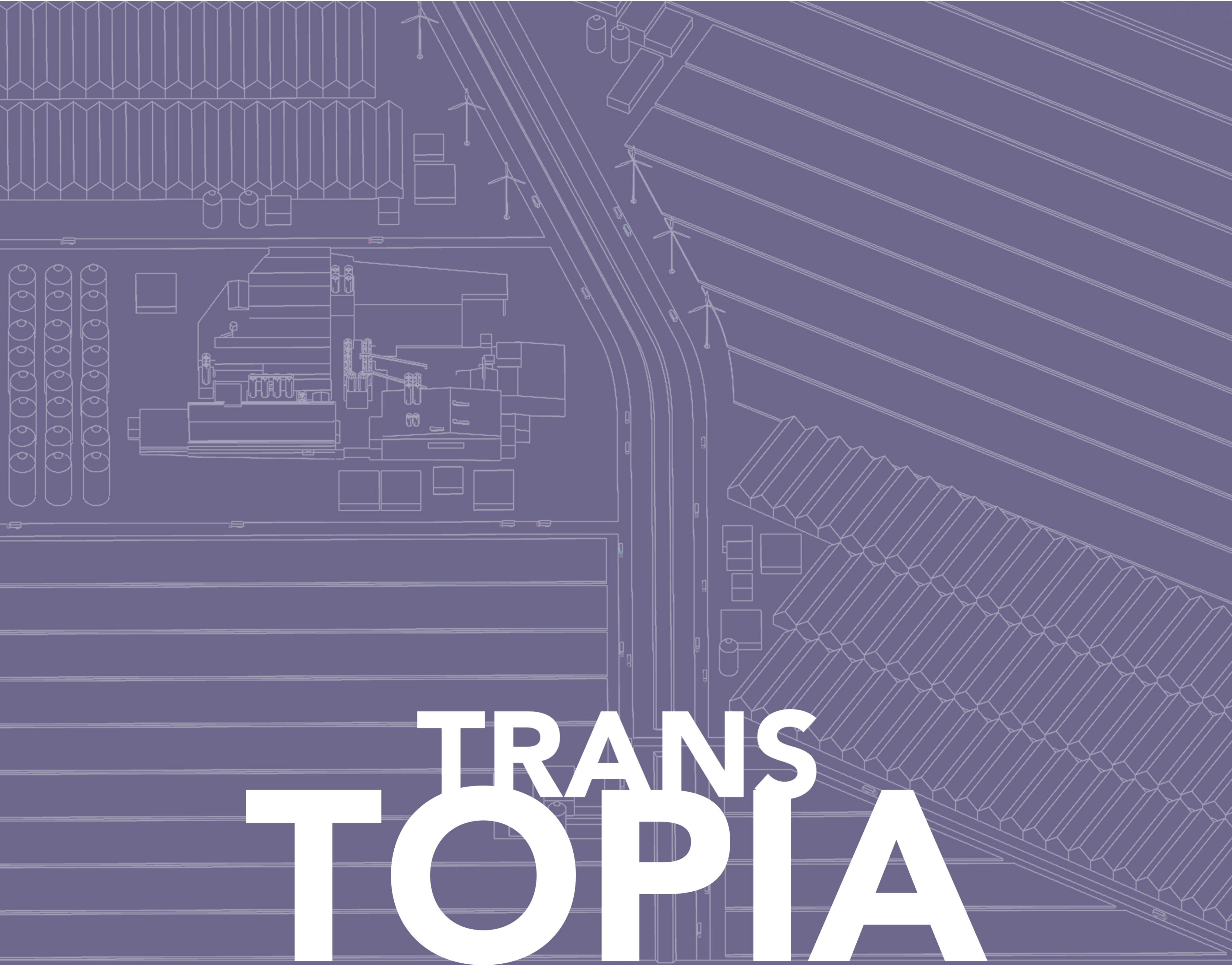

TRANS TOPIA

ZUID HOLLAND

APRIL 2022

Activating the energy transition through a synergy of landscapes

Delft University of Technology . MSc Urbanism (Architecture, Urbanism, Building Sciences)
Quarter 3 . AR2U086 R and D Studio . Spatial Strategies for the Global Metropolis
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TRANS.TOPIA

activating the energy transition through a synergy of landscapes

"Trans.topia"

Meaning: *Transformative landscapes or landscapes in transformation*

Etymology

Compound word: ***Trans + topia***
1. Trans: From the transformation, the metalaxis, the change
2. Topia: From Ancient Greek **τόπος (tópos)**, *"place, landscape" [EN]*

Refers to the transformations explained in the report
Trans.time, Trans.systems, Trans.energy, Trans.landscapes

ABSTRACT

The Port of Rotterdam has always been a pivotal player in the energy sector. Predominantly in the oil-based generation of energy and the consequent export of raw material. However, there is a need for a systemic shift in the energy sector as the Netherlands embarks toward its goal to become 100% carbon neutral by 2050. An analysis of the prevalent scenario revealed that the fossil-based energy production systems are not only embedded in the physical infrastructure of the region (Zuid Holland) but also in its social, economic and geopolitical networks. This means that as we phase out fossil fuels, its implications will be witnessed on both the local as well as global scales. Keeping this in mind, ***"Transtopia"*** aims to accelerate the transition towards renewable energy (production+consumption) by proposing synergies between the Port of Rotterdam and the rest of the Zuid Holland region. Primarily, by decentralizing, diversifying renewable energy production, and activating the potentialities of its regional landscapes to harness energy. It proposes endogenous methods of co-creating energy landscapes aimed to establish a resilient and adaptable energy system. One where all sectors of society (civil, public and private) can contribute and play an active role in facilitating this transition. Consequently, the spatial relations between areas of energy consumption and production can be seen as activators of urban development in Zuid Holland. Not only by strengthening the economic resilience of the region in face of the energy transition, but also ensuring social integration in this change by co-creating new infrastructure initiated by a collaboration of active sectors.

key words: *Energy Transition. Zuid Holland. Renewable Energy. Port of Rotterdam. Resilience.*

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01

INTRODUCTION

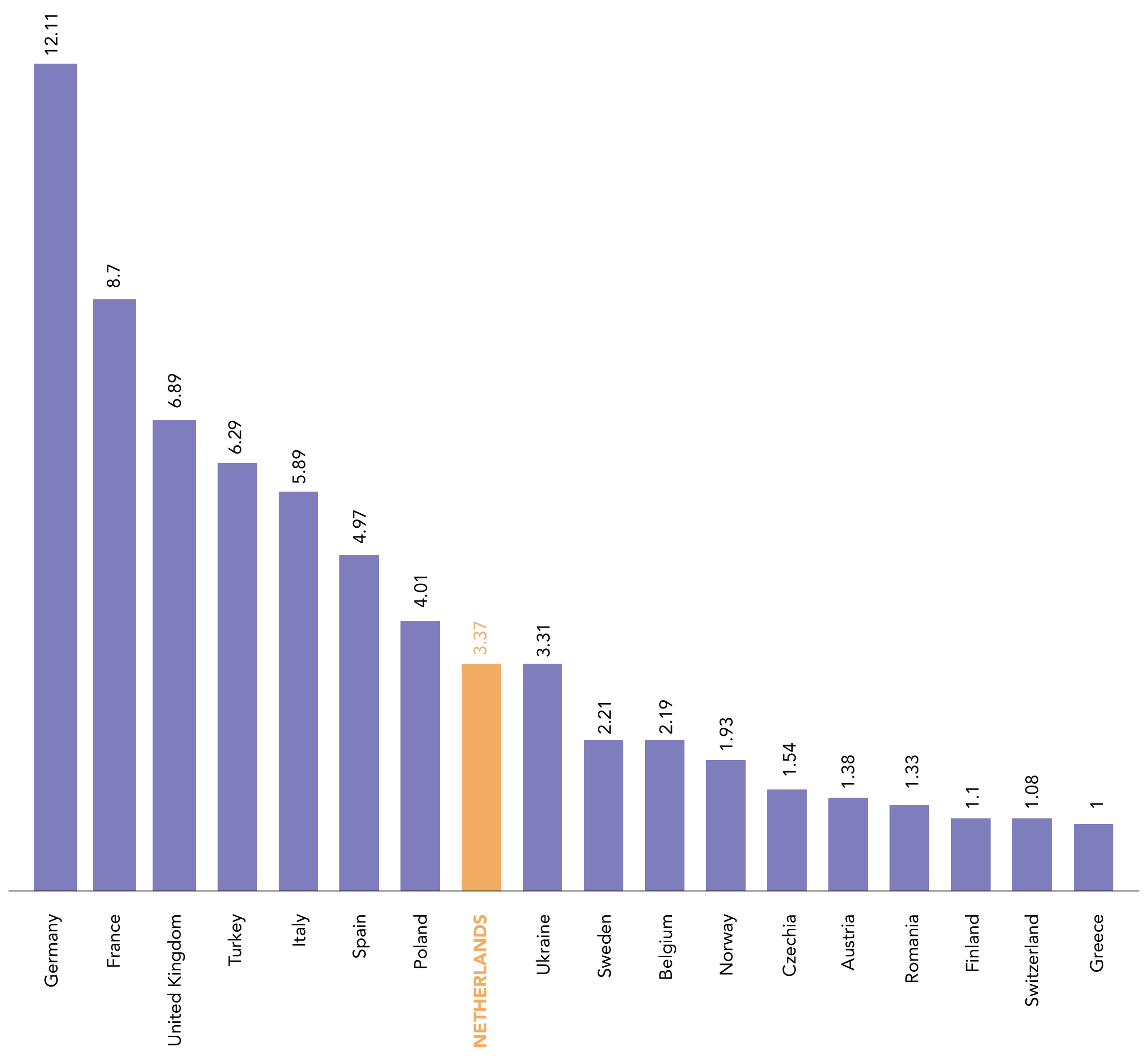
1.1
CONTEXT

For centuries, the Port of Rotterdam has been a critical player in the energy sector. Besides being Europe's largest port, it is also home to a vast industrial network and associated infrastructure. Which includes petro-chemical terminals and refineries, deep-sea terminals, offshore wind connections, and energy supply infrastructure that services the whole of Northwestern Europe. However, with an increased awareness about the negative externalities of the use of Fossil Fuels, the Dutch Government along with the Port of Rotterdam have defined a vision of becoming Carbon Neutral by 2050 (National Climate Agreement, 2019). An Energy Transition which means to phase out from the use of Fossil Fuels to Renewable alternatives of energy productions.

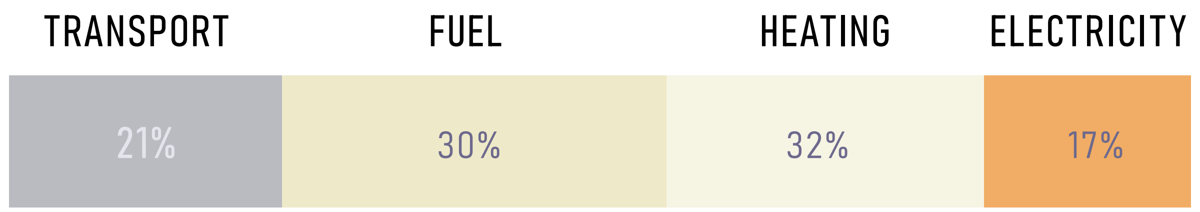
Today, virtually every system requires energy to function, from individual/household consumption to large-scale manufacturing industries. The global energy consumption has been increasing consistently for the past few decades. Today, fossil fuels cater to over 80% of the global energy demand (BP, 2021). The Netherlands alone consumes 3.37 ExaJoules of energy, ranking 8th in the whole of Europe for consumption of energy (BP, 2021). With a significant amount of energy consumed by solely the industries and the the Port, making it important for the Port to play a pivotal role in this energy transition. On the other hand, the rest of energy consumed is distributed across a large area and an assortment of sectors, from cities, services, buildings, cars, etc. Thereby coupling the energy transition with social inclusion and change in societal attitude.

Besides the influence of this transition on the energy consumption and production, it simultaneously also influences the spatial, social, environmental, economic and geopolitical relations of the region. All of which will be reshaped by the Energy transition.

Ultimately with climate change at the helm of all impediments, there is an acute need to accelerate this transition towards a less polluting energy manufacturing system. With temperatures rising by almost 1.5 degrees every year (IPCC, 2018) coupled with sharp weather extremities, among other implications, the demand for energy has only increased - setting in motion a vicious consumption cycle. Which only re-enforces the need to initiate strategies that accelerate the transition to renewable energy.



ENERGY CONSUMPTION BY COUNTRY IN EUROPE
Source: BP (2021)



ENERGY CONSUMPTION BY USE IN NETHERLANDS
Source: CBS

1.2

PROBLEMATIZATION

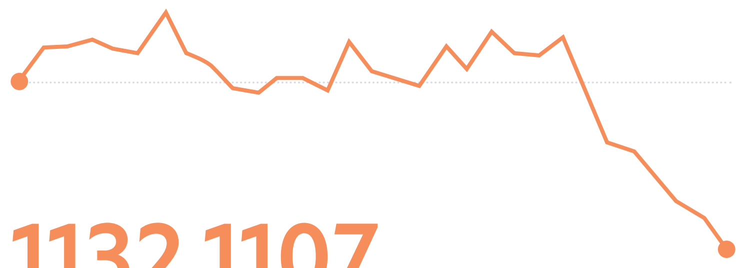
As established before, the Fossil Fuel Industry is deeply embedded within the Port and the region of Zuid Holland. This is not just in terms of physical infrastructure or energy consumption but also affects social, economic, and geopolitical relations. This means as we phase out the use of Fossil Fuels, there will be a manifold of implications in virtually every sector of the region. What we are faced with is a double task - to not only switch to renewable energy sources but also cater to the negative externalities of phasing out of fossil fuels.

Prevalent Energy Sector and Environment:
The energy transition is a pathway toward the transformation of the fossil-based energy sector to zero-carbon by the second half of this century. At its heart is the need to reduce energy-related CO_2 emissions to limit climate change. In the context of the Port and Zuid Holland, the region imports raw materials and produces and supplies products with an annual energy content of more than 2,000 petajoules (PJ) (BP, 2021). Approximately 260 PJ of energy is used in the production processes (Linde and Stapersma, 2018). Almost half of this energy input comes from the residual gases from the refineries, an almost equally large part is natural gas from the gas network, and in addition, a small part is energy from residual waste and electricity supply from the network. This energy consumption leads to an overall CO_2 emission of 18.6 megatons (MT) (2016). Thus decarbonisation of the energy sector across scales is required to mitigate the effects of climate change. Renewable energy in combination with energy efficiency measures can potentially achieve 90% of the required carbon reductions.

Energy Sector and increase in Demand:
Zuid Holland is one of the highest consumers of energy in the whole of the Netherlands. The presence of extensive greenhouses, large cities like the Hague/ Rotterdam, and above all the Port of Rotterdam in this region contributes to its heavy consumption of energy. The port alone consumes a significant amount of energy as it is a host to about 120 industries, almost all of which are powered by fossil fuels (Port of Rotterdam, 2021). To top this exorbitant non-renewable energy consumption, the country is projecting a population boom in the near future. This again translates into an increase in the energy demand, as the nation faces the task to build 1 million new homes (TU Delft, 2021) and thereby eventually power them.

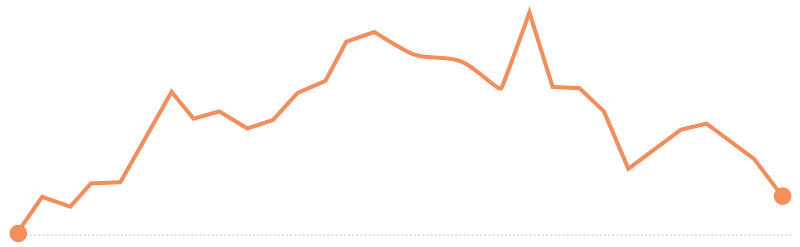
Single source of Energy:
Currently, 89% of the energy demand for Zuid Holland is solely met by fossil fuels, making the energy system rather vulnerable and economically unviable. Especially if we run out of raw material or in the case of future energy transitions, given that we intend to become carbon Neutral by

ENERGY PRODUCTION
TJ



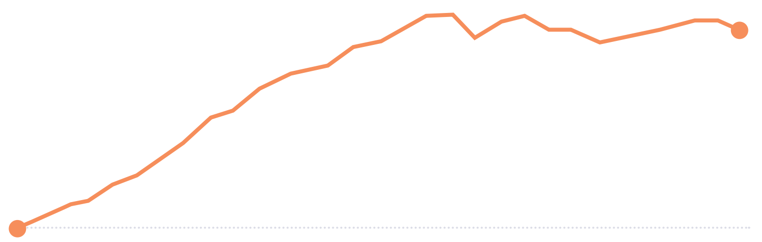
1132.1107
↓ -55.35% from 1990

TOTAL PRIMARY ENERGY SUPPLY
Mtoe



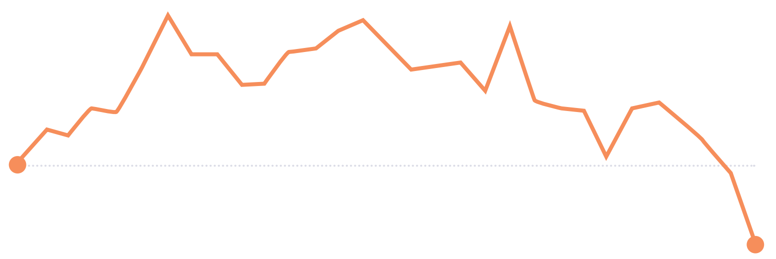
69.41
↑ 4.34% from 1990

ELECTRICITY FINAL CONSUMPTION
TWh



114.76
↑ 40.08% from 1990

TOTAL C02 EMISSIONS
Mt of CO2



134.72
↓ -8.84% from 1990

Source: IEA.org

curbing the use of Fossil Fuels by 2050. Hence renewable means of energy production will have to be explored, to not only meet the prevalent energy demand but to sustain as an adaptable and resilient alternative for the projected future.

High Dependency on External sources for Energy

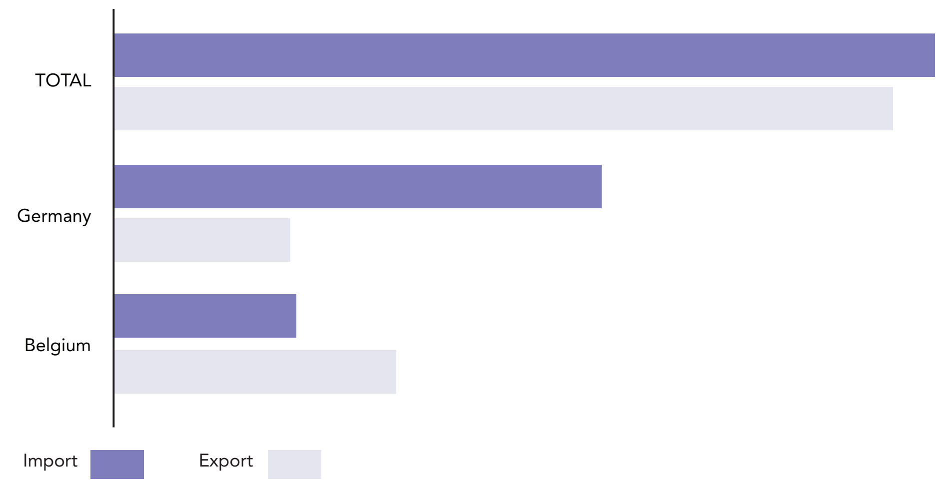
Presently, a significant amount of the National energy demand is met by importing fossil-based raw materials from places like Russia and U.S. to produce energy. Currently 19.77 billion kwh of energy is imported and 22.43 billion kwh of energy is exported (CBS, 2021). This makes us economically dependent on other countries for our energy supply leading to higher energy costs and a supply vulnerable to fluctuating geopolitical situations. Additionally, the very process of importing raw material and energy is rather environmentally harmful and non-sustainable as it is transported across seas through large ships.

Energy and Economy

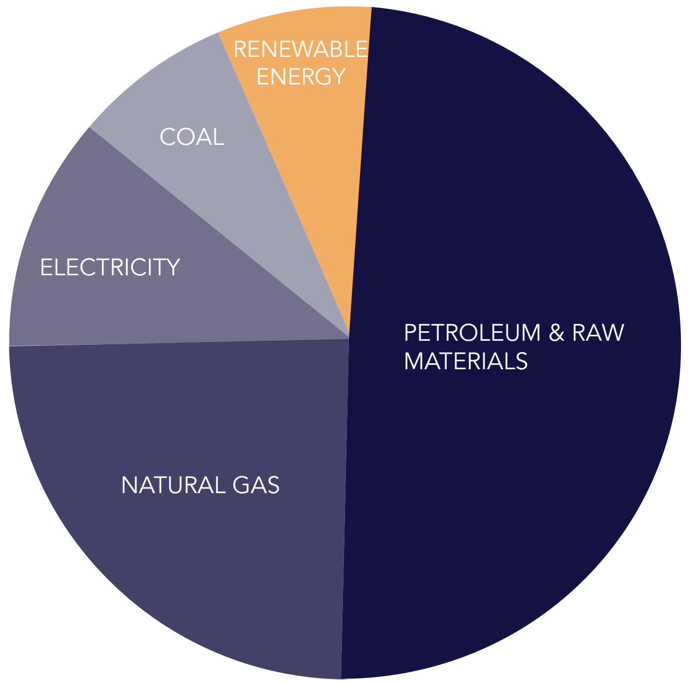
Currently, 14% of the GDP of the Netherlands is dependent on the fossil fuel industry. Thus in case of phasing out of non-renewable sources of energy generation, the national economy will get affected. Additionally, to support this energy transition all of the oil-based manufacturing systems in the port, the distribution networks as well as the allied industries, will have to get on board to undergo a rather expensive transition as we curb the use of fossil fuels. Especially for all the refineries and fossil infrastructures in the Port that will become redundant as they cannot be re-purposed for other functionalities. Making a rather unconvincing case for promoting the transition towards renewable alternative energy sources.

In conclusion, it can be said that the transition to renewable energy is inevitable as eventually, fossil fuels will become non-existent as they are a depleting source of energy. Not only is the transition to a renewable energy economy more efficient and resilient, but it is also a requirement by the 2019 Climate Act. According to which the Netherlands is required to lower greenhouse gas emissions by 95% and for all electricity generated to come from renewable sources by 2050 (IEA.org, 2021). The Netherlands ' economy, especially the port of Rotterdam, is heavily linked to the fossil fuel industry. As the transition to renewable energy will proceed, the existing fossil fuel landscapes and infrastructures will become obsolete, or termed as waste landscapes.

"The transition to sustainable energy means that our energy system will change radically. We will be working with new energy carriers, such as heat and hydrogen, and many innovations are needed for storage and control." (The Green Village)



IMPORT AND EXPORT OF ELECTRICITY 2021
Source: CBS



INDUSTRIAL ENERGY CONSUMPTION
Source: CBS

1.3
PROBLEM STATEMENT

Currently, we are faced with the double task of phasing out from the use of fossil-based energy while catering to the negative externalities of switching to renewable alternatives. Thus the challenge at hand is establishing an equilibrium between the demands of the economy, environment, and society during the energy transition.

Source: EJAtlas

02

METHODOLOGY

2.1
RESEARCH QUESTIONS

How can energy transition facilitate innovation in future socio-spatial developments?

How can different sectors at the local, regional and global scale participate in the transition towards renewable energy?

How can Zuid Holland in symbiosis with the port transform into a renewable energy production system (in the local, regional and national scale) to accelerate the energy transition?

How can the Port of Rotterdam act as a catalyst for the energy transition whilst becoming a reliable, affordable and sustainable energy hub?

How do we accommodate the uncertainties of the future in the energy transition?

2.2
CONCEPTUAL FRAMEWORK

Trans-Topia strategizes the transition from a fossil-based energy production system toward renewable energy. Our approach revolves around three main concepts, 'Inclusivity in the energy sector', 'Resilience of the system', and 'Economic Growth of the region'.

Inclusivity in the energy sector
Inclusivity is to enable civil society, private and public actors to actively contribute towards the transition to renewable energy. It advocates and promotes equitable measures for an energy transition that recognises and addresses in a meaningful way its impact on economies, communities, and industries (Heffron, 2021). Here the energy sector not only includes practical systems of energy manufacturing (like storage, distribution, etc) but also its governance that constitutes legislation, evaluation, and implementation.
In the prevalent scenario, there is a strong monopoly held by private players in the energy sector both in terms of power as well as economy. Through our concept of inclusivity, we intend to make this system more collaborative and hence decentralize the power. While ensuring equitable distribution of responsibility and benefits of the energy transition within the sectors.

The choices, preferences, and behaviours of individuals and households have a direct influence on the energy demand. Mainly by shaping the acceptability and effectiveness of technologies, strategies, and policies to bring about a sustainable energy transition (A. Miller et. al, 2015). This call for inclusivity in the energy transition also means that no one should be left behind, especially civil society. Where every stratum has varying demands, needs and abilities to participate in the energy transition. Thus, there is a need to address these vulnerabilities and empower them.

This component of the framework aims at redefining the energy sector scope as not just about how to produce energy but about what energy production and consumption means for the diverse groups and communities who inhabit or are associated with the energy systems.

Through time, energy transition choices will reconfigure societies, even as societies reconfigure the energy systems. Especially at moments when new energy systems are brought into being or during periods when existing systems are significantly rearranged through the persistent evolution, growth, and embedding of energy into human affairs. Thus, we argue, that inclusivity in the energy systems is particularly salient for energy policy choices in the context of large-scale energy transitions.

Resilience of the system
"Resilience is the capacity of a complex system to be recovered after a sudden change of the indicator." (Afgan, Veziroglu, 2012)

In the context of transitioning towards clean energy production, energy resilience is of critical value. In our project, energy resilience is the ability of the system to withstand or respond to sudden changes. This ability is based on how robust the system is, how fast it can recover, and/or how strong its capacity is to limit the consequences of malfunctioning. All while still being able to provide an acceptable level of service. (Jesse, Heinrichs, Kuckshinrichs, 2019)

Since our project focuses on a vision for 2050, the main challenge during energy transition is the unpredictability of the future. More specifically, parameters that can deter the resilience of the system like oblivion to long-term changes in technology, environment, climate, and the evolving socio-political scenarios (National and International).

Resilience is crucial in Trans. topia, since the malfunction or the vulnerability of the system can affect all three concepts, inclusivity in the energy sector, economic growth and further geopolitical relationships.

Economic development of the region
The economy of the Netherlands, especially the Port is heavily dependent on the fossil sector, including the jobs created, manufacturing industries as well as the 'backward indirect' and 'forward indirect' effects.

Backward indirect effects are the added values as a consequence of port companies conducting business elsewhere in the Dutch economy while forward indirect effects are the economic activities that are made possible in the Netherlands due to the presence of the Port of Rotterdam, such as re-export via

logistics and distribution (B.Kuipers, 2018). However, on phasing out the use of fossil fuels, the foundation of this economic set-up will be disrupted. Thus there is a need for a strategic approach, that will ensure a healthy economy during the energy transition.
We want to make sure that the infrastructure, spaces and policies taken will not only accelerate the economy of the port but also boost the regional market.

Thus, laying the ground for the development of mutually beneficial relationships within the region and also between the region and the port where we will ensure that the monetary gains will be widely distributed. By expanding the influence of the renewable energy sector beyond the port to the rest of Zuid Holland, there will be an indirect forward effect that will not only boost the port economy, but also economically activate other sectors to benefit from it.

By establishing synergies between the three guiding concepts, Trans. topia aims to mediate negative externalities of the energy transition on the society, environment as well as the economy of Zuid Holland. By linking space and systems across the local, regional and global scales, we will unveil potentialities that will guide the project towards a just and holistic energy transition.

