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spatial strategies for the global metropolis

R&D STUDIO
Province of South Holland

South Holland's petroleum (e)scape

Q3
2020-2021

Colofon

In this book:

AR2U086
R&D Studio: Spatial Strategies for the Global Metropolis (2020/21 Q3)

AR2U088 Research and Design Methodology for Urbanism (2020/21 Q3)

Part of the TU Delft MSc. programme of Urbanism

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April 2021

South Holland's petroleum (e)scape

a vision and strategy towards a mutualist energy landscape in 2050

Abstract

In the past decades, the port of Rotterdam has been considered as one of the main engines of the Dutch national economy, since it is the largest hub for fossil fuels in Europe. The province of South-Holland and the Port of Rotterdam hereby form the heart of the economic centre of the Netherlands, contributing to 21% of the national GDP.

However, the economic growth and prosperity of the region is inevitably linked to CO2 emissions and pollution. On the local level, the petroleumscape produces an invasive effect on the liveability of its direct environment, exposing the local population to the burdens of the financial gains of the petrochemical industries. Also, we urgently need to transition towards a more sustainable energy system due to growing risks as a result of climate change. This poses a challenge to the region, since the main driver of the current industry is based on a highly centralized energy system. Such systems are not fit to make use of locally perceived potential of renewable energy sources. In the transition towards a distributed energy system, ecologic, social and economic challenges with strong spatial components arise in the region of South-Holland.

Therefore, this strategy aims for an approach for giving shape and meaning to the energy transition in the province of South-Holland. Our team explores the way in which decentralization of certain building blocks in the mechanisms of energy production, conversion and storage could deliver a more democratic, self-sufficient and resilient system. Simultaneously, it should empower the local economy. By rearranging and reimagining the configuration of space in the port region, new spatial layers come to existence, which are oriented towards improving social and ecological structures.

Once the polluting industries transform into cleaner industries, new spaces and opportunities open up for sustainable redevelopment of the waterfront. Space for recreation, flora and fauna will bring about a more gradual transition from port to city to hinterland. The sum of all interventions will contribute to the global objective of mitigating climate change, while reintroducing spatial justice and creating meaningful connections between industrial, rural and urban landscapes in the region.

00 Preface

This document is the final report for the third quarter of the first year in the MSc Urbanism programme. The presented work is a collection of our collaborative work in analysis, planning and design to support the efforts of the Province of South Holland to initiate a transition towards a bio-based and circular economy. Our work explores the spatial implications of such a transition, by evoking a creative thinking process that aims at setting a liberated and progressive ambition, rather than a reactionary and chartered course. The work is a combination between input from two separate but related courses. The AR2U086 R&D studio, which focuses on the development of the spatial strategy, and the AR2U088 course, which in turn focuses on the formation of a research methodology. The coordination between both courses called for the persuasion of a coherent outcome, following a consistent methodology and maintaining a critical and academic perspective, paralleled by the formative energy of our creative thinking processes. We want to express our gratitude towards our tutors for guiding us through this quarter.

Content

01 Why escape?

The first chapter of this report will explore the design challenge in the context of the given location. It will provide the background in which the challenge can be placed, by briefly explaining the history of the petrochemical industry and the problems that it faces today. In this way, the reason for a transition and the necessity for a design strategy will be motivated. Furthermore, this chapter will give insight into the characteristics and other basic descriptive information of the province of South Holland. The exploration of the theme is largely supported by fieldwork, conducted on the (digital) site visit. On the basis of this initial work, our problem statement was made and the research questions were formulated. Together, they determine the scope of the rest of the report and the analysis.

BACKGROUND

The twentieth century marked the zenith of the petrochemical industry worldwide. The promise of oil as the inexhaustible source of energy drove society into a blind spot. Oil companies such as Shell sold this promise and were revered by all. Oil and oil-based products became the carrier of modern society. The ubiquity of plastic products characterizes the spirit of consumerism. Asphalt paved the roads and runways for petrol-fueled cars and kerosene-fueled airplanes, who in turn brought us wherever we wanted to go. From this perspective, one might argue that oil set the trends for suburbanization and globalisation, thereby drastically influencing the way our lives and the built environment took shape. Oil-driven optimism and prosperity laid out the foundation for today's world, in which fossil fuels are granted an almost unconditional trust (Hein, 2018).

> "History shows that oil industry, in close collaboration with national governments, has materially not only shaped the port, but the entire Randstad, through headquarter buildings, retail, infrastructure, and ancillary buildings." (Hein, 2018, p.922)

The flip side of this dependency on oil and other fossil fuels became painfully clear in the year 1973, when the post-war spirit of the west was confronted with a shortage of fossil fuels due to political conflicts. Oil drove society into a blind spot. However, such problems barely resulted in a change. Fossil fuels remained the cheapest available source of energy. Therefore, the persistent demand for oil is still prevailing in the 21st century. In this century however, humankind is increasingly confronted with the impact of this fossil fuel-based society - causing problems beyond our own capabilities.

These global issues form the basis of one of the greatest and most urgent challenges that humanity will face in this century. Therefore, it is also the basis of our own problem statement in the context of this research. The project is focused on the region of South Holland. The province of South Holland is an industrious and versatile region with more than 3.5 million inhabitants in an area of almost 3,000 km2. It is the most densely populated province and it is home to several universities. The port of Rotterdam and its industrial diligence, together with the hyper-efficient greenport of Westland-Oostland, ensures that the province has a major impact on the economy of the region, the nation, and even Europe.

In addition to these economic activities, South Holland is also an attractive province to live in, work and recreate. The province's natural landscapes vary from extensive rural areas with rivers, polders,

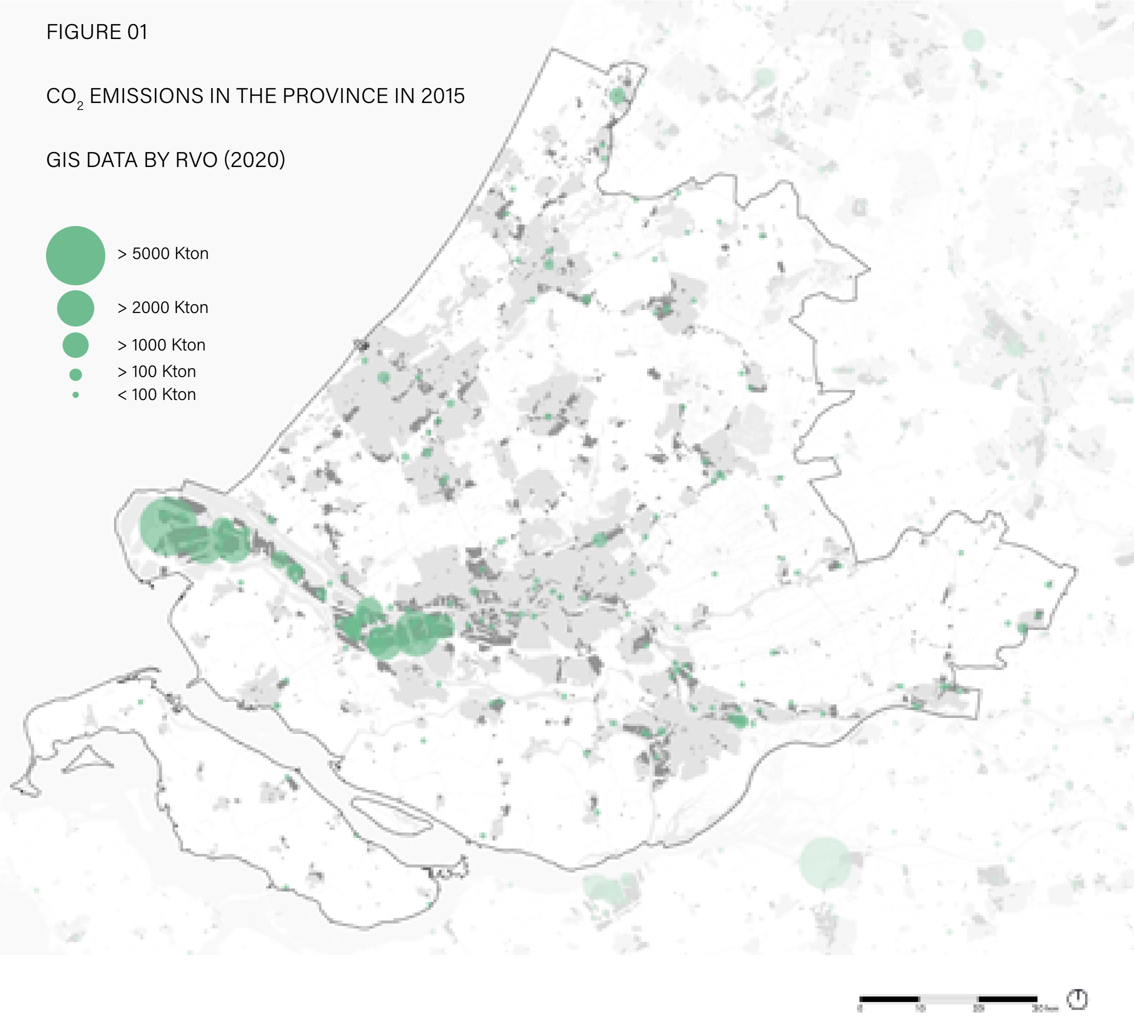


FIGURE 01

CO_2 EMISSIONS IN THE PROVINCE IN 2015

GIS DATA BY RVO (2020)

lakes, to dunes and vast sandy beaches.

In the province of South Holland, the emissions of CO2 by industrial functions are primarily produced in the port of Rotterdam. This highlights the scope of our challenge. The centre of gravity of the petroleum-based industries is found in the port. Although the transition towards a bio-based economy does not limit itself to the perimeters of the port, or even the province, it is likely to leave its strongest marks on the areas in which the oil refineries and storage terminals are currently located. As urbanists, we are challenging the spatial and representational dimensions of the petroleumscape. New energy production sites are about to redefine the urban landscapes of the petrochemical industries and it is up to us to give meaning to the port, the city and the countryside. We seek to produce new urban forms, synergies and identities, while simultaneously dealing with the contingency and path-dependency of a long-term transition.

INVENTARISATION

SCALE OF PERCEIVED IMPACT	ENVIRONMENTAL ISSUES	SOCIETAL ISSUES	ECONOMIC ISSUES
local	contamination of soil and water	social inequality and spatial segregation direct health risks	limited collaboration and resource efficiency
regional	air pollution	unemployment, disappearing jobs in the (petro)chemical sector reduced livability	
national	nitrogen crisis	drug trafficking	shrinking economy competition from emerging markets
global	dependency on resources from conflict areas or politically unstable areas plastic waste climate change	disposable consumer culture	shifting global economy scarcity of fossil fuels

FIGURE 02

PROBLEM INVENTARISATION/BRAINSTORM - THE PORT AND ITS HINTERLAND

> "The global dependency on fossil fuels is still rising and it is causing climate change, social inequality and pollution. These global issues directly and indirectly affect the province of South Holland. Regional problems, such as health risks due to air pollution, the linear material flows in the production process and spatial injustice between stakeholders, highlight the necessity of a transition."

FIGURE 03

THE SPIRIT OF THE COMING AGE

SHELL (N.D.)

FIGURE 04

THE LEGACY OF THE PAST AGE

EDITED FROM SHELL (N.D.)

MAIN RESEARCH QUESTION

M

How can a regional design strategy for the port of Rotterdam and its hinterland contribute to a transition from a petroleumscape towards a mutualist energy landscape?

to be answered in: conclusion

SUBQUESTIONS

1

Why is the current fossil fuel industry in need of a transition?

to be answered in: problem definition

2

What are the current spatial qualities and inadequacies of the port and its hinterland?

3

What are the material and energy flows of the current fossil fuel industry, and what potential is there for renewable alternatives?

to be answered in: analysis

4

What do we define as a mutualist energy landscape, and which concepts and values fit within this idea?

to be answered in: vision

5

How do we translate our concepts and values into a design strategy?

to be answered in: strategy

This chapter is mainly oriented to highlight the scope of our challenge. The urgency of the transition is evident, which explains the relevance and necessity of our work. Now that we outlined the boundaries and the scope of our challenge, the following chapter will build upon this, by focussing more on the approach and theory of the design challenge.

02 Escape Method

introduction

As indicated in the research question and problem statement, this project is structured around the concept of the current polluting centralized energy systems and impact of petroleum on our industry, landscape and society. These systems rely on unsustainable energy sources and result in negative externalities for the environment. Therefore, there is a need to transition towards an alternative decentralized energy system and a mutualist energy landscape. In the following chapter, the theoretical background is presented. Based on these theories a conceptual framework is formulated to show how these concepts work together to lead to the proposed vision and strategies of this report. This theoretical background is built upon the existing knowledge of experts in the field of the linear system it's impact on the environment, centralized and decentralized energy systems and the emergence of petroleumscape, the concept of wastescapes, Finally, the concept of transition management is taken into consideration.

THE LINEAR SYSTEM (ENVIRONMENTAL)

The unsustainable urban development can be linked to a linear system that is based on the concept of the take-make-dispose model. This model causes negative externalities such as water, air and noise pollution, the release of toxic substances and the emission of greenhouse gasses. The concept of linear systems can be applied to the current energy system. According to Alanne & Saari (2006), the current energy system can be defined as a centralized system. Where large power plants units, operating in central locations, burn fossil fuels causing emission of greenhouse gasses and other negative externalities like fragility and dependency, as illustrated in figure 04. In this context, we define the energy system as the energy chain of energy production, conversion, transmission, distribution and consumption. However, the energy systems should not only be considered as a physical energy chain, since political, economic, social and technological dimensions play a key role (Alanne & Saari, 2006).

PETROLEUMSCAPE (SOCIETAL)

The integration of the public and private actors in the formation of the energy systems has led to the creation of physical and financial flows of petroleum (Hein, 2018). These flows can be physical, like gas stations, but also represented or everyday practices. These flows have since the industrial revolution historically led to the representations of petroleum in our landscape and became an essential part of modern society and of citizens' everyday lives. Due to this integration of petroleum into our landscape, the concept of 'petroleumscape' emerged. The resulting path dependencies and an energy culture help maintain the physical and financial flows of the oil-driven landscape (Hein, 2018). Moreover, the feedback loops in the system cause societies to consume more oil. According to Hein (2018), only when the power and extent of oil is recognized, it is possible to engage with the complex emerging challenges of sustainable design, policymaking, heritage and future built environments beyond oil.

BEYOND WASTESCAPES

Wastescapes are the result of unsustainable linear growth processes and their spatial consequences in the context of urban development and related infrastructure (Amenta & van Timmeren, 2018). The transition towards a circular energy system poses changes and opportunities for further development in the urban and rural landscape. As a result of the unsustainable centralized and polluting energy system, wastescapes have emerged . These wastescapes are areas that have been extensively used by industry based on the linear model and have now been abandoned due to heavy pollution and resulted in unusable land (Amenta & van Timmeren, 2018). In the transition towards a more sustainable energy system based on renewable energy sources and a bio-based economy, the emerged wastescapes could be rejuvenated. The soil could be cleaned and Eco-Innovative Solutions (EIS) could be developed, tested and implemented. In this way, the wastescapes could tackle the dual problems of both space scarcity and spatial fragmentation (Amenta & van Timmeren, 2018)

DECENTRALIZED AND CIRCULAR ENERGY SYSTEMS

Climate change is caused by the emission of greenhouse gasses by burning fossil fuels. It has become clear that we have to transition towards renewable and sustainable energy sources. These sources could be of multiple origins. Conventional options, such as solar and wind energy generation, can already be discerned in many countries. Recently, also lesser-known options are being developed more and more, such as aqua thermal or geothermal heat. According to the concept of circularity, circular energy systems are resilient, renewable, localised, distributed and allow effective energy use, reducing costs and have a positive impact on the environment (Ellen MacArthur Foundation's, 2017). In this transition towards a circular energy system, the concept of decentralization plays an important role. According to Alanne & Saari (2006) in a decentralized energy system, the energy conversion units are located close to energy consumers. This decentralized energy system could be an efficient, environmentally friendly and reliable alternative through the use of local resources and networks compared to the traditional centralized energy system (Alanne & Saari, 2006).

TRANSITION MANAGEMENT

In order to lead the Port of Rotterdam and its industry into a transition, it is important to understand the definition and the different transition management approaches. According to Bosman et al. (2018) a transition is the result of the co-evolution of cultural, economic, technological, ecological and institutional developments which leads to a radical and structural change of a societal (sub)system. It follows the path of a simultaneous breakdown of unsustainable practices and the build-up of sustainable alternatives. An important concept in transition research is the regime, which is defined as the dominant culture, structure and practices within a societal system (Bosman et al., 2018). A change in this regime can be caused by external shocks, internal structural problems and bottom-up innovations in niches (Bosman et al., 2018).

As mentioned, a transition is the process of building up sustainable alternatives and breaking down unsustainable practices over a certain period. In the build-up of the transition changes agents start to experiment with alternative ideas, technologies and practices. While the established regime starts to optimize their processes. As alternatives start to become feasible, the established regime becomes destabilized which leads to increased pressure to transform. The transition is at that moment chaotic and disruptive and new combinations of emerging alternatives and transformative regime elements emerge into a new regime (Loorbach et al., 2017). In this process elements of an old established regime that do not follow in this transition are broken down and phase out. This process can be seen in figure 05. According to literature, the impact of actors and their power should be recognized in the way they could accelerate or slow down a transition. Geels (2014) argues that regime stability could be the outcome of active resistance by incumbent actors. However, over time actors may need to shift their strategy and contribute to accelerating a transition.

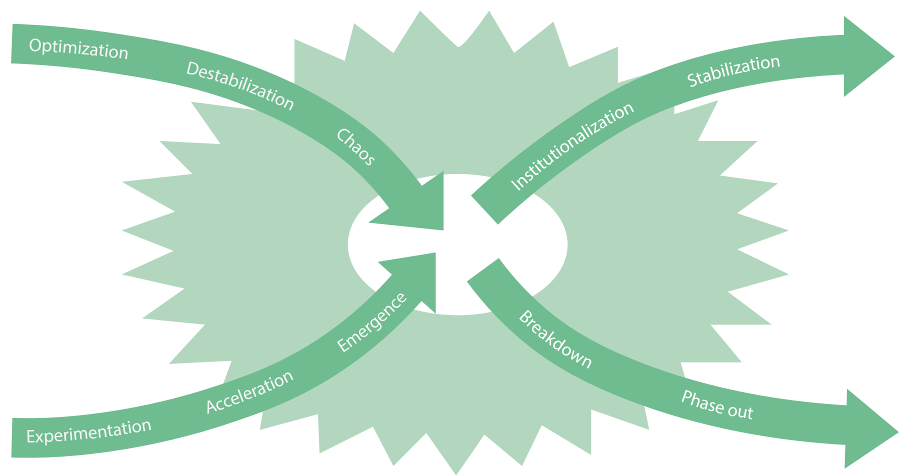


FIGURE 05

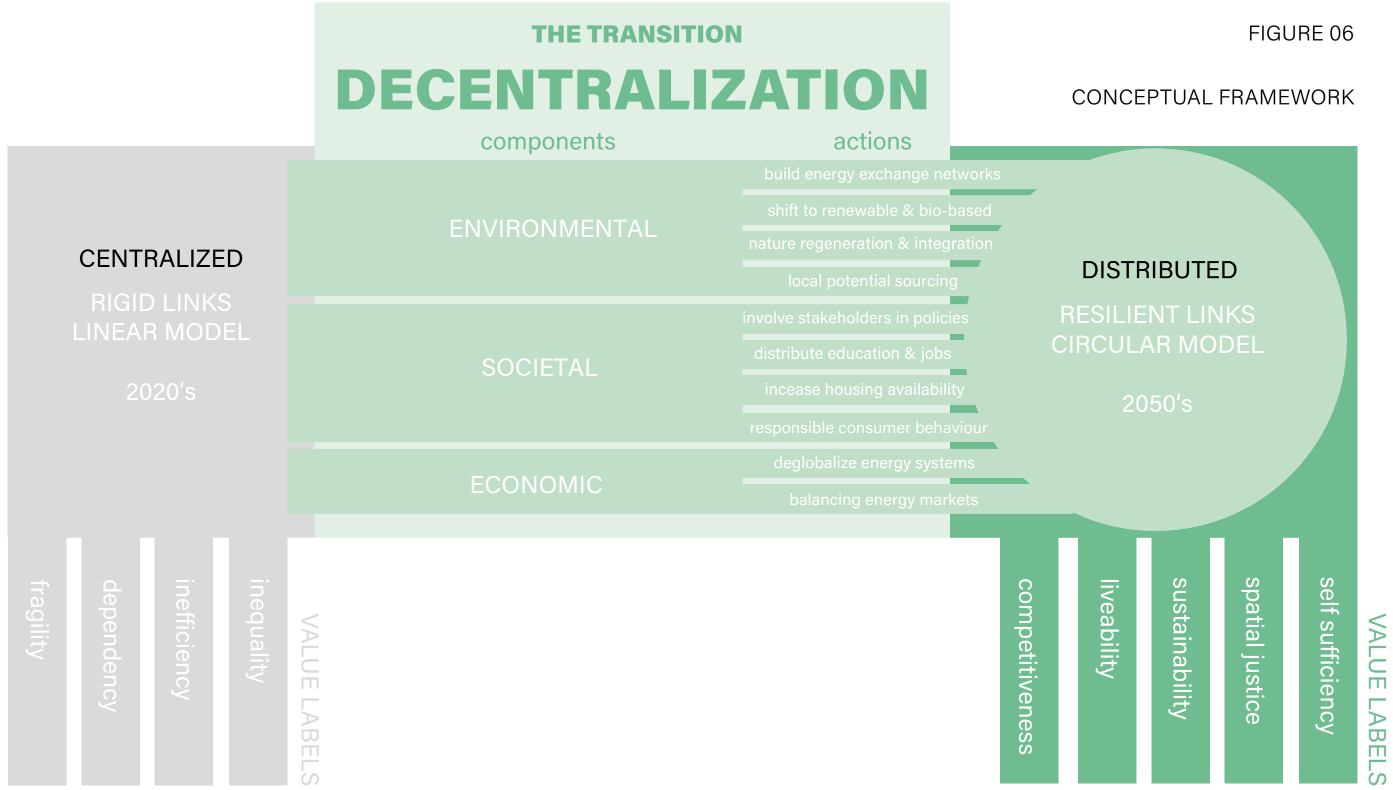
TRANSITION PROCESS

(LOORBACH ET AL., 2017)

As explored in this theoretical section of the document, the transition towards a more favourable energy system is not a one-dimensional transition. The complex set of problems manifest themselves in multiple fields of society. The plurality of the transition is displayed in the conceptual framework. The left end of the figure represents the current energy model. This model is characterized by certain values, which outline the currently perceived vulnerabilities of the system. The center of figure 06 represents the transition, in which decentralization of the energy system is presented as the main call for action in the transition. Within this path, three components are distinguished. The social, environmental and economic fields are projected to be the sub-components of the transition. Each of these components has its individual actions which are necessary to reach the favoured future conditions. The strategies, as presented in chapter 5, are the modes of operation in which these actions are taken. The end model, again, is characterized by certain values. They outline the favourable values. These values are further elaborated in the vision.

FIGURE 06

CONCEPTUAL FRAMEWORK



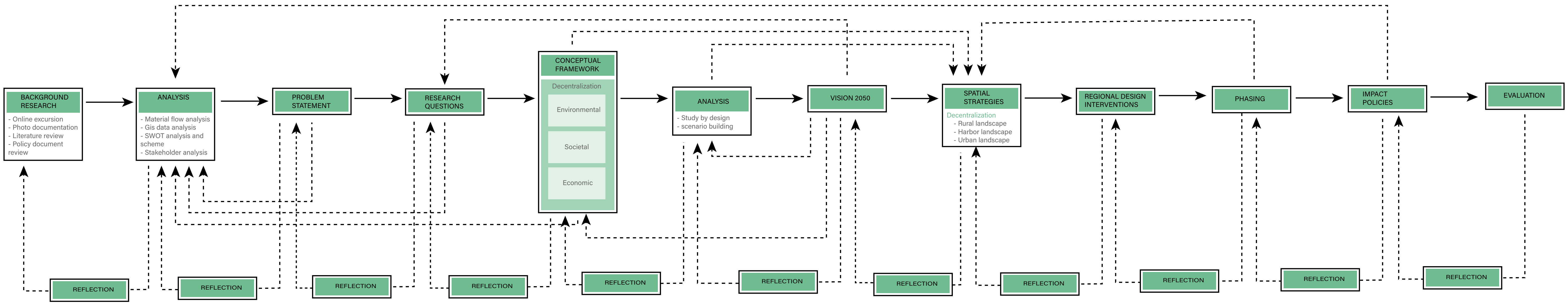


FIGURE 07

METHODS

As shown in figure 07 the project started with background research on the port of Rotterdam region. This research was to get familiarized with the subject of the bio-based chemical sector which was given by the province of South Holland. Different sources were used as illustrated in figure 07 to find background information about the region. To analyze the province of South Holland a material flow analysis and stakeholder analysis were performed. This background research and analysis of the region formed the basis to formulate the problem statement. Based on this problem statement the main research question and sub-research question were formulated. From this analysis, it was concluded that the current centralized energy system was not sustainable and that there is an urgent need to make a transition towards a resilient and sustainable energy system. To achieve this decentralized system, a social, environmental and economic transition needs to succeed. Therefore, these subjects form the core of the conceptual framework, which is based on the knowledge of previous experts in these different fields. The possible spatial implications of these transitions became the core of the in-depth analysis. Methods such as a study by design and scenario methods were performed, in order to finally formulate the vision. Next, four different strategies that convey the vision were formulated based on the different landscapes in the region of South Holland. For every landscape, different interventions will be proposed, a timeline was developed and policies were suggested. It must be noted that this was an iterative process. In every step of the process, the outcomes were reflected upon, and alterations in previous steps could be made, for the sake of coherence in the report.

03 What to escape?

introduction

This chapter aims at acquiring further understanding of relevant flows and mechanisms within the current energy system. The analysis of (spatial) data will help in developing a more informed and effective vision and strategy for the province. The subquestions "What are the current spatial qualities and inadequacies of the port and its hinterland?" and "What are the material and energy flows of the current fossil fuel industry, and what potential is there for renewable alternatives?" will be answered. By studying and mapping GIS data, performing a stakeholder analysis, studying existing literature, we gain more knowledge in potentials, limitations and other information that is needed to come up with evidence-based design solutions. We eventually summarize and conclude this chapter with an extensive SWOT analysis. In doing so, we create a starting point for possible strategies to explore.

THE PORT

Since the industrial revolution, the global energy system has undergone several structural changes. It is difficult to imagine that only a couple of generations ago, people had to gather biomass from nearby (wood or manure), store it and eventually burn it all themselves to get through winter (Smill, 2010).

Technological advancements made it possible to excavate increasing amounts of fossil fuels (depending on geo specific abundance). Coal, then gas and oil, could be transported in bulk to connect global producers with local consumers. Today, the province of South-Holland claims a prominent seat in worldwide fossil fuel distribution with the port of Rotterdam and its hinterland. The harbor has a market share of 42% in shipped bulk goods to Northwestern Europe (Port of Rotterdam, 2021).

With the era of fossil fuel coming to an end (as scarcity and environmental concerns rise), this chapter analyzes the impact of the current fossil energy system in the province, as well as the potential circular energy system for the future.

LAND USE AND INFRASTRUCTURE

The port of Rotterdam stretches 42 km from Maasvlakte to Charlois, and takes up about 20% of the total industrial land use in the province (Port of Rotterdam, 2021). As the harbor takes leave from fossil fuel to a more decentralized energy sector, this land could become available for alternative use. From a circular construction point of view, fossil fuel infrastructure and building typologies could be refurbished for new functions. In addition, this will keep the heritage and character of the port city in place.

