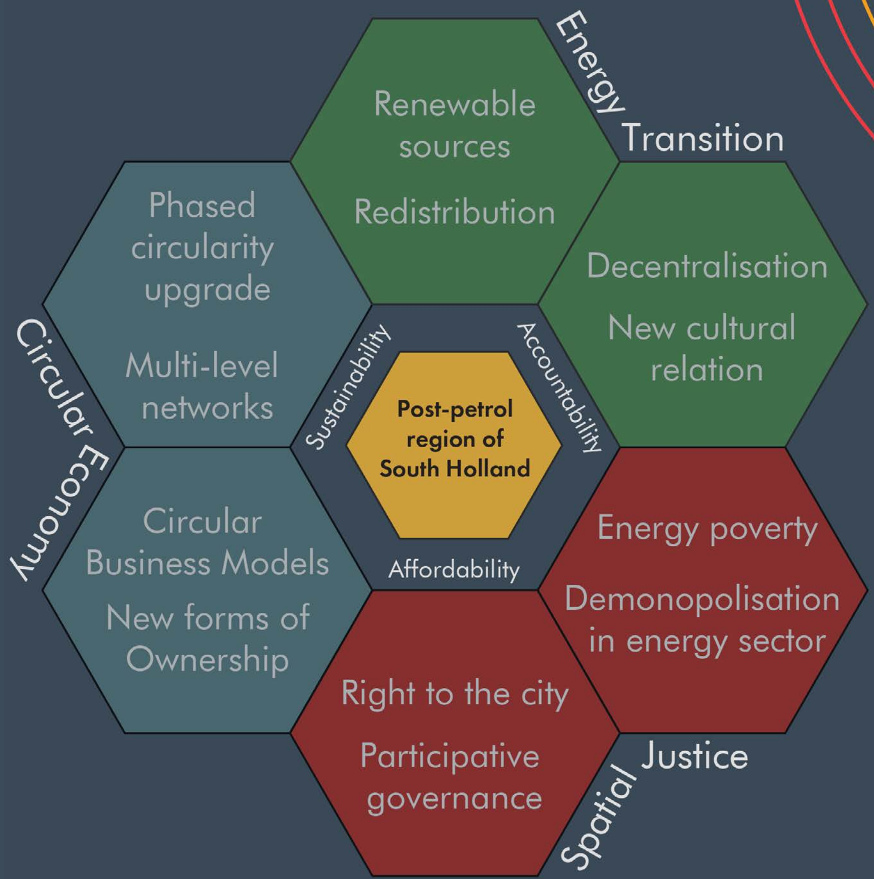


Figure 10 Conceptual Framework

2
ANALYSIS

2.1 Current energy landscape

Petroleumscape

Port of Rotterdam as a global node
The port of Rotterdam is a major global node of petrol and petrol-related chemical products. One of the main reasons for the establishment of a long span and strong position of Rotterdam in the global oil network, is its key location and connectivity to a large number of markets (Port, n.d.).

The main petrol related activities in the port can be classified in three categories: oil refineries, chemical industry and vegetable oil refining. Five oil refineries, 45 chemical companies and five vegetable oil refineries create a dense cluster within the boundaries of the port of Rotterdam (Refining, n.d.).

However, the port is not isolated and is part of a larger cluster in North-Eastern Europe. Along with other refineries in the Netherlands, Belgium and Germany, the port of Rotterdam forms the ARRRA cluster (Antwerp-Rotterdam-Rhine-Ruhr-Area) which account for 40 per cent of the petrochemical activity within the European Union (Refining, n.d.).

The size and facilities provided by the port of Rotterdam, create an environment ideal for large-scale production of chemicals, fuels and oils which are used for domestic use in Europe or for global trade (Refining, n.d.). Furthermore, structural advantages of the port such as the depth of water along with an extensive infrastructural network of pipelines, renders the port of Rotterdam ideal for petrochemical activities (Crude, n.d.). More specifically, the network of pipelines is more than 1500 kilometers in length and thus all these companies are interconnected. Via this network, liquid bulk can be efficiently distributed within the port and to other destinations (Port, n.d.). Amongst others, some advantages that the pipeline network of the port offers to companies refers to the availability and space available for new pipeline construction, leasing opportunities and connectivity within the ARRRA cluster.

Furthermore, pipelines primarily belong to the companies and refineries and as a result a significant amount of them serve for dedicated connections for specific products and routes. (Pipeline, n.d.)

Due to the advantages that the port of Rotterdam provides in terms of location and size, major players of the global fossil fuel market, including petrol, are operating through Rotterdam. Amongst them, there are four oil refineries of global scale, three industrial gas producers and thirteen large-scale tank storage and distribution companies (Port, n.d.).

Crude Oil
In terms of crude oil, specifically, Rotterdam is again dominating Northwest Europe. Every year around 95 to 100 million tonnes arrive at the port, at the Europoort and the Maasvlakte terminals. Most of the amount of crude oil entering the port of Rotterdam, comes from the Middle East, the North Sea and Russia (Crude, n.d.). Half of the amount of petrol is used by refineries within Rotterdam such as BP, ExxonMobil, Gunvor, Shell and Vitol, where crude oil is turned into for global trade (Refining, n.d.).

Furthermore, structural advantages of the port such as the depth of water along with an extensive infrastructural network of pipelines, renders the port of Rotterdam ideal for petrochemical activities (Crude, n.d.). More specifically, the network of pipelines is more than 1500 kilometers in length and thus all these companies are interconnected. Via this network, liquid bulk can be efficiently distributed within the port and to other destinations (Port, n.d.).
various fuels and products such as gasoline, diesel, kerosene and heating oil (Oil, n.d.). The rest of the amount is transported to the ARRRA cluster for the same purposes (Crude, n.d.).

Pipeline Network and Global Flow of the Port of Rotterdam

Legend

Oil flows

Nodes

Pipelines

Refineries

Gas Stations

Petrol

Figure 12 Pipeline Network connected to the Port of Rotterdam

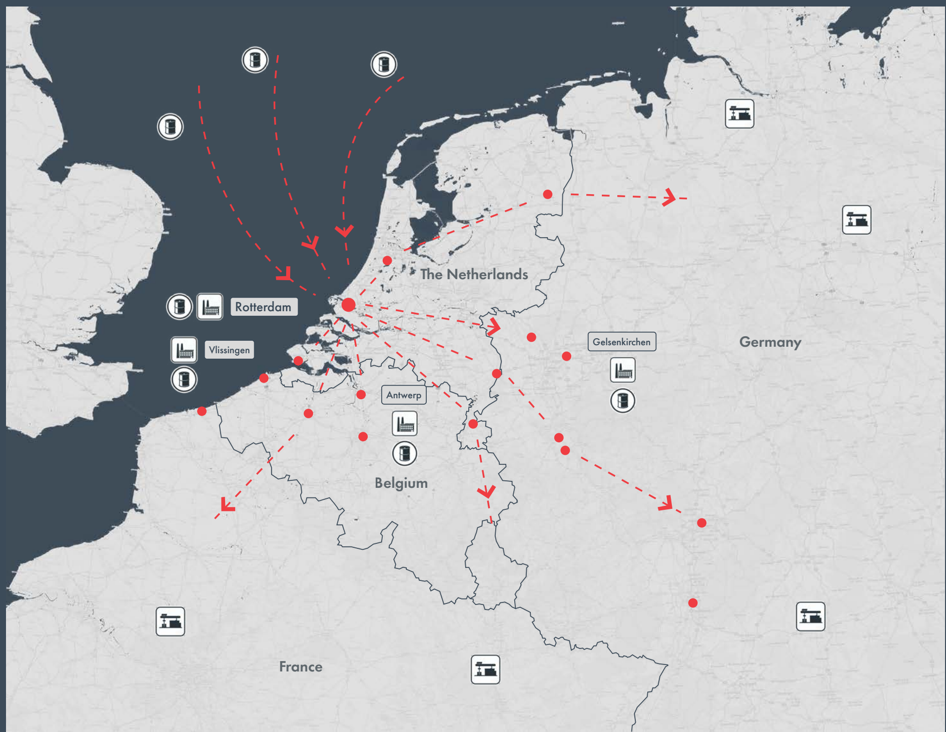


Figure 11 Global flow of the Port of Rotterdam

Petrol-Dominated Region of South Holland (region map)
All these petrol-related activities have a substantial impact not only in the port, but in the region of South of Holland in total. As Carola Hein writes in her research, “Oil drilling equipment, refineries, storage tanks, pipelines, dedicated road and rail infrastructure, and gas stations serve the physical flows of oil in industrial areas as well as in everyday life. Headquarters, research facilities, housing, cinemas, and leisure facilities are linked to the financial streams of oil. All stand as material witnesses to the invasiveness of petroleum, but some of them are much more subtly connected to petroleum flow” (Hein, 2018). In the following map, most of these elements are included into one map to express the extension of the petroleumscape throughout the whole region of South Holland. A massive amount of space is of course occupied by refineries and terminals in the port. The refineries alone use 8.970.000 m2 (Facts, 2016).

Petrol domination extends also in other parts of everyday life such as everyday mobility and consumerism, and its spatial implications can also be seen in this map. Infrastructure dedicated to the mobility of people and goods, uses a large amount of space through highways and gas stations that are spread in order to serve some of these uses of petrol. Petrol related products have become a substantial part of everyday life and have created dependencies, not only for people but also for companies and governments and other parties, rendering the change to sustainable forms of energy a significant challenge (Hein, 2018).

The global influence of the port makes the problem even more complex. Its position in the market and dependency on international flows of petrol and profit that stem from these activities dictate an approach that takes into consideration these relationships. In order to become less dependent on petrol and fossil fuels in general, a solution should be to consider a way for the port to maintain its position as a global energy node.

Spatial Justice
The extension of the petroleum has a negative impact on the share of space used by people. All these dedicated spaces for refining, storage and distribution of petrol require a large amount of private space for these activities. These spaces are mainly privately owned. In the energy transition phase, this space can be potentially redistributed and used to improve quality of life and the environment. An opening of space means it can be accessed and used by more people and thus become an active part of the region. If we also consider the amount of space dedicated for private mobility, this space is a significant part of the region. In the energy transition, a change in mobility patterns can be expected, affecting also land use and everyday mobility of people and goods.

Petrol-related companies in the Port of Rotterdam

Legend

Refineries

1. BP
2. Gunvor Petroleum
3. Koch
4. ExxonMobil
5. Shell

Terminals

6. MOT
7. Shell Europoort
8. TEAM
9. MET
10. Vopak Europoort

0 1,50 3,00 4,50 km

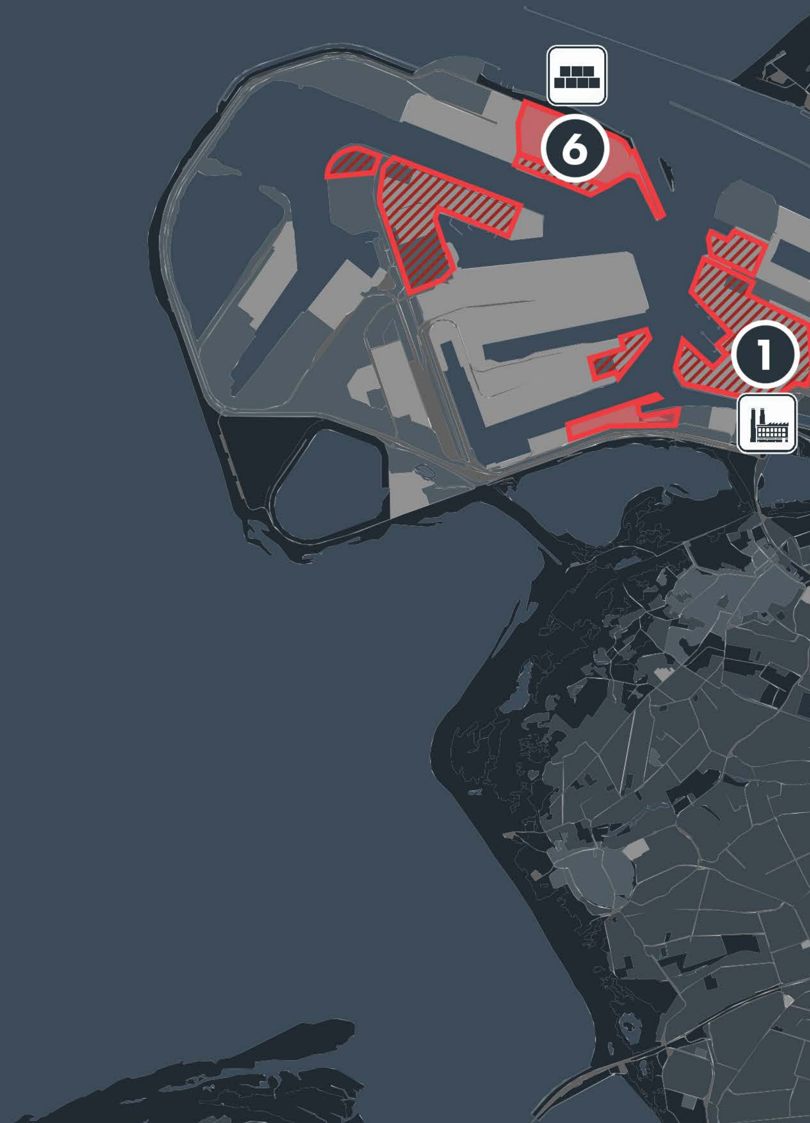
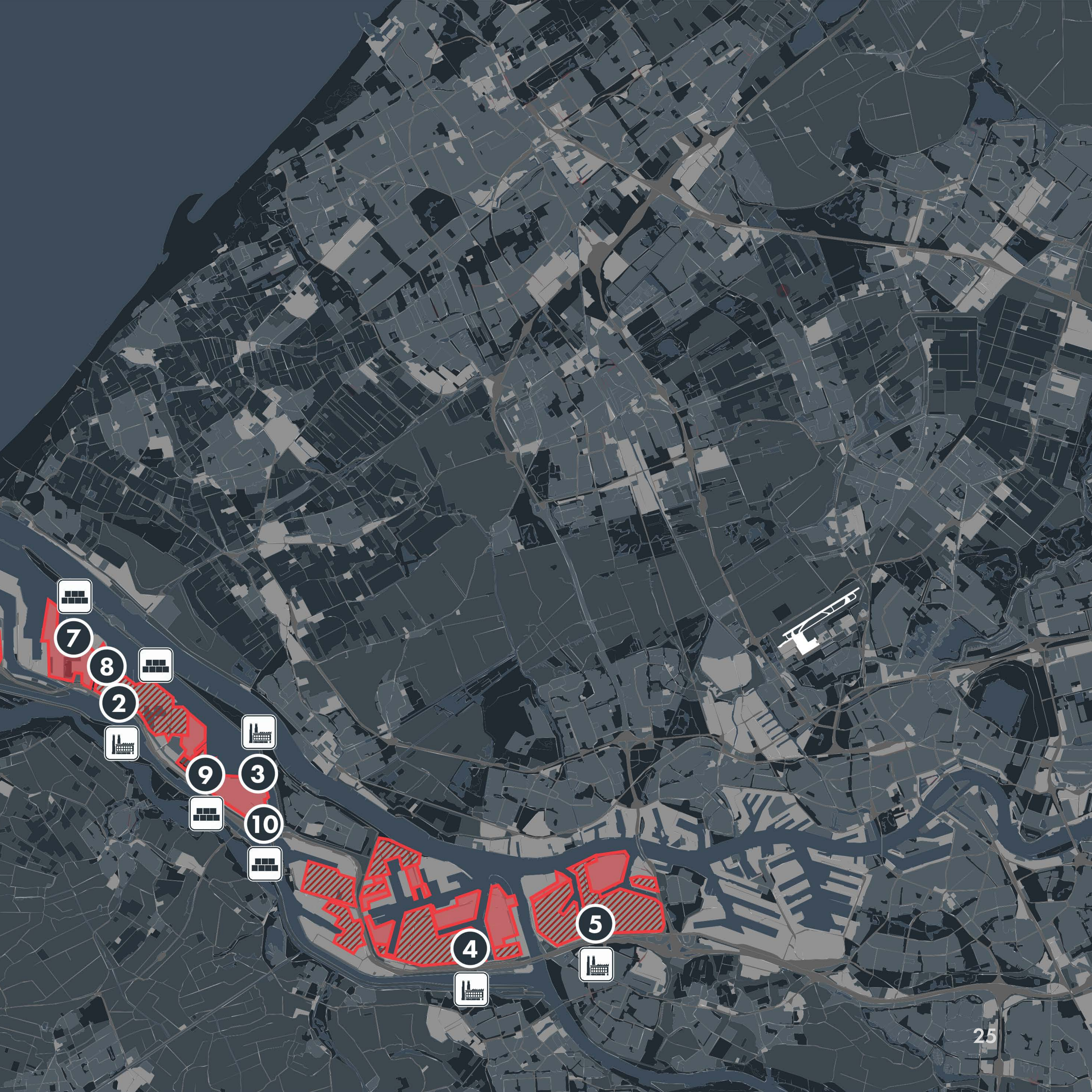


Figure 13 Petrol-related ompanies in the Port of Rotterdam


7
8
2
9
3
10
4
5

Petroleumscape in the Region

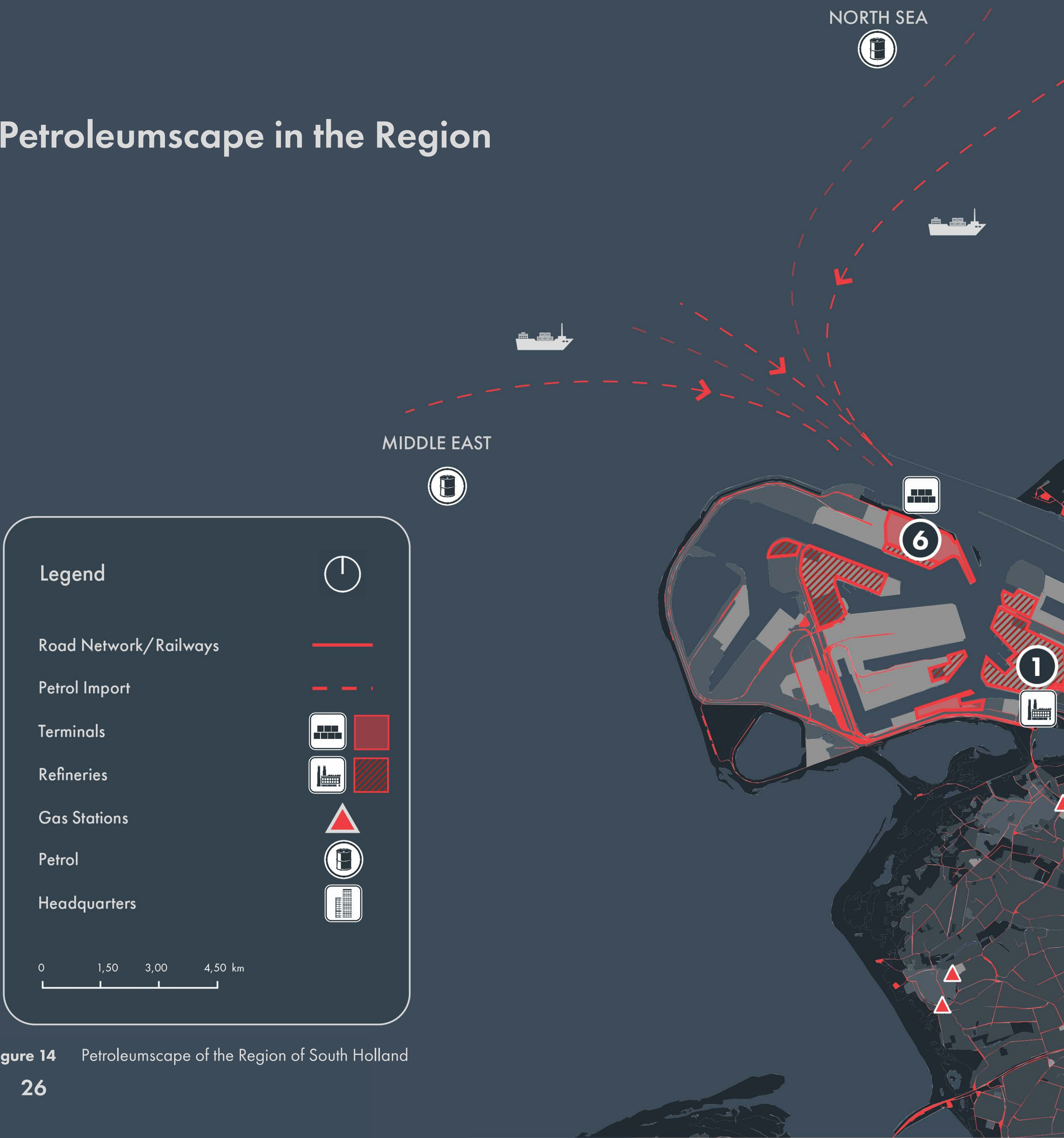


Figure 14 Petroleumscape of the Region of South Holland


RUSSIA
7
8
2
9
3
10
4
5

Environmental impact of the Port of Rotterdam

As part of the analysis, the environmental impact of the Port of Rotterdam on the surrounding landscape was investigated. The research of this investigation was mostly about various types of pollution. In the map, the main highlights of noise-, air-, soil- and water pollution are mapped.

Air pollution
The port of Rotterdam is home to a variety of activities. These activities, in particular, pollute the air in the area. Different hotspots can be classified in the map. The Port of Rotterdam is host to two of these hotspots. Coal-fired power stations are the cause of these hotspots. Burning coal for energy generates emissions that move generally northeast. This is due to the fact that the Netherlands' main wind direction is southwest. These hotspots generally produce PM10 particles (Rijksinstituut voor Volksgezondheid en Milieu (RIVM), 2020a). For this reason, the hotspots have been situated far away from the city. In addition to this, a different hotspot can be found at the east side of Rotterdam. This is a PM2,5 hotspot. This means that an increase in particular matter is found no larger than 2,5 Micrometers. Shipment repairment activities are the source of this hotspot (Rijksinstituut voor Volksgezondheid en Milieu (RIVM), 2020b).

Noise pollution
The port of Rotterdam is a large contributor to the high noise levels of the area. In the dataset of Rijksinstituut voor Volksgezondheid en Milieu (RIVM) (2017) the port of Rotterdam area is fully covered in dark colours indicating the noise pollution. This is mainly caused by the busy port activities. The noise pollution fades away the further the distance to the port.

Soil pollution
According to the dataset of the Provincie Zuid-Holland (2015) there is no data available of the adjacent areas of the port of Rotterdam. The most polluted areas can be found between Leiden and Gouda. However, these areas have no relation to the port.
In the south of the province, Provincie Zuid-Holland categorizes this area as 'Light polluted'. This means that the amount of pollution is not very high.

Water pollution
The port waters are the main waters that consist of pollution. The activities and ships are the main cause of this pollution. However, the dataset (Informatiehuis Water, 2015) speaks of moderate water quality. This means that the ecological qualities of these waters are moderate. When it comes to the various waters in the area, moderate was the poorest classification. Additionally, the Haringvliet is also contaminated. However, the port's impact in these waters is minimal. As a result, a different source is responsible for the pollution of these waters.

Figure 15 Environment Map

Landscape in Maps

Wind Energy in 2020

In the current situation, the wind energy is generated by wind turbines spread across the coastline and the wider region of South Holland. The wind energy is generated into electricity used mostly by the industries in the port of Rotterdam and the greenhouses. The urban agglomerations use a very small amount of wind energy. According to the map the gradience of green color indicates the amount of electricity consumption. In dark green color, we see the refineries, in lighter green the greenhouses and in grey color the urban agglomerations. It is clear from the map that the amount of electricity from wind turbines is not that significant.

Legend

Areas of electricity consumption

Refineries

Greenhouses

Urban agglomerations

Wind energy production

Wind turbines (existing)

Flows

Electricity flow

0 3,50 7,00 10,50 km

Elements of the region

Greenhouses

Refineries

Urban agglomerations

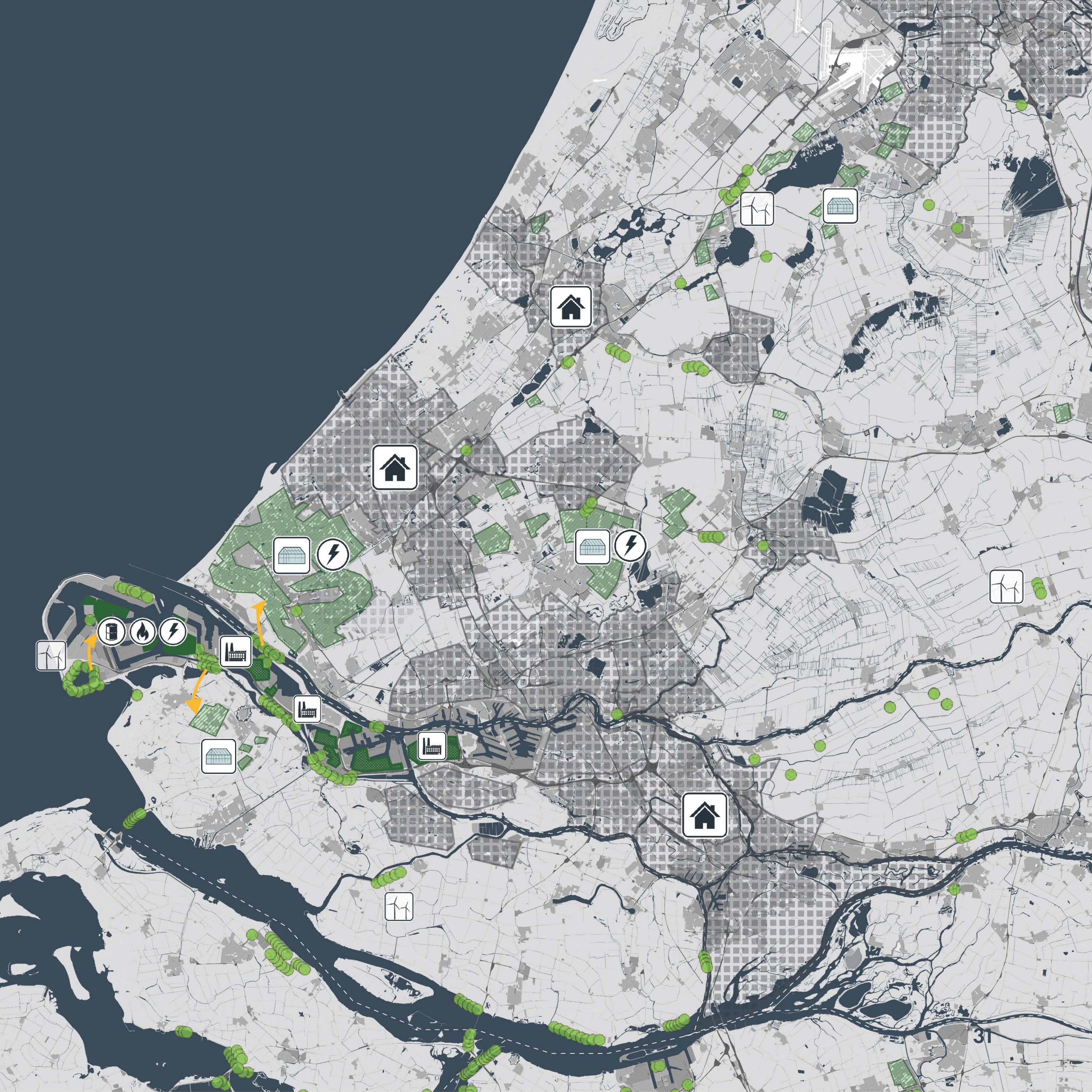
Materials

Electricity

Petrol

Natural gas

Figure 16 Current Wind Energy Landscape



Solar Energy in 2020

In the current situation, there is a significant number of solar parks across the region of South Holland. Solar energy leading to electricity is mostly used by the industries in the port of Rotterdam and the green houses while there a very small amount of solar energy used for urban agglomerations. The gradience of orange color indicates the amount of electricity consumption in the area. In the map, in darker orange color, we see the refineries, in lighter orange the greenhouses while in grey color the urban agglomerations. It seems that the amount of electricity generated by solar fields has to be reinforced.

Legend

Areas of electricity consumption

Refineries

Greenhouses

Urban agglomerations

Solar energy production

Solar parks (existing)

Flows

Electricity flow

0 3,50 7,00 10,50 km

Elements of the region

Greenhouses

Refineries

Urban agglomerations

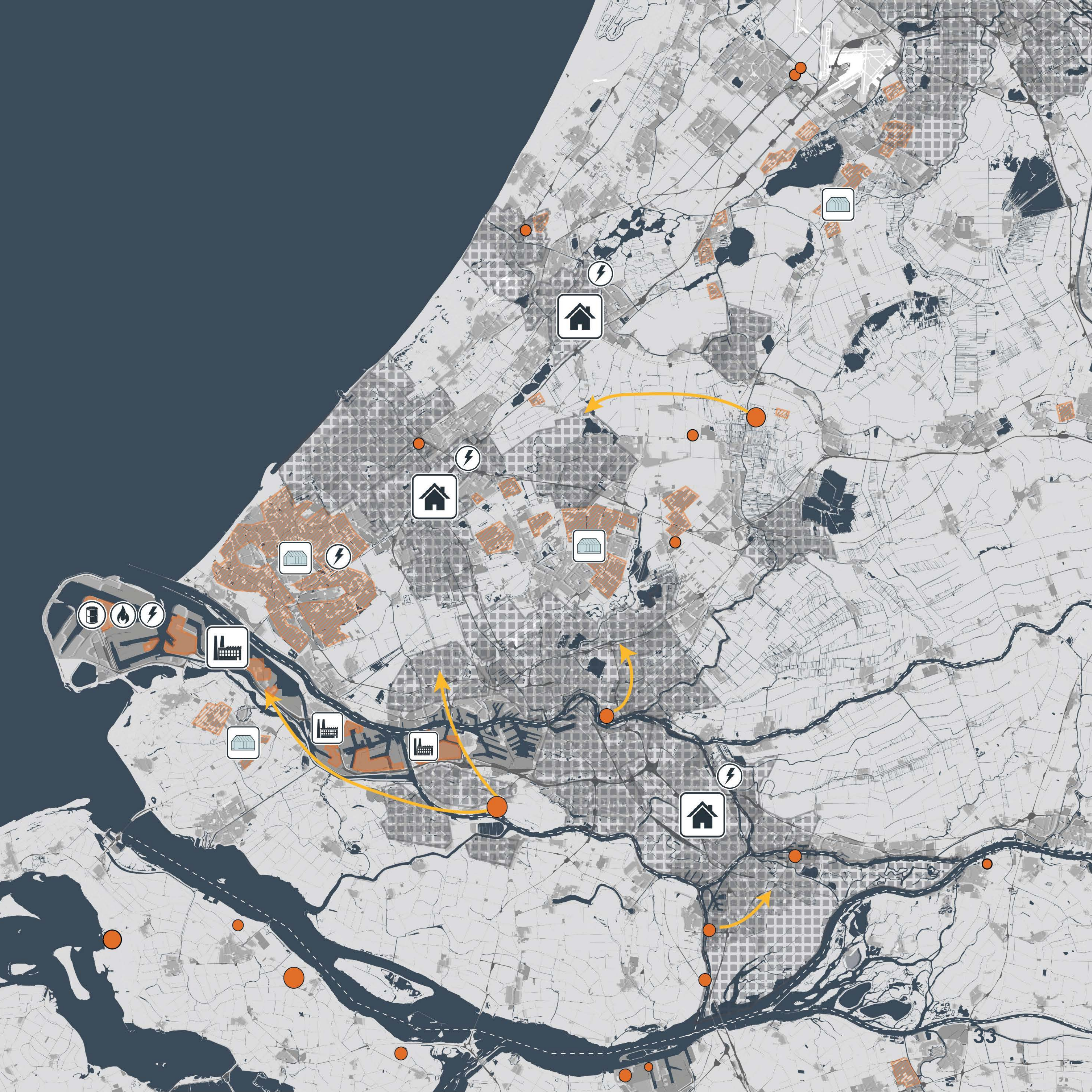
Materials

Electricity

Petrol

Natural gas

Figure 17 Current Solar Energy Landscape



Geothermal Potential

The use of geothermal energy in the current situation seems weak. However, there is a strong potential for geothermal energy in the future. From the map it is clear that there is a significant geothermal potential for industries, greenhouses and urban agglomerations in the future.

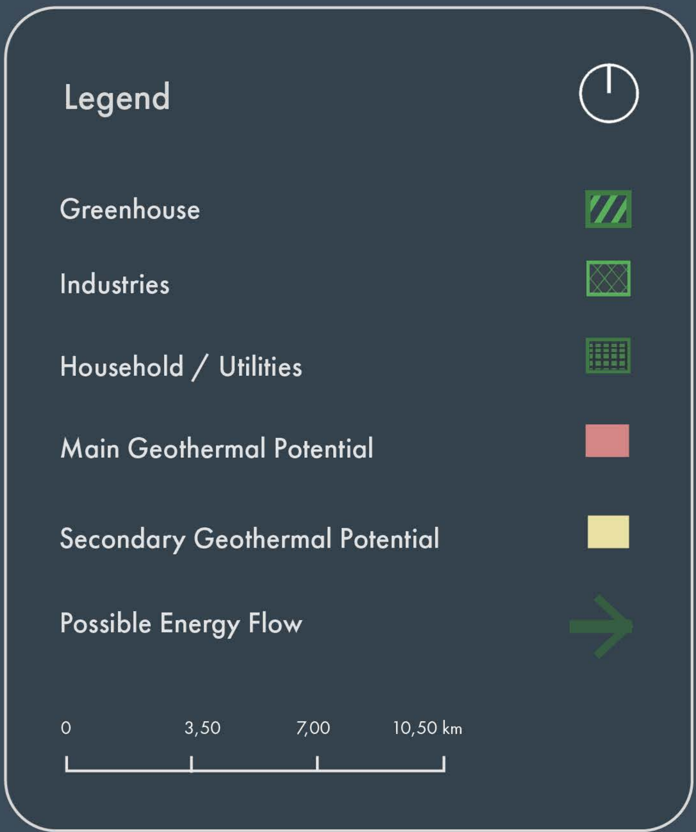
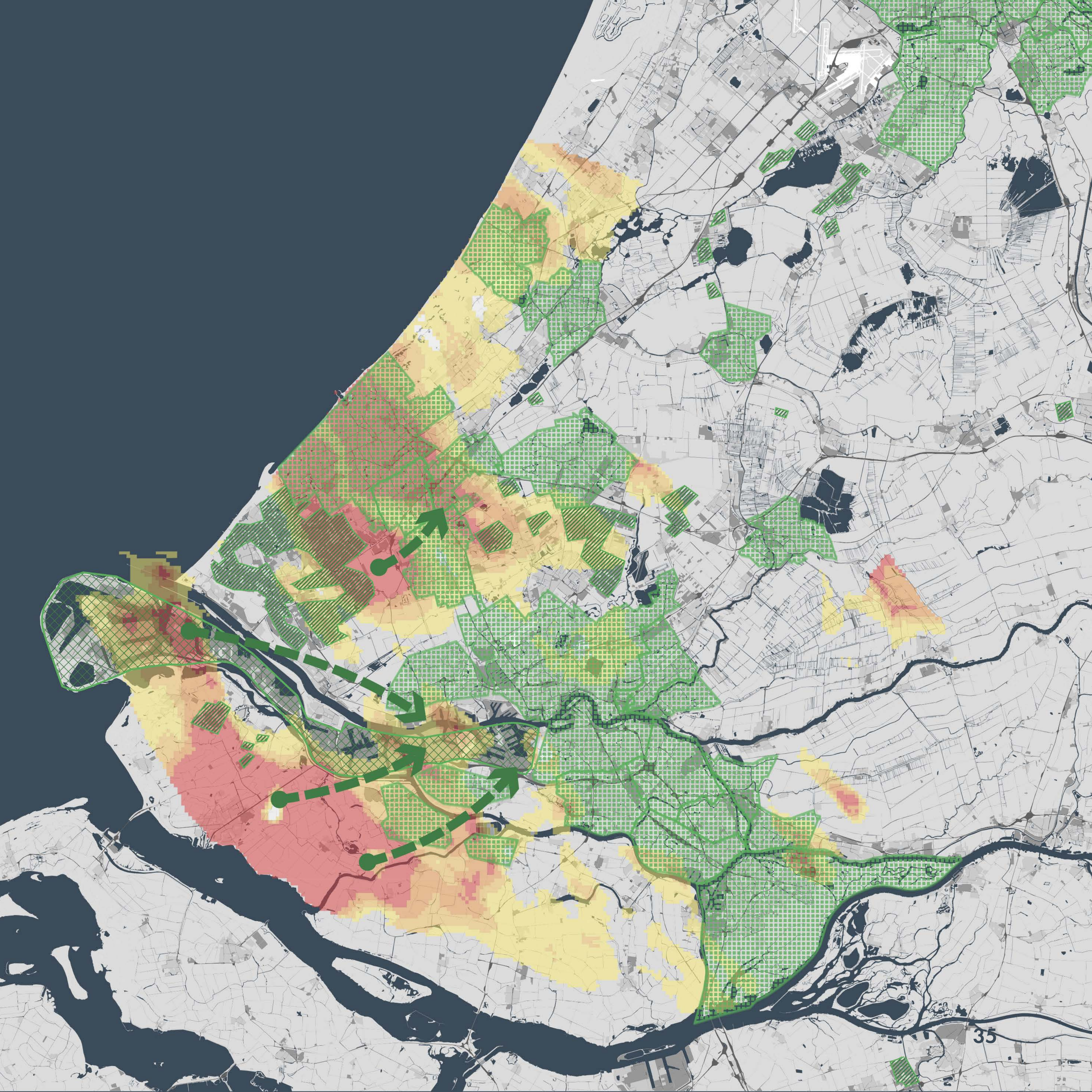


Figure 18 Geothermal Potential Map



Natural Gas Network in 2020

According to the map, there is a strong dependency on natural gas use across the region of South Holland. The pink gradience indicates the degree of natural gas consumption in the areas. In the current situation, the industries in the port of Rotterdam and the greenhouses consume the most significant amount of natural gas, while its presence is weaker in urban agglomerations. The natural gas pipelines are ideal for the flow of hydrogen in the future, where new hydrogen hubs will appear in the redefined energy landscape.

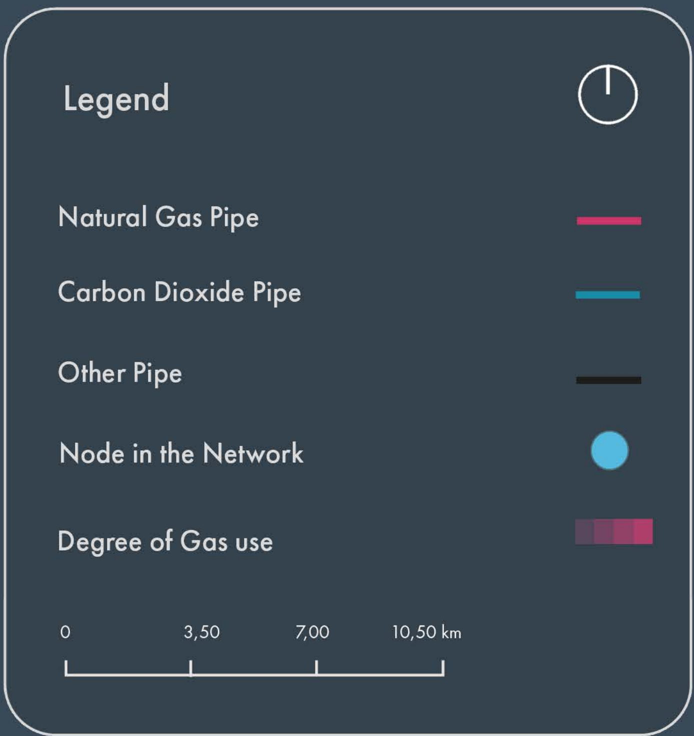
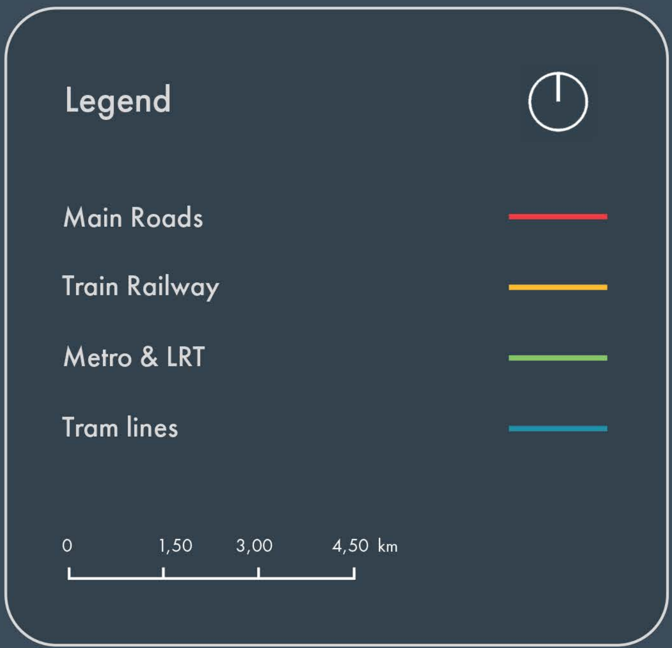


Figure 19 Natural Gas Network

Mobility Network in 2020

The transportation map shows the current main mobility network of the Province of South Holland. The main roads is a web of highways and provincial roads connecting different parts of the province. Tramlines are mostly found in the city centers, in this particular image Rotterdam and The Hague. The port of Rotterdam is connected via a train railway. In this way, the port is, in addition to waterways, connected to an important mobility network.