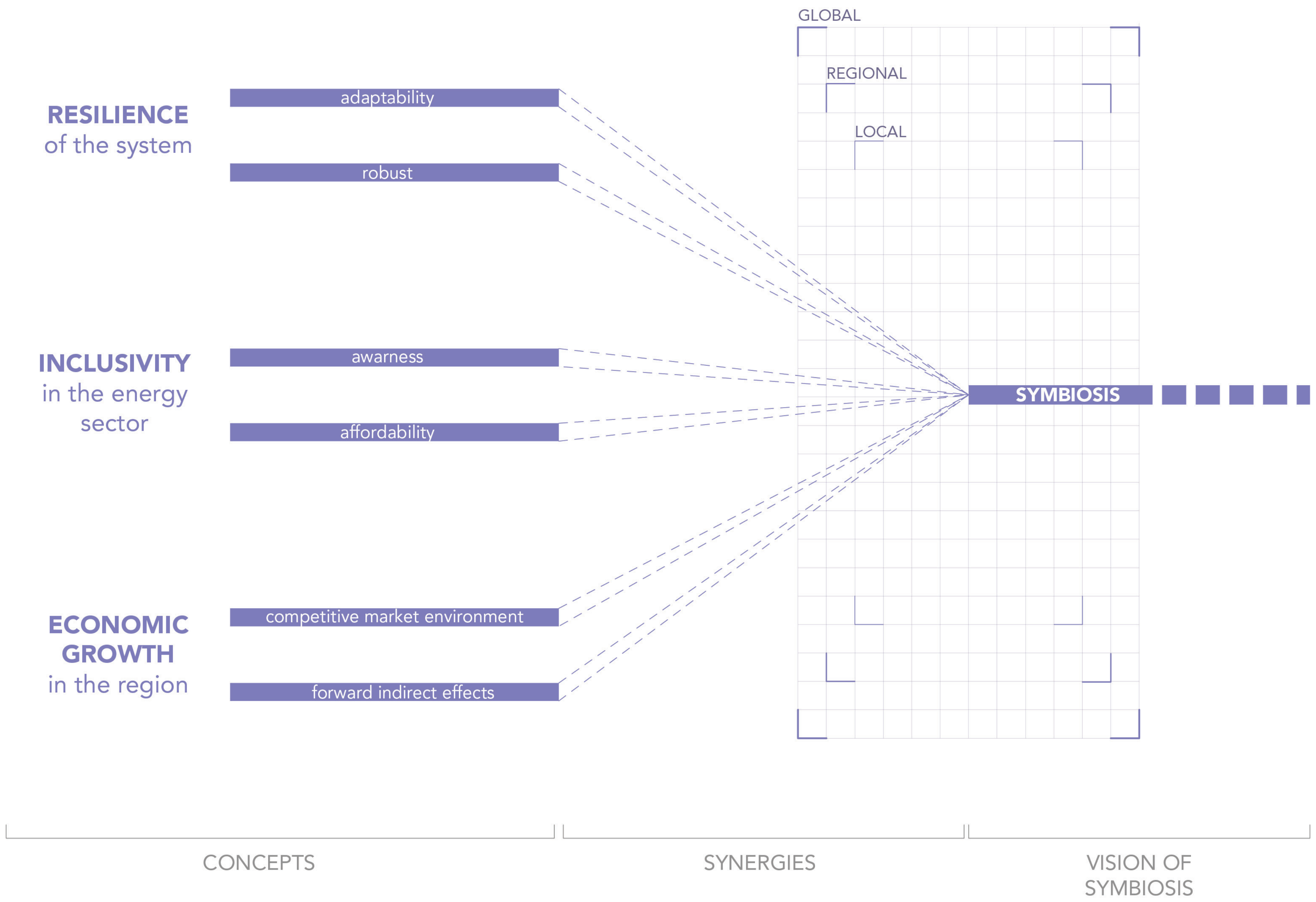


Figure 01. Conceptual Framework

2.3
METHODOLOGY

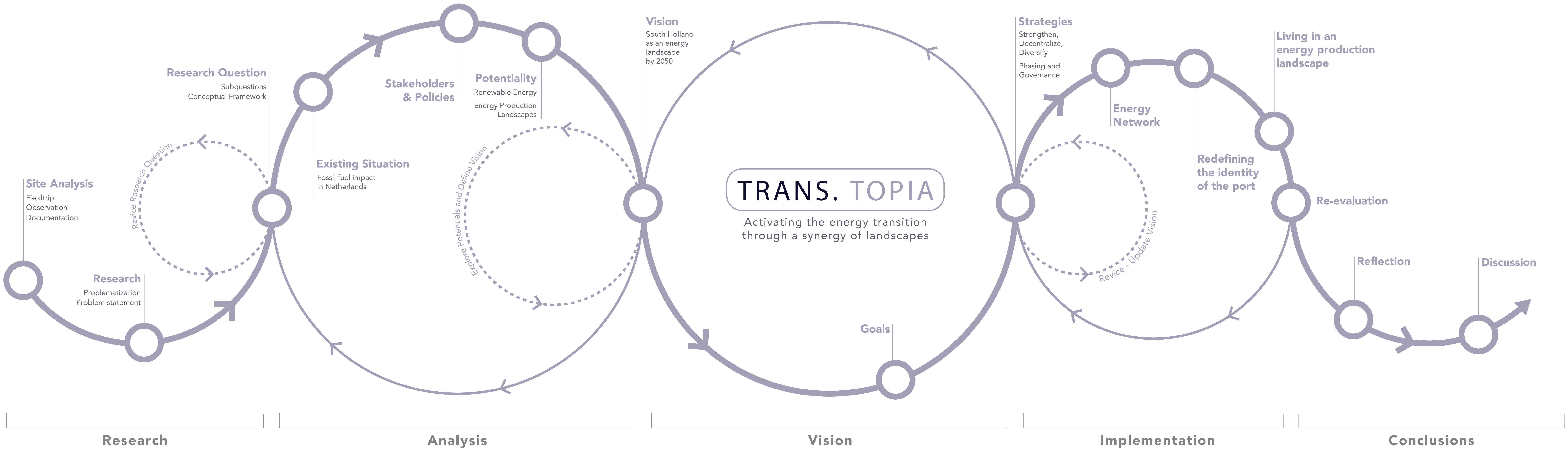


Figure 02. Methodology Diagram

03

ANALYSIS

3.1
FOSSIL FUEL IMPACT IN NETHERLANDS

THE GLOBAL NETWORK OF FOSSIL FUELS

The Port of Rotterdam, the largest port in Europe, is a critical factor player in the flow of goods and energy for the global market. Primarily acting as a global leader in the fossil fuel economy, supplying a majority of the consumed refined oil within North-Western Europe. It mainly distributes fossil fuels, with imports of crude oil and re-exports of refined oil for usage such as energy, plastics and various products for National, European and Global consumption (Port of Rotterdam, 2021). It imports crude oil from over 30 different countries around the world, ranging from Russia, U.K, Norway, U.S. and Kazakhstan (O.E.C.world, 2020) and is first stored and refined within the facilities in the port. Then is re-exported to countries like Germany, Belgium, Nigeria, U.S., and U.K., which can be seen in figure 03. Overall, the port of Rotterdam imports $32.1B in the trade value of crude oil.

This global network of distribution that passes through the Port of Rotterdam primarily happens via cargo ships, polluting the water and air with CO2 emissions. On a more European scale, oil and gas are transported via a pipeline network that branches through Netherland's neighbouring countries and further east.

As the Netherlands moves towards phasing out of fossil fuels, there is great potential for the re-use of existing distribution networks and infrastructure to supply other renewable forms of energy. As well as maintaining the current geo-political relations through the distribution of renewable energies via these existing systems.

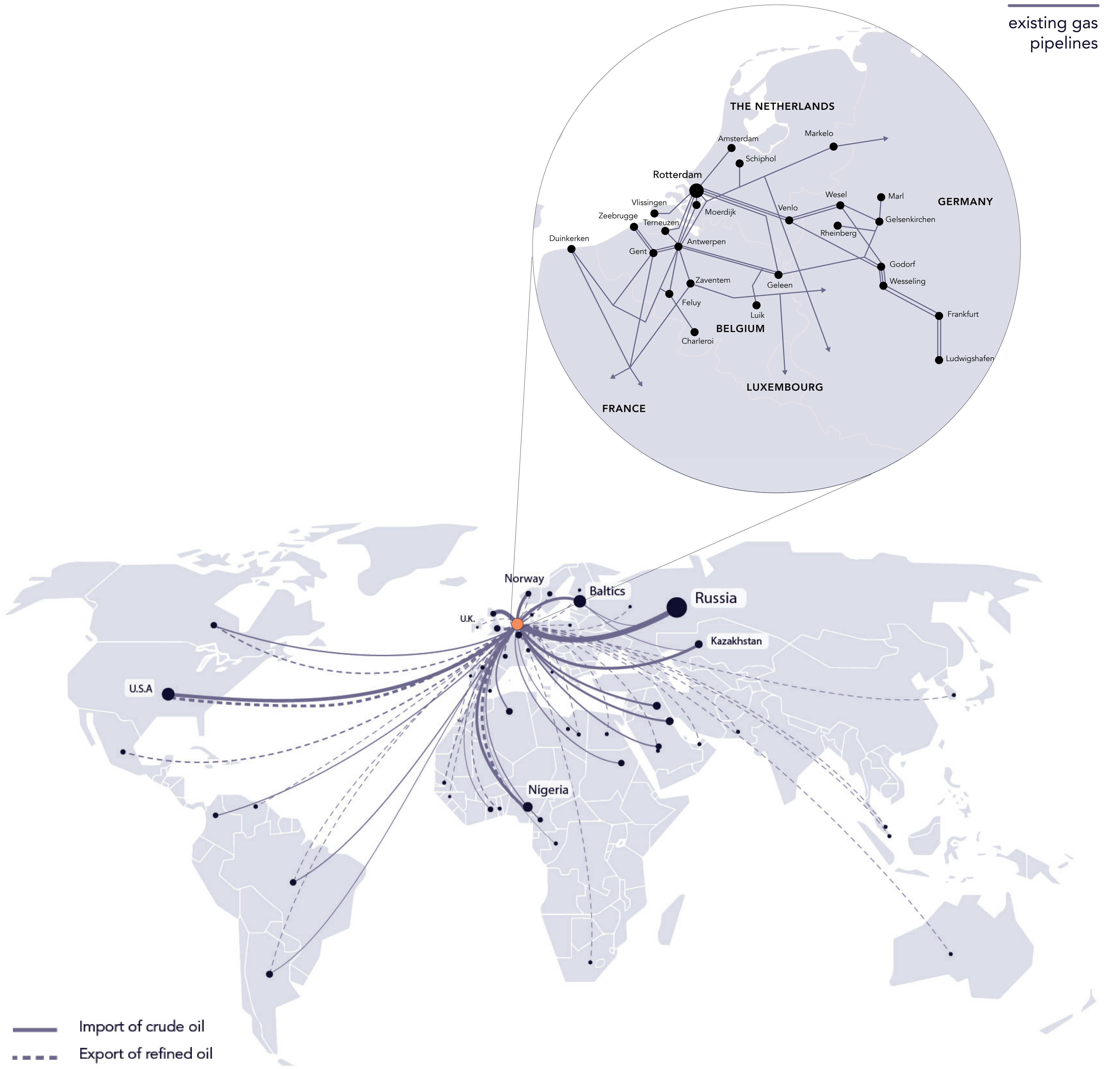


Figure 03. Global and European Networks of Fossil Fuels

THE FOSSIL FUEL IMPACT ON THE PORT

A large portion of the Port of Rotterdam is owned by various private Fossil Fuel companies such as Shell, BP, and Vopak. The physical infrastructure of the fossil fuel industries, oil terminals and oil refineries, seen in figure 05, is a major component of the port. As the port transitions from a fossil fuel-based industry, these infrastructures will become redundant and become waste landscapes, areas that hold no functional purpose for society. A large portion of these redundant infrastructures have the potential for transforming into functions, either related to renewable energy production or for societal needs. However, there is a need to treat the contaminated soi before use.
Switching to renewable energy will not only have a spatial impact, but will also affect many industries that are supported by the products produced by the oil refineries in the port. Crude oil produces not only diesel for the consumption of vehicles as a majority of the public assumes, but kerosene for aviation fuel, naptha for plastics, petrochemicals for medicine, and bitumen for laying down asphalt, seen in figure 04.

The transition to renewable energy will be critical in supporting industries that depend on the products that come out of refining oil in the port and in transforming the wasted landscapes for other functionalities.

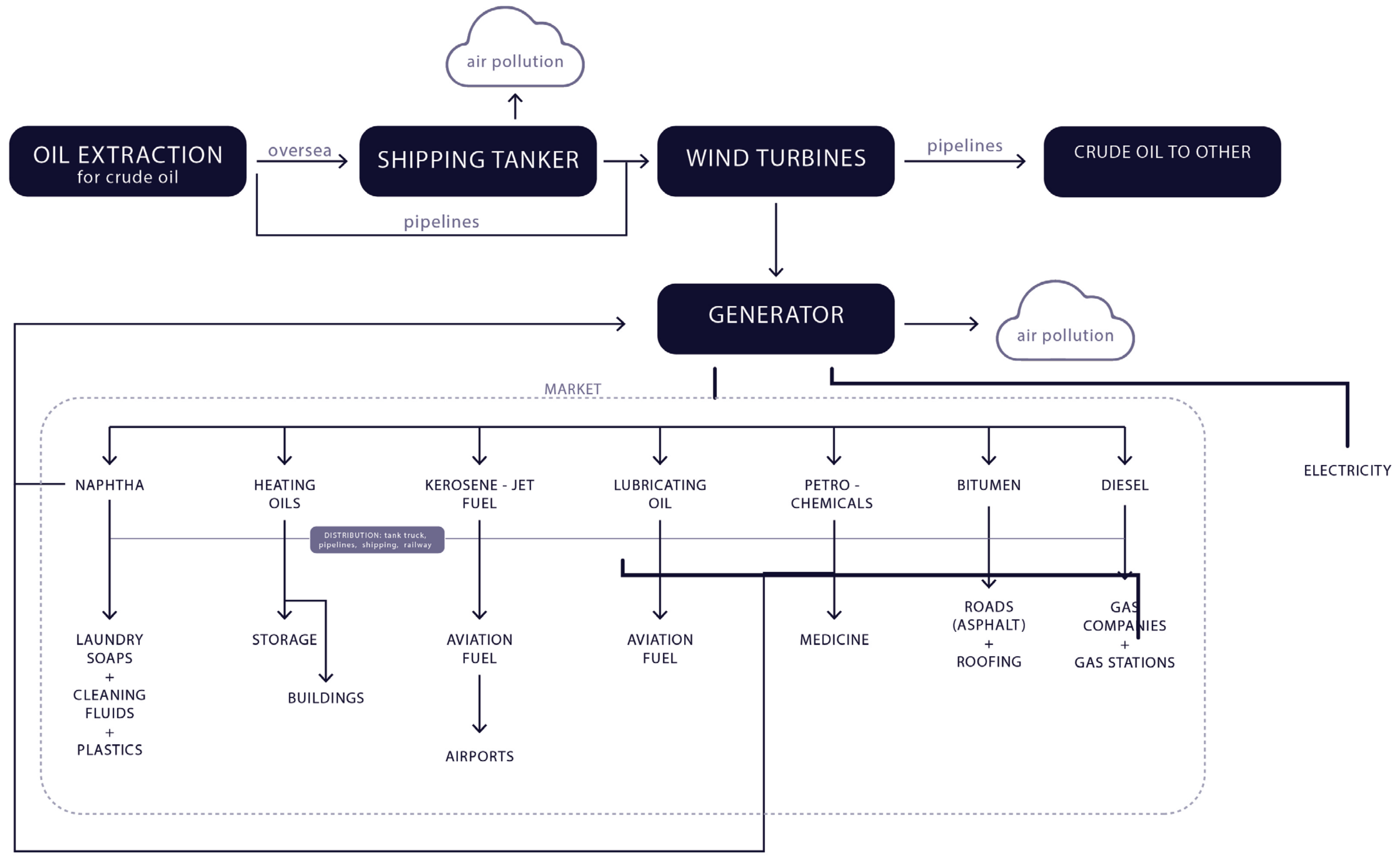


Figure 04. Production Diagram of Fossil Fuels

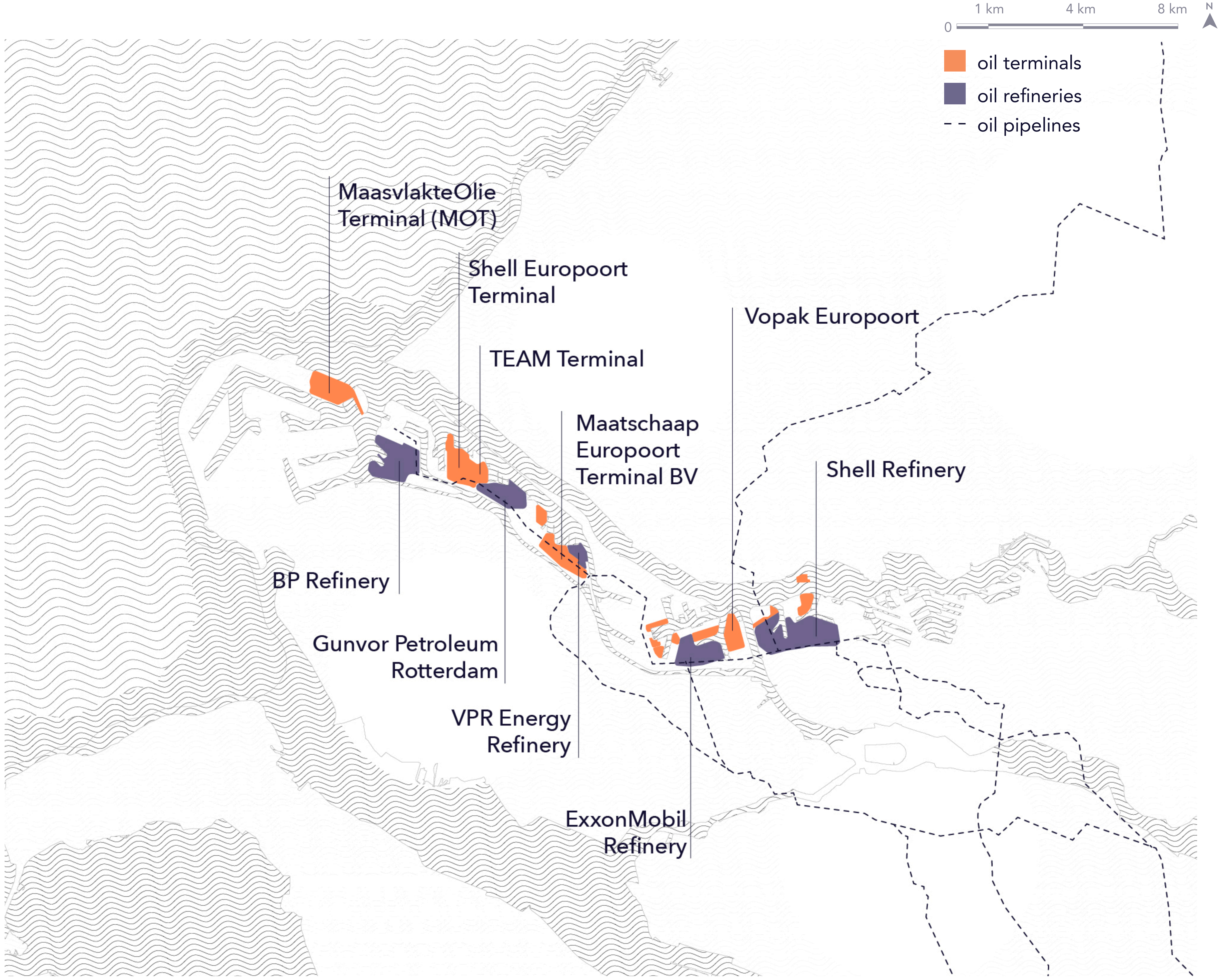


Figure 05. Fossil Fuel Infrastructures in the Port of Rotterdam

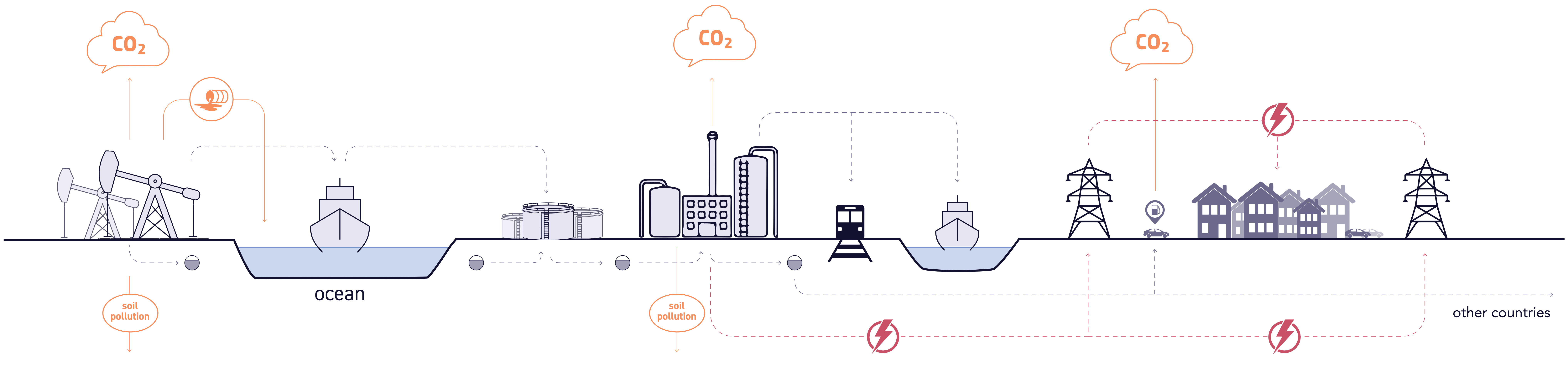


Figure 06. Existing Systemic Section

The current fossil fuel network, shown figure 06, illustrates the negative externalities in each phase, from extraction, distribution, and transformation to consumption.

The extraction processes produce CO2 emissions, pollute the soil as well as our water sources due to oil spills. The distribution of crude oil with storage tanks on cargo ships that run on fuel emits greenhouse gases. Once the crude oil reaches the Netherlands, the Port of Rotterdam stores and refines it. Through a process of burning, it emits greenhouse gases and toxins that pollute the air as well as the soil. Fossil fuels are in the end, the leading source of the world's global pollution.

The long distances that fossil fuel travels, from extraction to production to consumption, creates an inefficient system as well as disassociates the negative externalities of the fossil fuel-based energy system from the public. Making the general society widely oblivious to the harmful effects of fossil fuel energy.

The fossil fuel industry pollutes the air, soil, and water through every phase of the system, reiterating how urgent the switch from a fossil fuel-based economy to one of renewable energy is.

3.2
AN OPPORTUNITY FOR RENEWABLE ENERGY

HOW MUCH DOES IT TAKE TO MEET THE CURRENT ENERGY DEMAND?

As established before, switching to renewable energy is not an easy task. One of the main reasons is the difficulty to match the supply to the current energy demand, let alone the projected consumption in the future if we continue consuming at this rate. When we mention supply, it is not only about the availability of the raw material, but also the space needed to produce that raw material or the infrastructure required. The energy from fossil fuels has evolved to be rather convenient over time. With the infrastructure hardly occupying any space, where it can be located miles away from the consumption points and the raw material can be obtained with ease, especially through strong international trade relations.

Thus to understand the feasibility of this shift towards renewable energy, we conducted an experiment. Its aim was to explore the spatial requirements and limitations in the energy production capacities of various clean energy sources with the assumption that they were to singlehandedly meet the energy demand.

About 1.35 PetaJoule of energy is consumed by the province of Zuid Holland per day. (CBS, 2021). Which today can be met by burning about 192,200,000kgs of coal and the spatial requirement for these processes is hardly 200 sqkm. However, if we look at some clean energy sources instead (figure 07)-

Solar energy- Taking an average production capacity of 3kW per panel. Even if we smear the entire province with solar panels, we will not even produce 1% of the daily energy demand
Biomass- While for biomass nearly 84,375,000 kgs of waste from the agricultural lands would be required to meet the 1.35PtJ energy requirement. Which would need roughly 50-60% of the land to be transformed into farmlands for raw material.
Wind- Assuming the use of 2-3MW of wind turbines, wind farms of about 24716 wind turbines would be needed to meet the energy requirements. These farms could be placed offshore, however, they would block out a significant area of the sea.
Hydrogen- About 125,000 kgs of hydrogen will have to be manufactured or imported to meet the energy demand. However, the infrastructure required to manufacture it and generate electricity is not very large. Additionally, it can be centralized in a single location, reducing its spatial demand.

It is evident from the above experiment that it is nearly impossible to meet the energy demand of the province with a single source of renewable energy. Instead, we will have to depend on a network of multiple energy systems. This decision can be informed by overlapping 2 criterias. 1) The production capacity of the energy system, ie the amount of input required to cater to the desired output.
2) The space required, for not only the infrastructure but also for producing and storing the raw material internalizing, these processes within the region.
Based on the above diagnosis Transtopia aims to propose different energy systems to cater to different scales (local, regional and global) which would function in synergy to support and sustain one another. Solar can be restricted for individual and neighbourhood energy demands, biomass and wind can be used across local and regional energy demands while hydrogen can be reserved for more large scale regional or global demand.

1.35 PJ OF ENERGY CONSUMED PER DAY IN SOUTH HOLLAND

Figure 07. One energy source meeting the current demand

3.2 WIND ENERGY

As the Netherlands accelerates toward a fully renewable energy future, a primary source that Zuid Holland holds a capacity for is the expansion of wind farms for the production of electricity. Wind energy from wind turbines is currently one of the most common renewable energy production systems in place in the Netherlands and will be producing an estimated

TOTAL ENERGY PRODUCED: 8.78 GW of energy by the end of 2030 (Government of Netherlands, 2021). A majority of that percentage of projected energy comes from future developments of offshore wind farms in the North Sea, see in figure 08. Wind energy is a key player in the transition to a zero-carbon energy future.

Offshore wind farms have rapidly been under progress in the North Sea to ensure a safe supply of electricity for Zuid Holland. Due to the high wind speeds, close connection to the port, and fast decline in construction costs (Government of Netherlands, 2021), offshore wind farms have become a critical part of the energy transition for Zuid Holland. Onshore wind farms are less apparent in the Netherlands but are still active and have real potential for renewable energy production at a more local scale. The majority of the onshore wind farms of Zuid Holland are located within the port, framing the areas of industry and energy production with some exceptions of wind farms scattered in the agricultural lands of the region.

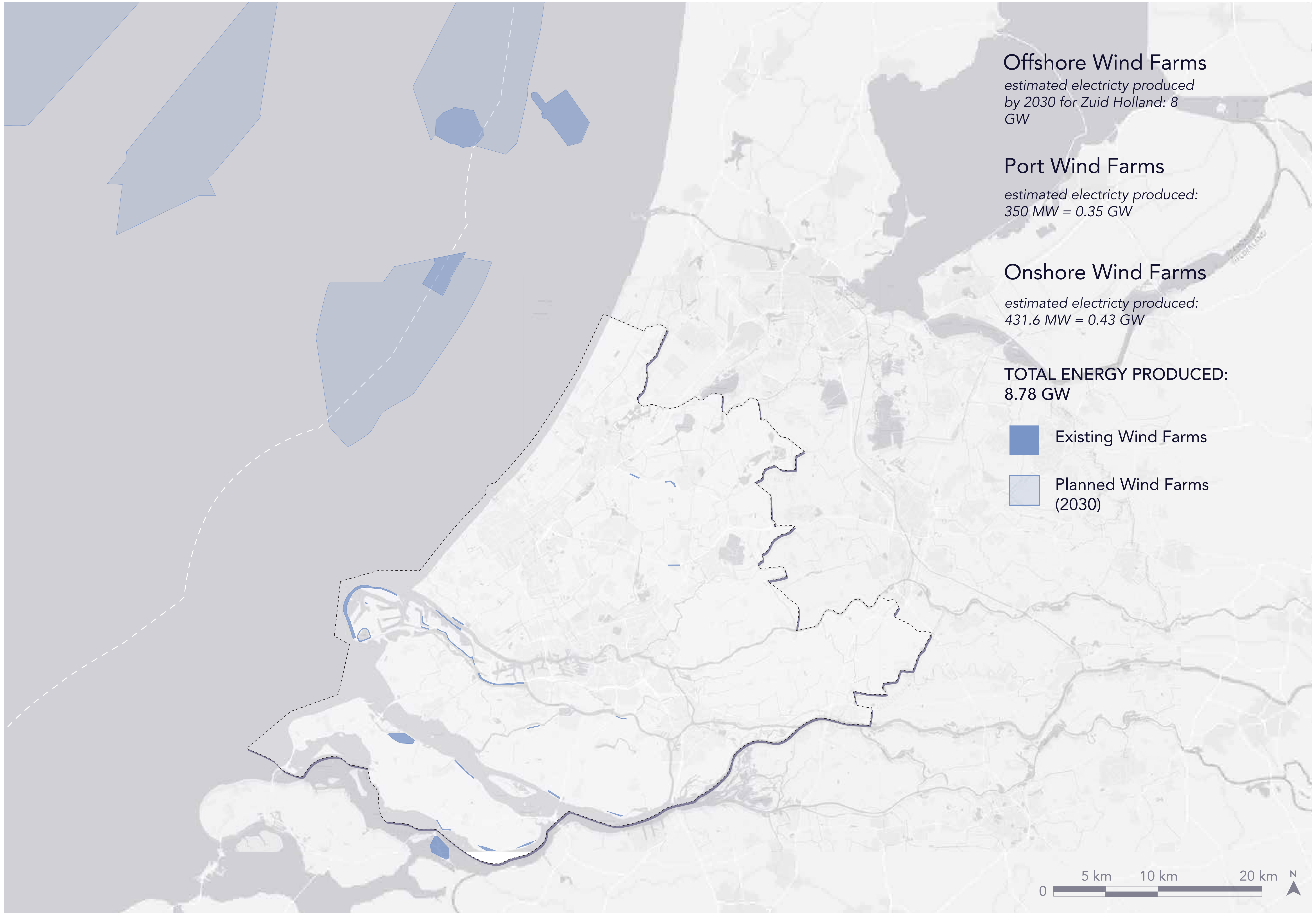


Figure 08. Projected and Existing Wind Farms

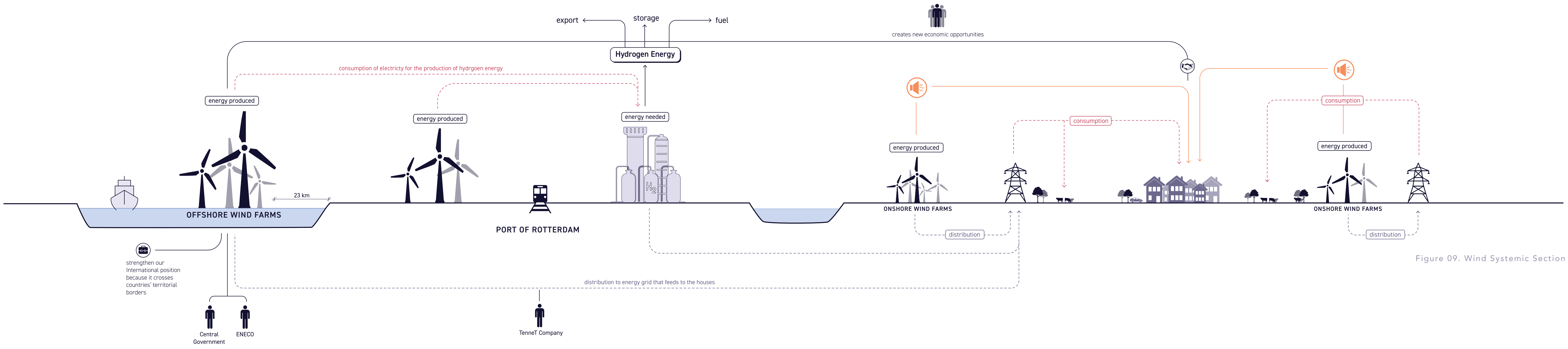


Figure 09. Wind Systemic Section

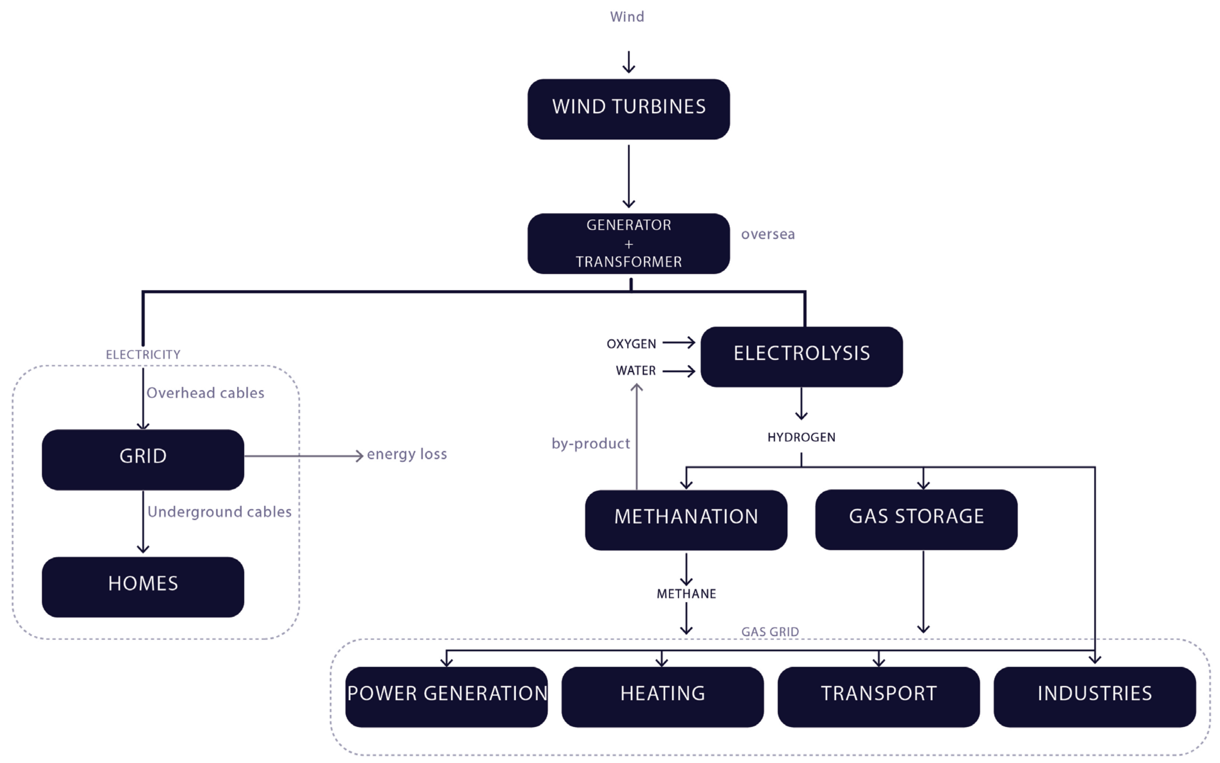


Figure 10. Wind Production Diagram

Wind energy provides a multitude of benefits for the future renewable energy system of Zuid Holland as well as for the stakeholders of the region.