	Hamburg	Bremer-haven	Wilhelms-haven	Amsterdam	**Rotterdam**	North Seaports	Antwerp	Zeebrugge	Dunkirk	Le Havre
Iron ore and scrap	11.8	3.9	0.0	17.2	50.0	7.8	1.9	0.0	13.2	0.2
Coal	7.3	0.8	2.3	19.3	22.4	7.0	2.9	0.0	5.0	0.0
Agribulk	6.2	0.6	0.0	7.9	9.8	5.2	0.8	0.2	2.0	0.0
Other dry bulk	3.4	1.8	0.6	3.0	12.2	14.5	8.5	1.1	2.9	1.0
Subtotal dry bulk	**28.6**	**7.1**	**2.9**	**47.3**	**94.5**	**34.6**	**13.9**	**1.3**	**23.2**	**1.2**
Crude oil	0.9	0.0	18.7	0.0	104.2	0.0	5.3	0.0	0.0	20.9
Mineral oil products	9.0	2.1	1.0	47.3	68.2	15.4	50.3	2.8	3.4	13.4
LNG	0.0	0.0	0.0	0.0	7.1	0.0	0.0	7.6	5.6	0.0
Other liquid bulk	2.8	0.0	0.5	2.7	31.7	4.7	16.5	0.4	0.4	1.8
Subtotal liquid bulk	**12.7**	**2.1**	**20.3**	**50.0**	**211.2**	**20.1**	**72.1**	**10.8**	**9.4**	**36.1**
Total bulk goods	**41.3**	**9.2**	**23.1**	**97.3**	**305.7**	**54.7**	**86.1**	**12.2**	**32.6**	**37.4**

FIGURE 08

BULK THROUGHPUT IN MILLION METRIC TONS BY COMMODITY IN THE HAMBURG – LE HAVRE RANGE

(PORT OF ROTTERDAM, 2021)

POTENTIALS

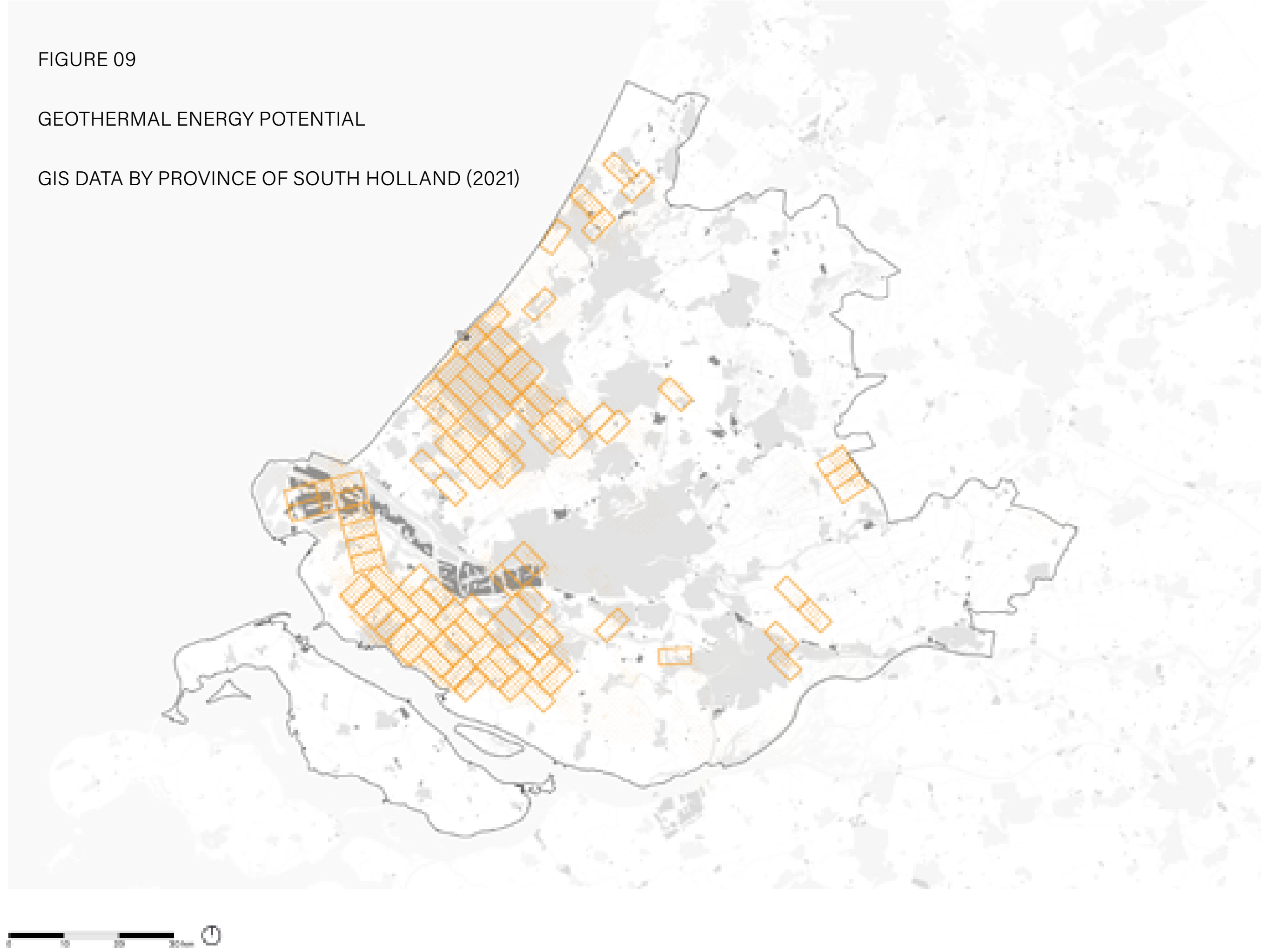


FIGURE 09

GEOTHERMAL ENERGY POTENTIAL

GIS DATA BY PROVINCE OF SOUTH HOLLAND (2021)

When leaving nuclear energy out of the equation due to its non-circular nature (nuclear waste takes thousands of years to decompose), and deeply ingrained societal concerns about safety, four contenders stay in the race to supply renewable energy for the province of 2050. Wind and solar farms generate around the same amount of electricity (5 MW) per km2. Replacing fossil fuels using these traditional methods will require vast quantities of land. Calculations indicate a surface requirement of over a 1000km2 (filling a quarter of the province). Because space is increasingly scarce in South-Holland, the spatial impact of large-scale implication is hard to justify. In the context of the smaller scale, integration in the landscape can be achieved by double ground usage. Solar panels can be placed on top of roofs, floating in water storage ponds for greenhouses, in between (offshore) windmills and motorways. Windmills can be built in biomass production forests (masking), but this will decrease their

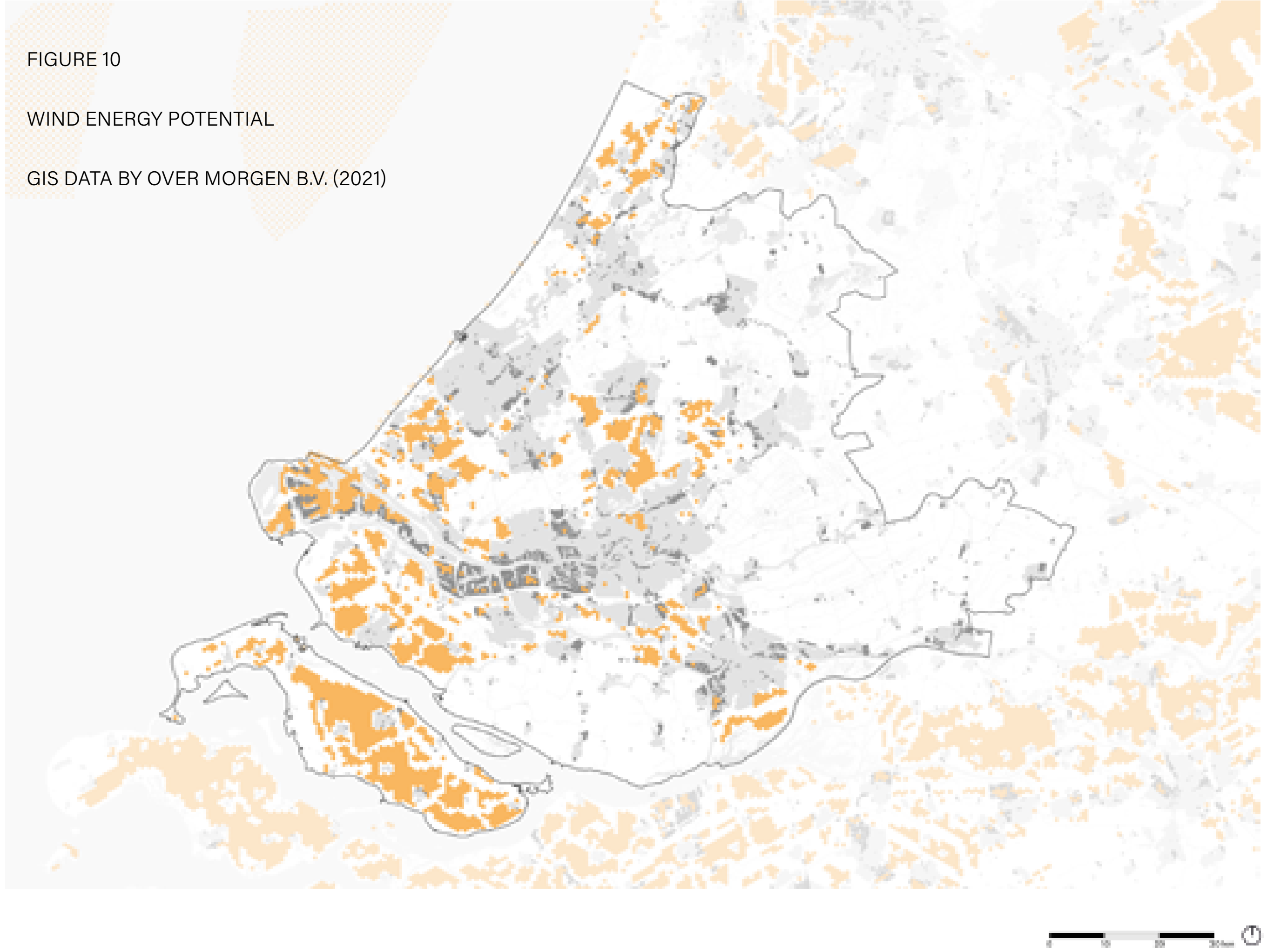


FIGURE 10

WIND ENERGY POTENTIAL

GIS DATA BY OVER MORGEN B.V. (2021)

efficiency. When growing biomass exclusively for energy production, the fast growing Miscanthus is most efficient, but still produces a marginal 0,70 MW per km2 (Clark, 2013).

The high geospecific potential, together with limited spatial impact, relative to the produced amount of energy, steered the project into focusing on geothermal and offshore wind energy. A single offshore windmill (220m in diameter) or geothermal doublet (takes up only 100m2 above ground, the size of a regular house) produces 10 MW annually (Platform Geothermie, 2018). This is the same amount of energy produced as two square kilometers filled with solar panels, or ten square kilometers of the most efficient biomass. The required spacing in between a doublet (1,5 to 3 km) or offshore windmill (1,1 km) limits the production potential in the province to a degree that the export of renewable energy (domestic or abroad) should not be considered as a goal.

NETWORKS

FIGURE 11

DISTRIBUTION OF HEAT

GIS DATA BY RVO (2020)

REGIONAL GAS DISTRIBTION

AREAS CONNECTED BY HEAT GRID

FIGURE 12

DISTRIBUTION OF ELECTRICITY

GIS DATA BY RVO (2020)

150 kV NETWORK

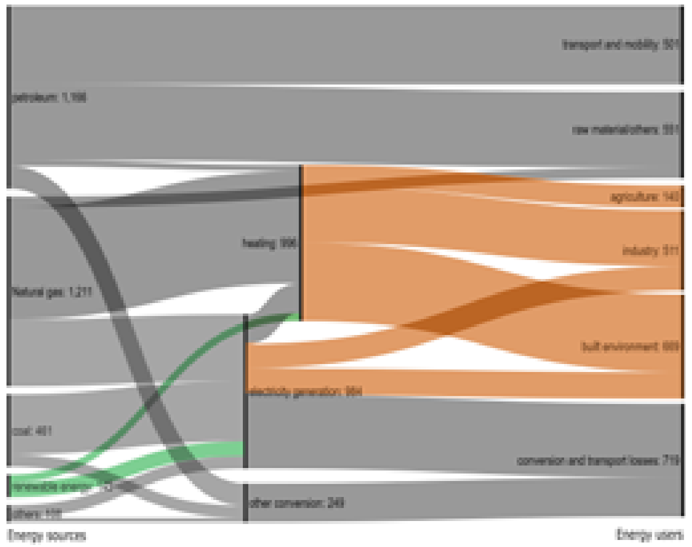
380 kV NETWORK

SPATIAL MATRIX

Based on: PBL (2017), Ros & Schure (2016), RVO (2018), Sijmons (2014)

		SPATIAL FOOTPRINT	INFRASTRUCTURE	DRAWBACKS	BENEFITS	PRODUCTION CAPACITY
ENEGRY SOURCE	GEOTHERMAL heat + electricity	Direct spatial footprint is one hectare Indirect spatial footprint is 450 hectares	Heat grid is required for distribution Underground infrastructure at 2-4 kilometers depth is required	Doublet service life of 30 years, regeneration time dependent on intensity of use Feasability of location unsure until after expensive exploration Potential is not equally distributed geographically Seismic risks unexplored	Limited spatial impact No pollution or excessive noise levels Consistent energy supply, low dependency on externalities High market potential HT and LT extraction is possible	Projected capacity nationwide is 85-1000 PJ/year Capacity individual sources dependent on location and extraction depth
	WIND electricity	Buffer zones dependent on size of windmill	High voltage energy networks are required for distribution	Limited support in society Impact on wildlife Generation of low frequency noise Strict regulations	Off-shore production possible No pollution High market potential	1 - 15 MW per unit, dependent on size
	BIOMASS/GAS heat + electricity	No direct spatial impact for production Storage space for biomass products is required Bio-digester required for processing	Existing infrastructure can be reused	Energy production with biomass is a low tier solution Emissions of fine dust	Limited spatial impact Limited additional investments	0,2 TJ/year per hectare of agricultural land
	SOLAR electricity	Large space required for PV-parks Solutions feasible on leftover space	High voltage energy networks are required for distribution	Low energy efficiency Resource consuming technology	Scalable technology, usable for collective and individual production	1 MW per hectare
ENERGY CARRIER/BUFFER	HYDROGEN	Storage space for hydrogen dependent on required capacity Space for hydrogen plant is required	Existing infrastructure can be partly reused	Only suitable as fuel or industrial purposes, not for households	Limited spatial impact High flexibility and little conversion loss	
	WATER RESERVOIR	Large space required, dependent on capacity	New land masses required	High projected costs	Integration with nature and other electricity production sources possible	
	BIO LNG	Installations for processing, cooling and heating required	Transportation by ship	Low energy density compared to fossil fuel liquids Suitable as transportation fuel only	Bio-gas compatibility Suitable for long distance transportation	

PROJECTION



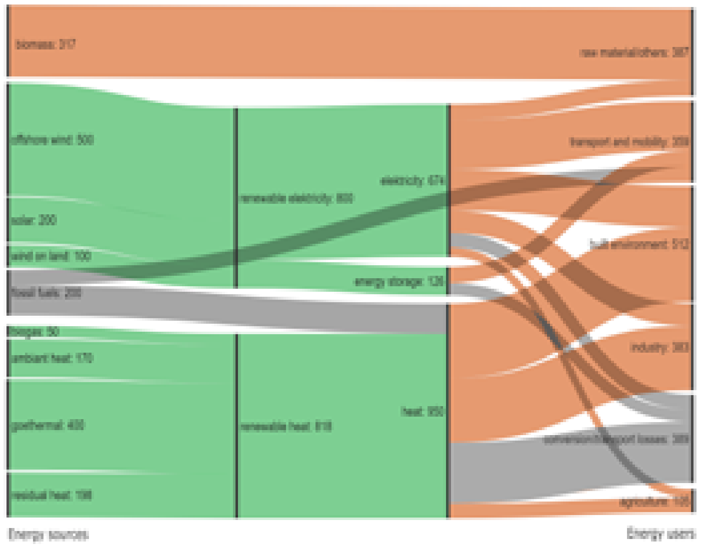


FIGURE 13

CURRENT NATIONAL ENERGY FLOWS

EDITED FROM SIJMONS (2015)

FIGURE 14

PROJECTED NATIONAL ENERGY FLOWS IN 2050

EDITED FROM SIJMONS (2015)

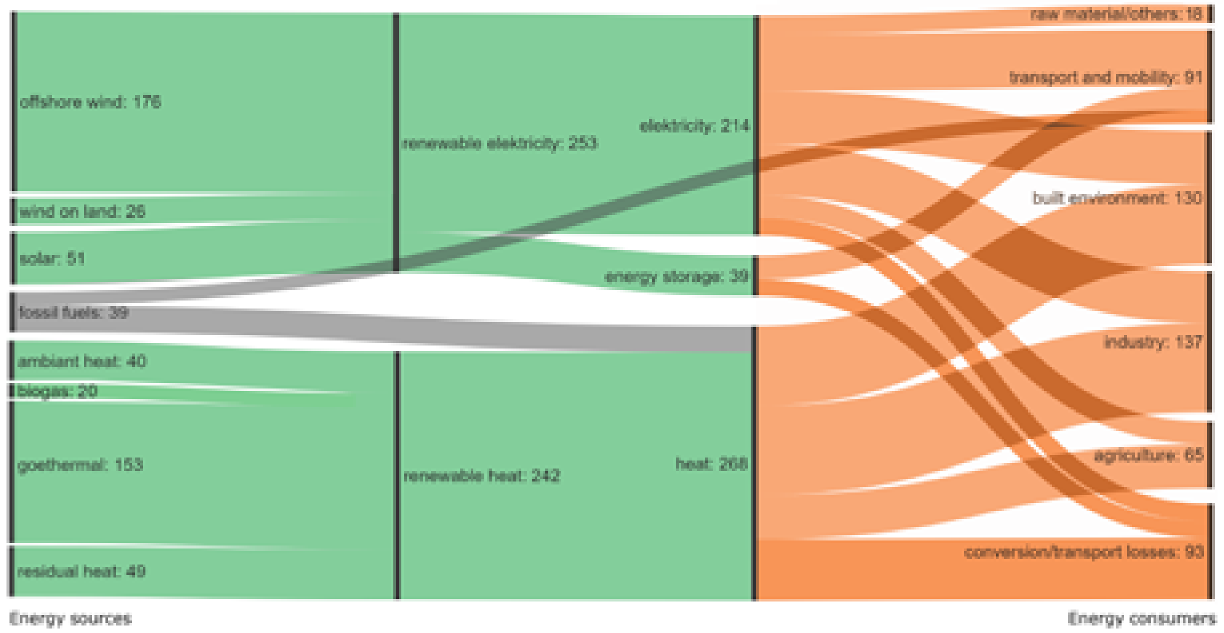


FIGURE 15

PROJECTED PROVINCIAL ENERGY FLOWS IN 2050

EDITED FROM SIJMONS (2015)

In the current system, the distance that is the width of inland waterways is the only barrier against pollution for nearby residents. Since producing and consuming renewable energy does not emit harmful or stinking gasses, a decentralized energy system, where the port and the urban landscape are interwoven with each other could become feasible.

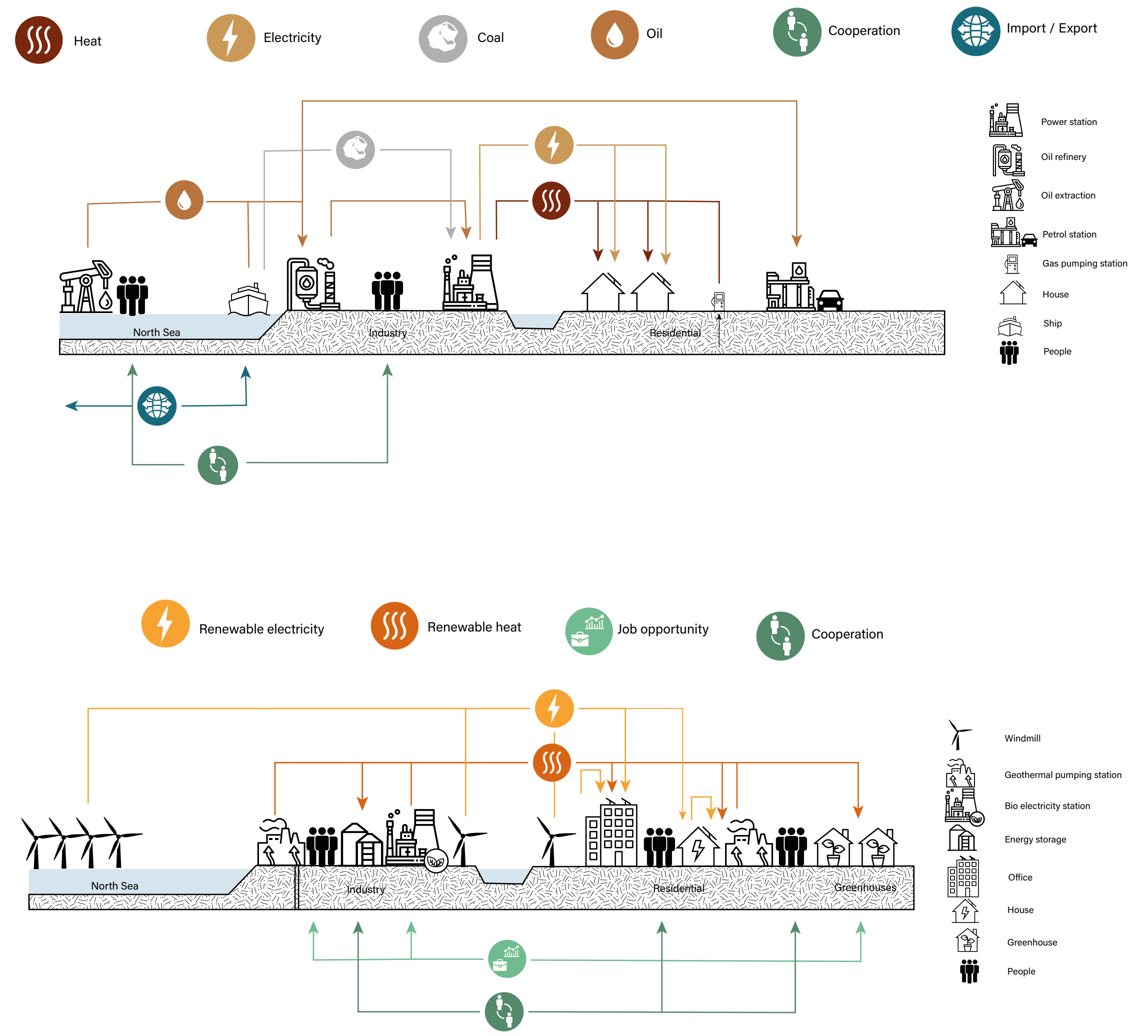


FIGURE 16

PORT SCENARIO - FROM OIL TO RENEWABLE ENERGY

The potential of collecting organic material for processing in the bio-based industries is not evenly distributed across The Netherlands. The main potentials in current waste flows for the production of biomass and biogas are perceived by RVO (2020) to be in logging, pruning waste, organic household waste, crop farming and liquid manure. In order to explore these potentials and locate sources, the residual flows in The Netherlands are mapped. Through this analysis, it becomes evident that the largest potentials are perceived in the rural provinces due to the relatively large presence of natural landscapes and agricultural activity in comparison to the Randstad area.

The potential for biomass collection from residual wood is found in areas with large forest areas. They are mainly found in the provinces of Drenthe, Gelderland and Noord-Brabant.

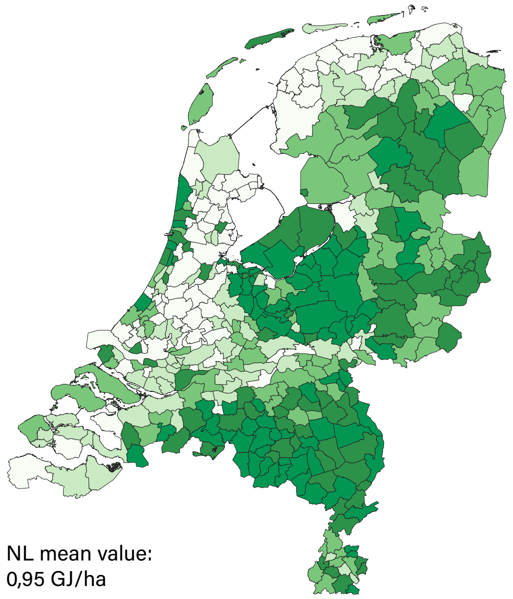


FIGURE 17

LOGGING

0 6,0 GJ/ha

Woody biomass can also be extracted through the collection of pruning waste. Urban areas seem to produce the most of this type of organic waste.

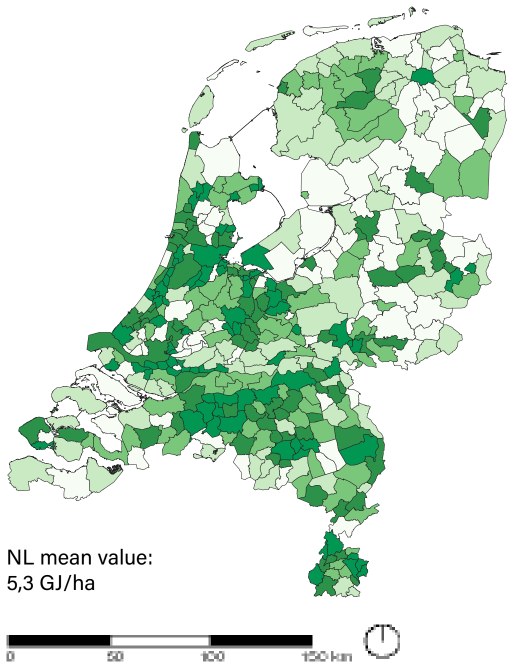
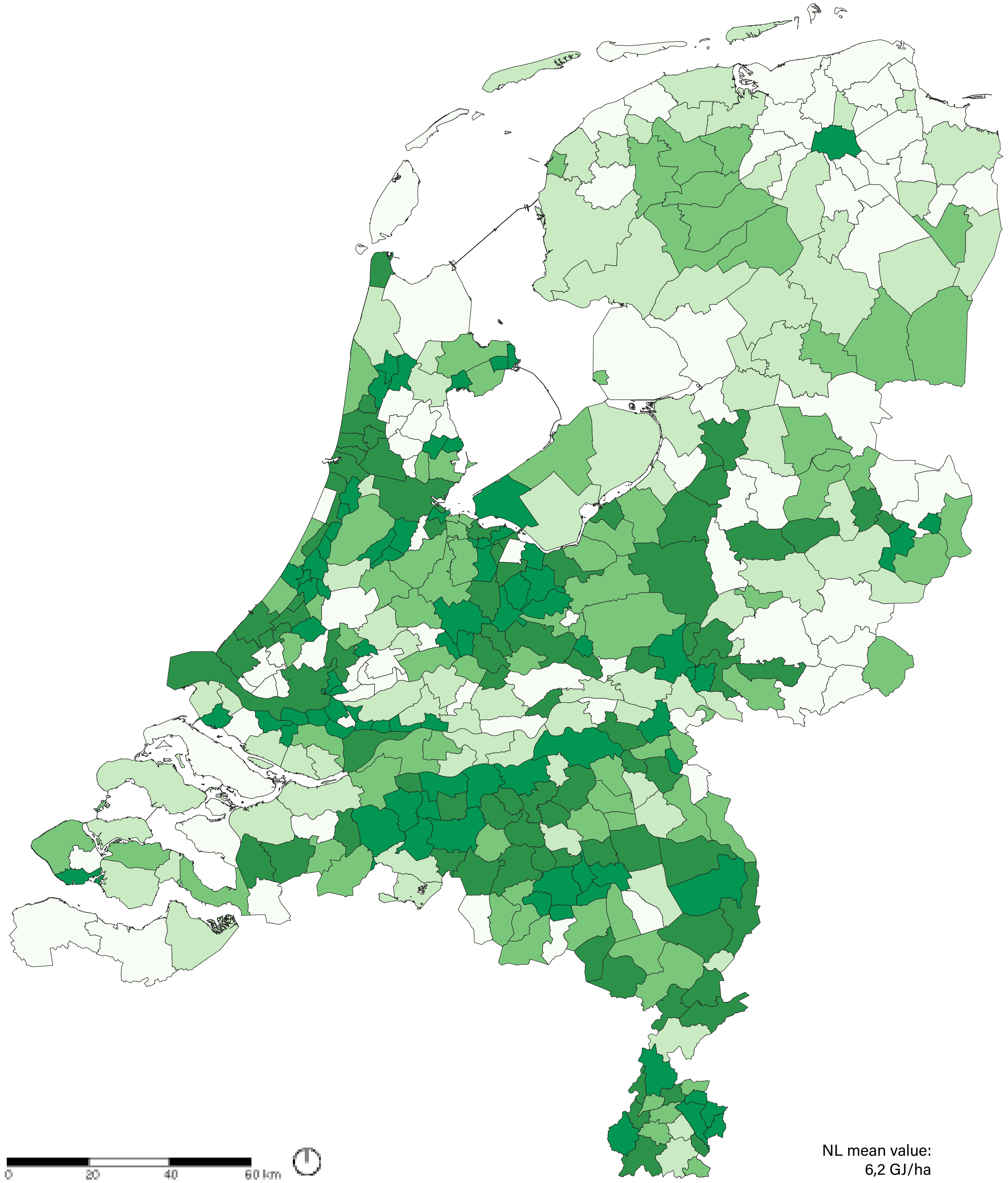


FIGURE 18

PRUNING WASTE

0 10 GJ/ha



GIS DATA BY RVO (2020)

FIGURE 19

TOTAL POTENTIAL (ACCUMULATED)

0 30 GJ/ha

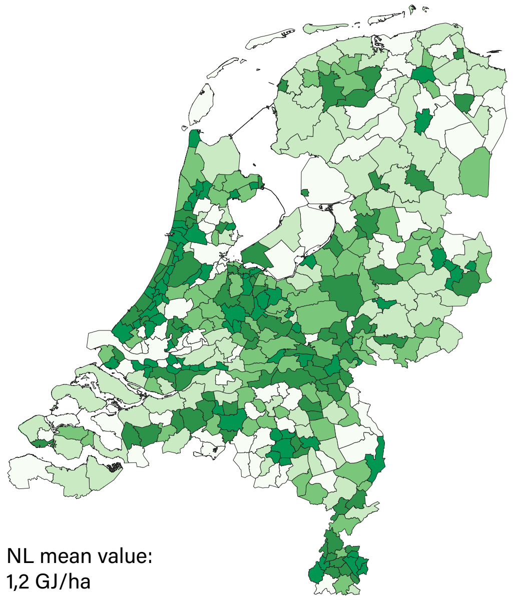
BIOGAS

The potential for biogas production from organic household waste is mainly concentrated in urban areas. The total energy production from this source is however marginal compared to the other sources.