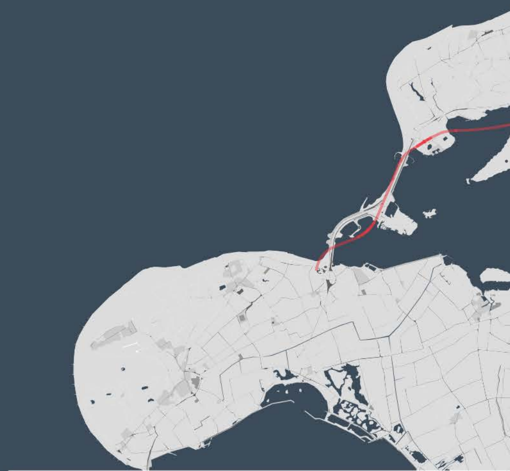
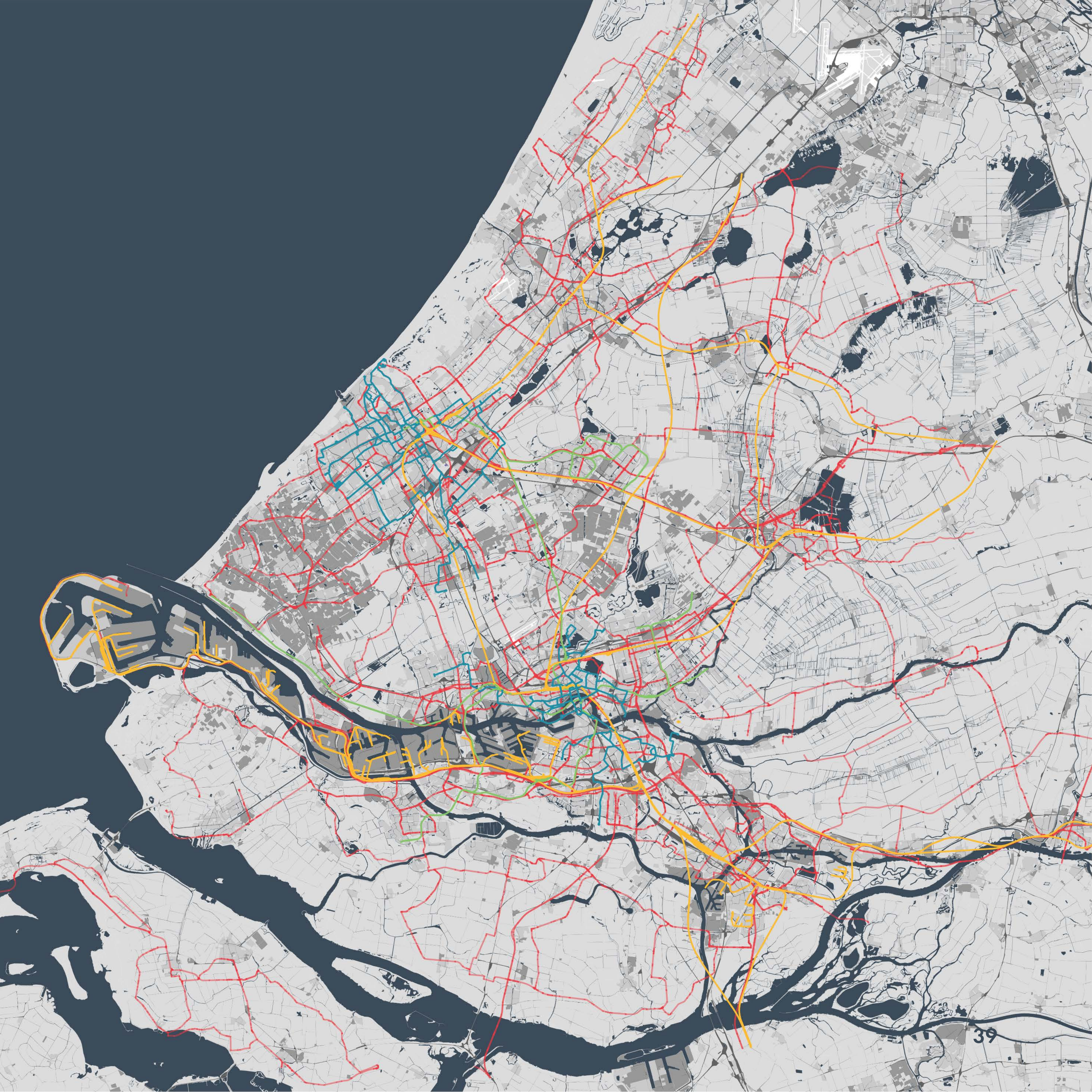


Figure 20 Public Transport in Rotterdam Region



Energy Balance

The Sankey of 2020 is representation of the actual energy composition balance and is based upon data gathered from 'Landscape and energy' (Sijmons, Hugtenburg, Hoorn & Feddes, 2014, p. 222). As shown in figure x (sankey 2020) the majority of generated energy originates from oil and Gas, which are -together with coal- covering 96% of the total amount as shown in red in figure y(Timeline). At the same time only 1% comes from renewable energy sources, respectively wind and solar. Since we perceive biomass as a temporary source of energy to compensate for reduction in use of petrol, this source is colored orange and will be phased out from 2030. In terms of efficiency, there is still much to be improved with having Housing, Utility and Greenhouses lose 20-24%, Industry & Electricity production loses 50-57%, and 95% of the energy for transport is wasted. This gives opportunity to enhance the energy efficiency in the following phases of the energy transition.

The table of the energy balance shows that a lot of heat is generated using gas, almost 80% of the current energy used by the different users in the build environment. The systemic section explains how the flows of materials and the energy according to the Sankey of 2020 of the province of South-Holland are going. The line weight represents the amount of the material or energy used for consumption. When observing the amount of flows and connections, it becomes clear that in the current situation, there is a high dependency on natural gas and oil for the majority of the actors. This shows the dominance of the petroleum sector in the energy landscape of the region, which is heavily monopolized. In conclusion, there is a strong division between energy users and producers. Since oil and Natural Gas are mostly imported from other parts of the world, the region also has a dependency on other countries. This means there is a double dependency: On one hand on fossil fuels itself and on the other hand on a geo-political level, from the actors that are the region's suppliers.

	ENERGY BALANCE 2020							
	Energy (PJ)	% Electricity	% Oil	% Hydrogen	% Geothermal	% Gas	% Biomass	% Coal
Household	45	20	-	-	6	74	-	-
Utility	55	20	-	-	-	80	-	-
Greenhouse	55	20	-	-	-	80	-	-
Transport	30	-	100	-	-	-	-	-
Petrochemistry	85	29	15	-	-	50	6	-
Industry	175	-	80	-	-	20	-	-

Figure 21 Energy Balance of current Energy Landscape

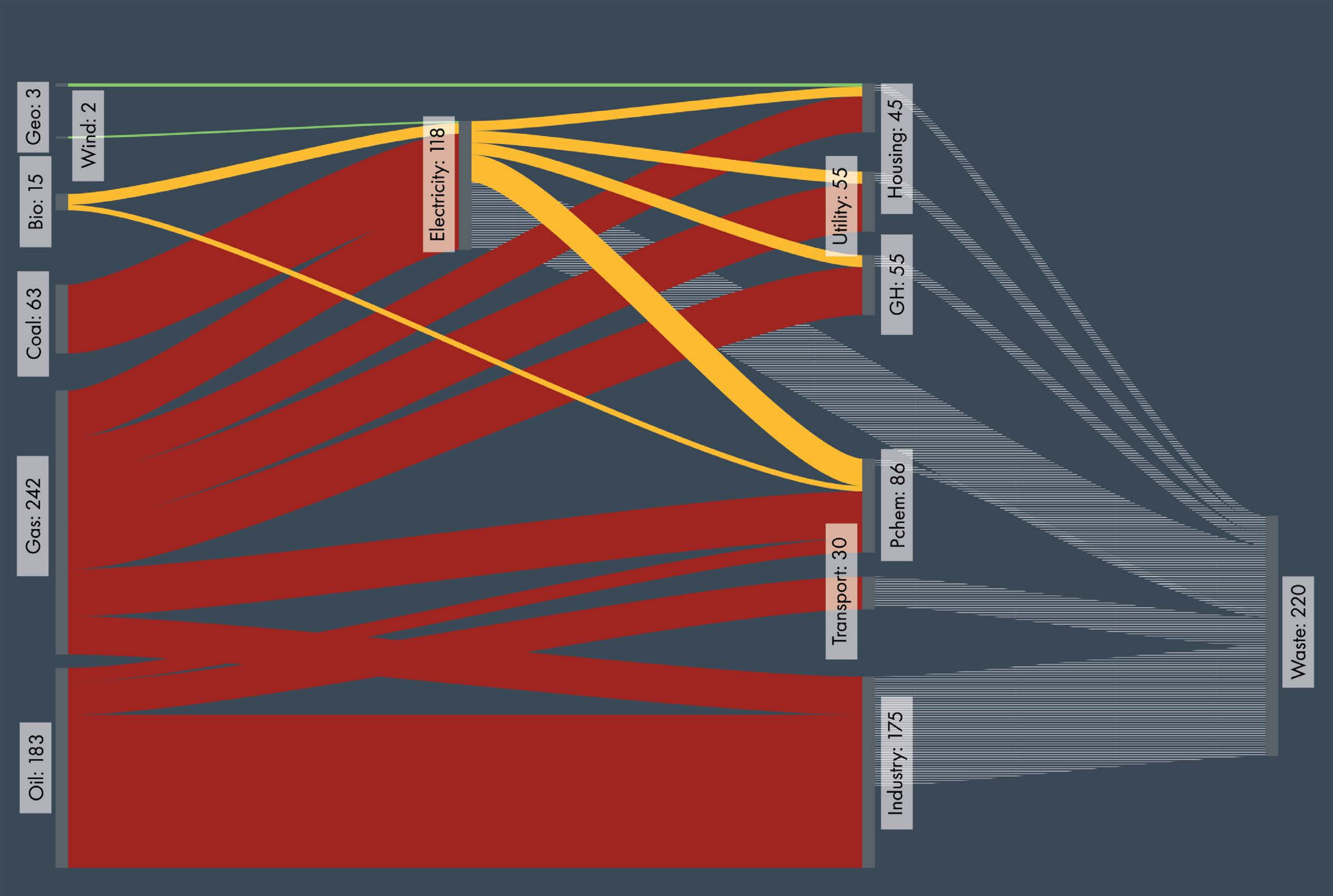
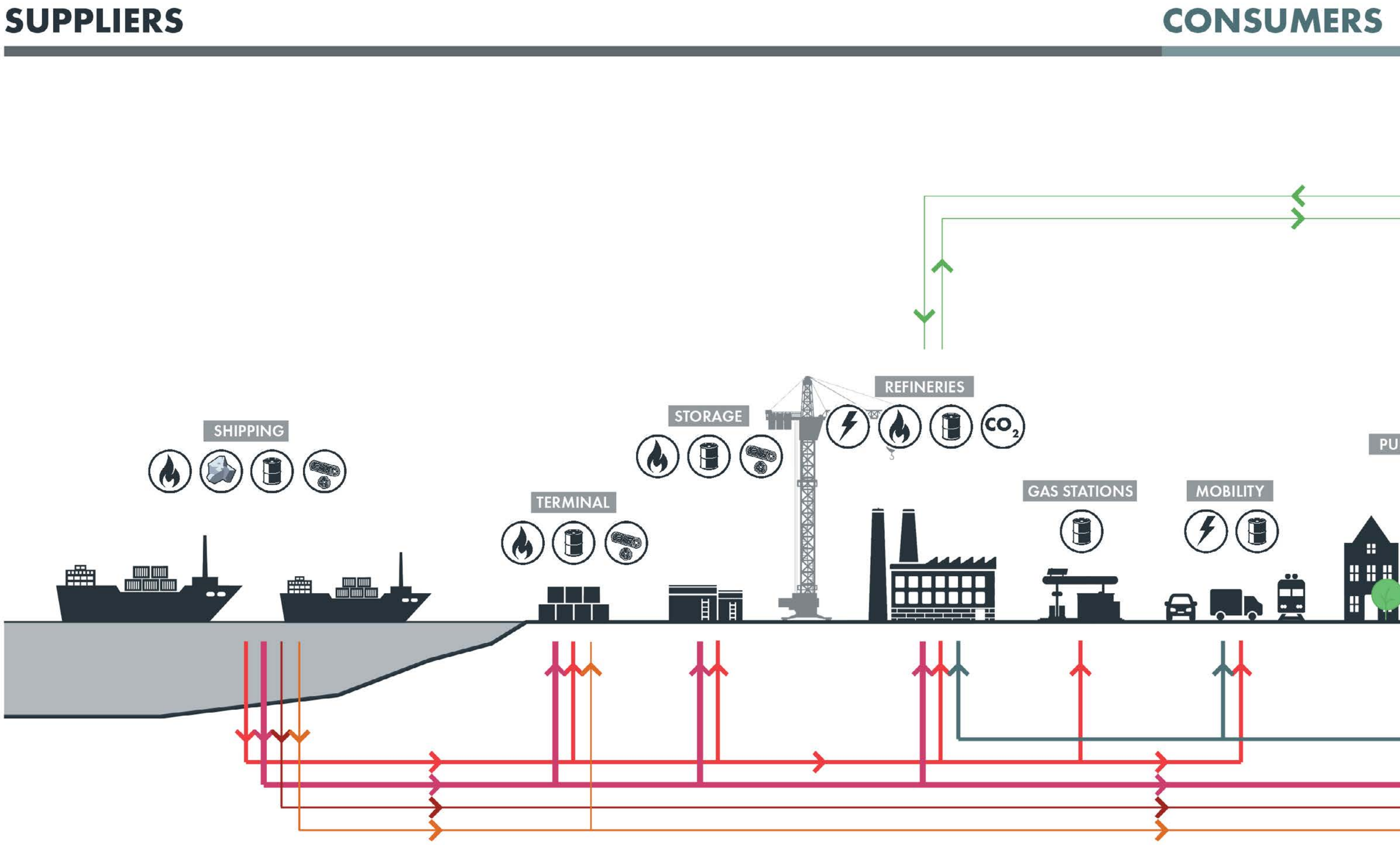


Figure 22 Energy Consumption of current Energy Landscape

Systemic section 2020



Energy flows

Coal	Biomass	Electricity	Geothermal
Oil	Carbon Dioxide	Solar	Residual Heat
Natural Gas	Hydrogen	Wind	

GENERATORS

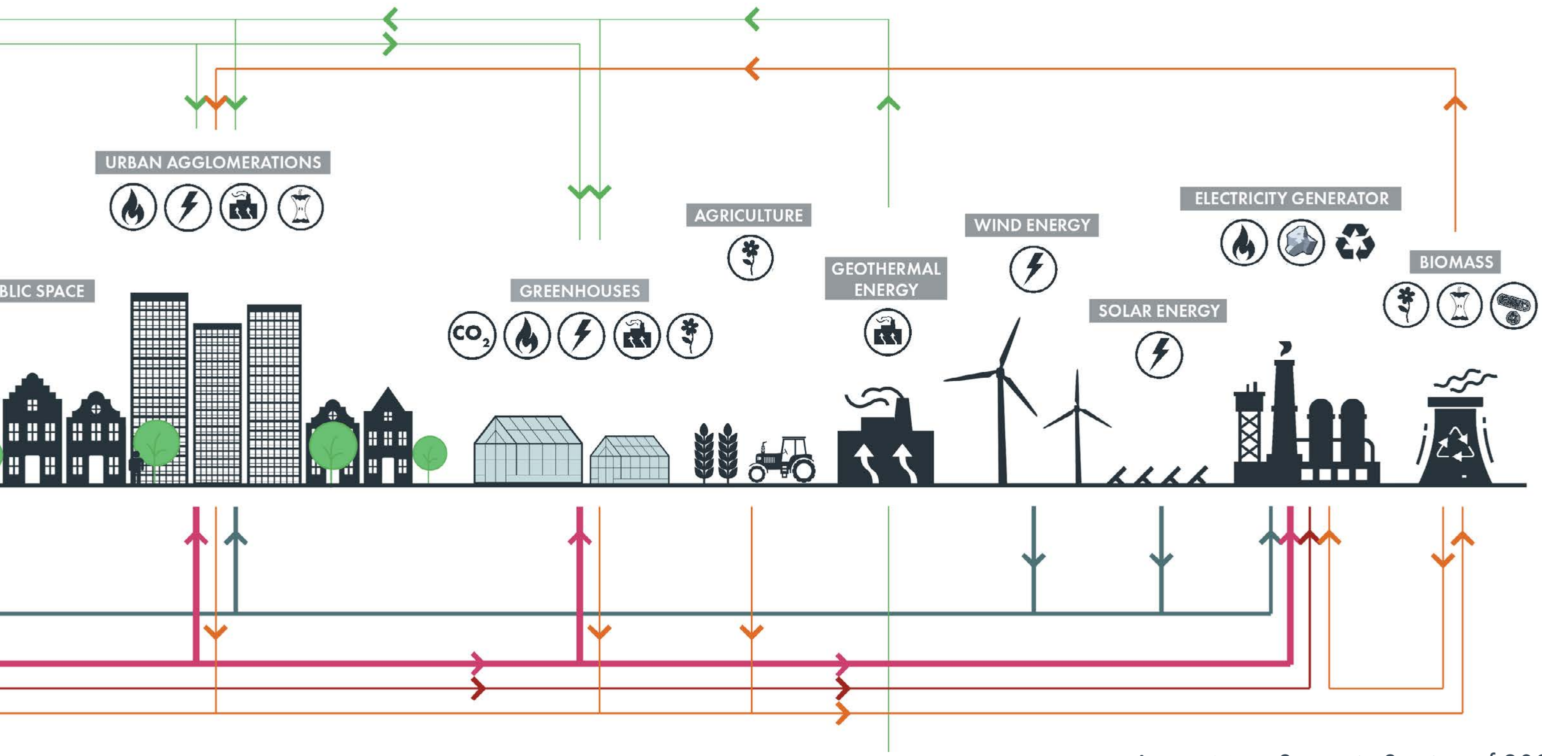


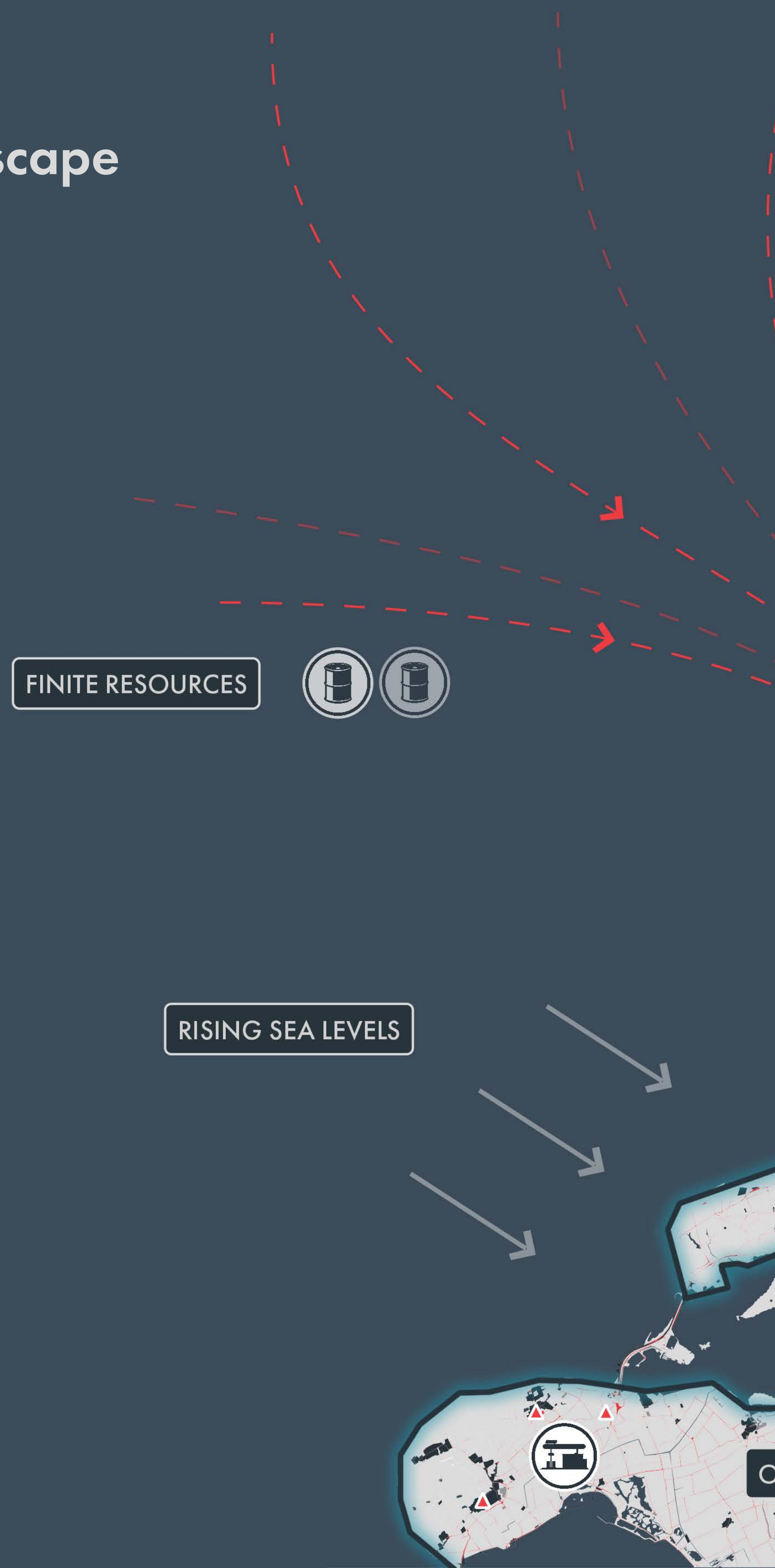
Figure 23 Systemic Section of 2020

Materials involved

Coal		Biomass		Electricity	
Oil		Carbon Dioxide		Geothermal	
Natural Gas		Hydrogen			

Urgencies for the Energy Landscape

In the urgencies map, the most pressing challenges are indicated. These include both global and region specific ones. Global challenges that already and will potentially affect the region of South Holland are climate change and finite energy resources. The latter also becomes a substantial region specific challenge as the port heavily relies on imports and exports of petrol and other fossil fuels and thus the economic viability of it is heavily endangered. The region also relies on fossil fuels to cover its energy needs and similarly finding alternative solutions is imperative. In the Netherlands and especially in the region of South Holland, the housing crisis is a pressing challenge that needs to be addressed and is at the front of the planning agenda. Last but not least, the segregation between the port and the city of rotterdam identity is a problem that is part of our scope and stems from the segregation of]energy processes of production of consumption.

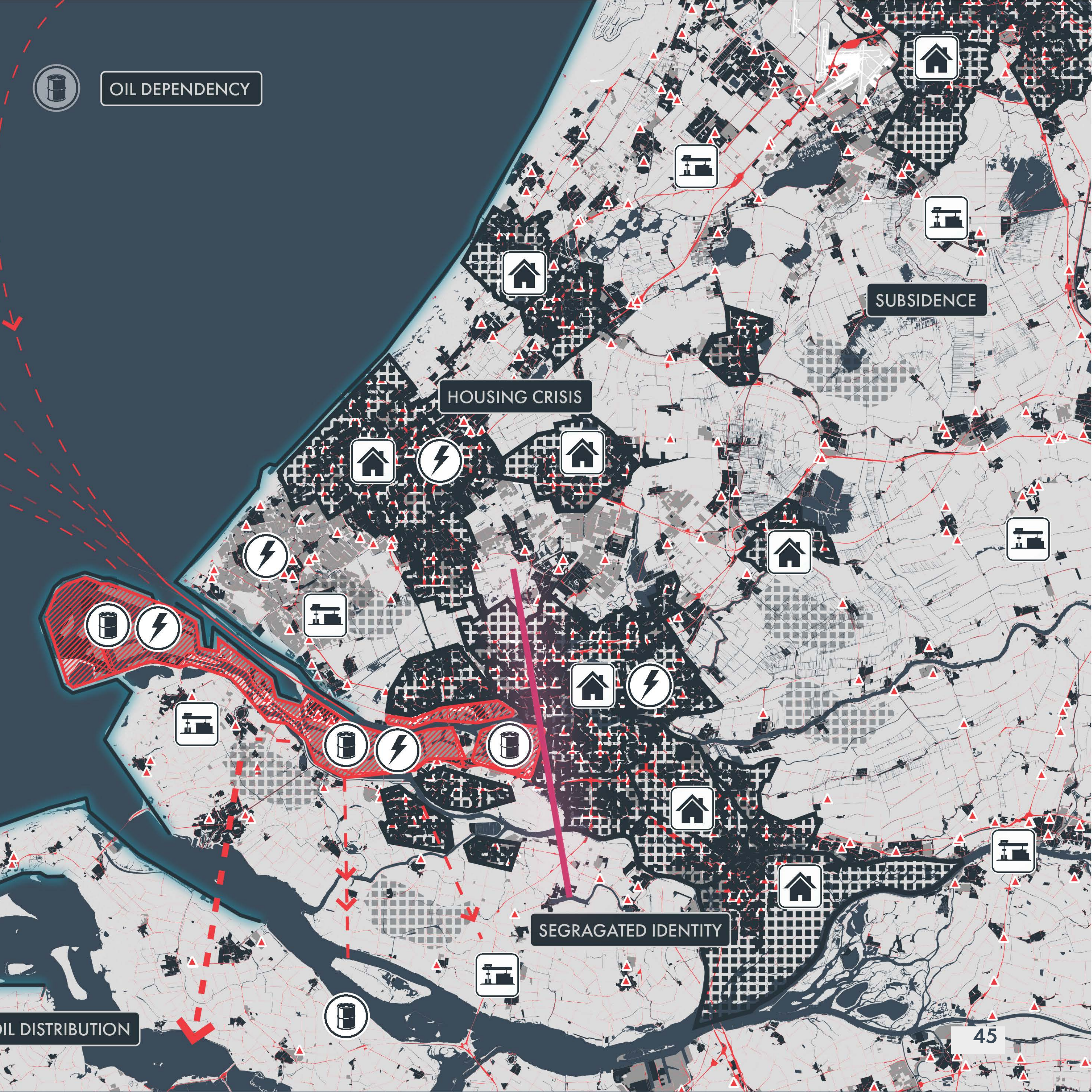


Legend

- Port
- Urban Agglomerations
- Petrol
- Gas Stations
- Energy Demand
- Housing Demand

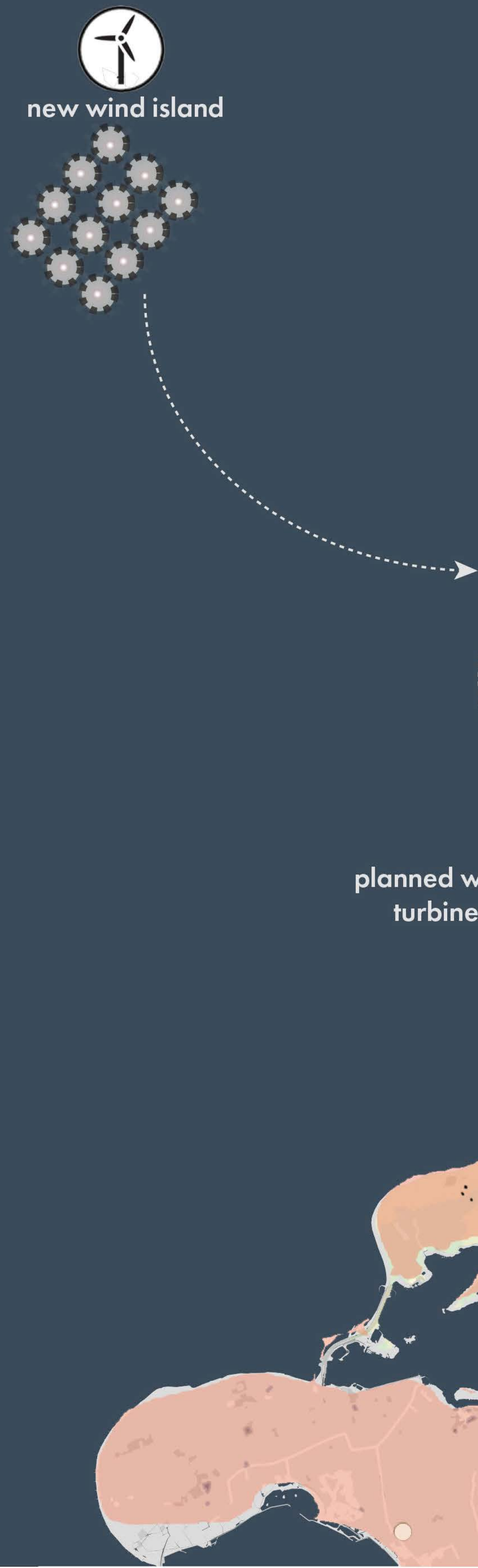
Scale 1:300.000

Figure 24 Urgencies Map


OIL DEPENDENCY
SUBSIDENCE
HOUSING CRISIS
SEGRAGATED IDENTITY
OIL DISTRIBUTION

Potentials for the Energy Landscape

From the potential map, it seems that there is a high potential for geothermal and solar energy. The Aquifer Thermal Energy Storage potential is also significant in the whole region. There is a possibility of addition of wind turbines both offshore and on the ground. Morever, there are many lands without current use that they could be repurposed for new development and housing expansion. Hydrogen production hubs could also be placed across the region in order to gradually achieve the phasing out of fossil fuels. The existing pipes could also be retrofitted for hydrogen flow. Biomass coming from crop and household waste could also be a temporary solution for energy generation. The creation of a regional energy network could assist in the energy transition and the phasing out of fossil fuels by the 2050.



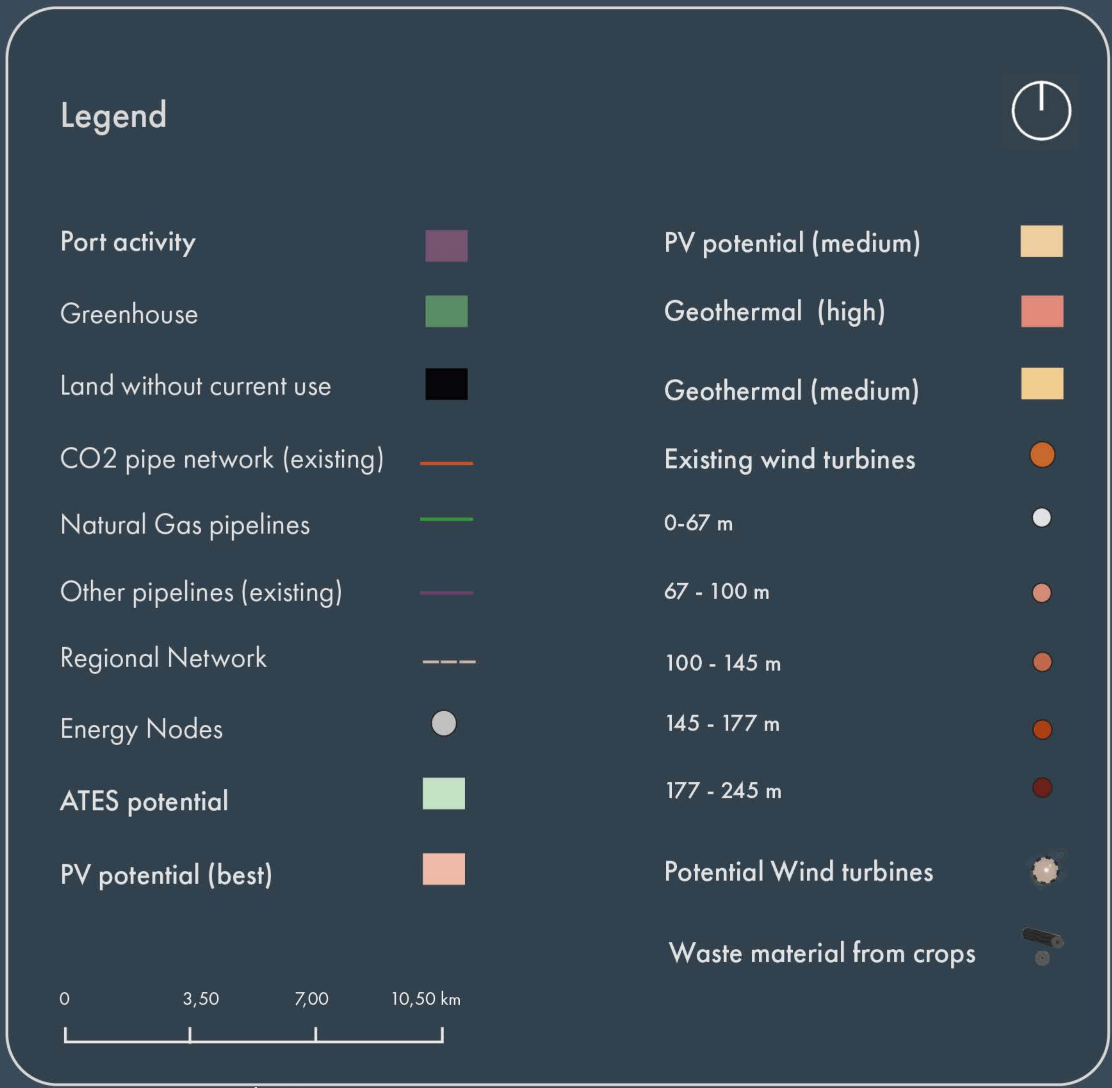
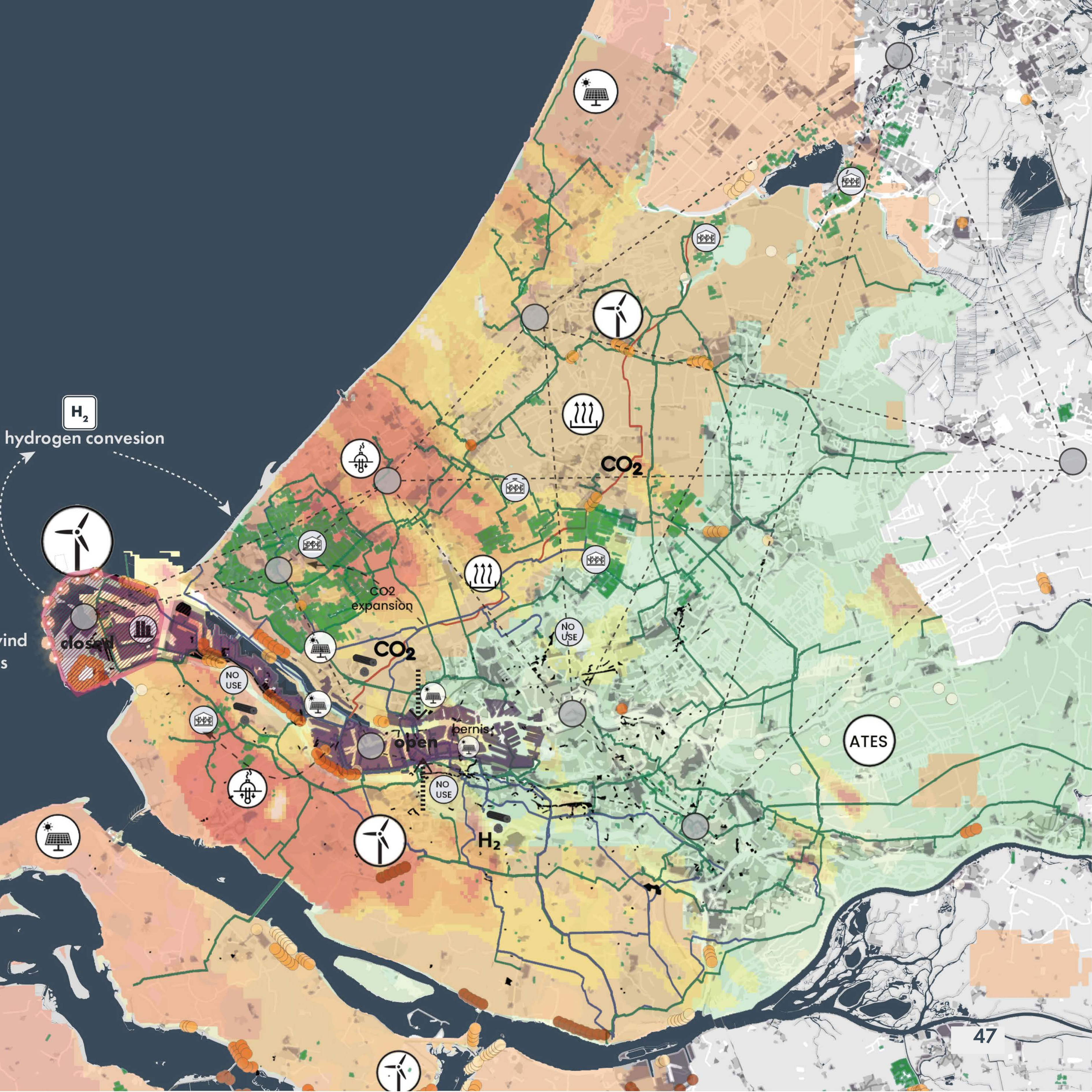


Figure 25 Potentials Map



H2
hydrogen convesion
CO2
CO2
expansion
CO2
closed
wind
s
NO USE
NO USE
NO USE
open
pernis
H2
ATES

Strenghts, Weaknesses, Opportunities and Treaths

SWOT-Analysis

STRENGTH

- Location:
  global node for fossil energy +
  close to rotterdam with talent and other economic activity and +
  part of a polycentric metropolitan region
- Infrastructure
- largest european port
- Financially strong
- Largest european port
- Port identity to the city

OPPORTUNITIES

- Can play leading role in energy transition (connection/impact other ports)
- Renewable energy potential
- Historical Culture for innovation
- Governmental focus on sustainable development
- Companies working on energy transition already
- Collaboration between the stakeholders

THREATS

- Ending fossil resources
- Great amount of petrol related activities
- Powerful counteractors that don't want to stop/change/switch from oil
- Climate change
- No acceptance by civil society for change
- Urban sprawl

WEAKNESSES

- Largest european port/takes up a lot of space
- Dependency on fossil fuel,
  big impact on natural landscape
- Dependency on european/global networks of actors and policies
- Extensive private use of land
- Limited space

Figure 26 SWOT Table

TOWS-Analysis

	STRENGTH	WEAKNESSES
OPPORTUNITIES	SO: How can you use your strengths to take advantage of your opportunities? The port can play a central role in the energy transition in favor of its location. As an epicenter it can be a leader in renewable energy transfer to other countries. The location, the identity and the economic resilience/strength can be a motivation for the collaboration between the stakeholders in the energy transition. The port of Rotterdam is the largest European port where companies are working on energy transition already. The economic potential of the port can assist in the expansion of the business and innovation network working on and kickstart the energy transition.	OW: How can you use your opportunities to overcome the weaknesses you are experiencing? Create strong collaborations between public and private actors and the civil society to build a strong vision and strategy that is supported by everyone. The mindset is already there, the technology will be there, but we should align all different needs, beliefs and interests to work together.
THREATS	ST:How can you take advantage of your strengths to avoid real and potential threats? As a financially strong and large port it can have a lot of influence to make a difference in the world order. Also, the infrastructure shows that the port is able to adapt to future situations very quickly. The position of the port is already there to take this leading position and adapt to the future to secure the future of the port.	WT: How can you minimize your weaknesses and avoid threats? The size of the port as a weakness can potentially be minimized by the strategic allocation of different functions. These functions include energy production, manufacturing as well as living spaces. Extensive use of land should be minimized in order for the port to be more open and accessible while a localization of energy production and consumption will minimize the dependencies on a European and global scale.

Figure 27 TOWS Table

2.2 Stakeholders

Power-Interest Matrix

High interest - high power
Public actors
Since governments have the responsibility to act on behalf of the society and create value for the greater good, they are the initiating actors for this change and not only have a lot of power but also have a high level of interest. Therefore their contribution in this transition is evident.

Private actors
Large Influential private actors like Shell, BP and Exxon Mobil are in the energy business and have a high interest in the trade, production and usage of petrol-related products, since it is their major share of business. Since these players also know fossil fuels are becoming scarce and obsolete, they claim to be keen to switch their focus on renewable forms of energy and maintain their market share. With a dominant position in the region at this point, these players will also play a role in the future of energy. If the region wants to sustain their position as a strong economic force, these players have to be allured to stay.
Banks and creditors are involved with loans and the financing of projects and have therefore an influential role in the energy transition. Both (other) private actors as public actors need them to get funding to the goals they want to achieve.

High interest - medium power
Civil society
Citizens (referring to customers, consumers and commuters(CCC)) are dealing with energy on a daily basis and have a considerably high interest in this transition, since it will affect the way they live their lives. Therefore, organised groups of citizens will take action to achieve desired mutual goals and demand actions from public and private actors.

Other (national) governments and institutions
The region of South-Holland is strongly connected to its direct and indirect surroundings. The port-city is by default depending on the flows of import and export; therefore, the goals and choices other public actors make have a certain impact on the region.

High interest - low power
CCC
Citizens have a considerably high interest in the energy transition, since it will affect their daily lives. Therefore, it is important that this group feels included and heard.

Academia/research institutes
Researchers play an important role in the provision of knowledge and insights regarding the energy transition. From different perspectives and disciplines they will share and discuss their findings and advice with peers to support evidence-based strategies and decision making. In order to achieve results that can make a strong impact, it is important that this group is funded and can do their work.

Low interest - low power
Employees of petrol-related industries
Employees in the current fossil fuel sector will be personally affected by the transition, as their work will change or their jobs will become obsolete.

Low interest - medium power
This category comprises several ancillary actors that are (in) directly related to the energy transition as they are also in need of it, but not necessarily directly associated with it as their core business. However, at this moment their activities take place in the port and have interdepencies with the other primarily energy-related companies. Thus, if the energy transition means their activities will change or partially become obsolete, this probably also initiates a domino effect in the region. Therefore, it is of value that these types of industries are attracted and engaged to transform and/or change their business practices.

Low interest - high power
Large petrol-related companies, with a strong interest in maintaining oil and gas as sources of energy have to be addressed properly. If the region and these companies maintain mutual dependencies, or when the companies, for various reasons, don't want to change, it is essential that good phase out steps are considered.

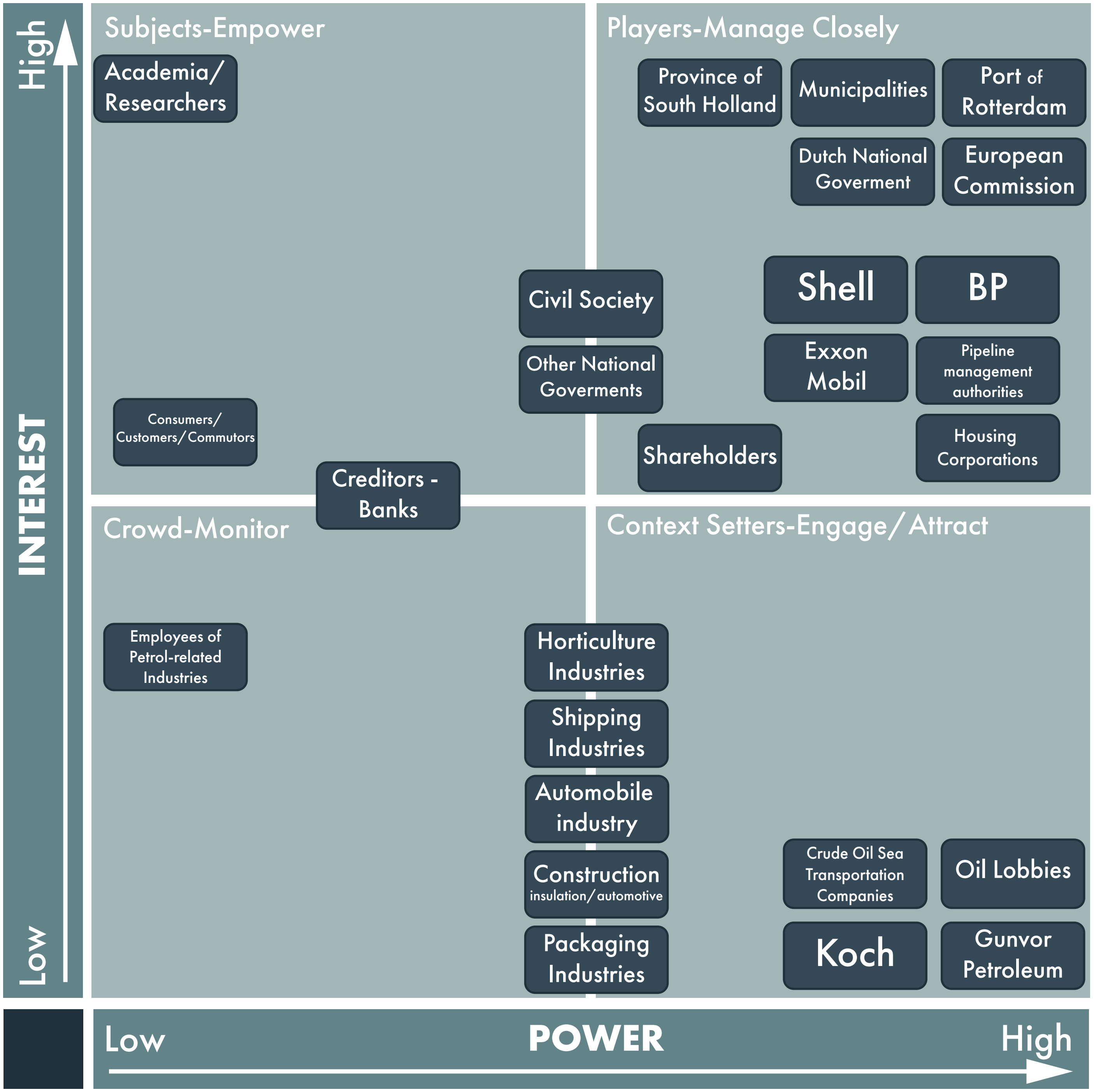


Figure 28 Power-Interest Table

Power-Attitude Matrix

Proponents
Actors with production power
Different public actors, like the European Commission, National Government, the province of South-Holland and the municipality of Rotterdam are important driving forces behind this transition. With clear objectives, steering regulations and subsidies they can inspire, allure and control private actors to follow their lead. They have to balance the level of support and constraints to create an attractive environment in order to keep private actors aligned with their goals. When they don't succeed in doing this properly, there is a change of economic loss, since companies can decide to leave the region and/or country.