Electricity produced by wind farms can be used for two purposes in the renewable energy future scenario of Zuid Holland. Electricity from turbines can directly feed into the electrical grid of the Netherlands, either powering companies, industries, or homes. Electricity produced wind farms can alternatively be used in the process of electrolysis, which separates water with electricity into hydrogen for energy consumption, see Figures 09 and 10. Wind farms, onshore and offshore, can provide for different scales to improve the efficiency and resiliency of the energy system. As it is currently wasteful to store electricity in a battery and there is a lot of waste electricity through transportation over long distances, wind farms in the region can cater to the more local region while the offshore wind farms cater to production within the Port of Rotterdam.

Generating energy from wind farms also involves a variety of actors across society. The central government sets the location and construction of the wind farms, the companies that purchase and run the turbines (ex. ENECO), the company that owns the power cable that runs from the offshore wind farms to the port as well as the electricity grid lines (TenneT), and the private citizens/companies that pay and consume the electricity produced (Government of Netherlands, 2021).

Wind farms also create new economic opportunities, creating new jobs and providing a relationship with other countries due to offshore wind farms' position in the north sea/international water.

Overall, wind farms in the Netherlands provide great potential in the imminent energy transition.

3.2
BIOMASS ENERGY

Bio-waste when converted to energy is a sustainable alternative to fossil fuels. However, the biomass energy generated in the Port of Rotterdam is mainly by burning imported wood pellets (Port of Rotterdam). Importing raw material from other countries via cargo ships for energy production is highly unsustainable, especially when a large amount of agro-waste is available within the region of Zuid Holland.

The three largest waste sources in Zuid Holland are manure from farmland and vegetable/garden waste derived from greenhouses and the crops of agricultural lands. As seen in figure 11, these categories of bio-waste have been analysed in each municipality resulting in a total of 4000 tons of biomass available for energy production (Organische reststromen Zuid-Holland). Where the areas with the most waste are generated in the outskirts of the region, primarily the southern and east-northern parts of the province which have large fields of arable land. Biomass energy production based on the estimated waste available can result in a

TOTAL ENERGY PRODUCED:
63 PJ of potential energy production.

The key to including biomass energy in the energy transition of Zuid Holland is BY taking advantage of thse vast agro-landscapes as sources of energy, connecting them through infrastructure and policies.

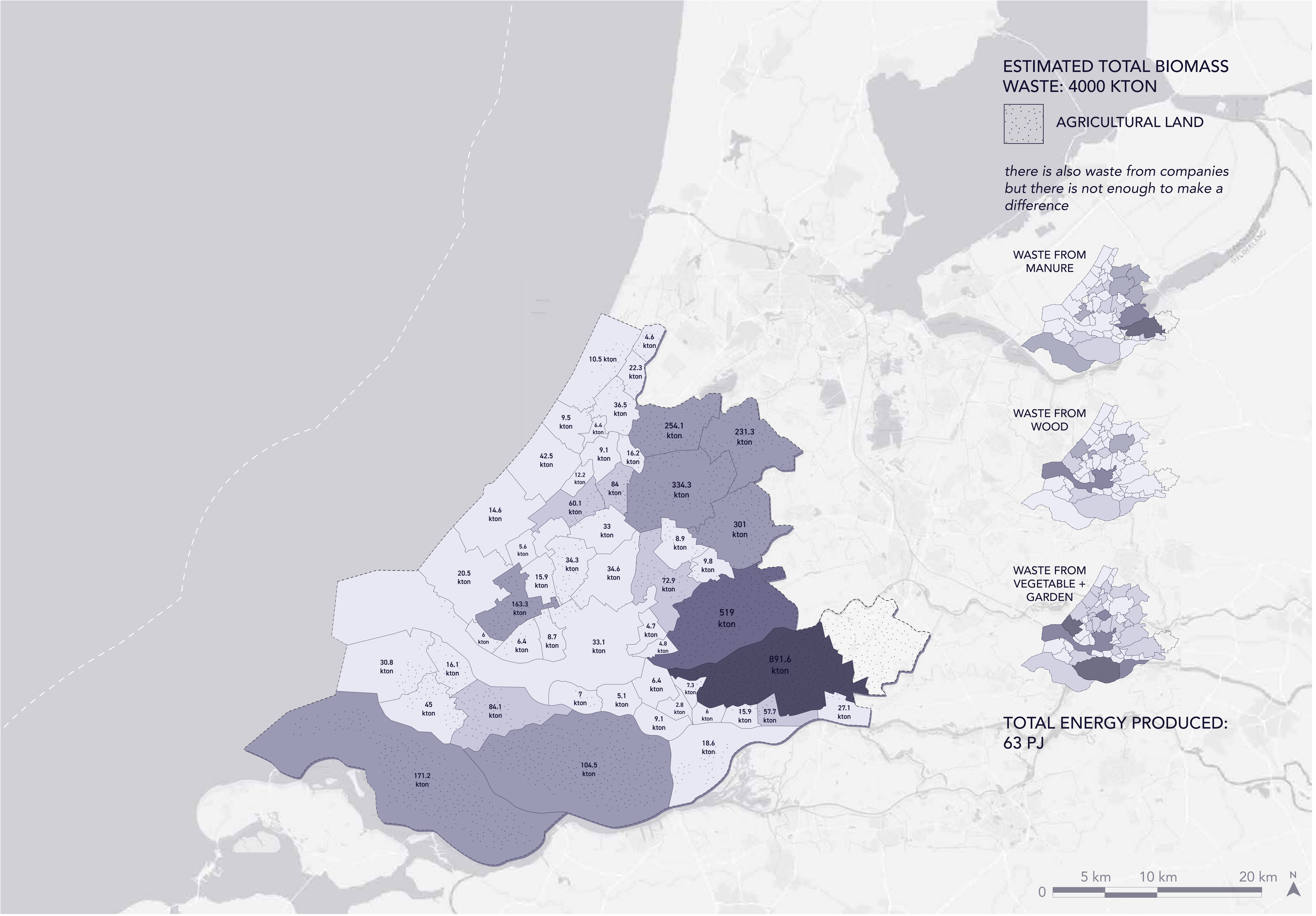


Figure 11. Biomass Waste Potential

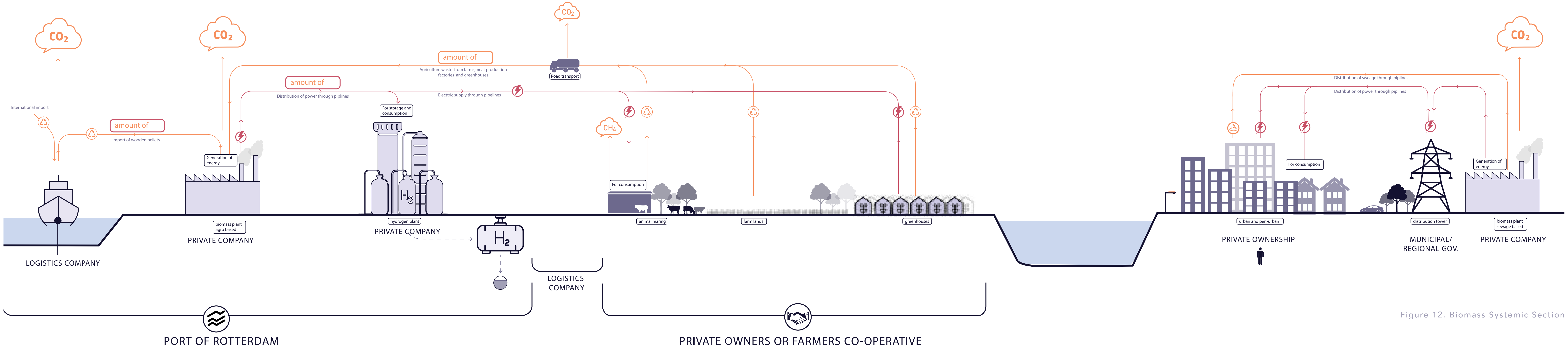


Figure 12. Biomass Systemic Section

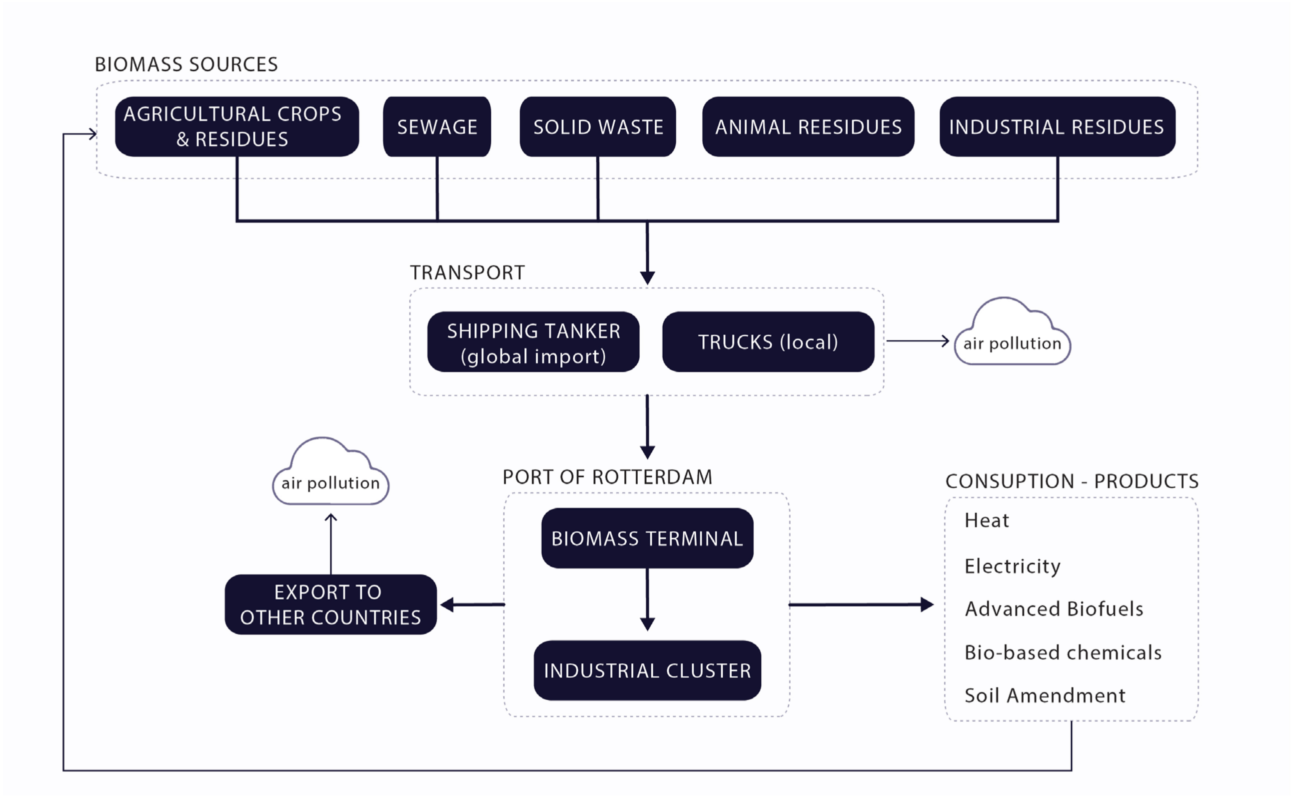


Figure 13. Biomass Production Diagram

Biomass can be generated not only from agro-waste but also from animal waste, sewage, and industrial residues (seen in fig 13). It can be used to produce heat, electricity, biofuels as well as bio-based chemicals.

The transport of bio-waste to biomass plants is mainly through roadways, the infrastructure for which already exists (as seen in figure 12). There is already a biomass plant in the port of Rotterdam, which due to the current situation of importing raw materials is mainly used for heating and energy consumption for the European market (Port of Rotterdam,2021). Given the existing infrastructure, there is a potential to take advantage and increase biomass energy production for the future of this transition. However, biomass plants emit greenhouse gases while burning waste. Moreover, the current transportation methods, via ships and trucks, also emit CO2 into the atmosphere as they largely run on fuel produced from crude oil.

3.2

GREENHOUSE + GEOTHERMAL

Geothermal energy provides electricity or heat generated from underground reservoirs using a pump system that taps the steam or the hot water and then releases it back to the ground. Geothermal heat pump systems can be established in the upper soil layer (3 m) for heating buildings or deeper in the ground (1.6 km) for hot water to heat homes, offices or growing plants in greenhouses.

Geothermal fields produce much less carbon dioxide than natural-gas plants and release almost no emissions. Another advantage is that geothermal energy is a constant energy provider, in comparison to dependent energy systems like wind or solar. However, the specific system may have environmental drawbacks, such as low disposal of toxic materials or hydrogen sulfide (gas). (National Geographic, 2021)

Currently, geothermal energy is mostly used in the Netherlands for heating greenhouses and South Holland estimates around 13 existing geothermal wells, each of which can provide heat for 0.2 Km2 of greenhouses. For the time being the energy produced from geothermal wells,

TOTAL ENERGY PRODUCED: 0.41 GW is imperceptible for the energy consumed by greenhouses at the moment. However, the ambition for geothermal energy is that by 2050, 700 doublets will

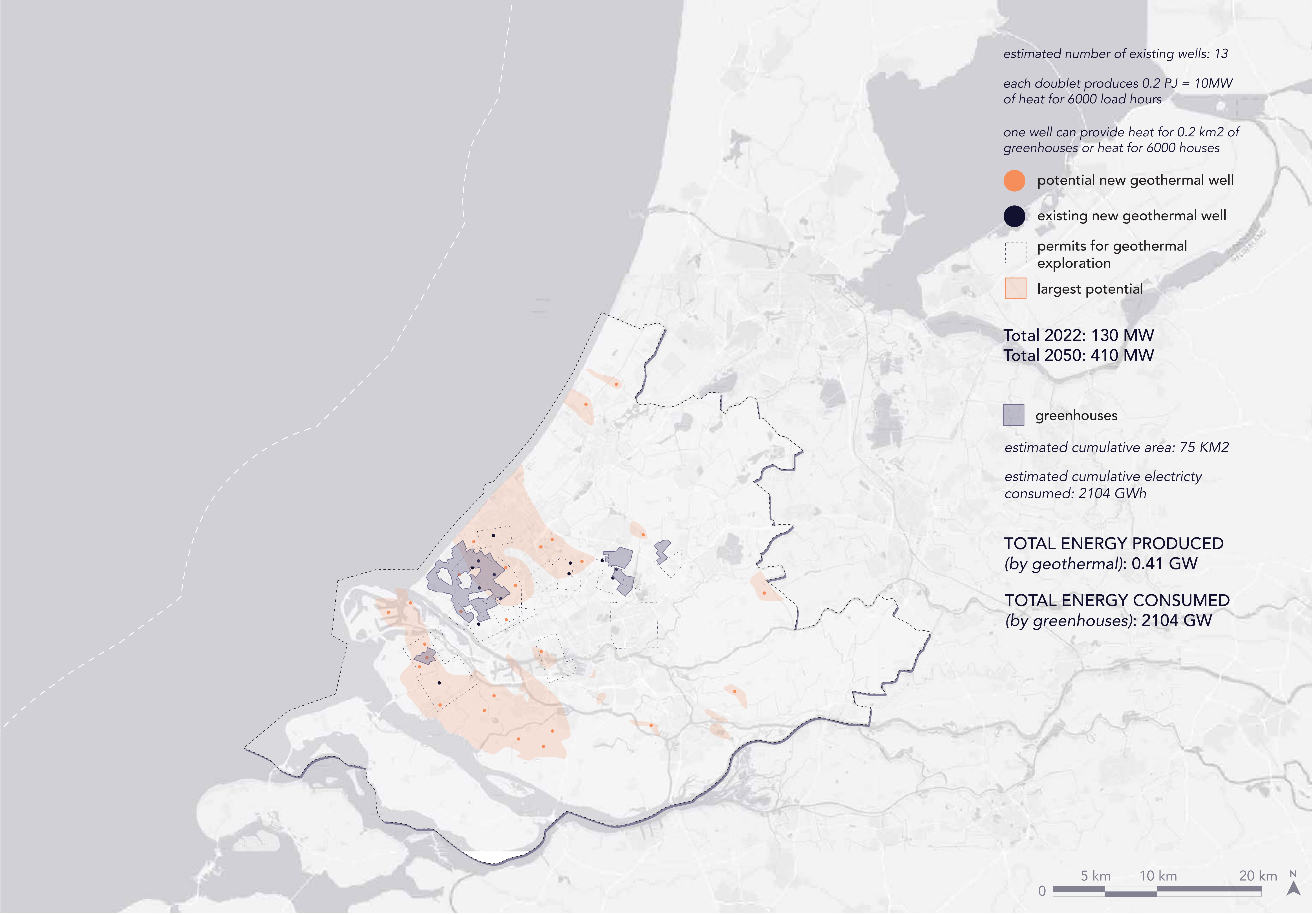


Figure 14. Geothermal and Greenhouse Existing and Potential

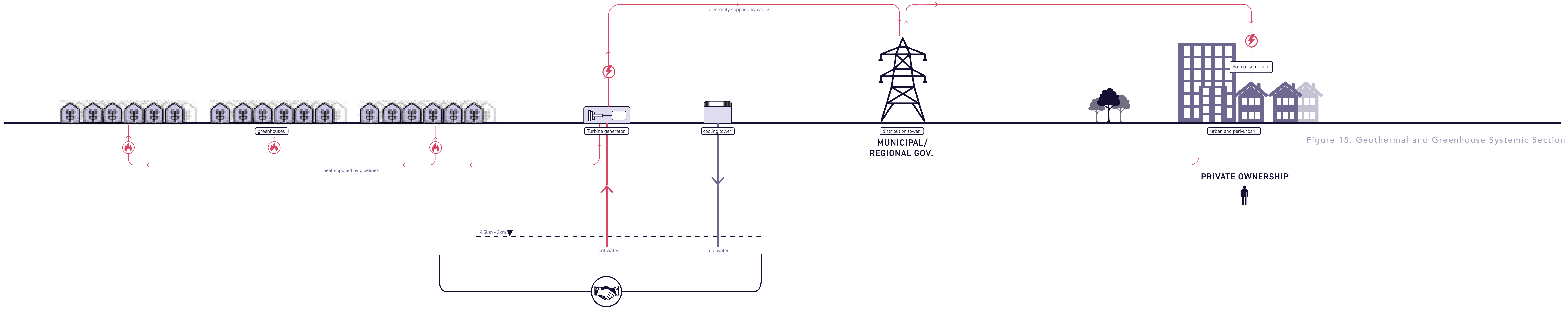


Figure 15. Geothermal and Greenhouse Systemic Section

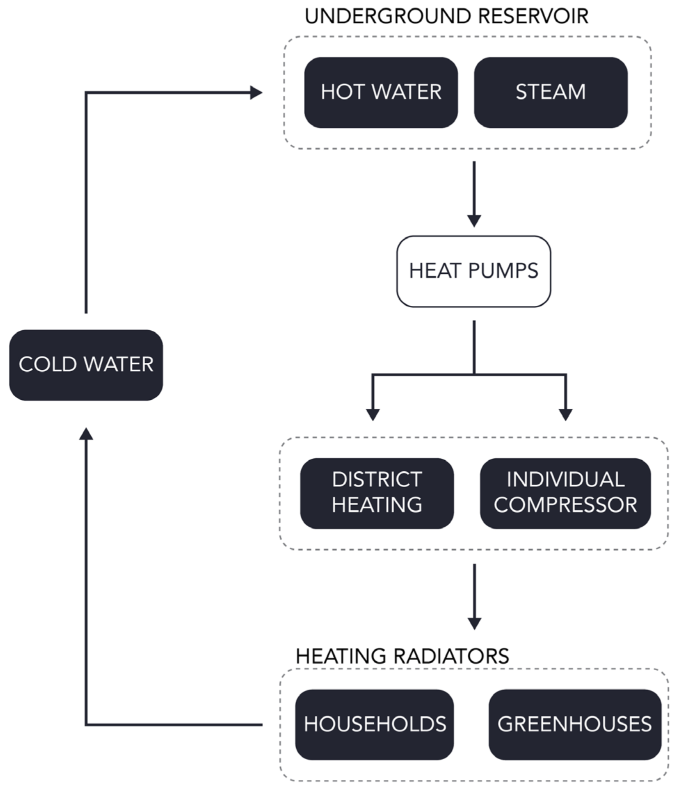


Figure 16. Goethermal Production Diagram

be applied, generating an amount of 135 PJ, able to heat up to 3.8 million households connected to a heating grid. (Stichting Platform Geothermie, 2018)

South Holland is one of the provinces with the most potential for geothermal drills and can become an asset for future settlements that use district heating from geothermal wells. Additionally, the energy demand of greenhouses can be met with a synergy between geothermal energy and other renewable energies, such as solar or wind, but also through new typologies for greenhouses or methods of heat cascading.

Transtopia aims to strategise the different energy systems for different scales and different activities, but also create synergies between systems to increase the resilience of the energy system. Geothermal energy needs to be better investigated to make the most of its potential and reveal the locations where geothermal energy can be used to provide the energy demand of the adjacent infrastructures.

3.2

SOLAR ENERGY

Solar generation of electricity is one of the most popular low-carbon energy generation systems. With an infinite source of sunlight, and an increase in the interest to participate in the energy transition, the global consumption of solar energy continues to rise: since 2010 by about 40% per year (CBS, 2022). With a 40% rise in the solar energy consumption (for electricity and heat), to 30 PJ in the Netherlands itself (CBS, 2022). This record increase can be attributed to the setting up of new onshore solar parks (privately owned) and the installation of over 10,000MW of solar panels in cities and towns. Thereby showing great potential as a clean energy source.
However, its use is restricted by the limited capacity of solar panels. An average solar panel can generate about 0.4 MW of energy per day. This means solar panels will have to be installed over large masses of land or will have to be restricted to supply energy to a house or a neighbourhood.

In order to achieve national and international climate objectives, we can and must harvest much more energy from the sun than we currently do. There are about 10 gigawatt-peak (GWp) of installed solar energy capacity in the Netherlands that can be increased to 50 GWp by 2030 and 200 GWp by 2050 with minimal impact on the spatial and ecological environment (CBS, 2022). This can result in an estimated

TOTAL ENERGY PRODUCED: 2.5 GW

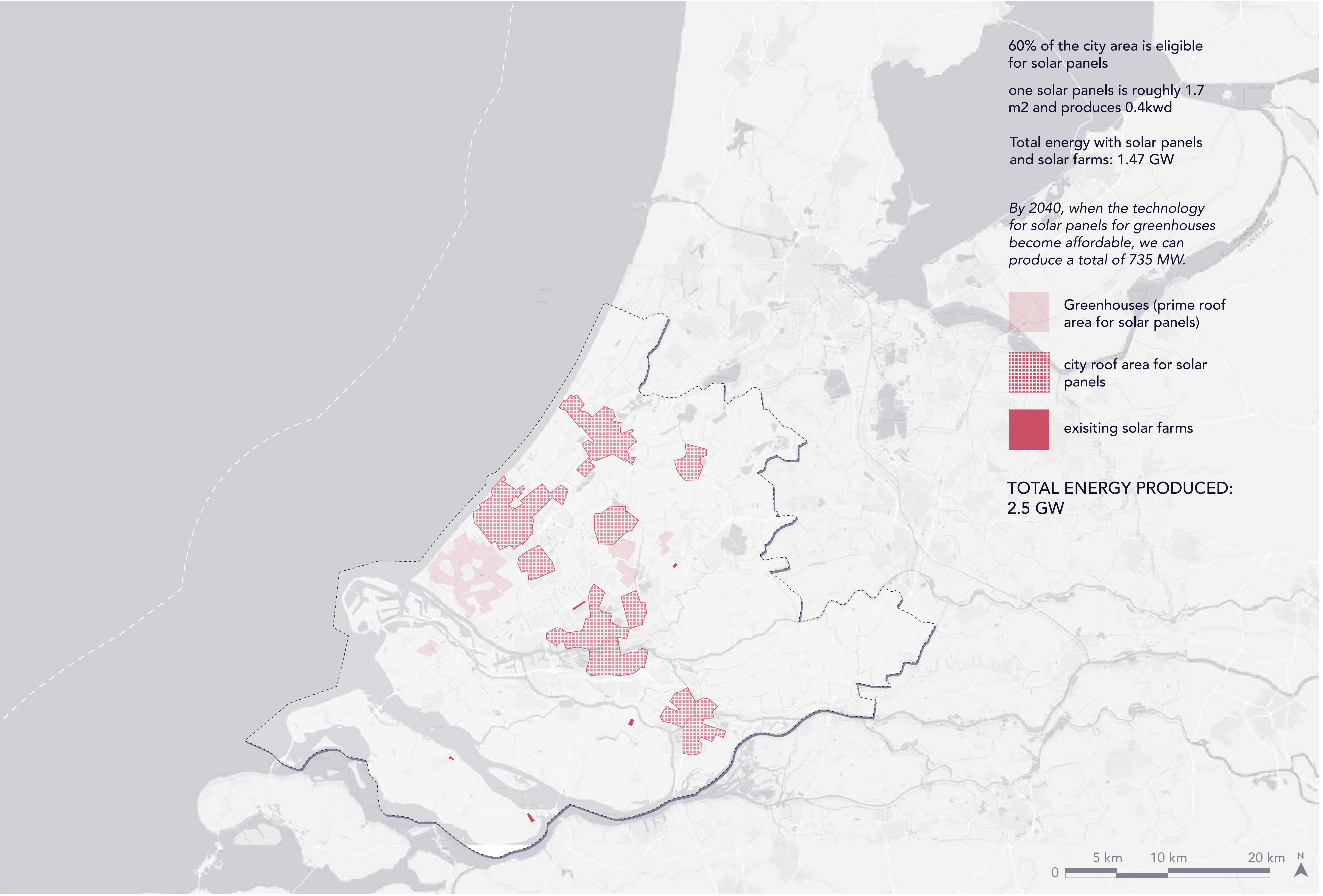


Figure 17. Existing and Potential Solar

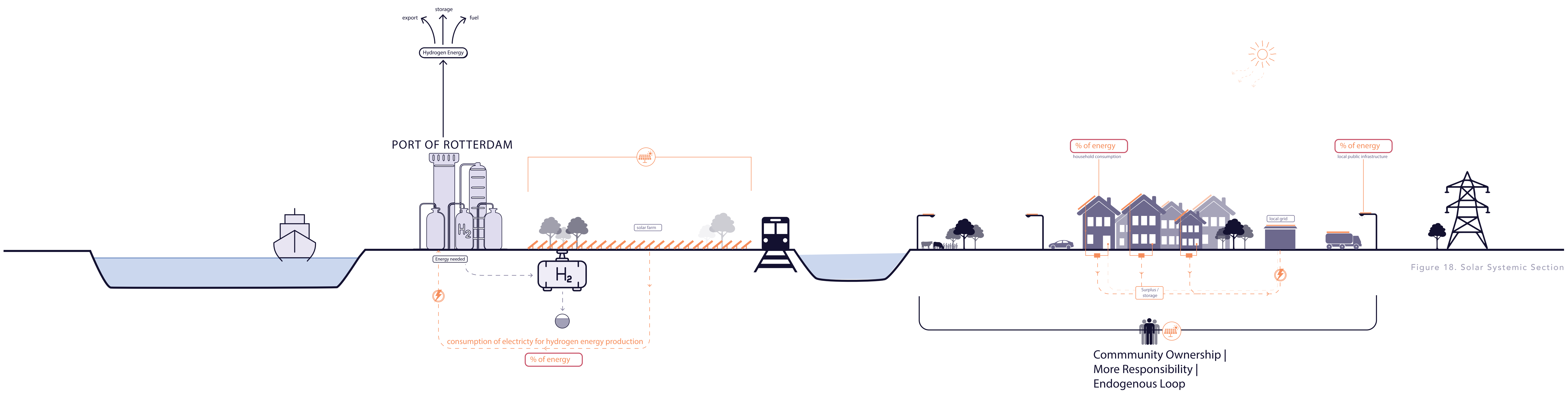


Figure 18. Solar Systemic Section

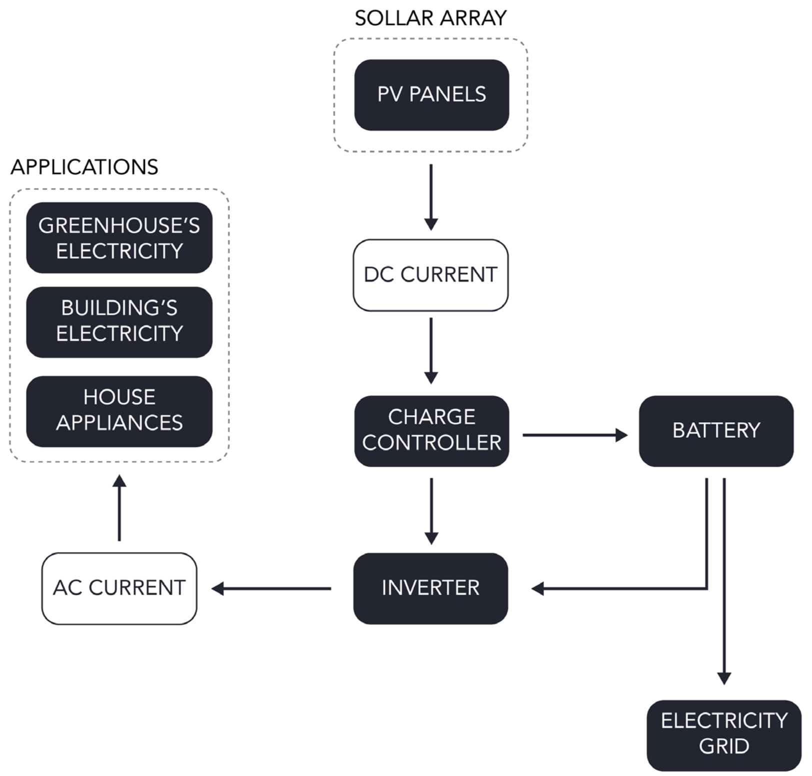


Figure 19. Solar Production System

To install this huge amount of PV, power solar panels must be applied on a much larger scale. An important aspect is installing PV on already existing functional surfaces such as roofs, facades, windows, roads, and noise barriers along roads and railways, cars, dikes, inland water areas and the sea. And this requires technical ingenuity in order to incorporate solar cells which are attractive or barely visible at acceptable costs and with high energy yields.
Figure 18 represents the potential for efficient generation of solar energy at a local scale. Where the roofscapes in the cities show great potential to harvest energy, that can be used in the building, adjoining streets or the residential unit itself. This approach would reduce the dependency on the regional energy supply and provide an opportunity to reduce the energy loss due to the movement of energy across long distances. (refer to figure 18) The energy can be produced at a building or block scale, stored (in case of a surplus) and distributed through the local grid. Thereby shortening the energy loops, and encouraging civil society to play an active role in the transition. There are also multiple ways by which co-operatives and other organisational systems can be set up within the civil, private and public sectors to ensure the implementation of collective solar energy generation. This will be elaborated further as we add policies and stakeholders.
Transtopia also looks into the role of technology as a means to accelerate this change. Where the roofs of the greenhouse can be fitted with transparent solar panels which could be used to harness energy and unused in the greenhouses themselves. While the technology is still in its early stage and expensive, it does show great potential in the coming years. But for truly large-scale applications, the cost of solar power, usually generated by so-called silicon photovoltaic (PV) cells, needs to be reduced and lower production costs, higher efficiency and longer life expectancy of the modules are essential.