FIGURE 20

ORGANIC HOUSEHOLD WASTE

0 8,0 GJ/ha



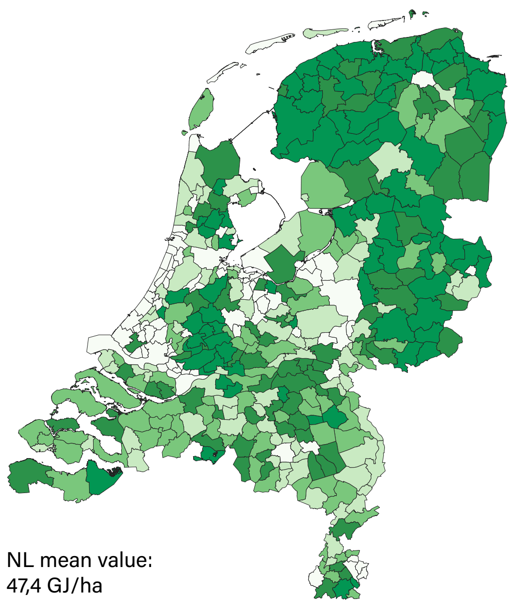
NL mean value:
1,2 GJ/ha

The potential for biogas production from organic waste from crop farms is mainly prevalent in the agricultural regions: the *Groene Hart* region, as well as the eastern and northern provinces.

FIGURE 21

CROP FARMING

0 100 GJ/ha



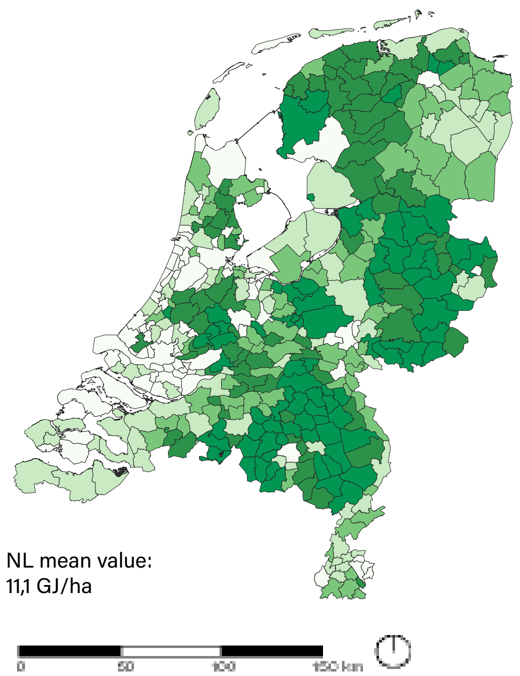
NL mean value:
47,4 GJ/ha

The potential for biogas production from liquid manure is also generated in rural areas with a high number of cattle farms. These areas are mostly outside the province of South Holland.

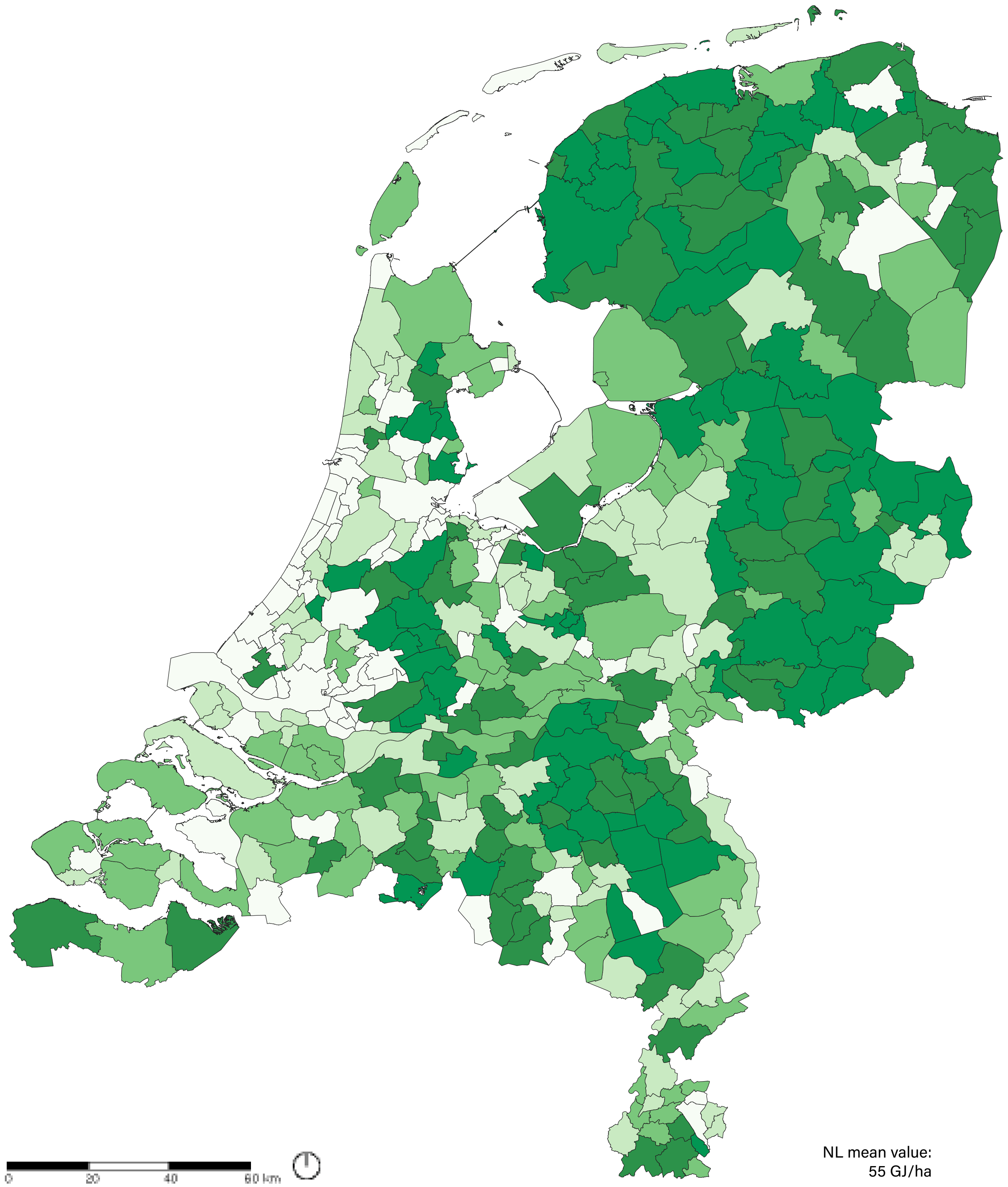
FIGURE 22

LIQUID MANURE

0 70 GJ/ha



NL mean value:
11,1 GJ/ha



NL mean value:
55 GJ/ha

GIS DATA BY RVO (2020)

FIGURE 23

TOTAL POTENTIAL (ACCUMULATED)

0 155 GJ/ha

PROJECTION

The combined biomass waste potential within South-Holland, as depicted in the previous maps, adds up to 20 PJ, around 10% of the province's heat demand. The limited regional availability, in combination with CO_2 and fine dust emissions caused by burning biomass means it cannot be considered an ultimate solution in the transition to a circular energy supply. The portion of heat it can supply should provide heat for vulnerable buildings or heritage sites, as biogas is able to be distributed through existing natural gas pipelines.

Additionally, the strategic location of the port of Rotterdam and its high level of infrastructure makes it feasible to collect biomass nationally and manufacturing it for the applications listed below. The Sankey diagram depicts the minimal availability (avoid using production flows) and minimal consumption (avoid burning it) of biomass on the national scale in 2050.

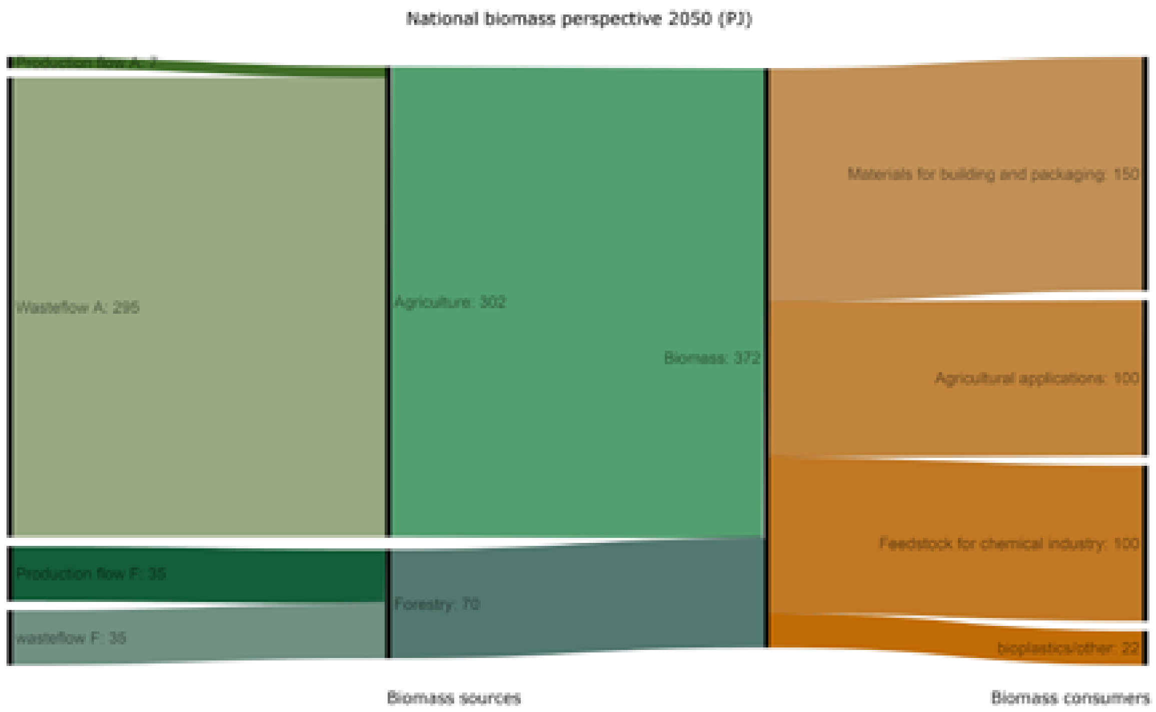


FIGURE 24

NATIONAL BIOMASS PERSPECTIVE 2050 (PJ).

DATA ADAPTED FROM (CE DELFT, 2020)

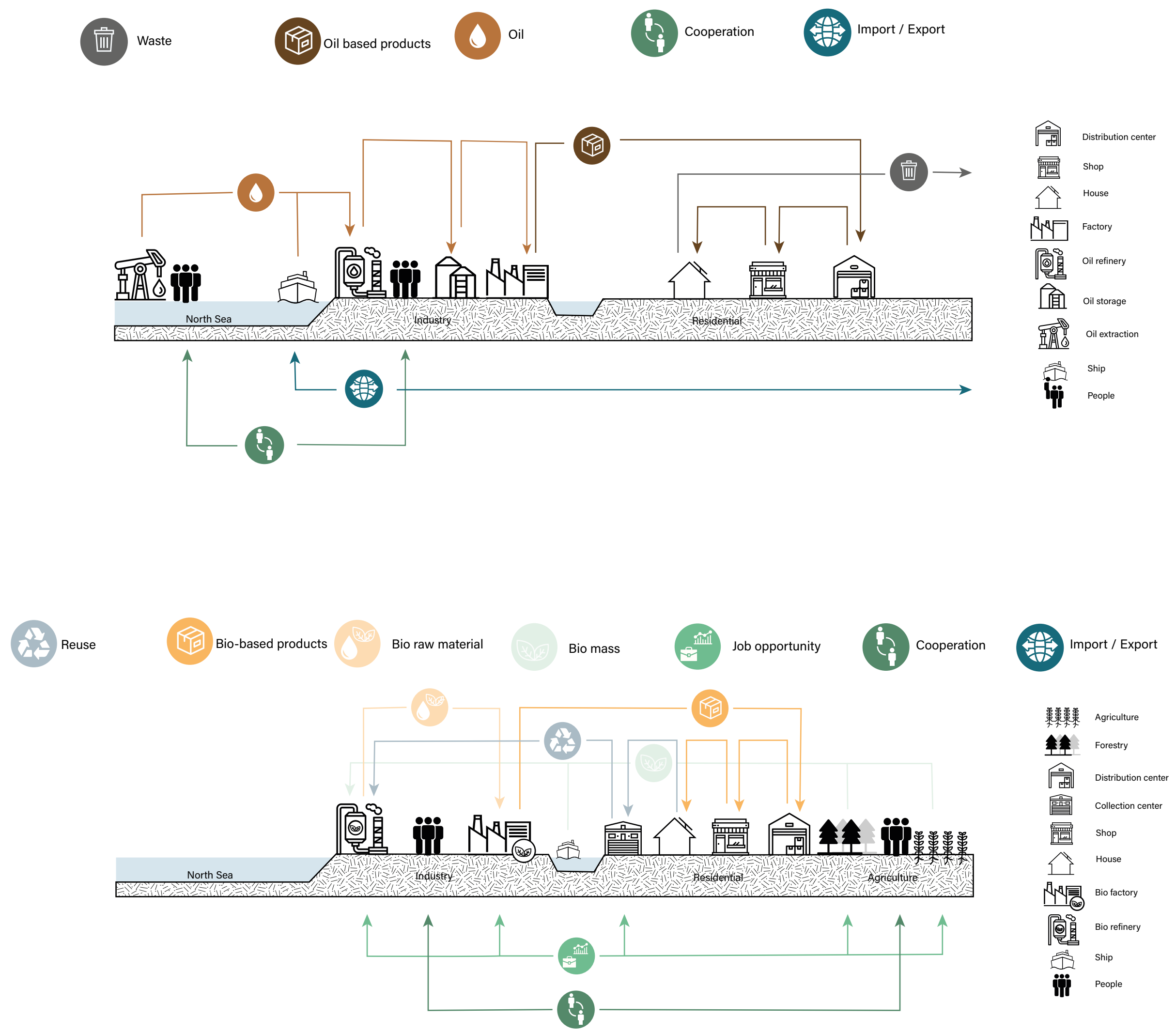


FIGURE 25

PORT SCENARIO - FROM OIL TO BIOMASS

AIR POLLUTION

The use of fossil fuels contributes greatly to the emission of pollutants that in some cases may cause serious health risks to the exposed population. The severity of this risk differs per specific type of particle, but exposure to more types of pollution simultaneously may have synergetistic adverse effects (Curtis et al., 2006). This analysis assesses the ambient dispersion of pollutants in the port region.

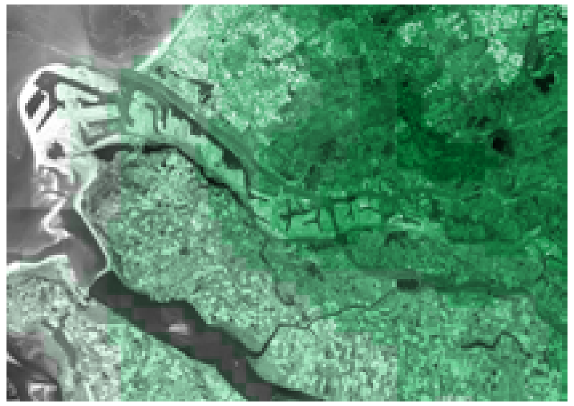
Carbon monoxide emissions and soot are mainly emitted by combustion engines as a result of burning fossil fuels. These types of pollutants are therefore found in urbanized areas and around coal-fired power plants. The Riverstone plant located in the Maasvlakte is likely to be the source of the locally perceived soot emissions. The plant is closed as of the year 2020. Fine dust, classified in particle sizes < 10 micrometers and < 2,5 micrometers, is emitted through motorized vehicles, biomass burning and industries. Fine dust is therefore commonly discerned in the port area. Emissions of particles spike in the Maasvlakte (Riverstone, power plant), Europoort (BP, oil refinery) and Botlek (Aluchemie, aluminum production and AVR, waste incinerator). PM2,5 is especially dangerous, since the size of such particles is small enough to infiltrate the lungs and cause damage to the organs. Curtis et al. (2006) therefore link fine dust to increased risk of lung diseases, cardiovascular diseases and cancer.

Benzene is found to have similar risks, but may also even cause schizophrenia, according to the same study. This type of pollutant is prevalent in the Botlek area and can be linked to the chemical industries mainly. SO_2 gas can be discerned through its unique and unpleasant aroma and can cause an irritating effect on the sensory organs. It is also actively emitted in the port area by vessels and oil refineries. NO_2 can also be linked to Industrial and vehicle combustion. The dispersion of this pollutant in the Rijnmond area is therefore similar to CO and soot dispersion. Also in agricultural uses nitrous oxides are emitted, often due to oxidation of nitrogen fertilizers (Curtis et al., 2006). Ammonia is more exclusively discerned in agricultural areas. Both the Midden-Delfland area and the island of Voorne-Putten have higher agricultural land uses. Ammonia is mainly emitted by cattle farms. The port therefore does not seem to be significantly contributing to these emissions.

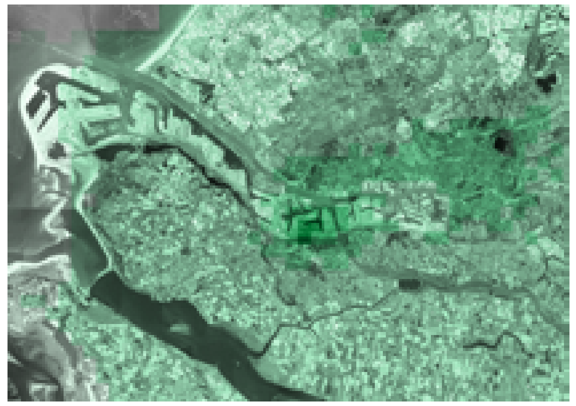
FIGURE 26

AIR POLLUTANTS AROUND THE PORT

GIS DATA BY RIVM (2019)

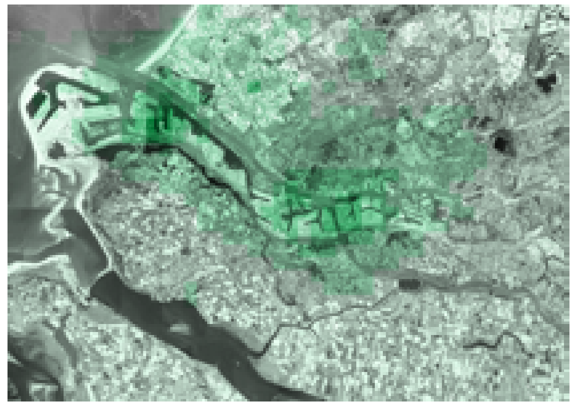


Carbon monoxide (COP98) concentration



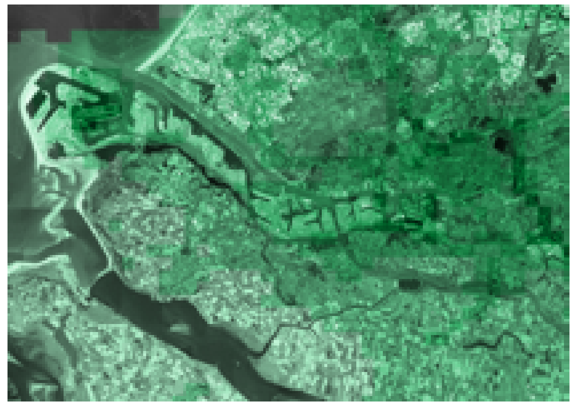
Benzene (C_6H_6) concentration

Soot (elementary carbon) concentration

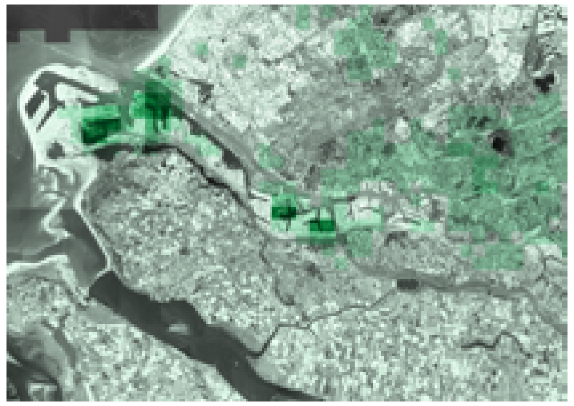


Sulfur dioxide (SO_2) concentration

Fine dust (PM2,5) concentration



Nitrous oxide (NO_2) concentration



Fine dust (PM10) concentration

Ammonia (NH_3) concentration

SOIL POLLUTION

Because the port was developed from east to west, along the Nieuwe Waterweg, the most polluted soil can be found at the old industrial cluster of Pernis (east, adjacent to the city). Rather than keeping contaminated soil vacant or refurbishing industry, healthy use of this area requires an intensive clean-up. Conclusions about to what extent the chemicals in the ground (leftover by the petrochemical industry) can be purged, together with how long this process will take (for phasing) requires specialist knowledge and data, outside the scope of this project.

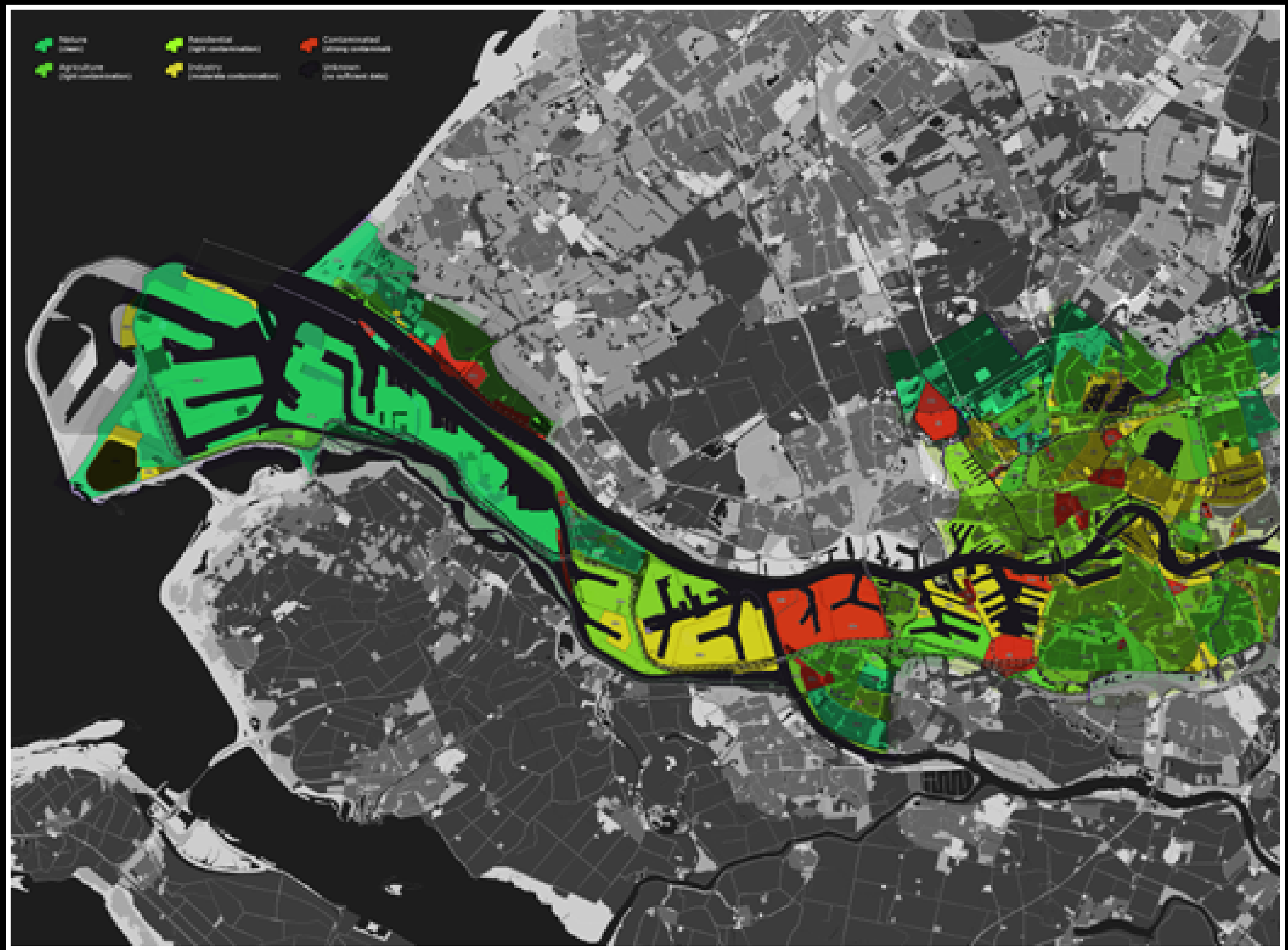


FIGURE 27

SOIL QUALITY (UP TO 2M DEPTH) MAP OF ROTTERDAM

(STADSONTWIKKELING GEMEENTE ROTTERDAM, 2011).

NOISE DISPERSION

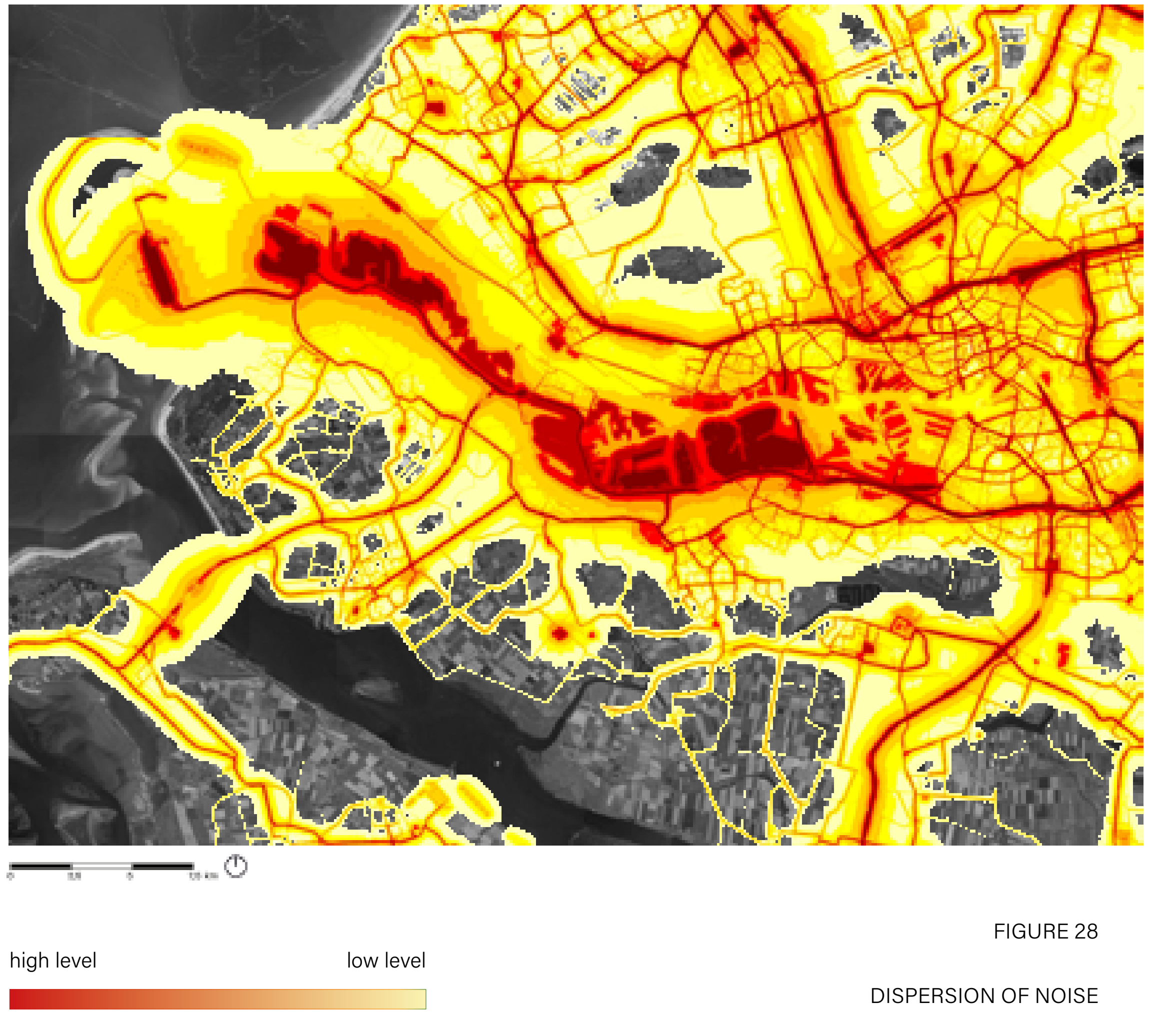


FIGURE 28

DISPERSION OF NOISE

GIS DATA BY RIVM (2019)

Systematic exposure to noise is strongly linked to causing adverse effects to human health. As found by the WHO (2018), noise from traffic, industries and neighbours may result in cardiovascular diseases, loss of sleep, cognitive impairments, tinnitus and other hearing impairments. Problematic areas are therefore located around highways, airports, railways and industrial sites. The port area, as shown in the figure above, is highly responsible for noise production. Especially in areas with large activity from the petrochemical industries, the problem seems to be most intense. Although distance and sound barriers may alleviate the intensity of the noise to which the surrounding populated areas are exposed, it can still be observed that relatively high values are being measured.

LIVABILITY INDEX

highly inadequate outstanding

FIGURE 29

LIVABILITY SCORE

GIS DATA BY MINISTERIE VAN BINNENLANDSE ZAKEN EN KONINKRIJKSRELATIES (2020)

SPATIAL JUSTICE

True spatial justice is difficult to achieve in the entire province of South-Holland, but moving away from fossil fuels will certainly help.

The economy of the province and the lifestyles of its inhabitants benefit from fossil industry in the port. However, direct environmental burdens are exclusively carried by people living in close proximity. A decentralized, circular industry, promises to spread burdens and benefits more evenly across landscapes. Energy producers would not be as polluting and less isolated from consumers.