Proponents/opponents
Actors with a diffuse power position
Private actors
Large private actors such as petrol-related companies like Shell, BP and Exxon Mobil can be both proponents and opponents in this transition: They are willing to change, under the condition they can sustain a viable business model. They have done and have to do investments and are demanding clear conditions they can rely on. At the same time, they have the (financial and also economical-political) power to accelerate change, by supporting innovations. Therefore, public actors also need these actors to let their vision become reality. However, when they see a threat to their business, they also have blocking power, since they can control these innovations by investing in them and decide not to act further on it.
Therefore, since private actors play an important role in the realisation of the energy transition they have to get a chair at the table. At the same time public actors have to watch out for letting themselves too much influenced by them, since a market-based strategy would result in an unequal distribution of benefits and burdens.

Civil society
Citizens that form institutions, organise protest and both accelerating and blocking change. By raising their voices they have the power to influence other actors.

For example, the housing protests initiated by organisations that come up for the rights of people to have a home have the same possibility to protest against unequal distributions of benefits and burden as a consequence of the energy transition. On the contrary, comparable groups could also organise themselves to get attention for climate change and demand actions from public and private actors.
In general, this diverse group of actors need to be included in the process to let democracy work and shape this transition in a just way.

Opponents
Actors with blocking power
Petrol-related companies that originate from countries that are economically heavily dependent on the use of petrol, are probably keen to keep the petrol industry alive. Therefore these organisations have to kept in mind when changing policies and activities in the region. If parties like this want to cooperate, there is a possible future, if they don't it could be the case these companies will leave the region. Companies that transport crude oil will have to be able to change the type of liquid bulk, if they want to maintain a function in a petrol-free region. Regarding to oil lobbies, it's clear they will try to block any forms of change into an petrol-free era, by influencing politicians, the public opinion, decision-makers and with jurisdictional means. Governments that want to accelerate change will need to find ways to prevent such representatives from blocking the road.

Free sitters
Actors with production power
The pipeline management authorities are another group of crucial players that can influence, control and profit from the existing and future flows of energy, since their infrastructure will be able to distribute both oil and hydrogen. By acting as the connection between different locations and actors they will have a secure position for the future.
Hence, they need to be informed and included in the process, since they can play an important role in an efficient transition.

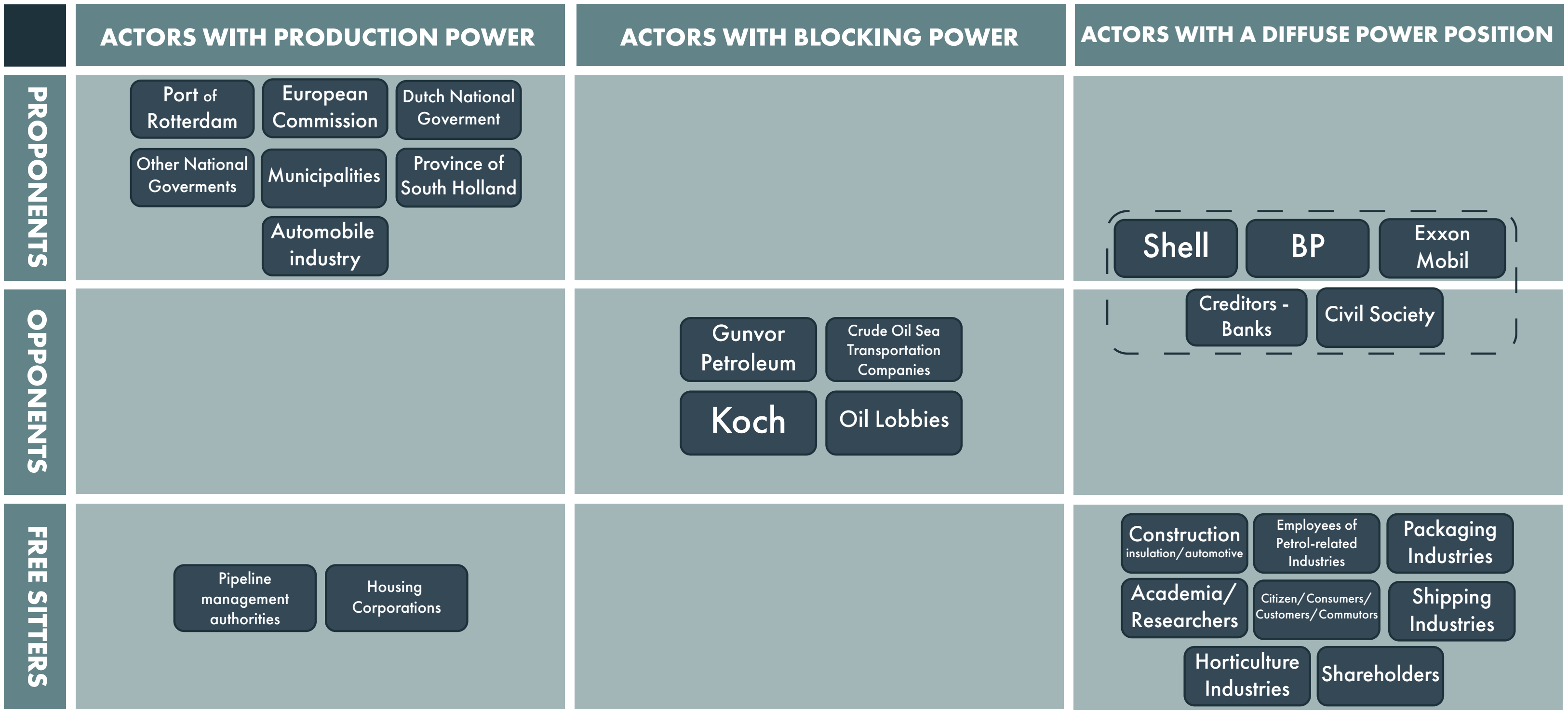


Figure 29 Power-Attitude Table

Actors with a diffuse power position
In this category there are many different actors that have another attitude and relation with the energy transition. Shipping industries are at this point still heavily relying on oil as their source of fuel and could block change by prioritising other harbours if they would be denied. At the same time, they could change simultaneously, by adopting new forms of fuels and benefit from potential subsidies that could be included with this transition.

Researchers should have an objective position in this transition. However, as a result from different perspectives they could for instance influence the development of technologies and steer the political debate on the transition by providing new insights. Shareholders are looking for investments that will give them a secure profit in return. By putting their money they strengthen a certain objective; therefore they can influence both accelerating and blocking change.

3
VISION OF THE POST-PETROL ERA

3.1 Vision Statement 2050

Vision statement

In the post-petrol era of 2050, the region of Zuid Holland will embody a dynamic and adaptive energy landscape. This new energy landscape will become more resilient and autonomous,. The landscape will consist of an interdependent and just network of actors and relies entirely on renewable energy sources.

The redefinition of the energy landscape will be achieved by focusing on three main pillars: the gradual energy transition, spatial justice and circular economy.

Activities / relation - spatial justice
By changing industrial activities, the identity of the port of Rotterdam region will be preserved and reinvented as an renewable energy node. Hereby, an energy paradigm shift is realised: a new cultural relation with energy use and production.

Resilient
By establishing a diverse composition of renewable energy sources, the region will become more robust. In this way, the region will be less dependent on one source of energy.

Because of this the new energy landscape will be adaptable to change which also contributes to the resilience of the energy landscape.

Autonomous / interdependent
Simultaneously, the energy network will be more efficient and energy consumption will be reduced. This will be achieved by implementing small-scale solutions in a decentralized energy network, as it will reorganize power structures, improve energy efficiency as well as decrease energy demand.

Just
This will result in a healthier, safer and less polluting port where activities for the people will take place, thus creating a new cultural relation with the port of Rotterdam. The accountability and responsibility of the

Renewable
The new energy landscape facilitates a phase out of fossil fuels and a phase in of alternative energy sources. This transition will happen gradually. Taking into account different interests and investments of different stakeholders.

3.2. Main Stretegic Actions

In the current situation the port is a hub for importing petrol as an energy carrier that is distributed in other countries in the hinterland. The region of South Holland has limited involvement and thus minor or non-existing social and economic benefits from these activities.

The vision of the Post/Petrol era of 2050 starts from the conversion of the petroleumscape into the center of hydrogen production where the possibility of hydrogen export across the globe is introduced. The port will become more open to people through public spaces without being segregated from the rest of the region. The decentralization of the energy network will be achieved by 2050. New hydrogen hubs will spread across the region of South Holland and their interconnection will be achieved through a green network.

Inverting the global flow
Nowadays the port is an important node for the import of energy in Europe. But the global energy landscape is changing. Therefore we envision a change in the role of the port on the global scale as well. We propose an invert of the energy flow. In the future, the Port of Rotterdam will be the export energy node of Europe. Everywhere in the hinterland of Europe renewable energy surpluses will be distributed to other continents through the port of Rotterdam. By this way, the port again acts as an important node for energy distribution through hydrogen on a global scale.

Decentralizing the Energy Network
At the same time, on the regional scale of the Province of South-Holland, autonomous energy areas emerse. Depending on the context specifics, every area is self-sustaining in terms of energy, with the local production of wind, solar and geothermal energy. Since space is very limited on land, we aligned the allocation of our solar fields according to the 'zonneladder' principle(Ministerie van Economische Zaken en Klimaat, 2022), which means that solar panels in the built environment are preferably located on existing roofs or combined with other functions at the same place. Already planned solar fields outside the built environment should also be reconsidered and combined with other functions. For large-scale wind energy production we align our vision with the envisioned wind turbine fields on sea from the national government (Ministerie van Economische Zaken en Klimaat, 2018,p. 4). Besides, we propose wind turbines only on the periphery of the built environment, with limited visual pollution and smaller-scale wind turbines on roofs of buildings.

Connecting the Hydrogen Nodes & opening the port
At peak moments surpluses will be converted into hydrogen and shared with the regional network through the regional energy nodes. These nodes are located on strategic sections of the existing gas pipeline network that will be reused and which is already connecting the different areas in the region.

Aside from this technological function, the energy nodes also connect the energy landscape with people. In the area around these nodes, new public and private functions will be added. On one hand this will be in the forms of Universities and other knowledge institutes, start-ups with energy experimental sites and former petrol-based energy companies. On the other hand this will be cultural centers accessible for the public, recreational functions that are creating energy awareness among citizens. This is how we want to create a new cultural relation with the use and production of energy. Since the port is now already the energy core of the region, we envision a likewised role in the new energy landscape. Here, the development of our vision will start and gradually spread out to the rest of the region. This will start with the redevelopment of the highly dominated petrol-related areas in the port that will be transformed into: on one hand, smaller-sized hydrogen production and storage locations. And on the other hand, opening up the port to the public, by the reclamation of green spaces, addition of housing and other urban functions

Enhancing the Green Network
Since a lot of the energy remains to be an abstract concept for people. Since the hydrogen through the region will be transported below the ground, we propose an intertwined transition of the enhancement of the green network to create a physical manifestation above ground. By the use of green corridors we can connect the region on another level. For the allocation of this green network we use existing plans of the province (Provincie Zuid Holland, 2017).

Figure 30 Inverting the Global Flow

Figure 31 Spreading of the Hydrogen Network

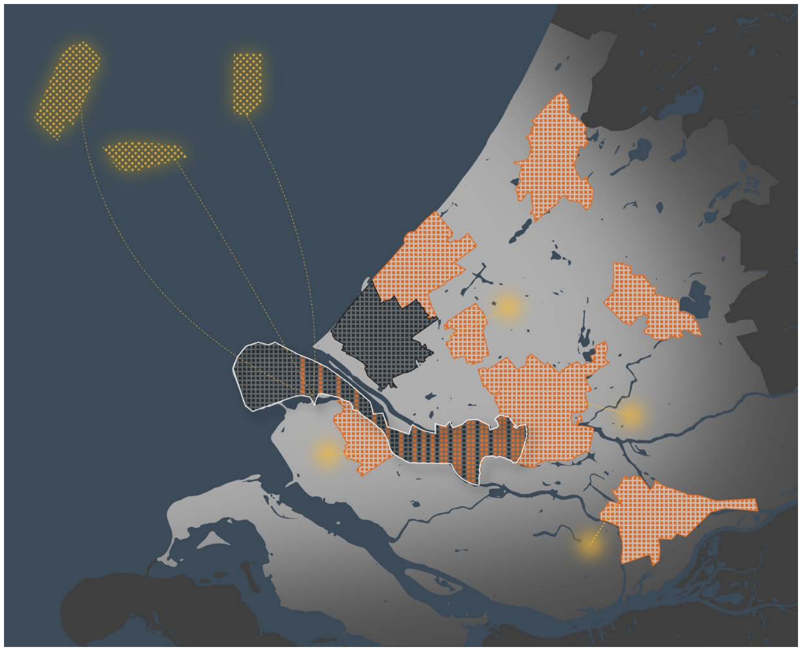
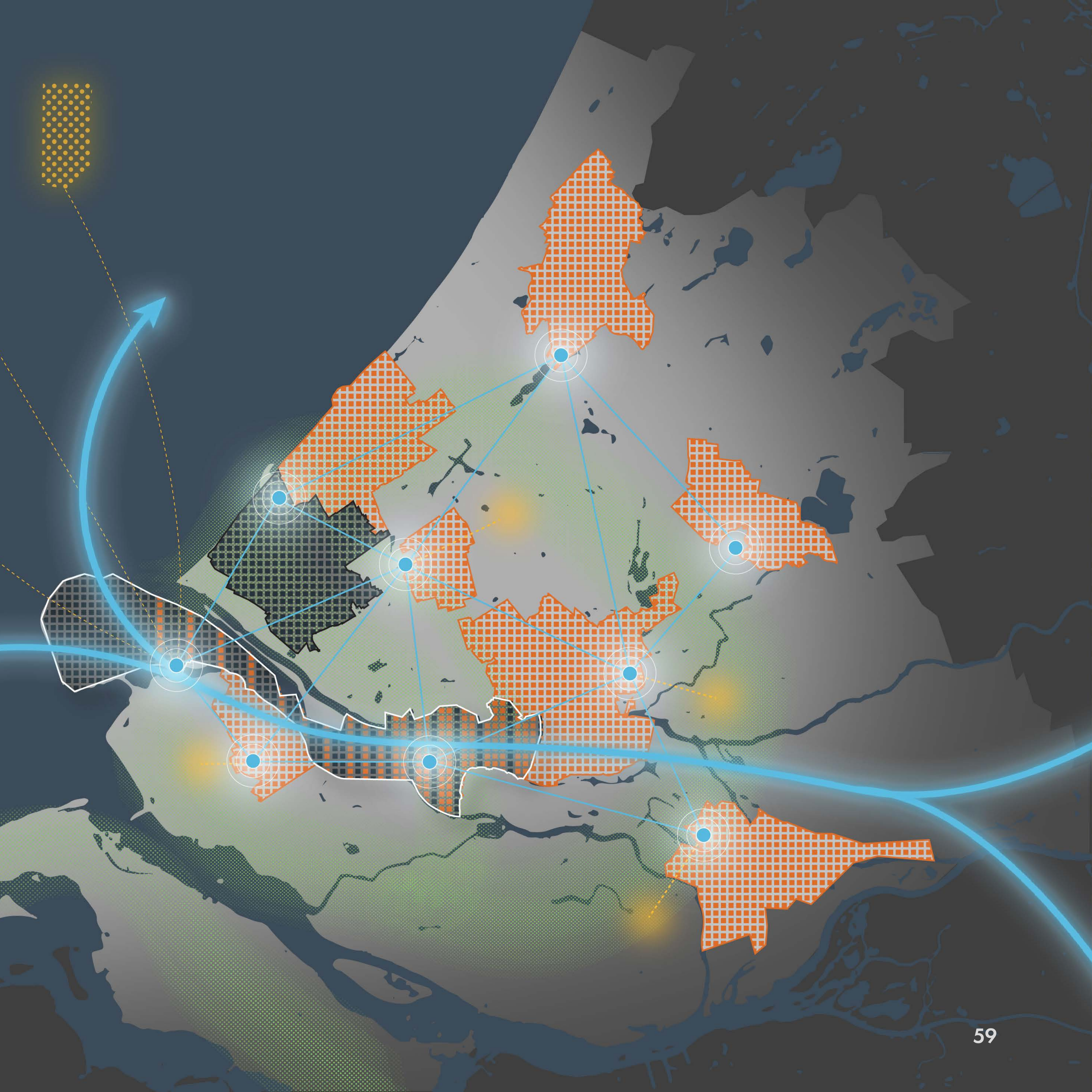


Figure 32 Decentralizing the Energy Landscape and Opening the Port

Figure 33 Enhancing the Green Network

Vision map 2050

Figure 34 Vision Map



4
DEVELOPMENT STRATEGY

4.1 General Strategy

The strategy towards the vision starts from the retrofitting of the existing petrol refineries and their conversion into hydrogen production and storage hubs. The epicenter of the intervention is the port where more green and public space is added in order to ensure the possibility of human activity in the previously closed port. The existing natural gas pipeline is ideal for retrofitting and future use of hydrogen. In the intersections of the network hydrogen production hubs will be placed across the region of South Holland. The new hydrogen hubs will be connected also through a green network based on the vision of the province of South Holland. In order to raise awareness of hydrogen production, we envision housing densification near the hydrogen hubs combined with the densification vision of De Zwarte Hond (2017). The selection of the four key locations (Pernis-Botlek, Delft, Westland and Brielle) is based on the proximity with the hydrogen production intersections which leads to an overall transformation of the wider areas.

Petrol Port

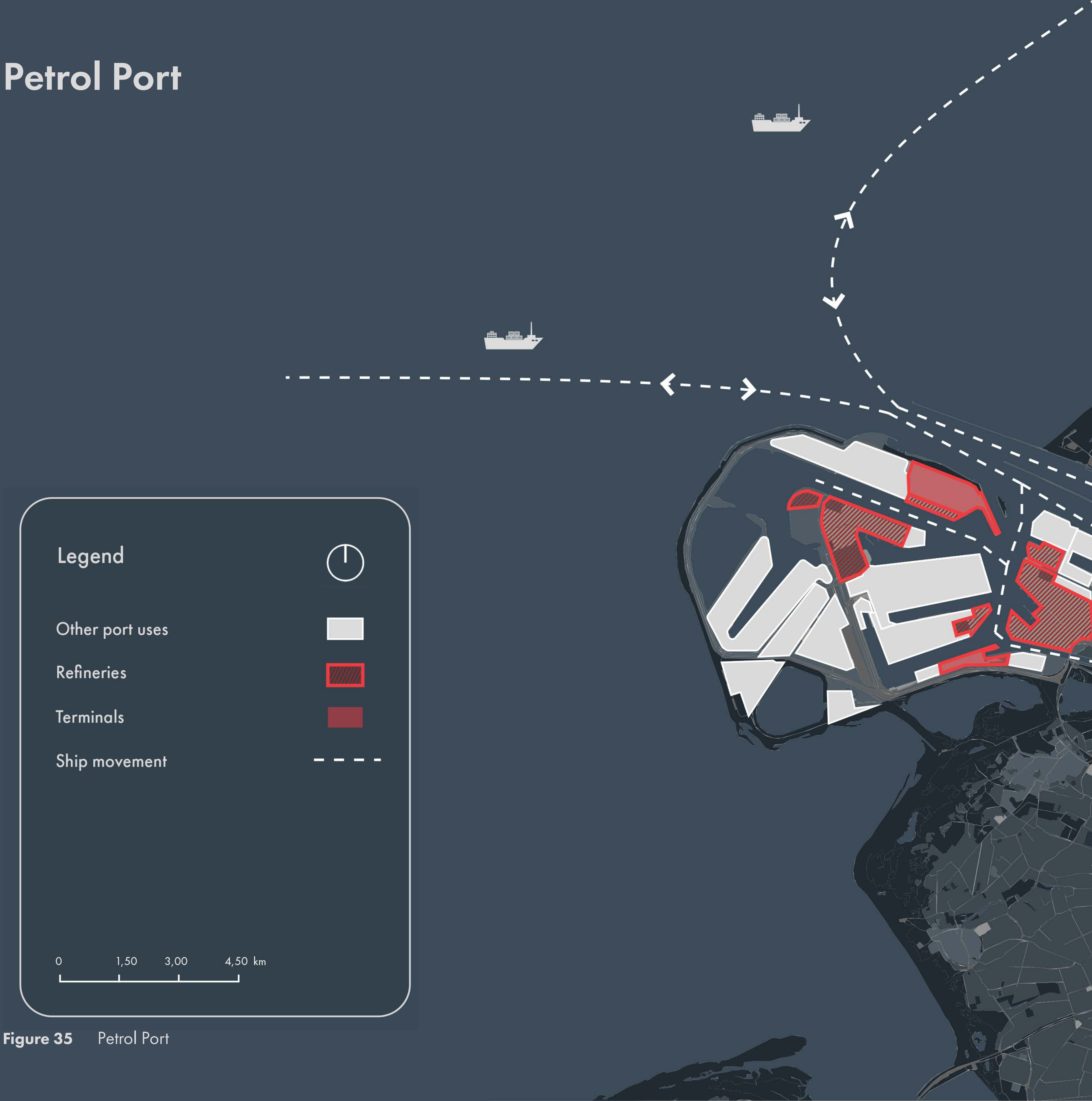
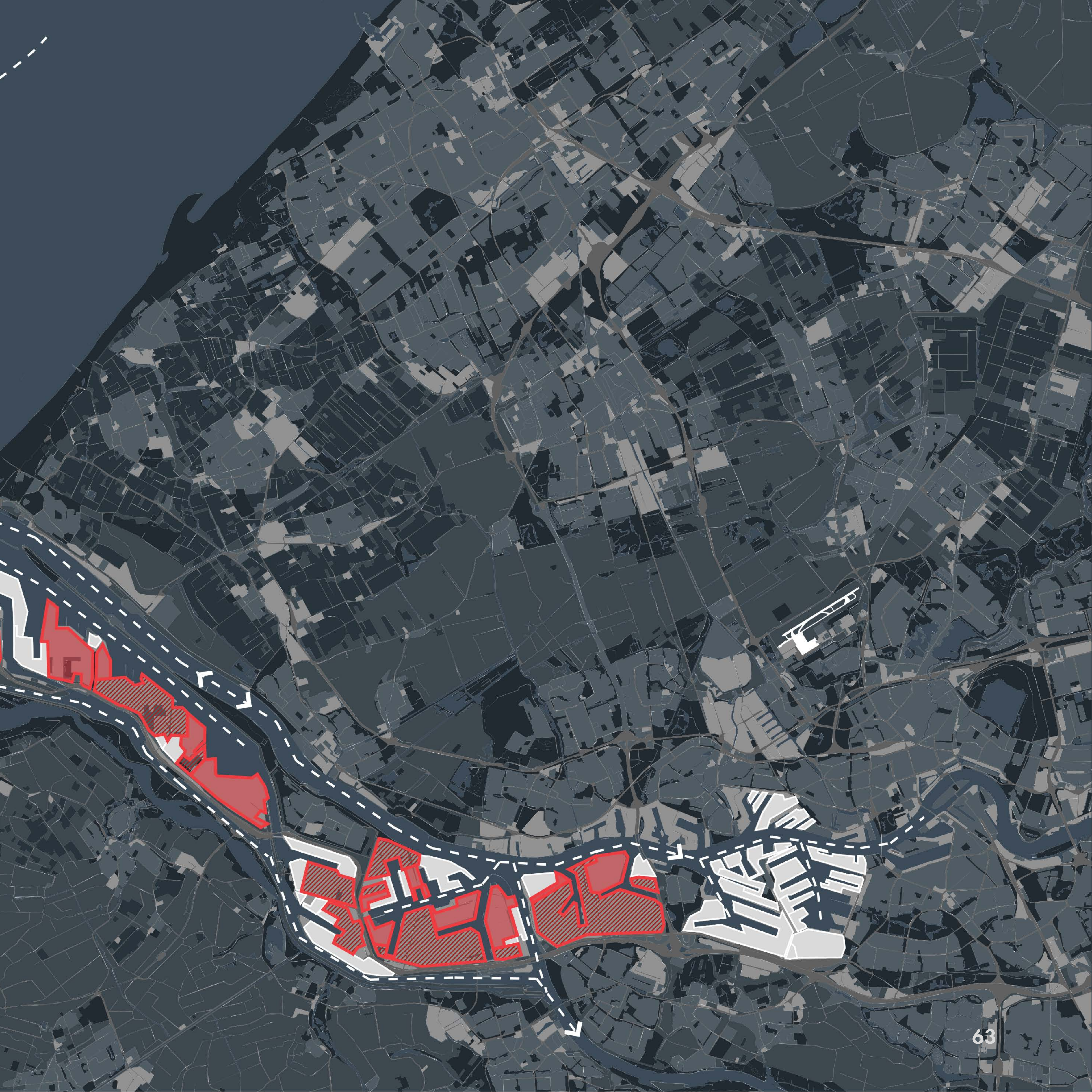


Figure 35 Petrol Port



Hydrogen Port

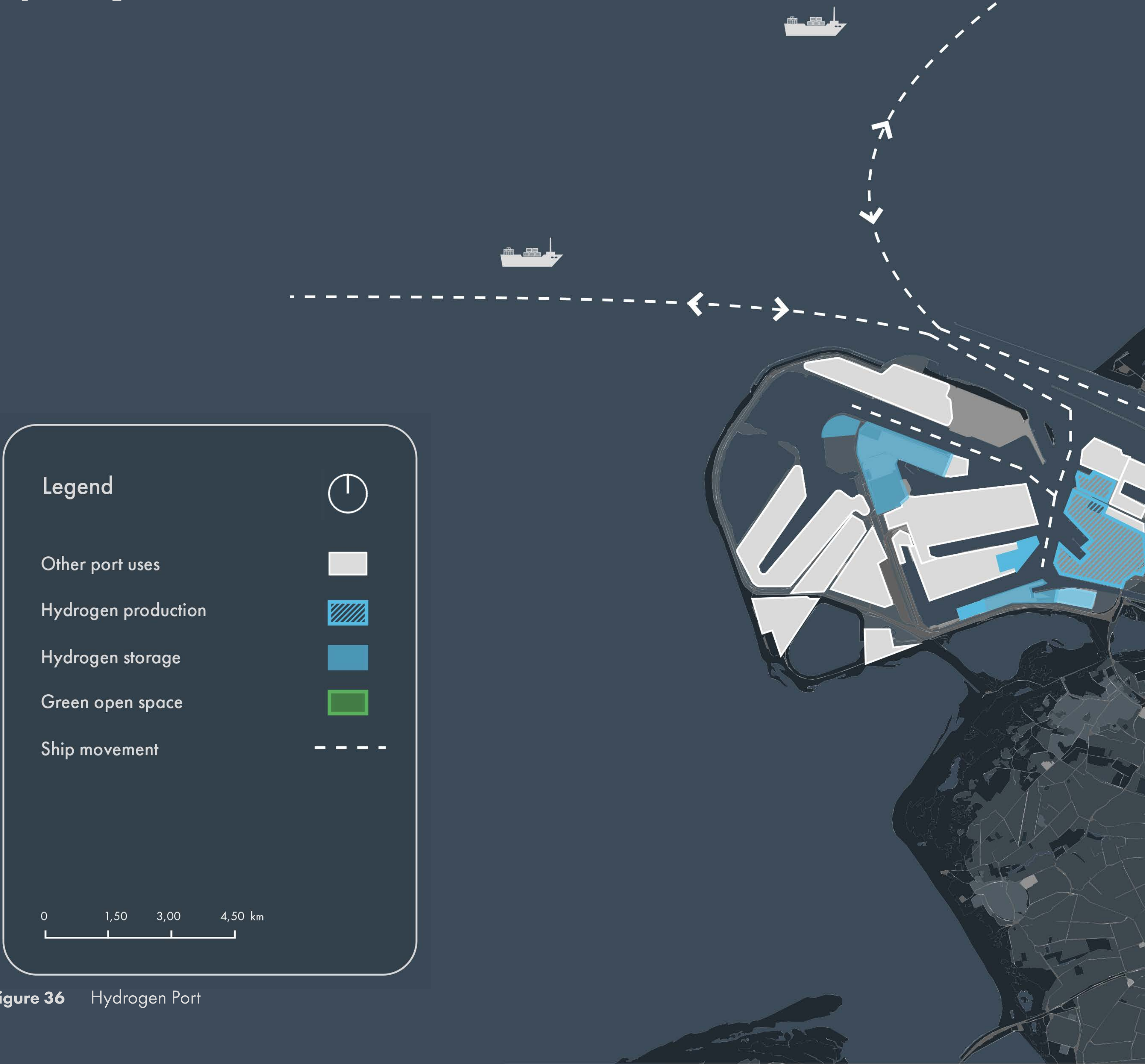
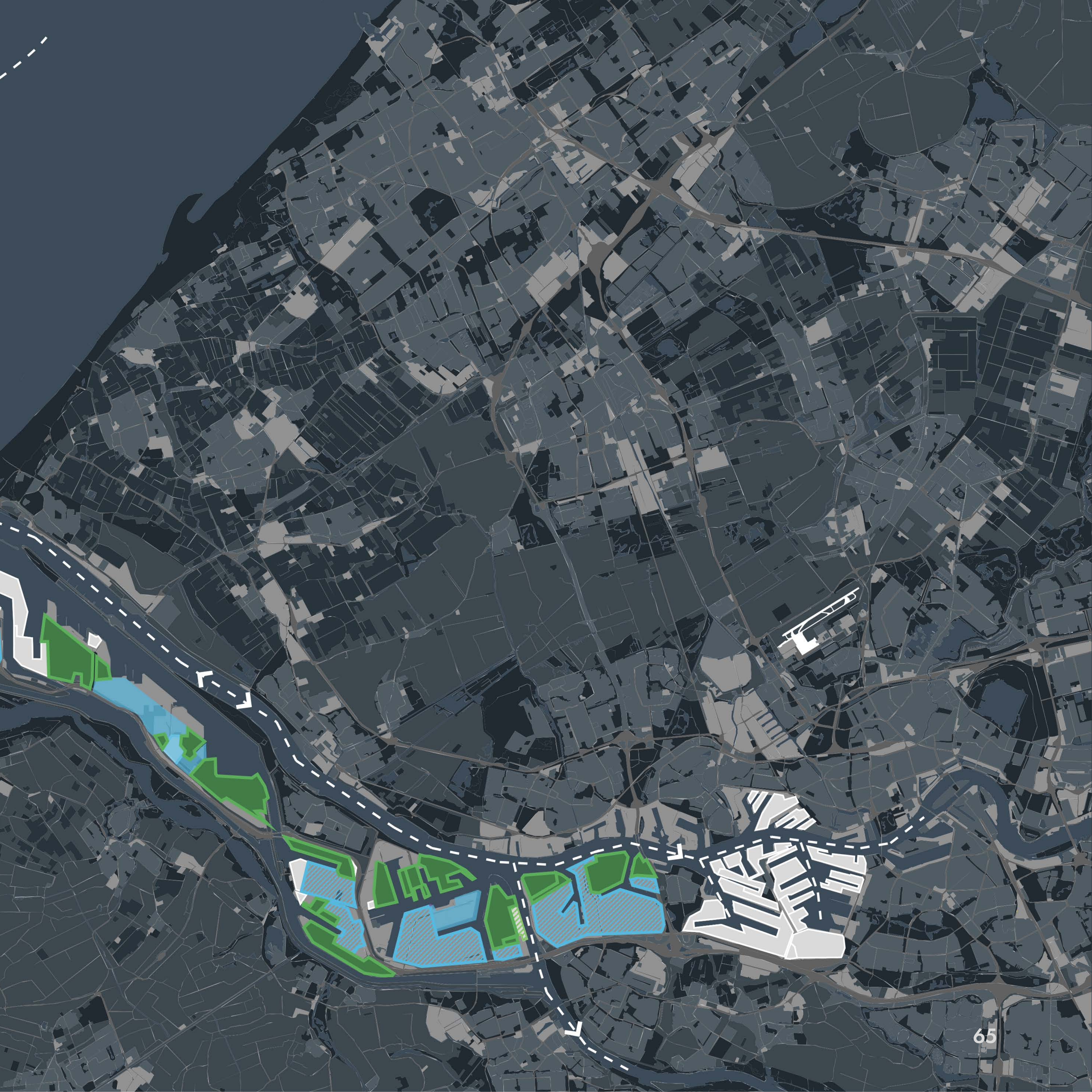


Figure 36 Hydrogen Port



Pipeline Network

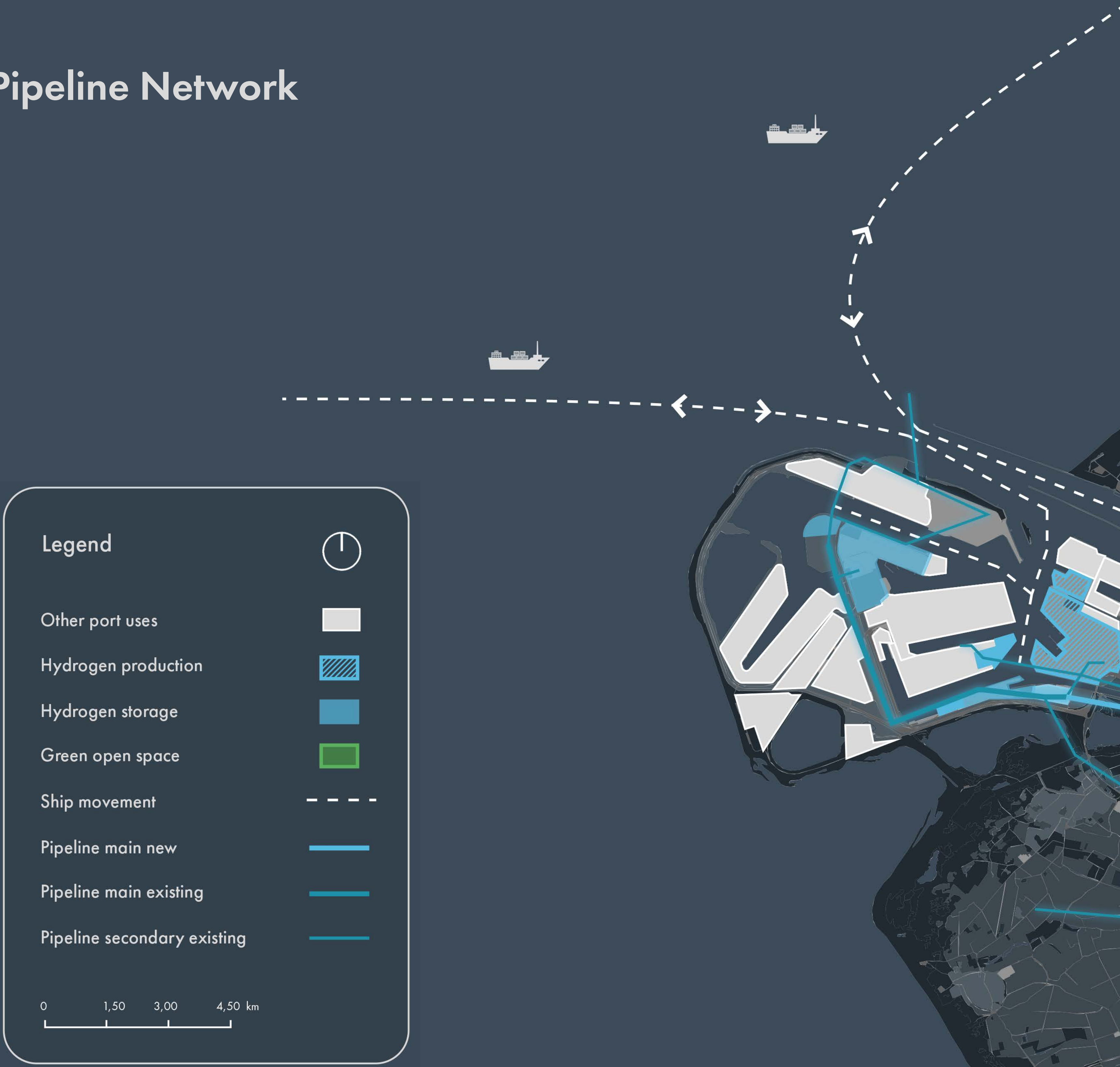


Figure 37 Pipeline Network

Hydrogen Hubs

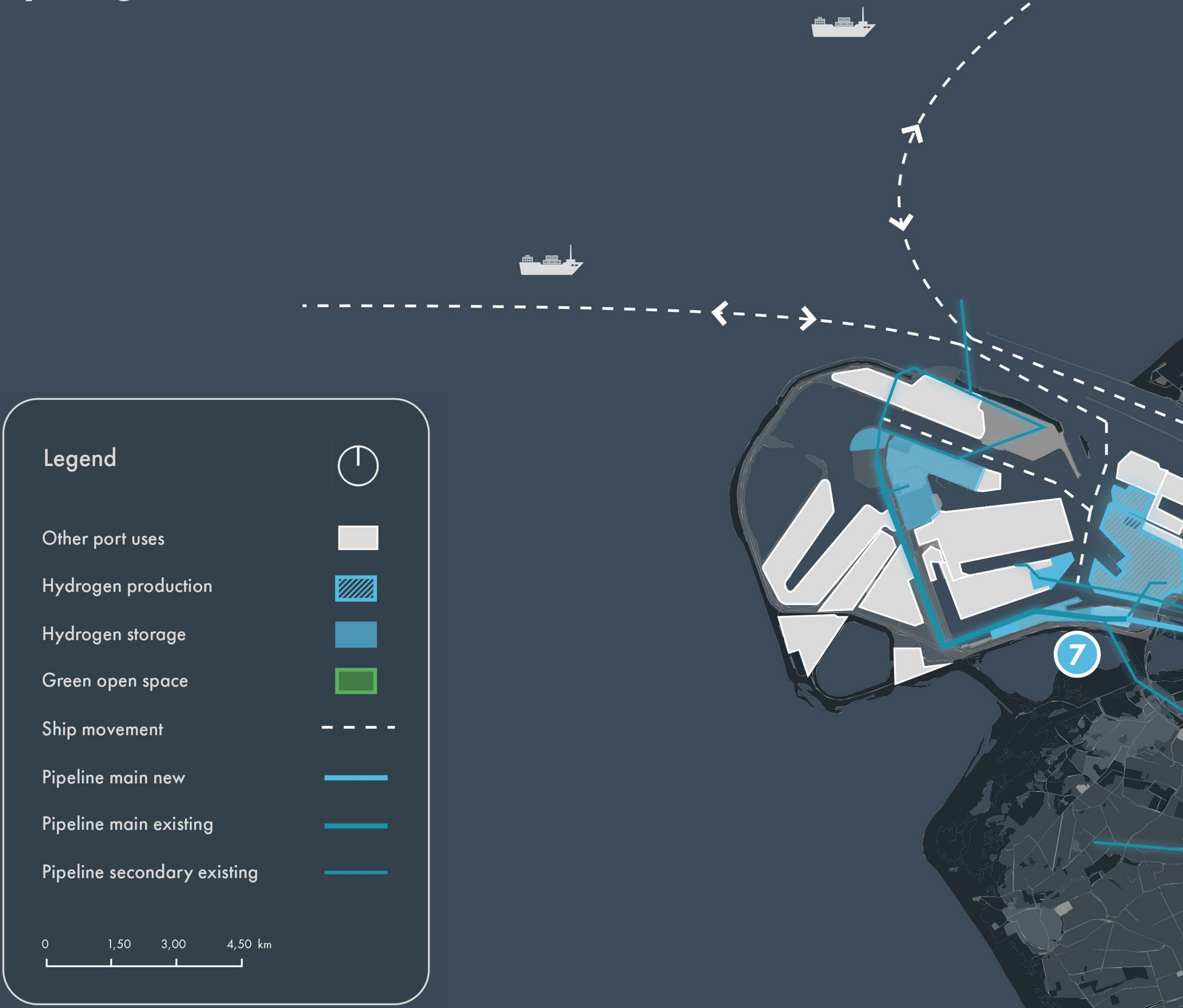
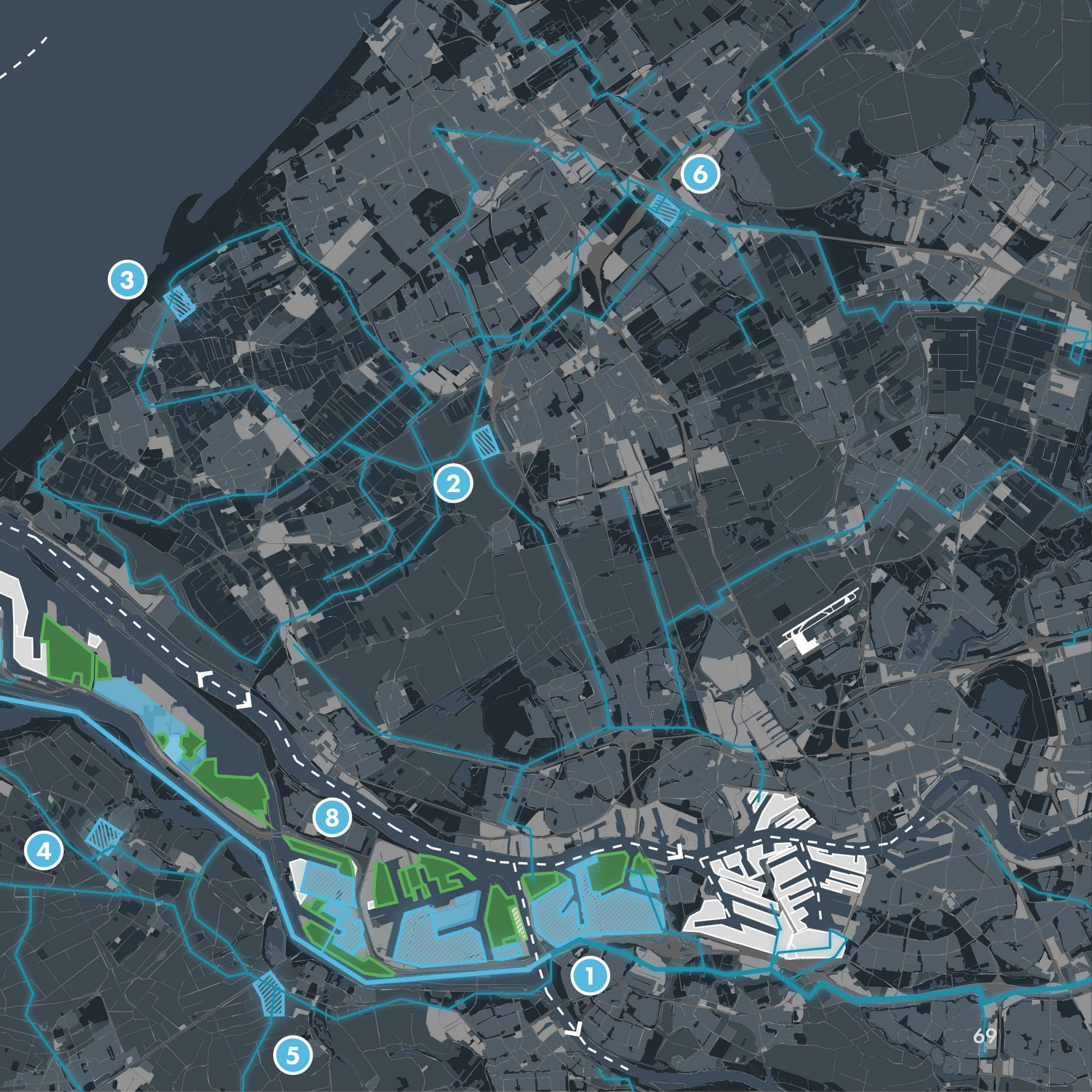