3.2

HYDROGEN ENERGY

Hydrogen in trans-topia is responsible for national and international demands.
Hydrogen is the most abundant chemical substance produced in chemistry and biology laboratories. It is developing as an important energy carrier in aviation, shipping, and heavy road transport. Moreover, it is used as a substitute for natural gas to generate high temperatures for greenhouses, and industrial processes and to heat homes. In addition to that, hydrogen is becoming a major player in the sustainable chemical industry and the production of bio- and synthetic fuels. (Figure 22)

Green hydrogen is produced by electrolysing water using renewable energy sources, for example, solar farms, offshore wind farms and biomass. This process does not pollute the groundwater, neither does it emit any greenhouse gases. (Figure 21)

Opportunities
Buffer for renewable energy.
The high energy capacity of hydrogen could play an important role in accomodating the fluctuations from renewable energy sources like wind or solar power.
Transforming the port into a hub for hydrogen will enable it to continue to play a international leading role, as well become the motor of the national economy. Right now, major steps are taken in the direction of import agreements for hydrogen. However, these need to be furthered so as to maintain the port's role as a reliable, affordable and sustainable energy supply for Northwest Europe. (figure 20)
In addition, the use of hydrogen can make an important contribution to the national climate targets, as well as to the EU climate targets set for 2050.

Hydrogen Transportation
Hydrogen can be transported through highways and pipelines. The first is enabling hydrogen vehicles and heavy road transport to travel through chains of hydrogen-equipped filling stations and other infrastructure along the road. The second, transporting hydrogen via underground pipelines is mostly used to connect the point of hydrogen production, which in this case is the conversion parks in the port, with the point of demand for example the industrial areas.

Since large-scale hydrogen usage requires a vast amount of transportation infrastructure, reusing existing oil and gas infrastructure can lead to more cost-efficient deployment.

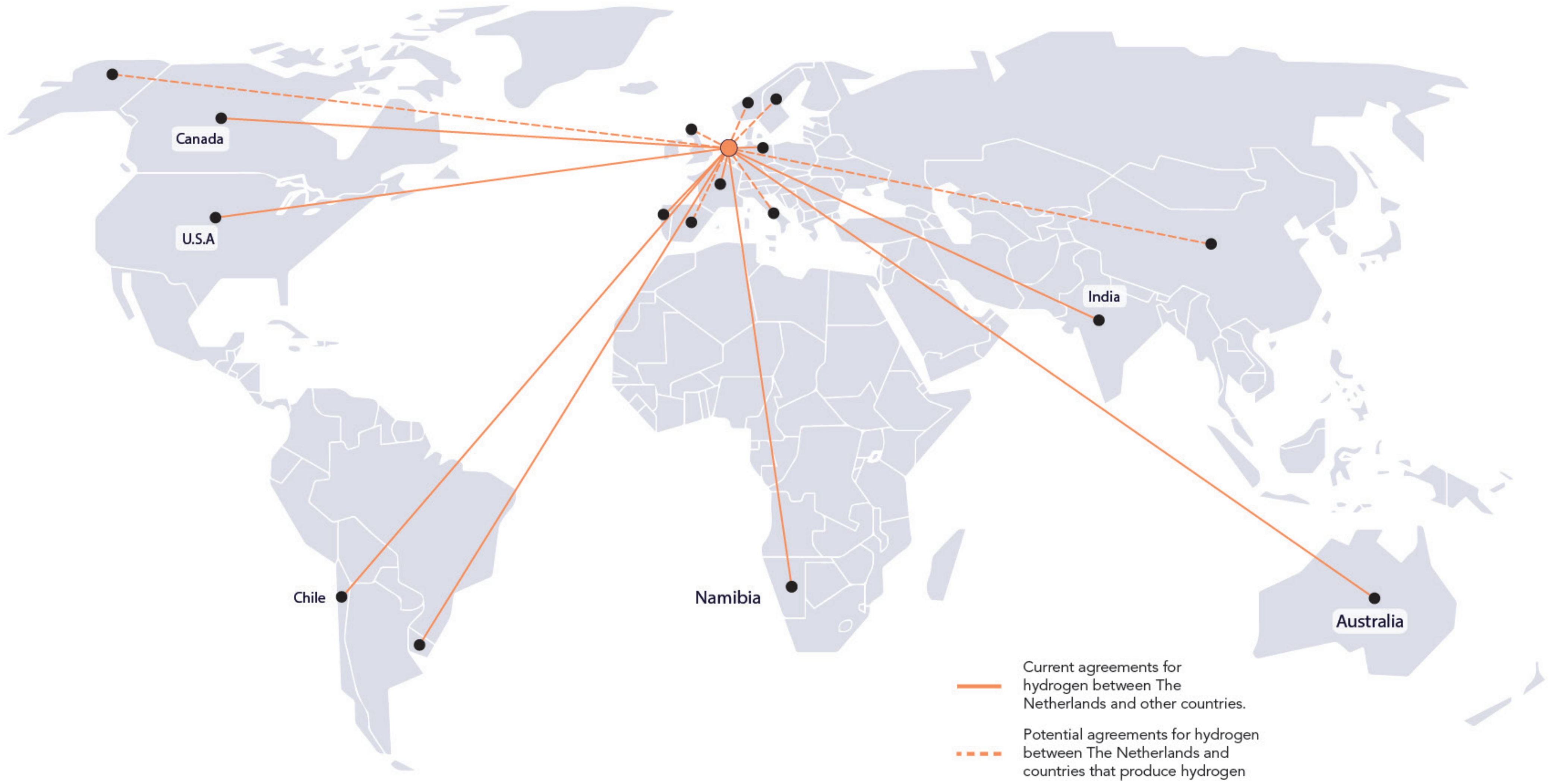


Figure 20. Hydrogen Global Agreements

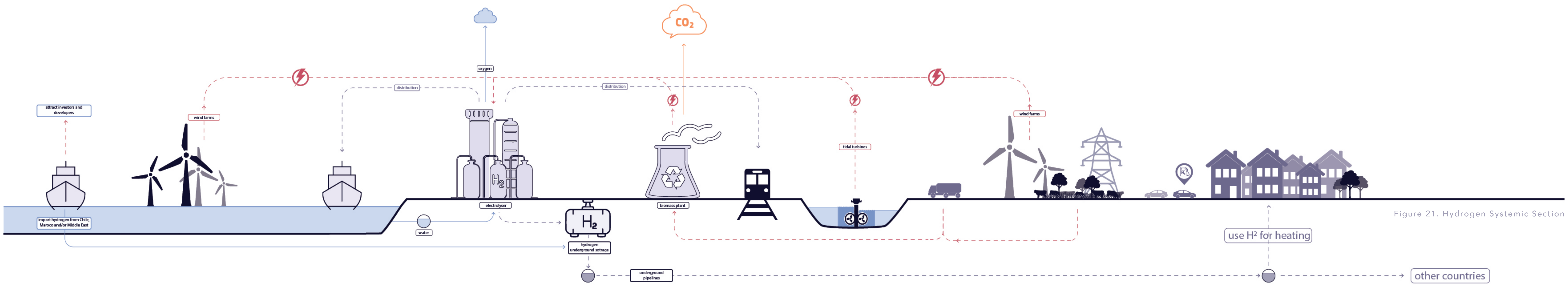


Figure 21. Hydrogen Systemic Section

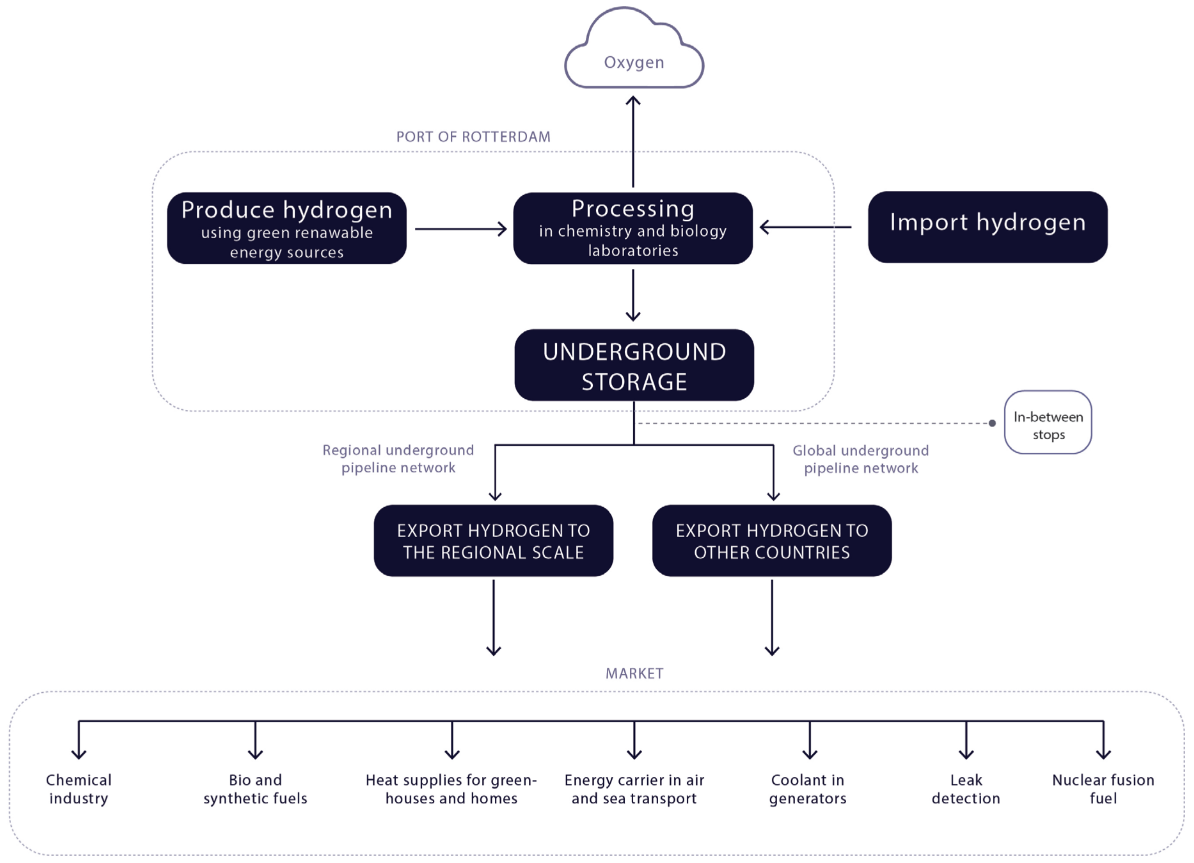


Figure 22. Hydrogen Production Diagram

(DNV, 2021)

Benefits of creating a hydrogen energy network.

Benefits of creating a hydrogen energy network. Constructing a network of energy infrastructure based on hydrogen can stimulate market development in the region of Zuid Holland and the Netherlands. The industries along the network could benefit from direct access to infrastructures strengthening their competitive position. Thereby boosting the economy and employment.

Furthermore, it will also create a fertile ground for new industrial clusters and start-up companies. (Ministry of Economic Affairs and Climate Policy, 2021)

Conclusion

Looking into hydrogen as the future of renewable energy, there are already major steps taken in the direction of import agreements for raw materials. However, these need to be furthered to maintain the port's role as a reliable, affordable, and sustainable energy supply for Northwest Europe

3.3

WHO IS INVOLVED IN THE ENERGY TRANSITION?

The energy transition is a global effort to tackle climate change and therefore the involved parties lie between greater institutions (like United Nations and Europe), where discussions take place and goals are set, and national institutions, like governments and local authorities, which in collaboration with the private sector and the civil society, define specific actions and policies to reach their milestones.

PUBLIC SECTOR
UN and EU
Climate change is an urgency of this century which becomes a priority in multiple severe discussions. The United Nations addresses climate change through the New Urban Agenda (NUA), where guidelines are described on how cities can be crucial in facing this emergency, led by the Sustainable Development Goals (SDGs). The NUA handbook intends to facilitate policymakers and key stakeholders in accelerating actions towards sustainable urbanization interlinked with more job opportunities and improved quality of life. (UN-Habitat, 2020).

Similarly, the European Commission launched the 2019 European Green Deal (EGD), a response to climate and environmental challenges, where policies and milestones are set. The EGD aims not only to finance but also to ensure a just transition to a more sustainable future, focusing on the well-being of the citizens. Specifically for the energy transition, Europe intends to ensure a secure and affordable energy supply, and develop a fully integrated, interconnected and digitalised EU energy market, while prioritizing energy efficiency, improving the energy performance of buildings and developing a power sector based largely on renewable sources.

The Netherlands
The Dutch Government's Vision is strongly allied to EGD, SDGs and NUA that define milestones aimed at dealing with climate change. Aligned with the Energy Agreement for Sustainable Growth, the Netherlands has set goals to use almost 100% renewable energy by 2050. (Government of the Netherlands) In order to achieve that, the government focuses on three main

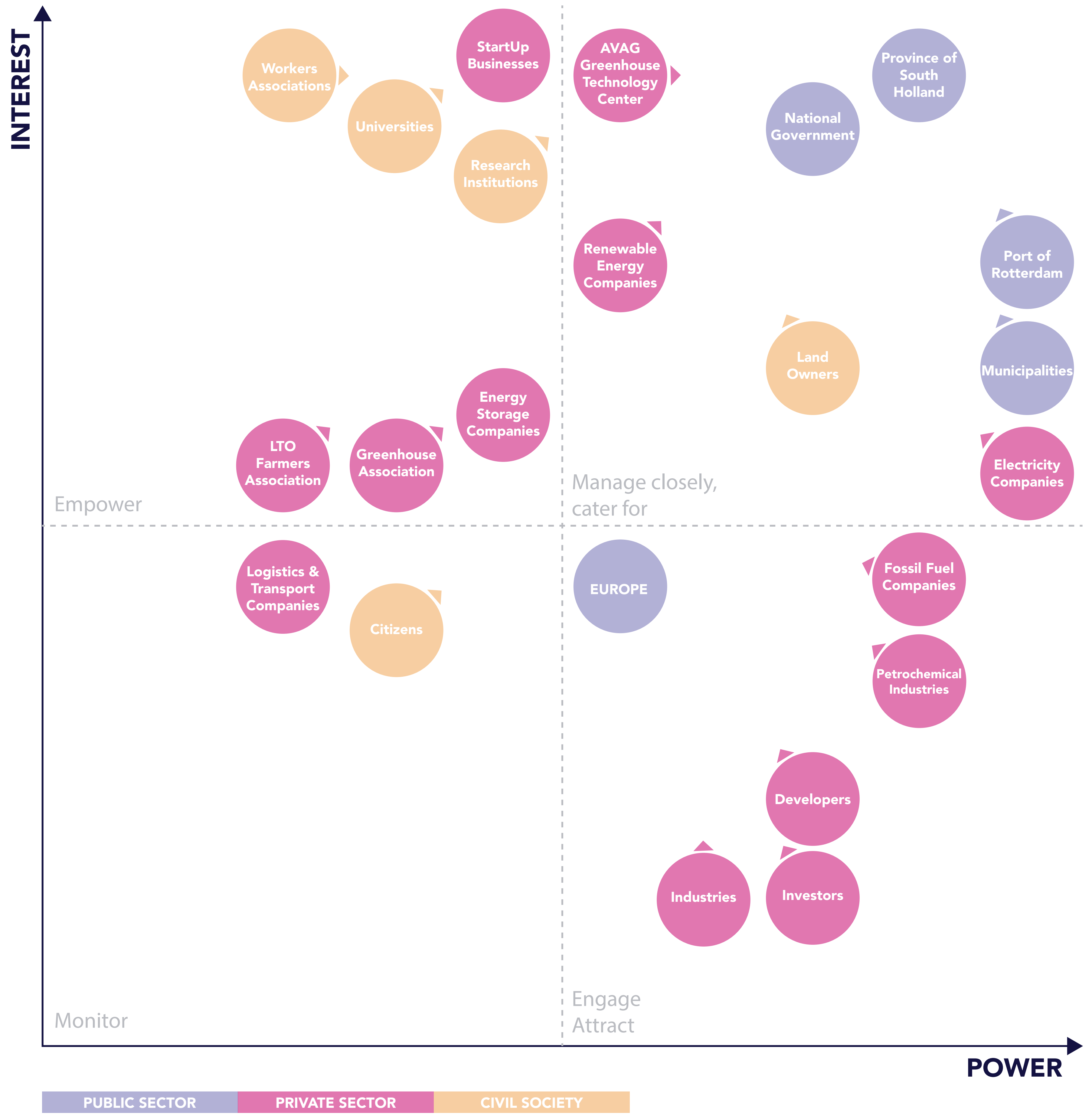


Figure 23. Power Interest Matrix

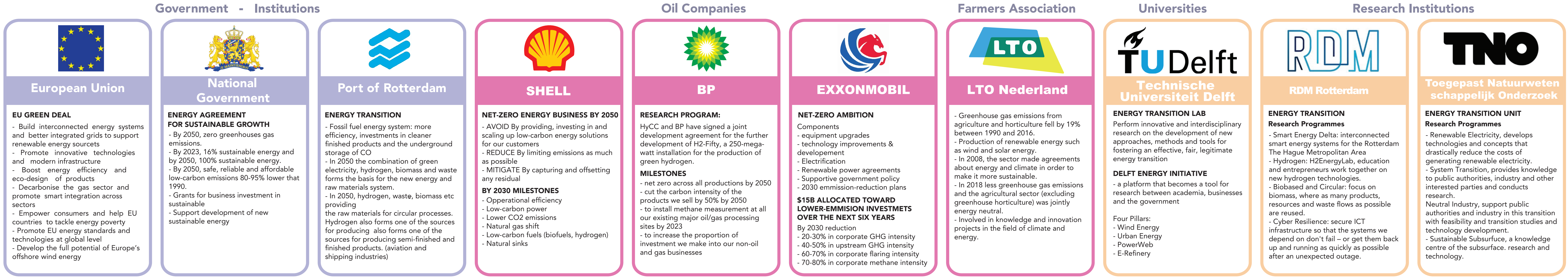


Figure 24. Stakeholder Cards

principles: CO2 emissions reduction, making the most of economic opportunities and integrating energy in spatial planning policy (Ministry of Economic Affairs of the Netherlands, 2016).

Port of Rotterdam

The port of Rotterdam is highly concerned about energy transition and is moving towards a circular port with sustainable industry and transport. The port has defined four pillars in its strategy which consist of making the existing industries more efficient and increasing the infrastructure related to renewable energy, creating a new energy system based on the use of hydrogen rather than fossil fuels, making the most of the waste management and the changing to more sustainable raw materials and finally shift to more efficient, lower consumptions and lower emission sea vessels. (Port of Rotterdam, 2021)

PRIVATE SECTOR

Oil companies

The private sector involved in the energy transition is quite wide since not oil-based manufacturers. This transition calls for a change in multiple sectors and it is important for all the parties to be efficiently represented in decision making.
For the moment, oil and petrochemical companies are being focused on turning into alternative energy sources and raw materials, in order to become more sustainable and CO2 emission neutral. In the Port of Rotterdam, there are 5 active oil refineries that have set their own goals to tackle climate change. For instance, Shell has set a goal of net-zero emissions by 2050, including direct, indirect and customer emissions (Shell, 2021). Exxonmobil has set the same goal and invested 15 billion dollars in lower emission initiatives (Exxonmobil 2022), while BP is becoming net-zero by taking actions such as improving the efficiency of their operations and integrating low carbon solutions (BP, 2022).

LTO

Other economic sectors are also involved in the energy transition. The agriculture and horticulture sectors of more than 70% of dutch land are aware of their impact on the planet through the emission of greenhouse gasses and the carbon capture in the soil. However, LTO Nederland is willing to contribute to the transition and currently participates in climate policy negotiations, while also involved in knowledge and innovation projects. (LTO, 2022)

CIVIL SOCIETY

Universities

South Holland has the advantage of a strong educational hub, where some of the biggest universities in the country are established. Universities, as part of the civil society, are connected to both private and public sectors and become an opportunity to bring together knowledge and expertise in the matter of energy transition to meet national goals.

Currently, TU Delft is running the Delft Energy Initiative, a platform that becomes a tool for research between academia, businesses and the government. In this program, opportunities for 4 sustainable pillars are investigated, including wind energy, urban energy, powerweb and e-refinery. At the same time, research is carried out for sub-themes, to reveal the potential in other subjects. (TU Delft, 2022)

Research - Innovation

Research and innovation are significant aspects in the energy transition. Renewable Energy is a subject that still relies on innovative ideas and opportunities of new technologies to be embedded. Therefore, the need of research institutions and innovative projects are essential for future sustainable developments and a transformation of the port towards circularity and carbon neutrality.

3.4
THE POTENTIAL

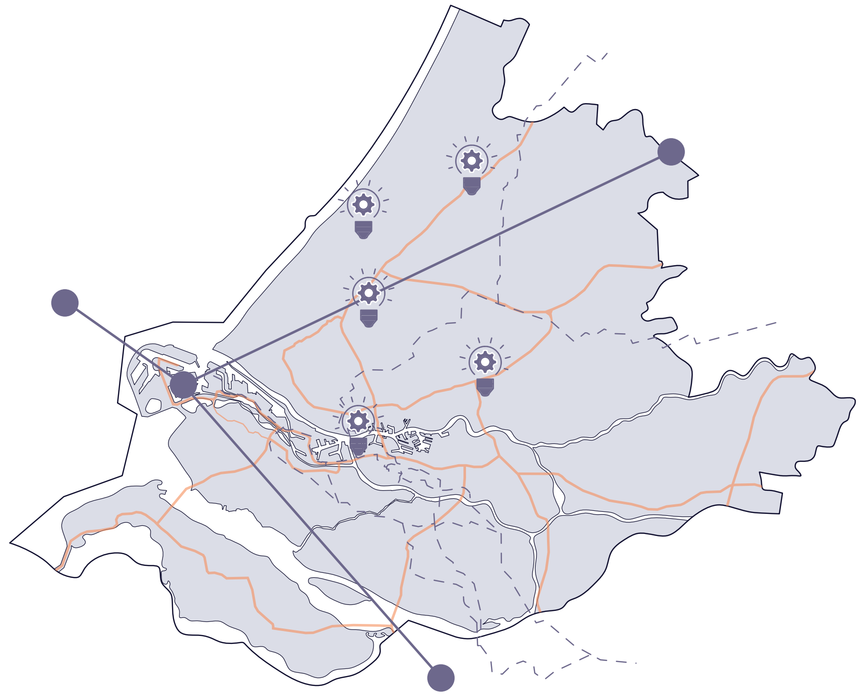
SWOT ANALYSIS

STRENGTHS

Strategic location of the port
Port of Rotterdam is located along the North Sea, which makes it significant for the energy trade to Europe or the Global through waterways and land.

Strong network of mobility infrastructure
The oil-based industry has developed an advantageous network of pipelines and road systems that can be utilized for the needs of the renewable energy industry.

Strong education system
Zuid Holland hosts a variety of universities and research institutions that are concerned with energy transition and investigate technologies to increase the efficiency of sustainable energy systems.

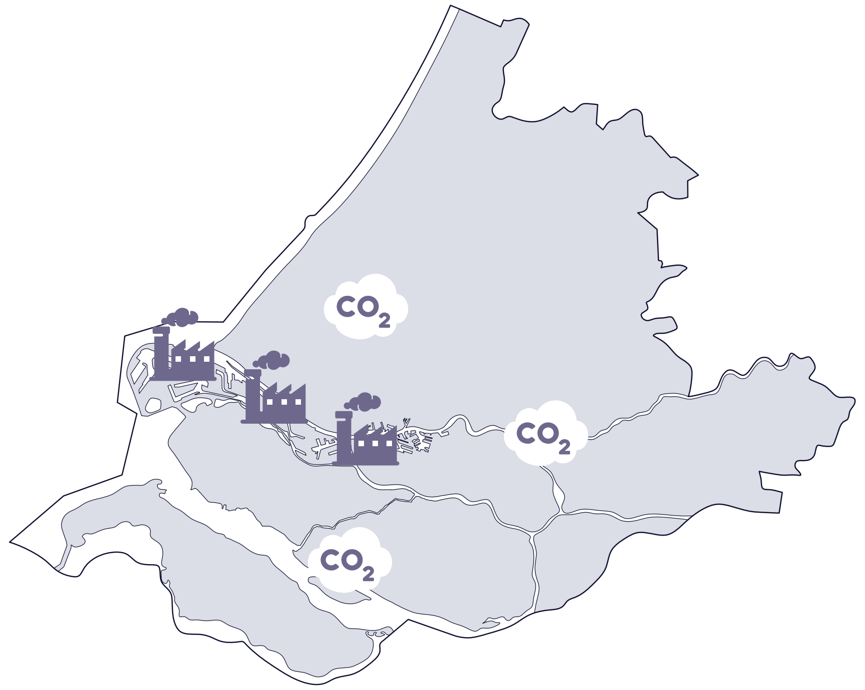


WEAKNESSES

High dependency on fossil fuel energy
In the Netherlands and consequently, in Zuid Holland the energy consumption is 88.9% nonrenewable, resulting in a non-resilient and unsustainable energy system.

Large environmental impact (CO2 emissions)
The Netherlands produces in total 134.72 Mt CO2 emissions, creating a severe environmental impact that needs to be addressed, especially in the energy sector.