In accordance with 'the polluter pays' principle, petrochemical firms that inevitably contaminated the soil (profiting from it) in the Rotterdam harbor should be obliged to pay for clean-up costs. Whether such policies can be implemented needs additional expertise.

When it comes to ecology, putting wind turbine farms on sea can be perceived as moving the burden onto the shoulders of marine life (animals have no say). In the construction phase, wildlife will undoubtedly be affected. However, algae growing at the base of the windmill can improve local biodiversity and healthy populations in the short term. Further ahead, the decreased use of fossil fuels will slow down the rising (water) temperature and the amount of microplastics in the oceans.

"True spatial justice is difficult to achieve in the entire province of South-Holland, but moving away from fossil fuels will certainly help."

FIGURE 30

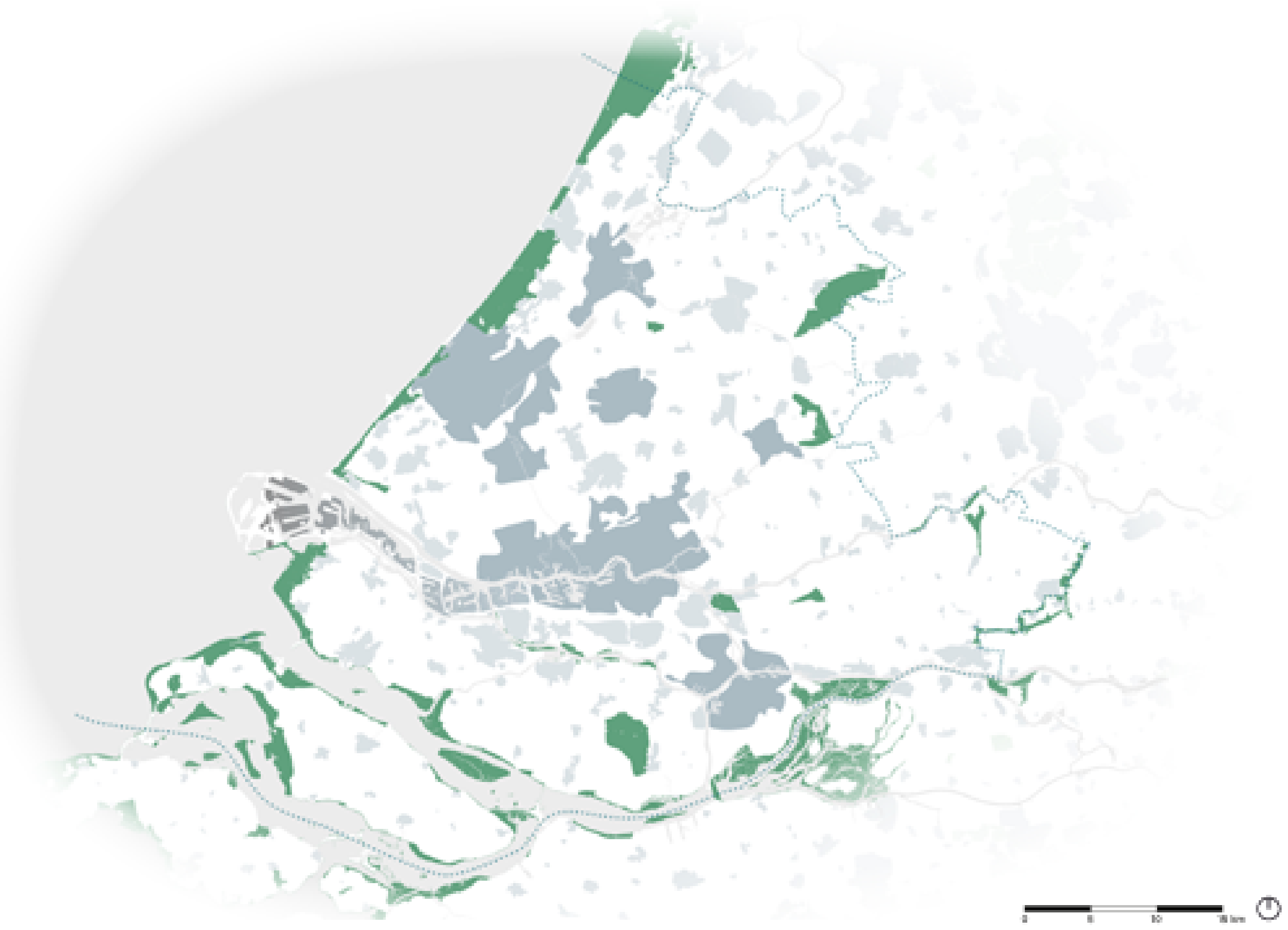
SPATIAL JUSTICE PHOTOMONTAGE

ECOLOGY

The majority of distinguished Natura2000 zones can be found along the North Sea coast. For these areas, stricter environmental rules apply. While nitrogen and carbon dioxide are considered essential nutrients for a plant, high concentrations will reduce biodiversity as fast-growing vegetation (such as grass) will take over the land. Similarly, shepherds are not allowed to let their sheep fertilize the ground on the Veluwe moorland. By taking away the pollution of chemicals caused by the petrochemical industry, ecological balances are no longer destabilized. By looking at the map, opportunities can be found too: the current port is an artificial boundary between dunes in the south and north. Is it possible to make an ecological network linking not only nature with nature, but also nature with industry and villages (before surrounded with a petroleumscape)?

FIGURE 31

NATURA 2000 AREAS SOUTH HOLLAND



INVENTARISATION

Governance	Port related companies	Energy and utility companies	Agriculture companies	Other stakeholders
Central government - Ensure the position of the ports. - A safe, accessible and liveable Netherlands	**Port of Rotterdam** - To be a frontrunner in sustainable and efficient supply chains - Increasing societal value	**Shell** - Be a distributor for solar and wind energy production. - Focus on producing bio-fuels, hydrogen and geothermal energy.	**Biomass producers** - Converting a knowledge into concrete plans. - Increase use of biobased energy, chemicals and materials	**Knowledge centres** - Making a transition to a sustainable future through innovation
Europian Union - Strengthen the port's competitiveness	**Espo** - Creating a safe, efficient and environmentally sustainable European port sector	**BP** - Creating a low carbon electricity and energy industry - Net zero, people, planet	**Farmers** - Produce high quality agricultural resource and food production	**Local residents** - Living in an affordable and liveable area
Province of South Holland - Makeing the transition to a biobased economy - Strengthening organizational capacity	**Deltalinqs** - Connection companies in the Port of Rotterdam - Use hydrogen as accelerator for energy transition	**Vopak** - Be the link between supply and demand - Retain a leading position in the port and to expand its global network		**Employees** - Having job opportunities with a long term perspective
Municipality of Rotterdam - Creating economic and social values - Realizing sustainable growth	**Port's chemical and manufacturing industry** - Create biobased chemical and manufacturing industry	**Electricity suppliers** - Investing in solar and wind farms. - Being fossil free		**Flora and fauna** - Reduction in greenhouse gases and further pollution. - Expanding nature and habitat for animal species.
Municipalities Region - Increase the quality of life - Lowering the pressure of the region		**Gas and electricity network operators** - Keep distributing gas and electricity - Retain strong market position		**Nature and environmental organizations** - Create a fair and climate friendly society for the next generations to live in
Regionale energie strategie (RES) - Reducing the CO2 - Creating a sustainable region		**Gas, power and coal companies** - Reducing emissions - Investing in wind and solar energy and energy storage		
		Export/import suppliers - Ship goods at low rates - Creating a chain that is automated and optimized		
		Gasunie - Investing in green gas and hydrogen - Construction and management of a network for heat and CO2.		

FIGURE 32

CURRENT STAKEHOLDERS

The stakeholders are divided into five categories: governance, port related companies, energy and utility companies, agriculture companies and other stakeholders. Each category consists of stakeholders with their own interests and goals.

GOVERNANCE

Most government functions are located in The Hague and look at the bigger picture than just the region. For this reason, these stakeholders focus on maintaining the strong position of the Port of Rotterdam in a sustainable way (Ministerie van Infrastructuur en Waterstaat, 2020)

What was striking from the analysis is that many municipalities in the province of South Holland do not have a clear vision of the region and the port, but mainly focus only on the municipality (Gemeente Leiden, 2019).

PORT RELATED COMPANIES

This category includes stakeholders with an important function in the port, such as the port or Rotterdam itself or the umbrella port authority. These stakeholders see the need to become more sustainable in the future and to use this to strengthen the position of the port (ESPO, 2020).

ENERGY AND UTILITY COMPANIES

This category includes the major stakeholders present in the port of Rotterdam, such as BP and Shell. If fossil fuels are no longer used in the future, these companies will have to transform themselves. The analysis showed that these stakeholders are also willing to transform and focus on renewable energy sources (Shell, n.d.). The other stakeholders in this category also want to transform towards a more sustainable future. It is also important for these stakeholders to maintain the leading position during this transition as the demand for renewable energy continues to rise (Weijer, 2021).

AGRICULTURE COMPANIES

In the future, more biomass will be produced, making agriculture an important sector in the production of plastics, materials and energy. For many farmers, the priority will still be the production of

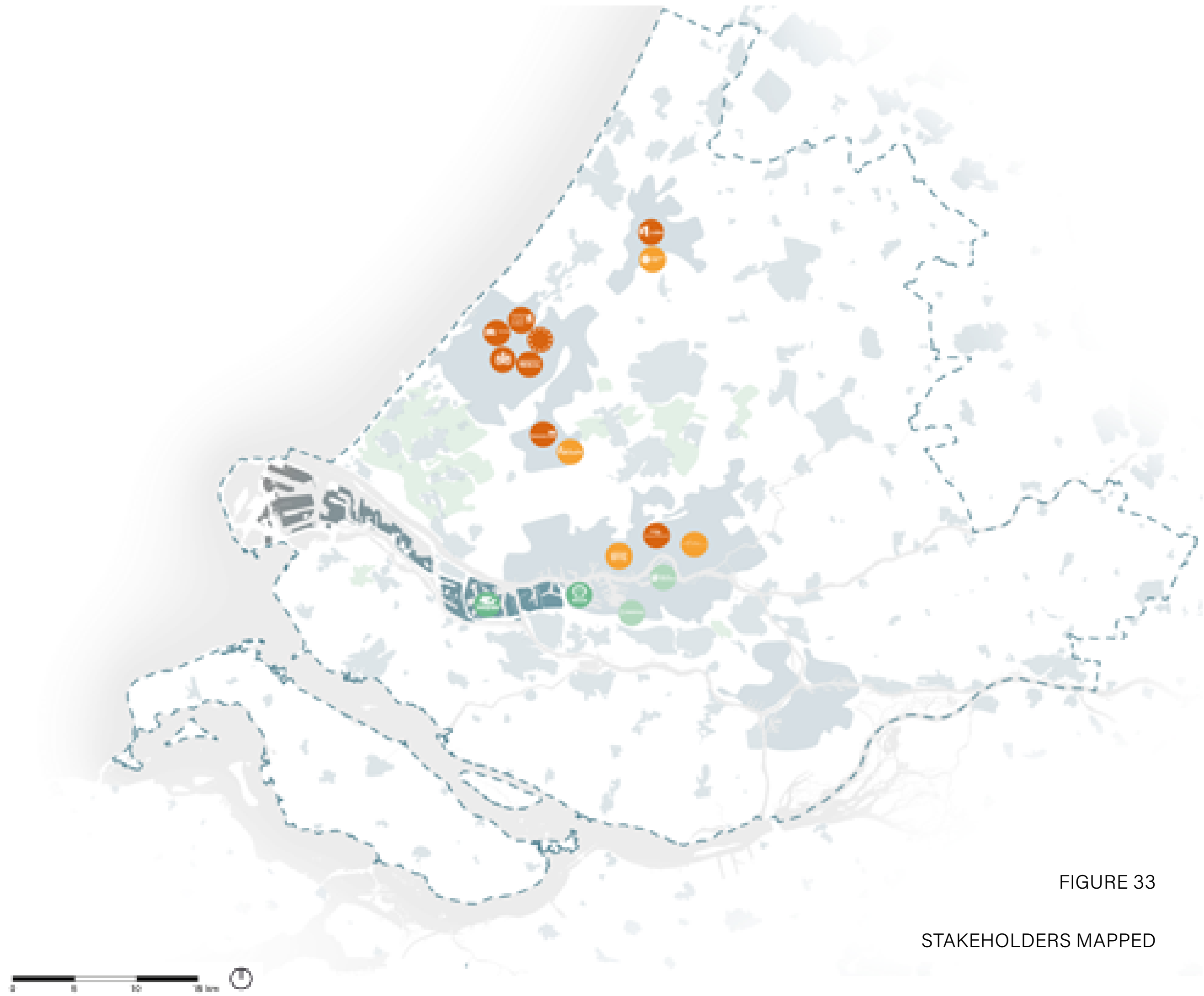


FIGURE 33

STAKEHOLDERS MAPPED

food and agricultural products, this is likely to be the case as the development of biomass production is still relatively new (Platform Groene Grondstoffen, 2010).

OTHER STAKEHOLDERS

This category currently consists of stakeholders who have little to say during the current developments within the region. Nevertheless, these stakeholders have an important voice that must be followed up. For this reason, it is important to include spatial justice in the vision and strategy.

What distinguishes this category from the other categories is that these stakeholders have very different interests. The economic position of the port is not important to these stakeholders. But creating a safe and healthy living environment with a reduction of greenhouse gases (Milieudefensie, n.d.).

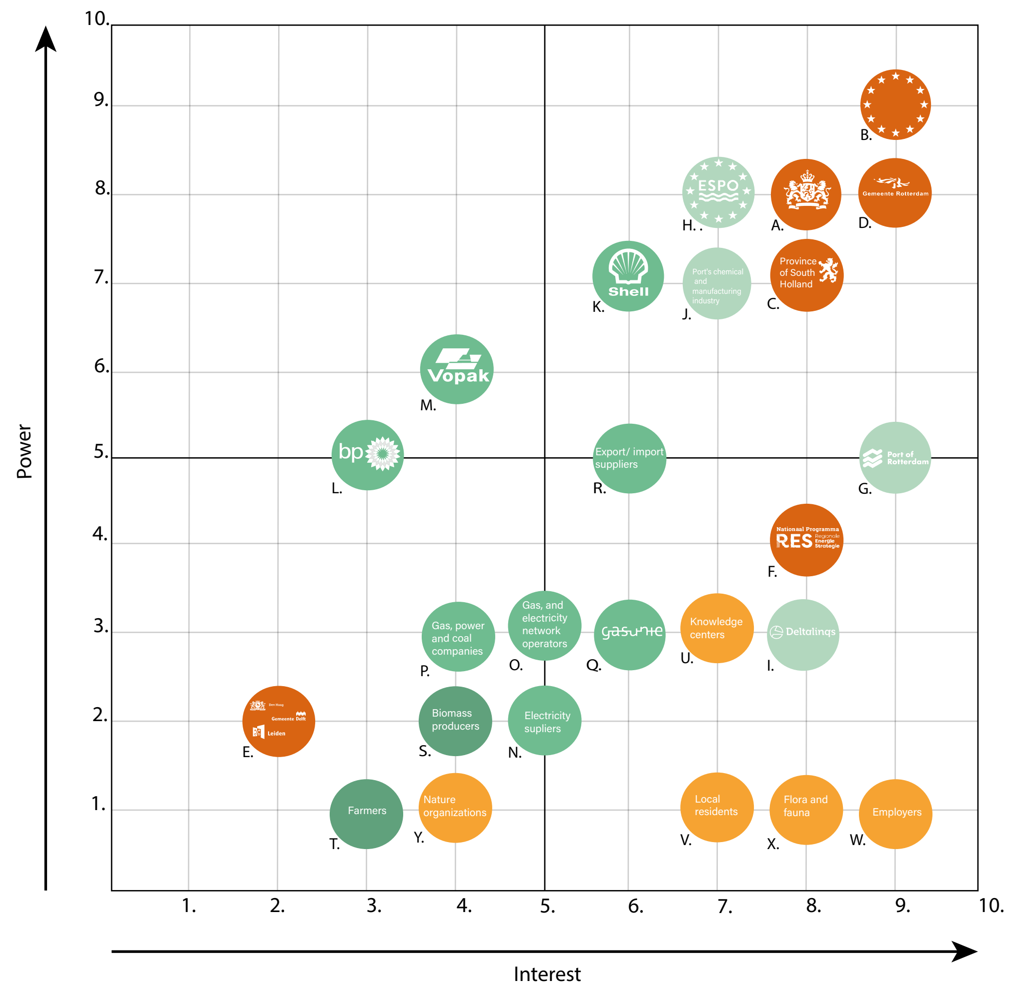
PROJECTION

Every stakeholder agrees that in the future it will no longer be possible to use fossil fuels as this is harmful to the environment. If we continue in this way, it will have an effect on the living environment for many stakeholders.

It is also important for many stakeholders to maintain the economic position of the port of Rotterdam, as this has a major economic effect on the economy of the Netherlands.

The stakeholders are also placed in the matrix to see which stakeholders have the most interest and power. The matrix shows that the governmental stakeholders have been given the highest position, as the stakeholder has the greatest effect in the region and the port.

In the current situation, there is a fairly large boundary between the governance stakeholders and the other stakeholders. This will have to be less in the future, as several stakeholders will have equal powers. In this way, stakeholders whose voices are not heard will gain more power and inequality will gradually decrease.



Stakeholders

A. Central government
B. Europian Union
C. Province of South Holland
D. Municipality of Rotterdam
E. Municipalities region
F. RES

G. Port of Rotterdam
H. Espo
I. Deltalinqs
J. Port's chemical and manufacturing industry

K. Shell
L. BP
M. Vopak
N. Electricity suppliers
O. Gas and Electricity network operators
P. Gas, power and coal companies
Q. Gasunie
R. Export/import suppliers

S. Biomass producers
T. Farmers

U. Knowledge centers
V. Local residents
W. Employees
X. Flora and fauna
Y. Nature and environmental organizations

FIGURE 34

PROJECTED STAKEHOLDERS 2050

SWOT ANALYSIS

The SWOT analysis summarizes the conclusions from the analysis and converges the key points into strategies that may be included in the vision. The perceived opportunities and threats are explored by imposing them on the discerned strengths and weaknesses of the port region. The conclusions and possible strategies are displayed in the presented matrix. As a result of doing this analysis, we are more aware of the technical and spatial considerations that we need to be aware of in our design strategy. The results of our analysis may turn out to be a helpful instrument to come up with a well-informed strategy. The various topics that we explored are expected to be important themes in our vision and strategy.

OPPORTUNITIES

- Shift of economic centre of gravity to China and other emerging marktes
- Transition from linear to circular economy
- Growth of technology sector and emergence of artificial intelligence
- Growth of potential of biomass processing
- Transition of energy provision towards renewable sources
- Market shifts due to Brexit
- Growing interest in off-shore developments

THREATS

- Conflicting interests and policies of different stakeholders
- Loss of jobs due to automation and AI, making human labour obsolete.
- Decentralisation, globalisation of economies
- Disconnection of industrial identity with urban culture of Rotterdam
- Climate change impacts
- Shift of economic centre of gravity to China and other emerging markets
- Collapse of demand for oil and petrochemical products
- Tightening of environmental regulations

STRENGTHS

- Presence of infrastructure for transportation and logistics
- Strong identity of the port and its role in the urban culture of Rotterdam
- Stable position of The Netherlands in terms of economy and politics
- Proximity of the Westland area as greenport
- Presence of high capacity energy distribution networks
- The global and local integration due to its proximity to the sea and European rivers
- Presence of relevant knowledge/educational institutes
- Proximity of production sites in the harbour and other areas within the province

MAKE USE OF OPPORTUNITIES THROUGH STRENGTHS

- Improving coordination of flows between industries and efficiency of resource consumption using the potential upcoming technologies
- Using ability to adapt to the circular economy with the help of economic strength, presence of existing infrastructures and integration with knowledge institutes
- Becoming a global pioneer by setting ambitious goals and innovative clout of the port and strong role of the port authority
- Using and adapting existing energy distribution networks and production sites to foster the transition to renewable energy use
- Use proximity to UK to take over roles of British harbours and by becoming the main node of trading routes between UK and EU

PREVENT THREATS THROUGH STRENGTHS

- Contain unemployment rates by exploiting educational institutes to reskill workers
- Align the focus of the port to regional markets and resources to become more flexible to the adapting market ranges
- Using economic power of the port, province and country to increase adaptive capacity to climate change effects
- Using innovation and technology to stay ahead of tightening environmental regulations in the transition to renewable energy systems
- Rebranding the harbour as a sustainable region with a powerful and dynamic identity by integrating natural landscapes, small-scale manufacturing businesses and non-industrial urban functions to diversify the patterns of harbour activity

WEAKNESSES

- Dependency of current industries on oil and petrochemical products
- High levels of pollution due to combustion of fossil fuels and related processes
- Limited space and support for further expansion of the port and industrial activities
- Lack of collaboration between industries for optimal efficiency of resource flows
- Large political influence of petrochemical industries due to their economic clout
- Dissatisfaction of local population with living conditions
- Vulnerability of petrochemical sector to political volatility abroad
- Vulnerability to climate change due to low-lying land in close proximity to the sea

MAKE USE OF OPPORTUNITIES TO MINIMIZE WEAKNESSES

- Involve the petrochemical sector and its key players in the transition, by facilitating and supporting their efforts and find new roles to utilize their knowledge and assets
- Using the transition towards sustainable production processes to alleviate the ecological pressure and health risks of industries vis-à-vis the nearby population
- Exploit potential of regional biomass production to accelerate the transition to circular production processes
- Use the strong coordinating role of the port authority to create synergies and effective top-down policies in transition management
- Become more efficient in the use of available space with the help of technologies and explore the potential of off-shore developments

LIMITING EFFECTS OF THREATS ON EXISTING WEAKNESSES

- Deceasing demands for oil will deminish the political influence of petrochemical insustries due to their weakened economic positition.
- Tightened environmental regulations will increase prospects for livability of the surrounding areas
- Deglobalisation may limit the impact of shifting world markets and risks of resource supply due to political instability in confiict areas

SWOT ANALYSIS

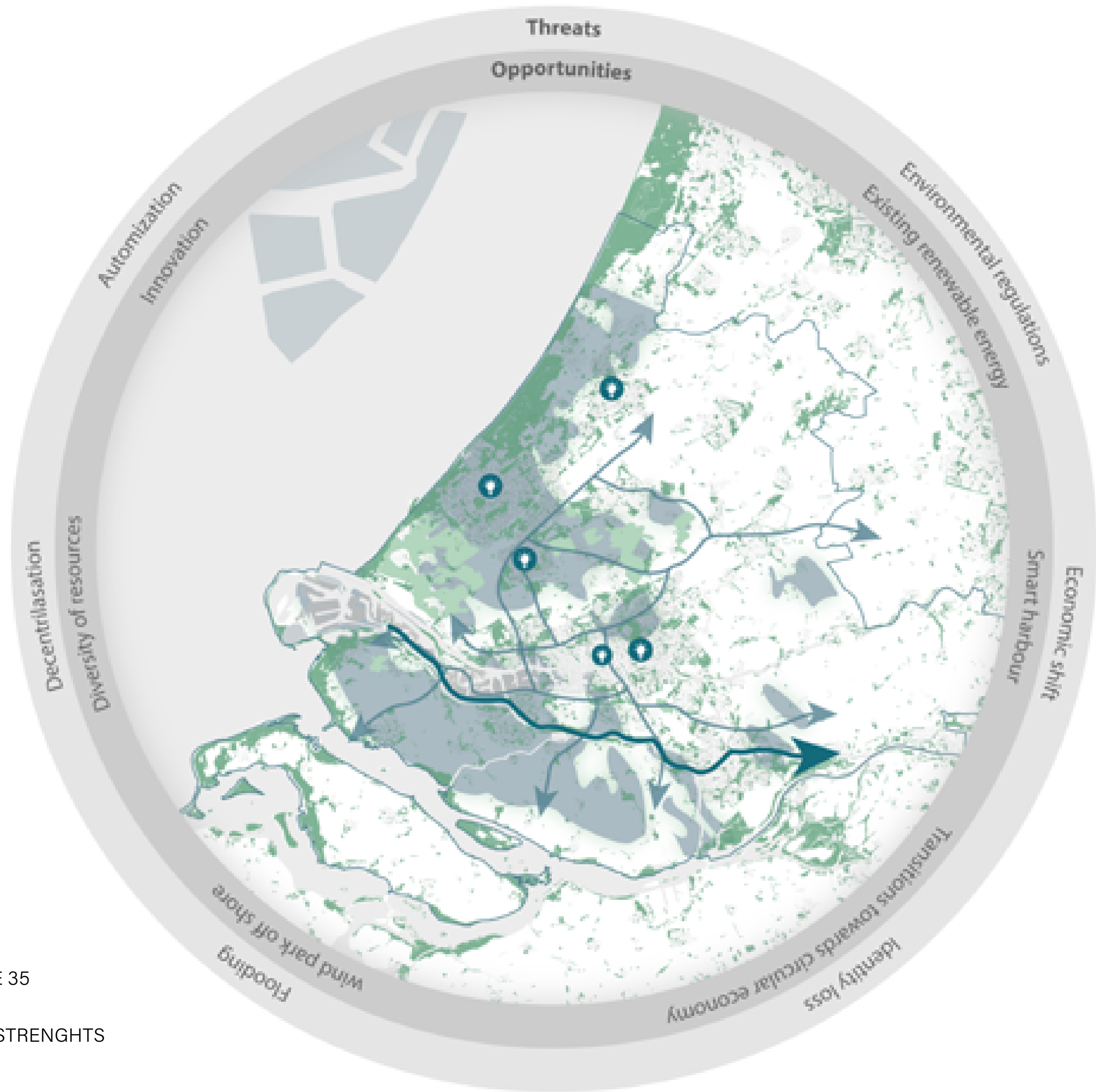


FIGURE 35

SWOT STRENGHTS

Figure 35 shows that the strengths are well distributed over the entire province. The region is well connected with surrounding areas and has a lot of potential for local regulation of energy production.

LEGEND

- Wind energy potential
- Geothermal energy potential
- Agriculture, potential for biomass
- Natural areas
- Knowledge hubs
- Betuwe line
- Highway connections

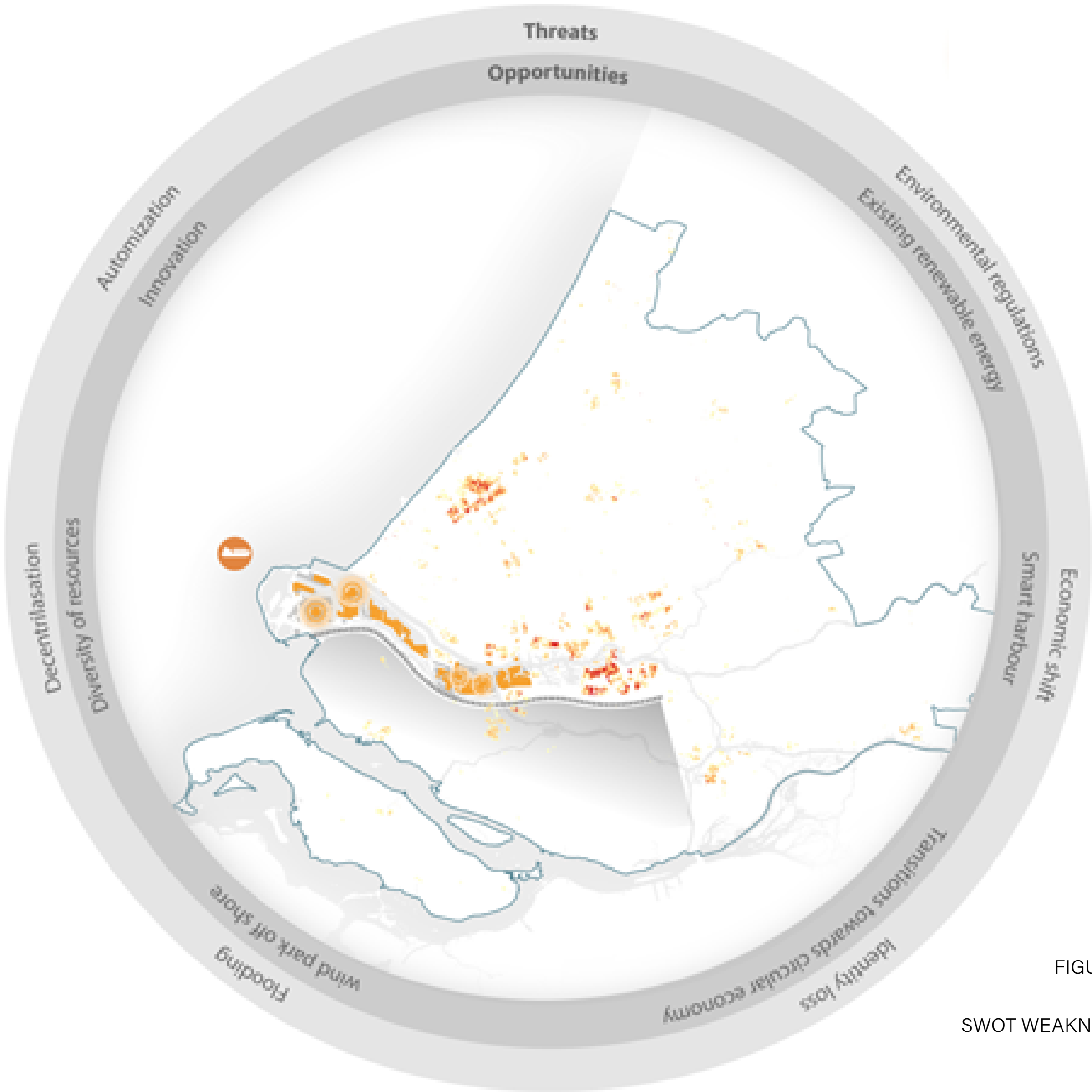


FIGURE 36

SWOT WEAKNESSES

LEGEND

- Weak liveability
- Oil and the petrochemical industry
- Import of fossil fuels
- Heavy pollution sources
- Segregation effect

Figure 36 shows that most of the weaknesses of the region are located in the Port of Rotterdam and a little above it. There are hardly any major weaknesses under the port area, except that this region is not well connected with the northern part of South Holland. For this reason, it is logical that the vision and strategies focus on the port and the cities where the greatest weaknesses are currently located.