Figure 38 Hydrogen Hubs



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Green Network

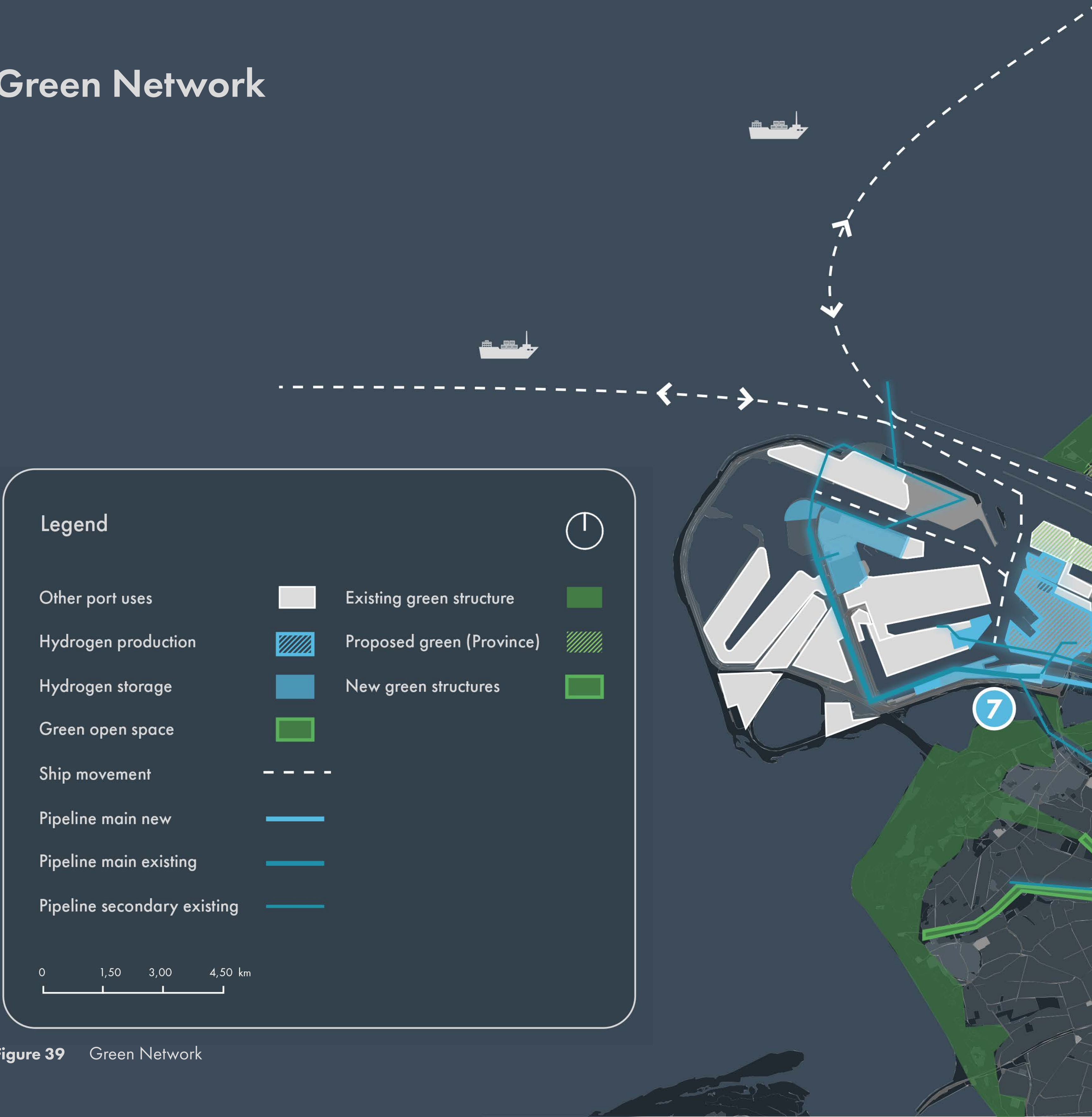
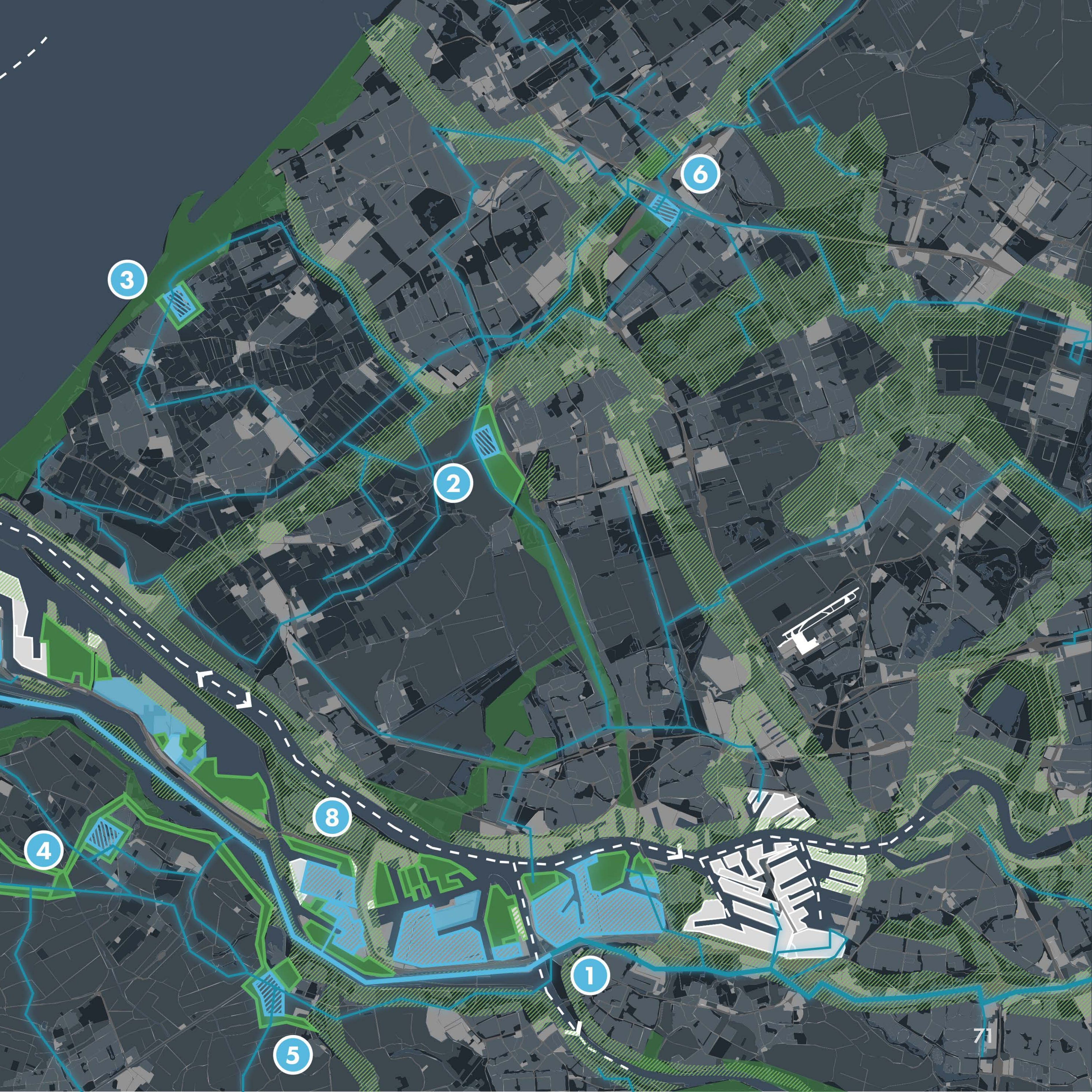


Figure 39 Green Network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Housing Development

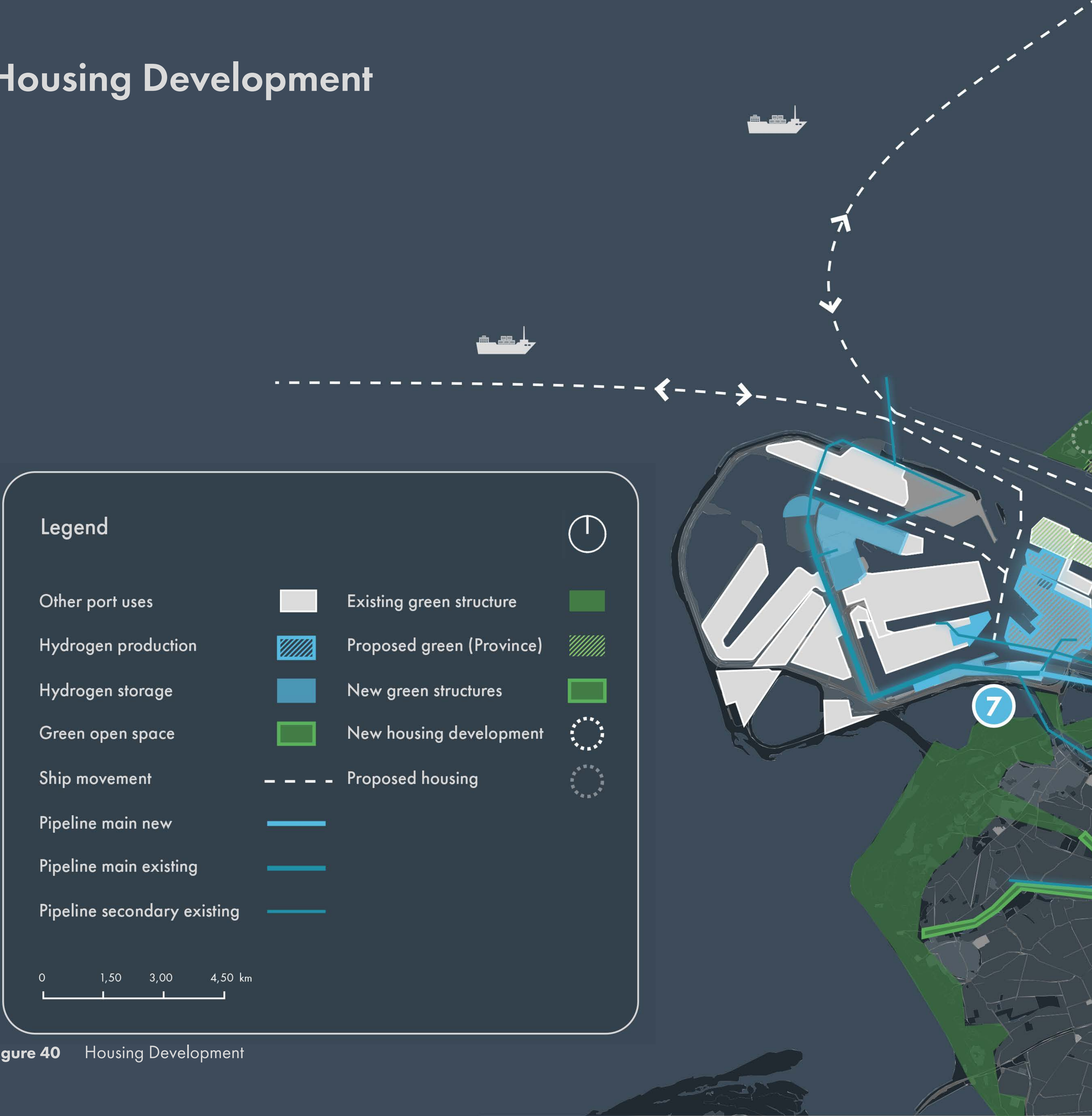
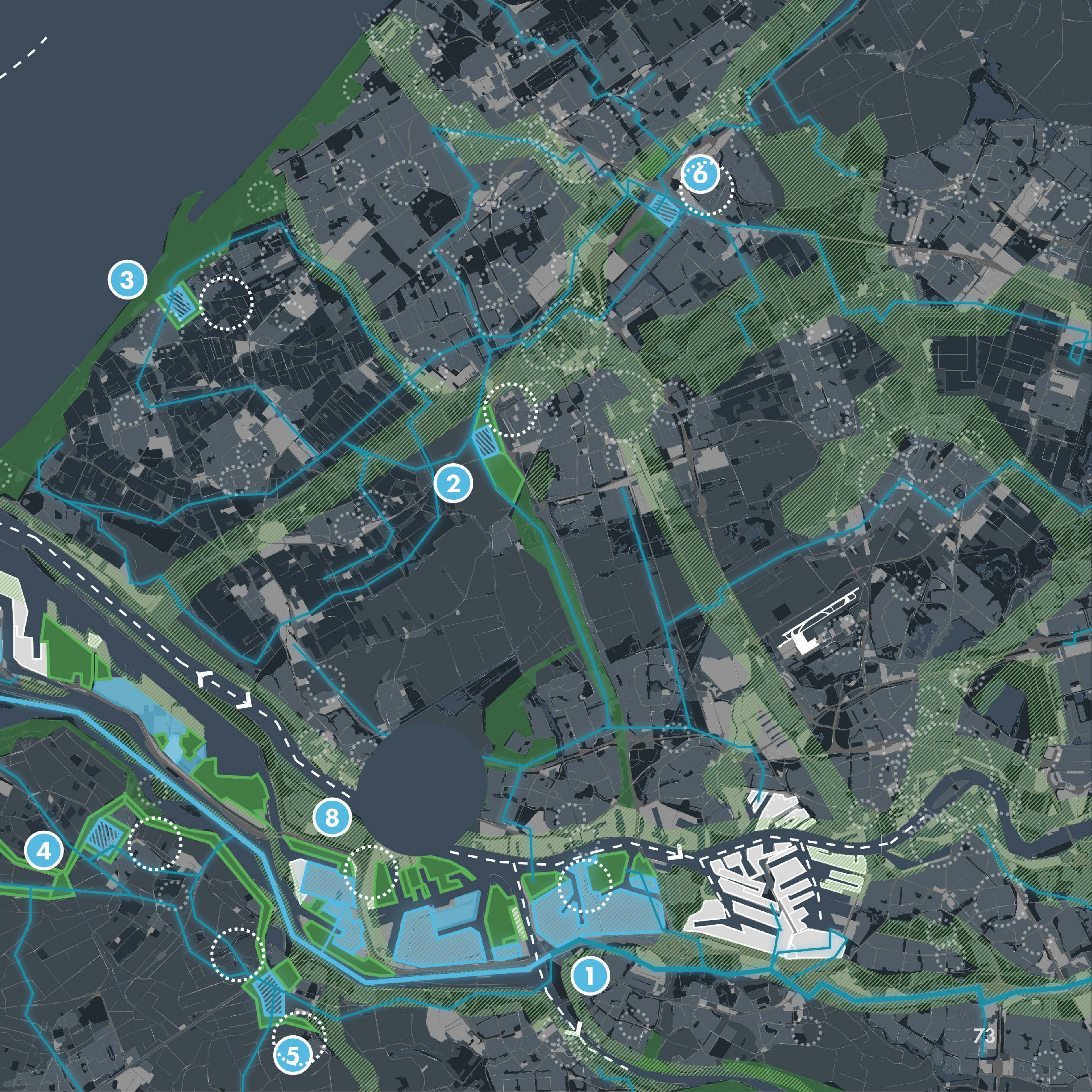


Figure 40 Housing Development



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4.2 Phasing towards the Post-Petrol Era

Energy Landscape in Transition of 2030

Energy Balance
Because of general reduction of energy use of 1,5% per year, according to the document 'Watt Anders' by Provincie Zuid-Holland (2016), and the gradual shift to renewable sources of energy, the dependency on natural gas and oil in the energy Landscape of 2030 is decreasing. Also the use of coals as a source for electricity production is planned to be phased out by 2030 (Wet verbod op kolen bij elektriciteitsproductie (35.167), 2019). However, since it's not plausible the region is able to produce this amount of renewables that should replace the energy demand. Therefore, the import of wind energy is proposed. In conclusion, the depency is still there, but better distributed over different external actors. Because of changing industrial activities and use of land, the port will become more accessible to the people and new green public spaces will be created across the region. The previously divided suppliers, consumers and generators will increasingly intertwine.

Simultaneously, to enhance energy efficiency all types of urban regions are being retrofitted and will be covered with solar panels & small scale wind turbines to make these regions self-sustaining. At the same time, the first hydrogen hub in Pernis is now in full operation and other hydrogen hubs follow and are starting to connect the different areas in the built environment. This is how the regional energy network of hydrogen will be created. Through this network of repurposed gas pipes, these autonomous energy areas can now start to share their surpluses. Now, urban regions can produce hydrogen that could potentially be consumed by the industry. By doing this, the role division between energy users and producers will be more mixed. Next to the previously mentioned import of wind energy, already existing plans for wind turbines on sea and solar fields on land will be added for electricity generation and hydrogen production in the region itself. The green hydrogen will also be used as a heat source for industry and petrochemistry, as well as a fuel for transportation. Since we expect there's still a conversion loss of roughly 20% in the electrolysis process, more energy has to be generated to provide the appropriate amount of hydrogen (Yan et al., 2019).

	ENERGY BALANCE 2030							
	Energy (PJ)	% Electricity	% Oil	% Hydrogen	% Geothermal	% Gas	% Biomass	% Coal
Household	39	30	-	-	32	10	28	-
Utility	47	30	-	-	31	10	29	-
Greenhouse	47	30	-	-	31	10	29	-
Transport	26	67	-	33	-	-	-	-
Petrochemistry	73	31	7	30	-	32	6	-
Industry	150	8	48	20	-	24	-	-

Figure 41 Energy Balance of the Energy Landscape of 2030

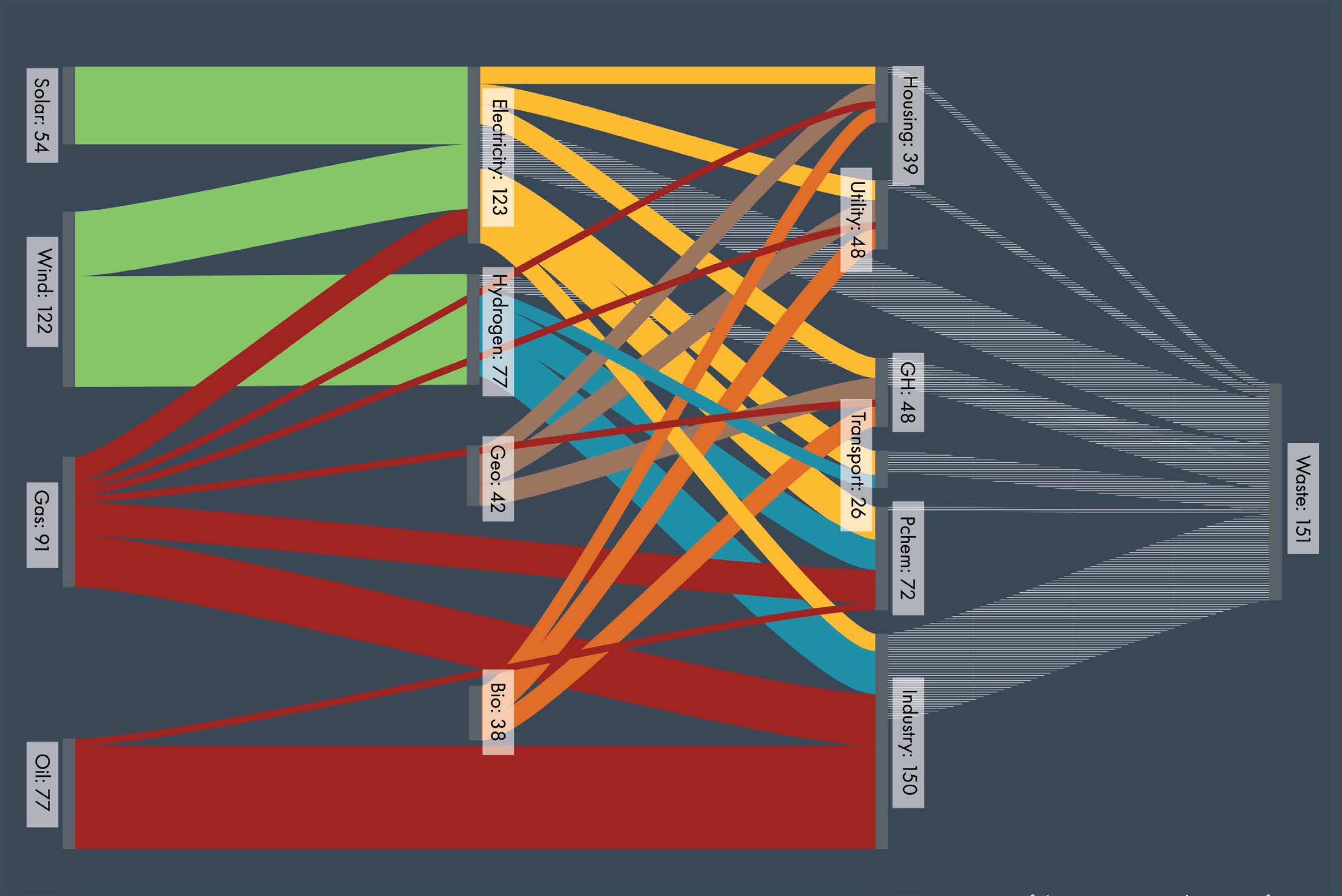
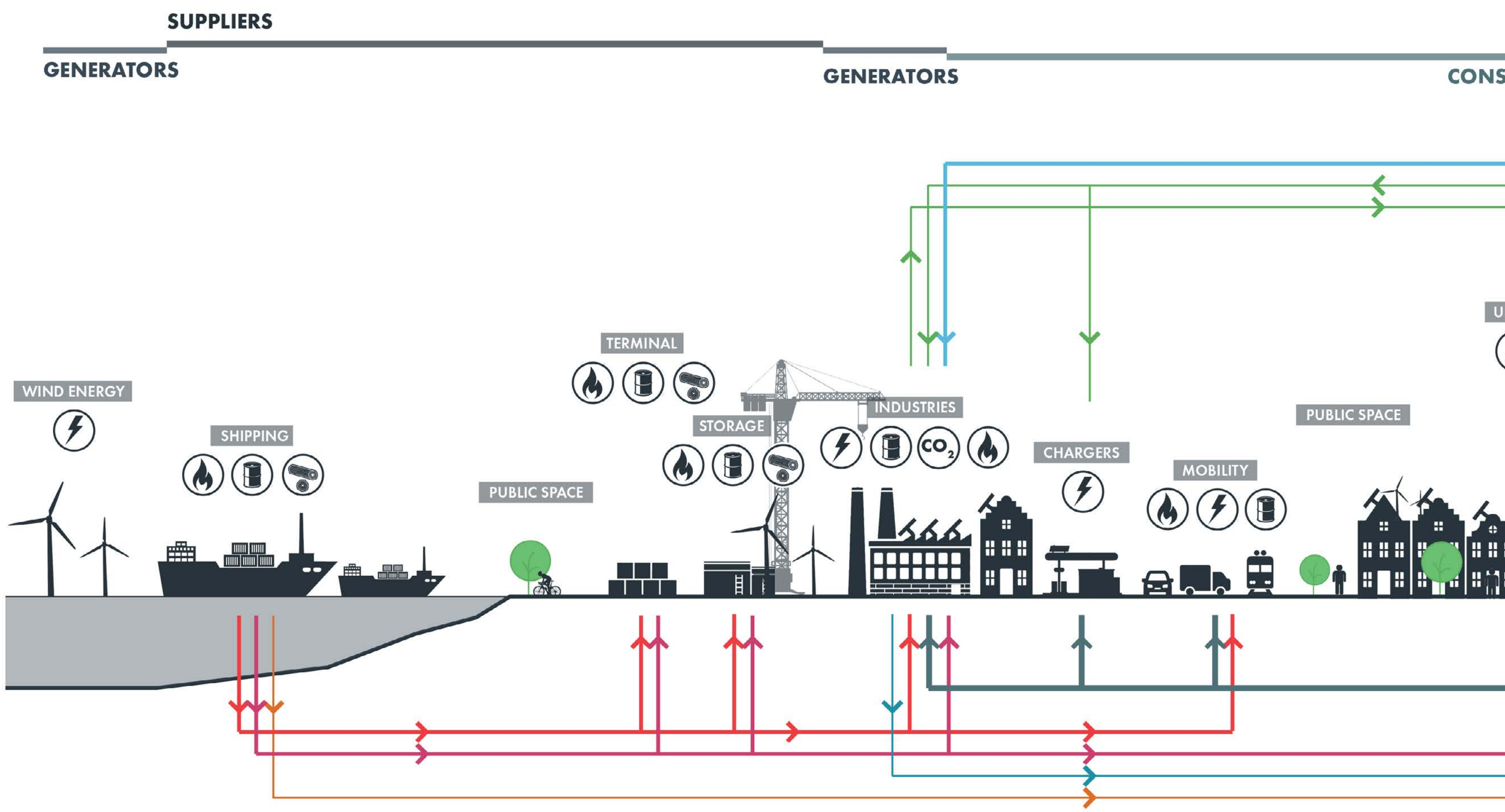


Figure 42 Energy Consumption of the Energy Landscape of 2030

Systemic section 2030



Energy flows

Coal		Biomass		Electricity		Geothermal	
Oil		Carbon Dioxide		Solar		Residual Heat	
Natural Gas		Hydrogen		Wind			

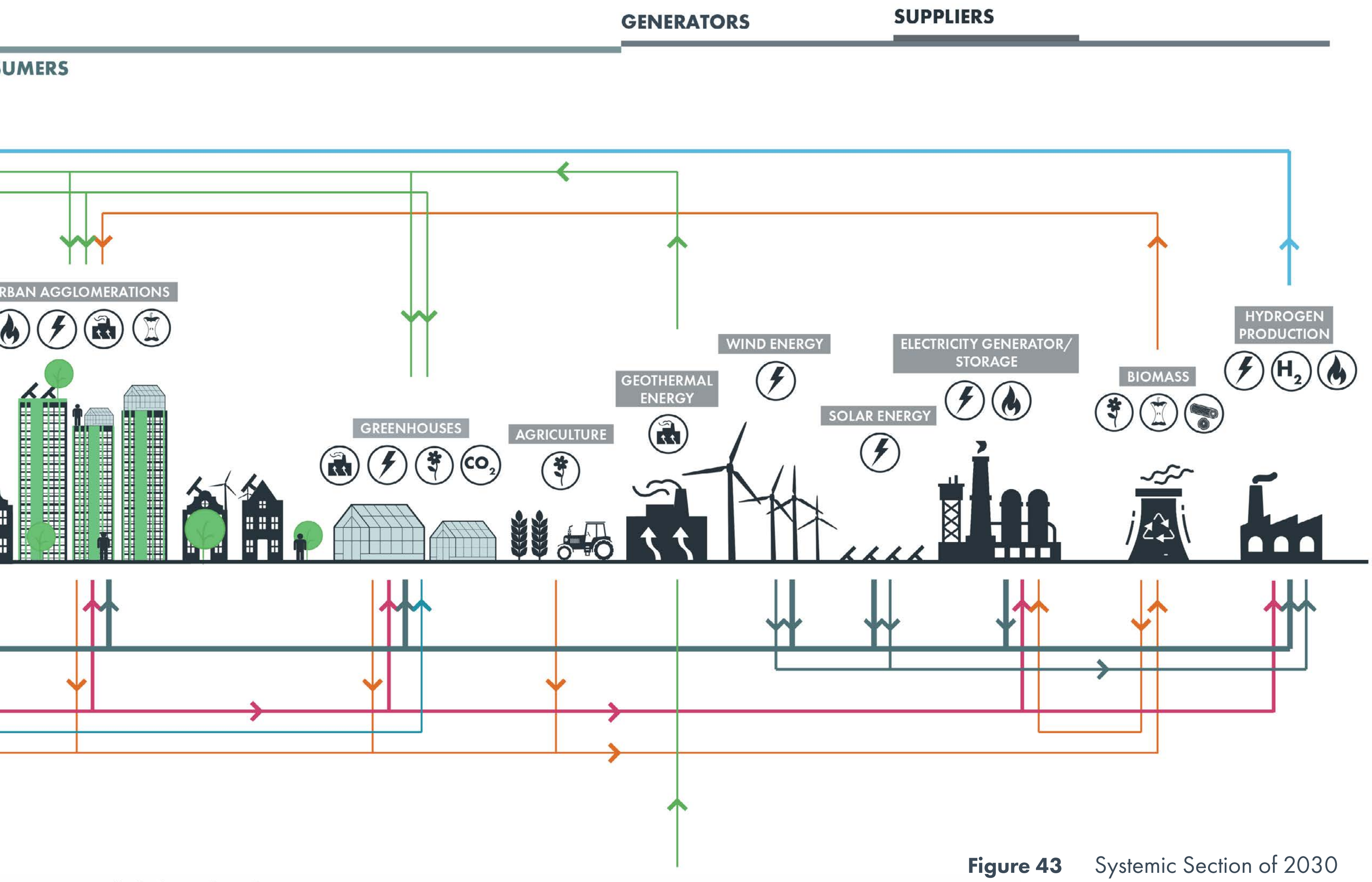


Figure 43 Systemic Section of 2030

Materials involved

Coal
Oil
Natural Gas
Biomass
Carbon Dioxide
Hydrogen
Electricity
Geothermal

Wind Energy 2030

In the in -between phase of 2030, the addition of wind turbines offshore and across the coastline will take place. The existing petrol refineries will gradually transform into places for hydrogen production. Small wind turbines will start being incorporated in the roofs of urban agglomerations. The self - efficiency and sustainability of urban agglomerations through small wind turbines generating electricity is the goal for the future. The wind turbines will assist in wind energy needed for hydrogen production for industries and electricity generation. The gradience in green color indicates the amount of electricity consumption in the areas. The refineries will use less electricity generated from wind in 2030 and the urban agglomerations will start being more self sufficient and use wind energy for local purpose.

Legend

Areas of electricity consumption

- Refineries
- Greenhouses
- Urban agglomerations

Wind energy production

- Wind turbines (existing)
- Wind turbines (future)
- Wind turbines (roofs)

Flows

- Electricity flow
- Hydrogen flow

0   3,50   7,00   10,50 km

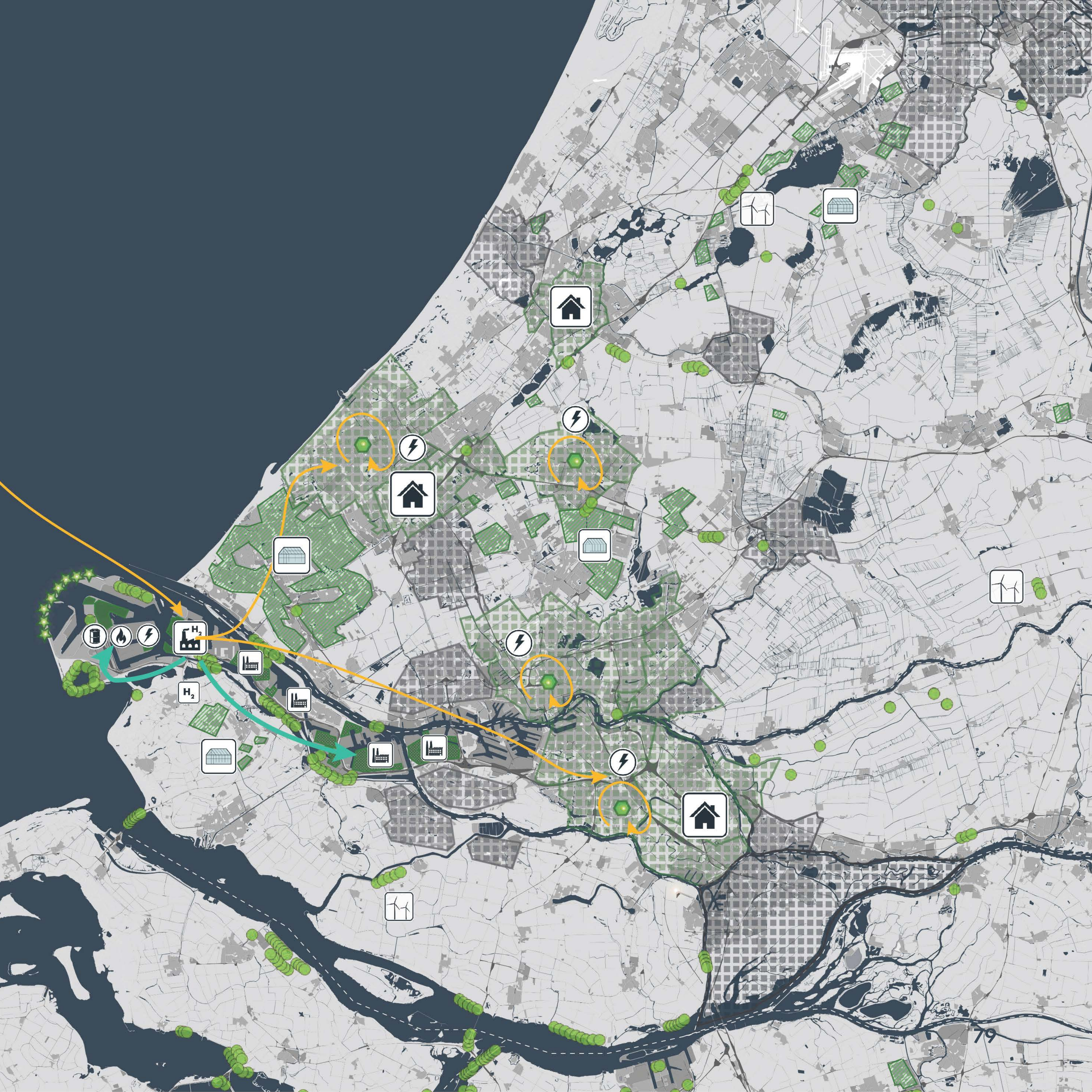
Elements of the region

- Greenhouses
- Refineries
- Urban agglomerations
- Hydrogen production
- Wind turbines

Materials

- Electricity
- Petrol
- Natural gas
- Hydrogen

Figure 44 Wind Energy Landscape of 2030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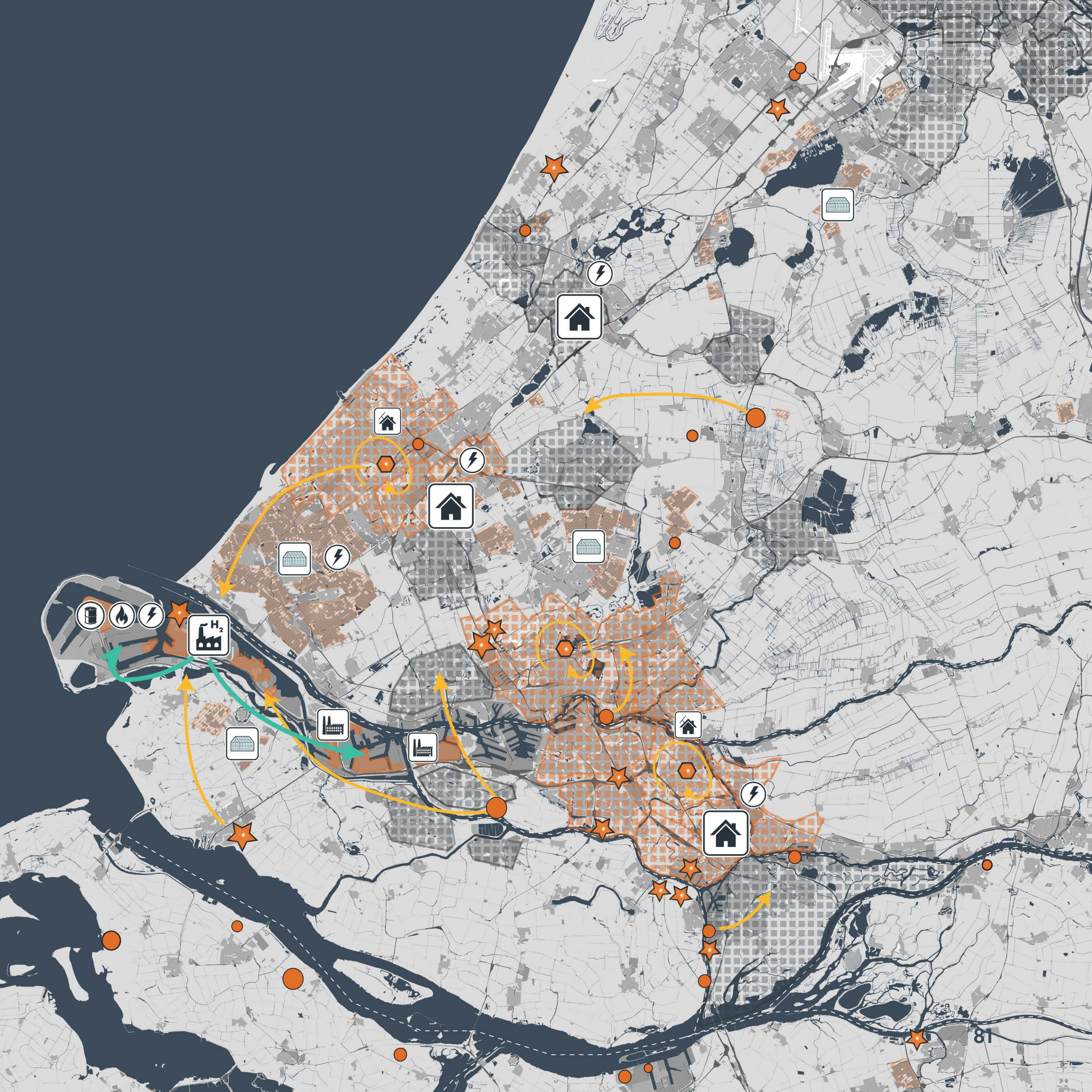
H2

Solar Energy 2030

In the in between phase of 2030, new solar parks will be introduced in the region according to the province of South Holland. The addition of solar panels in the roofs of urban agglomerations will take place in order to achieve self- efficiency and sustainability on a local scale. The solar panels and parks will assist in solar energy needed for hydrogen production for industries and electricity generation. The gradience in orange color indicates the amount of electricity consumption in the areas. The refineries will use less electricity generated from solar installations in 2030 and the urban agglomerations will start being more self -sufficient and use solar energy for local purpose.

Figure 45 Solar Energy Landscape of 2030



Redefined Energy Landscape of 2050

Energy Balance

The energy landscape of 2050 will consist of fully renewable energy sources and the phasing out of fossil fuels is achieved, including the phase out of biomass. New wind turbine parks on sea will be in full operation and the retrofitting of the building stock will be complete. This includes the whole built environment and industrial areas being covered with solar panels and small-sized wind turbines. Hence, the province is now a connected system of areas and has become a decentralized regional energy network, being able to use hydrogen as a carrier and storage for energy surpluses in peak moments. With the regional production of wind, solar and geothermal energy and hydrogen as an important source of heat for industries the region also has become energy independent on the global scale.

The addition of wind turbines and the integration of more solar panels and small wind turbines in the roofs of urban agglomerations will be incorporated in the process. This will result in an independent and self-sufficient energy landscape.

Biomass as an energy source will not be used because the burning and decay of biomass scores low on the R-ladder introduced in the Methodology chapter of this booklet. The energy efficiency will increase because additional housing will be retrofitted. Through the decentralized energy network of 2050 and the redefinition of land uses, the suppliers, consumers and generators will be significantly merged. This also increases the energy efficiency of the energy landscape. In addition to this, housing will expand, more mixed use and recreational areas will be added. The port will become more open to the people and there will be an invert of shipping flow form import to hydrogen export across the globe. The energy balance will shift.