Lack of synergy between stakeholders
While a lot of stakeholders are taking actions toward energy transition and climate resilience, the lack of synergies between each other causes lost opportunity

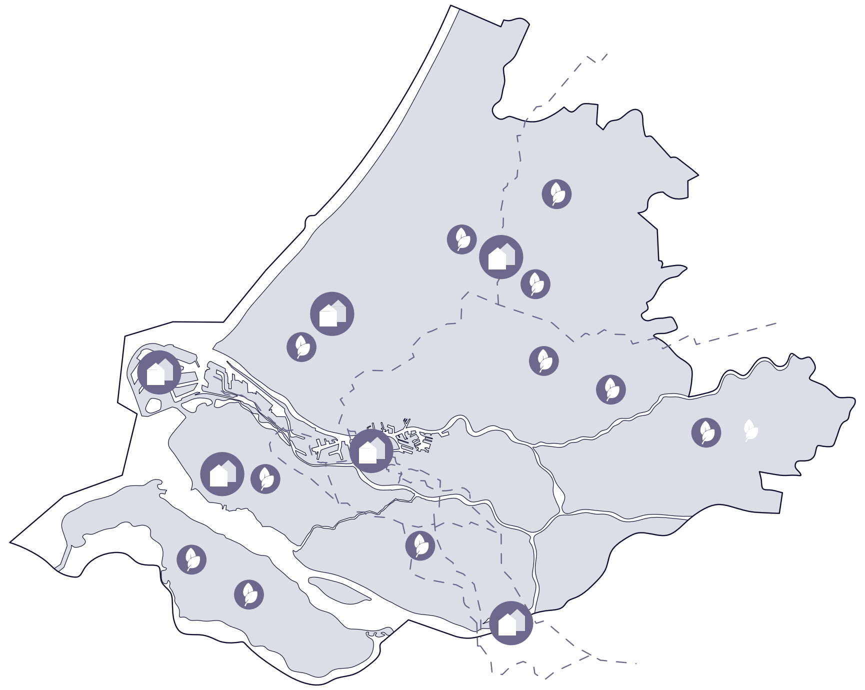


OPPORTUNITIES

Reuse of bio-waste to generate energy
The vast expanse of agriculture and horticulture land in Zuid Holland has the opportunity to transform into a potential energy landscape. Particularly as a source of raw material.

New innovative typologies
Future developments call for a need to integrate multiple functions in one landscape and the energy transition can create opportunities for innovation in the built environment.

Reuse existing fossil infrastructure
The oil-related infrastructure such as tanks for fuel storage or oil pipelines systems could be used for hydrogen storage and distribution accordingly.



THREATS

Population growth
The predicted population growth in combination with the lack of available land has resulted in a housing shortage.

Decline in jobs
Digitisation of the fossil fuel industry raises doubts about job security and job availabilty in the future.

Climate change + rising sea level
The impact of climate change, especially the possible risks of flooding makes it difficult to predict and design for the future.

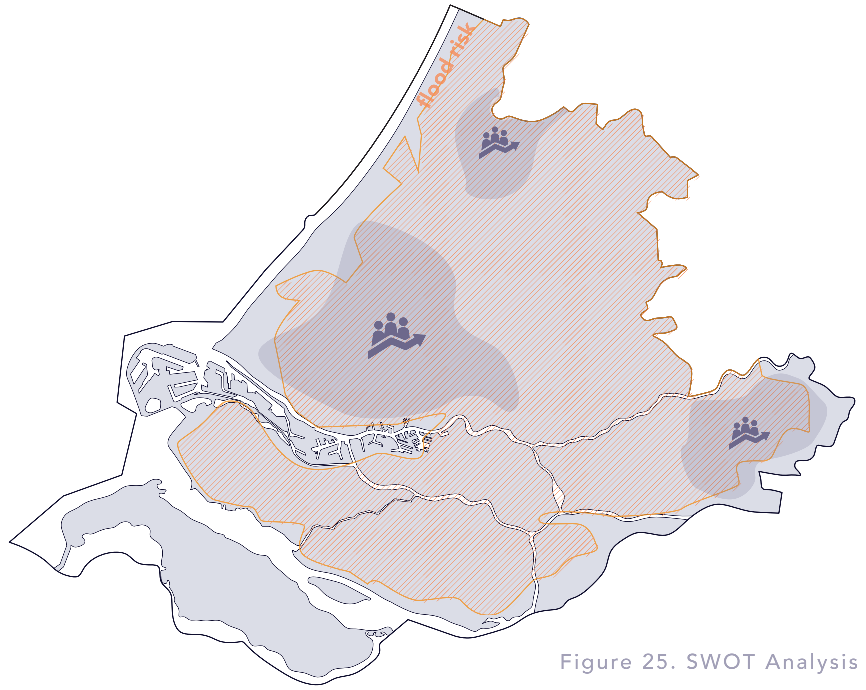


Figure 25. SWOT Analysis

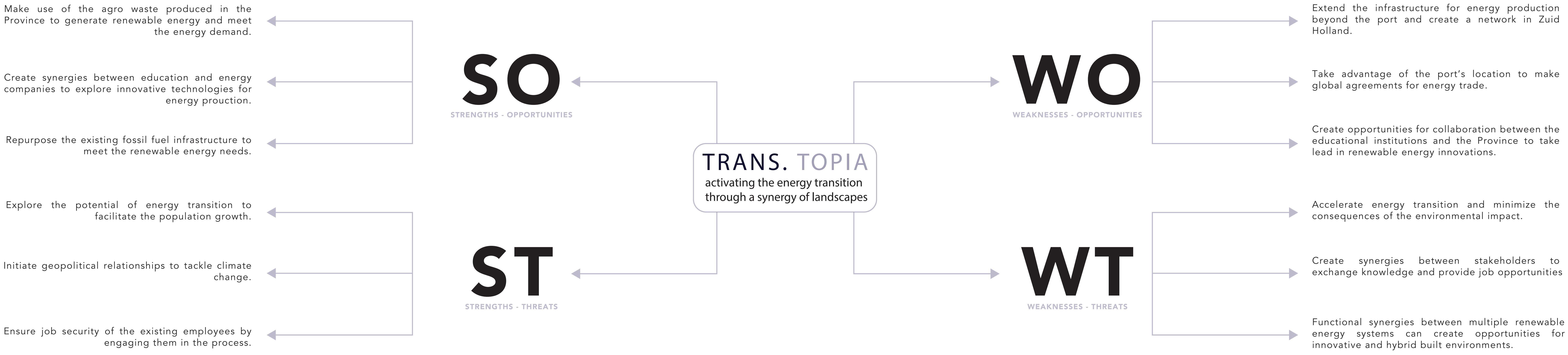


Figure 26. TOWS Strategies

DIAGNOSIS

The Netherlands are highly dependent on fossil fuel-based energy, creating a large environmental impact deriving from the CO2 emissions. At the same time, the government has to tackle the eventual population growth and the consequent increase in energy demand. Therefore, the acceleration of energy transition and the phasing out of fossil fuels is inevitable and immediate. The analysis carried out for Zuid Holland and the Port of Rotterdam revealed significant strengths and opportunities essential for the energy transition but also identified potential threats and negative externalities of the transition that need to be addressed.

The opportunities and the negative effects that come with the energy transition are compiled and critically analyzed using the tool of SWOT. Afterwards, we delved into identifying the strategic objectives for Zuid Holland and the Port of Rotterdam using the TOWS strategies method, where the attributes of SWOT are further elaborated. This process is a preliminary attempt at exploring possible synergies between the stakeholders, spaces and energy production systems that would shape our project. Here we aimed at harnessing opportunities and banking on our strengths to mediate the impacts of the threats and curb our weaknesses.

Consequently, we are addressing the energy transition on different scales, from global to local. Given the existing agreements and policies, as well as the role of the port in the global energy trade, Transtopia aims to empower geopolitical relationships through the trade of renewable energy. At the same time, we are taking advantage of the potential energy production landscapes, like agricultural lands that produce bio-waste, to extend the energy production beyond the port and create an energy network in Zuid Holland. Thereby, the port is becoming a backbone for the production and distribution of energy to the region, country and global world.
A significant strategy to accelerate energy transition is the boost of innovation and research, linked with the institutions located in the Province that are very concerned with energy transition. Understanding the importance of technology for renewable energy systems as well as the interdependence between the technology and the efficiency of the proposed systems, establishing synergy and coordination between them becomes a necessity. A strong education-research network is important for the energy transition in order to constantly update energy-related technology towards 2050.
The energy transition is an inclusive process and requires the most participation from different sectors of society. Critical in the implementation of inclusivity is the ability to converge social sciences and technology to motivate and enable civil society, private and public actors to actively contribute to a sustainable energy transition.(ISSC and UNESCO, 2013; Hackmann et al., 2014; Sovacool, 2014; Weaver et al., 2014).

04

TRANSTOPIA VISION

4.1 SOUTH HOLLAND AS AN ENERGY LANDSCAPE BY 2050

4.2 GOALS

4.1

SOUTH HOLLAND AS AN ENERGY LANDSCAPE BY 2050

TRANS.TOPIA strives to redefine the identity of Zuid Holland as an energy landscape, whilst strengthening the role of the Port as an energy hub.

Primarily by decentralizing and diversifying renewable energy production systems within the region. A network of synergies will be established between the local, regional, and global demand and supply. Resulting in a resilient and adaptable system that initiates new functional relationships between the Port and the region.

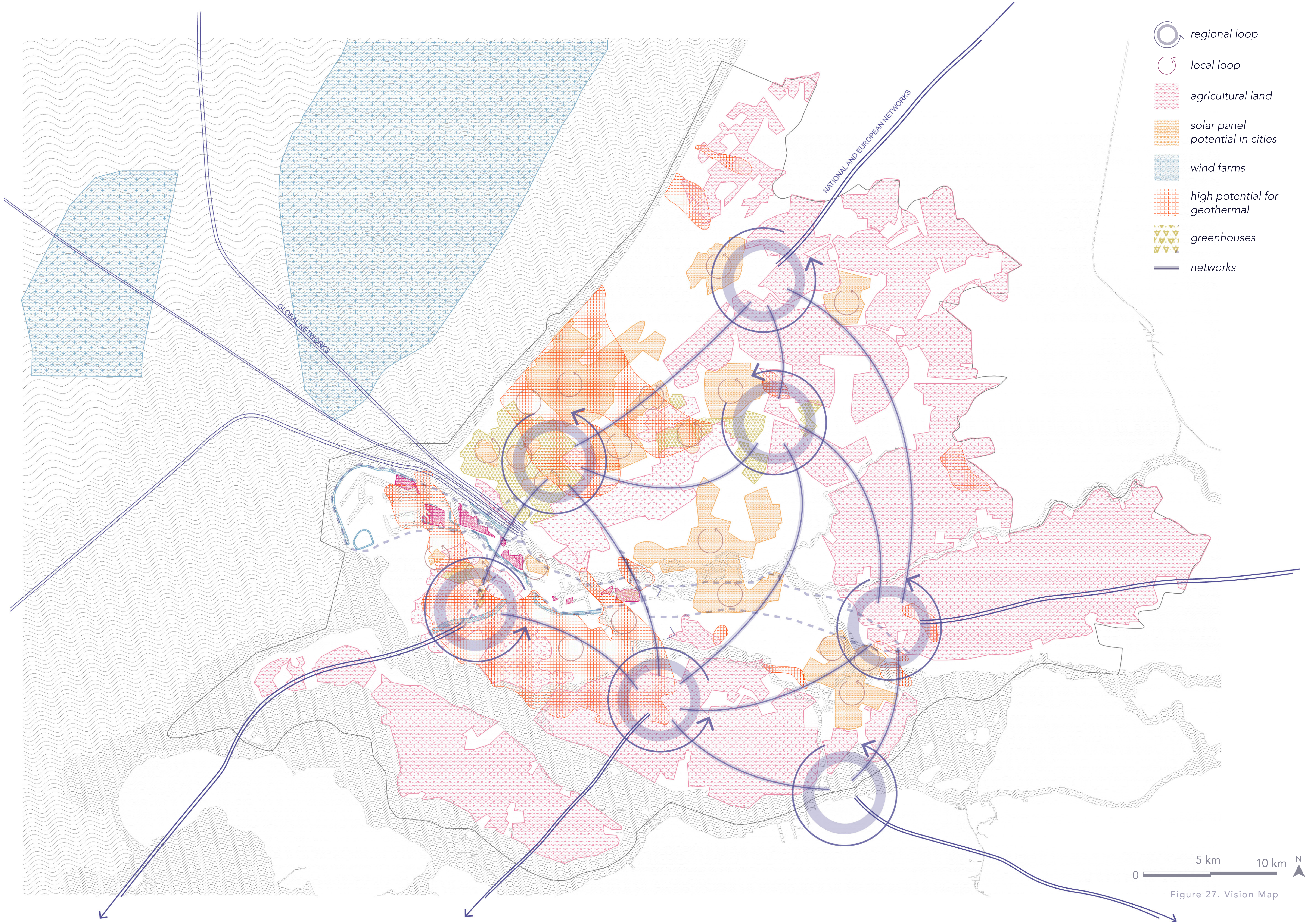


Figure 27. Vision Map

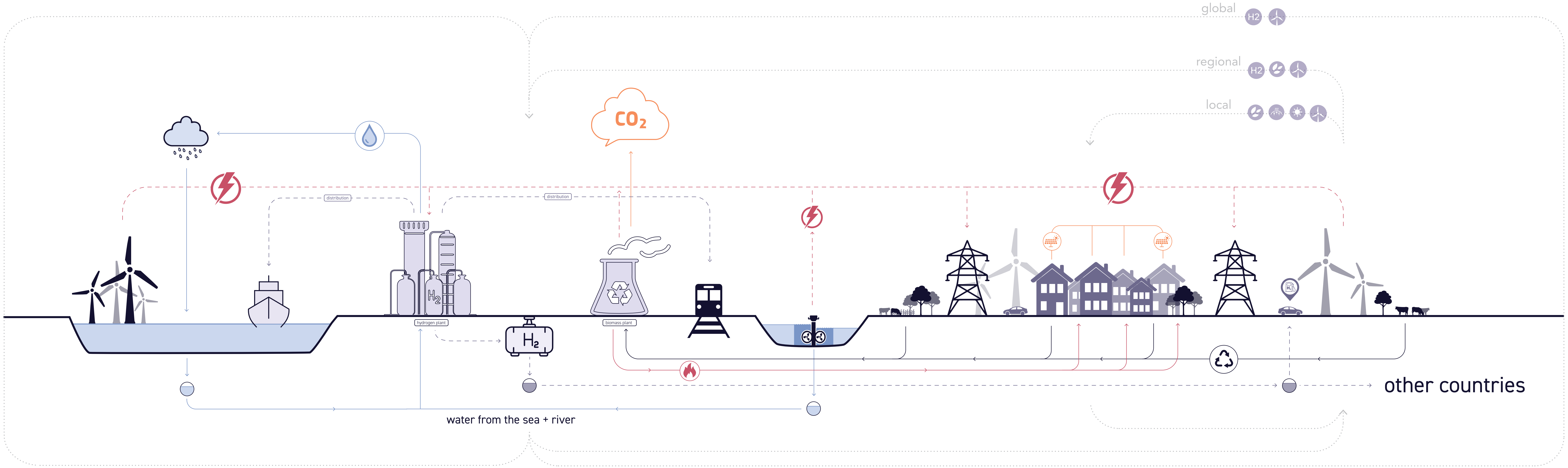


Figure 28. Proposed Systemic Section

THE FUTURE SYSTEM

Currently, energy in the Netherlands is centrally manufactured from fossil fuels in the Port of Rotterdam, which are then distributed to the rest of the region and country. Besides the process being environmentally unsustainable, large open loops of energy flows make it highly inefficient.

In strong contrast to this prevalent scenario, Transtopia proposes to shorten the loops of energy (supply and demand) by creating an overlap of multiple renewable energy production systems across scales- namely global, regional and local. It emphasises on decentralizing the energy production from the port to the local scale which constitutes smaller areas in the region with high potential for renewable energy production.

Taking into account the spatial and capacity limitations of the different clean energy sources, the project proposes to align their uses based on the scales. Solar and geothermal energy can be used in a building or at a neighbourhood level. While wind and biomass energy, although generated at a local scale, can be used to power both local and regional demands. Ultimately hydrogen generated at the port can be used to meet large scale energy demands in the region (like industries and heavy greenhouses) on, a national and global scale.
Since most renewable energy sources are not stable, owing to fluctuations in the climate, Transtopia ensures an overlap of energy systems at every scale. This means more than one energy system can cater to the demand and the surplus can be stored or directed to the regional grid. Thereby ensuring that the local energy manufacturing clusters are always integrated into the region as well as the port.

Transtopia, through endogenous systems of energy production, will encourage the participation of the local and regional sectors in the energy transition. Bestowing more ownership, power, responsibility and immediate liability towards this transition. Thus stirring an attitude to reduce energy consumption in society.

Furthermore, these systems will also ensure efficiency through smaller energy loops with limited wastage. Lastly, the scope for innovation via functional and spatial synergies between the local, regional, and port will explore opportunities to close the energy loops, making them as circular as possible.

4.2

GOALS

SUSTAINABLE DEVELOPMENT GOALS

The ***Sustainable Development Goals*** is part of the 2030 Agenda adopted by the United Nations (UN, 2021). At a total of 17 themes, the UN has developed goals to protect our natural environment, to promote prosperity and to move towards a just society. We have selected the most relevant goals for Transtopia and refitted them to the context of our regional strategy.

Source: SDGS.UN

AFFORDABLE AND CLEAN ENERGY

As we progress into phasing out from fossil fuels to renewable energy, it is important to ensure that the future of energy is inclusive, affordable and reliable. Our dependency on other countries for energy makes us vulnerable to changing geo-political situations, like the prevalent situation with Russia. Moreover, we aim to reduce the dependency of the Netherlands from other countries, ensuring a boost in economic stability (BBC, 2022).

DECENT WORK AND ECONOMIC GROWTH

Our goal is to attract different industries and start-up companies rising the development of the region, promoting a competitive economic environment within Netherlands. Leading to an increase in jobs as we continue to a leader in export of renewable energy.Moreover, we aim to reduce the dependency of Netherlands in other countries, ensuring continuation of economic stability.

INDUSTRY, INNOVATION, AND INFRASTRUCTURE

As we shift from fossil fuels, we will be dependent on engineers to upgrade our existing systems to function on renewable sources of energy. As well, in the face of technological advancements in the energy sector, our project can utilize these innovative developments by establishing a network connecting industries and institutions (TU Delft, Erasmus, etc.). By doing so, we aim in creating a fertile ground that fosters experimentation and creativity.

SUSTAINABLE CITIES AND COMMUNITIES

As cities and communities are extremely vulnerable to the negative effects of climate change, emphasis must be given in forming a socially, environmentally (as explained in the climate action goal), and economically sustainable living environments. Our goal is to transform the living environment into inclusive and innovative communities. We propose to bring different functions together and create synergies between them which will enable a meaningful symbiosis.

RESPONSIBLE CONSUMPTION AND PRODUCTION

In order to achieve a sustainable society within the Netherlands, our current production and consumption patterns are degrading our environment. We must switch to more sustainable patterns by creating systems within the local scale and involving citizens in the energy transition. We can create awareness concerning environmental and energy issues and in turn more responsibility as the liability is increased.

CLIMATE ACTION

The national government's goals for 2050 (Government of Netherlands, 2019) will lead us to transform Netherlands and specifically Zuid-Holland into a 100% renewable energy and a CO2 emission free environment. Moreover our goal is to increase the awareness of the people, concerning environmental issues.

PARTNERSHIPS FOR THE GOALS

Moving towards a more sustainable and inclusive society we need to combine different levels of governance within the nation to ensure a better collaboration between them, where different parties could benefit from each other. In addition, as the port has a strong economic position not only nationally but also globally, it is strategic to make stronger relationships between the Netherlands and different countries (Port of Rotterdam, 2021).

05

STRATEGIES

STRENGTHEN THE PORT AS AN ENERGY HUB

DECENTRALIZE THE ENERGY LANDSCAPE

DIVERSIFY ENERGY PRODUCTION

5.1
STRENGTHEN.
DECENTRALIZE.
DIVERSIFY.

STRENGTHEN THE PORT AS AN ENERGY HUB

Transtopia aims to strengthen the role of the Port of Rotterdam in the global energy network whilst making it the backbone of the energy transition for the region of Zuid Holland.

In the current scenario, the Port of Rotterdam is a critical actor in the global energy trade. However, a large amount of the raw material is still imported by the Netherlands for fossil-based energy. A practice that is not only unsustainable but also makes the Netherlands economically dependent on other countries for energy consumption.

Transtopia proposes to expand the influence and redefine the port to boost its role as a renewable energy generator and distributor. Acknowledging the promising prospects of hydrogen as the future of renewable energy, we intend to situate hydrogen manufacturing plants in the port. At a scale that will not only suffice the regional/ port energy demands but also generate surplus for international export. The existing oil-based energy infrastructure can be used for storing and distributing hydrogen, via storage tanks and pipelines, respectively.

The strategic location of the Port will allow us to make use of land as well as waterways to connect the port to places like Chile (for import of raw hydrogen), Chemelot (for the supply of hydrogen energy) as well as greenhouses in the Westland (for import of raw material and export of electricity).

Besides hydrogen, there will be other clean energy manufacturing plants and industries also situated in the port that would transform it into a diverse end-to-end energy hub. It would also be connected to other commercial and educational institutions in the country that are associated with the shift towards renewable alternatives. Thereby defining its significance as a critical activator in the global, regional as well as local energy transition.

Figure 29. Strengthen the Port as an Energy Hub

5.1

STRENGTHEN.

DECENTRALIZE.

DIVERSIFY.

EXPAND THE ENERGY BEYOND THE PORT

In the current scenario, the port is dominated by a mono-functional fossil fuel-based energy landscape, making us question the resilience and efficiency of the existing system. (Johannes-Jesse, Heinrichs and Kuckshinrichs, 2019)

Since a majority of the energy production is consolidated within the port, there is almost no association of the port and energy production with the rest of Zuid Holland, increasing the gap between the two. This manifests a lack of responsibility and awareness about the energy transition.

For that, we are proposing to create smaller endogenous loops of energy and connect them through a network to sustain the entire region. This would create synergies between diverse energy systems and act as a fulcrum for future developments.

In addition, we propose to establish a functional relationship based on energy systems between the local, regional and global scale, with the port acting as a backbone in this transition. For instance, instead of depending on the port for energy, residential areas could use locally produced biomass energy. Where in case of a surplus, energy from these endogenous loops could be diverted to the regional grid.

Through the strategy, the responsibility and participation in the energy transition are distributed among different stakeholders within the region.

Figure 30. Decentralize the Energy Beyond the Port

5.1

STRENGTHEN. DECENTRALIZE. DIVERSIFY.

DIVERSIFY ENERGY PRODUCTION

As established in the previous chapters (Chapter Analysis), one renewable energy source is not sufficient to accommodate the current power demands of Zuid Holland. Especially with a projected increase in the energy demand in the near future due to population growth.

Since each renewable energy system has its limited capacity to generate energy, we need to decentralize. Transtopia proposes to align different energy production systems based on their capacities to generate energy for varying functions and scales.
The energy produced in the smaller local clusters would be fed to the local grid and consumed internally within the subregion.

The regional landscapes of Zuid Holland hold immense potential to harness clean energy. For instance, wind farms can be located on agricultural land to provide energy for the farmlands, or the agro-waste can be used to generate biomass energy. Synergies can be established between different landscapes and energy systems by using the prevalent land use as sources of raw material and spaces for energy production. Thus giving rise to a new form of spatial, functional and socio-economic symbiosis within these areas. Such smaller loops of energy will reduce the load and dependency on a single source of energy, while the overlapping methods of energy generation will ensure an adaptable and resilient system. In the case that one renewable energy system fails or ceases to exist, the local grid can still ensure a stable supply of energy.

Figure 31. Diversify Energy Production

5.2
IMPLEMENTATION

SYNERGETIC ENERGY LANDSCAPES

At the core of Transtopia is the intent to create endogenous overlapping systems of energy production in alignment/accordance to the potentialities of the regional landscape. Thereby establishing synergies between the space, function and socio-economic sectors involved in the energy transition across the local, regional and global scales in this energy transition. (As seen in figure 32). Here the energy demand has been categorised into 3 components based on their use.

Hydrogen: As an energy carrrier
Starting from the largest scale, the manufacturing of green hydrogen requires energy which can be obtained from offshore wind farms. This can be either exported internationally via ships and pipelines or stored in large tanks that will be eventually directed into the region for national consumption. Since hydrogen is a carrier of energy and not directly a source, it must go through a conversion plant that transforms it into electricity which can be fed into the grid. In the current scenario the power towers are owned by a semi-public company called TeneT. Thus it would be practical for Tenet to establish and maintain this new infrastructure. Since Transtopia plans to reserve hydrogen based energy for large scale purposes, like to power industries or greenhouses.

Electricity
Collection points in the subregions will receive agro-waste from greenhouses and farm lands, which will then be supplied to the main biomass plant. This plant will convert the waste into energy that will be supply back to the local grid that powers these very greenhouse and agriculture lands.Since the greenhouse owners and farmers both are a part of an association,they could collectively set up one such biomass plant.Thus avoiding high energy rates and holding more power and governance over their energy.Wind mills can also be set up by these associations to internalize energy generation and optimize the potentialities of their land. However, private players can also participate by generating energy via large-scale offshore or on shore wind farms which can supply electricity to the grid or to select sectors like the hydrogen manufacturing and industrial units. And lastly, at the lowest scale, solar panels can be used to power homes, streetlights etc.

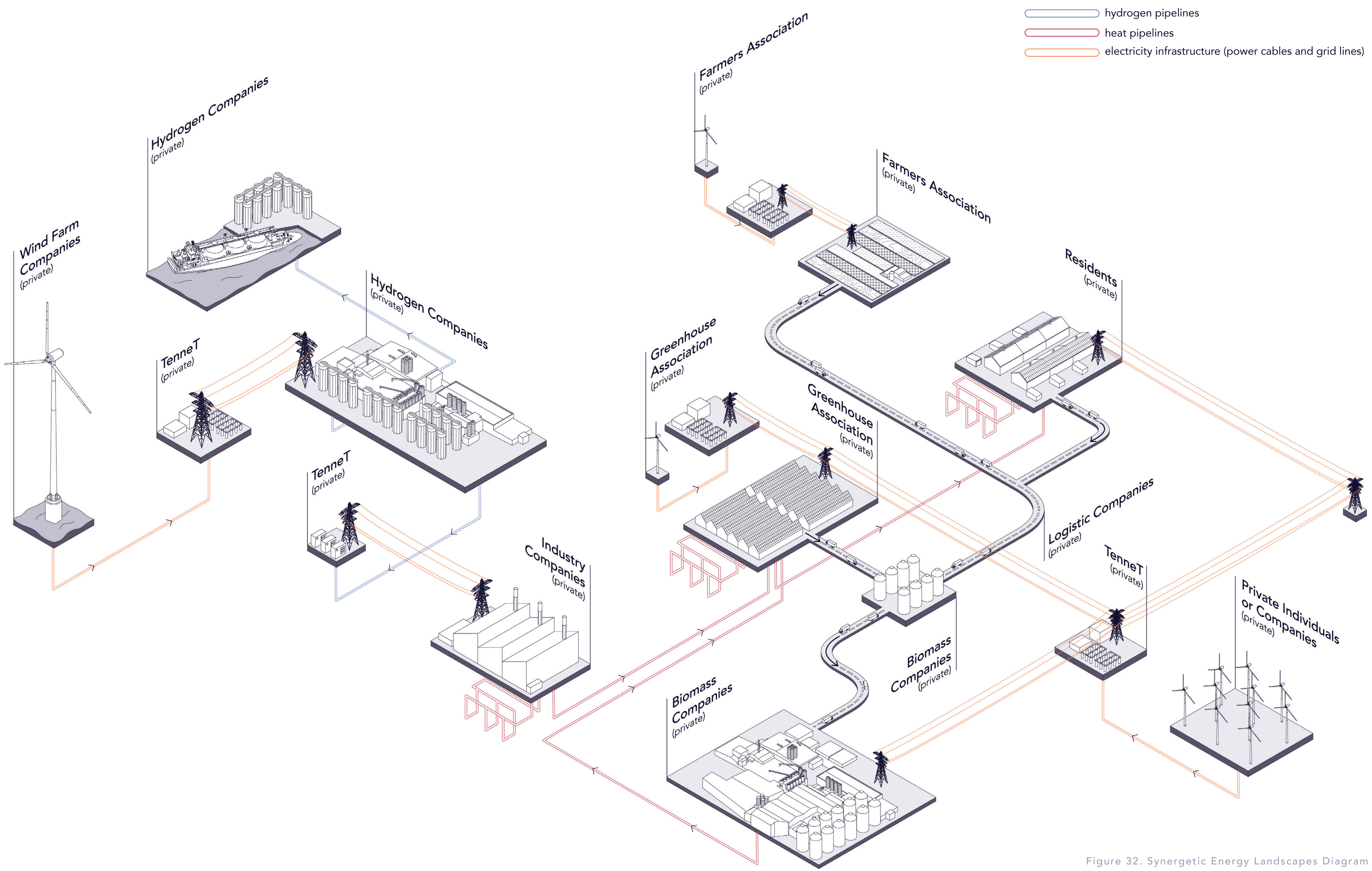
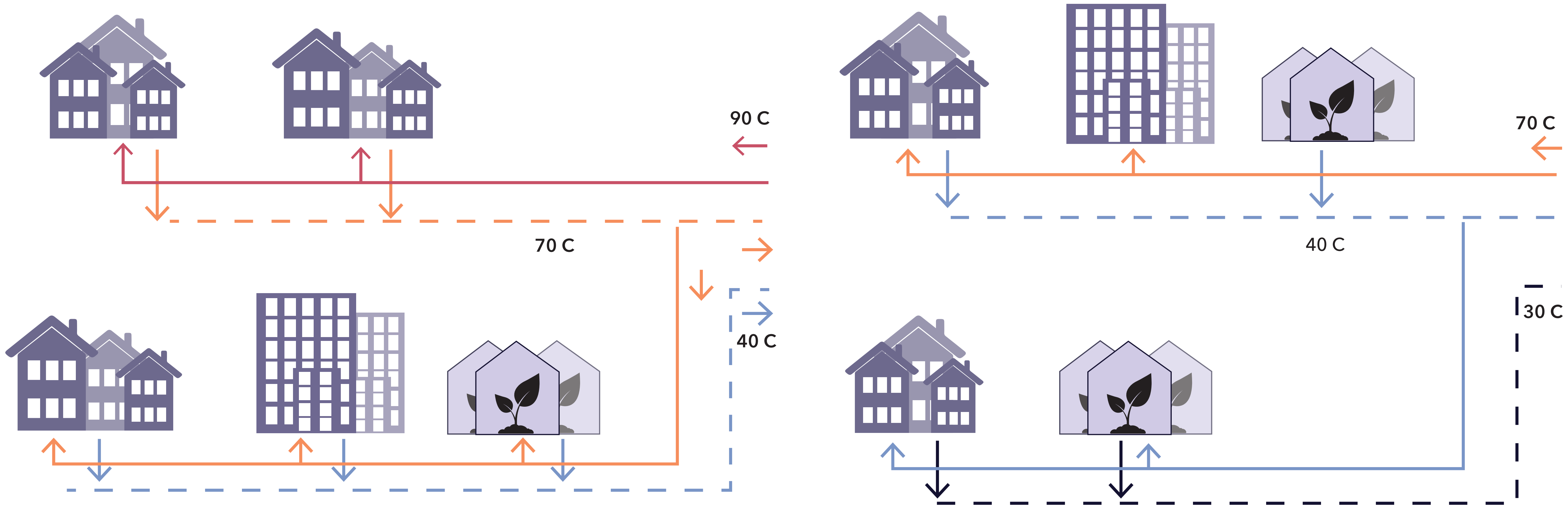


Figure 32. Synergetic Energy Landscapes Diagram

CASCADING HEAT

Heating
The climate of Netherlands makes it heavily reliant on heating systems for most part of the year, consuming about 32% (cbs, 2020) of the energy share. Since the first step towards energy transition is to reduce its consumption, Transtopia proposes to cascade heat energy between different functions. It involves the use of the residual energy in liquids or steam emanating from one process to provide heating, cooling, or pressure for another process. (Ehrenfeld and Gertler, 2010). This is based on an understanding of the heating demand for different sectors and their infrastructure. For instance, the heat generated from the industries is very high which could be used to heat up the greenhouses that require about 28°C of consistent indoor heat. While the residual heat from the greenhouses can be channeled into residential, commercial and educational buildings via pipelines in the form of hot water. Depending on the number of connections or cascading steps and system's efficiency, the intelligent tuning and exchanging of heat of different qualities could reduce the demand for primary energy for heat (at the start of the chain) by a factor of 2 at least. (Tillie et al., 2009)

In conclusion, shorter and more inter-related systems, increase efficieny and establish a stable supply of energy. This synergies will not only expand the functional potentialities of the regional landscape but also creates scope for shorter loops of energy and sows seeds for unique socio-economic collaborations.