04 Where to escape to?

introduction

The fourth chapter will introduce our vision. After finding the main qualities and inadequacies through our analysis, the next step is to develop a vision for the province. This chapter will clarify what our team understands as a 'mutualist energy landscape', thereby providing an answer to the subquestion "What do we define as a mutualist energy landscape, and which concepts and values fit within this idea?". By providing a vision statement, supported by multiple representational techniques, such as maps and photomontages, the scope and outline of our vision will be conveyed. Our vision will set the course of our strategy, by promoting concepts and values that we believe to be favourable outcomes of our design by the year 2050. The values that we will define in this chapter, will simultaneously become assessment criteria, and will allow us to critically reflect upon our strategy. After all, these values relate to the qualities that we perceive as non-negotiable prerequisites for a succesful port region.

PROJECT SCOPE

"In 2050, the port of Rotterdam and its hinterland will no longer be revolving around processing fossil fuels. Our vision aims to integrate port with region, in which clean industries co-exist with additional urban program to guarantee a liveable new part of the city region."

The ambition to fully cut off greenhouse gas emissions by 2050 will fundamentally change the Port of Rotterdam and its hinterland. This transition will resonate through every type of landscape in the port region, whether it is the historic inner city of Delft, or the remote rural landscape on Goeree-Overflakkee. To begin with, there is going to be a major shift in the economy, which will stimulate the adoption of circular systems. Bio-based industries will have replaced petrochemical industries. The existing infrastructures and facilities, such as natural gas pipelines and oil storage tanks are being appropriated to adopt a new use. Alternative energy sources will have replaced the fossil fuels, and key stakeholders in the current petrochemical sector, such as BP, Vopak and Shell will be involved and are encouraged to rethink their role in these new energy systems and its dynamics. Also, the strong presence of educational institutions in the province could help to reskill port employees that fall victim to this transition in a new profession.

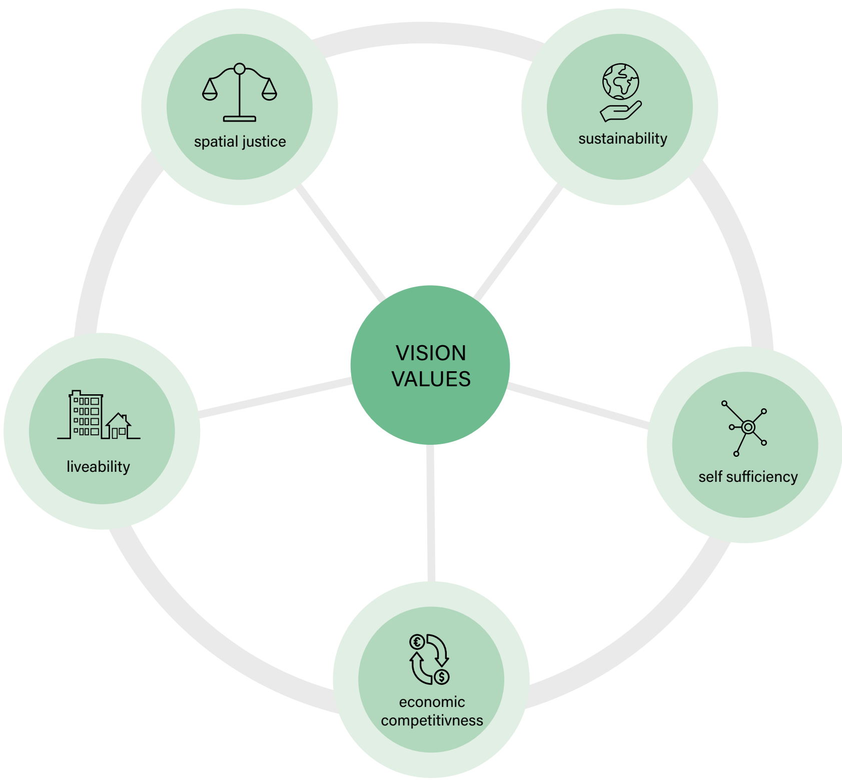


FIGURE 37

VISION VALUES

AMBITION MAPS

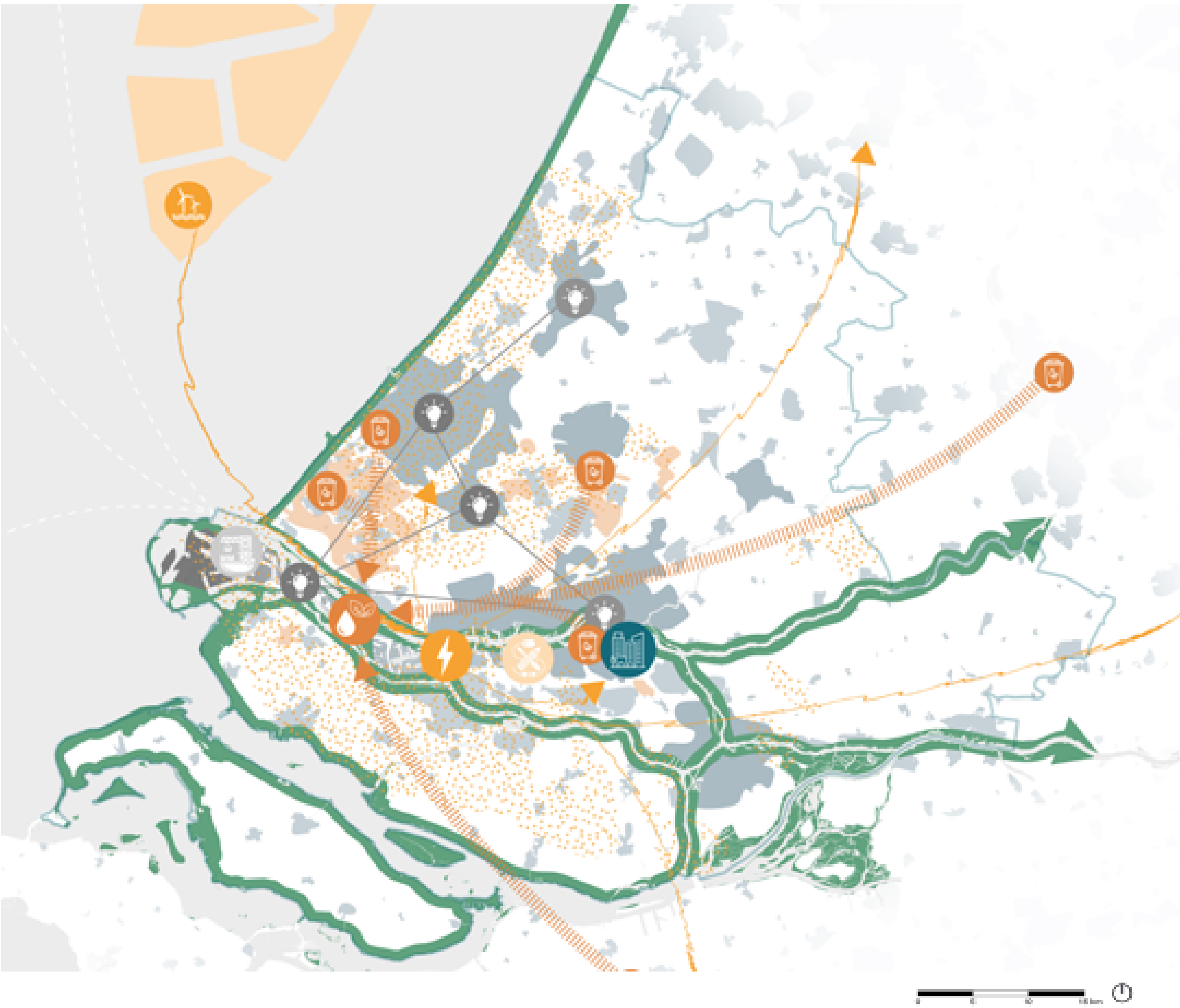


FIGURE 38

VISION MAP PROVINCE

- Harbour
- Knowledge institute
- Biobased material production
- Organic waste
- Energy storage and conversion
- Offshore wind turbines
- Manufacturing industry and dwelling
- City of Rotterdam
- Geothermal sources
- City
- Village
- Greenhouse industry
- Harbour industry
- Wind turbine zone
- Import of biomass
- Wind energy flow
- Flora and fauna flow

FIGURE 39

VISION MAP PORT REGION

The decarbonization of the harbour will have tremendous effects on the livability of the areas in and around the port. Air pollution and soil contamination will no longer take place, which opens up possibilities for natural systems to flourish alongside industrial activity in the former petroleumscape. It may even cause new urban areas to emerge within the boundaries of the port and will increase the interaction of the port with the public realm and nature. Rural landscapes could revitalise, by forming an important link in the production of resources for the bio-industry and energy production. Urban landscapes will no longer be held in the grip of consumerism and pollution from motorized traffic.

All these projections will be effective in order to grant the port and its hinterland a new type of future. Mutualism between energy production, storage and conversion and consumption on one hand, and ecological and social spaces on the other hand is something which seems unimaginable in the fossil fuel industry. However, our team's ambition is to give shape to these mutualist energy landscapes, in order to build towards a future that will be clean, sustainable, profitable and equitable.

FIGURE 40

VISION PHOTOMONTAGE

05 How to escape?

introduction

In the fifth chapter of the report, the strategies are introduced based on the vision formulated in the previous chapter. First, the technical transition strategy towards a distributed energy system is explained. This strategy will be the result of the explored options in the analysis. Although this transition is mostly of a technical nature, it will become apparent that the physical accomodation of the energy system in the province will have major spatial consequences. How this system will be embedded and what kinds of further opportunities this will bring, will be presented through the three spatial strategies that will follow. These strategies will explain how three landscape archetypes in the province will change. Every strategy will be explained and elaborated across multiple different scales.. This is followed by the phasing and an impression of the strategy. At last, proposed policies are discussed and their impact on the most important stakeholders are analyzed.

DECENTRALIZATION

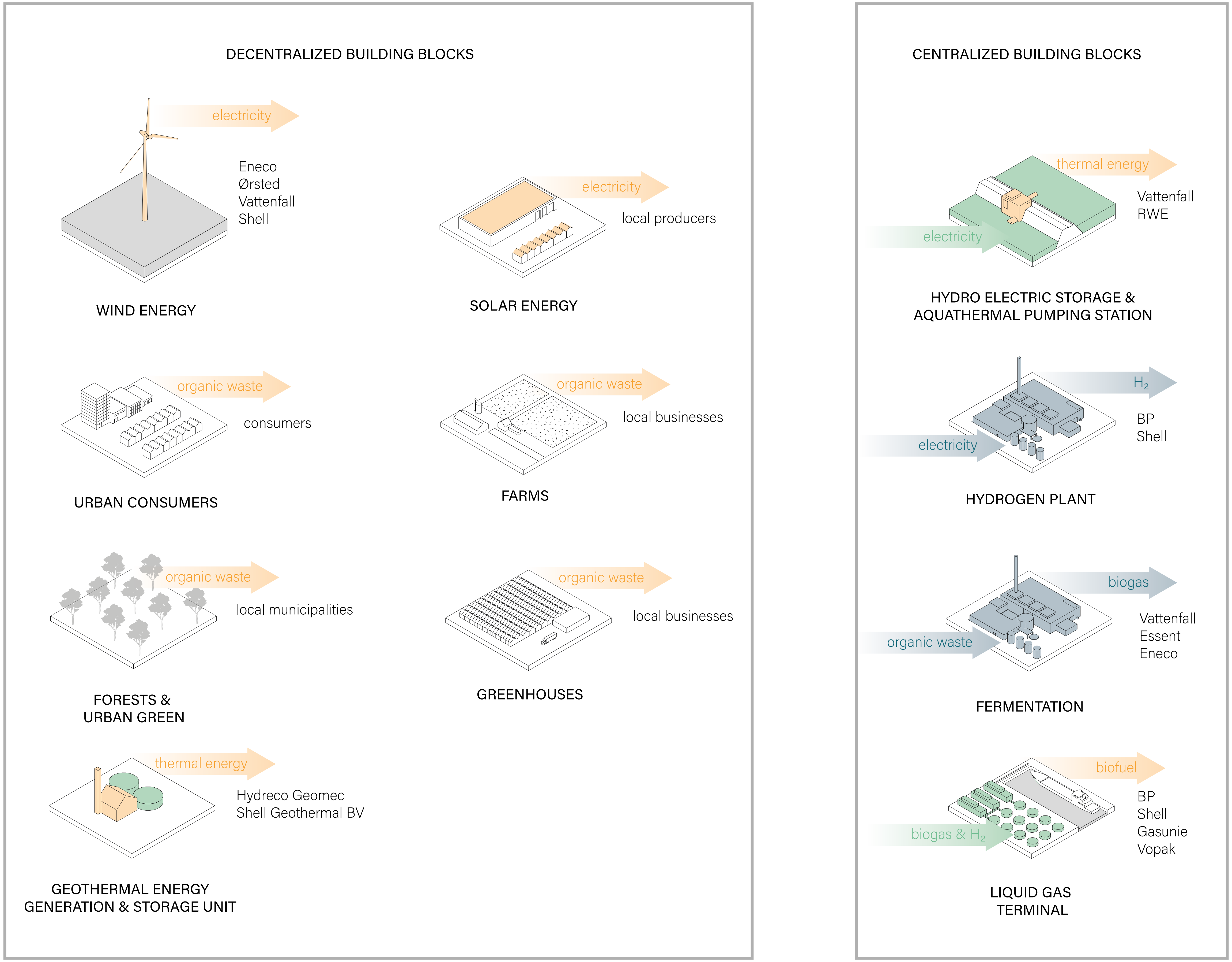
The basis of our strategy lies in the implementation of a new energy system. In the quest for renewable sources, it became clear that potentials for different sources, such as solar energy, wind energy, geothermal energy etc. are geographically not evenly distributed across the Netherlands. This means that potential for energy production is perceived on a local scale. The current energy system relies mostly on imported fuels for energy generation, meaning that centralized power plants take account for the largest part of the produced energy. Because of this multitude of utilized energy sources in the new model, future energy systems cannot be solely centralized.

However, a fully decentralized model also does not seem very probable. After all, most renewable energy sources do not have a consistent power supply. For example, solar energy output is dependent on solar radiation. Seasonal and daily cycles can be expected. In nighttime, production capacity will be minimized. In wintertime, lower yields can be expected than in summertime. Similar fluctuations can be expected for wind energy production. In short, this implies that the future energy system requires significantly more buffering capacity in order to create conformity between supply and demand of energy. Fortunately, there are ways to convert and store energy. Electric energy can be used to create hydrogen, which can be stored as a gaseous or liquid energy carrier. Other forms of energy storage can also be used, such as hydro-electric storage, or underground thermal energy storage systems.

> "The projected future energy system will thus consist of decentralized and centralized elements."

Such storage and conversion mechanisms are to be centrally located for a number of reasons. Cost-efficiency, scalability, energy conversion efficiency and the availability of existing infrastructures and facilities are legitimate reasons to opt for centralized energy storage and conversion. The projected future energy system will thus consist of decentralized and centralized elements. To clarify the functionality of the new energy system, the individual elements of the system will be shown as building blocks, in which each of the blocks has its individual output, operator(s),function(s) and location(s). Figure 41 can be seen as a catalog of building blocks for the energy system.

BUILDING BLOCKS



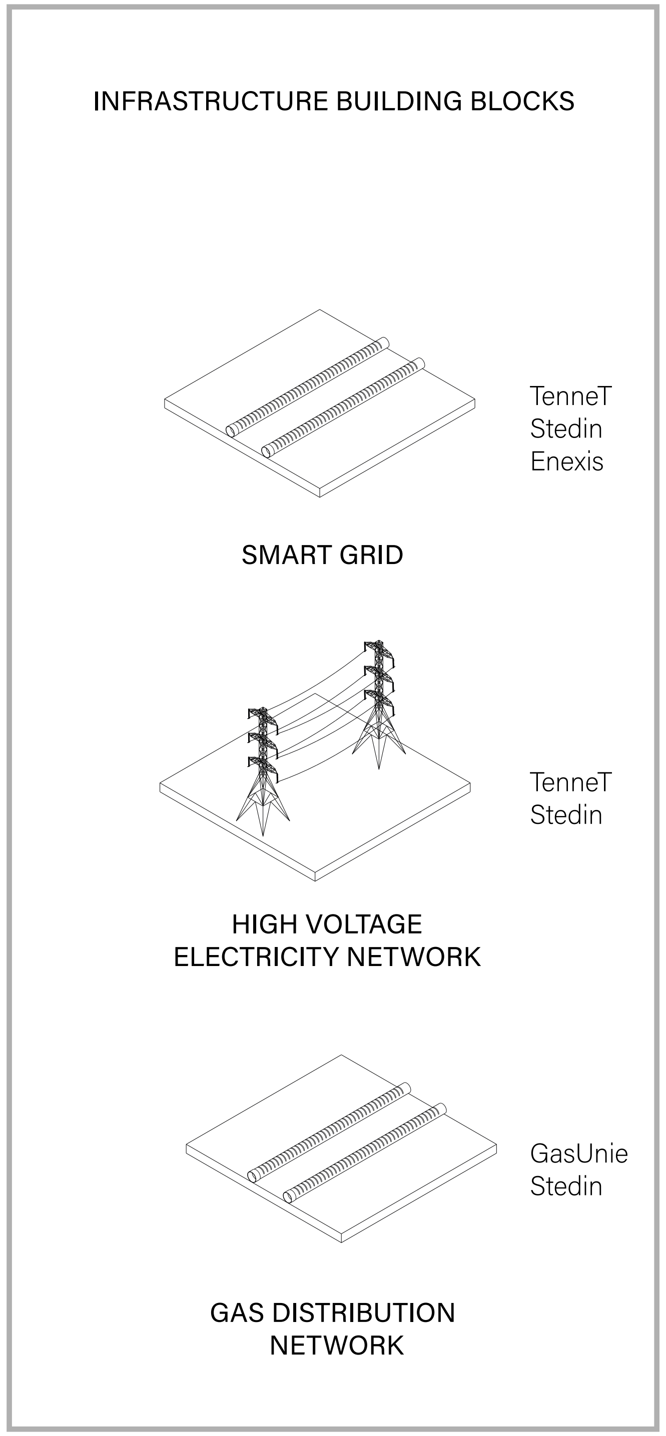


FIGURE 41

ENERGY SYSTEM BUILDING BLOCKS

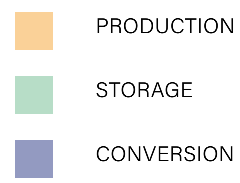
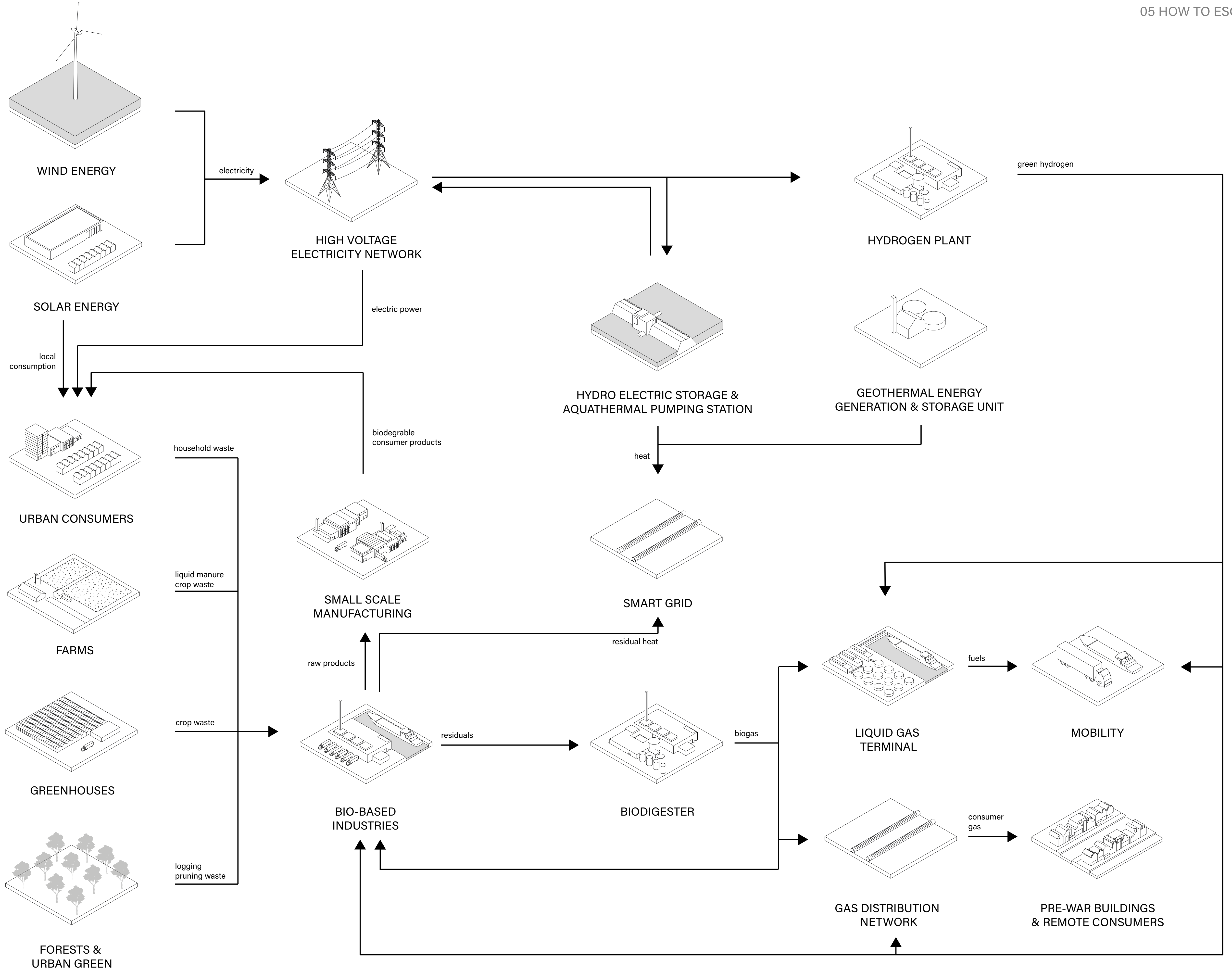


FIGURE 42

ENERGY SYSTEM FLOWS



FLOW MAP

FIGURE 43

MAPPED FLOWS

The flows of energy and bio-based resources, as presented in figure 42, are largely circular. Waste flows can be processed in other building blocks and the overall efficiency of energy transport and conversion is optimized due to smart grids, and storage solutions. In periods of overcapacity in terms of production, energy is not fully lost, but will be converted into an energy carrier for conservation. The geographical representation of the flows is difficult to map, since the system is both centralized and decentralized. However, a schematic map is provided in figure 43. This scheme shows how centralized energy building blocks can be found in the ports of Rotterdam and Dordrecht, whereas decentralized energy building blocks and consumers are dispersed across the province. As explained earlier, different landscapes in the province account for different flows and building blocks. How these building blocks are integrated into the several different landscapes in the province will be elaborated in the next part of this chapter. The spatial and social implications of this transition will then become more tangible.

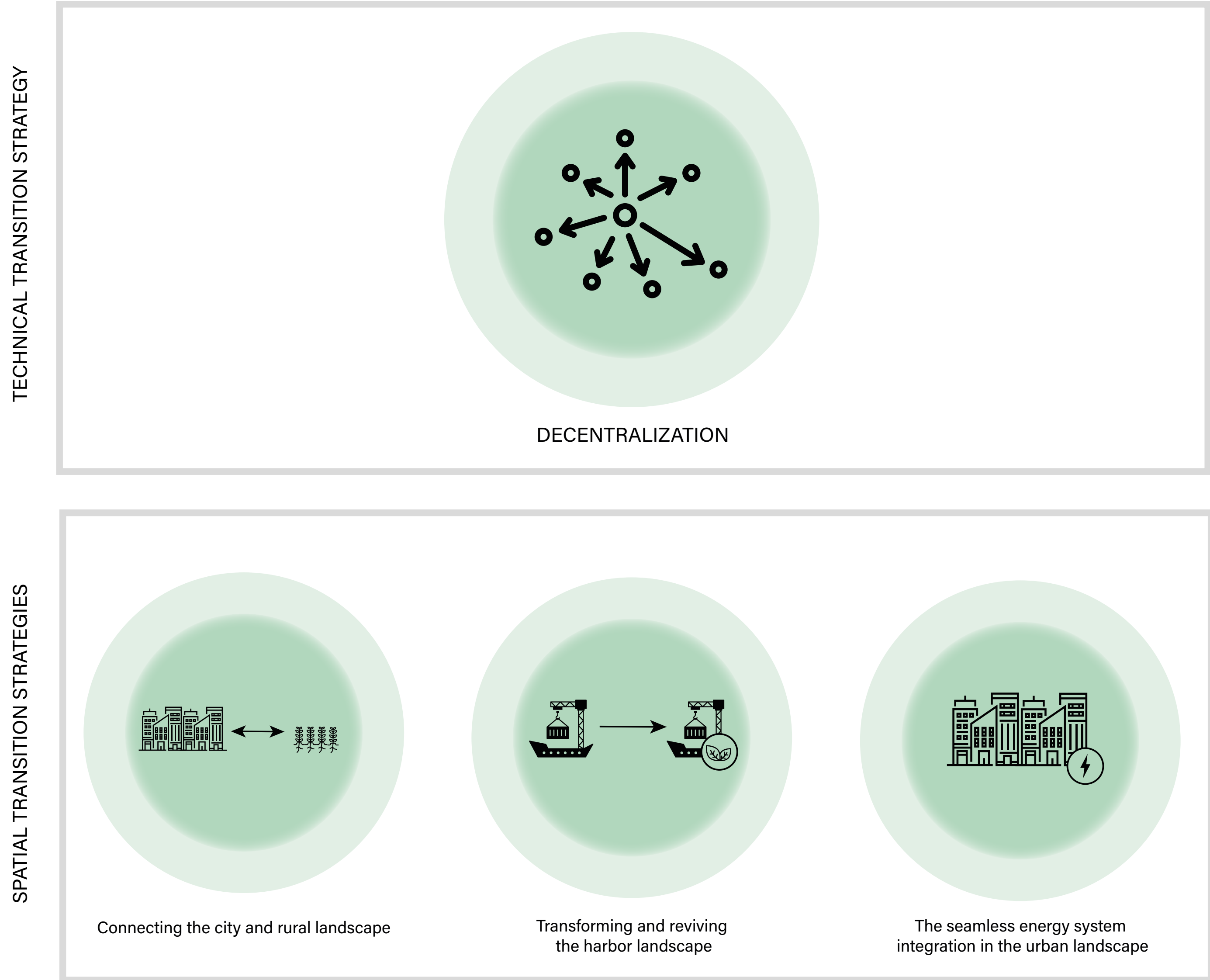


FIGURE 44

STRATEGY HIERARCHY

IDENTIFICATION OF LANDSCAPE TYPES

By decentralizing the energy system, this will have an effect on the different landscapes. Three landscapes are distinguished from each other. The rural landscape surrounds the other landscapes like a blanket. The harbour landscape consists of the Port of Rotterdam. The current harbour has an enormous impact on the region due to the polluted industry. This landscape will therefore change drastically when these industries have left. The urban landscape consists of the cities of Rotterdam, Delft, The Hague, Leiden, Gouda and Zoetermeer. Due to the expectations that cities will be expanding in the future, resilient urbanism is key.