	ENERGY BALANCE 2050							
	Energy (PJ)	% Electricity	% Oil	% Hydrogen	% Geothermal	% Gas	% Biomass	% Coal
Household	29	75	-	-	25	-	-	-
Utility	35	75	-	-	25	-	-	-
Greenhouse	35	25	-	20	55	-	-	-
Transport	19	50	-	50	-	-	-	-
Petrochemistry	54	15	-	60	25	-	-	-
Industry	111	10	-	70	20	-	-	-

Figure 46 Energy Balance of the Energy Landscape of 2050

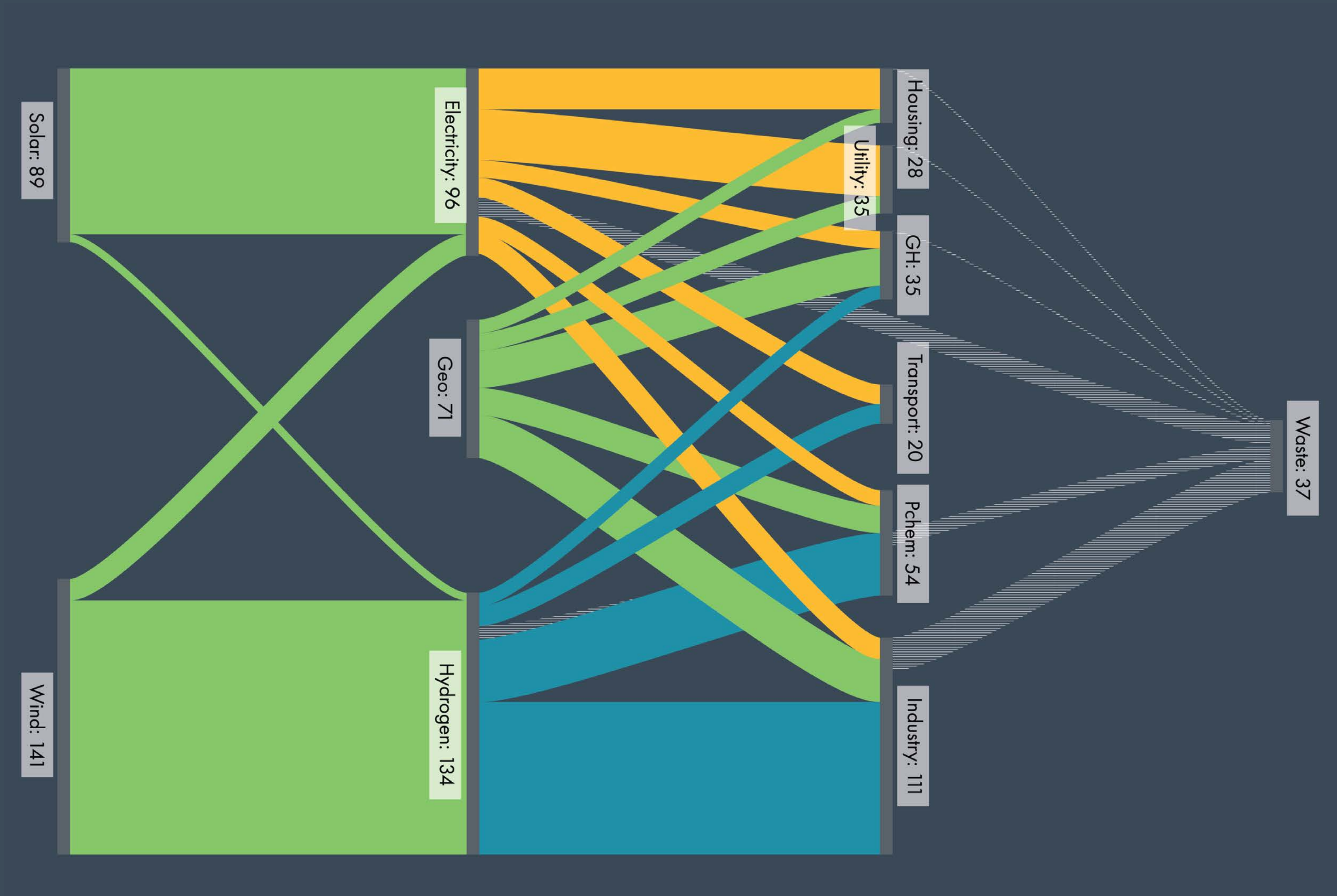
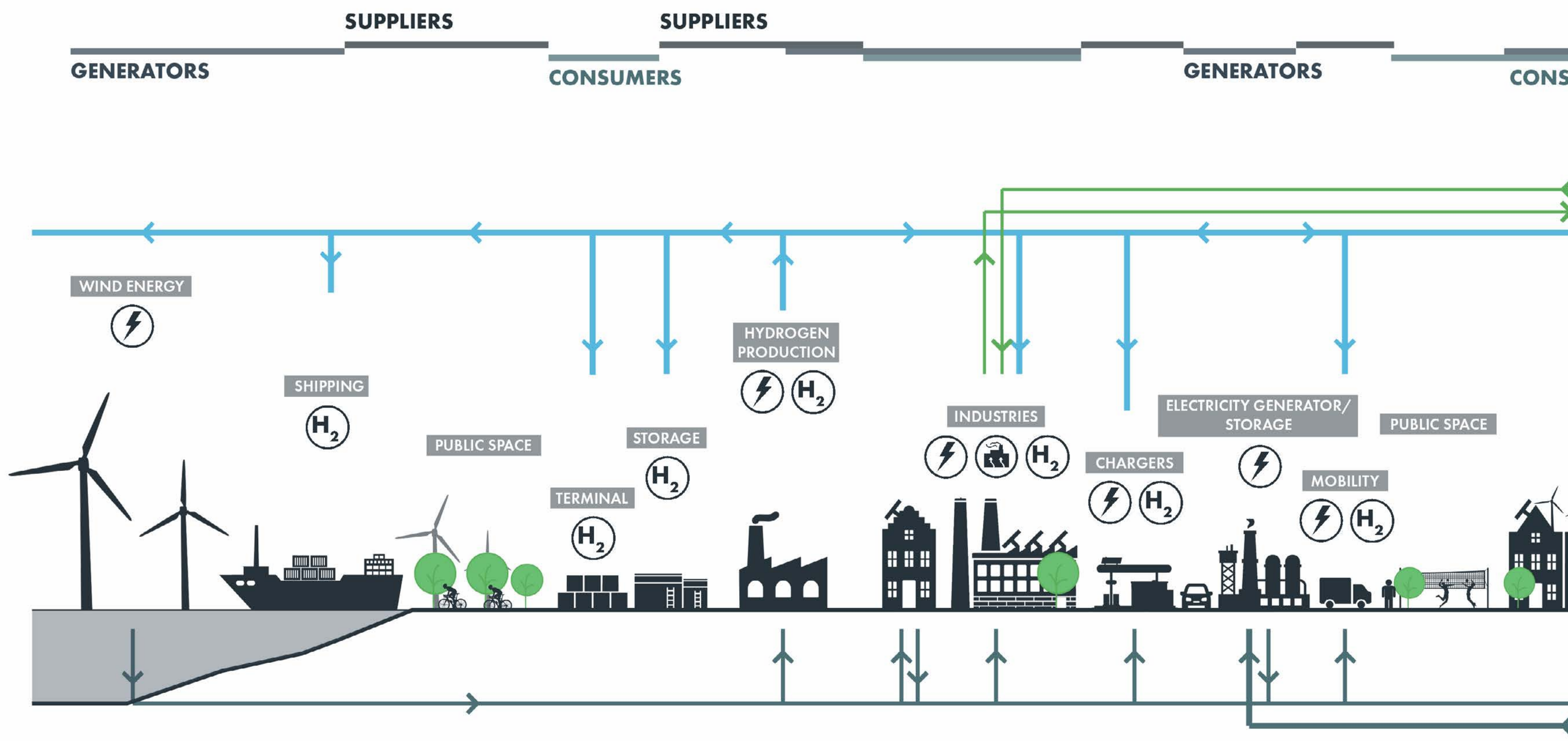


Figure 47 Energy Consumption of the Energy Landscape of 2050

Systemic section 2050



Legend

Energy flows

Coal
Oil
Natural Gas

Biomass
Carbon Dioxide
Hydrogen

Electricity
Solar
Wind

Geothermal
Residual Heat

Mater

Coal
Oil
Natura

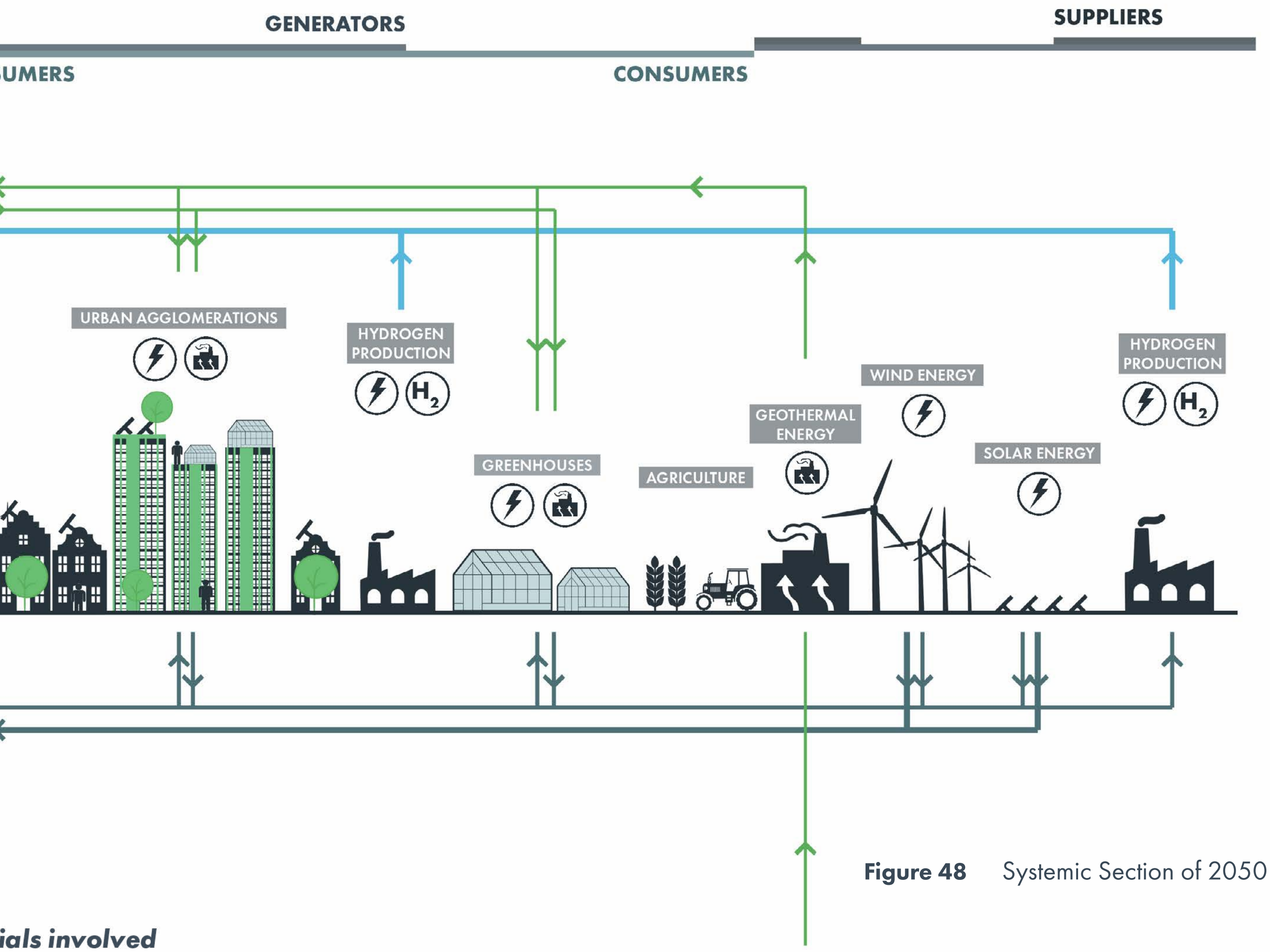


Figure 48 Systemic Section of 2050

ials involved

	Biomass	Electricity
	Carbon Dioxide	Geothermal
l Gas	Hydrogen	

Wind Energy 2050

In 2050, the phasing out of fossil fuels will be accompanied by the addition of solar panels in the roofs of urban agglomerations for sustainability and self - efficiency. The refineries in the area of the port of Rotterdam will be transformed into hydrogen production hubs. More hydrogen hubs will be placed across the region of South Holland. The addition of solar panels will contribute into the electricity generation and hydrogen production. The gradience in orange color indicates the amount of electricity consumption in the areas. It is clear from the map that in 2050 the urban agglomerations will consume the most electricity generated by solar installations compared to greenhouses and industries (Arcgis, n.d.; NLOG n.d.).

Legend

Areas of electricity consumption

Refineries

Greenhouses

Urban agglomerations

Wind energy production

Wind turbines (existing)

Wind turbines (future)

Wind turbines (roofs)

Flows

Electricity flow

Hydrogen flow

Elements of the region

Greenhouses

Urban agglomerations

Hydrogen production

Wind turbines

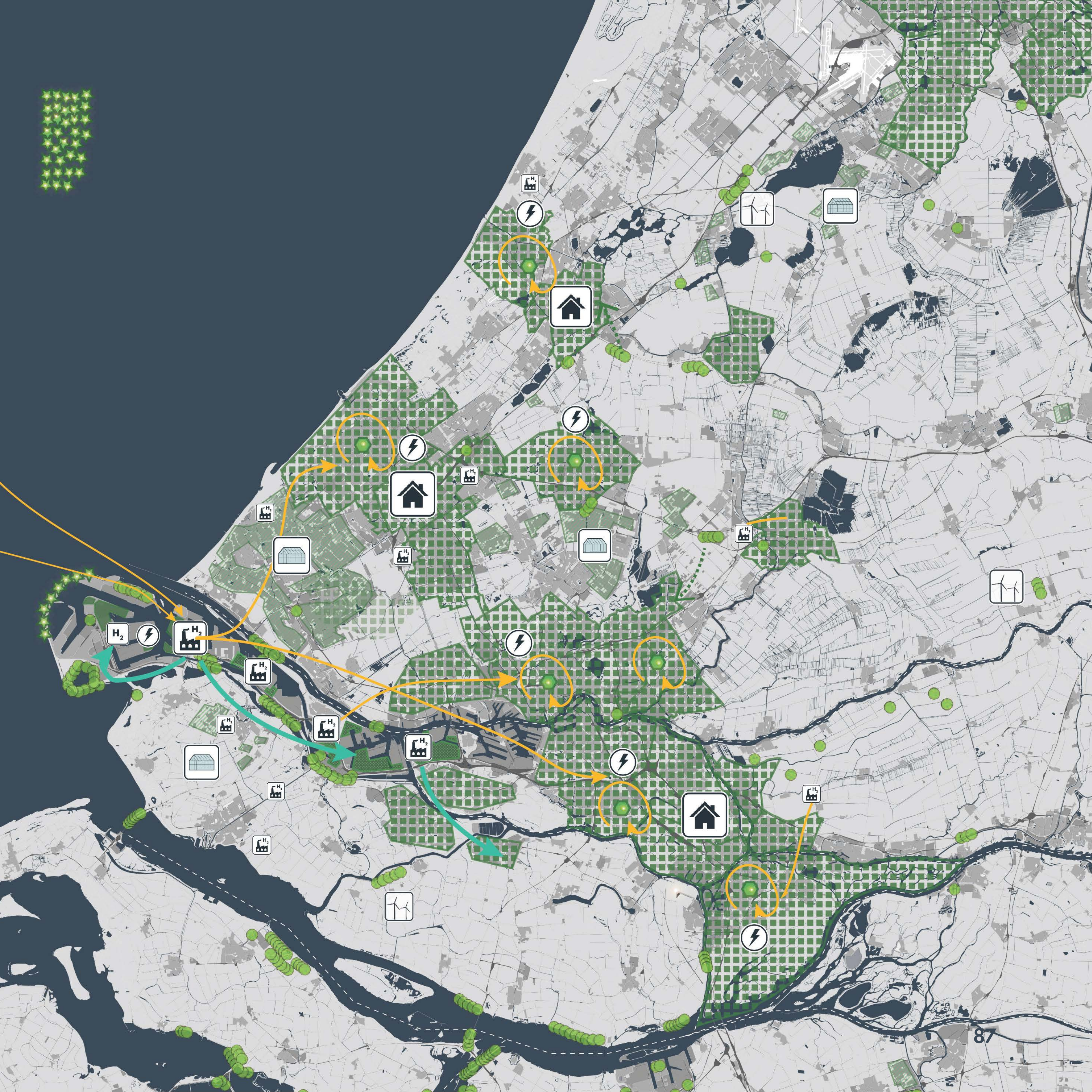
Materials

Electricity

Hydrogen

0 3,50 7,00 10,50 km

Figure 49 Wind Energy Landscape of 2050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Solar Energy 2050

In the post petrol - era of 2050, more wind farms will be located offshore. The addition of small wind turbines in the urban agglomerations will take place in order to ensure sustainability and self - efficiency on a local scale. The phasing out of fossil fuels will lead into the transformation of the petrol refineries into places for hydrogen production in the port of Rotterdam. Hydrogen hubs will also be placed across the region of South Holland. The addition of wind farms and small wind turbines will contribute into the electricity generation and hydrogen production. The gradience in green color indicates the amount of electricity consumption in the areas. It is clear from the map that in 2050 the urban agglomerations will consume the most electricity generated by wind installations compared to greenhouses and industries, thus leading to a more sustainable future for the 2050 (Zon op kaart, n.d.).

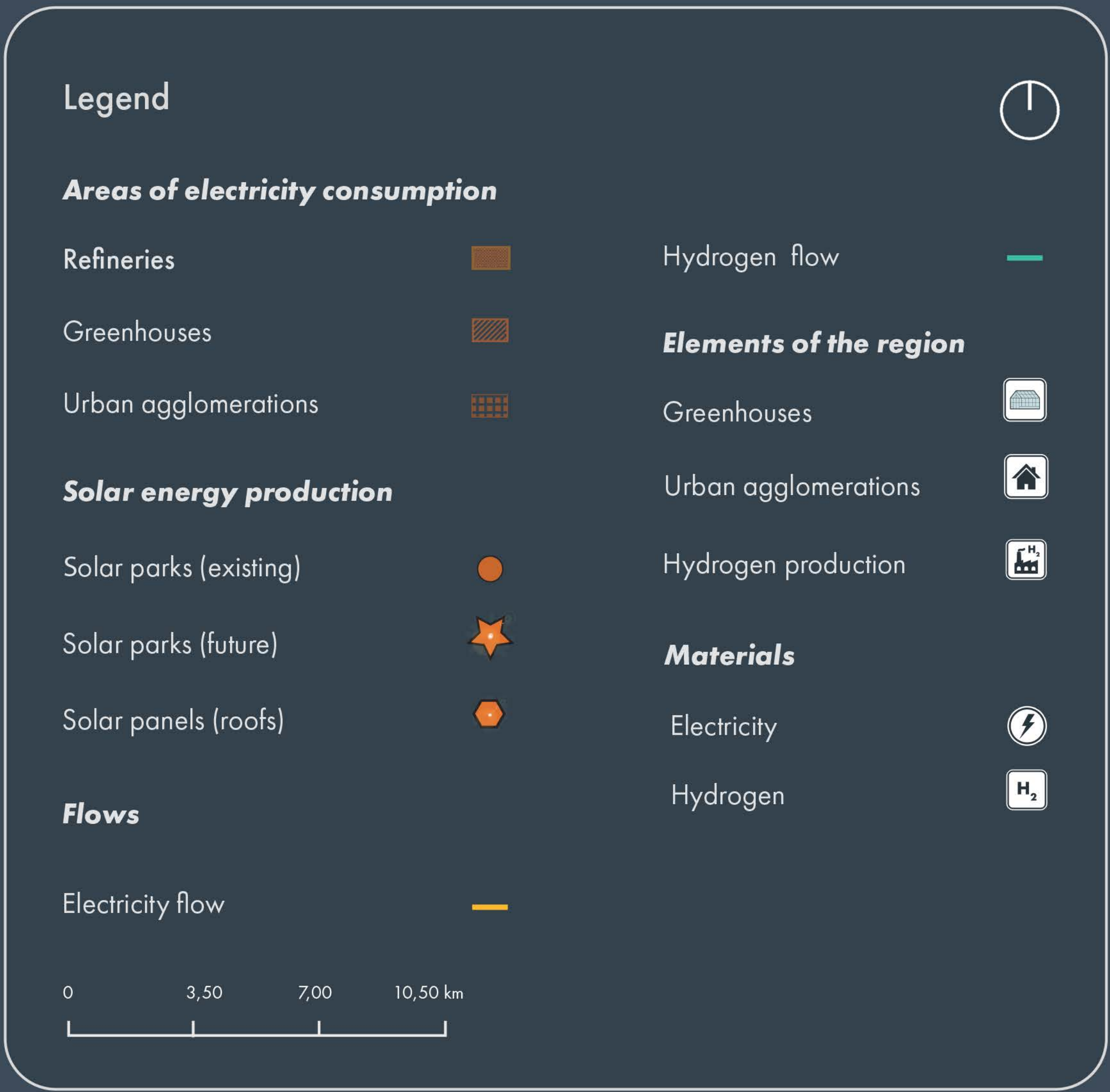
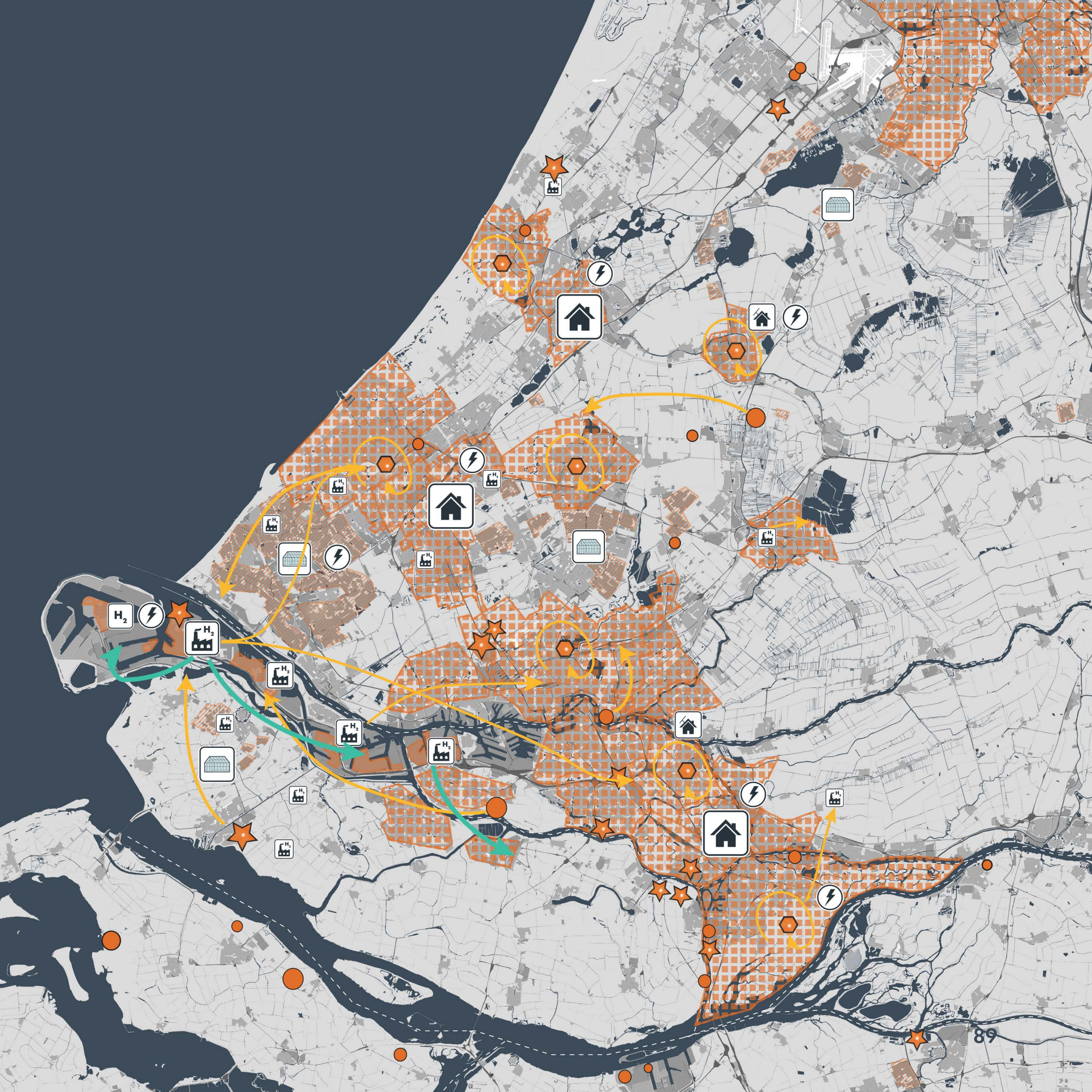


Figure 50 Solar Energy Landscape of 2050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Geothermal Energy 2050

In the post petrol era of 2050 the geothermal energy will strongly increase in the urban area. It will be the main heat source of this entity. Geothermal will also be used in Greenhouse industries. Like the potential map showed, this area has a lot of Geothermal potential and this will be used for this industry. In combination with hydrogen hubs, large scale geothermal generation hub will be realized to heat these built environments. Industrie however, like the port industry, will largely use hydrogen because of the high temperature intensity of hydrogen.

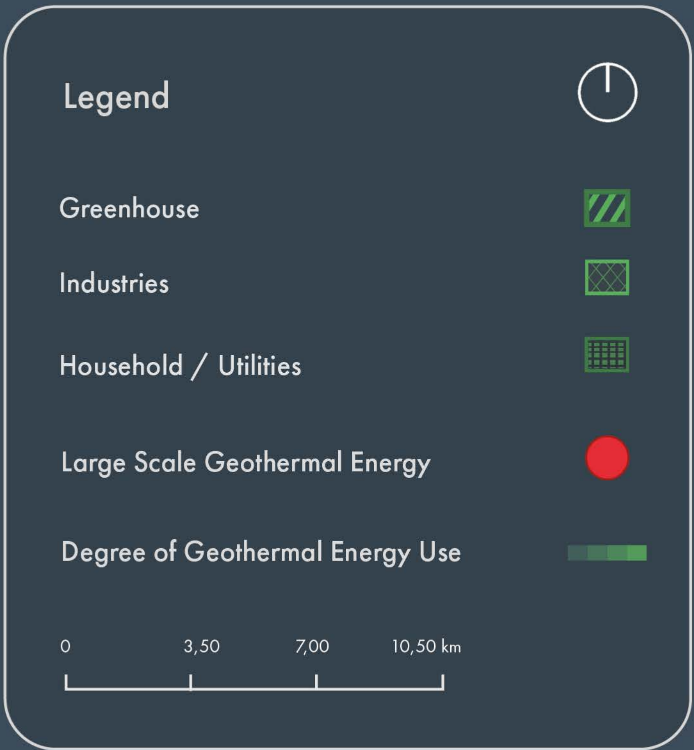
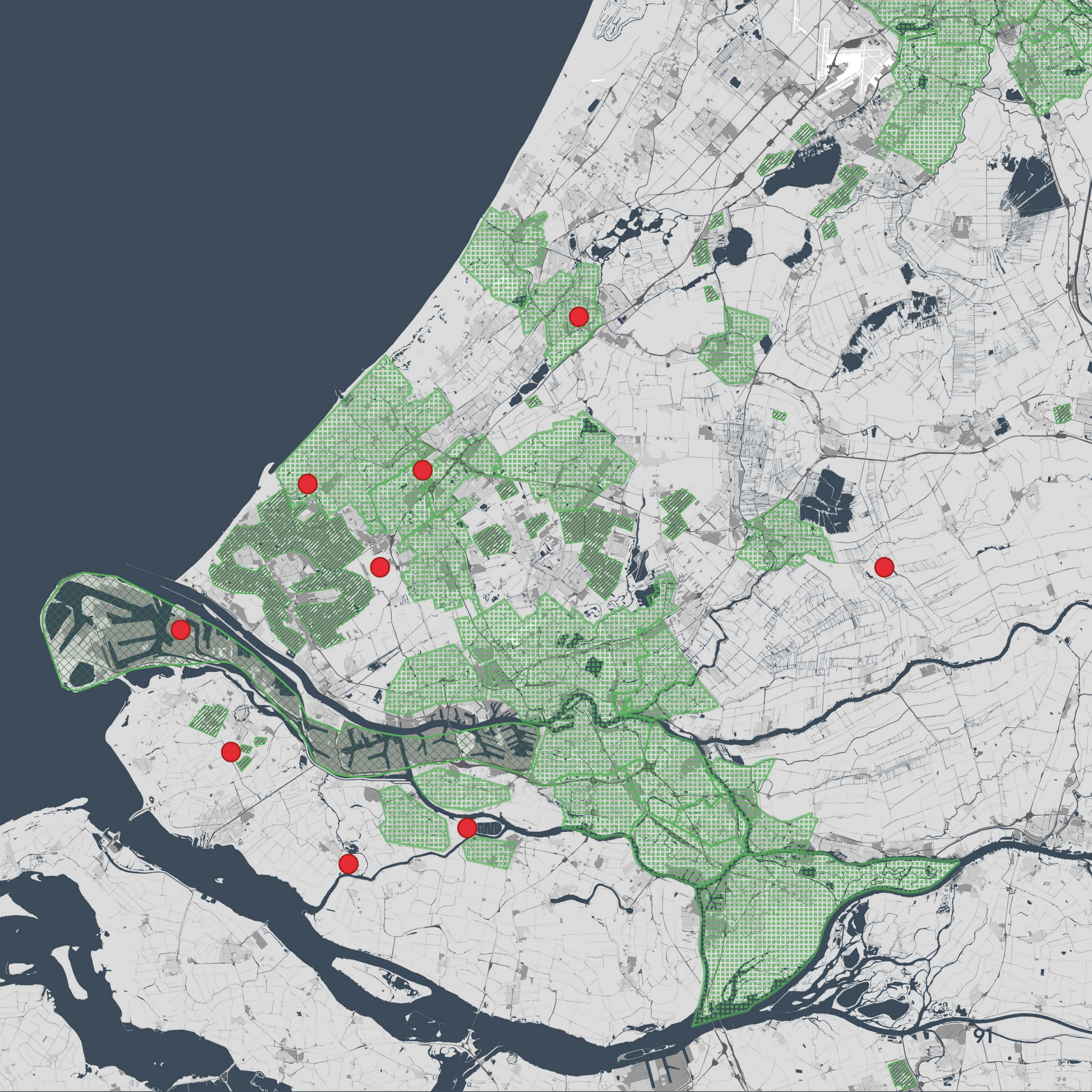


Figure 51 Geothermal Energy Landscape of 2050



Hydrogen Network 2050

In the 2050 where the phasing out of fossil fuels will take place, the hydrogen will be the main energy source in South Holland. The hydrogen flow will be achieved through the reuse and retrofitting of natural gas pipes. New hydrogen hubs will appear in the intersection of hydrogen pipes across the region of South Holland. The blue gradience indicates the degree of hydrogen consumption in the areas. The industries and greenhouses will reuse most of the hydrogen while the mobility will shift to hydrogen as a sustainable fuel.

Legend

Hydrogen Pipe

Carbon Dioxide Pipe

Energy Hub/ Storage/ Distribution / Generation

Degree of Hydrogen Use

0 3,50 7,00 10,50 km

Figure 52 Hydrogen Network of 2050

General Roadmap

A roadmap was constructed in order to gain a better understanding of the project's phasing. The transformation of the energy landscape to the post-petroleum age is illustrated in this map. The phasing has been given various names to illustrate different time periods. The energy landscape will experience its most significant transformation between 2020 and 2030. Between 2030 and 2050 The energy landscape will be transformed in such a way that the shift from fossil fuels to renewable energy sources will be nearly complete. From 2050 onwards, the energy landscape will be redefined as the Post-Petrol Era.

The map consists of three layers. The first one being the Spatial layer. This layer exists of actions with spatial implications. The Social layer is the layer with social implications. The final one being the Technological layer, which adapts to data gathering and evolving techniques in the energy transition.
The actions in the roadmap have been color coded. In green the initiators. These are actions which initiate change. These can mostly be found in the social layer of the roadmap. Social actors will be responsible to initiate actions that can change the energy landscape.The blue actions are resources or tools that change the energy landscape. The upscaling and downscaling of different energy sources are the main actions for this. The actions colored in red are the milestones. These milestones are a priority in the transition of the energy landscape and have to be met in order to redefine the energy landscape of the Post petrol Era.
Distinct sorts of lining has been used to identify the various actions. These represent the different planning instruments. The 'shaping'-instrument aims for soft steering and from a distance. 'Capacity Building' is also soft steering but steers through consultation. The third instrument also steers through consultation but uses hard steering.

This is the 'Stimulating'-instrument. The final one completes the quartet and steers hard at distance. This is the 'Regulating'-instrument. In figure 55 more information about the planning instruments can be found.
These instruments give an indication of the way these actions need to be governed and planned. This can help to identify the engagement strategy to use for different stakeholders connected to the actions. For instance, the downscaling of fossil fuels needs to be regulated in order to make the transition happen. After these actions, upscaling of renewable energy sources in the 'Transformed Energy Landscape'-time period will be stimulated and don't require steering at distance anymore. In this way, the strategy towards the phasing and the engagement of stakeholders get clear with the use of this roadmap.

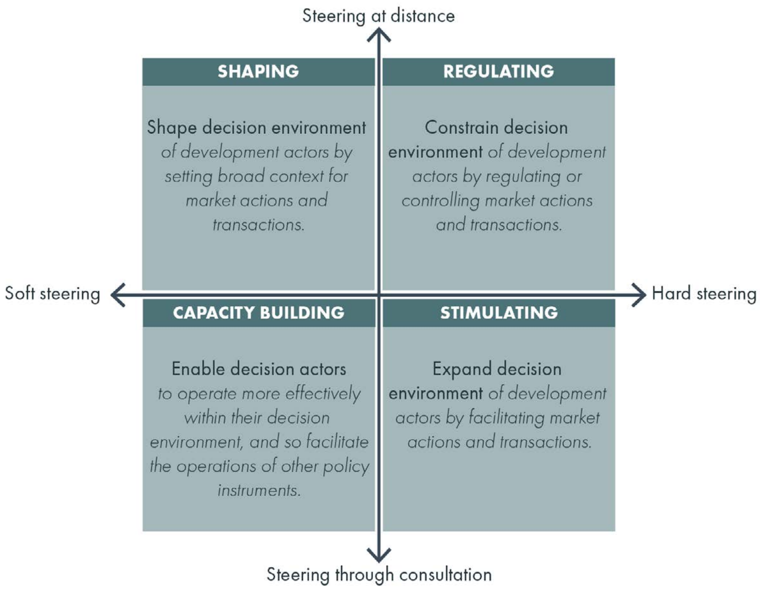


Figure 53 Planning Instuments

Redefined Energy Landscape in the Post-Petrol Era

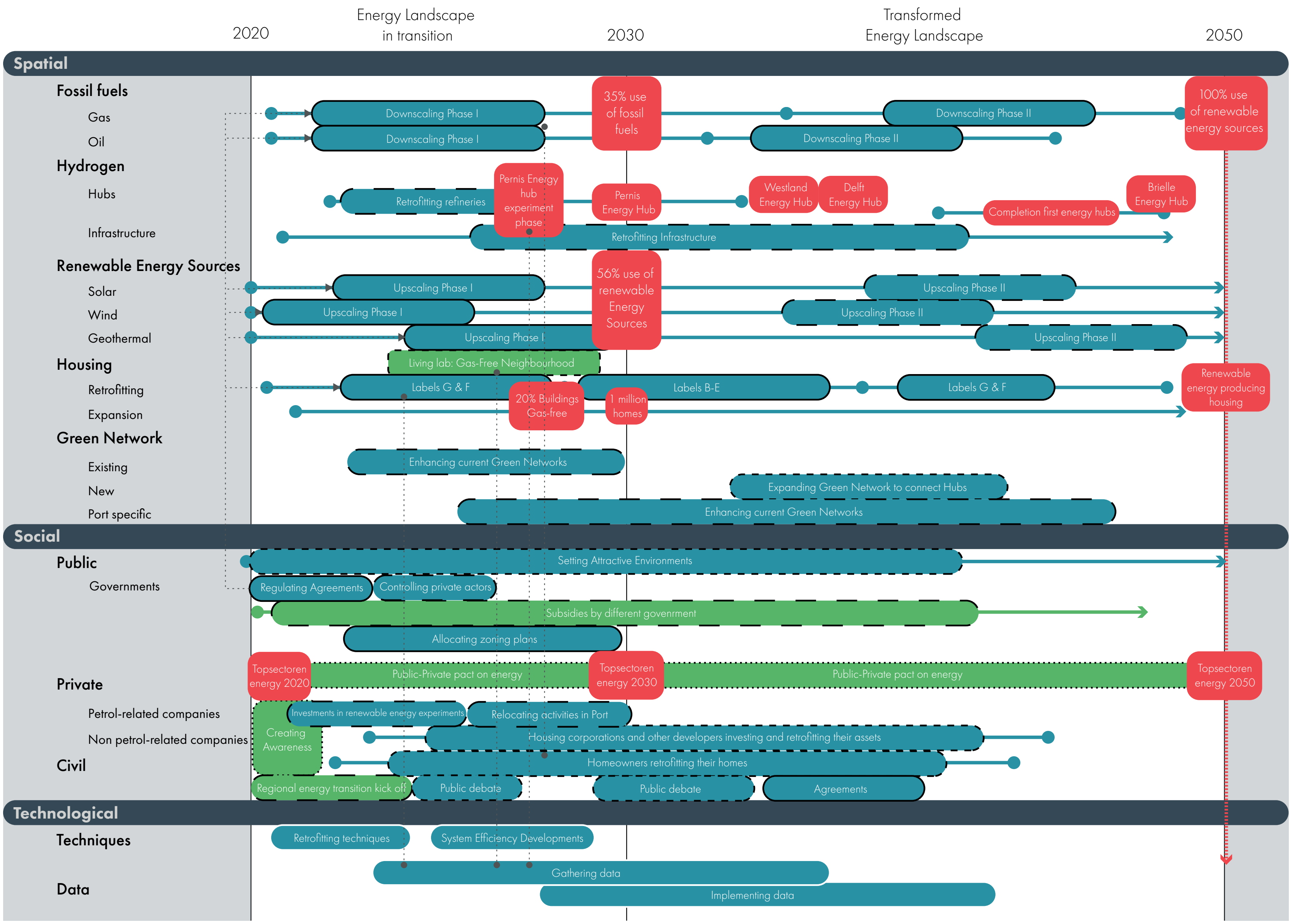
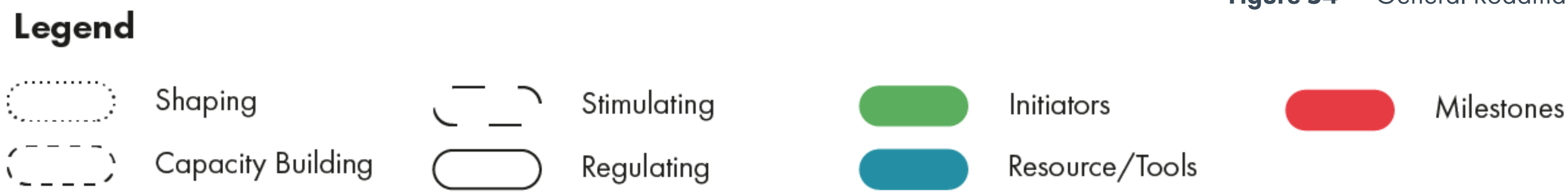


Figure 54 General Roadmap



Conclusion

To conclude, the development strategy is build up into different timeperiods to smoothen the energy transition. The energy landscape of 2020, which is shown in chapter 2, has a large dependency on fossil fuels. Renewable energy sources contribute to less than 1 % of the total energy generation. In addition to this, the large amount of energy loss constributes to a high amount of energy that needs to be generated by fossil fuels.

The Energy Landscape of 2030 is a step up into the energy transition. A first phase out of fossil fuels is happening in this 'Transformed Energy Landscape'. The energy landscape will partially be independent of fossil fuels. There will be a mix-use of renewable energy sources and fossil fuels. Also, a start is made into the efficiency of energy use. A decline in the use of overall energy need is starting to be realized.

The Energy Landscape of 2050 will consist of 100% renewable energy sources. Biomass, as a heat source, will not be used. The energy efficiency will increase in this timeperiod in a significant way.

This will lead to a gradually phasing out of fossil fuels and phasing in of renewable energy sources in a Redefined Energy Landscape of the Post-Petrol Era. The timeperiods will also be a guideline for the adaptation of the energy landscape in the stategic areas.

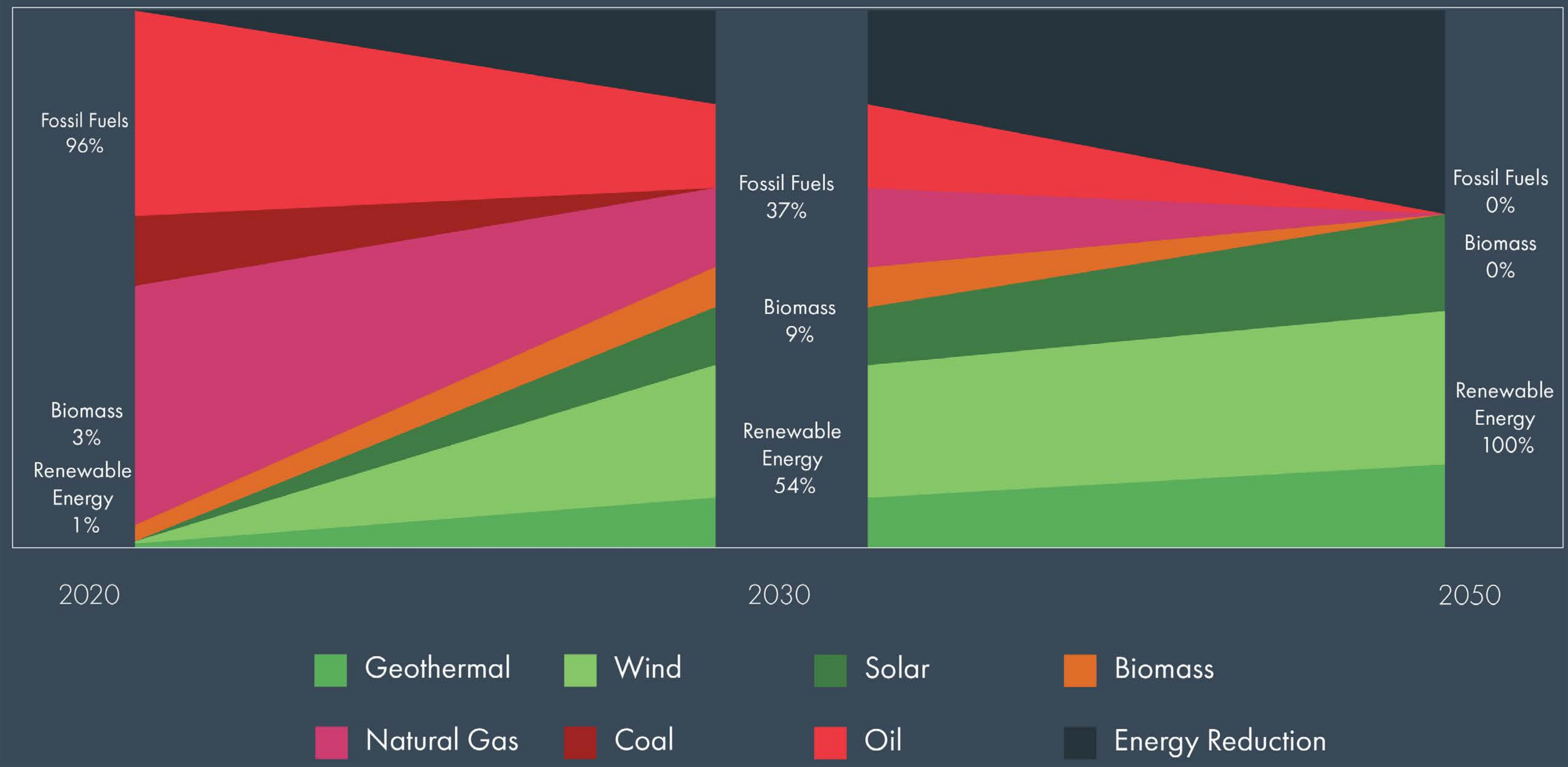


Figure 55 Timeline phasing out fossil fiels and phasing in renewable energy sources

4.3 Strategic Locations in the Post-Petrol Era

In order to have a better overview of the implementation of the redefined energy landscape, four stretigic locations have been chosen to visualize the redefined energy landscape on a smaller scale. Pernis-Botlek, Delft, Westland and Brielle depict the interventions in the local scale.