Cascading Heat
Source: REAP2 Study

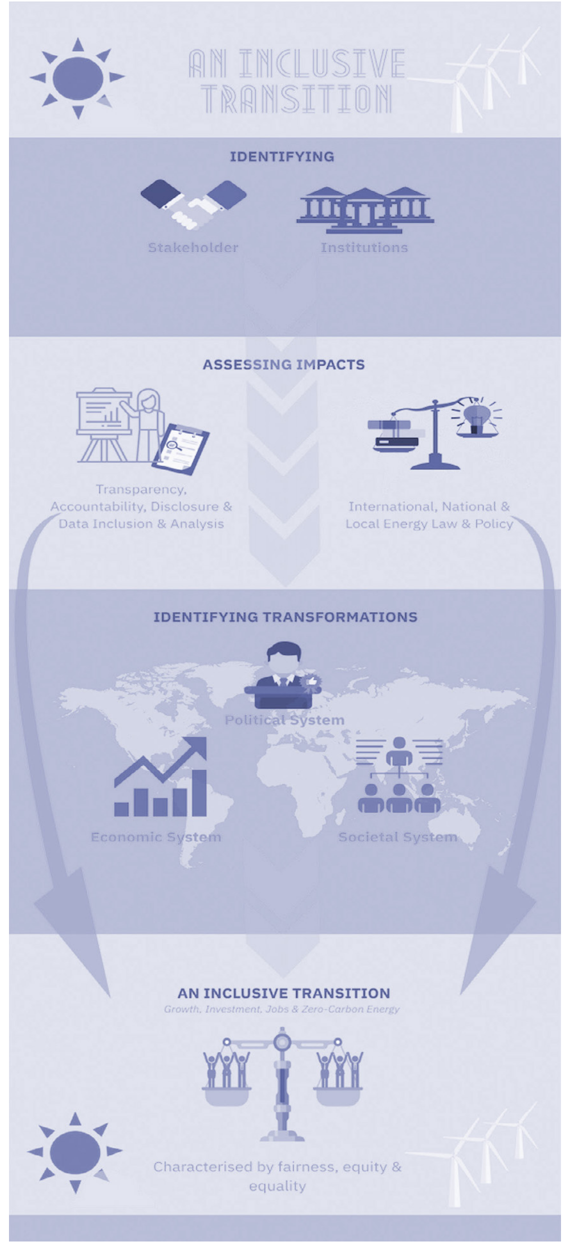
5.3
PHASING AND GOVERNANCE

Large-scale projects like Transtopia often involve a wide variety of stakeholders, either by active participation and decision making or because they are affected by the outcomes of the project. In previous chapters, policies on different scales (international, national, local) were identified, and the prevalent political, economic, and societal relations were understood (Heffron, 2021). The actors thus revealed can be divided into three categories, the public sector, the private sector, and the civil society, forming the governance of our project (Rocco, n.d.). Transtopia aims to engage multiple stakeholders in the process of the energy transition. Creating synergies between actors is important to ensure the resilience of the project and develop a sustainable future.

Governance is distinguished as hierarchic governance, networked governance, and market governance. Hierarchic governance is based on rules and vertical top-down decision-making. So far, this type of governance has proven to be ineffective, since it does not include controversial voices, increasing the risk of creating great conflicts that slow down the project. On the other side, there is networked governance, a multi-level polycentric system that involves multiple players in decision making and takes into consideration the complexity of the city and the importance of engaging silent voices and other interested parties. The latter, market governance, is when the private sector is powered enough to directly influence the decision-making. (Rocco, n.d.). Ideally, an equilibrium of the three types of governance would be the most effective for projects like Transtopia.

As described on page 56, the stakeholders involved in the energy transition belong to different sectors (public, private, and civil society). To ensure that the project would be embraced by all the interested parties, the process of energy transition needs to be inclusive. Discussions and participation must take place before the realization of the strategies proposed and accountability should be shared between stakeholders for the decision making. Especially at the local level, the space must be given to the marginalized population to express their opinions and allow local initiatives to encourage inclusivity. (Heffron, 2021) Nevertheless, the market cannot be excluded. Understanding that the energy transition creates opportunities for the economy, through Transtopia, the port is transformed into an energy hub open to investors, while local developments around the region create opportunities for developers. This approach will trigger forward indirect effects in the port and eventually the region. Such that they can simultaneously involve stakeholders in the process and boost the economy to support the country.

Transtopia emphasizes on the collaboration between the different sectors, creating symbiotic relationships between stakeholders and promoting the co-creation of the future living environment in the region as well as the port. Critical in our project is to achieve an inclusive energy transition that promotes fair energy management where accountability and responsibility are equally delegated.



The process of inclusive transition
Source. Heffron, 2021

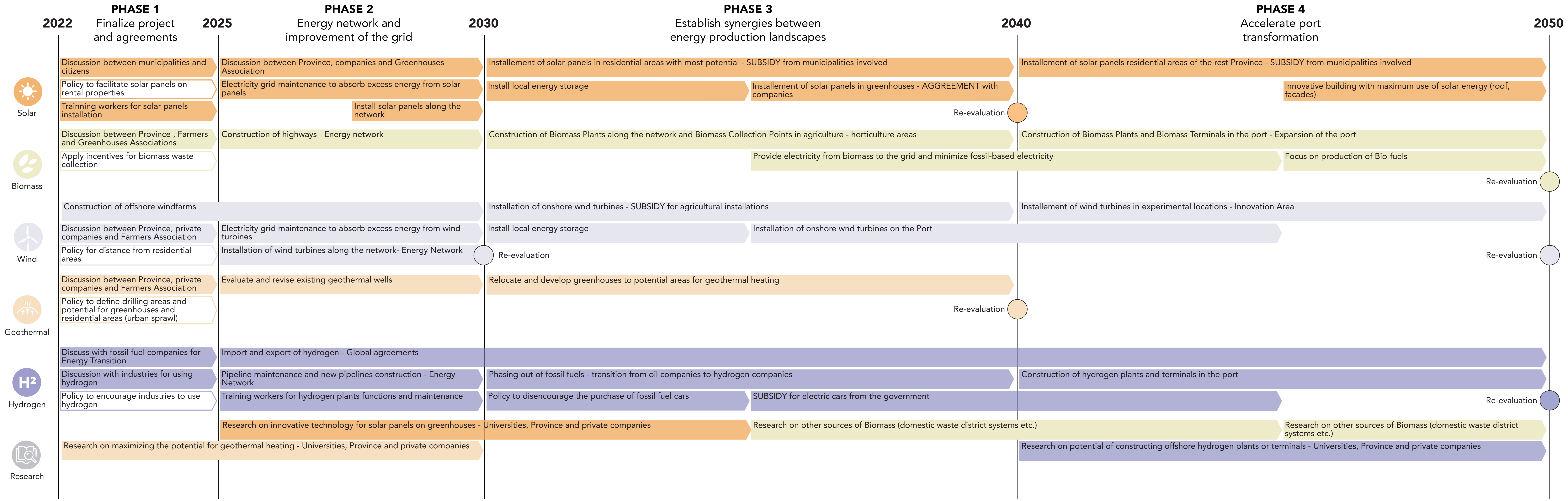


Figure 33.Timeline

TIMELINE TOWARDS 2050

The implementation of this project can be organized in 3 phases to facilitate the transition from fossil fuel to renewable energy while resulting in the simultaneous transformation of the port and the region.

Phase 1 (2022 - 2025) is dedicated to culminating the strategic designs of the project, through discussions between interested parties and the formation of policies that aim at accelerating the transition. We would also seek the engagement of other disciplines for the technical implementation of the strategies.

Phase 2 (2025 - 2030) is about establishing the energy network. This includes improving the electricity grid to be able to absorb excess electricity from renewable sources. We would be maintaining the existing pipelines and installing new ones for the distribution of hydrogen and constructing the highway to facilitate mobility. Which can not only be used by people for movement but also the conveyance of raw materials and logistics. At the same time, preparation works will take place for subsequent steps, such as training workers, research, and site analysis for potential geothermal drills.

Phase 3 (2030 - 2040) focuses on establishing synergies between energy landscapes around the Province of South Holland, to initiate local energy production-consumption. The designated hybrid areas will lead this period through the developments proposed and the infrastructures set up along the network that will be crucial for the functioning of the energy production landscapes. Therefore, attention is given to the biomass plants and hydrogen converters which will allow the development of local industries and innovative - multifunctional areas. Simultaneously, subsidies will be running to encourage the purchase of electric cars and the installation of solar panels in the residential areas with the most potential.

Phase 4 (2040 - 2050) is marked for accelerating the port transition. Taking into account that the existing fossil fuel industries will be transforming into more sustainable renewable-based industries, in this decade the biomass and hydrogen plants will be constructed. Thereby forming the energy production area of the port and facilitating its expansion to the north and the south. The other infrastructures of the port would consist of the wind turbines in the innovation area and the innovative buildings in the port, making the most use of available roofs or facades for solar panels. During the implementation of Transtopia research will be carried out on other different energy production systems and their potential. At the same time, a monitoring system will keep a record of the progress and re-evaluate its function given the input from research to adjust the strategies accordingly. (figure 34).

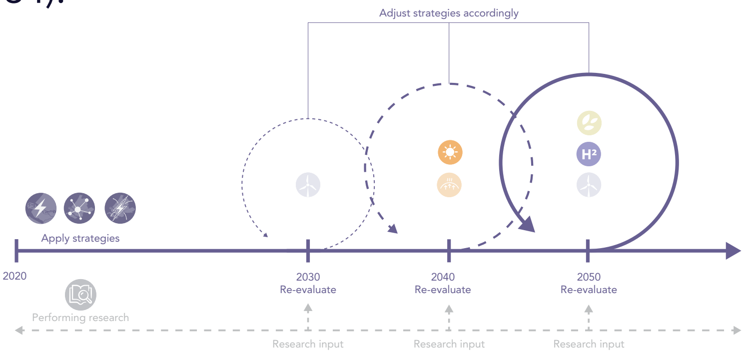


Figure 34. Revaluation Diagram

Figure 35. Phasing Timeline Maps

By 2030, the energy network in the region will be implemented. It will thus become an initiator of the transition, unveiling potentialities for the areas to be developed. At the same time, offshores wind farm will be completed as already planned, providing electricity for the port's functions and the region.

By 2040, the hybrid overlapping areas will be consolidated. Most of the interested parties will be engaged in energy production and the areas will be efficient enough to produce energy. Secondary and tertiary networks will be activated and local infrastructures will be developed to facilitate energy production and meet the energy demand.

By 2050, the port will have already been through the process of transformation. Since the energy network will be functioning and energy will be produced on local scale, the port's transformation can now be accelerated. With new hydrogen and biomass plants as well as innovative areas will be developed.

5.3
STAKEHOLDER SYNERGIES

SYNERGETIC POLICIES

As explained at the beginning of this chapter, for the transition to be implemented, several synergies and subsidies need to be integrated into the process.

Currently, there is some financial help provided by the government to facilitate the use of renewable resources. For instance, the Sustainable Energy Production and Climate Transition (SDE++) concerns anyone that intends to produce renewable energy, while the Energy Investment Allowance (EIA) is for companies that invest in energy-saving and sustainable energy.
Additionally, the Sustainable energy investment scheme (ISDE) is directed to owners that install devices for sustainable energy like connecting to the heat grid, and installing small-scale wind turbines, heat pumps, solar boilers or solar panels.
As well as the Subsidy Scheme for Cooperative Energy Generation (SCE) is for energy cooperatives and homeowners' associations that aim to generate renewable energy from solar (PV), wind or hydropower.
However these subsidies are not enough to accelerate the energy transition, especially since they are not taking into account specific difficulties. For instance, the installation of solar panels is usually inevitable in rental properties, hence a policy should facilitate this, for the (long-term) tenants to have a say on that and be offered this opportunity.

Moreover, since Transtopia proposes the collection of biowaste from agricultural landscapes and greenhouses, considering the challenge for the farmers, an incentive should be applied to those who intend to participate. In addition, to make wind turbines more accepted, we suggest that a distance from residential areas should be applied as well as an incentive for installing wind turbines in agricultural properties must be implemented. The other policy refers to geothermal energy which can be used for greenhouses. After defining the most promising location, a policy to encourage greenhouse installation could be applied. Finally, since hydrogen is booming as one of the most efficient energy carriers and could be integrated into industrial processes, a policy to encourage industries to use hydrogen-based infrastructure would facilitate the growth of local enterprises.

To make these policies more effective, there is a need for synergies between the interested parties, to meet the varying needs and expectations. Keeping in mind that collaboration between them is essential to see this transition through.

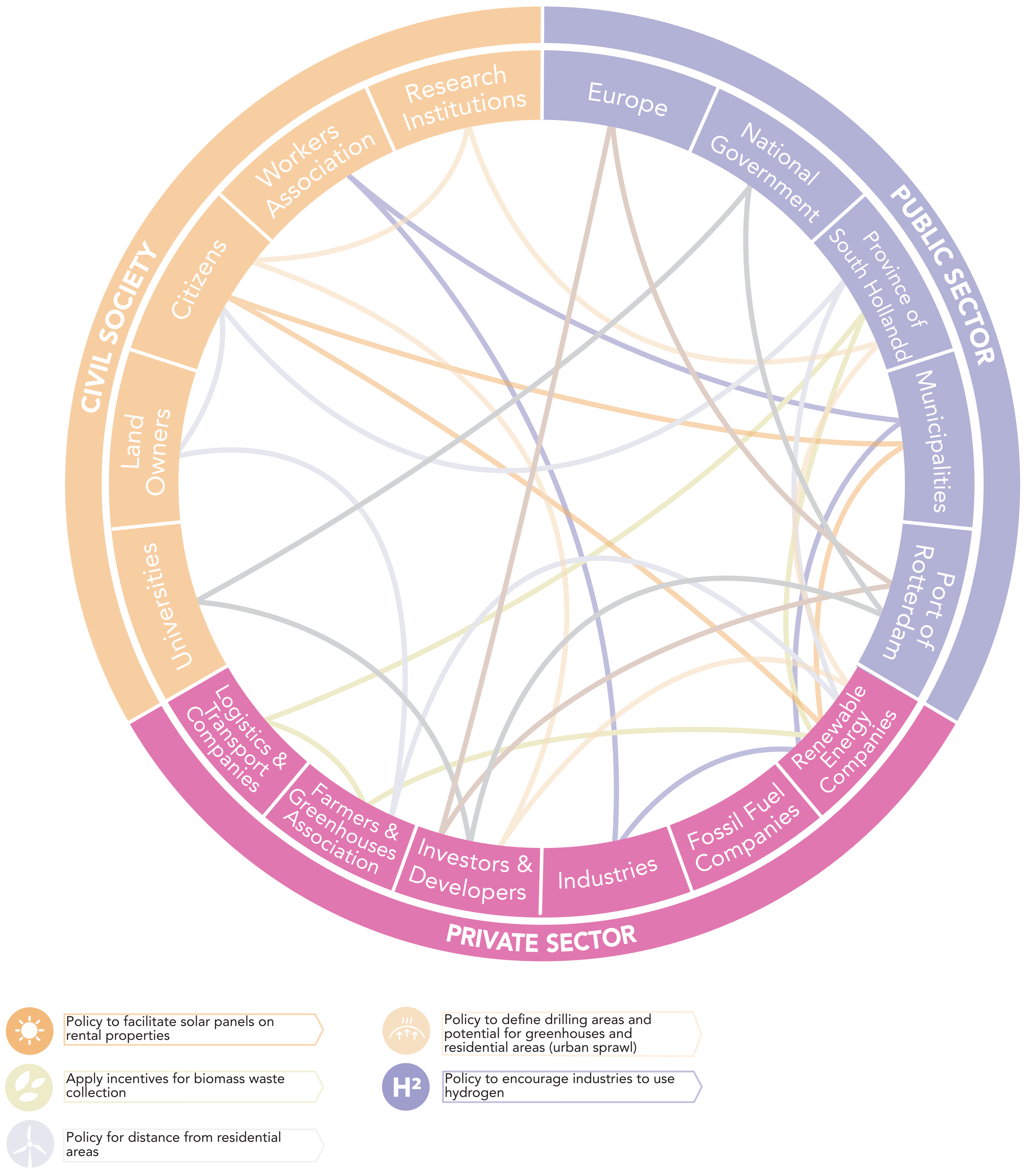


Figure 36. Stakeholder Synergies through Policies/Incentives

06

INTERVENTIONS

6.1
ZUID HOLLAND

Trans-topia proposes the creation of an energy network along the region of Zuid Holland (including the port), distributing, and producing energy from the local to the regional scale which will ultimately connect to the national and international networks. This network will have a polymorphism character, that will be transformed based on the demand for energy in each area, the stakeholders involved and the amount of raw material and energy that the different landscapes can produce.

The areas in which the network passes have been strategically selected based on the existing highways passing through the region, the underground pipelines of energy distribution, the land uses in the areas along with the flood risk and critical infrastructures like dikes, dunes, and waterways (Figure37). We emphasize on the facilitation of synergies via the network from a local to a regional scale. It will distribute renewable energy through the most efficient network possible since our aim is not only to produce as much energy as possible from each different landscape but also to design the systems with which we will diminish the transportation of energy and thus reduce the energy loss. For that to happen, we are creating smaller endogenous clusters of production landscapes where we are proposing cascading of energy as an exchange of raw material, energy, and heat between the different landscapes.

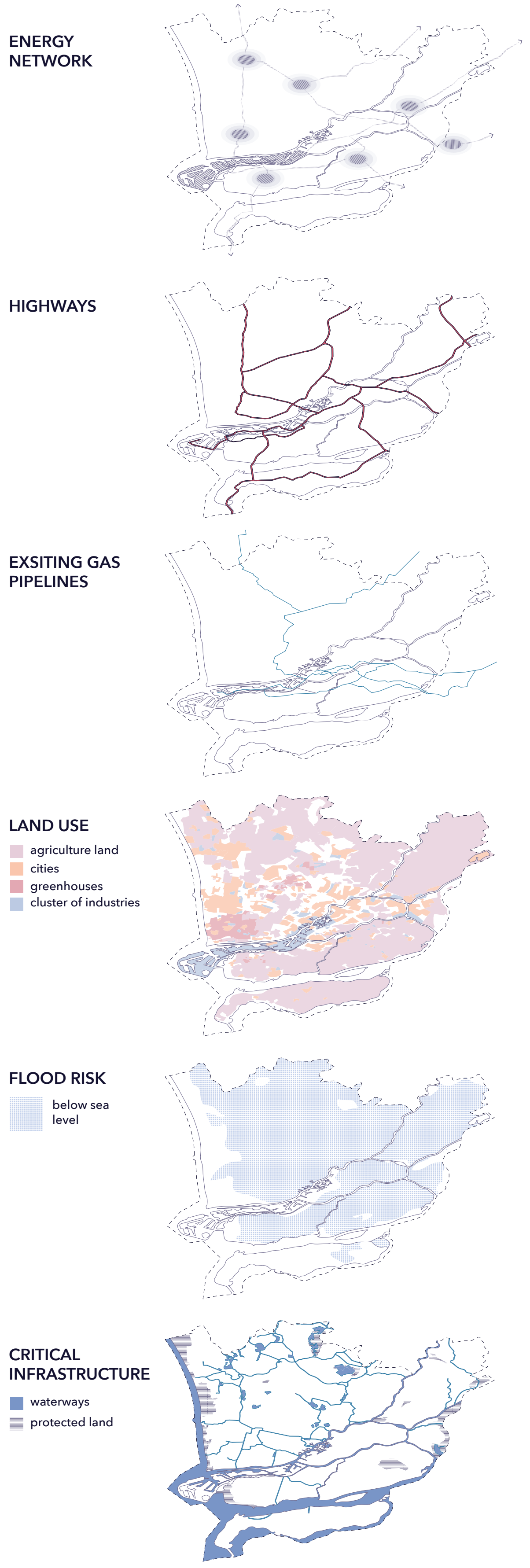


Figure 37. Energy Network Exploded Diagram

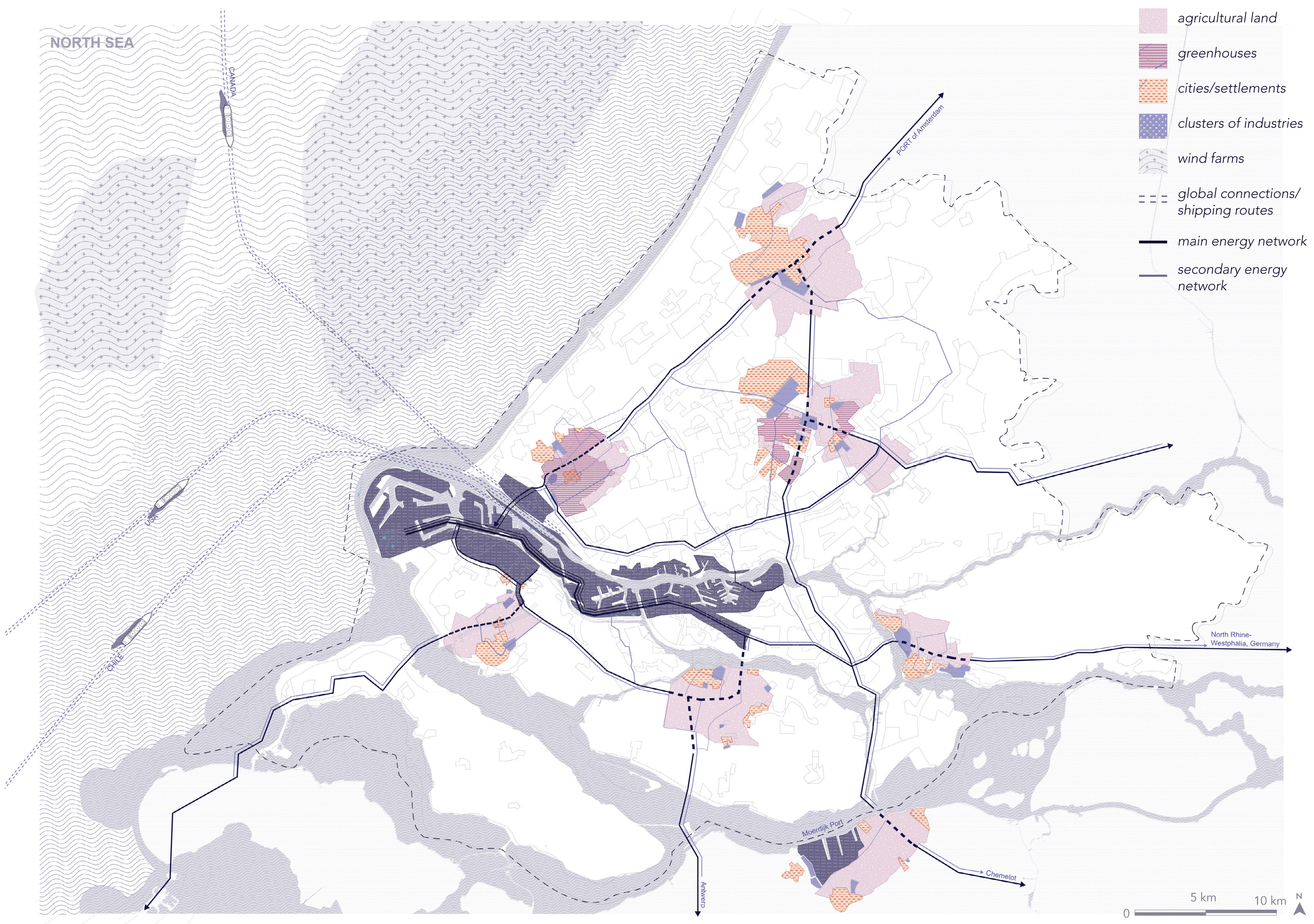


Figure 38. Final Transtopia Map

6.2
ENERGY NETWORK

With the term 'energy network', we are not only referring to the physical infrastructure but also to the spatial synergies in the landscapes and the actors involved in the energy production and consumption.