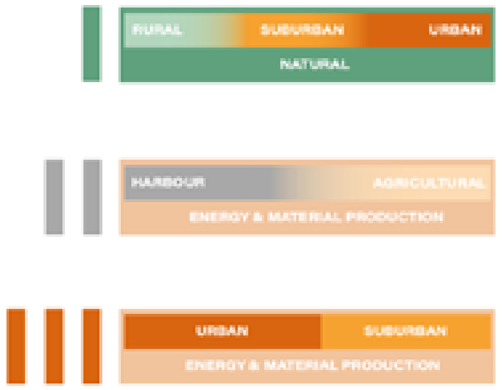


FIGURE 45

STRATEGIES AND LANDSCAPES

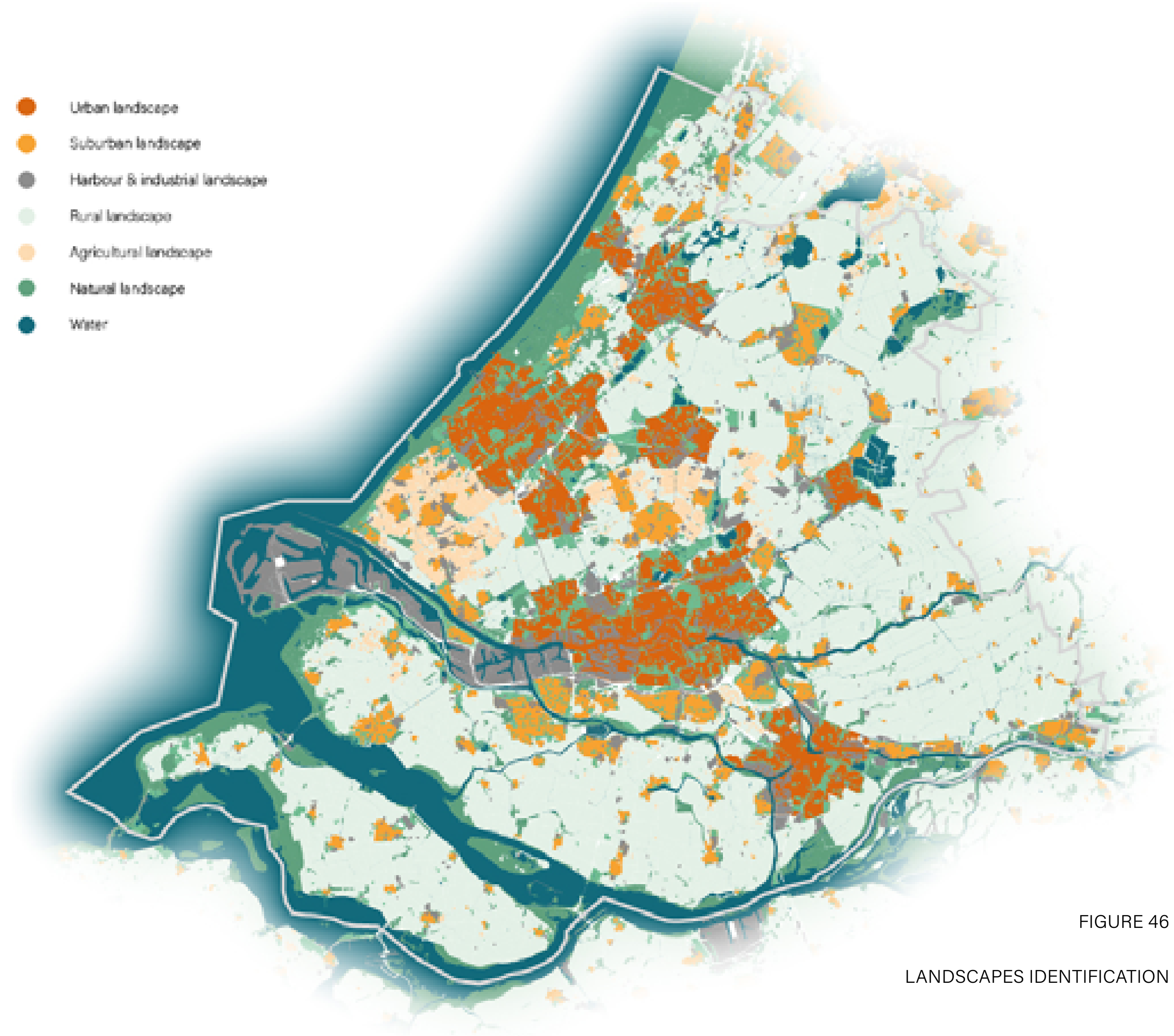


FIGURE 46

LANDSCAPES IDENTIFICATION

I CONNECTING THE CITY AND THE RURAL LANDSCAPE:

The transition towards more sustainable industry practices in the port of Rotterdam will open up space surrounding the port region that was previously suffering from negative externalities, such as soil and water contamination and air en noise pollution. The revitalisation of the countryside can help tackle the problem of space scarcity in the urban and rural region surrounding the port of Rotterdam. This provides opportunities for additional housing in the port region. To make it an attractive region for urban dwellers it is vital that these port regions are properly connected to the city and provided with all the necessary facilities. Decentralized energy production will ensure that employment opportunities will arise in these previously segregated areas.

II TRANSFORMING AND REVIVING THE HARBOUR LANDSCAPE:

The port of Rotterdam is at the centre of the current centralized energy system and fossil fuel-based industries. Therefore, the port should play a key role in the transition towards a circular and sustainable economy. In this transition, certain changes to the current port industries and spatial configurations will occur. These alterations pose opportunities for reconnecting the city with the harbour and hereby reviving the harbour landscape, by adding new layers to the landscape.

III THE SEAMLESS ENERGY SYSTEM INTEGRATION IN THE URBAN LANDSCAPE:

Currently, the city region is primarily a landscape of energy consumption, rather than energy production. In city centres, where space is limited and identity and history is a public good, embedding energy systems into the image of the city could compromise these values. Therefore, the strategy in the urban realm is to limit the spatial impact of the transition. Existing infrastructures will be kept, and the new system will be adapted to it accordingly. Building blocks of the energy system will only be brought into the realm when the spatial impact is not considered invasive. In the outskirts of cities, where space is more abundant, and systems can be more properly integrated, the energy transition could be more visually present.

I RURAL LANDSCAPE

The rural landscape surrounds all other landscapes. Central to this strategy is therefore to allow the boundary between these landscapes to merge with its surroundings. They will become more interconnected through the additioin of a new natural landscape along the Maas river and integrated into the suburban and urban landscape.

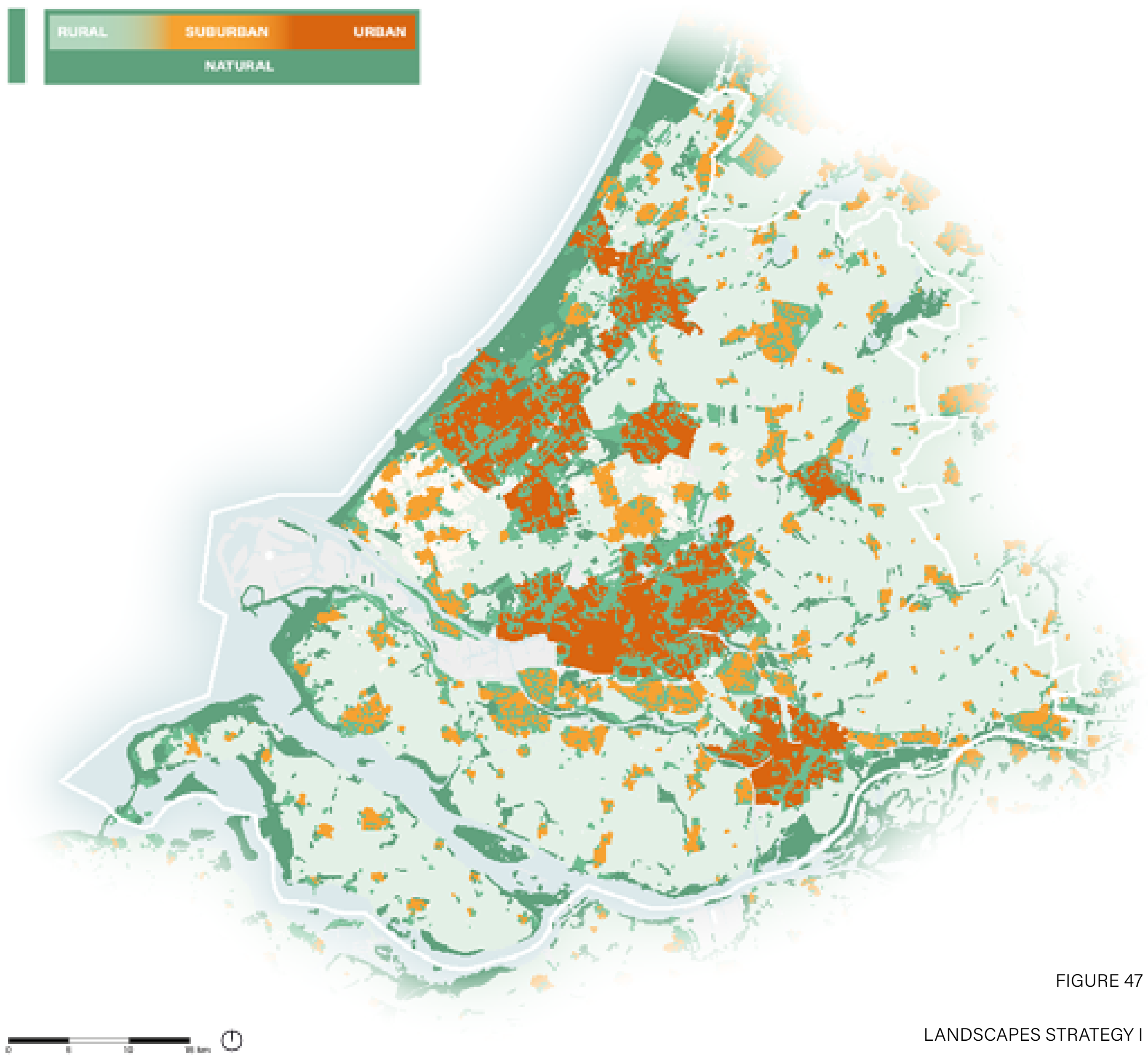
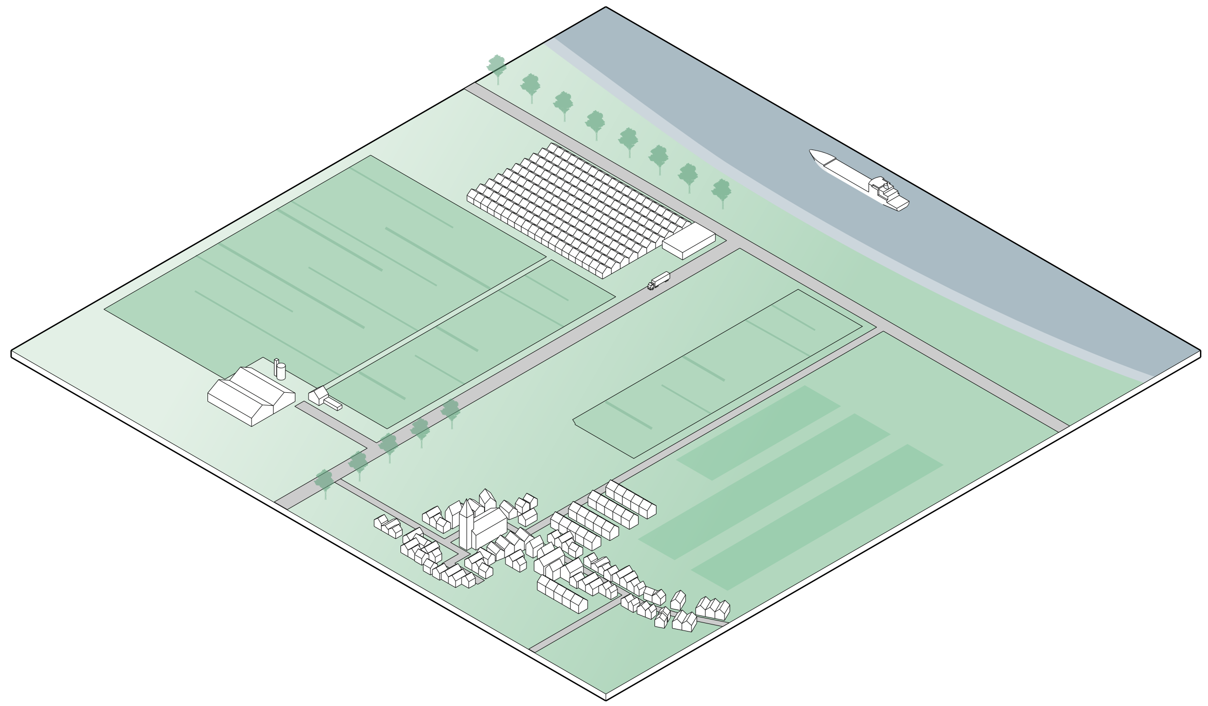
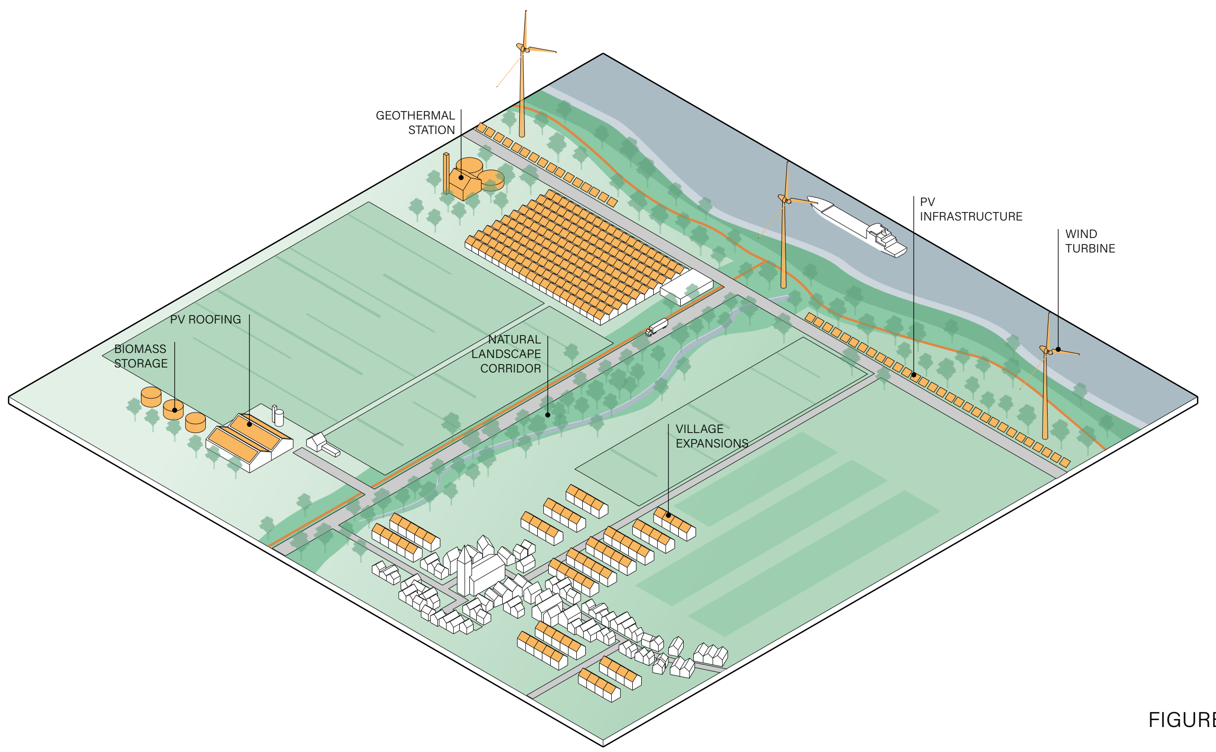


FIGURE 47

LANDSCAPES STRATEGY I



THE RURAL LANDSCAPE 2020



THE RURAL LANDSCAPE 2050

FIGURE 48

SOURCE LINE

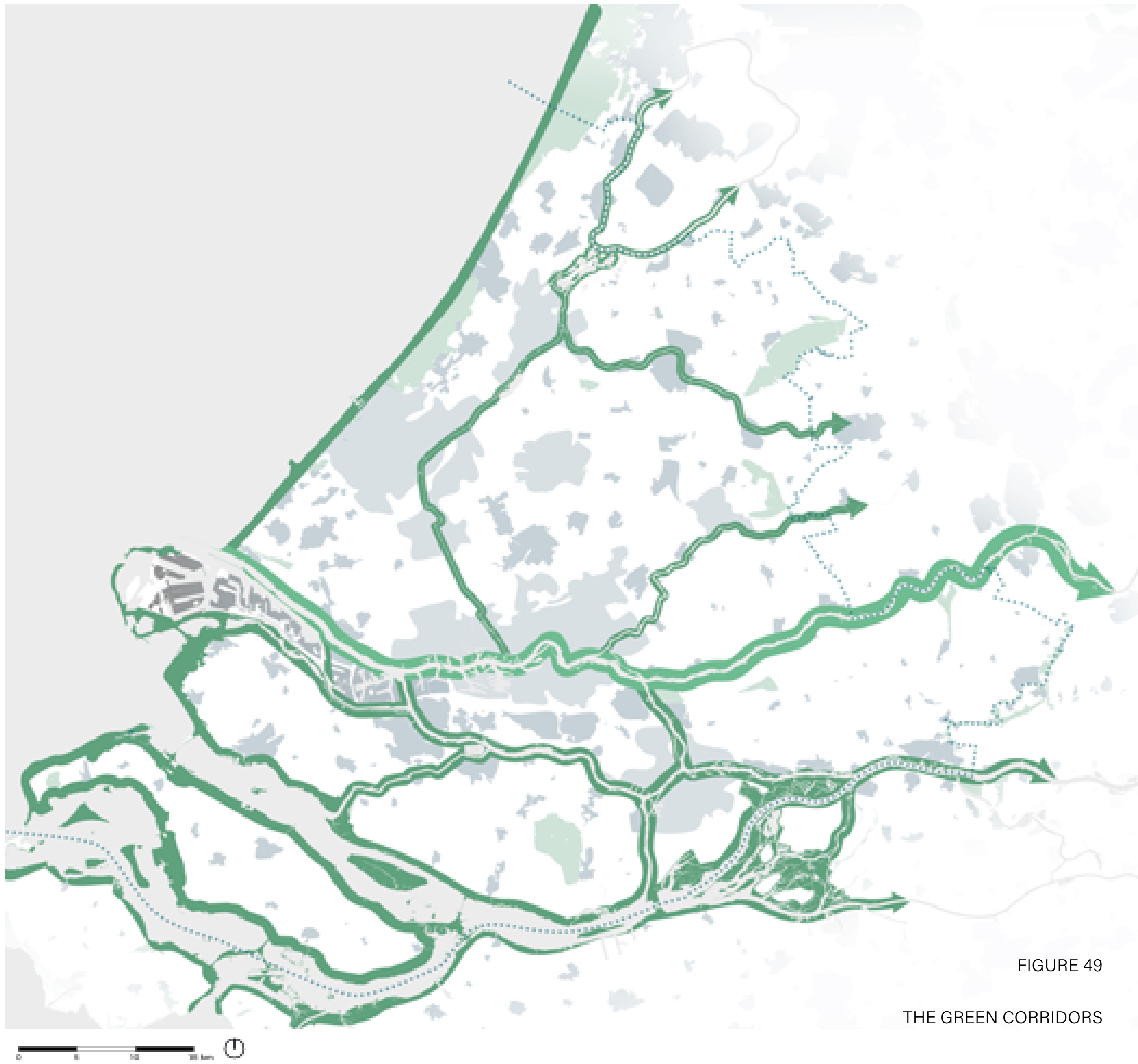


FIGURE 49

THE GREEN CORRIDORS

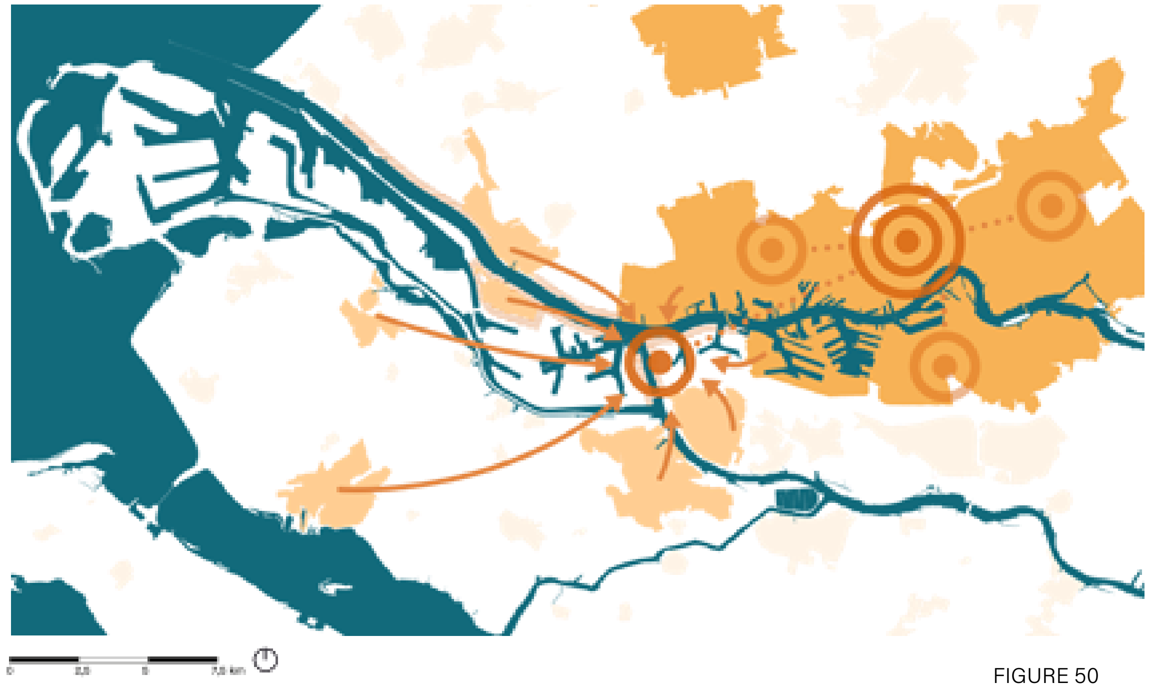


FIGURE 50

THE NEW URBAN CENTRE

The main spatial consequences for the rural landscape in the province will be that natural corridors will be strategically interwoven. These corridors could form valuable recreational corridors, connecting remote villages and suburbs with the city. These natural landscapes provide the rural landscape with a structuring element, serving as an efficient ecological network that has numerous positive effects on air quality, biodiversity, liveability and connectivity. In that way, it could also compensate for further urbanization, enabling villages to expand and become a serious alternative to living in the city, especially now that the decentralized energy system caters for new employment opportunities in the countryside. Simultaneously, the green corridors will account for an increase in biomass production, which anticipates the demand for organic waste in the future bio-based industries and energy system. In support of the revitalization of the rural landscapes south of the port, a new urban centre is envisioned, in which new central functions of the new local economy could be integrated. It could become a node in the provincial knowledge network, a marketplace for Rotterdam's small scale manufacturing industry and should offer access to everyday amenities.

I RURAL LANDSCAPE PHASING

The strategy to connect the city and the rural landscape consists of two main components that occur simultaneously. The realization of the green corridor and the creation of a new urban sub-centre. In both cases, involvement of all stakeholders is crucial for successful implementation of this strategy.

GREEN CORRIDOR

Phase I focuses on assessment of the quality of the soil and assess the feasibility of the green corridor. In phase II the existing greenery is extended. In phase II en III the polluted soil surrounding the harbour region is cleaned, while the existing greenery is connected along the Maas river. In the final phase, the green corridor along the port region is connected and extended to join with the surrounding green regions in the province of South-Holland.

EXPANDING FACILITIES AND LIVING ENVIRONMENT

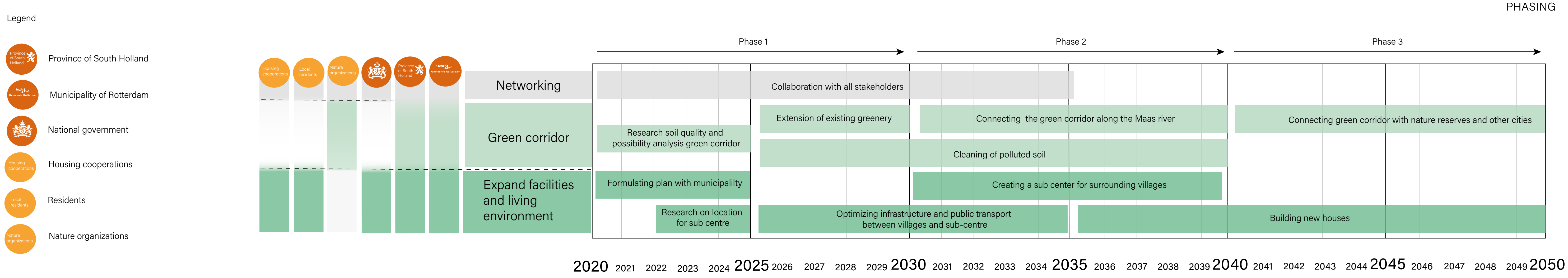
In phase I a plan is formulated with the municipality of Rotterdam and the province of South-Holland to research the possibility for additional infrastructure, location for the sub-centre and a timeline for building the additional houses is proposed. In the following phases, the infrastructure is optimized and connection lines for public transport between the surrounding villages and the new sub-centre are realized. Alongside the green corridor, new cycling infrastructure will improve the connection between the city and the rural areas. In phase III, the municipality will commence with the sub-centre for the surrounding villages. When most of the green corridor and important infrastructure is completed the rural landscape will be connected with the city and additional houses are near the river.

FIGURE 51

THE RURAL LANDSCAPE PHOTOMONTAGE

FIGURE 52

PHASING



II PETROLEUMSCAPE

The most serious spatial changes are expected in the areas that are currently occupied by the petrochemical industries and coal/gas fired power plants. The spatial conditions in this petroleumscape could significantly improve. Since bio-based industries and renewable energy systems pose less burdens on its direct environment, the new energy landscape could become more permeable. By integrating the former petroleumscape into the projected green corridor, these industrial areas could open themselves to more interaction with public space. New functions, such as educational, residential and commercial zones, may well be integrated in areas where the port meets the surrounding landscape. Since the port will become an energy landscape, new building blocks will appear. Hydrogen plants, biorefineries, biomass storage and production facilities will be built in areas that were previously occupied by oil refineries and terminals.

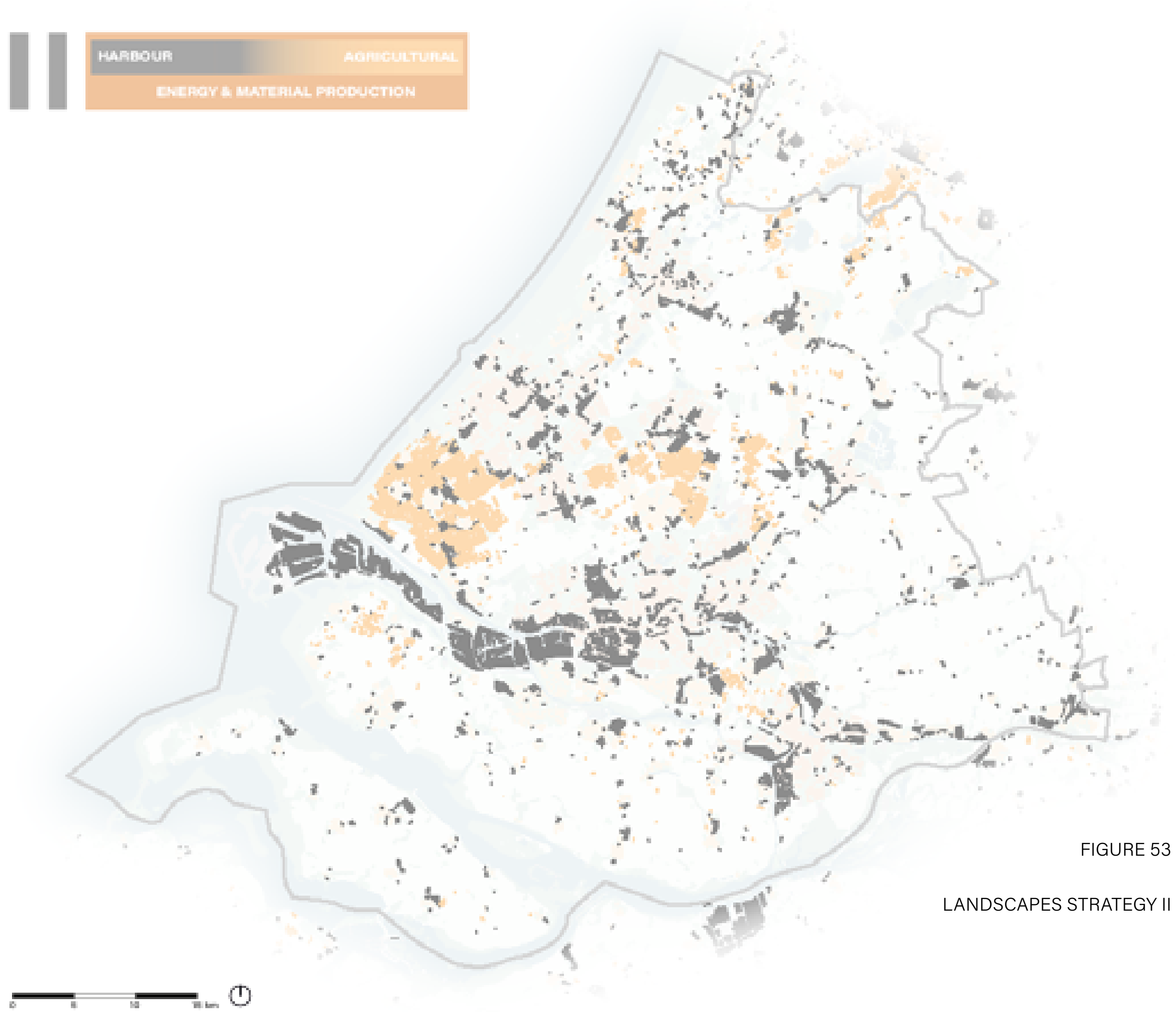
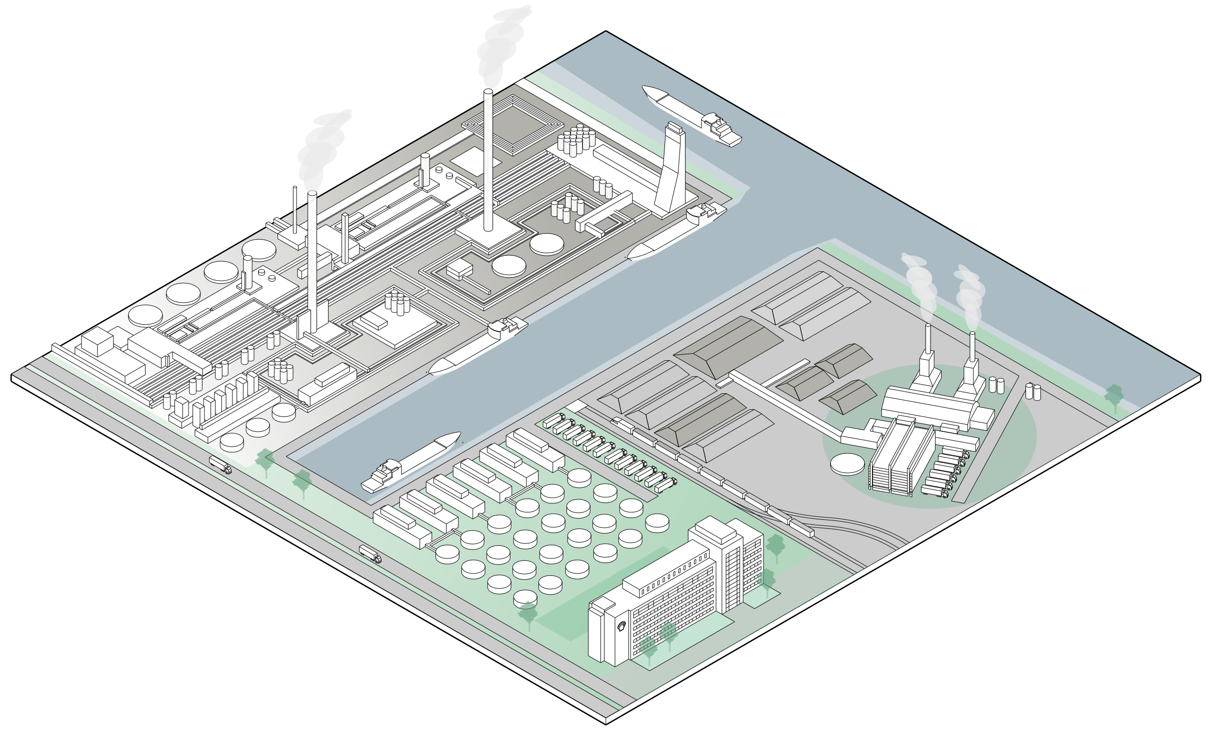