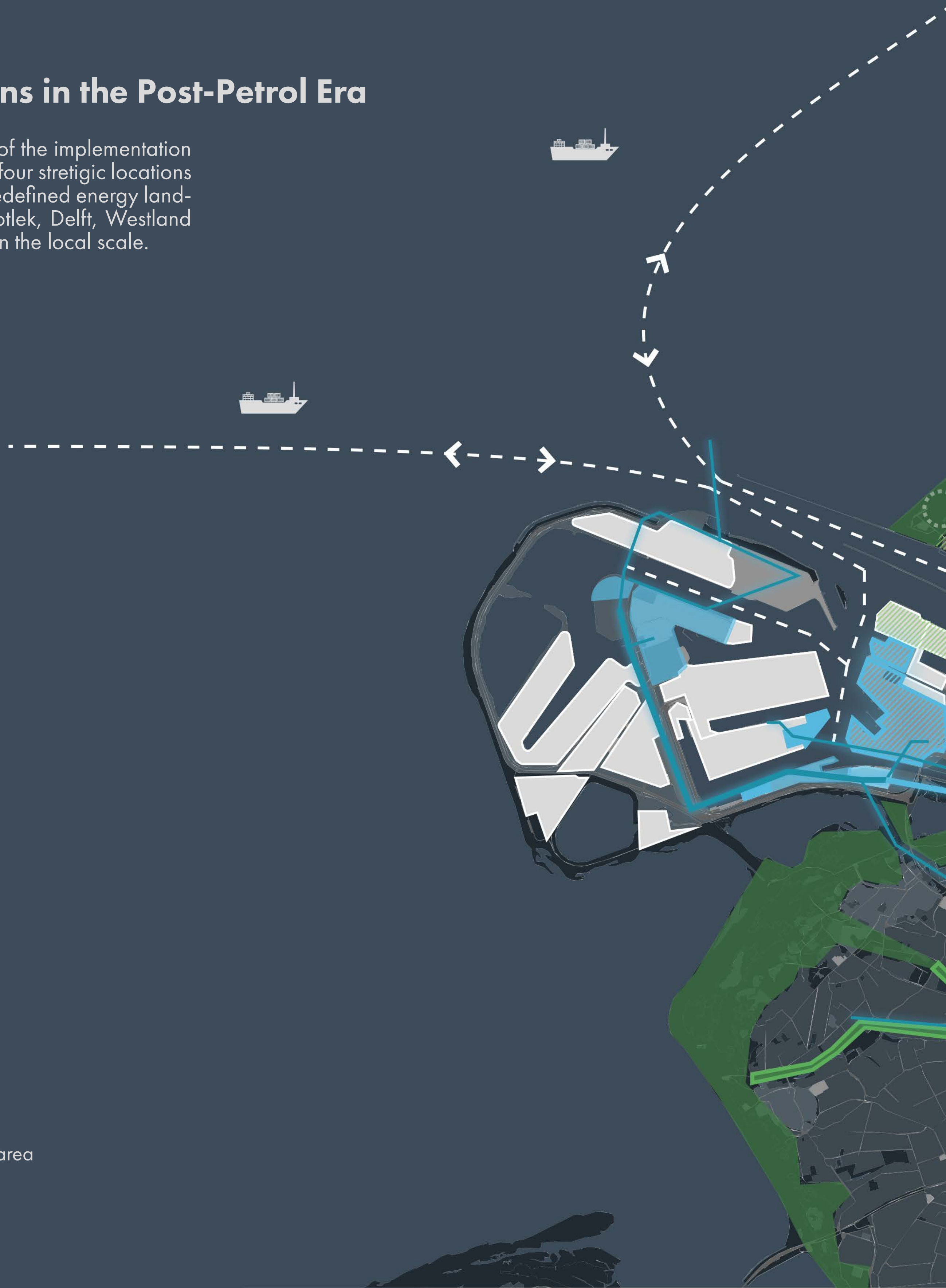
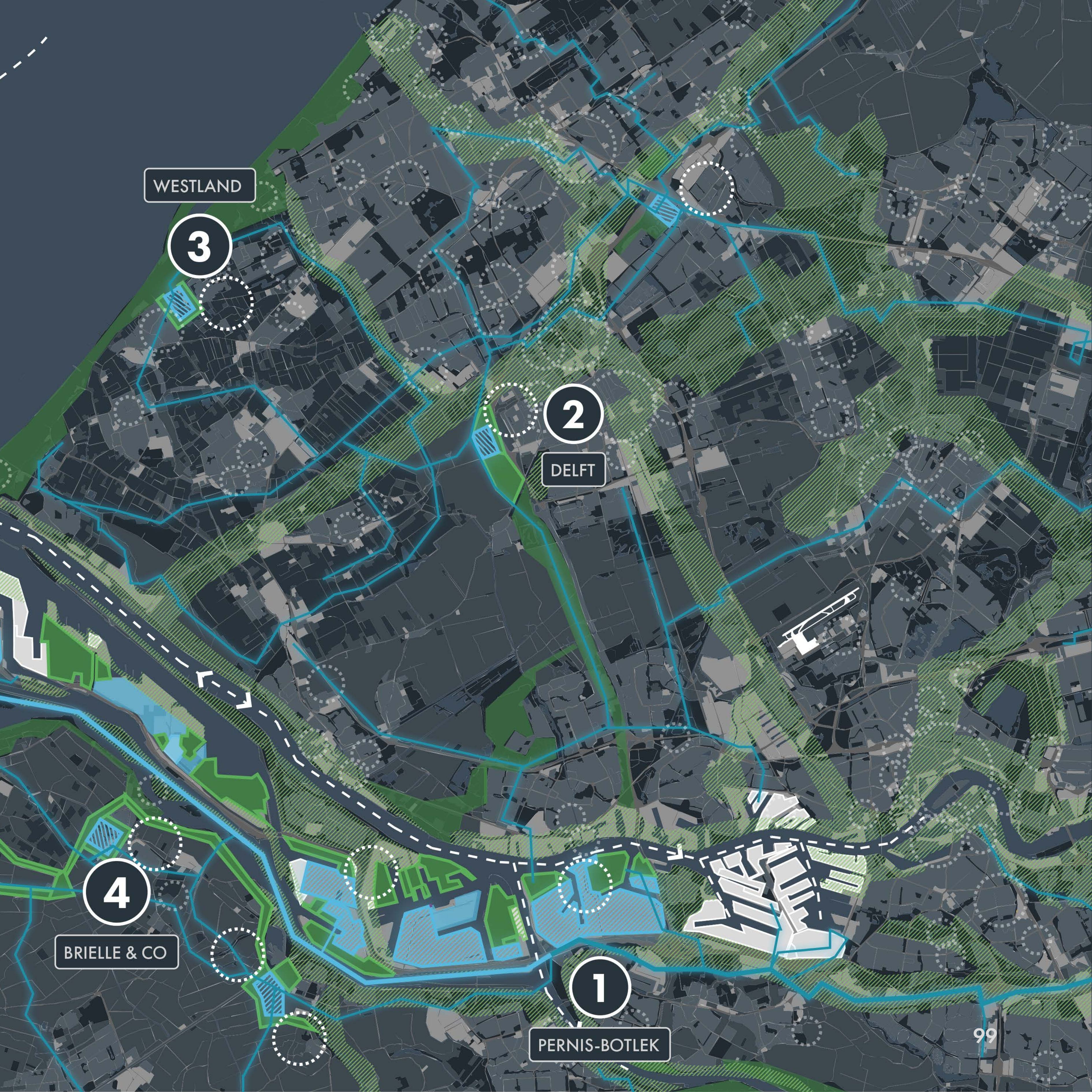


Figure 56 Strategic locations in the area


WESTLAND
3
2
DELFT
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PERNIS-BOTLEK

Pernis-Botlek

In the current energy landscape, the Botlek Harbour, which is part of the port of Rotterdam, is the main petroleum hub. According to the vision, the port should be more open to citizens as a living area where densification and expansion can be applied. It should also house public green activities to improve the port's healthy and sustainable environment. As a result, this location serves as the starting point for establishing the Post-Petrol Energy landscape.

Delft

Delft is situated in the province's heart. It is a strategic location since it is a gaspipe network node. This is combined with a hydrogen hub in the vision. In addition, housing corporations oversee a large portion of the housing stock. It is notable that this area represents a sizable number of stakeholders from around the province, making it a strategic and vital area for further research and explanation.

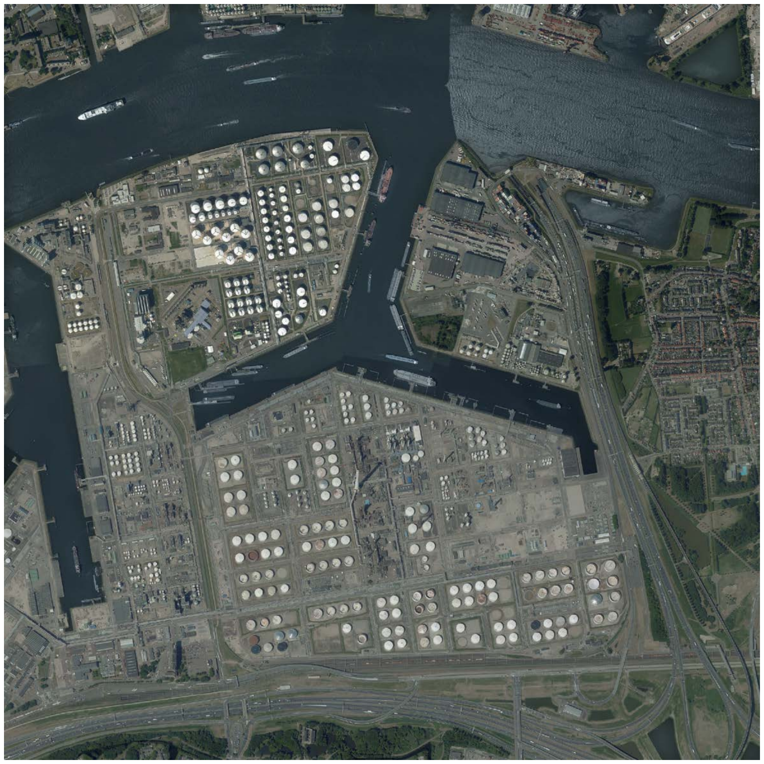

Figure 57 Current situation in Pernis-Botlek

Figure 58 Current situation in Delft

Westland

Westland is the most competing greenhouse production industry in the world (Centraal Bureau voor de Statistiek, 2016). That goes to say that it is a significant industry in the Dutch province of South Holland. Therefore, it is important to analyze the industry's transition and what the differences will be between the existing and future situations. Westland is connected to a future Energy Network by a hydrogen hub, as illustrated in the vision. For this reason, Westland is an important location within both the region and the future energy landscape.

Brielle

Brielle is a historical city located to the south of the Port of Rotterdam. Locations on the province's south side are frequently overlooked in other studies. This area represents stakeholders who are not directly connected to major urban centers, but rather live in rural regions. It is critical to investigate the energy landscape's mobility question in this area. Brielle is connected to the Energy Network via a hydrogen hub, just like other strategic places. As a result, Brielle's location plays a significant role in the implementation of our vision.

Figure 59 Current situation in Westland

Figure 60 Current situation in Brielle

PERNIS-BOTLEK

Spatial Interventions

In the current energy landscape, the Botlek Harbour, which is part of the port of Rotterdam, is the main petroleum hub. This specific location serves as a starting point for establishing the Post Petrol Energy Landscape with a focus on incorporating public activities, housing development as well as an overall transformation of the petroleum landscape. The proximity of the area with the city of Pernis makes the connection of the two areas important in an aim to attract the citizens of Pernis in the new port. In terms of spatial interventions, the current refineries of the area will be retrofitted in order to house the hydrogen production and storage facilities. A green buffer – safety zone will surround the hydrogen facilities. Some of the green spaces will serve as places for communal interaction through sport facilities. The need for housing is addressed through the introduction of high dense, medium dense and low dense housing blocks reaching up to 3969 new housing units in total. It is notable that the size of the housing block is a typical block of the city of Pernis. Moreover, the partial closing of the port is ideal for the creation of new floating houses in the area. In an aim to reinforce the multifunctional character of the area, a new campus will be introduced. The buildings will include new university departments of TU Delft for hydrogen education and awareness as well as a research center for hydrogen production. The business district will be the place for the installation of office buildings and companies. The business area in proximity with the hydrogen storage will include the offices related to hydrogen facilities. The mixed – use zone will bridge the previously divided areas of the port. The citizens of Pernis can reach the area through underpasses and through an existing path near the port. Two new metro stops will be introduced in order to attract people from other areas and cities. Moreover, the area will also be accessible through a ferry line with a stop near the campus. Last but not least, a new local bus line will serve all parts of the area.

All in all, the decontamination of the petroleum landscape, the introduction of hydrogen through the retrofitting of the current refineries, the public space, the housing expansion, the multifunctional facilities and the creation of new jobs will improve the quality of life in the area. The civil society will be more active through the incorporation of people in the area. The circular economy will be achieved through the retrofitting of the current petrol facilities for hydrogen production and storage. The decontamination through sustainable solutions related to green public space will foster the shift towards a healthy and sustainable future of the area.

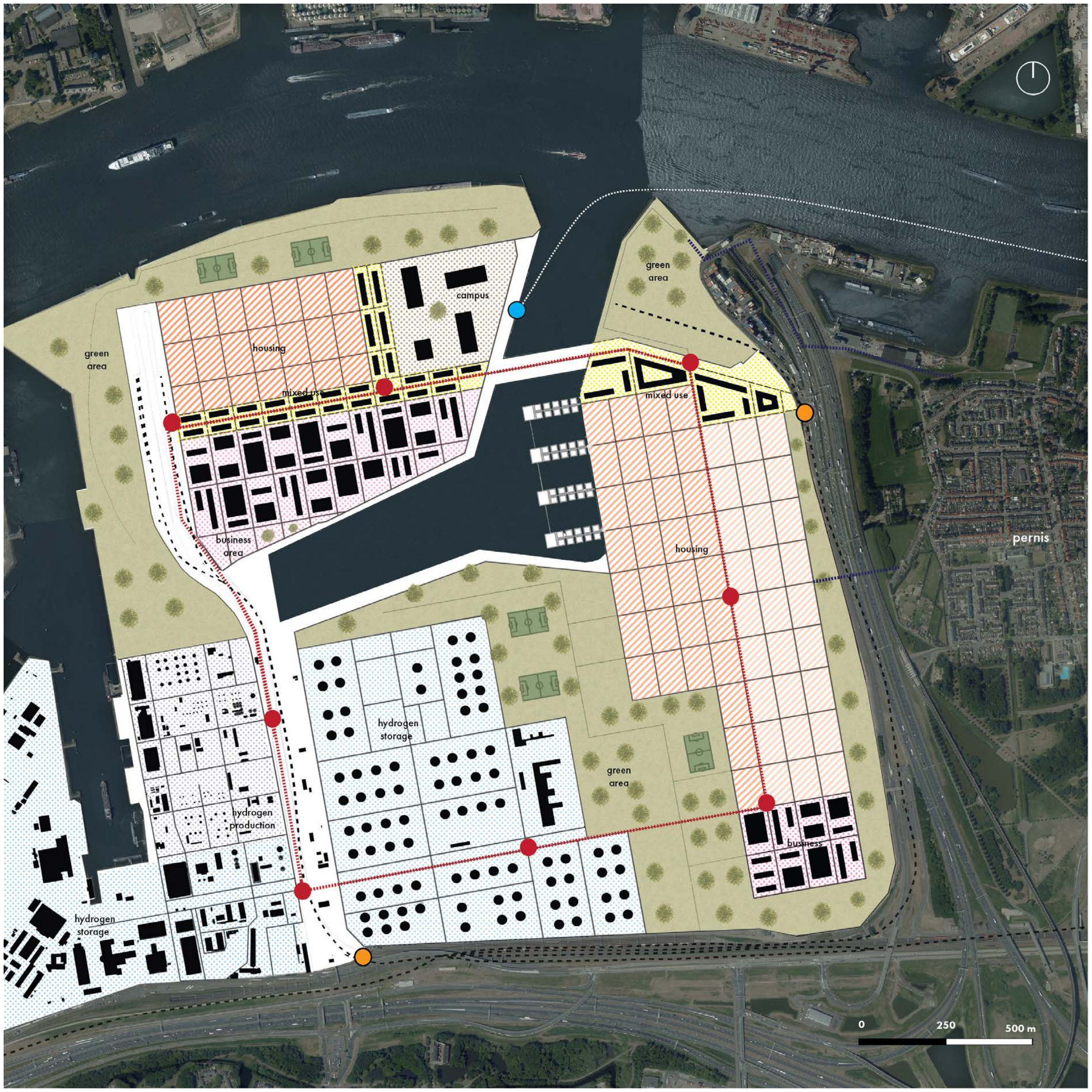

Figure 61 Spatial interventions in Pernis

Legend

New Bus Line	········	Hydrogen production	▦	Business area	▦	Green area	▦
New Bus stops	●	Hydrogen storage	▦	Mixed-Use area	▦	Campus area	▦
Existing railway lines	········	High Density Housing	▦	Medium Density Housing	▦	Low density housing	▦
New ferry stop	●	Metro stations	●	Underpass connection	········		

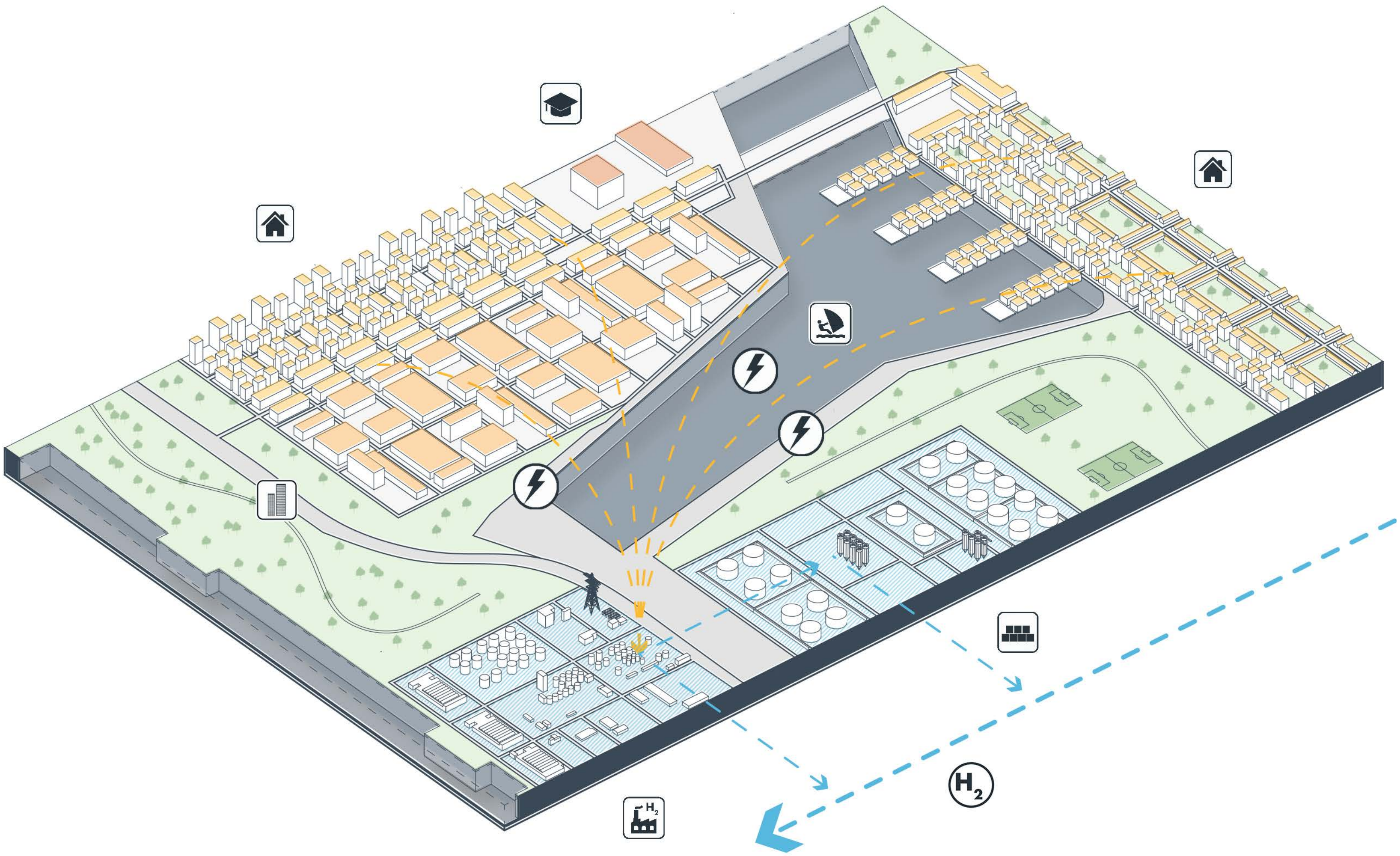

Figure 62 Isometric of Energy Landscape of Pernis

Pernis

3969 new housing units in total

- Housing Area = 751.807 m2
- Green area = 1.168.000 m2
- Campus Area = 107.600 m2
- Business Area = 306.568 m2
- Mix use Area = 175.395 m2
- Hydrogen production area (retrofitting)= 213.716 m2
- Hydrogen storage area (retrofitting)=700.5000 m2

Legend

Spatial elements

- Business park
- Recreation
- University campus
- Hydrogen Storage
- Hydrogen production
- Housing
- Green space
- Solar panels
- Water

Materials

- Electricity
- Hydrogen

Energy flows

- Electricity
- Hydrogen

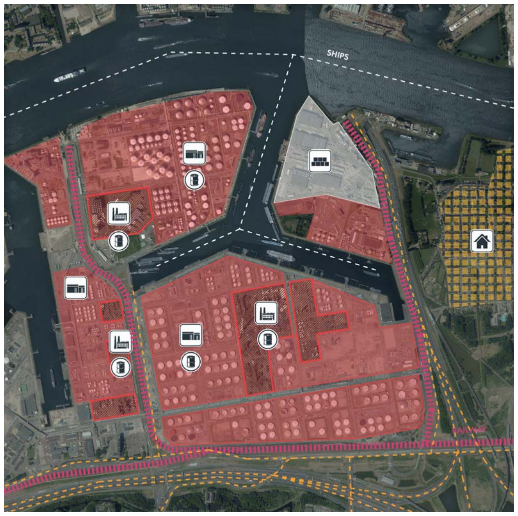

Figure 63 Phasing 2020

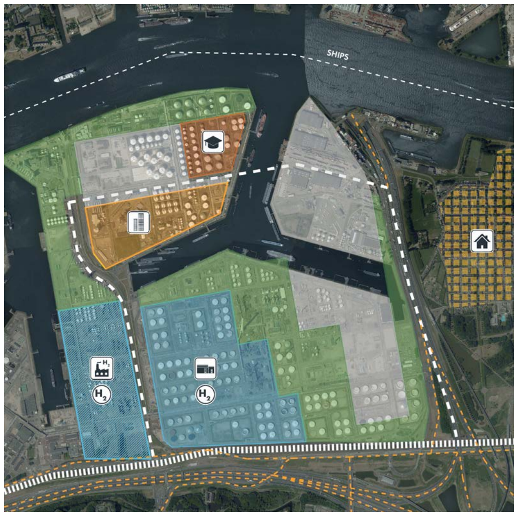

Figure 64 Phasing 2030

Figure 65 Phasing 2050

Spatial Phasing
The spatial transformation of Pernis – Botlek will be achieved into three phases from 2020, 2030 and 2050. In the current situation, the area is occupied by petrol refineries and storage. The privately owned land of the port is not accessible from people. Moreover, the existing highway serves as a barrier making it difficult for people in Pernis to visit the port. By 2030, the decontamination of the soil will have taken place and the retrofitting of the petrol refineries will have been completed. The closing of the port in the area will constitute a strategic action in order to bridge the previously divided areas. Hydrogen production and storage will use the same facilities of old petrol refineries. The green public space, the business district and the campus will have been constructed by 2030. The introduction of a new bus line, a ferry network two new metro stops and underpasses will solve the problem of accessibility in the area. In the last phase of 2050, the housing varying in density will have been constructed. One part of the port will be unified in order to connect the housing areas. The addition of green public space and the construction of the mixed use strip will have been completed by 2050. The buildings will integrate solar panels and small wind turbines in the roofs for local consumption. The area will be accessible by people and it will gain a new strong economic character.

Stakeholders

Private Sector
Shell:
Shell wants to help consumers and stakeholders with the energy transition. They are undecided about moving and shrinking in the Botlek region. Because of this uncertainty, this can make them both an influential active backer or influential active blocker. The persona will focus on this stakeholder in a more detailed way.
Koole:
Koole aims to be a part of the energy transition, regardless of the fuels or chemicals they store and distribute. They want to keep their business and operations running (Koole, 2021). However, in the proposed redevelopment in the Botlek area Koole will have to suspend their activities. Therefore, they will be an influential active blocker of the plan.
Exxon & CCT
In this region, Exxon and CCT own a tiny plot of land. Developers must develop the property, in addition to this, the port authority and municipality can have an impact on this perhaps by stimulating Exxon to relocate their activities. This makes them both insignificant passive blockers of the plan.
Project developers:
There is a lot of money to be made in this sector for project developers. Together with the Port Authority, they may be able to influence the port's new development. This makes them influential active backers.

Stedin:
Stedin owns the cables and pipes in the subsurface of the area. In the new energy landscape the cables and pipes need to be adapted to the decentralized network to be able to facilitate two way streams of energy. Stedin needs to facilitate this and upgrade the network for that matter to make the network more robust. This makes them influential passive backers of the plan.

Public Sector
Port of Rotterdam Authority;
Is a key participant in the area; they own the land and have significant influence over the port's redevelopment. In addition, they desire this transformation. (Havenbedrijf, 2021) This makes them influential active backers.
Municipality of Rotterdam;
Is an active backer of the redevelopment plan. The city benefits from being circular and a leader in the energy transition; the main drawback is that the built environment will likely require greater management. However, the municipality is an influential active backer.
National government;
Is an active backer who works to enact legislation, levy taxes, and set (climate) objectives that provide direction and incentives for change and therefore influential.
Watertaxi Rotterdam & RET
For their taxi boats, they are increasingly depending on sustainable energy sources, including new hydrogen-powered vessels (Watertaxi Rotterdam, 2022). As of other types of public transport, more options for public transportation links are necessary. It is essential to investigate the best method for expanding the network and connecting this area of the port to Rotterdam's city center (RET, 2021). This will make the public transport companies insignificant active backers because their power is smaller than other stakeholders.

Civil Society
Employees:
If their jobs become obsolete, they will face insecurity. It is dependent on the companies' decisions. This will make them both insignificant passive backers or insignificant passive blockers. However, when they band together, they will have a powerful voice that we must protect. Shell employees will be able to maintain their employment, although in a reduced capacity. As a result, this will make them more active.
Citizens:
The port's air pollution will be reduced, which will benefit the citizens. Keeping the port's identity while undergoing redevelopment. The only disadvantage may be the growth in population in the region as a result of the redevelopment of the Botlek and the new links with Rotterdam by watertaxi. As a result of this, the citizens will be insignificant active backers of the redevelopment.

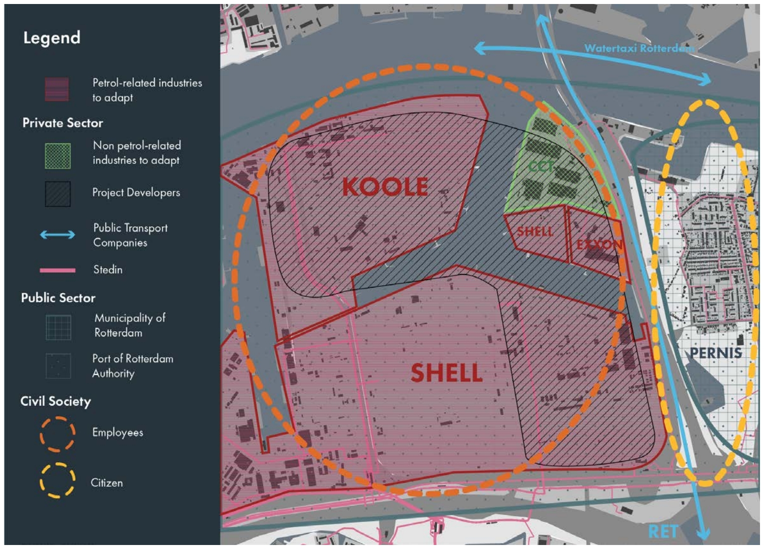

Figure 66 Locations stakeholders in plan

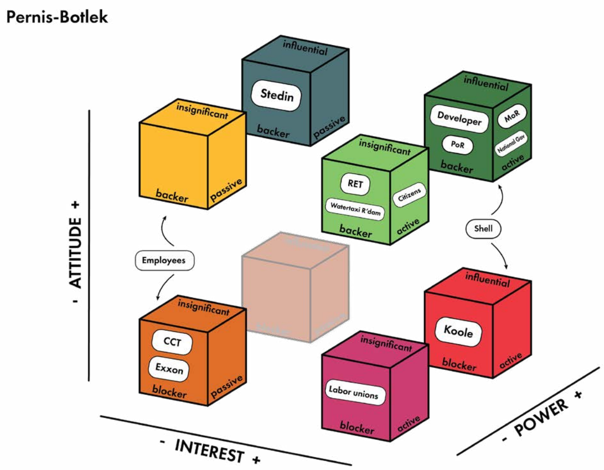

Figure 67 Power-Attitude-Interest Matrix

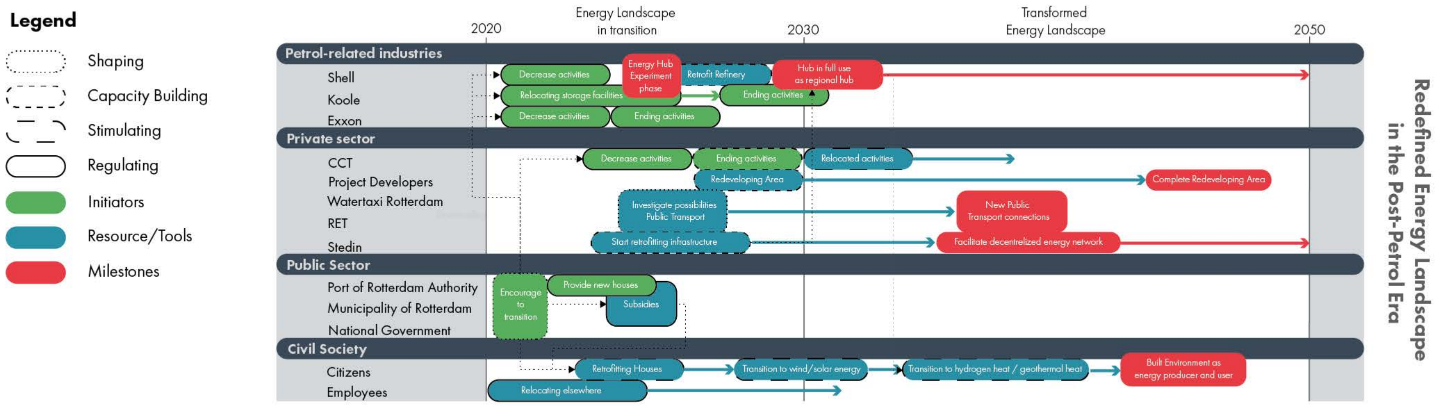

Figure 68 Roadmap engaging stakeholders

Engagement Strategy
The main catalyst in Pernis-Botlek is the public sector. They need to encourage petrol/related industries to decrease their activities and relocate or end their activities. Shell is already working on the retrofitting of their hydrogen hub and expects activities to start in 2025, making it ready for the experimental phase. Around this time, project developers and other stakeholders in the private sector investigate their possibilities in the area. Meanwhile, Civil Society will contribute to the energy transition by upgrading buildings and utilizing renewable energy sources.This will eventually lead to Pernis-Botlek use as hydrogen hub, new public transport connections, and a decentralized energy network where the built environment is both user and producer of renewable energy.

Persona
In the persona we follow Sarah, an innovation manager at Shell. Shell is an important player with an extensive use of land in the Botlek area, situated in the Port of Rotterdam. On behalf of the company, Sarah wants to stimulate collaborations and facilitate the energy transition with other public and private stakeholders. According to Shell, the future of energy supply will have to be shaped at a local level (Bekkers, 2019). Therefore, they are planning to retrofit their refinery. The refinery in Pernis will become a green hydrogen hub (Shell, z.d.). The fact that investments are already made, shows the fact that Shell wants to play an important part in the energy transition and that it is beneficial for Shell to continue these investments and to occupy their new place in the energy transition.
However, in addition to this, the development strategy also describes that a large proportion of the current land use in the Botlek will be developed to accommodate new activities that will make the port more accessible for the public. This means that the activities in the Botlek part of Shell need to be reduced. This land is mostly used for the storage of petroleum for the global scale. However, because of the decentralized network proposed in the vision, only the regional storage has to be taken into account in the new energy landscape which makes this space obsolete.

When it comes to timing and the whole process, the organization of realizing this transition has issues. Conducting dialogues with various market players and neighboring municipalities, according to Sarah, can help to improve planning for the changing energy landscape. As a result, the procedure will be quick and the costs will be low (Bekkers, 2019). This implies that the Municipality of Rotterdam and the Port of Rotterdam Authority, with the support of the Province of South-Holland, should take the lead and pull in various companies.

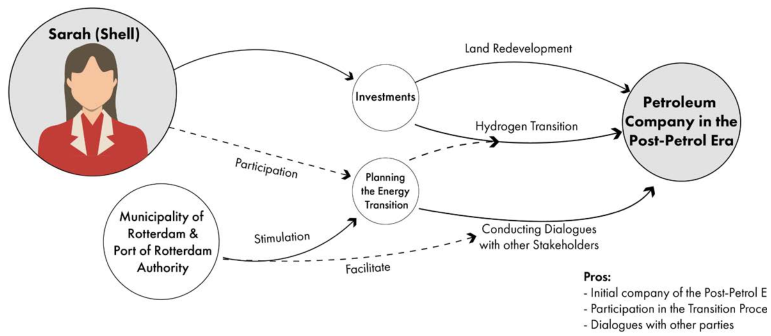

Figure 69 Connections and actions of the persona

Figure 70 Collage of Pernis-Botlek in 2050

DELFT

Spatial Interventions

Delft is situated in the province's heart while it constitutes a hydrogen pipe network node. The transformation of the area will start through the hydrogen production which will be located near the existing glasshouses. A green buffer – safety zone will surround the area of hydrogen production. On the other side of the highway, near the city of Delft, the transformation of the area will incorporate the housing expansion, business facilities, education areas, a mixed – use strip and green public spaces. According to the plan, an estimate of 2750 new housing units will be build in the future in order to partially correspond to need of 1.000.000 million houses in the city of Delft. New businesses will be located in the proximity with the highway, while a new educational area for hydrogen awareness will be introduced. The hydrogen production area can be accessible via an underpass below the highway from the campus area. A new plaza between the education, business ditrict and housing will be created. Recreational and sport facilities will upgrade the quality of life in the area. It is notable that the green network is the connecting element between the areas of intervention. An expansion of the existing bus line network will serve all parts of the area. In terms of sustainability and electricity generation for hydrogen production , it is proposed that the houses will incorporate solar panels and small wind turbines in the roofs.

Figure 71 Spatial interventions in Delft

Legend

Existing Bus Line
Existing Bus stops
Underpass connection
New ferry stop

Hydrogen production
New Bus Stop
Bus Line Extension
Housing

Business area
Mixed-Use area
Education
Green area

Agriculture

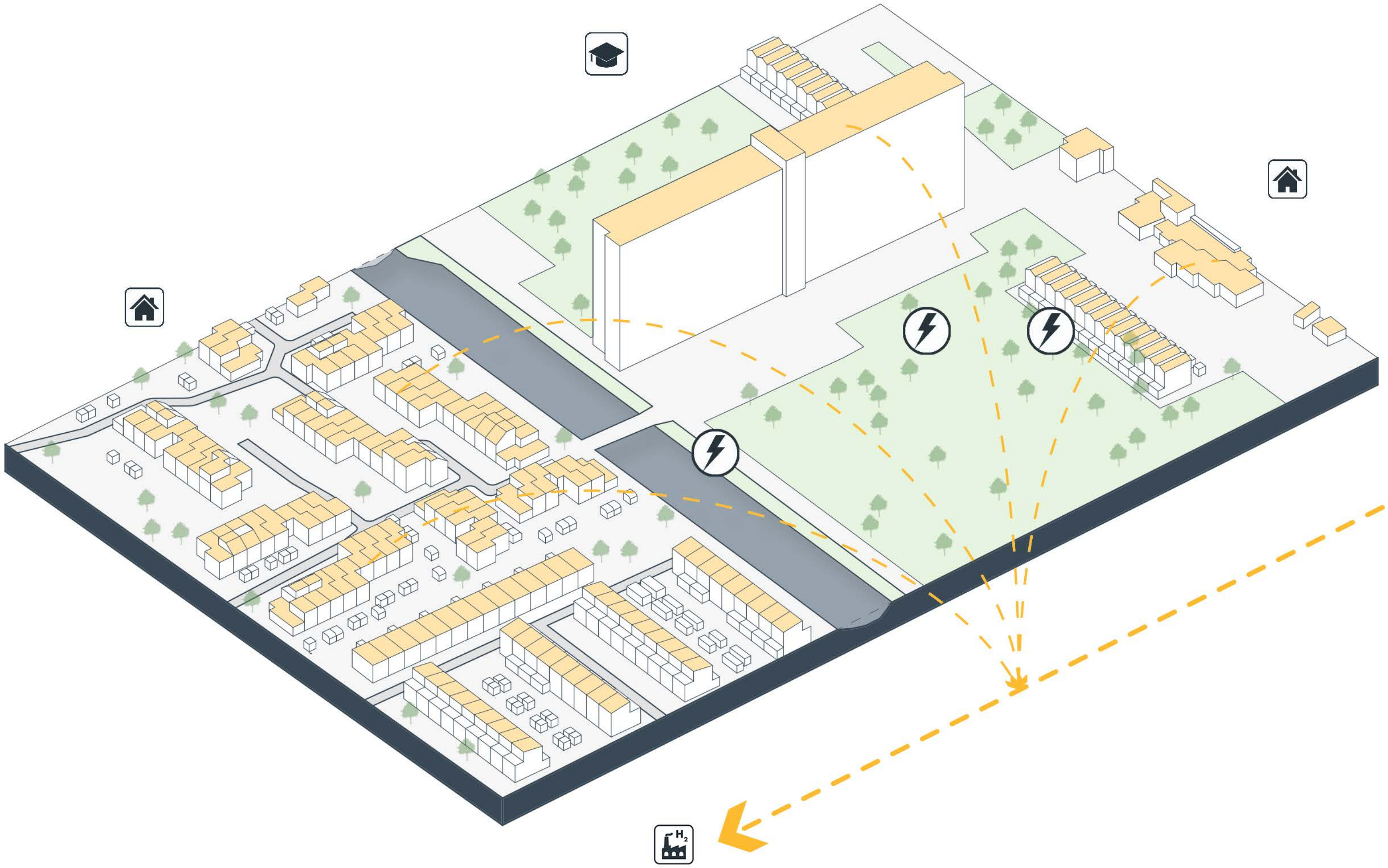

Figure 72 Isometric of Energy Landscape of Delft

2750 new housing units in total
- Housing Area = 366.880 m2
- Green area = 942.171 m2
- Business area = 246.350 m2
- Education area = 106.010 m2
- Mix use Area = 94.471 m2
- Hydrogen production area (new)= 82.636 m2

Legend

Spatial elements

Refinery

Housing

Green space

Solar panels

Water

Energy flows

Electricity

Materials

Electricity

Figure 73 Phasing 2020

Figure 74 Phasing 2030

Figure 75 Phasing 2050

Spatial Phasing

The intervention in the strategic location of Delft will happen in three phases from the current situation to 2030 until 2050. Nowadays, the chosen area is composed by housing land use, small businesses, greenhouses and agriculture. By 2030, two new business districts will have been constructed. By 2050, the partial removal of some greenhouses will have taken place in an aim to create a new green buffer zone. The hydrogen production will have been installed, the green public spaces, the campus, the mixed - use area and the housing districts will have been built. Last but not least, the buildings will integrate solar panels and small wind turbines in the roofs for local consumption

Stakeholders

Private Sector

Industries;

Industries will be required to adapt their buildings. This was discussed in further detail in the previous section. It appears that the industries are influential active blockers. The industrial area will be renovated, according to the redevelopment plan. As a result, the large-scale industry that is now operating on that site must relocate to make way for different small-scale businesses.

The greenhouse company, on the other hand, must relocate to make space for the new hydrogen hub. A gas pipeline node is where the greenhouse firm is located. A 300-500 meter safety zone is required around the perimeter of the hydrogen hub. In any case, due to a change in energy supply, the companies need to adapt their energy systems in order to continue operating. If this appears to be impossible, consider changing your activities. Again, (local or regional) public actors should lead this process and ensure that this private actor is not left behind and/or enabled to profit from the larger-scale shift that will be implemented. This makes the greenhouse company both backers and blockers.

Landowners;

If they do not want to participate in the energy transition in this area, they must be bought out of their property. Aside from that, there are business opportunities that might be addressed.

Project developers and public actors such as the province and the municipality can also play a role in ensuring that common goods are distributed equally. Landowners are therefore both influential passive backers and influential passive blockers.

Housing Corporations;
Housing corporations, like industries and other buildings in the built environment, must retrofit their properties. As a result, they must begin making improvements now to make their building stock compatible for new types of energy and efficient in order to be ready by the time energy systems are established. This process can be hastened with active support from public actors such as the national government and municipalities, in the form of subsidies or tax reductions. Simultaneously, it's critical to create methods to incorporate renters, since their daily lives will change. They should be able to profit from this transformation as well. Therefore, housing corporations are influential passive backers in the transition. The persona will focus on this stakeholder in a more detailed way.

Project developers;
Are influential active backers in the area. They can assist in making the plan functional. Have a strong desire to improve the location.

Stedin:
Stedin owns the cables and pipes in the subsurface of the area. In the new energy landscape the cables and pipes need to be adapted to the decentralized network to be able to facilitate two way streams of energy. Stedin needs to facilitate this and upgrade the network for that matter to make the network more robust. This makes them influential passive backers of the plan.

Public Sector
Municipality of Delft;
Is a strong supporter of the redevelopment project. The municipality of Delft owns the carpool. Because of its position, when the carpool is connected to the hydrogen plant to simplify recharging for automobiles parked there, there is a lot of potential. In addition, the carpool has the ability to serve as a new central center for shared transportation.