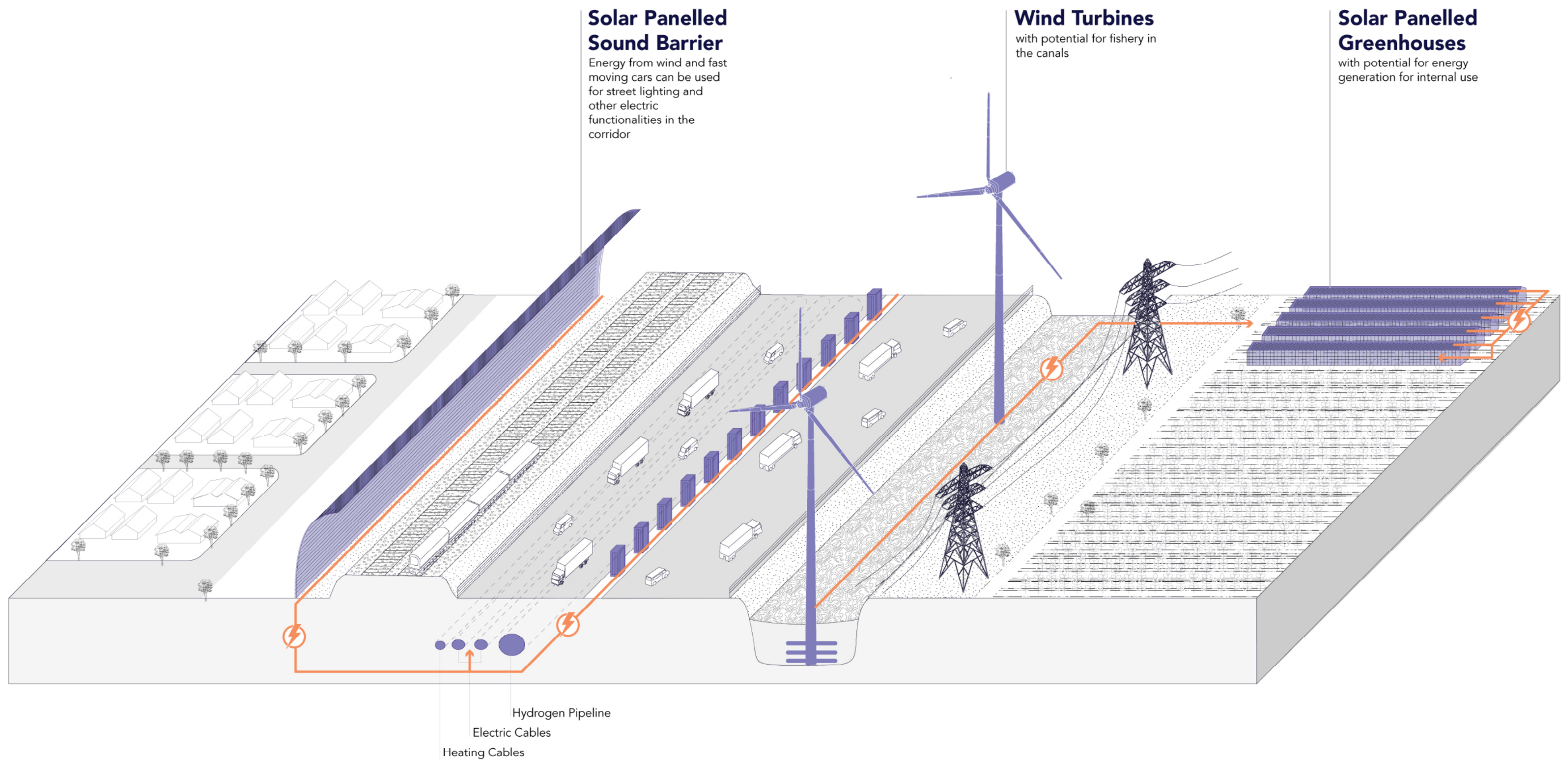


Figure 39. Energy Network Local

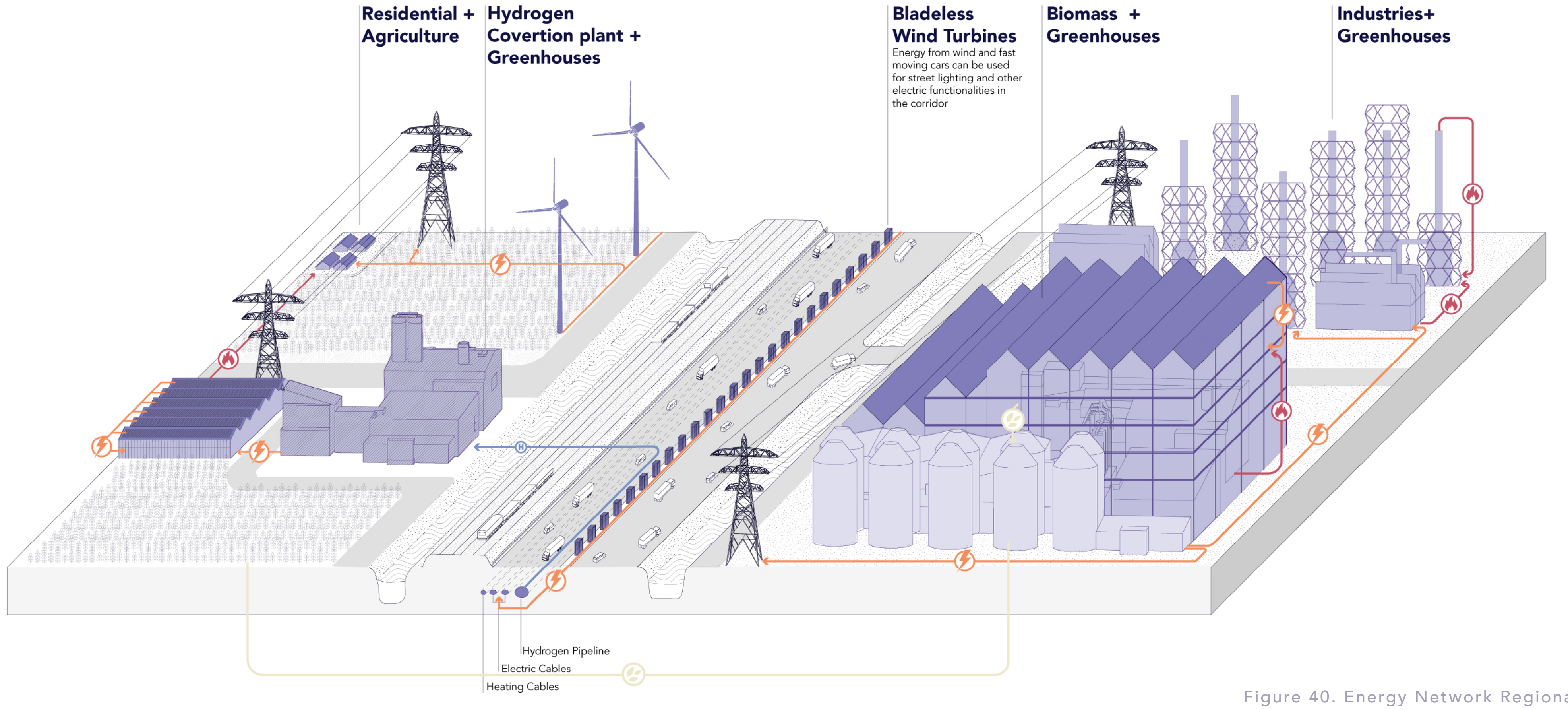


Figure 40. Energy Network Regional

LOCAL SCALE. NETWORK AS A NEGOTIATOR BETWEEN THE LANDSCAPES

The character of the network on the local scale will act as a negotiator between diverse energy production clusters. These clusters consist of different landscapes which have the potential to harness energy from diverse renewable sources. However, they are lacking the systems and the policies with which they can be transformed into synergetic landscapes. For example, the excess heat from the industries could be used in the residential areas and greenhouses. And hence, we are proposing the network as an urban activator where each landscape could benefit from each other, creating a more affordable, environmentally friendly, and resilient living environment.

REGIONAL SCALE. NETWORK AS AN ECONOMIC BOOSTER

The energy network on the regional scale will link the urban activators together with the port. Meaning that these clusters would have a direct connection with the industries in the port, and thus the raw materials and access to hydrogen energy can stimulate the market development in the region of Zuid Holland and the Netherlands. The industries along the network could benefit from the direct access to the infrastructures strengthening their competitive position. This will result in a boost in the economy and further employment. Additionally, it will also create fertile ground for new industrial clusters and start-up companies.

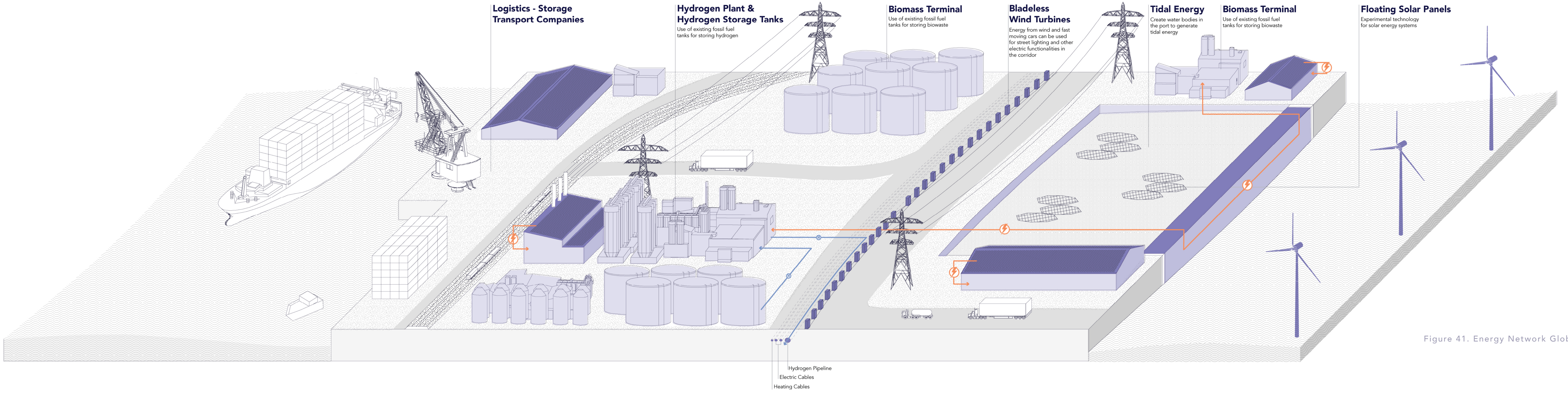


Figure 41. Energy Network Global

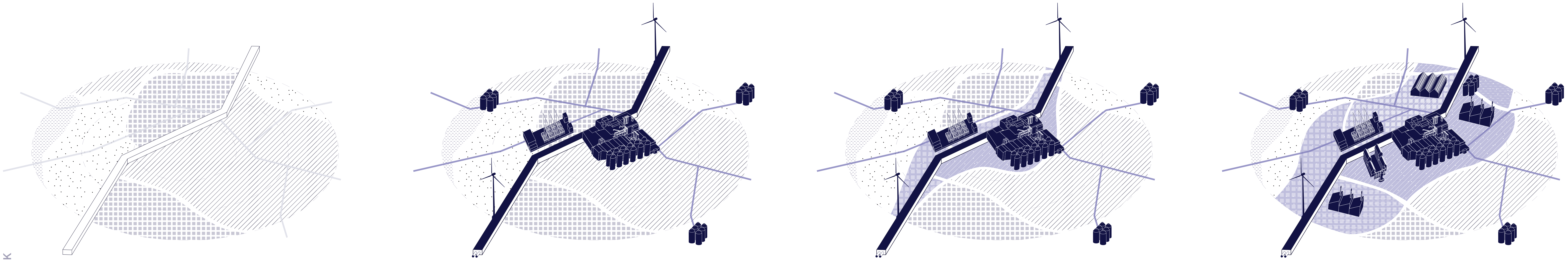
GLOBAL SCALE. NETWORK AS AN INTERNATIONAL ENERGY HUB

The network in the global scale focuses on making the port an international hub for hydrogen production, import, application, and transport to other countries in North-Western Europe. Moreover, the port will continue to play a leading role internationally, as well as remain the motor of the national economy, boosting the earning power of the port complex. Right now, there are major steps taken in the direction of import agreements for hydrogen. Trans-topia aims to build up from these steps by expanding the energy production to maintaining the port's role as a reliable, affordable, and sustainable energy supplier.

PROCESS DIAGRAM

ACTIVATION THROUGH THE ENERGY NETWORK

Figure 42. Energy Network Process Diagram



01

The urban activator is an area that combines different energy production landscapes directly connected with the energy network.

The chosen areas for urban activation have existing potential for energy generation due to a variety of land uses (greenhouses, residental, industry, agricultural land, etc.) and existing infrastructure.

02

First, the network penetrates the area as a negotiator between the different landscapes, where each landscape could benefit from each other. New policies and synergetic systems are going to be established, like collecting points for agro-waste which will be transformed into energy for the needs of the whole cluster. In addition, excess heat and energy will be cascaded within the cluster.

03

New infrastructure will be placed in between areas with different landscapes, that will begin to blend with each other. This will result in the creation of hybrid overlapping areas between different energy productions. These hybrid areas will have innovative spatial and functional synergies.

04

In the future, the hybrid overlapping areas will expand. Offering space for innovative spatial and systemic configurations, maximizing the potential of every landscape. Consequently, attracting new industries and collaboration between stakeholders. These areas will become fulcrums of energy-based development or urban growth which would ultimately benefit the economy of the region whilst strengthening the endogeneity of the activator.

6.3

THE PORT

REDEFINING THE IDENTITY OF THE PORT

The adjoining diagram illustrates the overlap of different energy systems as elaborated in chapter 05, which would not only redefine the identity of the Port of Rotterdam but also the region of Zuid Holland. It indicates the functional synergies initiated by the energy network and their consequent spatial implication on the port and the urban activators in the region. Here the port acts as an Energy Hub, constituting a diverse cluster of functions associated with the energy transition. Although the infrastructure is situated in the Port of Rotterdam, its influence extends beyond the physical boundaries from the local to the global scale.

Local and Regional Connection

The port of Rotterdam can be seen as an intensive region of energy production with prospects of manufacturing energy from hydrogen, wind, biomass and tides. Given the promising advances in hydrogen as a clean energy carrier, a particularly large area is reserved for its manufacturing and storage. Hydrogen can be transferred to the urban activators in the region through pipelines and cables running under the energy corridor.
Mobility infrastructures in the energy network connect the port to the region via trains and highways to transport goods and raw materials. This network will ensure that all the local endogenous energy clusters are co-related and function in sync with the region and the port.
Transtopia thus makes certain that the identity of the port is no longer restricted by its spatial or administrative boundaries. Rather the energy production areas can expand and bleed into rest of the region of Zuid Holland which is now completely isolated from the Port of Rotterdam.

Global Connection

The port also consists of areas to store and later distribute hydrogen via ships to other European and Global countries. It thus acts as a connection between the local/regional prospects of energy production to the global demand where the two can be a link for a socio-economic boost for the region.

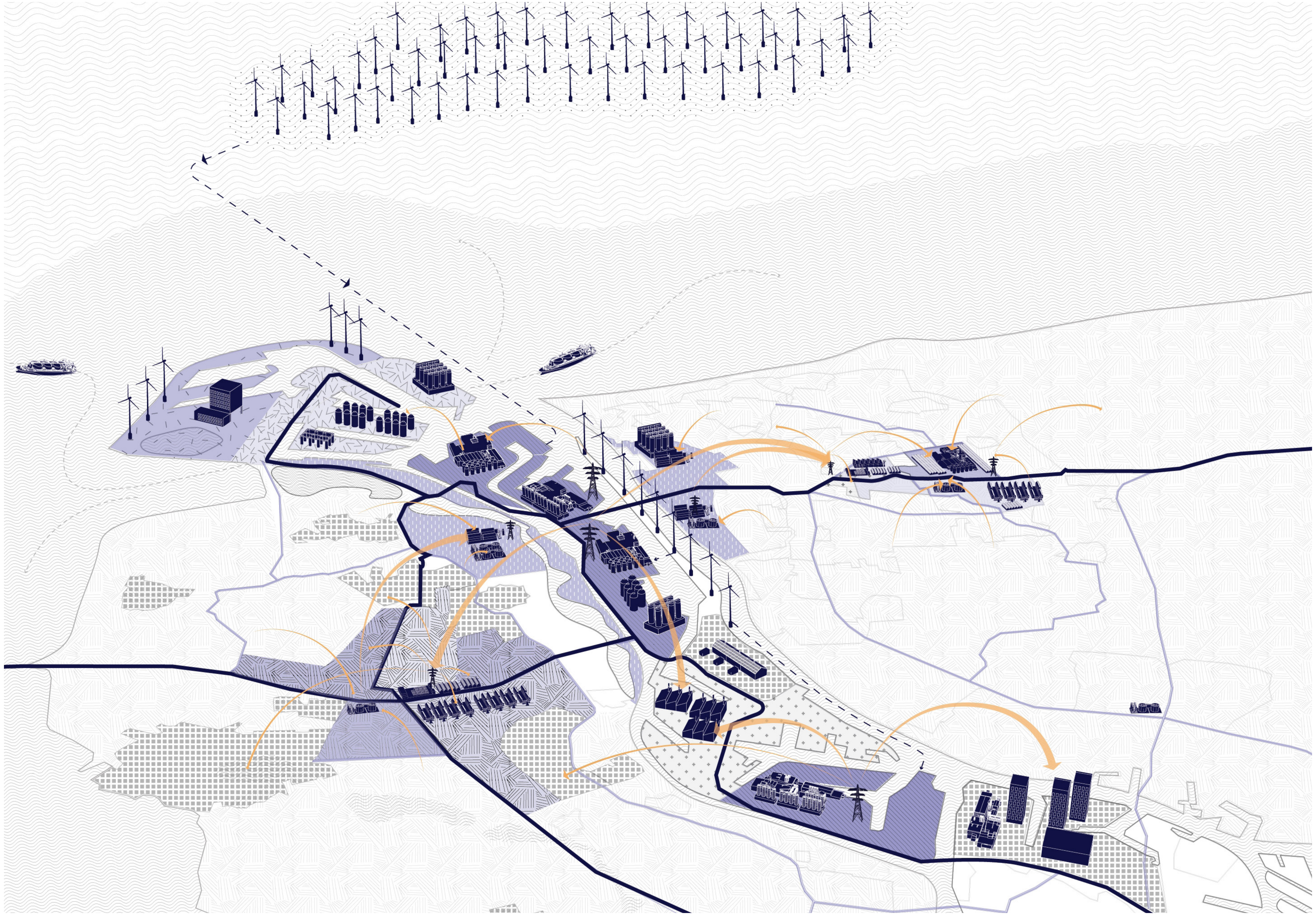


Figure 43. Redefining the Identity of the Port of Rotterdam

THE NEW FUNCTIONALITY OF THE PORT

Transtopia proposes to redefine the identity of the Port of Rotterdam as an energy hub, which means it transforms into an end-to-end energy manufacturer and service provider. In doing so, establishes new opportunities for functional and consequently, spatial relationships between the port and the local, regional, and global scale. As an energy hub, the functionalities of the port region mainly revolve around energy related processes.

Innovation

At the western end of the port is the Innovation centre, which will be aligned with RDM and other educational, technological, and research institutes. Here, place will be given to conduct experiments with new forms of infrastructure and energy manufacturing processes. The region will have living laboratories, vast lands for prototyping innovative infrastructure, biodiversity and certain areas reserved as a visitor centre.

Distribution

East of the Innovation area is the Distribution centre which will be easily accessible to large ships that will distribute the stored hydrogen/raw materials in this region to the rest of the Europe. This site is currently populated with several storage tanks used for oil, which can be eventually be reused to store hydrogen. The location of this region away from cities and inner parts of the port will ensure that larger and more container ships can dock in this region without hindrance caused by sea depth, narrow water channels or landlocked areas in the inner regions of the Port of Rotterdam.

Energy Production Landscape

Conveniently located to its east is a large area reserved for Hydrogen Manufacturing, acknowledging the promising advances in the scope for this clean source of energy. This is a critical area of energy production with the energy corridor passing right through it, which means it is the critical functional and infrastructural connection point between this intensive energy production area and the rest of the region. Here the energy production functionality can be seen to expand to the north and south of the region where the energy can be manufactured via biomass, wind, solar or even tidal. The energy thus generated can be fed into the regional grid along the energy corridor.
Next to it are the existing chemical industries and other manufacturing units which would depend on the hydrogen facility to power them.

Industrial Park

As we move eastwards, there would interesting functions and spatial synergies between energy production, the existing infrastructure and land use, like industrial parks, business districts that are energy neutral, makers districts etc. The east end of the Port has less heavy energy infrastructure and manufacturing as it is in close proximity to towns and cities like Schiedam, Rotterdam, Groenenhagen, etc.

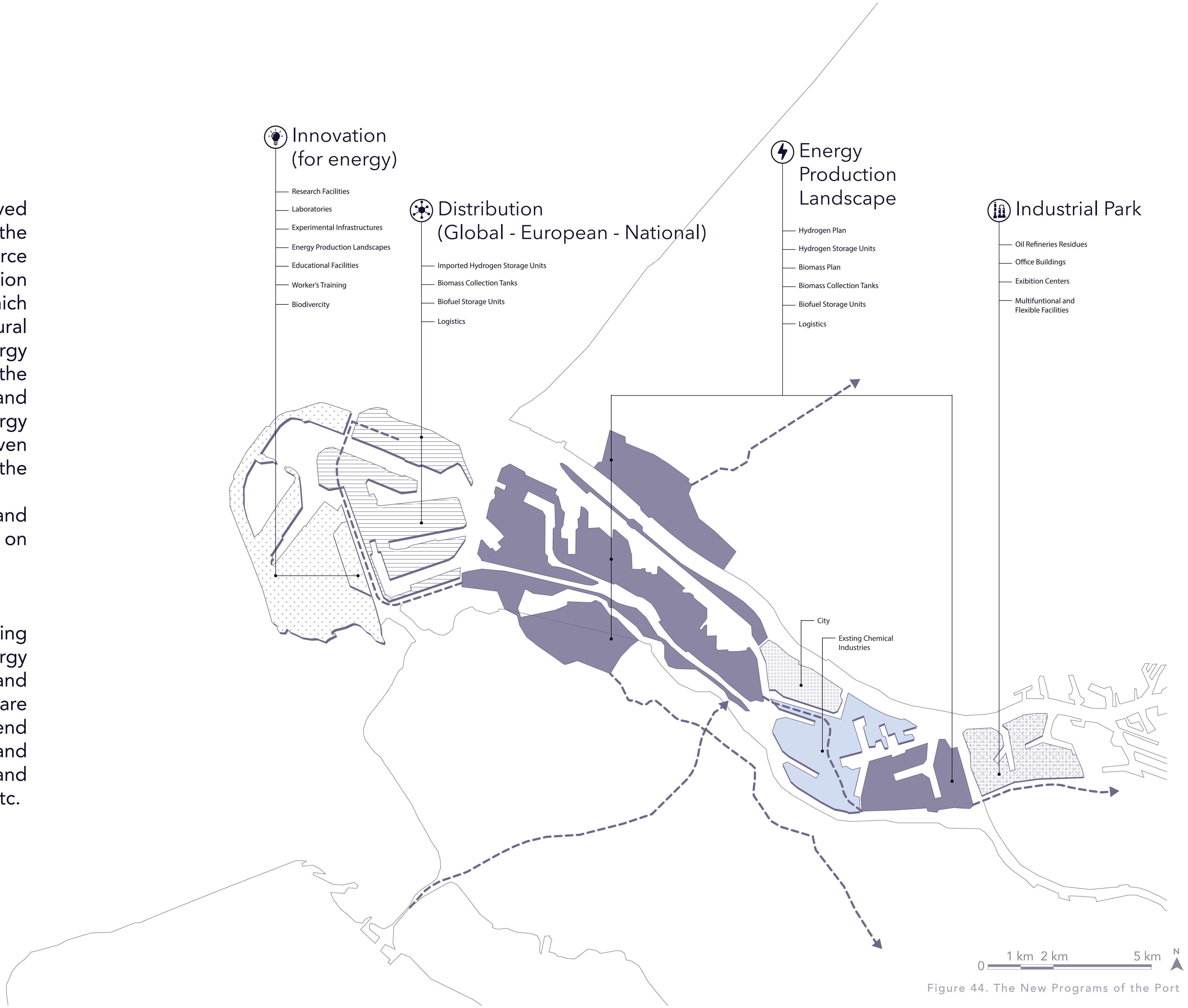


Figure 44. The New Programs of the Port

INNOVATION AREA IN THE PORT OF ROTTERDAM

Figure 45. Innovation Port Area Collage

Figure 46. Education Network in Zuid Holland

- Innovation Area
- TU Delft
- Rotterdam University of Applied Sciences
- The Hague University of Applied Sciences
- Leiden University
- RDM
- TNO

Innovation Network

The proposed innovation area in the port becomes a living land for researchers, engineers, private companies, and investors, where opportunities for experimentation allow innovative ideas to rise. The advantageous educational - research network in Zuid Holland can be boosted from this area since this center can function as a coordinator and a hub for knowledge exchange and collaboration.

6.4
STRATEGIC PROJECT

LIVING IN AN ENERGY PRODUCTION LANDSCAPE

Figure 47 zooms into one of the proposed Urban Activators, representing the spatial and functional synergies that define these areas as fulcrums of urban development. The selected region is in Westland which characterised by its greenhouses, a very important sector for its economy.

Here, the network has a distribution and production character, facilitating synergies between different landscapes and actors within the urban activator. We have scattered biomass collection points along secondary networks adjoining agricutural land and greenhouse clusters. The collected bio-waste is thus used for the energy production in biomass plants. This energy is then distributed to the urban activators with surplus going to the regional network.

Furthermore, this area has a beneficial position next to the port, which will make it a lucrative space for new industrial development. These industries that benefit from the energy network which will in return boost the economy and provide new employment opportunities for the area of Westland.

Taking advantage of that, we are proposing the design of different hybrid synergetic landscapes. For example, one landscape is blending residential areas with agricultural land and greenhouses. Where wind turbines and solar panels are integrated in the landscape to supply energy.

These systemic connections will be manifested in the physical environment in the form of hybrid landscapes. Through this proposal a variety of functions can co-exist giving rise to a new form of urban symbiosis (between functions, infrastructure and stakeholders).

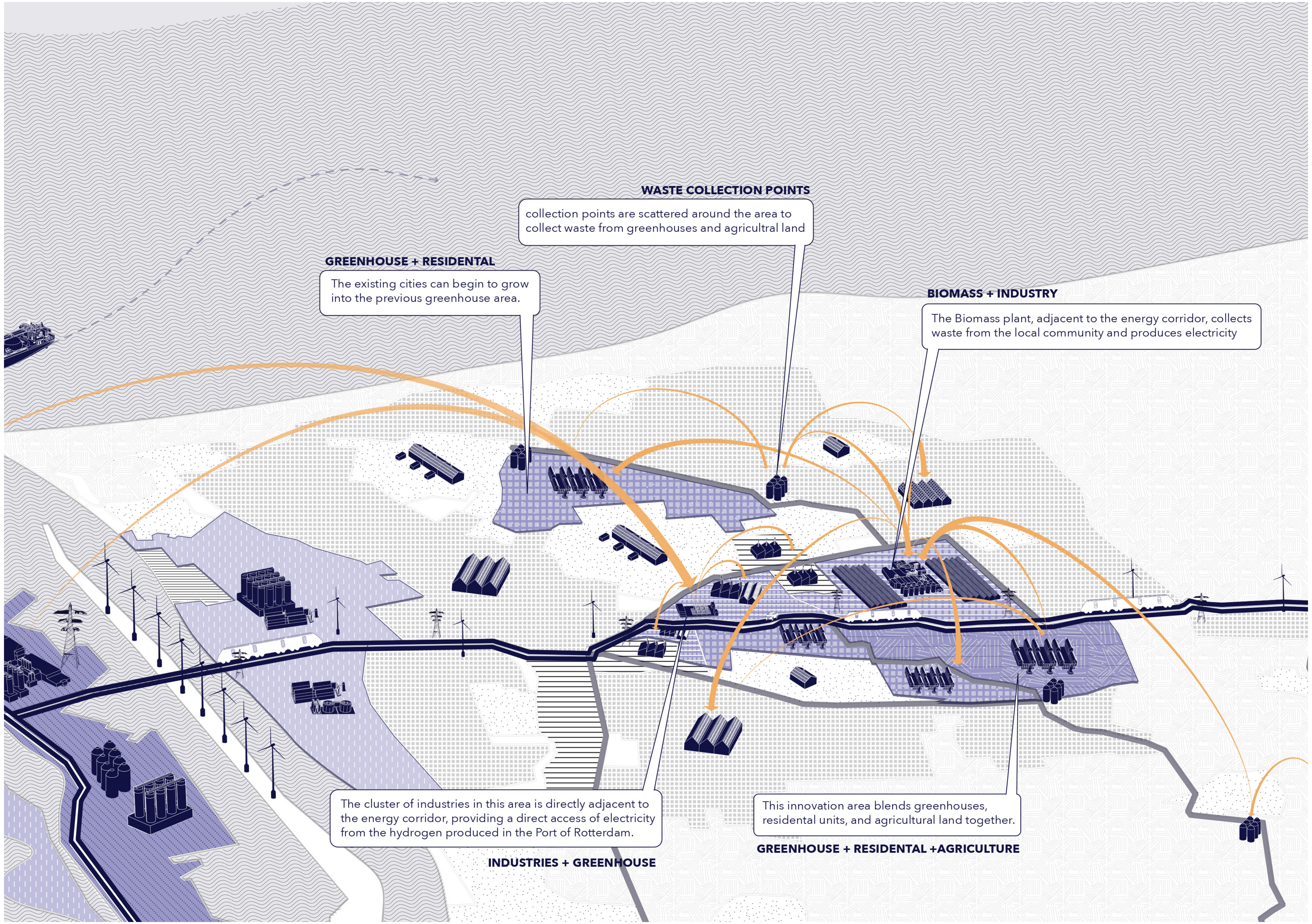


Figure 47. Strategic Project

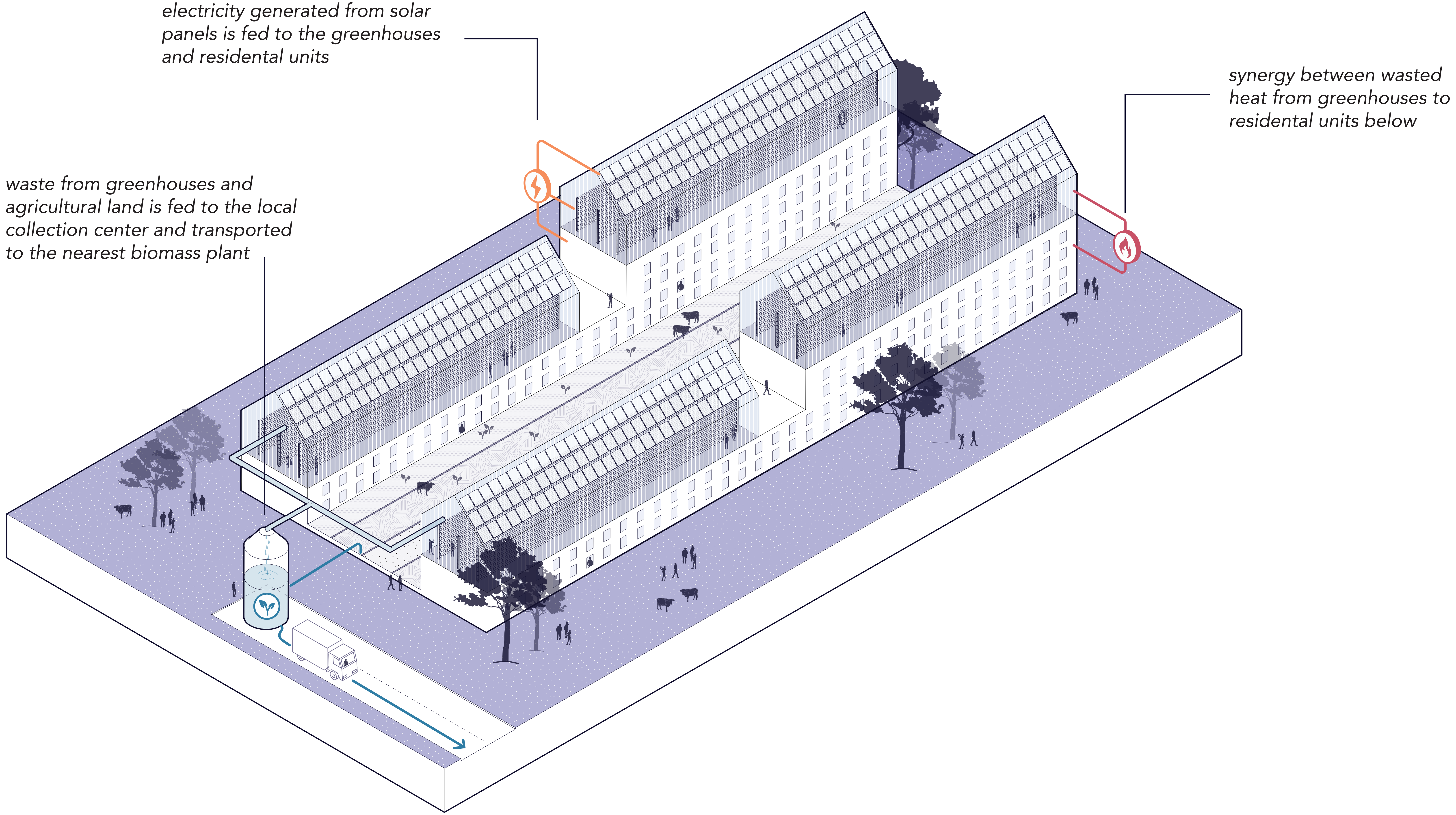


Figure 48. Greenhouses + Residental + Agricultural Land

Figure 48 represents one such hybrid landscape where greenhouses and residential areas exist in symbiosis.