FIGURE 53

LANDSCAPES STRATEGY II



THE PETROLEUMSCAPE 2020

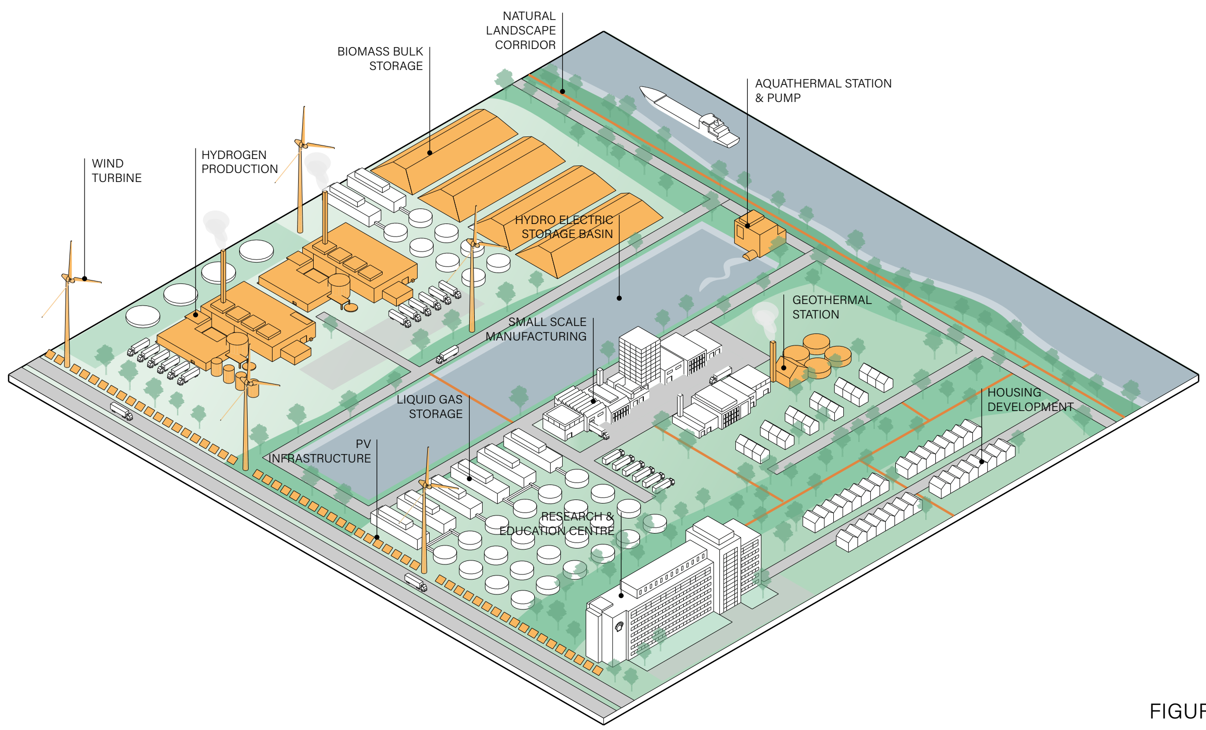


FIGURE 54

SOURCE LINE

THE PETROLEUMSCAPE 2050

II PETROLEUMSCAPE PHASING

At this moment most space in the harbour is occupied by the oil industry in the port of Rotterdam. The oil is 85 % used as fuel for the transport sector, 15 % of the oil is used in the chemical sector. Due to the electrification of the transport sector, and the chemical industries transitioning towards bio-based materials the demand for oil will drastically decline. This poses opportunities for new industries and functions in the harbour. The strategy to transform and revive the harbour landscape consist of three main components that will occur simultaneously. The implementation of efficiency measures and CO2 storage, the energy transition and the replacement of fossil fuels through the transition towards a biobased chemical sector. In these transitions, vital function changes of the port of Rotterdam will occur. The phasing of this strategy is shown in figures 55-57.

CO2 STORAGE AND EFFICIENCY MEASURES

Phase I focuses on the preparation and cooperation between the port of Rotterdam, Gas Unie and EBN for the exploitation of the CO2 capturing beneath the North Sea. Simultaneously existing industry takes all kinds of efficiency measures, the residual heat will be used to heat homes, company buildings and greenhouses. In the middle of Phase II, additional infrastructure will put in place for the exploitation of the CO2 storage system in the North Sea.

ENERGY TRANSITION

The energy transition requires the generation of energy through the use of sustainable resources like solar or wind power. At the same time, a plan is formulated and prepared in cooperation with all stakeholder for the realization of hydrogen plants. These plans will be executed in the middle of phase II, as shown in figure 56. Multiple hydrogen plants will be exploited between roughly 2030 and 2040, in order to facilitate enough energy for the port's industry. In 2030 all the gas and coal power plants will be shut down, which opens up opportunities for different industries to be manifested in that area, as can be seen in

FIGURE 55

PHASING 2021

FIGURE 56

PHASING 2030

FIGURE 57

PHASING 2050

figure 57. Finally, the energy storage system will be realized in the harbour basin.

TRANSITION TO A BIO-BASED CHEMICAL SECTOR

The oil refineries will be replaced by biorefineries, as can be seen in figure 58. The oil tank terminals will transition towards the storage of biomass of the oil products from the biorefineries. In the circular economy, products will need to be reused, therefore in the middle of phase II until the middle phase IIII waste to chemical hubs will be realized, in order for the port of Rotterdam to become Europe's waste to value hub and attain its economic competitiveness.

CITIES EXTENSION

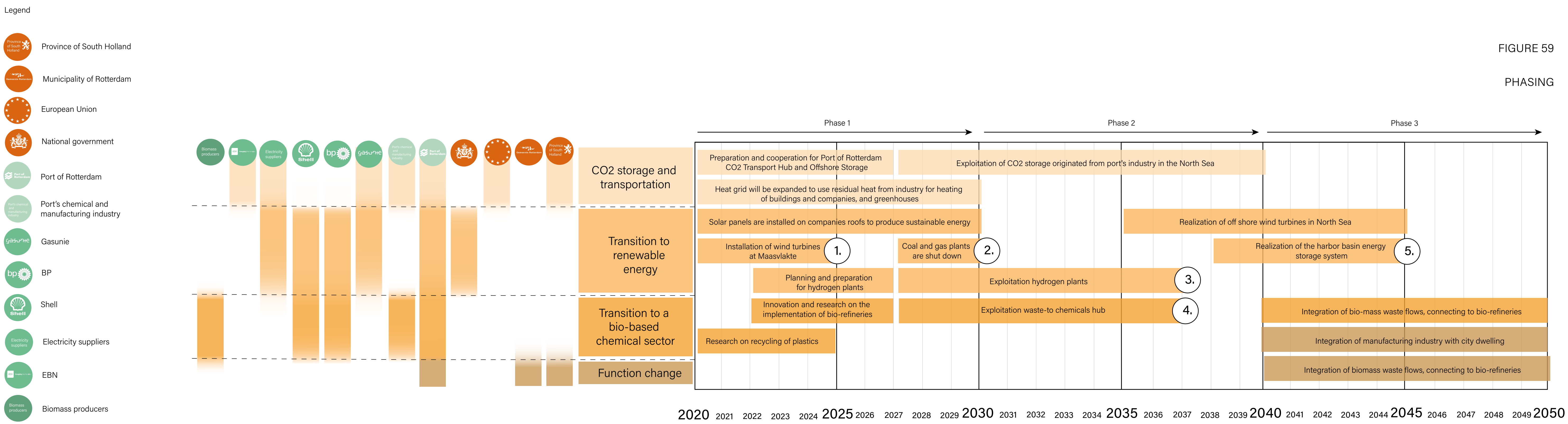
The space occupied by the oil industry in the harbour will decrease due to the limited demand for oil. This poses opportunities for the east side of the port to be revitalized by connecting this area with the city. In order to soften the transition from the harbours industry and the urban region, the manufacturing industry will become more apparent in combination with public utilities for the surrounding additional housing.

FIGURE 58

THE PETROLEUMSCAPE PHOTOMONTAGE

FIGURE 59

PHASING



III URBAN LANDSCAPE

The last strategy aims at the urban landscape. Cities remain crucial in the province of South-Holland, since urbanization is a continuous process and the urban population in the province will likely grow significantly until 2050. The strategy to seamlessly integrate the new energy system into the city aims at limiting the spatial impact. While processes like densification already put pressure on the spatial layout of cities, we hope to restrict the additional pressure of the spatial impact of energy production facilities. Therefore, in this strategy, the approach is to alleviate historic city centres from this pressure. It is important to protect the heritage and identity of historical town/city centres of e.g. Leiden, Brielle, Delft and Gouda. In post-war expansions, office areas and in the proximity of infrastructural axes, we find more potential for integrating energy production sites. In such areas, space is not as scarce, and the physical presence of renewable energy production could even have a positive effect on the identity of these areas.

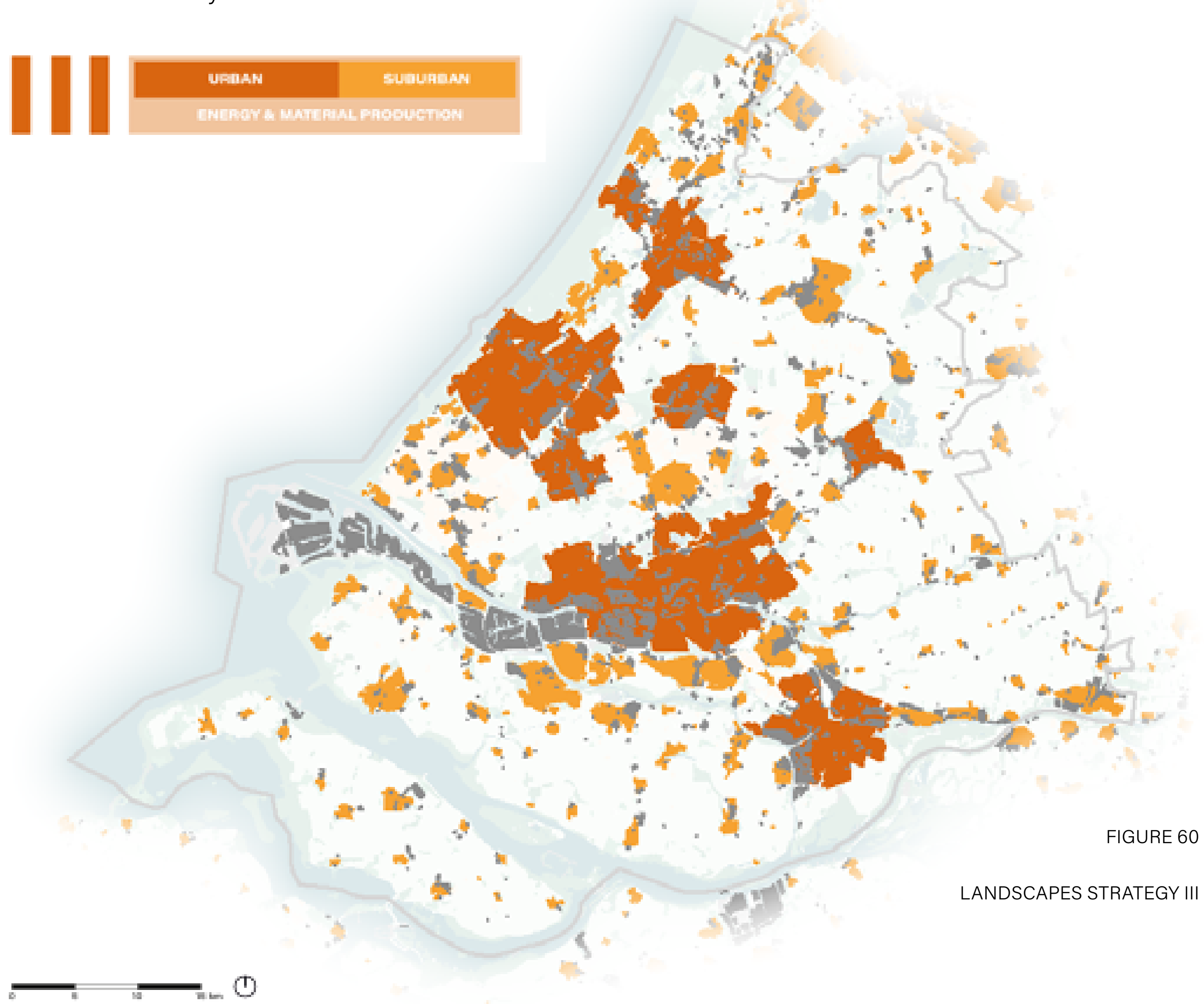
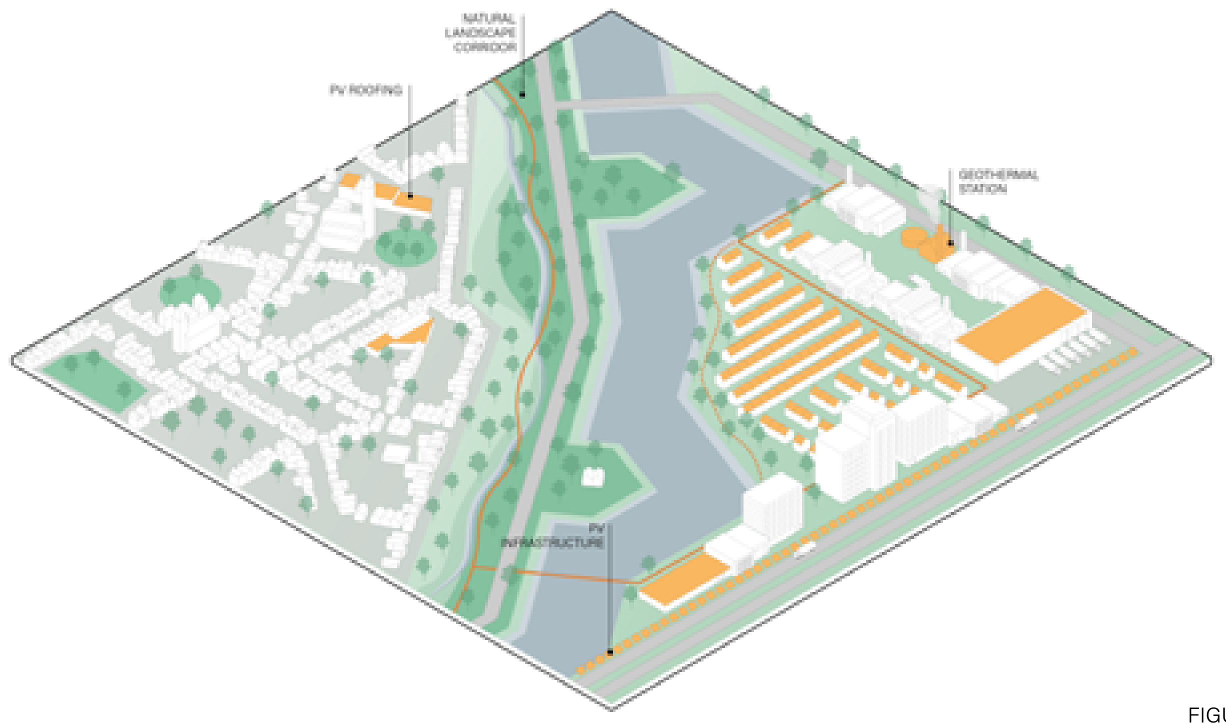


FIGURE 60

LANDSCAPES STRATEGY III

THE URBAN LANDSCAPE 2020



THE URBAN LANDSCAPE 2050

FIGURE 61

SOURCE LINE

The strategy for the seamless integration of the energy transition into the urban landscape consists of three main components that will occur simultaneously. The implementation of biogas for the heating of houses and companies in the old urban historic centres, the creation of a new smart grid for renewable heat, and innovation. Since sustainable energy technologies are still innovating and developing rapidly, it is important that this strategy is adaptable for changes in technology. The phasing of this strategy is shown in figure 65.

BIOGAS

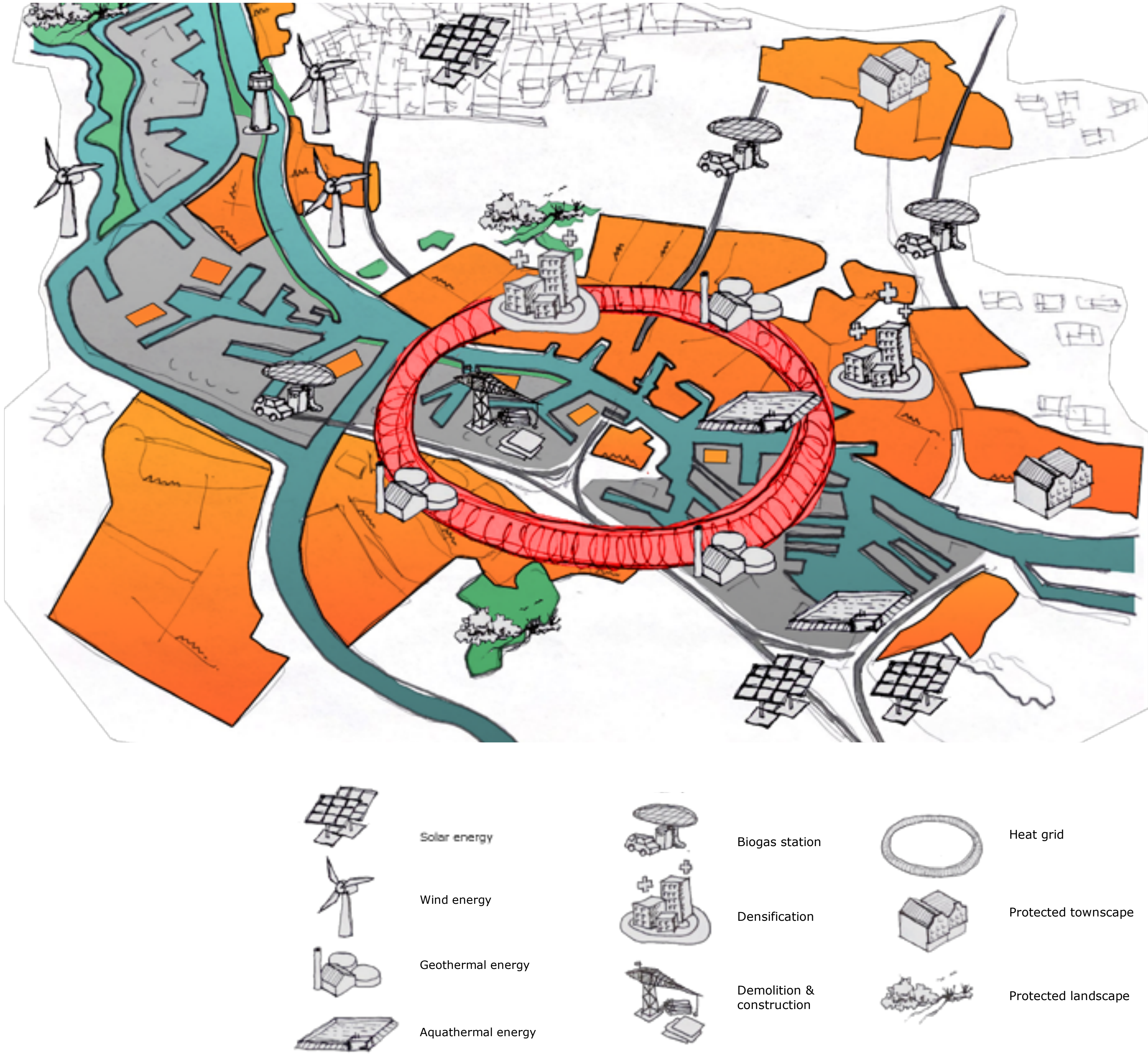
In the strategy of the seamless integration of the energy transition, biogas plays a vital role in the historic centres. Since there are many historical buildings in the area, it can be harder to implement a smart grid, which requires additional (underground) infrastructure. Such a large intervention in historical centres may be too expensive, it is not a favourable option. Moreover, these buildings are not fit for heating with lower temperature supply from a smart grid due to poor insulation. Adapting the heating system in historical buildings is often not feasible. In this strategy, these homes will therefore be supplied with biogas, which means that no significant alterations to the current gas network will be necessary. From 2035 onwards, all the buildings in the historic centres of urban regions will be heated using biogas.

HEATING NETWORK

The buildings that could be adapted or built to fit more efficient heating systems, will be connected to the new smart grid. In this smart grid, geothermal energy will be the main source, but also residual heat from industrial processes or data centres can be used. In the first phase, the necessary infrastructure will be built, followed by the construction of the new geothermal and aquathermal stations. From the start of phase III, buildings will be connected to the heating network.

FIGURE 62

THE PORT AND THE CITY



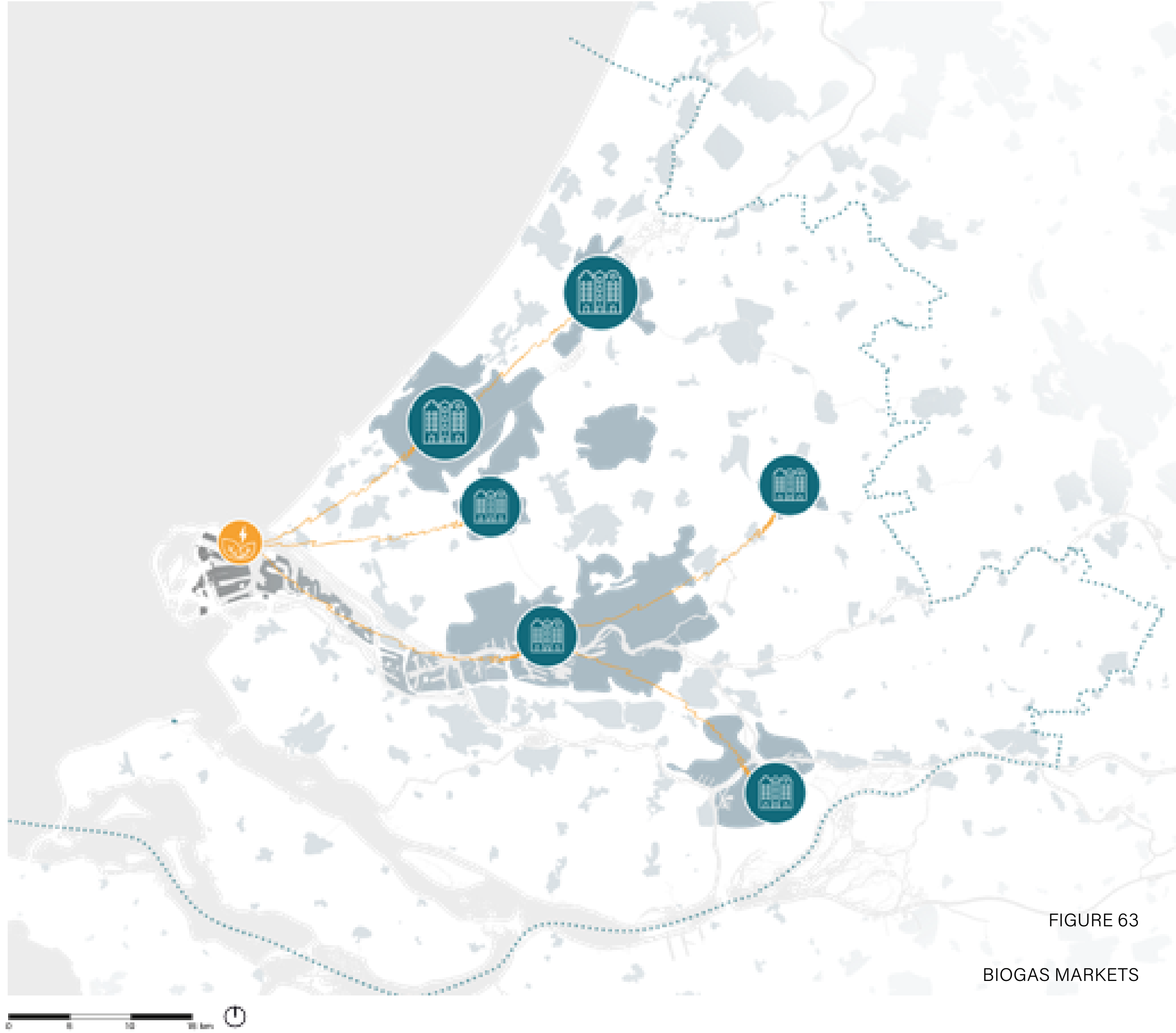


FIGURE 63

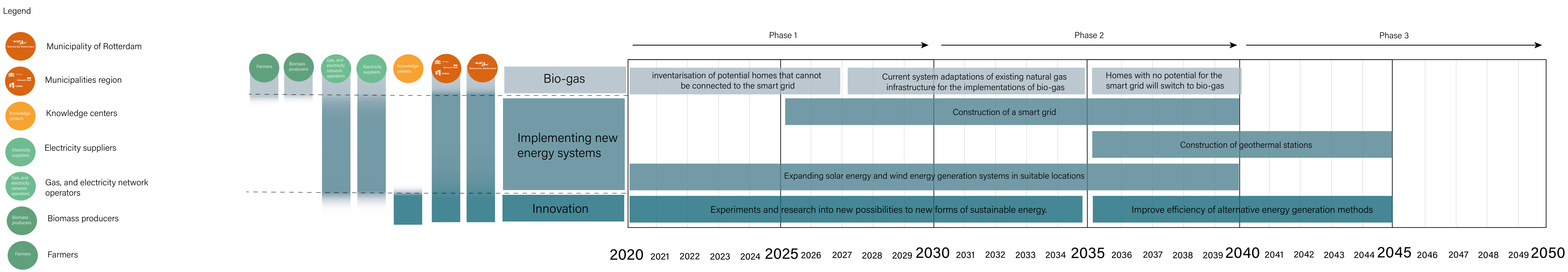
BIOGAS MARKETS

FIGURE 64

THE URBAN LANDSCAPE PHOTOMONTAGE

FIGURE 65

PHASING



POLICY

STAKEHOLDER IMPACT

The policies formulated and shown in figure 66 are divided into four categories: shaping, capacity building, regulating and stimulating policies. Shaping policies are maint to set a broad context for market action and transactions. These shaping policies are meant to steer from a distance and are relatively soft steering policies, meaning they don't hold consequences when not applied. Capacity building policies should enable actors to operate more effectively within their decision environment, and so facilitate the operation of other instruments. These policies are steering through consultation and are similarly soft steering instruments. However, regulating and stimulating policies are more hard steering instruments. Regulating policies constrain the decision environment of development actors by regulating or controlling market actions and transactions. These policies are likewise steering from a distance. Stimulating policies expand the decision environment of development actors by facilitating market actions and transactions, these are more policies steering through consultation.