Civil Society
Employees;
The greenhouse company, as well as the industries, must relocate in this case. These employees, in this scenario, are influential passive blockers. It will become an issue if not handled appropriately.
Citizens;

Citizens must be assisted in making the transition to having their own rooftop solar panels installed. People who rent their houses must also profit in the long run from the transformation, necessitating the development of innovative solutions. The persona will focus on this stakeholder in a more detailed way.

Figure 76 Locations stakeholders in plan

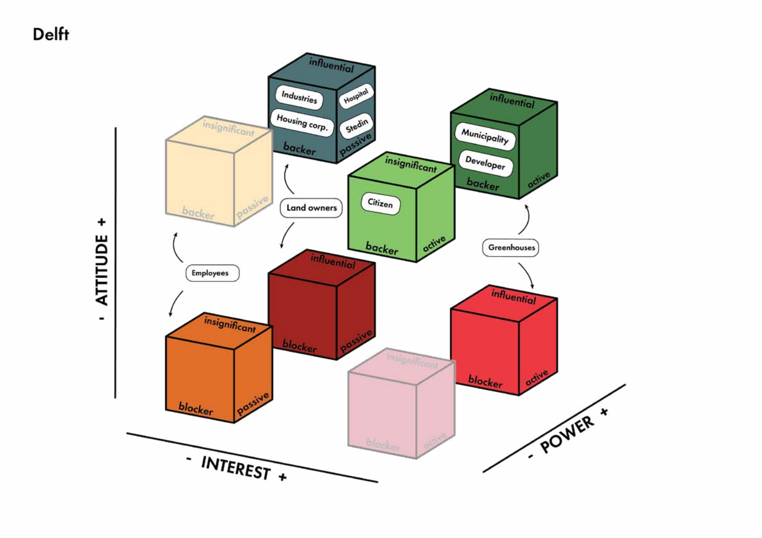

Figure 77 Power-Attitude-Interest Matrix

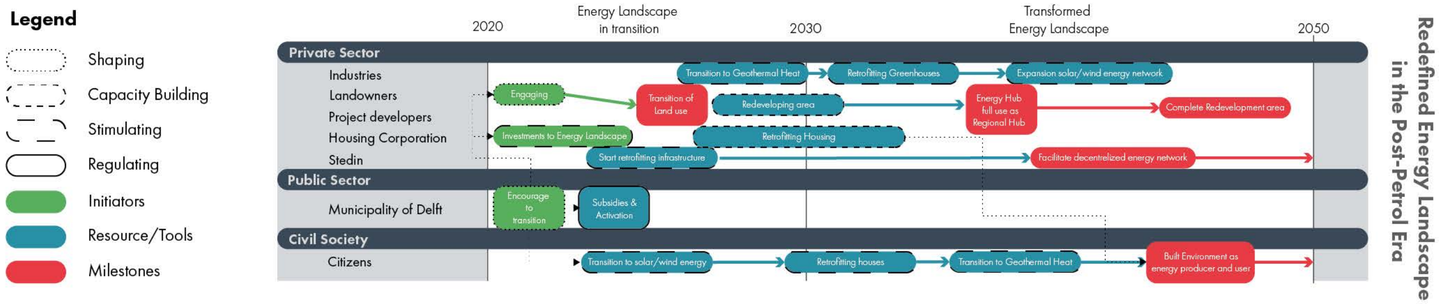

Figure 78 Roadmap engaging stakeholders

Engagement Strategy
The public sector, in this case the municipality of Delft, must encourage the change, just as it must in other places. The housing corporations are the main focus in this scenario. They must start investing in the retrofitting of their housing stock. Meanwhile, landowners and project developers must transition land to produce additional housing, as encouraged by the municipality. This will be accomplished by involving stakeholders and working together throughout the process. A new energy hub will be built, which will act as the area's batteries.

Persona
Mahmood lives in a social housing apartment in the Westside of Delft, close to the new envisioned location of the hydrogen generation and the shared car hub. In the transition to a new energy landscape he will face some changes that can both be beneficial and be a burden for him. Mahmood can both profit and be disadvantaged from the fact he isn't responsible for the retrofitting of his home. On one hand, he doesn't have to do the building related investments himself. On the other hand, when the housing association is forcing change upon him, he is excluded to participate in this transition.

Since his apartment complex is already outdated and in need of retrofitting measurements, the quality of the energy performance of his building will improve significantly. With better insulation the energy of his home will be more efficiently used and therefore the demand and his monthly costs will reduce.

However, these changes in the energy system of his building will also affect his daily life. He might have to buy new appliances that are still running on gas and other adaptations to the building itself will potentially cause spatial and aesthetic change for his place. This means he has to do investments and also culturally and emotionally adapt to this transition.

Especially when housing associations aren't including their inhabitants within the process of retrofitting, this could mean that there is a lot of incomprehension for Mahmood with the changes that he is confronted with.

Therefore, it is very important that inhabitants are empowered and included in the process of retrofitting. This will mean that all renters have to be properly informed and heard when housing associations are designing their future plans. This is the moment they should start including their perspectives and needs. Subsequently, some inhabitants, when there's a certain interest, should be more intensively involved with the developments. Participations can create ownership and give inhabitants a role in this energy transition that is also affecting their lives. Already there are examples of inhabitants that even were faster with this change by exploiting 200 solar panels on the roof of their building (Bruin, 2015). Initiatives like this could play an important role for the acceleration of this transition, since housing associations still not always prioritize the retrofitting of their buildings over constructing new ones (Van Muilekom, 2021).

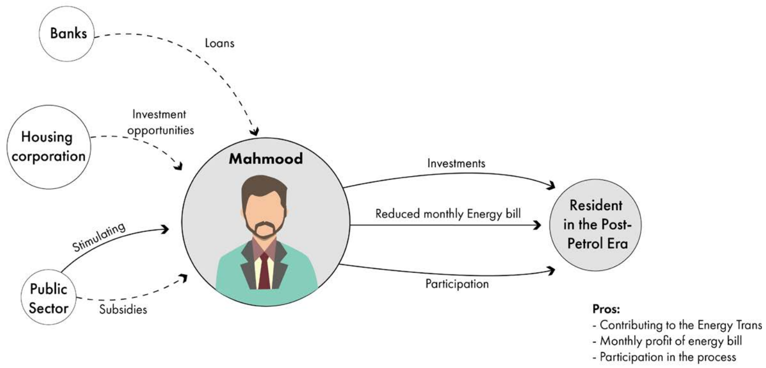

Figure 79 Connections and actions of the persona

Figure 80 Collage of Delft in 2050

WESTLAND-MONSTER

Spatial Interventions

Westland region constitutes a significant greenhouse production industry in the Dutch province of South Holland. Moreover, Westland is connected to the future Energy Network by a hydrogen hub which makes it a strategic location within both the region and the future energy landscape. The hydrogen production will take place in the facilities of an existing refinery. A green buffer – safety zone will surround the hydrogen production. Part of the existing greenhouses will be demolished in order to re-create new ones in an organized manner which will serve as experimental greenhouses of the area. An important element is the green protected zone of Natura 2000. This area will be accessible through the new recreational mixed - use strip with sports facilities, restaurants, cafes and buildings for hydrogen awareness. The need for housing makes vital the expansion of the housing plot reaching up 2664 new housing units in total. A new green public space will connect the new housing area with the rest of the intervention. A key action is the removal of the part of the road between the hydrogen production and the experimental greenhouses in order to ensure the safety of the people in the area. The partial removal of the road will lead to a reassessment of the mobility in the area. Last but not least, the green network is the connecting element of the intervention in the region. The vision for Westland aims to upgrade the quality of life of the people in the area through public involvement and recreational facilities in the post petrol era of 2050.

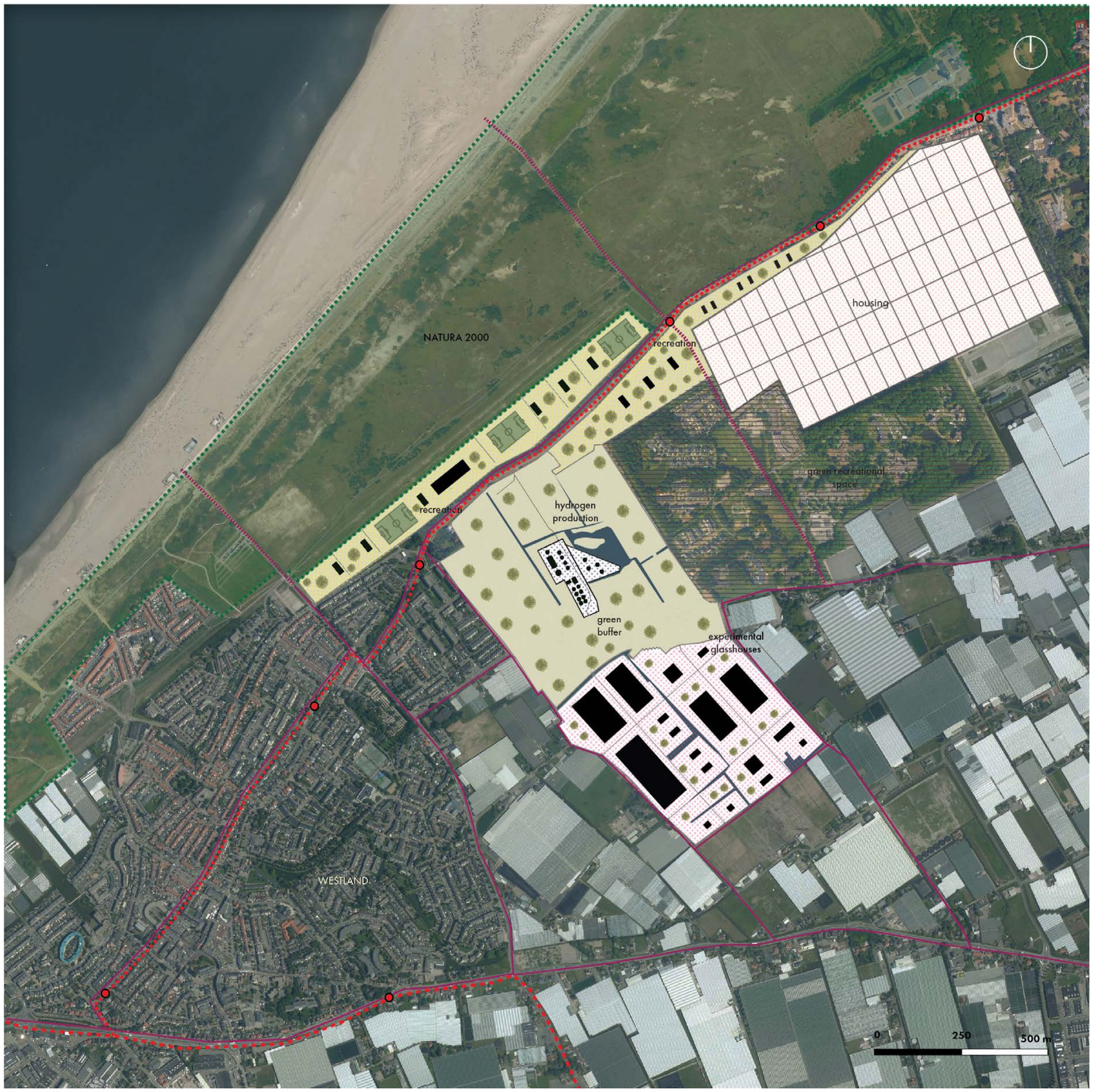

Figure 81 Spatial interventions in Westland-Monster

Legend

Existing Bus Line
Existing Bus stops
Business area
Mixed-Use area
Hydrogen production
Natura 2000
Housing
Green area
Pedestrian paths
New mobility line

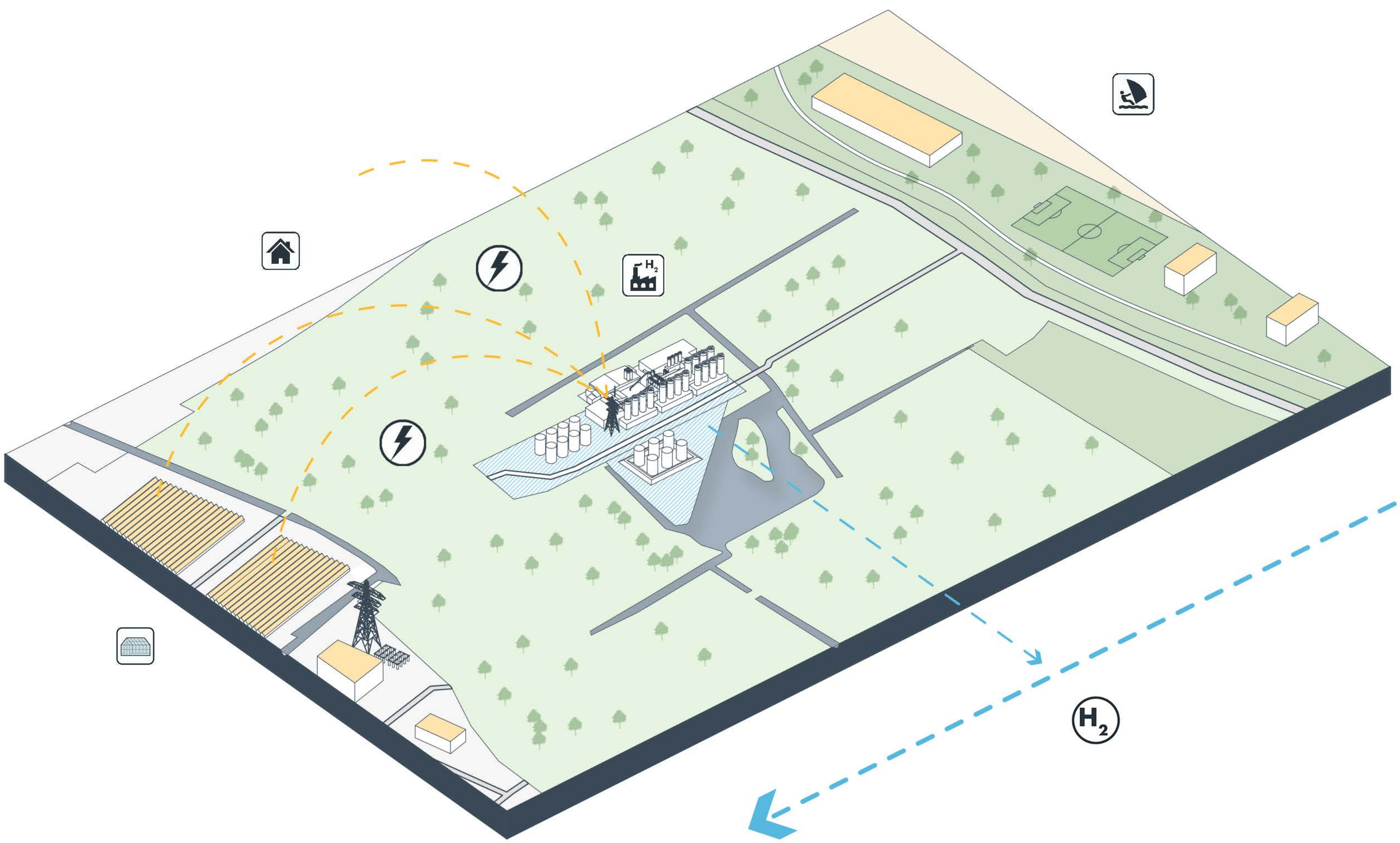

Figure 82 Isometric of Energy Landscape of Westland

2.664 new housing units in total
Housing Area = 183.731 m2
Green area = 322.812 m2
Experimental glasshouses area = 262.392 m2
Mix use Area - Green Area = 226.363 m2
Hydrogen production area (retrofitting)= 22.800 m2

Legend

Spatial elements	*Materials*
Hydrogen production	Electricity
Recreation	Hydrogen
Glasshouses	
Housing	*Energy flows*
Green space	Electricity
Solar panels	Hydrogen
Water	
Dunes	

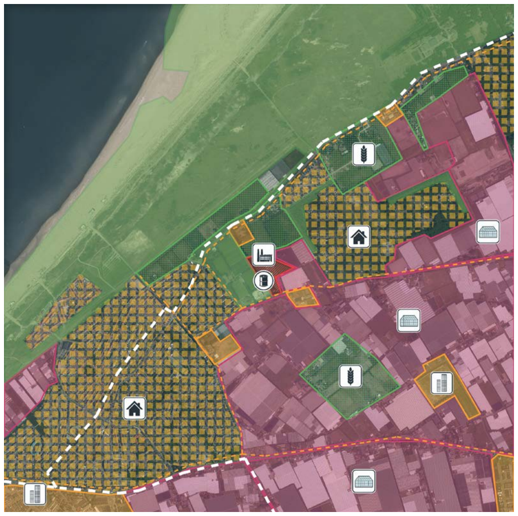

Figure 83 Phasing 2020

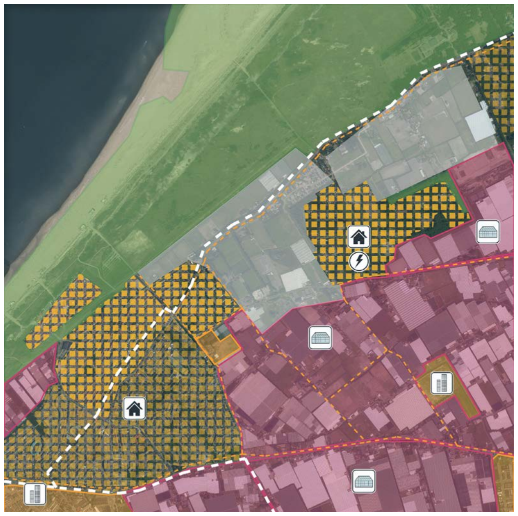

Figure 84 Phasing 2030

Figure 85 Phasing 2050

Spatial Phasing

Westland is characterized by the great number of greenhouse companies. The selected location for intervention is close to an existing petrol refinery. The urban landscape of the area is composed by the glasshouses, the housing land use, the dunes, the green natura network 2000, agricultural areas and some small businesses. By 2030, the integration of solar panels and small wind turbines in the roofs will take place for local consumption. The existing petrol refinery will have been retrofitted by 2030. A strategic action is the partial removal of the road and the change of mobility connection in Westland by 2030. By 2050, the new hydrogen production will have been installed in the previous facilities of the petrol refinery. Moreover, the housing expansion, the recreational and mixed use facilities, the green buffer zone as well as the experimental greenhouses will have been constructed. The new buildings will also integrate solar panels and small wind turbines for local consumption in the roofs.

Stakeholders

Private Sector

NAM Monster;

This stakeholder must be included in the process. This stakeholder faces new challenges. It's crucial to retrofit his property and buildings in order to construct a hydrogen hub (located in the vision). This stakeholder must be shown the advantages of the transition. Therefore, this stakeholder can be both an influential active backer or influential active blocker.

Greenhouse companies;

Will be able to adapt to the changing energy landscape. First, a significant investment will be required, but long-term advantages will and should be realized for these stakeholders. These investments were subsidized by the national government (Jetten, 2022). Additional financing should be considered to get all companies involved in the energy transition. Alternatively, corporations can initiate assistance, the Rabobank principle as an example (Rabobank, 2020). As a result, the stage's disadvantages should be eradicated, and the overall benefits of the transition must emerge. It is therefore important to identify this stakeholder as an influential passive backer. The persona will focus on this stakeholder in a more detailed way.

Landowners;
They need to be displaced from their land. The project developers are the primary focus of this, as it is their business case. This is something that the province and municipality have a lot of power over.

Project developers;
Are influential active backers in the area. Can assist in making the plan functional. Have a strong desire to improve the location which makes them influential active backers.
Westland Infra
Westland Infra owns the cables and pipes in the subsurface of the area. In the new energy landscape the cables and pipes need to be adapted to the decentralized network to be able to facilitate two way streams of energy. Stedin needs to facilitate this and upgrade the network for that matter to make the network more robust. This makes them influential passive backers of the plan.

Public Sector
Municipality of Westland;
Is also an active backer of the redevelopment plan. Has played a key part in the creation of this strategy. As a municipality, one of its policies is to increase the amount of renewable energy sources in the area and to adapt the built environment to the energy transition (Gemeente Westland, 2020). For this reason, the municipality is an influential active backer.

Civil Society
Employees:
Employees, in this case largely of greenhouse industries, have no negative consequences from this energy shift. This makes them insignificant passive backers.

Citizens:
They must be assisted in making the transition to having their own solar panels installed on their rooftops and connected to a renewable heat source. They don't have a lot of power. Therefore, they need to be protected. This makes them insignificant active backers of the redevelopment.

Figure 86 Locations stakeholders in plan

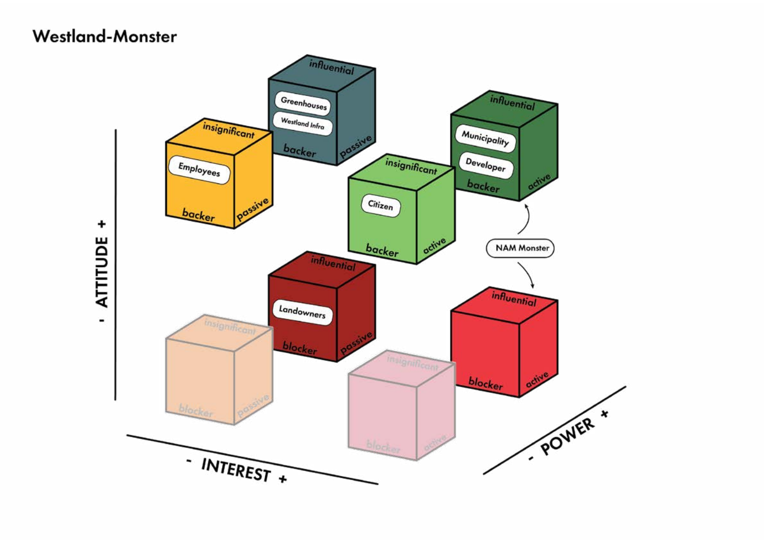

Figure 87 Power-Attitude-Interest Matrix

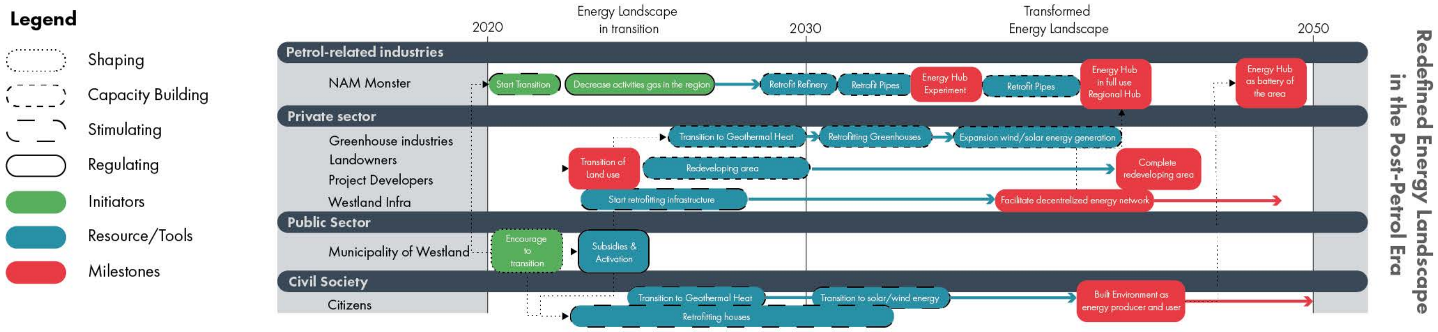

Figure 88 Roadmap engaging stakeholders

Engagement Strategy
Like Pernis-Botlek, the public sector is the main catalyst in this area as well. The municipality needs to encourage NAM to facilitate the transition by decreasing activities to retrofitting their gas distribution center. Meanwhile in the Private Sector, a transition of land use is happening between landowners and project developers, also encouraged by the municipality. Subsidies will help greenhouse industries and citizens to retrofit their buildings and transition to renewable energy sources. After this, the retrofitting of the gas distribution center can really start. Following that, the gas distribution center will serve as a new energy hub in the region, acting as a battery for the area, storing energy during peak hours and discharging it during off-peak hours.

Persona
Johan runs his own business as a greenhouse operator in the Westland area, a large polycentric agglomeration of greenhouses and small towns in the midwest of South-Holland. In the transition to a new energy landscape he will face some changes that can both be beneficial and be a burden for him.

When his greenhouse and home is substantially covered with solar cells, he will be able to generate large amounts of energy, that could make him more energy-independent, and possibly in times of sun peaks, even an energy producer. At the same time, when his greenhouse is connected to a local network of geothermal heat, the use of fossil-fuels for oil will become obsolete. Lastly, improved insulations for his house and new technologies like heat pumps can make the use more efficient and reduce his energy demand.

In order to move to new forms of energy Johan will need to do investments. As a greenhouse operator there is a lot of competition, hence the margins in his business model can be limited. When not planned, this could be a nuisant burden that makes it hard for him to anticipate this transition.

When Johan is informed and included in the process of this transition in an early stage, to explain the importance, showing him the possibilities he can anticipate to make this transition work for him. Additionally, stimulating efforts like subsidies for investments in his company could accelerate his plans. When this is not sufficient for Johan to do large investments, improved accessibility to loans should be arranged to support well-willing entrepreneurs (Rabobank, 2020). At this moment, the relative amount of netting is already limited and will decrease in the coming years (Jetten, 2021) (Ministerie van Economische Zaken en Klimaat, 2022). This has to be returned for businesses and home-owners to be able to sell electricity back to the grid.

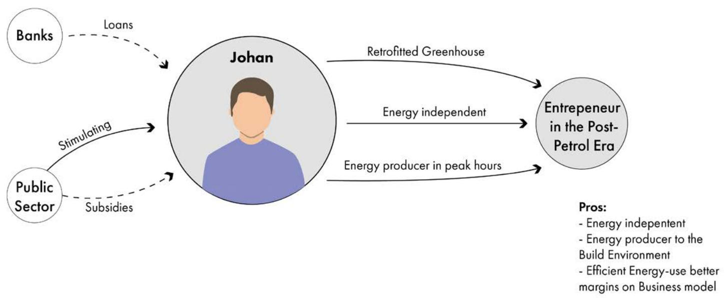

Figure 89 Connections and actions of the persona

Figure 90 Collage Westland-Monster 2050

BRIELLE

Spatial Interventions

Brielle is a historical fortified city located to the south of the port of Rotterdam near the most rural part of the region. The selection of this area is important as it is a node for hydrogen production. The hydrogen production will take place outside the city and it will be surrounded by a green buffer safety zone. A new mobility hub near the city for buses and light rail will be introduced in an effort to facilitate the non-petrol use of mobility. The spacial interventions will be limited to the adding of a mobility hub, the enhancement of the green network and a hydrogen production area. The main focus will be on the persona and the engagement of the stakeholders.

Figure 91 Spatial interventions in Brielle

Legend

Existing Bus Line	red dotted line	Hydrogen production	dotted hatch	Green area	green-beige square
Existing Bus stops	red circle	New Bus Stop	yellow circle	Agriculture	beige square
Bus line extension	black dotted line	Mobility hub area	red hatch		
New LRT line	orange dotted line	New LRT stop	orange circle		

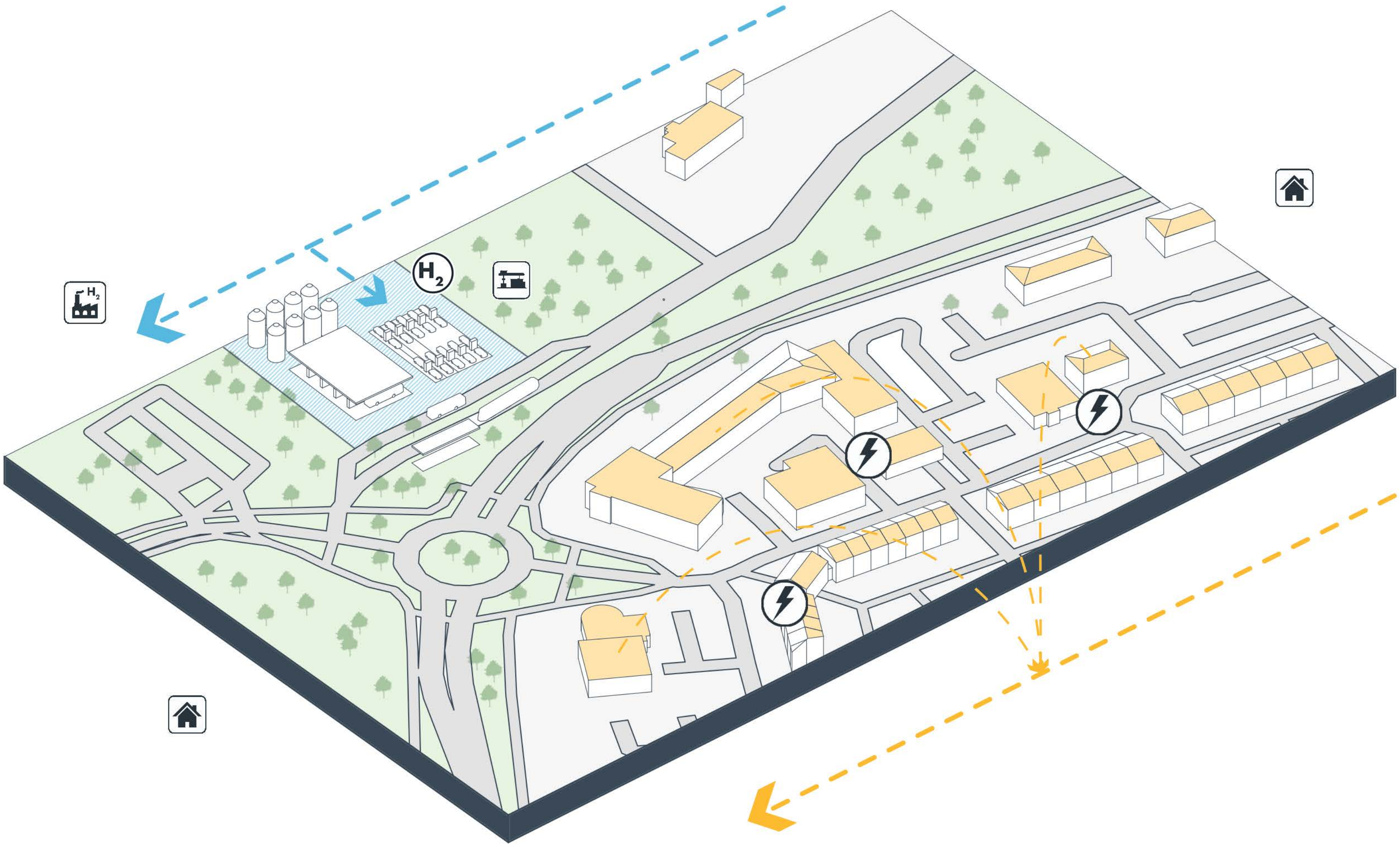

Figure 92 Isometric of Energy Landscape of Brielle

Green area = 702.836 m2
Agricultural network = 1.251.399 m2
Mobility hub Area = 30.626 m2
Hydrogen production area (new)= 87.609 m2

Legend

Spatial elements

- Hydrogen production
- Multimodal node
- Housing
- Green space
- Solar panels

Materials

- Electricity
- Hydrogen

Energy flows

- Electricity
- Hydrogen

Figure 93 Phasing 2020

Figure 94 Phasing 2030

Figure 95 Phasing 2050

Spatial Phasing

The transformation of Brielle will become into three phases from the current situation, to 2030 and 2050. The historical city is in close proximity to greenhouses, agricultural land and some businesses. By 2030, the integration of solar panels and small wind turbines in the roofs will have started. By that time, the extension of the existing bus line and the creation of the new light rail line connecting with the port of Rotterdam will have neem completed. In the final phase of 2050, the hydrogen production and the surrounding green buffer will take place. A strategic action is the creation of a new mobility hub by the end of the 2050 as well as the final addition of solar panels and small wind turbines in the roofs of the buildings.

Stakeholders

Private Sector

Landowners;

Like in the other situations, if they do not want to participate in the energy transition in this area, they must be bought out of their property. Aside from that, there are business opportunities that might be addressed. Project developers and public actors such as the province and the municipality can also play a role in ensuring that common goods are distributed equally. Landowners are therefore both influential passive backers and influential passive blockers.

Greenhouse industry;

The greenhouse companies aren't the main stakeholders in this location, thus they won't be the center of attention. However, greenhouse companies, such as in Westland, must still adapt to the new energy landscape. They've been labeled as "passive" as a result of their lack of enthusiasm.. As a result, they've been labeled as influential passive backers.

Project developers;
Are influential active backers in the area. In cooperation with the municipality of Brielle and EBS, they will realize a new mobility hub. They can assist in making the plan functional. Have a strong desire to improve the location.
Stedin:
Stedin owns the cables and pipes in the subsurface of the area. In the new energy landscape the cables and pipes need to be adapted to the decentralized network to be able to facilitate two way streams of energy. Stedin needs to facilitate this and upgrade the network for that matter to make the network more robust. This makes them influential passive backers of the plan.

Public Sector
Municipality of Brielle;
Is also an active backer of the redevelopment plan. The municipality plays a key role in the energy transition. Facilitate in different forms of mobility.

EBS
Needs to investigate their options for expanding their network in terms of viability and feasability, as well as transitioning to a different kind of energy. The most significant shift, however, is the conversion of buses to hydrogen or electricity. Together with the citizens, they will get a closer look into the engagement strategy and their function in the transition.

Civil Society
Citizens;
Apart from the fact that residents must modify their homes, mobility is a significant factor in this location. In the Netherlands, rural areas frequently have poor public transportation links. As a result, people who reside in rural areas frequently commute to other parts of the country by car. The car is the most common form of petroleum transportation. This shift has a significant influence on citizens' daily lives.Citizens can therefore be both backers and blockers of the energy transition transition. The persona will take a deeper look into the transition of this stakeholder.

Figure 96 Locations stakeholders in plan

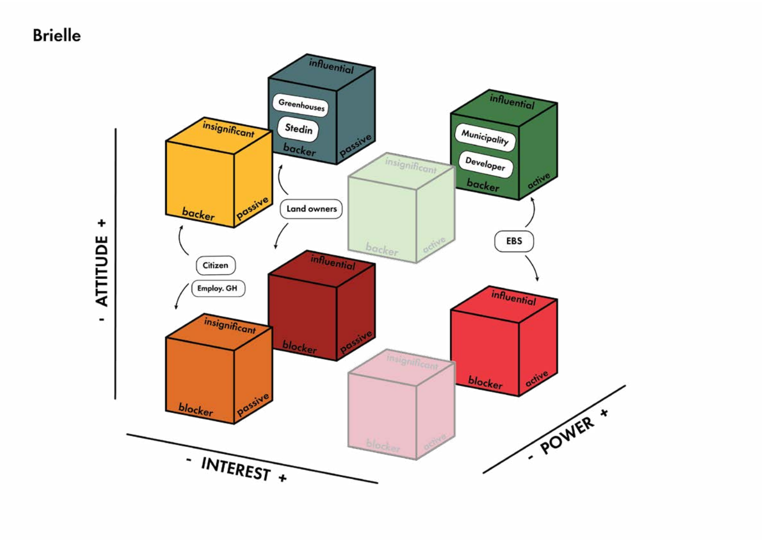

Figure 97 Power-Attitude-Interest Matrix

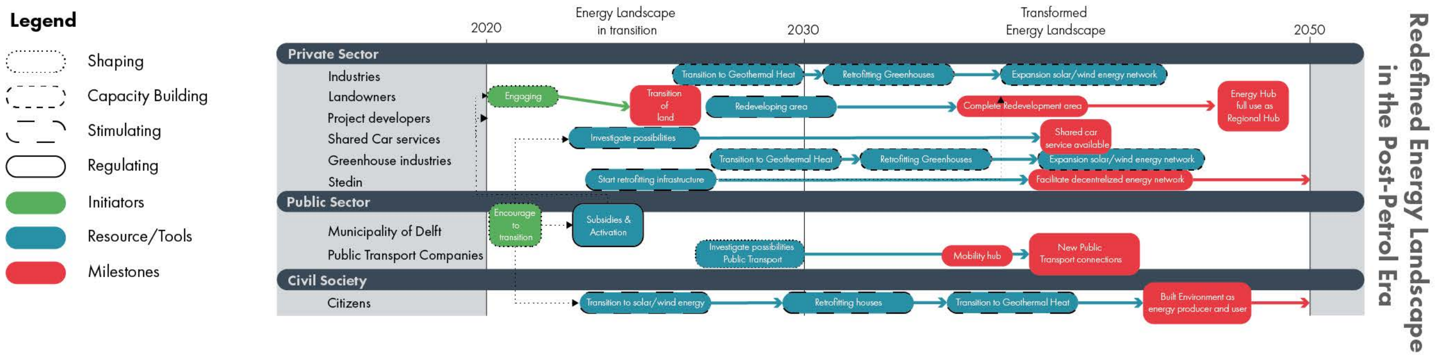

Figure 98 Roadmap engaging stakeholders

Engagement Strategy
In Brielle, the municipality will also encourage transition. It will engage landowners to transition their land, with help from project developers, for new development that connect to the new energy landscape. Together with future Shared car services and public transport companies, the municipality will create a renewable mobility network. The mobility hub will combine various types of transport. Meanwhile, as can be seen throughout all locations, civil society and industries will adapt to the energy landscape by retrofitting their buildings and generate their own energy through renewable sources.

Persona
Carmen lives in Brielle and commutes to Rotterdam on a daily basis for work. In this case, we want to focus on the changes Carmen will face and how she may effectively transition into this new energy environment, with the support of many stakeholders.

The impact of the energy transition will be felt in a typical setting like this, because the car is such a key element of the existing energy landscape. Also, since the car is perceived as a symbol of welfare and freedom, it offers comfort and takes you to your destination in a sensible period of time. It is important to take time and provide an attractive alternative for people to shift from this car-use paradigm.

In the Post-Petrol Era, cars will run on hydrogen and/or electricity. People must be encouraged to move from petrol to hydrogen or electric cars. The manner in which people interact with cars has a diversity of options. New forms of ownership, like car sharing concepts, could become more common. The municipality, and other public organizations, will need to provide subsidies to encourage both citizens to potentially buy electric and hydrogen cars. Private actors should be stimulated to establish a shared concept enterprise.

Carmen however, is on a limited income and can't afford to buy a new hydrogen or electric car. Therefore, Carmen pays a monthly membership to use these vehicles, which can be provided by the municipality or private companies. She is able to utilize shared hydrogen or electric vehicles at the mobility hub of the city. The mobility hub combines public transport options and serves as a center for shared cars.

Additionally, hydrogen and electric cars should be able to fill up and recharge their tanks more easily and quickly. To do so, the public sector may respond to this by putting fast chargers and hydrogen stations in a variety of easily accessible locations.

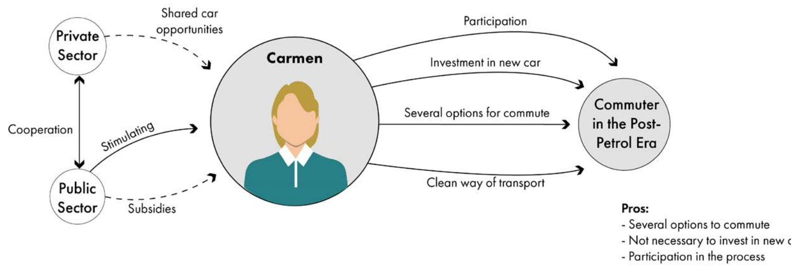

Figure 99 Connections and actions of the persona

Figure 100 Collage of Brielle in 2050

5
CONCLUSION

In general, our approach towards the Energy Transition of South Holland envisions the gradual phasing out of fossil fuels until 2050. In the short term, we aim to reduce the energy consumption and CO2 emissions with an incremental transition to sustainable energy and reduce fossil fuels by 50%. In the long term, we assume that there will be no dependency on fossil fuels in 2050. There will be a just and decentralized energy renewable energy network with hydrogen as the energy carrier and storage of surpluses, respectively wind solar and geothermal energy.

The current energy landscape of the Port of Rotterdam region has both a regional and global significance. The analysis indicated that there is a heavy dependency on fossil fuels and a promising potential for wind, solar and geothermal energy in the future. The petroleumscape has shaped the identity of the port, while at the same time it seems segregated from the rest of the region due to the lack of its accessibility. Therefore, we propose our inversion of global energy flows, to switch from an important import of fossil fuels to an export node of hydrogen. On the regional scale our proposed decentralized energy network, including the port as the core of the region, is more open up to the public. By establishing different knowledge institutes and recreational functions we want to create a new cultural relation with the use and production of energy for the people of South-Holland.

According to the research, the majority of government bodies and other public-sector organizations aim to reduce 100% CO2-emissions by 2050. This is translated to a complete elimination of fossil fuels. The sources indicated that solar panels will be mostly installed on roofs of buildings rather than in open areas outside of cities. The majority of wind turbines will be built on sea and connected to the mainland. The wind turbines also contribute to generation of green hydrogen, and blue hydrogen should be phased in gradually no later than 2050. In the westland region, geothermal heat is particularly suitable for greenhouses. The primary heat source for the built environment should also be geothermal energy. Overall, the energy landscape should facilitate an increase in energy efficiency and a paradigm shift in energy use.

In the in-between phase of 2030, with the first regional node in Pernis in full operation, hydrogen will be introduced. Wind and Solar energy will be increased through the addition of wind turbines, solar parks and solar panels in the roofs, while hydrogen hubs will start spreading across the region. However, our desired amount of wind energy is higher than the estimated amount we can produce in 2030; so we propose to import the deficiency.

By 2050, the phasing out of fossil fuels will have been completed and the region is self-sustaining in the production of wind, solar and geothermal as the alternative energy sources. The regional hydrogen nodes will be spread across the region as part of the decentralized energy network. The retrofitting of buildings as well as the addition of solar panels and small wind turbines in the roofs will have been completed by then. To be prepared for future growth of demand, more wind turbines offshore will be added for electricity generation and hydrogen production.

The port will maintain its energy identity both globally and regionally with the main difference of flow inversion. In the hinterland of Europe surpluses of hydrogen are distributed through Rotterdam and exported to other countries around the globe. The existing petroleum landscape will be turned into smaller-sized plots for hydrogen production and storage. The port will gain a social character since public activities will take place. The strategy of creating new hydrogen hubs on the intersection of the existing natural gas pipe network will lead to a transformation of the surrounding areas. The "green" connection between the hydrogen hubs will be unified with the dutch green landscape.

The interventions in the four strategic locations underline the dynamic presence of hydrogen and how it can be combined with public activities, housing expansion, public space, business facilities and mixed – use areas. The main goal is hydrogen awareness through the creation of educational departments and research centers. The Botlek area close to Pernis will become the epicenter of the strategy. The petroleumscape will be retrofitted and replaced by hydrogen hubs combined with mixed density housing, a new business district, a new campus and a mixed-used strip, giving the area a new strong economic character. In Delft the hydrogen hub will be placed near the greenhouses. The need for transformation in the area will lead to housing expansion due to the high demand, new public space, sport facilities, a business area, an educational center and a mixed-use area. In Westland, the hydrogen production will be located in the existing facilities of a refinery. The proximity with the dunes and the 'natura 2000 network' makes necessary the creation of a recreational zone near the existing and the new housing area. The experimental greenhouses will conduct the research for future potential related to agriculture. In the South part of the port, in Brielle, the hydrogen production will be placed in a more rural area and a new mobility hub near the city center combined with a new light rail line connecting with the port will take place. It is notable to say that in the four locations, we repurpose mobility and accessibility.
Engaging stakeholders is an important part of the development strategy. With the use of a roadmap, the phasing of redefining the energy landscape can be visualized. The way of governance of the implementation of these tools are shown. The main conclusion of this roadmap is that at the start of transforming the energy landscape, stakeholders need to be regulated in order to start the transition. After this, a snowball effect may arise causing the governance tools to be focused on less steering and more on stimulating and capacity building.

Overall, the Public Sector will be the main catalyser of the energy transition. The engagement of stakeholders is visualized in more detail in the strategic- and typical locations. These roadmaps show the interaction between different stakeholders and what type of governance is needed to kickstart the transition. The persona entails the engagement of one specific stakeholder which is of high importance in the location. This is done to get a more detailed and zoomed in engagement of this stakeholder and how this stakeholder needs to adapt to this. The research will achieve an insight in the process and is focused to make this transition as smooth as possible for this stakeholder.

The three main pillars of Energy Transition, Spatial Justice and Circular Economy are adapted to our strategy. We envision the gradual energy transition towards a sustainable future for South Holland in three phases until 2050, where renewable energy sources will be used and hydrogen will replace fossil fuels. Spatial Justice is addressed through the accessibility of all people into sustainable energy sources. Solar panels and wind turbines will be placed in the roofs for local consumption through the decentralized energy network. The port from a private owned area will be open to the people for public use. The expansion of housing will also be a catalyst for spatial justice. The creation of business districts, mixed use areas and campus will result in new jobs and the overall economic growth in the area. The quality education and awareness though the educational centers for hydrogen production will reduce the social inequalities. The circular economy is addressed through the retrofitting of the existing natural gas pipe network towards its use for hydrogen. Moreover, the refineries of the petroleumscape are retrofitted in order to accumulate the hydrogen production and storage.

The redefinition of the energy landscape is not only about placing new alternative energy sources. It has to do with the experience of landscape itself through catalyst transformations in the regional and local scale. The distinctive identity of the petroleumscape will be maintained but it will be reinterpreted in order to receive the sustainable source of hydrogen. The roofs of the buildings are redefined through the use of solar panels and wind turbines. The hydrogen production across the region becomes the attractor that leads to an overall transformation in the area according to the needs. Energy transition, Social Justice, Circular Economy, Sustainability of cities and communities, Quality education, Economic growth, Innovation and infrastructure will compose the portrait of the redefined energy landscape in the Post Petrol era of 2050.

6
DISCUSSION

6.1 Transferability of the Strategy and Vision

Context specific conditions for policy transfers
In general, the establishment of a regional interconnected energy network is possible everywhere. This large scale network consists of local self-sufficient energy systems that rely on renewable sources and through their connection with the larger system, they can share their surpluses. This is done in the form of electricity that is then used for hydrogen production at larger scale sites that produce hydrogen for industrial activities. Per location the type of suitable renewable energy can differ, but the main concept remains the same.
However, context-specific conditions can cause a different probability of success for a concept like this. So what are the requirements for this concept to work for the region of South-Holland? What elements are transferable to different contexts?

Urban agglomeration
The level of urbanization of Europe and more specifically of the Netherlands, provide a certain level of density that is able to facilitate this kind of energy networks and make the connection of different energy systems viable. However, when looking to other parts of the world, there are other spatial organizations that could make this transition challenging. On one hand low-density regions with dispersed and secluded urban agglomerations do not provide the proper conditions for connectivity and they should be autonomous. On the other hand, large metropolitan regions can be extremely complex to plan and manage

Existing infrastructure
In the Netherlands, there is a highly connected pipeline system dedicated to gas distribution to almost the complete building stock. Apart from that, another large pipeline system is used for oil transportation to other European countries as part of the primary trading activities of the port. This type of infrastructure and the possibility of repurposing can be considered as a strong advantage of the region of South Holland. In other contexts the costs of establishing similar infrastructure requires huge investments, something that makes this region ideal for this energy transition concept.
Affordability
Generally speaking, the establishment of a functional system requires investment, consisting of a wide range of stakeholders that need economic power to engage in the process. This however, could be very challenging in less affluent parts of the world. Considering this, inequality could be increased even more, since this is something that has to be already addressed in more prosperous parts of the world.
Style of governance
Within a progressive democratic state, there is an increasing interest in decentralized energy systems, with a provision of such a framework that is ideal for private investments to take part. There are parts of the world, with secluded areas that already have a self-sufficient system.
Other parts of the world with a more top-down style of governance, where the state wants to control and maintain ownership of the energy production and provision, could be potentially less suitable for the consumer-producer intertwining concept.

Geographical typologies
Location-specific environmental conditions can lead to different levels of renewable energy potentials. For instance, In the Sahara desert there is an abundance of sun for solar energy production, while in Iceland there is significant volcanic activity which offers a lot of opportunities for geothermal energy applications.

6.2 Reflection on Ethics

In general, a wide variety of values and ethical issues become part of long discussions when planning and designing for people. Since our topic for this quarter was at the regional scale, one of the most significant things to consider is the number of people affected by design decisions. This has implications on a wide variety of values and ethical issues that arise from the decisions.

To begin with, **involvement** in the planning process of a large share of different people or organizations is crucial. Taking into account a wider variety of opinions and making use of expertise of people from different backgrounds can potentially lead to shaping better and more refined plans. This also makes the whole procedure more **democratic**. At the same time, this affects the aspect of **equality**, since voice is given to **less powerful groups** that otherwise could not be expressed and their interests could not be addressed. In terms of equality, another important aspect is **affordability** of the investments required in order to implement these plans so that a larger number of people can be benefited. Lastly, burdens required by these plans should be distributed according to a number of factors in order to favor less powerful groups.

Another important aspect is **accessibility**, which relates to a variety of elements. Especially in our project, access to energy provision is of great significance. Since, we are facing a global energy crisis that originates from the dependency on fossil fuels that are finite, equal access to energy should be addressed. **Job opportunities** and economic viability in general is a substantial matter in general and specifically in our project with the phasing out of petrol activities of the port, these matters play a central role. This is achieved by putting renewable energy and hydrogen as the main driver of change and as one of the main economic assets of the region.

Simultaneously, along with accessibility, **spatial justice** is addressed. Diffusing the borders between energy production, distribution and consumption, by spreading these activities across the whole region, people are always in proximity and participate in these processes. This has also implications on raising awareness of the public consideration towards sustainable energy use. By creating these hubs for hydrogen and combining them with educational facilities, more chances are created for people to have access to knowledge.

By removing a significant amount of petrol activities in the port and replacing them with more compact hydrogen related activities, a lot of space is turned into green space. These actions eventually give a significant amount of space back to people, creating healthy and friendly environments where human interaction can thrive.

Last but not least we acknowledge that in this scale and in such a complex topic such as the energy transition, some parties can be less favored from visions like this. Among them, large petrol related companies, everyday commuters and gas station owners can all be possibly against these kinds of changes. This is however addressed by creating a new framework through hydrogen and renewable energy in general, for repurposing their economic and everyday activities.

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APPENDIX

Individual Reflection: Pavlos Andrianos

As the world is increasingly becoming urban, the planning and design process of cities and regions is becoming more complex. Technological leaps such as private mobility and the Internet, and current globalization processes, have created a world of interconnected urban agglomerations where human activities are widely spread. This is more apparent in the Netherlands, and especially in South Holland where mobility of people and goods is intense. These patterns have huge impacts spatially, as we can also observe in this region which is completely occupied by human activities and offers a glimpse to a future of complete urbanization.

As I am strongly interested in this matter, this course gave me the opportunity to explore the matter and have a better understanding on how metropolitan and polycentric urban regions are shaped and how they function. Through the lecture by Rodrigo Viseu Cardoso, I became more familiar with these concepts.

While matters of population growth, climate change and need for food and energy become more pressing, this course helped me understand how regional design can have a strong influence in addressing these matters. Through the scope of circularity and sustainability and especially through the sub-theme of the material dimension of the energy transition I was able to explore how planning and design decisions can have significant implications on how flows of energy and exchange of materials can take place not only on the regional scale but also on a global and a local scale. These matters have also strong implications on human behavior, a matter that needs to be concerned during the energy transition as we learned from the topic of this project, the post petrol energy landscape.

However, this course also made me realize that the complexity of regional design heavily relies on the involvement of a large number of different stakeholders and different parties. These range from national governments, in the case of the port of Rotterdam, to inhabitants of a small neighborhood. Design decisions will always please or not different parties and finding the right balance is the key for a successful plan or design.

At the same time, exploring and delving into vision development was extremely important during this course. Understanding how you can bring on board all the different stakeholders and finding a positive way to convince them, was a very valuable lesson for me.

Last but not least, being part of a multidisciplinary group was of great value for me. Coming from an architecture background, I wanted to understand how people of different backgrounds think and apply their knowledge to regional design. As this is the scale I have the least experience in, I believe my group shared valuable insights on this respect. Having also people from the Netherlands in the group helped a lot in understanding the context and finding the relative data needed for this research. All in all, I enjoyed being part of this team and completing this project altogether.

Individual Reflection: Erik van Diermen

First of all, I am pleased with the result and the team's collaboration. In recent months, I've learnt a lot about the regional design process. Earlier in my career, I worked on some regional designs. That's why I had the feeling that I could put my design skills to good use in this quarter's end product. The project's scale, as well as the zooming in and out, are activities I am familiar with. My teammates also provided me with a lot of information. There were times when my team members' perspectives on various topics inspired me to come up with new ideas. However, because I have prior experience working on a large scale, I also attempted to deliver new information to my team members. We struggled as a team to find the correct scale and tools to use for the project design at times. It occurred to us that the various lectures could actually assist us in selecting the appropriate scale for designing our redesigned energy landscape. Various guest speakers from the Province, Municipality, and Port Authority gave us an overview of the Port of Rotterdam's scale and challenges at the start of the course. This was extremely helpful in getting up to speed on the assignment.

Also, the university also provided us with insides. One example is the systemic sections tutored by Alexander Wandl. In this lecture, we got a grip on the existing energy landscape in the port of Rotterdam region. This allowed us to visualize the existing energy landscape and energy flows in space. This gave us an inside to the issues and challenges we faced in redefining the energy landscape in the post-petrol era. A different example is Fred Hobma's lecture. He informed us about the many planning tools and instruments that can be used in governance. This helped us in explaining the engagement strategy to the various stakeholders in the region.

During this course, the tutors were also really helpful. Birgit made a significant contribution. Her ability to provide examples, recommend literature, and point out shortcomings is highly impressive. She is extremely critical of the design decisions, which I appreciate. Marcin was also an amazing teacher. His knowledge of how to involve stakeholders came in handy when we were nearing the end of the project. I'm glad we were able to combine Fred Hobma's lecture with Marcin's insights. These insights served as the foundation for the overall strategy as well as the roadmaps for the various strategic locations.

Overall, I am very satisfied with the workflow we used as a group. We were able to maximize one other's strengths while also assisting in the development of each other's weaknesses in order to move the assignment closer to its goal. This course informed me a lot, and I feel like I received a lot of useful experience that I will use later in my career.

Individual Reflection: Maria Lakoumenta

As an architect and future urban designer, I investigate the power of architecture in connection with the cohesion of the city. Climate change, the hectic pace of life, social inequality and differing economic scales dominate the world and they have contributed to the change of the city. The possibility of developing new city patterns, their interpretation as well as the redefinition of existing urban factors, all constitute the main research topics I am passionate about.

The experience that I gained from the quarter Q3 was more than didactic. The multi-scalar approach of the Energy transition in South Holland assisted in my evolution as a student and professional. More specifically, I became more confident with the spatial and regional scale of analysis and planning. The SDS lecture series helped me recognize the complexity of challenges and opportunities that contemporary cities deal with. The vision of Energy transition towards a sustainable development in South Holland is a multidimensional topic that apart from planning and strategy process, it involves the engagement of stakeholders such as public and private sectors as well as the civil society. The SDS lecture series provided fruitful insight in terms of material flows, regional strategies, transformation scenarios, and useful policies for the topic.The Capita Selecta lecture series were vital in terms of identifying and critizing the agreements and controversies coming from the Dutch spatial planning and territorial governance.

As a team combined by two architects, one spatial planner and one industrial designer we worked very methodologically in organizing the vision of our project. Our focus on the redefined energy landscape in the Post Petrol Era of 2050 was very demanding and the feedback gained from the SDS series was very helpful in order to proceed towards the strategy for the decentralized energy network combined with hydrogen hubs for the 2050. Starting from the fieldtrip, we came to the conclusion that the region is heavily dependent on fossil fuels with a minimum imprint of sustainable energy sources. Then we proceeded on mapping the main Energy sources in three phases of transition in order to come to the vision that in 2050 hydrogen will replace the fossil fuels and wind, solar and geothermal energy will be more dominant elements in the region. The port of Rotterdam will maintain its importance and identity as a node for energy sources with the main difference that hydrogen will be the main element. Our strategy focused also on opening the previously divided port to the people by incorporating more public activities. The four strategic locations for interventions represent the nodes for hydrogen production and the need for overall redevelopment and redefinition of the wider area. The identification and engagement of the stakeholders was very crucial for our project. The critical analysis coming from the lectures and booklets of the Methodology and Research Course assisted me and the overall team to overcome the difficulties and doubts for the stakeholders, spatial justice, energy transition and circular economy.

All in all, the quarter Q3 was both a tough and a wonderful experience. I had a great time working with my peers and I think that the diverse educational backgrounds were very fruitful for discussion, criticism and decision making. Marcin and Birgit were more than helpful during the whole process and I am grateful for their support. The topic of Energy transition will continue being a matter of global discussion in the near future after the war between Russia and Ukraine. After this quarter, I have to say that I feel more mature as an architect and future urban designer. The knowledge that I gained will be very useful for the vision of Energy transition in my home country, Greece, in the coming years.

Individual Reflection: Ludo van Muilekom

With the start of the course in quarter 3 I was involved for the first time with urbanism. From my background as an AMS MADE student I do have experience with the different systems and scales in the built environment, including engaging different stakeholders and focussing on (sustainable) transitions. Concepts like circular economy, spatial justice and the energy transitions, the themes of our project, were topics I already had studied before. For me, it was therefore quite satisfying to be able to share my knowledge and share insights from my earlier gained experience to strengthen our project. It really felt that I could substantially contribute. At the same time, spatial design was something new for me, however when starting to do this, I realised it is something that naturally suits me, since I could clearly see what we needed to do and could quite easily resonate and speak the same language with perspectives from my group members and professors.

Nevertheless, I learned a lot of new things, since the field of focus and knowledge -however it overlapped with previous projects in different ways- was different from what I was used to before. For me it was very interesting to experience how you can relate the spatial dimension to the different topics that were covered during the SDS lectures, the capita selecta lectures, the reading of the booklet from the methodology course and the discussions during the studio sessions. All the input from the aforementioned lectures was really enriching and widening the scope for our project. Personally, I really like to get a broader perspective on the level of scientific knowledge from different disciplines, different topics and focuses of other groups and presentations from the Province of South-Holland and the Port of Rotterdam Authority. When regarding all these different communities of knowledge, I am able to intertwine and integrate perspectives and insights into our project. This is how we can give meaning and societal relevance to our vision and strategy. Also the way how the course is structured made sense to me, with our project as a red line, nourished by lectures, workshops and discussions during studio sessions with intensive coaching from our professors.

On another note, I also experienced the amount of knowledge that was shared with us was quite a lot and could sometimes be a bit overwhelming to digest and remember. Especially in the beginning, when we were still distilling our own focus for the project, there was sometimes a bit of a 'paralysis by analysis', since all the different things we came along were interesting and important to consider. At the same time, I was and am aware this is part of the process, where we just need to find our own direction. However, after all, it is also debatable if the amount of knowledge is necessary, since I couldn't possibly remember and didn't use all the shared information. Nevertheless, I also realise this broad variety of lectures is a collection of topics that are partially more or less of higher relevance for the different project groups, and therefore it makes sense.

Methodology Course

The idea of justice

Introduction

An equal distribution of burdens and benefits. Nowadays large multinationals are gaining large profits, but pay very little taxes. They are only extracting value from the public, without giving something back. They are undermining our institutions. When Amazon would pay taxes, Jeff Bezos might have to sell his super yacht and more communal value could be created for the people of Rotterdam instead. - As Massey would say

What do you think are the great societal challenges of our times?

Nowadays, due to the uneven distribution of wealth and power, there is a growing inequality derived from several social, environmental and economic factors. For instance, the limited access to resources and public goods being affected by environmental crises, the undermining of democracy as well as the spatial and social fragmentation depict the great societal challenges of our time.

How does space (and especially urban space) play a role in justice?

Doreen Massey refers to urban space as the dimension of multiplicity where various backgrounds and opinions can be expressed simultaneously. Space and especially urban space plays a vital role in justice. The geography and spatial design shapes social justice in two ways. Firstly, distributive justice; the even distribution of accessible amenities in the city enables justice regardless of background or group. Furthermore, equal distribution of workplaces and job opportunities providing identical travel times to work, reachability of fresh food etc. Private claim on large portions of land which excludes other users while still earning a large amount of private profit.
Secondly, procedural justice; For example, the red lining classification back in the 30s is still having an impact on today's inequality of changes in neighborhoods and still affects the ability of getting loans and having opportunities for businesses to establish, which is coined by Johnson & Kossykh as the concept of 'Life Chances''.

How can spatial planning be an instrument for democracy building/Democracy strengthening?

Interaction and participation are tools to enable spatial planning in an aim to be more democratic and sustainable. Through "sustainable freedom" (Sen) and intergenerational justice there are opportunities for present generations without threatening the ability of future generations to meet their own needs. This can eventually lead to planning fostering for equal distribution of amenities, opportunities, affordable housingl, access to education and healthy environments.

How do you see the issue of 'rights of nature'? Is it feasible?

Unfortunately, we have to agree that we are not there yet and apparently, it is a utopian scenario. If we try to approach it pragmatically, this can be achieved by setting up the right institutions, giving a voice to such concepts and empowering frontmen wishing to pioneer with such initiatives, we might be heading in the right direction. Already we experience increasing public consensus in the scientific and political debate on a different way to treat our planet. Lastly, we need to look beyond our market-based perspective and prioritize our values differently.

Attention, please!

Does your country have an active and robust civil society?

In Greece we have an active civil society, however this is mostly happening when people organize protests to raise their voice. However, in order to have a robust civil society there should be other ways of expression and participation of people in the common affairs. For instance, citizens should be more involved in organizations in order to contribute to the common good and to act and think in a more collective way.

In the Netherlands we have a strong history of an active and robust civil society. However since Covid, we see the way of protest becoming more tense and frequent. Some say peaceful and constructive protests are often claimed by extremists to promote and provoke their beliefs and agendas. But we must not forget during this time of crisis, with a lot of insecurities, polarizing perspectives are more likely to occur. Besides, actions of the government also caused tensions and conflicts that led to this effect. Reasons for this level of aggression/protesting is a low level of trust in institutions, a lot of insecurities and polarization.
Governments also need to contribute. They need to facilitate transparency and communication with their citizens in order to establish an active and strong civil society. For instance, by being also honest about their failures and listening to the rising voices from the public for a more bottom-up approach.

What are structural inequalities and injustices?

It is common that minorities are subjected to inequalities and injustices, since they are different from the rest. Due to this deviation from the mass, they are treated differently than it seems. Structural inequalities and injustices stem from the historical trends or inequities of the past which tend to affect the present, thus causing certain groups underprivileged. For instance, the patriarchy deals with the inferiority of women and as a result men have more rights and obligations. There are striking examples of minorities which have to do with the religion, the sexual orientation, the refugees, the race, the gender and the physical impairements. In these cases citizens have to fight for their fundamental right for full citizenship and access in the majority of the countries in the world.

Legal protection of the law is unclear for refugees who tend to be the most vulnerable case of injustice. It is difficult for refugees to be assisted by foreign governments when they seek asylum in a foreign country. However, refugees are protected by international organizations such as the Declaration of Human Rights, Geneva Convention and the 2018 Global compact on Refugees.

What are some problems of networked/ multi-level governance?

Although networked/multi-level governance can be seen as a positive thing, there are still aspects of it that are problematic. Firstly, due to the complex network of different voices and actors there is an evident difficulty in tracing back decisions to a responsible person or organization thus leading to a decreased level of accountability of important decisions.
Secondly, this complexity may lead to slow processes in decision making and implementation of plans , affecting the final outcome and goals.

Finally, this type of governance suffers from problems of democratic practices where for example if the majority of actors is not involved then the common interests are not expressed.

What is the role of conflict in planning and design processes?

Conflicts are important moments wherein the unheard voices can gain leverage to fight for the needs from their perspective.

Without the possibility of conflicts, a purely top-down approach, with only the influence of stakeholders is considered. The process of decision making is often based on set criteria, for instance regarding affordability, accessibility and environmental impact. However, social implications could be forgotten: The voices of actual users that will be using or in another way being affected by the urban intervention aren't included and informed.

In the example of the new light-rail connection from The Hague to Binckhorst, a lot of citizens were opposing this project and complained about noise, visual pollution and safety declination for their children. We can ask ourselves the question if this is just a "not in my backyard" situation or if this might be also a matter of including citizens within the process of urban development. Informing them about the incentives behind the project to explain the importance of different scales. Without including the public, governments deprive the change for negotiations; therefore they won't succeed to synthesize a proposal that resonates with the needs of all involved groups.

So, why is having an active civil society beneficial for planning and design processes?

The active participation of citizens in the common affairs is beneficial for the planning and design process as it assists the robust function of the multi - level governance. Verloo conceives the conflict as a chance for dialogue and consensus-building.The involvement of citizens is an opportunity for expression of ideas, thus helping the smooth and democratic process of decision - making.

I have a dream !

Why is coordination a challenge in planning?

One of the biggest challenges in planning is the coordination which derives from several factors. More specifically, the sectoral organization of public administration in combination with the different specialization of knowledge, creates 'island-working' in sectors. As a result, the isolated perspectives cannot be integrated into the complex system. Moreover, the emergent behavior, the non-linear dynamics accompanied by peaks and sudden transitions, the limited predictability, the self or spontaneous organization as well as the wicked problems constitute striking factors of limited coordination.

Another challenge is the number of people involved. All of them have their own interests and visions on how to solve and attack the problem. The large economic burden also needs to be shared equally among all actors. This makes the interconnected nature of these challenges more complicated for creating consensus.

Last but not least, coordination becomes a challenge in planning due to the lack of a connected vision. Creating a positive view of the future and setting a common goal can inspire people to co-operate and thus this vision could connect all different perspectives and disciplines.

Why can't supercomputers model our cities well?

Super computers cannot model in an effective way our cities due to the complexity of their physical and political nature. The city is a product of many actors in simultaneous competition and cooperation. All these different actors could possibly be able to find consensus on the big societal challenges (however even this can be tricky with climate change deniers), but even more, the amount of diverging interests and interpretations on how to deal with those challenges is huge. Therefore, we see much less agreement on possible solutions.

When looking into the challenge of climate change, we clearly see this phenomenon. With abundance of evidence that fossil fuels are accelerating the process of warming our planet (for instance delivered by the IPCC), still many people are denying the urgency of this challenge. As described with the story of the frog in cold water that boils slowly, humans seem to be unable to address the gradual subtle changes that are occuring. So when will they be convinced of this challenge? Do they need to experience a heavy crisis themselves? Probably yes. But do we have time to wait for a disaster like that? Certainly not.

Therefore, we need politicians around the world that share a clear long-term vision to convince everyone and to combat this challenge together. As Timperley describes, the allocation of accountability is a necessary step in the transition to non-fossil sources of energy. Since, many people around the world are still very much dependent on fossil fuels for their daily needs. These people are not granted access to clean alternatives and it would be unjust and false to say that they are responsible. A super computer cannot oversee and fathom the complex nature of this challenge with all its different actors and dynamics. Governance is not about twisting the knobs, but about including the complexity of the city, with all its interdepencies, human interactions and interests.

What is the Dutch government's vision for climate change? Is it enough?

The Dutch government envisions a reduction of greenhouse missions in the future. The vision is achieved through international agreements and cooperation against climate change. The first goal of the dutch government is the adaptation to climate change. In order to combat this, they are highly relying on technology to protect the Netherlands against future flooding, heat stress, droughts and subsidence. Moreover, the coordination between several actors as well as the contribution of businesses in the transition depict the tools towards the less dependency on fossil fuels.

However, are these actions enough? The Dutch government relies on better technology to combat climate change a bit too much. By doing this it is not overseeing the complex socio-technical nature of this transition, that includes the interconnectivity of technology with culture, institutions and politics. What is more, the coordination of the government among several actors has to be scaled up and take matters into their own hands more often. Last but not least, there is a need for changing the public perception and creating awareness of the threats resulting from climate change.

What is communicative planning?

Communicative planning recognizes the complexity of human interaction within the given social and economic structures and the abundance of different perspectives and knowledge that often lead to the lack of agreement on common problems. To deal with this, communicative planning aims to engage all stakeholders in a planning process that considers the interests of all sides involved. This has a direct implication on the way planners interact with stakeholders, and at the same time, it affects spatial justice through the fair allocation of resources within the city. This approach in planning to function also requires the active involvement of citizens in a way that they express their opinions but also take into account the opinions/knowledge of other parties of the discussion.

In this direction, planners should stop relying on planners but also embrace people in the planning process. To achieve that they need to learn how to facilitate participation of people by accepting different perspectives and world-views and thus creating an environment that can lead in reaching a consensus.

The use of narratives and storytelling play a significant role central in communicative planning, because they are understandable by a larger portion of people, as opposed to reports, which can only be interpreted by planners and technocrats. This leads to a more democratic and inclusive practice of planning and decision-making.

What Innes and Ostrom have in common?

Ostrom and Innes have in common the participatory decision making and the interconnection between larger networks in order to achieve communicative planning. People and actors play a vital role in decision making. The diversity as well as the interdependence of interests constitute the common ground between them in aim to engage all participants in an authentic dialogue.

More about Ostrom

According to the text, Ellinor Ostrom is the first woman to win a Nobel Prize in Economics for her analysis of economic governance in 2009. However, Marie Curie was the first woman in general to win a Nobel Prize in 1903.

Attention, please!

In the current situation the port is a hub for importing petrol as an energy carrier that is distributed in other countries in the hinterland. The region of South Holland has limited involvement and thus minor or non-existing social and economic benefits from these activities.

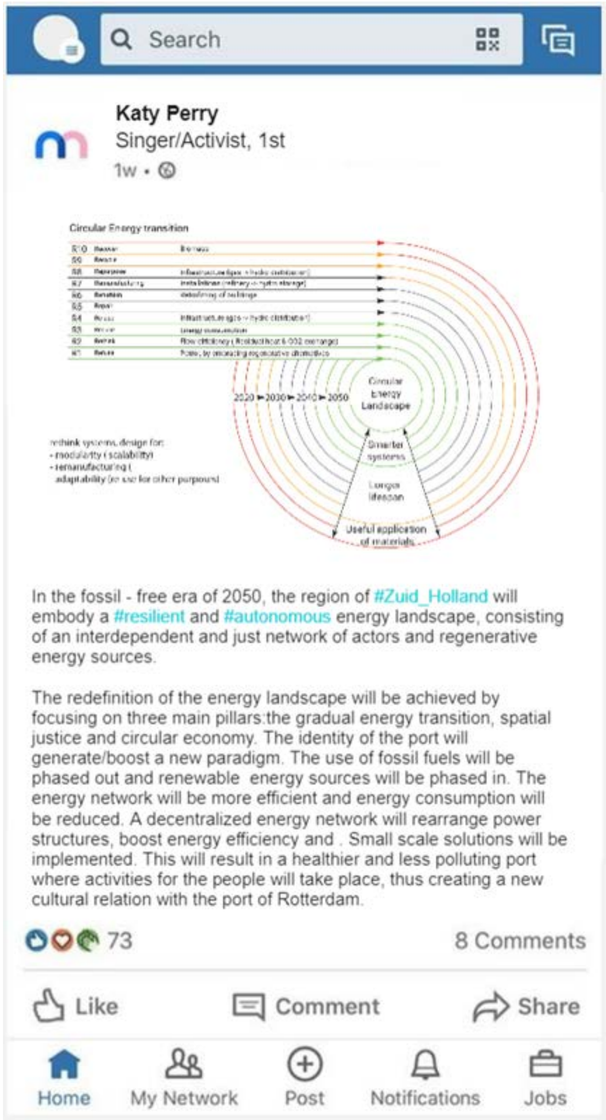
In our vision two things will change. Firstly, we shift the global flow of energy and its carrier - Hydrogen. Secondly, on a regional scale we propose a decentralized energy landscape with more accessibility for people, that share in the benefit of energy activities.

The global port
The energy landscape is changing. Therefore we suggest a change in the role of the port on the global scale. We propose an invert of the energy flow. Renewable energy surpluses in the hinterland on European scale will be distributed to other continents through the port of Rotterdam. By this way, the port again acts as an important node for energy distribution through hydrogen on a global scale.

The regional port
At the same time on a regional scale, it is part of a decentralized network of energy production where different urban agglomerations contribute to the hydrogen production for regional use, by providing electricity through renewable sources of energy (wind energy mostly on sea, solar energy on roofs in the whole region and on already existing fields).

Local/Regional spatial effects
Hence, this involves citizens having a new cultural relation with the port. Locally, this means the areas dedicated to petrol are transformed into places for hydrogen with more space free for different activities such as research, education, leisure. In the region, this will also mean obsolete petrol infrastructure will create opportunities for other uses of space and renewable forms of energy.

Can you explain the vision and strategy in a short and engaging Facebook/linkedin post (with an image?)



Can you explain the vision and strategy in a tweet? (280 characters + an image?)

Can you explain the vision and strategy in an Instagram post? (more image focused)

It’s a deal

What happened during the Neolithic Revolution?
Around 10.000 BCE the first great human technological revolution, the Neolithic Revolution, took place. During the Neolithic revolution there was a huge shift from hunting and nomadic life towards agriculture and more permanent settlement. That fact had as a result the ability of sustaining larger populations and creating a stabilization of settlements in Mesopotamia, the Indus Valley and ancient China. The revolution had a significant impact on the distribution of goods and that resulted in the division of social classes and the complex forms of political organization.

Why do we need a New Green Deal? What’s the name got to do with it?
Due to climate threats stemming from the overuse of technology advancencements as well as the need for social justice and democracy, there is a significant requirement for a New Green Deal. According to the author, the title Green New Deal refers to the New Deal of President Franklin Roosvelt in response to the Great Depression of 1929 in the US. The New Deal was a combination of social and economic solutions. The Green New Deal merges the approach of Roosevelt with the requirement of renewable energy and resource efficiency. There are two examples of attempting legislation for a New Green Deal. The first one was during the 116th United States Congress by Senator Ed Markey. The second one was in 2019 where there was a proposal from the European Commision for a European Green Deal and in January 2020 by the European Parliament. It is worth noting that the European Union conceives the Green Deal as a socially sustainable solution that comes from social policies.

What is a Habitat meeting and how many have there been?
There have been four habitat meetings throughout history. These were meetings attended by various countries of the world to make agreements considering the climate and status of nature of the earth. In these meetings

Habitat I; Deeper understanding , creating consensus, defining actual status and formulate common goals

Habitat II; recognition that cities are engines of growth, with a huge increase of people living in cities, call for a stronger role for local authorities and the empowering of citizen’s participation.

Habitat III; After 9/11 a set of tensions in the world were ignited, which caused for the comeback of nationalism and countries to retrench themselves from agreements.

Habitat Alternativo; organized by critics of the New Urban Agenda, profound discomfort between the disconnection between concept and practice. Voices that “the system was not working for normal citizens”

What’s the connection between science and democracy?
Science and democracy are closely intertwined in an aim of creating a sustainable environment for civil society. According to Doreen Massey, “the city is the space where we all need to learn to live together and is therefore, the space of politics”. The technological and scientific advancements have to keep the balance between people and their freedom. Access to science, interaction between the stakeholders, the correct information,the proper use of technology and the cooperation between the institutions is essential for a flourishing democratic society.

You get extra heart emojis if you can explain why technology (understood as tools and artefacts only) doesn´t solve the climate emergency.

Technology does not solve the climate emergency in a sense that its overuse polarizes civil society. Climate threats can be solved only by social justice and the overall collaboration between the stakeholders. Since, technology threatens the fundamental balance between them, it seems difficult to elaborate effectively in future climate related problems.

Do artifacts have politics?

Why does it sound a bit off to say that objects have politics?
The problem is a single perspective in modernist thinking. It seems like it is a bit off to believe the idea that objects on its own are shaping our societies. This is because it seems like a too narrow minded approach because objects alone don't necessarily have a meaning like that. However, unless they are embedded in a social or economic system this would be the case. This phenomenon is called the social determination of technology.

What are examples of spatial expressions of political ideologies?
One example are the racist bridges in New York. These were bridges that were not high enough for buses to ride underneath. This reflected the segregation between black and white. Blacks couldn't afford their own car and used buses instead. For this reason, they couldn't use infrastructure because they were too poor. This segregated the city even more. Another example in the United States is the US capitol building. The neoclassical style of the building reflects Roman imperialism and the need to make America great again. Maybe a different example of spatial expressions of political ideologies are the apartment blocks in Eastern Europe, as remains of the Soviet era. Communist thinking enhanced the idea that everyone was part of the same socialist class. This communist thinking is reflected in the way of housing of that era.

What may solar panels produce in terms of internal political relationships?
Solar panels are described as the opposite form of energy production than nuclear energy. Whereby solar energy is relatively affordable and accessible for single households to take control and ownership of their own energy production and use, which gives an opportunity for a more equal demonopolitised decentralized energy system with autonomous actors. In contrast, nuclear energy, for both safety and reasons of complexity, has to be organized centrally and within a hierarchic state with top down governance and strong coordination. However, solar energy could also cause inequality, since autonomous players (more affluent homeowners) can have another advantage compared to the people that could not benefit from this due to affordability reasons or non-homeownership. Therefore it can increase lack of solidarity amongst citizens.

How does Facebook undermine democracy? In your opinion, does it simultaneously help democracy?
On one hand, Facebook, and probably Social Media in general, undermines democracy. Algorithms are trained to get people's attention and use tricks to keep them on the platform, since the attention is their core business value they sell. On one hand, topics that trigger people in a negative way seem to get people very much engaged. At the same time, when they see reactions and perspectives of others that meet their beliefs, they feel strengthened in their perception. As a consequence of this, people are put together and are forming stronger polarizing perspectives, since they are constantly confirmed and challenged by the algorithm's feed of content. Subsequently, people are developing a lack of criticism of their own thought process and get alienated from other perspectives, which causes increased segregation.

On the other hand, you can argue that Facebook enhances democracy. You are able to express your views without any consequences. You are able to express your opinion to a great deal of people all in once. However, it is debatable how effective and fruitful these discussions are, since they are many times created to frustrate people instead of bringing them closer to each other, since facebook seems to prioritize economic gain over a healthy public debate.

Unfortunately, this all is not intended from the point of view of giving people a voice to the general public.If Facebook is primarily focused on selling their user’s attention to advertisement parties and only trying to keep people hooked to their platform as much as possible. How can this then be a sincere democratic construct?

Energy Management Calculations

2020

Energy Generation	PJ	%
	494	
Geothermal/resi	3	0.7
Wind	2	0.5
Solar	0	0
Biomass	15	3
Natural Gas	220	44.5
Coal	64	13
Oil	189	38.3
total	473	96
total	15	3
total	6	1
total	494	100

energy conversion		PJ	%
electricity generation			
from gas	80	43	36
from coal		64	54
from wind		2	2
from solar		0	0
from bio mass		10	8
total		120	100
electrcity netto		60	

Energy use	Use %	PJ	PJ%
Household heat	100	35	8
household electr	100	10	2
Utility heat	100	43	10
Utility electricity	100	12	3
Greenhouse Hea	100	43	10
Greenhouse elec	100	12	3
Transport	100	30	7
Petrochemistry	100	59	13
petro elec	100	26	6
Industry	100	175	39
elec use total		60	
			100
total		445	100
diff		49	

WATT ANDERS (Energieagenda 2016-2020-2050 PZH)

0.985	1.5

Energy loss	% loss	PJ loss
Household heat	20	7
Utility heat	23	10
Greenhouse Hea	24	10
Transport	90	27
Petrochemistry	10	6
Industry	57	100
elec gen	50	60
total loss		220
total effective use		225
export		49

energy balance		%electra	% oil
Household	45	20	
Utility	55	20	
Greenhouse	55	20	
Transport	30	0	
Petrochemistry	85	31	
Industry	175	0	
electricity gen	60		
TOTAL PJ	445.00	58	
TOTAL generatior		60	

2030

Energy Generation	PJ	%
Geothermal/resi	45	11
Wind	122	30
Solar	53	13
Biomass	37	9
Natural Gas	73	18
Coal	0	0
Oil	77	19
margin wind		
total	150	37
total	37	9
total	219	54
total	406	100

energy conversion		PJ	%
electricity generation			
from gas	0	23	19
from coal		0	0
from wind	122	45	37
from solar	53	54	44
from biomass	0	0	0
total		122	100
electrcity netto		92	
Hydrogen production			
from wind		77	102
from solar		-1	-2
total		75	100
hydro netto		60	

Energy use	Use %	PJ	PJ%
Household heat	86	30	7
household electr	86	9	2
Utility heat	86	37	8
Utility electricity	86	10	2
Greenhouse Hea	86	37	8
Greenhouse elec	86	10	2
Transport	86	26	6
Petrochemistry	86	51	11
petro elec	86	22	5
Industry	86	150	34
elec use total		52	
			86
total use		383	100
margin		23	
demand		406	

Energy loss	% loss	PJ loss
Household heat	15	5
Utility heat	15	6
Greenhouse Hea	20	7
Transport	60	15
Petrochemistry	5	3
Industry	40	60
elec gen	25	31
hydro prod	20	15
total		141
total effective use		241
export		23

energy balance		%electra	% oil
Household	39	30	
Utility	47	30	
Greenhouse	47	30	
Transport	26	67	
Petrochemistry	73	31	
Industry	150	8	
electricity gen	92		
hydrogen prod	60		
TOTAL PJ	383	92	
TOTAL generatior	383	92	

WATT ANDERS (Energieagenda 2016-2020-2050 PZH)

0.985	1.5

2050

Energy Generation	PJ	%
	494	
Geothermal/resi	76	25
Wind	141	46
Solar	89	29
Biomass	0	0
Natural Gas	0	0
Coal	0	0
Oil	0	0
total	0	0
total	0	0
total	306	100
total	306	100

energy conversion		PJ	%
electricity generation			
from gas	0	0	0
from coal		0	0
from wind	141	0	0
from solar	89	85	100
from biomass	0	0	0
total		85	100
electrcity netto		77	
Hydrogen production			
from wind		141	187
from solar		4	5
total		144	100
hydro netto		137	

Energy use	Use %	PJ	PJ%
Household heat	64	22	5
household electr	64	6	1
Utility heat	64	27	6
Utility electricity	64	8	2
Greenhouse Hea	64	27	6
Greenhouse elec	64	8	2
Transport	64	19	4
Petrochemistry	64	37	8
petro elec	64	17	4
Industry	64	111	25
elec use total		38	
			64
total use		283	100
margin		23	
demand		306	
100	128	46.75	
117.96875	151		

Energy loss	% loss	PJ loss
Household heat	3	1
Utility heat	3	1
Greenhouse Hea	3	1
Transport	0	0
Petrochemistry	1	0
Industry	15	17
elec gen	10	9
hydro prod	5	7
total		35
total effective use		248
export		23

energy balance		%electra	% oil
Household	29	75	
Utility	35	75	
Greenhouse	35	25	
Transport	19	50	
Petrochemistry	54	15	
Industry	111	10	
electricity gen	77		
hydrogen prod	137		
TOTAL PJ	283	85	
TOTAL generatior	290	77	

	2020						total %	total PJ
	% hydro	% geo	% gas	%biomas	%coal			
0		6	74	0	0		100	45
0		0	80	0	0		100	55
0		0	80	0	0		100	55
100		0	0	0	0		100	30
18		0	65	6	0		120	102
83		0	25	0	0		108	189
			-43					
			36	16	50			
190	0	3	199	15	30			
189		3	220	15	64			

	220										
Sankey input		2020									
		PJ electra	PJ oil	PJ hydro	PJ geo	PJ gas	PJ biomas	PJ coal	PJ wind	PJ solar	check
Household	45	9	0	0	3	33	0				45
Utility	55	11	0	0	0	44	0				55
Greenhouse	55	11	0	0	0	44	0				55
Transport	30	0	30	0	0	0	0				30
Petrochemistry	85	27	15	0	0	55	5				102
Industry	175	0	145	0	0	44	0				189
						-43	0				-43
electricity gen	60					43	10	30	0	0	82
hydrogen prod						0	0	0	0	0	0
export											
Total		58	190	0	3	220	15		0	0	
check		60	189		3	220	15	64			

	2030						total %	total PJ
	% hydro	% geo	% gas	%biomas	%coal			
0	0	32	10	28			100	39
0	0	31	10	29			100	47
0	0	31	10	29			100	47
0	33	0	0	0			100	26
7	30	0	32	0			100	73
48	20	0	24	0			100	150
			-23					
			19					
77	61	42	67	38	0			
77	60	45	73	37	0			

	2030										
Sankey input		2030									
		PJ electra	PJ oil	PJ hydro	PJ geo	PJ gas	PJ biomas	PJ coal	PJ wind	PJ solar	check
Household	39	12	0	0	12	5	10				39
Utility	47	14	0	0	15	5	14				47
Greenhouse	47	14	0	0	15	5	14				47
Transport	26	17	0	9	0	0	0				26
Petrochemistry	73	23	5	21	0	24	0				73
Industry	150	12	72	30	0	36	0				150
						-23	0				-23
electricity gen	92					17	0		45	54	116
hydrogen prod	60					0	0		77	-1	75
export											
total	377	92	77	60	42	69	37		122	53	
check	383	92	77	60	45	73	37		122	53	

	2050						total %	total PJ
	% hydro	% geo	% gas	%biomas	%coal			
0	0	25	0	0			100	29
0	0	25	0	0			100	35
0	20	55	0	0			100	35
0	50	0	0	0			100	19
0	60	25	0	0			100	54
0	70	20	0	0			100	111
			0					
			0					
0	127	71	0	0	0			
0	137	76	0	0	0			

	2050										
Sankey input		2050									
		PJ electra	PJ oil	PJ hydro	PJ geo	PJ gas	PJ biomas	PJ coal	PJ wind	PJ solar	check
Household	29	21	0	0	7	0	0				29
Utility	35	26	0	0	9	0	0				35
Greenhouse	35	9	0	7	19	0	0				35
Transport	19	10	0	10	0	0	0				19
Petrochemistry	54	8	0	32	14	0	0				54
Industry	111	11	0	78	22	0	0				111
						0	0				0
electricity gen	77					0	0		0	85	85
hydrogen prod	137					0	0		141	4	144
export											
total		85	0	127	71	0	0		141	89	
check		77	0	137	76	0	0		141	89	