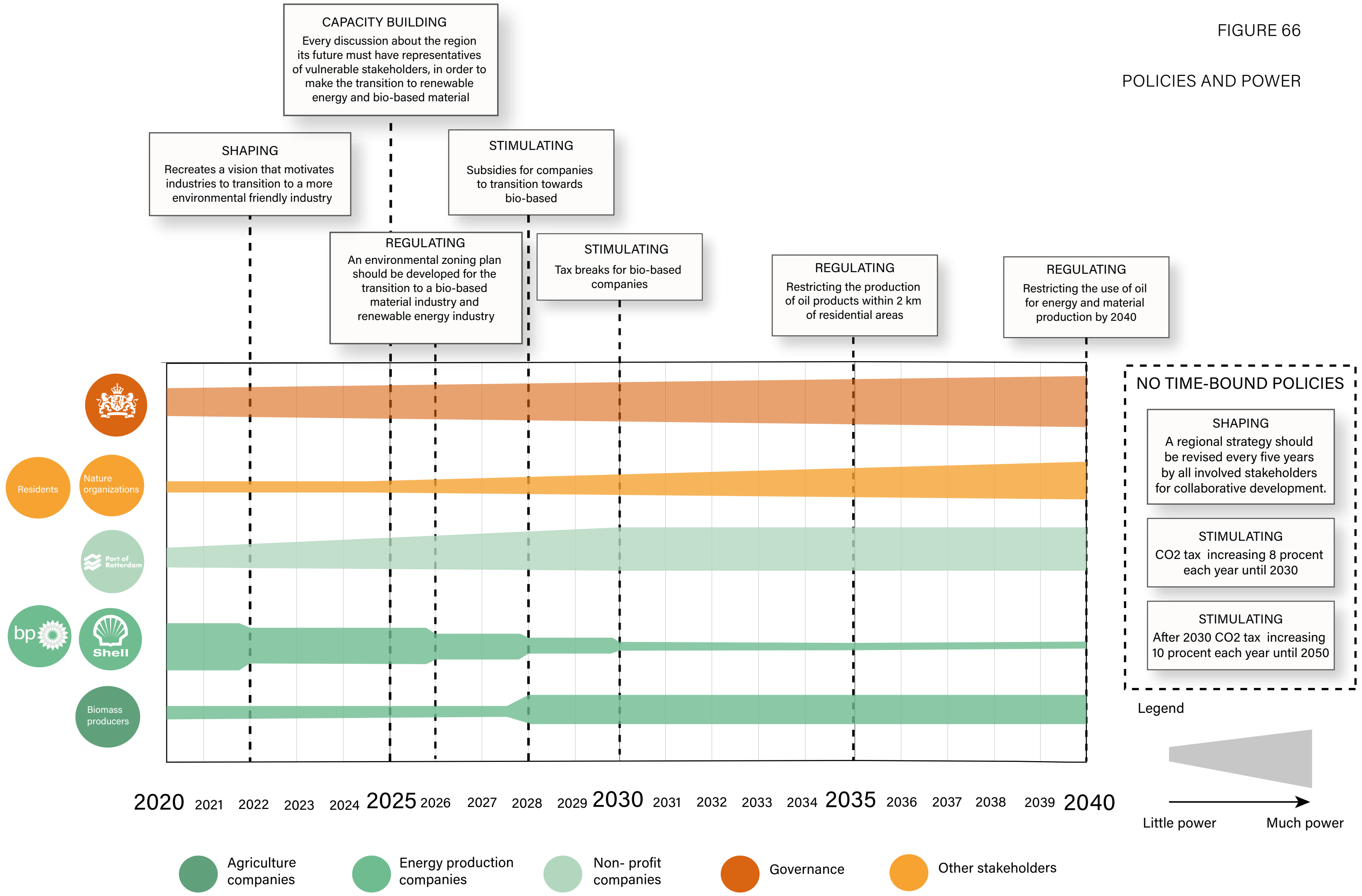
Figure 66 shows three no time-bounded policies. Meaning they will occur from 2020 and will be revised on a regular basis. The time-bounded policies are visualised in figure 66 and show how these policies will affect the power of the most important stakeholders in the proposed strategies. The power of the central government will in time further increase due to the implementation of several regulating and stimulating policies. These policies are meant to steer sustainable business practices and transition to a sustainable energy system. Over time, vulnerable stakeholders like residents and nature organisations will gain power due to cooperation and increased interest in the preservation of natural resources. Since the Port of Rotterdam is at the current heart of the fossil fuel-based economy they will play a key role in the transition and therefore gain more power over time. Their main goal is to get all stakeholders involved to transition towards more sustainable practices and away from fossil fuel.

> "Over time, vulnerable stakeholders like residents and nature organisations will gain power due to cooperation and increased interest in the preservation of natural resources."

Due to the gradually decreasing demand of oil the power of the most apparent oil companies in the port of Rotterdam Shell and BP will over time lose their power. However, there is also a big

FIGURE 66

POLICIES AND POWER



opportunity to diversify their business portfolio and invest in sustainable energy generation technologies like hydrogen, wind and solar power. Oil companies could transition towards sustainable energy generation companies, or invest in the exploitation of biorefineries and waste to chemical hubs. It is in the hands of these companies if they will turn their business model around, if so they could regain their power and become a dominant player in the future of sustainable industries. Furthermore, In the transition towards bio-based chemical sector the use of biomass becomes more important. In 2030, a stimulating policy will be implemented that provides subsidies for companies to transition towards bio-based material production. From this moment the power of biomass producers will increase.

This chapter provides concrete examples and interventions that emphasize how we can make the shift from a petroleum-based energy sector to a renewable energy system. It provides a more detailed insight in which aspects of the new system will be positioned in which types of landscape. In this way, our understanding of what a mutualist energy landscape should look like comes to live. The knowledge that we gained from our analysis was used to narrow down our vision into concrete steps that should be taken from a design perspective, as well as a policy-making perspective. This resulted in three seperate transition strategies, which are outlined by a main technical transition strategy. This overarching strategy defines how the energy system should function, whereas the spatial strategies prescribe what measures should be taken to really implement this strategy in the physical environment.

06 Conclusions and Reflection

introduction

In this sixth chapter of the report, conclusions of the research and design are summarized. The sub questions, to which the answers are presented in the previous chapter conclusions, are now being converged in order to answer the main research question. In the group reflection, our team will reflect on the ethical perspective of the proposed vision. The chapter ends with individual reflections of all the group members on the design process and the group studio work. It also reflects on the gained knowledge during the lecture and workshop series of SDS and Capita Selecta.

"How can a regional design strategy for the port of Rotterdam and its hinterland contribute to a transition from a petroleum-scape towards a mutualist energy landscape?"

The studio started off with the exploration of the current energy and material flows of the petroleum port and their externalities. At this early stage, the need for transition became eminent. The task ahead (and its spatial implications) is vocalized in the main research question. In order to answer this main research question, the formulated sub questions and conclusions will be addressed.

WHY IS THE CURRENT FOSSIL FUEL INDUSTRY IN NEED OF A TRANSITION?

The existing environmental, societal and economic externalities, caused by the oil industry, bring the port of Rotterdam under par when it comes to sustainability themes such as livability and resilience. These issues manifest themselves on a local, regional, national and global scale. In order to move towards a transition, all scales have to be taken into account to enforce the current lack of collaboration and commitment.

WHAT ARE THE CURRENT SPATIAL QUALITIES AND INADEQUACIES OF THE PORT AND ITS HINTERLAND?

The port of Rotterdam has a strong position in the world's economy. The spatial qualities of the port mainly revolve around the existing infrastructure and industry, and therefore the strong connection between the port and its hinterland on the national and global scale. On the other hand, on a regional and local scale, it becomes clear that this same infrastructure causes a division between the urbanized landscape and the periphery within the province of South Holland. Change in the port is halted by the economic power and benefits of large petroleum firms, and therefore lacks spatial justice for its residents, flora and fauna.

WHAT ARE THE MATERIAL AND ENERGY FLOWS OF THE CURRENT FOSSIL FUEL INDUSTRY, AND WHAT POTENTIAL IS THERE FOR RENEWABLE ALTERNATIVES?

After analyzing the energy and material flows in the region, new methods and possible strategies came to light. This made it feasible to replace the current linear model with a circular energy system and economy. By offering sustainable alternatives, optimized for the context of South Holland, the system no longer pollutes or depends on the import of raw resources, making the region a pioneer in becoming self-sufficient and circular . The alternatives are focused on a variety of renewable energy sources that work together on a smart grid, in order to provide energy and material for the region.

WHAT DO WE DEFINE AS A MUTUALIST ENERGY LANDSCAPE, AND WHICH CONCEPTS AND VALUES FIT WITHIN THIS IDEA?

Different landscapes within the region are separated by harsh borders, in order to protect the port its residents from the negative effects of the oil industry. As the oil industry will be transitioned towards a biobased chemical industry, these borders will no longer be necessary. This creates the opportunity to connect and integrate these landscapes, and thereby creating a mutualist landscape, where landscapes interact with eachother and both benefit from eachother. This doesn't only include energy production, storage and conversion, but also the ecological landscapes and the urban and suburban realm.

HOW DO WE TRANSLATE OUR CONCEPTS AND VALUES INTO A DESIGN STRATEGY?

In order to move to a transition towards a bio-based mutualist landscape, the energy system has to decentralize in order to make space for sustainable development and integration of the port area. The production and storage of energy will be more focused on the local scale, shortening the distance between supply and demand. This decentralization results to three strategies that manifest themselves in different landscapes.

The first strategy focuses on connecting the city and rural landscape and therefore relieve the pressure on the urban landscape. By integrating the city with the rural landscape, it becomes more attractive to live in this region. This also created the opportunity for a new (sub)urban center in the port region, as the liveability and human activities increase. A green corridor along the Maas river, as well as along other smaller waterways will be implemented, in order to connect ecological areas and access to recreation for the province its residents, flora and fauna.

In the second strategy, the harbour landscape will be transformed and revived by replacing the old unsustainable industries with renewable ones. Industries such as the convertion of bio mass, waste to value and manufacturing industries will work together to provide a sustainable material production chain. The sustainable energy production industry will revolve around the production of bio gas, hydrogen and renewable energy sources such as wind, water and solar energy.

"How can a regional design strategy for the port of Rotterdam and its hinterland contribute to a transition from a petroleum-scape towards a mutualist energy landscape?"

To conclude on our main research question, we perceive our regional design for the port area and its hinterland to be an inspiration for the current stakeholders and industries in order to move towards a port area in which collaboration and participation is key for a successful transition. A crucial element of the building blocks of the new energy system have to be carefully integrated into the different landscapes of the province. By doing so, the act of energy production will no longer be a burden to its direct environment. Instead, it will create a positive effect on the environmental, economic and social structures of the province of South Holland.

Since the potential for solar, wind or geothermal energy varies throughout the province, there is not a single applicable solution for the whole region. A combination of renewable sources on land and sea is necessary, working together in smart distribution networks that can fine tune local demand with production (through energy storage and feedback loops). The grid also ensures turbines and geothermal stations don't fish in the same pond of energy, as this will decrease efficiency.

Biomass can translate waste flows into a primary flow of heat. Because of limited potential, self-sufficiency on the regional scale is not feasible. Biomass emits CO2 when producing energy, but this CO2 has been taken out of the air to grow the plant earlier (net production is zero). For these reasons, biomass should be used to pump biogas (through the existing natural gas infrastructure) to vulnerable buildings, as this does not require illicit modifications to these heritage sites.

The proposed energy system does not only spread the spatial impact among the residents of the province, it is expected that jobs will be spread more balanced between city and periphery. With agriculture shrinking in employees in the countryside, new jobs can play a crucial role in keeping the countryside vibrant. The new green corridor intertwines industry with nature and Randstad with the countryside. Stimulating livability and interaction between landscapes.

For stakeholders, it is important to realize that without responsibility, one cannot have authority. The transition to circular is in the interest of the public, which should weigh heavier than the economic interest of international petrochemical firms for governmental bodies. For early adapters, a revised energy system gives opportunity (to increase market share), but there is also risk. If one of the firms is successful producing renewable energy with the help of the government, more will follow as realization dawns that fossil fuels are no longer relevant.

ETHICS

First of all, we want to reflect on the group dynamic that we experienced during this quarter. Our experience of the first few weeks was comparable to skydiving into an endless sky full of new information about the petrochemical industry and its processes. Overwhelmed by the huge amount of information, we tried to encapture as much information as possible, and solve the world's entire energy issue. After a while, we found our place in the sky and were able to hold onto eachother as a team, to get through this slightly strange experience of the design process through Zoom. We found a way to cope with all the data and information and chose to focus on how decentralization of the energy system would impact the port of Rotterdam and the region of South Holland.

Our vision shows a possible future scenario without pollution and contamination by the oil industry. The global environmental issues are in need of drastic measurements in order to save our planet. As scarcity is going to rise in the coming decades, the need for a transition towards a bio-based chemical sector will be more desirable.

The province of South Holland can take this opportunity to be a frontrunner in the transition towards a renewable energy industry, as well as sustainable redevelopment of the scars in the landscape that the polluting industries left behind. Since the port of Rotterdam contributes to the problem on a global, national, regional and local scale, it also should be responsible for moving away from this unhealthy and unresilient system and start restoring the damage it caused in the past decades, especially the big polluters: the oil companies. We also see these stakeholders in the oil industries as allies, instead of enemies, since we need them in order for the transition to work. We would rather work with them to tackle the problem, instead of against them, which will result in an endless battle. Collaboration is key in this transition. We need to inspire them to change their mentality, activity and perspective. We need to show them the damage that has been done to the environment and society, but also help them see a sustainable future in which they can exist as well, as long as they make this transition. Their effect on the region is huge, negatively affecting residents, flora and fauna. We need to turn the tide and involve these stakeholders in the planning process as well, so their needs can be heard. Spatial justice needs to start today. By working together with all stakeholders, see them as equals, and addressing the urgency to start changing today, we believe we can set this transition in motion.

To address the importance and contribution of our vision and strategy to the transformation of the EU's economy for a sustainable future in which spatial justice is also more present a reflection on the various elements of the Green Deal is discussed. However, it needs to be noted that our vision and strategy not only comply with this transformation if certain elements are touched upon in the Green Deal. It needs to be recognized and acknowledged that the climate neutrality goal is only attainable if social policies are taken into account. In the following chapter we will reflect upon those policies.

At the heart of our vision and strategy lies the transition towards a clean energy system, where decentralisation is a central concept of our vision. Currently, in order for our vision to become reality it is important for the port of Rotterdam to transition towards a clean energy system. If not, the pollution will only increase due to the rising energy demand and the surroundings of the port will stay an unpleasant place to live. To conclude, the main focus points of our vision are good health and well-being, affordable and clean energy, industry innovation and infrastructure, sustainable cities and communities and partnership for the goals.

GOOD HEALTH AND WELL-BEING

Human beings, as well as flora and fauna, are the centre of concern for sustainable development and human development. Fossil fuels pollute the air, water, and soil. Hazardous concentrations can cause deaths and illnesses. This includes wildlife in and out of the water. River deltas are especially contaminated since the river picks up chemicals on its way downstream.

Our vision put liveability aspects at the centre of our vision. In order to meet the needs of the population in South-Holland it is important to assure a healthy and liveable living climate.

The goal of our vision is to touch upon the target formulated by the SDG indicators. By harvesting energy from sources that do not burn up finite materials and pollute (such as geothermal, wind and solar), the health of residents living nearby the port is no longer compromised. In 2030, the number deaths and illness related to these hazardous chemicals and air, water and soil pollution and contamination, will substantially be reduced. Transitioning away from the petrochemical industries will eventually result into a reduction in health risks.

The vision enforces the extention of ecological networks by integrating natural landscapes with industrial, rural and (sub)urban landscapes, in order to make these natural landscapes accessible for as many lifeforms as possible and increasing biodiversity. Bringing people in to the shoreline to enjoy nature rather than plastic garbage.

The transition comes with the creation of a new employment and education sector that will increase the sense of belonging and prosperity among the region its residents, employers and employees.

AFFORDABLE AND CLEAN ENERGY

Our vision is focused on implementating and substantially increasing new forms of energy, based on renewable energy sources. However, constructing them requires material and energy, which cannot be retrieved back (currently) in the demolition process. As an urban designer, it would be responsible to consider what is left behind for future generations after the solar panels and windmills of today complete their life cycle.

By decentralizing the energy systems, the country of the Netherlands will be less dependent on the port of Rotterdam as its main energy production source. Geothermal, wind and solar energy can be extracted on a smaller, more local scale, focussing on the local potential and demand, which relieves the pressure on the port region. Private energy production, such as solar panels on the roof, can be connected to a smart energy grid, in order to recoup initial installation costs, as well as keep energy affordable. In this way regions can be more self sustaining and be less dependent from future fossil fuel scarcity and global fluctuations.

Becoming self-sufficient does not mean energy will stop fluctuating in price, but fluctuations will be smaller in attitude and frequency than the existing petroleum model. Energy storage can balance seasonal and daily irregularities further, making the energy price more stable.

INDUSTRY INNOVATION AND INFRASTRUCTURE

In the future, the character of the harbor will stay in place as an industrial throughput hub. Instead of foreign petroleum, biomass and energy will flow to the port where it will be stored and processed. By 2030, upgrade infrastructure and renew industries to make them sustainable, with more efficient use of resources and greater adoption of clean and environmentally friendly technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.

In the South Holland region, this will be done by reusing existing infrastructure and pipelines. Efficiency will be increased by the use of a smart grid to which multiple energy sources can be connected.

In this model, biomass will not be incinerated as this causes harmful pollution. Suitable biomass (like manure) will be stored in air-tight terminals, where fermentation produces hydrocarbons that can be used as an alternative to petroleum for heating or the manufacturing of plastics. Low spatial efficiency means biomass should not be considered as the key for circularity. Innovation is found in combining themes for an intervention. For example, the continuous green corridor needs to cross the inlets of a portion of the harbor basins. By building a dam here (the slow traffic goes over), the basin itself can be used to store water and indirectly energy (letting water rush in to harvest hydropower, pumping it out to gain potential energy for later).

It is also important to strengthen scientific research, improve the technological capacities of industrial sectors in all countries, especially developing countries, including, by 2030, boosting innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending

SUSTAINABLE CITIES AND COMMUNITIES

By decentralising the energy system the province of South - Holland and the cities are less dependent on the import of fossil fuels. Since the energy is locally generated the cities become more resilient. This spreads external effects across the landscape. Pollution or spatial impact will not be as concentrated, but the same applies to jobs. The loss of jobs in the harbor should be (partly) compensated by introducing a new biomass industry. For the periphery, extra jobs can halt the outflow of young people to cities, keeping communities and cultures in place.

Through the integration of decentralized energy systems citizens become more involved in the energy production process. Since the energy is locally produced the cities and their neighborhoods will become more inclusive. Additionally, local energy production adds to resilience as it limits external influences (economic and political). By using this decentralized energy system, we are dependent on multiple green energy sources. The green energy transition is only possible with an energy production mix. This decentralized energy transition thus ensures sustainable cities.

PARTNERSHIP FOR THE GOALS

Petroleum firms cannot be expected to start the transition without an economic incentive as gas and oil are safe options to make money: they have undergone development for ages, the national infrastructure has been built around them and they are relatively cheap in the first place. The province can stimulate the willpower to change in multiple ways. This requires good cooperation between different industries in the port, and encourage polluting companies to make the transition together. Knowledge hubs must therefore be involved in the transition to help companies retrain employees.

A strict and firm attitude should be used as a last resort, when deadlines have passed or the company actively obstructs the transition. Stakeholders that dare to pioneer can get rewarded with subsidies, or taxes can be put on polluting petroleum companies. While similar, as the consumer will indirectly pay for these taxes, there are existential differences between these methods. Taxing will be in line with the polluter pays principle, but economically vulnerable groups might not always have the luxury to pay more for a circular product and will relatively carry a bigger burden. It is therefore important to involve the vulnerable stakeholders more in the transition process so that the burdens are more evenly distributed.

The broad task ahead sketched by this project can stimulate stakeholders in getting involved and seeing opportunities (also the risk of missing out, as the power balance between companies is about to shift).

INDIVIDUAL REFLECTION

JASMIJN HOFMAN

This reflection answers the question: 'What is the relationship between research and design in the group project?'

The problem that needs to be addressed in the future is clear. In the future it will no longer be possible to use fossil fuels as this is harmful to the environment. If we continue in this way, it will seriously affect life on a daily basis.

Creating a future without fossil fuels is a more difficult task. Plastic production is dependent on petroleum and the alternatives are not without drawbacks. Renewable sources for sustainable energy also have disadvantages and are sometimes not yet further developed.

Research is almost always the basis for a design and this is no different during this design project. During the research, weaknesses, threats, opportunities and strengths are found that can be addressed during the design strategy. This project has given me insights that it is important to conduct research through design throughout the design process. Since not all specific analysis can be done at the beginning of the project. I also learned that it is important to reflect and look back after every big step that has been taken. In this way, we as a group continued to critically examine the steps that were taken and, if necessary, adjusted. And to see what impact this has on the environment and stakeholders.

However, this project is not only a spatial issue but also a technical issue. During the research we were quickly drawn into the technical issue. It is important to have more information about the technical transition to be made, but this ultimately had to be mapped out spatially.

This was a difficult transition for the entire group to make. These are the points in the process where teamwork is important. It is therefore sometimes difficult that we have not seen each other much because of the COVID-19 crisis. Nevertheless, we have had a lot of contact with each other, and during this project I learned a lot from the experience and knowledge of my teammates. My teammates have more experience with processing research and making the transition to a spatial vision and design. Because of this I have grown further as an urban planner and I am more aware of the importance of integrating research into your design. Not only did I develop myself more as an urban designer during this project, but my other teammates also gained more knowledge and experience from each other. Exchanging experience and knowledge is therefore the most valuable element of this project and we will contribute throughout our career.

To create a future in which fossil fuels will no longer be used and spatial justice, liveability, self-sufficiency, economic competitiveness and sustainability come together, a balance is needed between research and design. Research and design are not separate elements that arise consecutively in the process, but are elements that stand side by side and can be found throughout the design process. It is therefore important to continue to reflect and investigate throughout the process.

INDIVIDUAL REFLECTION
KIMBERLEY NGUYEN

The starting point of this project were the following five words: "Towards a biobased chemical sector". The end goal was quite clear, but the process in order to get there was way more complex. The first few weeks were mainly focused on trying to understand the reason why society needs to transition towards a biobased chemical sector, therefor a lot of research had to be done. The research scope was so broad, that the group took this as an opportunity to use eachothers strenghts and skills to specialize. As we saw research and design as a scale, rather than two different things, we were able to complement eachother and learn from eachother in order to support our design choices with research, as well as the other way around.

Social, economic and environmental trends, as well as the Dutch spatial planning system, existing material and energy systems and flows, had to be understood in order to start designing for the complex region of South Holland. This shows the importance of research, especially when you're trying to solve a problem that consists of overlapping disciplines, such as regional design, urban design and petrochemical processes. Using data for mapping is a great tool in order to point out current social, economic and environmental problems and where they are specifically located within the region.

While working on a regional scale, in this case the province of South Holland, it is important to keep designing through the scales. What kind of impact do the proposed strategies have on the province, as well as on the residents and animals near the port of Rotterdam? What does that mean for the employers and employees currently working in the polluting industries? How do you deal with so many different interests? We tried to include as many different stakeholders into our vision and tried to propose a vision that has a spatially just effect on every party living or working within the region, by looking at the problems, the transition and the desired end result from multiple perspectives.

The role of our proposed vision is to inspire the province of South Holland and its stakeholders, to open their eyes for the spatial implementations of the new sustainable possibilities for reviving and integrating the harbour area into the public realm. To make them optimistic about the future developement and to hand them a framework that could help them redevelop the area in the future. I personally see our role as designers and planners as inspirators for change, focused on the process and advocacy aspects, in order to help the province and stakeholders see outside of the box and how we can use design strategies to tackle such complex problems as the energy transition. To help them see how policies can bring such change towards the desirable future vision that we proposed. Ofcourse, the way that stakeholders perceive existing problems and their roles can change over time, but I believe that our vision can help them make a step towards a transition in the right direction, that's not only profitable for themselves in the current situation, but also provides a profitable, inclusive, spatially just future for all parties involved, in 2050 and beyond.

INDIVIDUAL REFLECTION
DOUWE DOUMA

In this individual reflection, the learning process for courses U86 and U88 will be put under a magnifying glass. To make the evaluation critical, different perspectives (such as methods, personal- and interpersonal context) are considered.

Concepts, theory and methods

Tuesday and Friday mornings consisted of zoom meetings with the R&D advisors. On Thursdays, lectures and discussions for the methodology course filled the afternoon. Planning wise, this meant preparation work for the studio on Friday couldn't wait until the last moment (or would fall short).

The quarter passed by quickly, as we moved from analysis to vision and strategy. At the start, I am glad we were given time to get familiar with the matter, because making petroleum industry circular can be approached from a wide range of angles and scales. Additionally, it is not a subject that is touched upon before in the bachelor. Looking back, coming up with a cohesive story that would be greater than the sum of its parts (a common denominator for the spatial, societal, economic and technical transition) could bring the project to a higher level at this stage.

Interaction with others

Because the design course was a group effort, a lot of poldering (coming up with a plan everyone could agree with) was required. For this purpose, meeting on campus on Wednesdays was ideal. It is without a doubt more fun and inspiring than deliberating through a webcam, which might be why I am less talkative in front of a screen (especially early). Because communication is so important in this field, this is where I should look to improve foremost. For starters, stronger coffee in the morning is worth a try.

Personal thoughts and actions

A praise about how the course is set up: you can choose a subject that interests you the most. The transition away from fossil fuels is more technical than earlier urbanism subjects, which limits creative freedom, but isn't this how it should be? The energy transition will come at an economical and spatial cost. From a personal view, urban planners and designers should not join petroleum companies in glossifying up the challenge (by not taking into consideration technical data and properties). A spectre is, in my opinion, useful to create awareness for the amount of change that is required to replace fossil with renewable sources. Because elections for the national government were held during this quarter, it was especially interesting to compare our energy ambitions and phasing to those of political parties. Finally, I would like to thank the group members and the teachers for their involvement, constructive feedback and the positive learning environment.

JESSICA STOLK

In this personal reflection I review our regional design process based on the four characteristics of regional design as proposed by Jeroen van Schaik (2021). The first principle is continuous re-interpretation of territory and societal challenges based on changing context, the local, regional, national, international and global (Schaik, 2021). Our design process started off with background research on the chemical sector. We identified problems based on different scales, to really understand the depth of the proposed challenges. Since the main component used in the chemical sector is oil, we quickly realised that in order for this industry to become circular we would have to change the petrochemical industry. Next, we evaluated what the impact of the petrochemical industry is on a more local scale and mainly looked at the port of Rotterdam. During the entire design process we re-evaluated the problem statement, to assure our design would fit the problem. So, I think it could be argued that as a team we succeeded on the first characteristics of regional design.

In building our vision we tried to envision a future which was desirable and probable, meaning that it was ambitious enough so stakeholder would get motivated and inspired. But, also that stakeholders knew that it was achievable. According to van Schaik (2021), this should be the role of regional design planners. In order to achieve our proposed vision we tried to incorporate the second characteristic of regional design, interactively dancing though spatial scales (Schaik, 2021). Meaning, we not only propose a strategy based on one scale, but really look at all possibilities on different scales. This concept can be mainly applied to green corridor intervention, where we first proposed the green corridor on a more local scale, by connecting the rural area around the port with the city. Next, we looked at the possibility to connect the green corridor with the rest of the province and approach the design challenges more from a regional scale.

The current urban design challenges can be described as wicked problems, which require collaboration between different actors to be solved. It requires multi level governance, as proposed by Marcin Dabrowski (2021) in his lecture. The importance of connecting governance, planning and regional design, and seeking alliances between them is also recognized by Jeroen van Schaik (2021), and therefore the third characteristic of regional design. In our strategy we see an important role for the government in accelerating the transition towards a fossil fuel free industry and circular world. However, we do acknowledge the importance of the current companies and in our strategy we highly value cooperation between different actors. It is only through cooperation we can make this transition.

To conclude, the assignment we were given by the Province of South-Holland was challenging. It took us some time to understand the spatial impact of the transition towards a bio-based chemical sector. However, after all and now evaluating the step we took based on the proposed regional design strategy characteristic I think we can argue that we did a great job.

INDIVIDUAL REFLECTION

BJARNE VAN DER DRIFT

As the last week of the course comes to an end, it is time to look back and reflect upon the work that has been done. For me personally, the courses in this third quarter of the MSc. Urbanism programme turned out to be the most challenging so far. While my background and experience as a graduate of the MSc. Architecture program was more useful in the first semester, it required a new perspective and set of skills to be able to come up with a regional design strategy. Moreover, our group had to familiarize ourselves with a theme of a highly complex and technical origin of the energy transition. It took us a while to get a solid grip on the matter, in order to really understand the challenges at hand. In retrospective, I found the input of the lectures a vital element to get acquainted with our subject, especially the q&a session that we had with Carola Hein.

As a result of the struggle that we were faced in the first weeks, we did not fully succeed to present a coherent vision at the mid-term. Our plan so far missed hierarchy and it reflected in the discussions that we had. However, in the weeks that followed, we started to feel more equipped and confident with the knowledge that we acquired, meaning that we were able to draft meaningful conclusions from our analysis, and managed to really translate concepts of technical systems into spatial ideas. In my opinion, this step turned out to be crucial to align the scope of our challenge with the setup of the R&D studio. In the end, I think it is a fair conclusion to state that we spent too much time in the inventorisation and analysis of data, in comparison to the time that we actually used to develop our strategy. On the other hand, I sincerely believe that we needed to thoroughly understand the technical component of our challenge to make our design relevant.

Speaking about relevance, many scholars and policy makers are aware of the extremely urgent nature of the energy transition. This means that a great amount of previous research had been conducted on this topic. In my opinion, the spatial component, especially the human scale, of the energy transition appears to be underexposed in the discourse of current policy documents by governmental organisations. Spatial interventions often remain anecdotal, which implies that the specific context of a location seems to be of lesser importance. In our strategy, I believe that we made a step in the right direction in this regard, by specifically orienting our strategies towards a certain type of landscape. However, we did not manage to propose interventions in location-bound case studies. The highly contingent nature of the energy transition hardly caters for this type of design.

To conclude, I am pleased with the setup of this quarter. The combination between a design-oriented course and the academic basis of the methodology course was very helpful in order to come up with a structured process. The clear-cut organisation of the methodology course created order in an otherwise chaotic process, of which I learned over the past weeks can become quite chaotic (partly due to the Miro and Zoom-based workflow).

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