Here the waste from the greenhouses can be fed into the nearest biomass collection point from where it is transported to the local biomass plant. Which will in return supply electricity to this very greenhouse and if required even to the residential units. However the primary source of electricity for the residential units will be the solar panels installed on the greenhouses.

The residual heat from the greenhouse can be re-used to heat the residential units below (cascading heat).

In terms of ownership, the greenhouses could be run by private companies, for which the residential co-operative would get some electricity or monetary returns. Or the residents themselves could run the greenhouses as a co-operative.

In this case the surplus electricity could be supplied to a local grid for monetary benefit as well.

SYNERGIES BETWEEN THE ENERGY PRODUCTION + CONSUMPTION LANDSCAPES

Figure 49 represents another possibility of a hybrid landscape between greenhouses, agriculture and biomass as a means of energy production. In this case the biowaste from the agriculture land and greenhouses can be fed into the adjoining biomass plant. Which would supply electricity to the local grid. The heat could be cascaded from the biomass plant to the vertical farms above it.

While the technology is still nacent, the solar panels on the greenhouses could generate energy at least enough to power the production facility, if not the greenhouses themselves.

Such a system can also prove to be a boost to the agro-based economy in the form of new avenues for revenue generation on the basis of energy and raw material supply. Making the overall system efficient and thereby circular in the context of flow of energy and material.

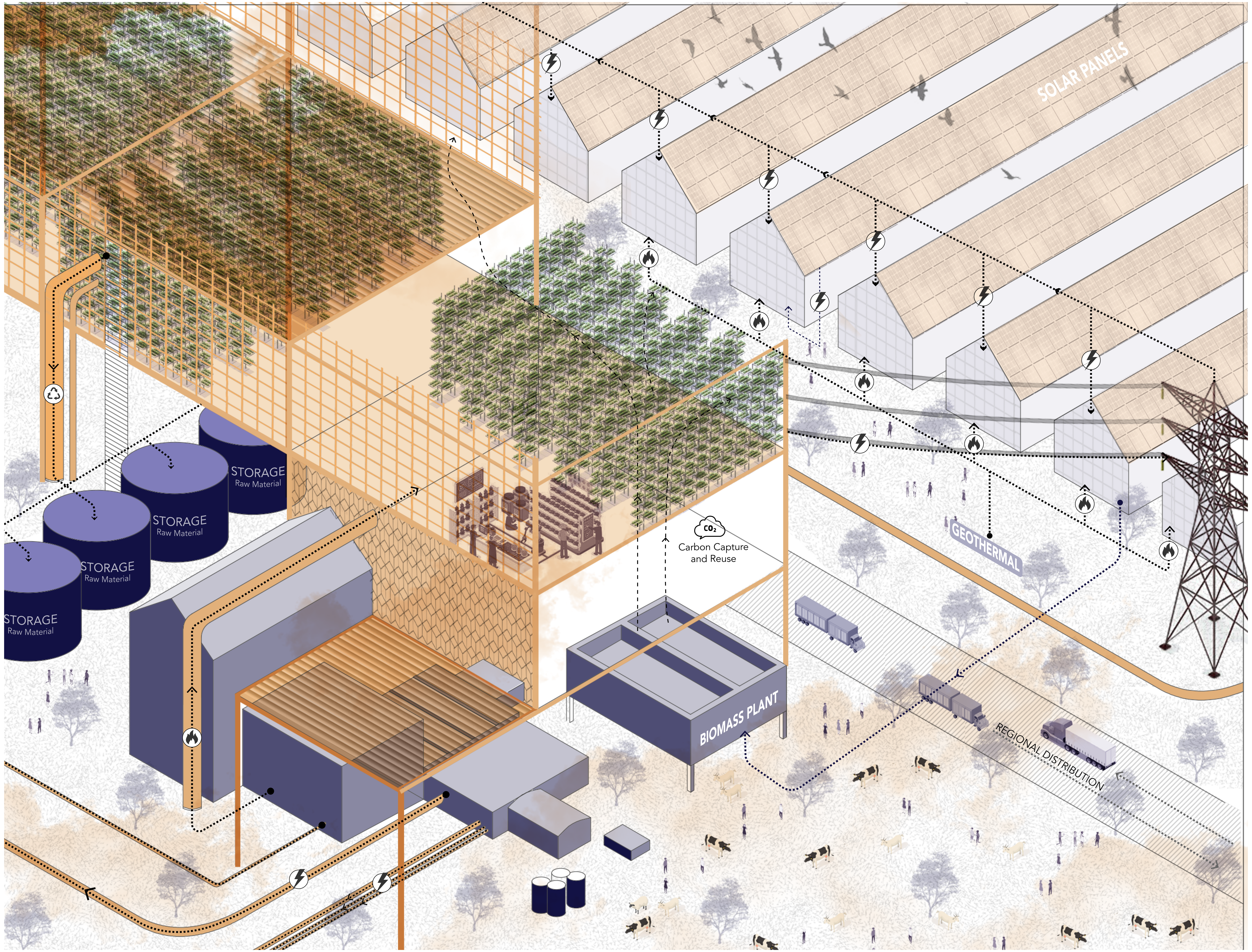


Figure 49. Synergies Collage

Figure 50. Living in the Energy Landscape

Figure 51. Energy Transition Collage

07 CONCLUSIONS

The Project brief this quarter was focused at understanding the relationship of the Port with region of Zuid Holland, thereby speculating about its future prospects. The province of Zuid Holland aims to become Carbon Neutral by 2050. By aligning and aiding this very agenda, Transtopia proposes strategies to phase out from the use of fossil fuel based energy, consequently curbing the CO2 emissions. However fossil dependancies are so deeply rooted in our society that a transition towards renewable energy will be faced by several negative externalities.

Making it a rather delicate and precarious task to strike a balance between the demands of the society, environment and ecology. Furthermore, this project imagines the energy transition as a catalyst for urban development. To achieve these goals, a synchronized intervention was essential across scales, namely the local, regional and global. This was achieved by first decentralizing and diversifying energy production. Which means that the local energy demands would be full-filled within the area through renewable energy systems like solar, geothermal, wind and biomass installed within these areas. The energy capacities of the region were identified and streamlined to develop a functional and spatial relationship between the region and the port. Thus ensuring the reduced dependency on a single centrals source of energy. While at the same time, the fossil fuel industries in the port would cease to exist and be predominantly replaced by hydrogen based energy infrastructure besides other clean energy sources. By creating an overlap of energy systems across different scales, the project would ensure a resilient and adaptable energy system. At the core of this project were values of inclusivity in the energy transition, which has been achieved via endogenous methods of energy production and policies aiding synergies between different stakeholders.

The project thus establishes opportunities for functional, spatial and systemic synergies between the Port and the region as they shape the urban growth of Zuid Holland whilst embarking on the energy transition.

GROUP REFLECTIONS

GROUP REFLECTION

Transtopia aims to provide Zuid Holland with a clear and synergetic strategy to accelerate the transition to renewable energies. Although designed for the mutual welfare of the society, economy, and environment of the Netherlands, negative externalities are inevitable with a complex and interdisciplinary project as such. The limited time frame of the project restricted us from delving too deep into researching the prevalent senarios on site. Where would would have liked to connect with the different stakeholders to understand the implecations of the transition from their perspectives, thereby covering all grounds. The project aiquainted us with the multitude of paradigms as well as stakeholders involved in a regional planning project as such. Especiatlly educating us about the systems and practicalities of the energy transition. However as architects and aspiring urbanist our understanding of the technical engineering of energy systems was rather primitive. However in reality this tehcnical gap would be bridged by feild experts.

However for the scope of the project we made crued quantification for the energy demand and production based on our the data available to us. Furthermore, we largely restrained our energy transition proposal to the province of Zuid Holland. However, sectors related to energy in real-life scenarios cannot be confined to the borders of a region or a country. For the success of the future energy transition, these issues need to be addressed beyond the region and on a more national, or even global scale, which was included in this proposal on a basic level to acknowledge this reality. This incorporates elements included in our proposal such as the energy network, policies enforced, and synergies between different energy landscapes.

ETHICAL ISSUES

Throughout the development of Transtopia, a key guidance on the project has been the prevention of a monopolisation of energy. A prevalent reality where the oil producers controlling the energy economy of the Netherlands. As oil has an over-reaching domination on our society, we are vulnerable to fluctuations in geo-political relationships like the present situation with Russia (BBC, 2022). With this in mind, we proposed to create a system of diverse energy sources involving a variety of actors to create a healthy dose of competition within the energy market. As we include a multitude of actors, such as greenhouse associations and farmers associations, energy becomes more affordable and reliable as the control of energy prices does not lie within a one corporation/association (SDG #7).

However, with the proposal of synergetic relationships between different energy landscapes and stakeholders, there lies a larger question of ownership and governance. With the creation of symbiotic relationships between stakeholders and sectors, our project leans towards a multi-level and networked governance of the energy network within Zuid Holland, with the intent of equitable representation (Rocco, 2022 p. 33-54). However, in today's world where social and environmental justice is ever more important, efficient coordinated development is essential. However coordination presents a challenge in complex and multi-level governance systems due to the overlap in responsibilities, opinions, and interests that tend to elongate the process of decision making (Rocco, 2022, p. 55-73). For example, private companies might prefer the prioritisation of maximising energy production systems to boost profit while the public/ citizens may prioritise the quality of their living environment, citing that more energy production systems result in more visual pollution. In this type of proposal, who is ultimately responsible for fulfilling the role of the umbrella organisation that brings all actors, public and private, involved together and resolves the conflicts of issues that arise?

As we continue to involve a diverse selection of actors, how do we break through the NIMBY (not in my backyard) mentality of landowners to take part in this proposal, as Transtopia's fundamentals are based upon the co-operation of a variety of stakeholders to create these synergetic local loops of energy? Therein lies an issue that with the concept of decentralisation and localising energy production, there must be a solid structure in place with constant collaboration of everyone concerned in the energy transition. Our strategy for tackling this issue was through a creation and advancement on current policies to incentivize people to participate throughout the energy transition and initiate a discussion between stakeholders. However, during the process of this project, we had to make assumptions based on the needs of different parties (ex. Farmers associations, Greenhouse Associations, Industries, etc.). In an ideal practice, this project would continuously collect the input from a variety of stakeholders.

While Transtopia proposes energy networks branching throughout the region of Zuid Holland and acting as a main supplier/hub for innovative energy landscapes, how will these proposed structure affect the development of the existing, adjacent cities and communities? Will the experimental and innovative hybrid developments along the network lend to the gentrification of these established areas? Technological and innovative advancements may not have a political agenda, but the authority residing over them do. This has the threat of creating disparities between groups of people, enforcing a divide between vulnerable and wealthier groups of people. For example, the fragmentation and autonomation of energy production (using solar panels) may lead to a lack of solidarity between wealthier and poorer citizens. As previously instated, technology such as solar panels are not the underlying issue. On the contrary, the technology is very useful for the acceleration of the transition to renewable energies. It is, hence, the responsibility of the authorities to allow this technology to be accessible to the larger public, which therein lies the ethical issue (Rocco, 2022, p. 55-72).

Along with societal issues in relation to the energy transition, the switch to renewable energies spurs a permanent change to markets, industries, and trade which inevitably brings uncertainty during these transitionary periods. Vulnerable and disadvantaged groups as well employees of Fossil Fuel industries will be heavily impacted by this transition. Loss of jobs for a wide variety of people will have to be carefully planned into the implementation of this project, guiding those social groups in the process so as not to negatively impact people's lives and sources of income.

Although the voices of people will always be a rising influence in these proposals, the voice of nature may be muffled. With the efforts of Transtopia, we have maximised the potentials of Zuid Holland's landscape to their full capacity to produce energy for the current demands. However, what will the effects of these decisions to maximise capacity have on the environment? What are the rights of nature? Generally, the theory of the rights of nature consists of the acceptance that humans are not conquering our planet and must respect and facilitate the existence of ecosystems and nature's inhabitants (Rocco, 2022, p. 15-34). However, it is necessary to consider where those rights derive from, who defines the rules and to what extent are those rights natural or manmade. Governments and other institutions draw specific measures and policies to protect the planet, just as Transtopia has done, rather than finding a balance between energy production and allowing space for environment to recuperate. By making all landscapes and available space production based for the benefit of our society, we are pushing the rights of nature aside and leading to a future that can never become carbon neutral and sustainable.

Since we (humans) are designing in our mindset, we tend to first think about the proposal that will benefit us the most, boosting our economy and insisting on a capitalist world. For example, Greenhouses have a far-ranging negative effect on the environment, causing climate change by trapping heat and adding to our air pollution. However, in the energy transition of the Netherlands, greenhouses are overvalued and will remain as a prevalent landscape in our society due to their large and positive impact on the identity and economy of Zuid Holland. Rather than seeking new ways of producing food or changing our societal habits, we cling to practices that are unsustainable, a critic to the world, not just the Netherlands and not just our proposal.

This way of thinking can be perceived in our proposal for the Port of Rotterdam, as we re-use waste landscapes namely, redundant oil refineries, for functions that will boost the economy of the Netherlands by introducing businesses, new industries, and educational functions instead of reclaiming these landscapes for nature.

Lastly, we cannot predict the impact of climate change on future developments/projects in the Netherlands. Although we have researched projected shifts in the landscapes of Zuid Holland, our proposal is fundamentally based on the existing political, economic, social, and environmental situation.

RE-EVALUATION

RE-EVALUATION

Concluding, it is important to go back to our research questions and evaluate Transtopia, Understanding how our strategies reflect the aim of the project, in order to be critical of the aspects that could be addressed differently and the limitations derived during the process. Our main research question is "How can Zuid Holland in symbiosis with the port transform into a renewable energy production system (on the local, regional, and national scale) to accelerate the energy transition?", and through the re-evaluation of the sub-questions, we examined the features that contribute to its fulfillment.

How can energy transition facilitate innovation in future socio-spatial developments?

Energy transition as elaborated in the report is significantly dependent on technological advances. In Transtopia technology becomes a binder between society, the environment, and the economy. As such we pay attention to providing the space for innovative developments and the necessary area for technological experimentation. However, the uncertainty of the implementation of the project, or the strong connection between technology and energy transition raises questions about the access to technology, the related profit, and the timeframe in which these technologies will be established. Who owns these technologies? Will these technologies fill the needs of the energy transition? While energy transition creates the opportunity for innovation in future developments and Transtopia makes sure to encourage that, it is unclear to what extent, we as regional planners are capable of indicating such ambitions.

How can the Port of Rotterdam act as a catalyst for the energy transition while moving towards a reliable, affordable, and sustainable energy hub?

Transtopia proposes an energy network in which the port acts as a backbone, whose identity extends beyond its physical boundaries. This network connects to a number of different activities and infrastructure, creating a functional relationship between the port and the region. The transformation of the port into an energy hub, characterized by multi-functionality, creates "forward indirect" effects. The identity of the port shifts from a monofunctional energy landscape to a place for innovation, experimentation, and co-habitation, enhancing overlaps of landscapes and activities, while maintaining the energy industry as the primary function. Having that said, it is also important to realize that, besides the private lands for energy production, the project is also integrating a form of partnership between private companies, the authority of the port, and the research-educational institutions. What is the criteria to evaluate such a proposal? Is it economically viable and what are the social consequences? Are these lands accessible to the public? To what extent? And what does this mean for the security and the safety of these places? Nevertheless, considering that the port is becoming more welcoming to the public, the connection to the city is strengthened, while the energy infrastructure is branching into the region involving the public, private sector, and civil society in the energy transition.

How can different sectors at the local, regional, and global scale participate in the transition toward renewable energy?

Climate change is a challenge expressed globally, and thus must be tackled in coordination with all countries. The environmental impact of fossil fuels industries as well as indirect CO2 emissions, need to be addressed through the energy transition, by shifting to renewable energies. In order for that to be achieved, actions shall be taken on different scales and the engagement of different stakeholders is necessary.

Transtopia proposes a number of strategic policies and spatial interventions, aiming to accelerate the energy transition in Zuid Holland, but also identify the potential for synergies between stakeholders outside the boundaries of the Province. As such, we create networks and infrastructure to empower the distribution of green energy to Europe and the Global. At the same time, we align with the UN's SDGs, which are embraced by the state members, where we expect that actions toward carbon neutrality are also taken.

As for the intervention proposed for the region, a research and design project can do as much as creating a base on which energy transition can be achieved. Our proposal relies on the inclusivity and the participation of different sectors. Therefore, the implementation of Transtopia needs to be established through a process of co-creation and co-transformation, engaging the involved parties. The alternative scenarios of stakeholders benign, unable, or unwilling to participate could not be examined for this academic project.

Another issue that couldn't be addressed, is whether the transition will be just and won't result in inequalities or negatively impact the vulnerable populations. The question of who will own this energy and how energy will be distributed equally and be affordable belong to other disciplines with whom this project should be revised and adjusted. More ethical issues on that were discussed in the group reflection chapter.

How do we accommodate the uncertainties of the future in the energy transition?

Our project is a long-term transformation process, which was strategically designed based on information gathered and ambitions derived from the different interested parties. Even though, Transtopia still remains vulnerable to the changes that will happen in society, the economy, or the environment. For this reason, we explicitly suggested on our timeline to perform re-evaluation processes, in order to revise the situation at the moment and adjust the strategies. We additionally propose a resilient energy system resulting from synergies between different systems and different stakeholders. While we believe that those synergies will act as a driving force for more collaboration, it is unsure how long the suggested synergies will last. For that, a continuous effort is needed, where dialogue and understanding are encouraged in order to please all the actors. We also didn't manage to integrate into Transtopia the impact of energy transition in industries related to fossil-based byproducts and remains uncertain what the conflicts would be as we phase out fossil fuels, or how realistic it is to get rid of all the fossil-based plants in the port. (SOURCE ASK SANIKA). Similarly, we haven't examined the impact of our project on the ambition of the Dutch government to become fully circular by 2050. (Climate Agreement, 2019) Transtopia accelerates the energy transition which means a massive production of related products and high consumption of raw materials will be taking place in the Netherlands. Therefore, it is impossible for energy transition and actions toward a circular economy to exist simultaneously. (Cooper 8, 2018)

The re-evaluation of our research question revealed a number of aspects related to our project that need to be further developed. Indeed, Transtopia failed to address the complexity of energy transition to the maximum. However, we believe that our project, in the timeframe given, manages to propose a bold intervention in Zuid Holland and the port, which could eventually transform the region to a symbiotic energy hub.

DISCUSSION

Constructing the future of energy in Zuid Holland is not an easy task. Such intentions need a multidisciplinary composition of a team that can manage to research in-depth and defines strategies for the Province which take into account not only national goals and regional policies but also societal aspects as well as economic and environmental. At the beginning of this report, we explained our conceptual framework, elaborating on the need for an inclusive energy sector and a resilient system that could contribute to the economic development of the region. Our analysis focused on the technological potentials of different energy systems and the synergies that could be established between each other. Eventually, through our network and a strengthened energy port, we aim to develop a system of local hybrid developments that can initiate a transformation of the region and accelerate the use of renewable energy as we phase out fossil fuels. Our report is the outcome of academic research and design course thereby constituting material for further research or input to other projects.

As such, our project can become an inspiration for urbanists to rethink the urban environment and investigate methods to innovate, in terms of multifunctional developments, and integrate renewable energy systems or energy management systems into their designs. Transtopia is also a call for local authorities to take advantage of their opportunities and revise the existing energy systems to ones more synergetic and efficient while engaging the citizens and the local companies in the energy transition. Also, the transformation of the port enables a discussion on the identity a port should have. Our strategy of transforming the port into an energy hub goes beyond energy production and consumption. Inviting research and innovation as well as the public to the port. Though quite bold, it can be very beneficial for establishing synergies between the port and the academia, or even initiate an energy-related knowledge exchange on a national or a global level.

Transtopia was executed in a period of 9 weeks and our objective was to develop a spatial strategic project which can be implemented by 2050. Unfortunately, during this time it was impossible to perform inclusive decisions making, hence assumptions were made to define the need of the involved actors. Therefore, as elaborated in the timeline, our strategies and our vision for an inclusive energy transition, with a resilient energy system that can result in the economic development of the region, must be communicated to the interested parties. A certain period for discussion and agreement as well as the formation of policies should precede, under the responsibility of the Port of Rotterdam and the Province of Zuid Holland. Having the input and the suggestions of the stakeholders involved is an essential parameter for Transtopia, without which the project shall fail.

Along with the inclusive process, more technical work needs to be done for the implementation of the project. Considering the advanced technological requirement of Transtopia, time must be given to engineers, urbanists, and architects to collaborate for more precise designs. During this period, the input of experts in energy-related engineering and technology is important as well as the communication with the potential users of the proposed development to enable participatory processes for their design.

Transtopia is a visionary project for a future without fossil fuels. Understanding the difficulties, our team is grounded and realizes that such projects need a strong political will to be implemented. As well, the aim for achieving the UN goals (SDGs) as well as the ambition of the Dutch government to consume 100% renewable energy, requires several projects like Transtopia to take place in the entire Netherlands in a coordinated manner, with shared goals and ambitions. For this to happen, we cannot rely on the individual will but a set of strategic policies shall be applied to enable and accelerate the energy transition.

08

APPENDIX

INDIVIDUAL REFLECTIONS

LARISSA MULLER *(5465664)*

As countries around the globe deal with rising populations, urbanisation, and the negative effects of climate change, it becomes more and more apparent of our collective need to switch to renewable energy. With the Netherland's heavy dependence on fossil fuels, there is an ever-increasing urge to phase out with the constant threat of raw material depletion, a disadvantageous dependency on other countries, and its harmful influence on the environment.

Although a considerable task, my team and I chose to develop a regional design vision for the energy transition, but with a present relationship with the local and global scale. Jumping through different scales and intensively investigating the ins and outs of fossil fuels and renewable energies has pushed me past my comfort zone and in turn, opened a wealth of knowledge. Through the progression of this project, I also recognised to importance of regional scale design with a far-reaching critical issue as this. This form of design is crucial because it not only touches upon space (as previously emphasised on in previous studios) but systems, stakeholders, culture, policies, social justice, etc. and how all these elements are interlinked and interdependent. Which shows that regional design, at its core, must be transdisciplinary.

In conclusion, collaboration has appeared as a key make or break factor in a design as intensive and extensive as this quarters. Pertaining not only to the co-operation between stakeholders and systems involved, but also the collaboration between the design team. We have each supported and continued an open form of communication as we all started this project with no previous education or experience in this subject matter. The positive dynamics within the team lended a hand in our persistent motivation to put in the research, time, and effort in creating a strategic vision I hope people can be inspired by.

The comparison from the beginning of this quarter when terms like circular economy, synergies between stakeholders, and energy landscapes held very little meaning to me, to just 9 weeks later shows the considerable impact this quarter has been on my education.

ANDRIA CHARILAOU *(5628938)*

Working in the regional scale and the port was a challenge not just to understand the bigger scale of planning but also the strong political, social, economic, and environmental impact of designing in this scale.
Concerning the social impact, and more specifically how regional planning can affect the way of living. Based on the video 'The food deserts of Memphis: inside America's hunger capital' accessibility plays major role in the social structure of the system and thus there is a fractured relationship between structural inequalities and injustices that needs to be bridged.
The region due to the presence of the Port of Rotterdam has an active role in the economic growth in the regional and national scale and it is creating a network of companies and businesses which is spread in Europe making the region of an international importance. Saying that, sounds a well-known fact but working on the regional scale made me understand the spatial qualities of the economic networks related to energy and to further realize its consequences in geo-political issues.
Because of the different values, and opinions within the team, we had long and fundamental discussions and debates that resulted in a studier project. The discussions together with the SDS and methodology's exercises highlighted the importance of embracing participation by bringing different parties, stakeholders and interests together avoiding a unilateral approach.
Moreover, the 'boiling frog' syndrome example made us aware of the time limit that we as urbanists have in big scale projects and that we must act now. Especially due to the present's instable character due to the pandemic, the war, and the environmental issues which have pointed out our main concept of resilience 'as a way of describing a system's ability to cope with changing circumstances or disruptions' *(Bernhard-Johannes Jesse, 2019)*.
In the view of the political impact, watching the debate of Delft's municipal elections *(NIJS, 2022)* made me realize that the project's topic was of a great relevance and that we should pay attention in who/what we will prioritize through this transition. In addition, that it is important to give voice to nature and future generations which they don't have a voice in the present but they're the ones that will live in our projects. The diplomacy as an essential quality in urbanists, on how to present a vision and suggest policies.
Regional planning is a super complex process involving different actors which makes it also time consuming. We as urbanists should give the foundation for an approach which will balance between the nature, economic growth, and social benefits. To conclude, I am still debating myself into what extend we as urbanists, can contribute to the formation of the future living environments. Nevertheless, quarter three was a decent societal simulation which grounded me making my way of thinking more realistic and methodic.

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SANIKA CHARATKAR *(5499984)*

My experience working on Spatial Strategies for the global Metropolis was equal parts intimidating and exhilarating. It exposed me to an array of variables that accompany Urban projects as such and introduced ways of dealing with them.
"Research by Design" was one such approach that defined the trajectory of this studio making me question my usual linear approach of research followed by design. It positively restricted us as a group from drowning in a plethora of data, nudging us to question and synthesize it based on an iterative design process. Additionally, this back and forth method of research and design revealed to us the complex realities at a regional level. Thereby dubbing my naïve understanding that this project could be a one-stop solution for all regional issues. Research and analysis of the prevalent scenarios and stakeholders helped shape our vision for the project. A lens that streamlined our intent and directed us towards contentious planning by ensuring the project covered all grounds within its scope.
However the greatest learning curve for me for the knack for speculating about the future. Coming from an architecture background, I was accustomed to designing for the immediate future, with limited actors and ease of predictability. However, for a project of this scale with a time frame as wide, the clarity of the forthcoming scenarios begins to fade as we look further ahead into the future. Which left me puzzled about how to design for the unknown? Not to mention the manifold implications caused by increased fluctuations in the global environment, society and economy. Thus, where do we start from? Which scenario/s do we design for? And on a more debatable note, Where and how do we draw a line between design based on extreme scientific speculations and designing dependent on unrealistic technological advancements?
Despite this contemplation, what truly helped Transtopia progress was the emphasis on values and ethics that backed the proposal. The intent is to bring about a positive or reforming change in different aspects of the urban realm. Although we as a group came from different backgrounds, our thoughts aligned strongly on this matter. Where healthy debates and discussions resulted in strengthening our vision for the project. This quarter has made me a staunch believer that moral and strategic intents make the urban plan resilient to shifting dynamics of the future, whilst staying focused on the ultimate goal.

CHARALAMPOS SPANOS *(5502225)*

Transtopia is the outcome of a 9-week-long project for the studio Spatial Strategies for the Global Metropolis of Quarter 3 in the Master d Urbanism. Admittedly, since this is the first time I come across such a complex project of regional planning, I was concerned about the difficulties I would face. My lack of confidence, though, was quickly sided, because of the intensity of this quarter. Regional planning is an evidence-based approach, which required an immediate leap into data and information that could trigger our vision for the future of the port and Zuid Holland.

During the first period of this quarter, I was overwhelmed with information, not only from research but also from the SDS lectures and the Methodology course, which have been very helpful for the realization of Transtopia. The need of forming a vision first encouraged us, not only to make fast decisions but most importantly to identify the more significant aspects that would guide us to define our strategies. As known, R&D is not a linear process, and evidently, our group was always interlinking design or strategic decisions to the research, in order to have strong arguments for what we believed could be achieved through Transtopia. By the midterm, we managed to clarify our ambition for the Province and the energy transition.

As for the midterm, I appreciated the attention given to the presentation. In both courses (Studio and Methodology), a session was dedicated to explaining how to communicate our projects. Especially for the complexity of regional planning, communicating clearly your ideas is important, since in practice we will have to convince multiple stakeholders for their involvement. Unfortunately, we did not have the opportunity to interact with potential stakeholders, in the framework of our study. However, I feel confident that during this project I developed the skills to share thoughts and ideas as well as present our project explicitly and concisely.

Our group soon found a way to collaborate efficiently. We all come from architecture studies backgrounds and defined some ground rules regarding our workflow that appeared to be essential. During the quarter we were freely sharing ideas with respect to each other's opinions and we all worked equally hard to give our input for the project. However, such a complex project would be much more interesting if we had the opportunity to collaborate with students from other disciplines (such as energy, or engineering). This way some lack of knowledge or lack of information could be moderated and the project could be more realistic.

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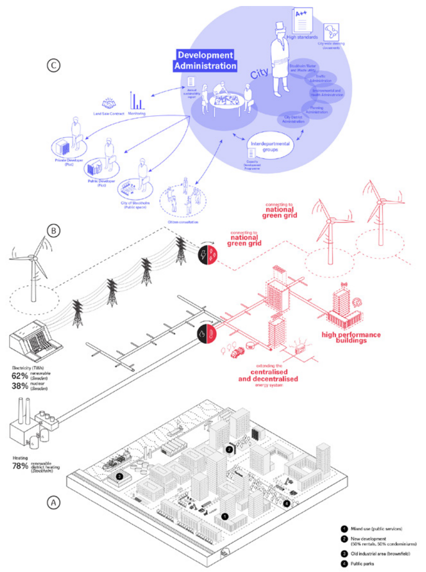
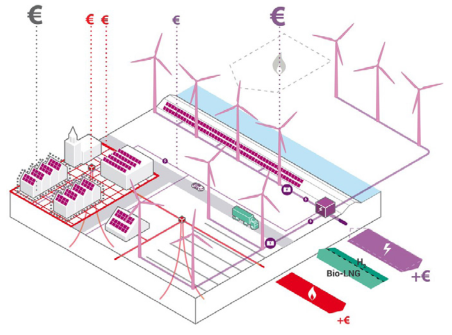
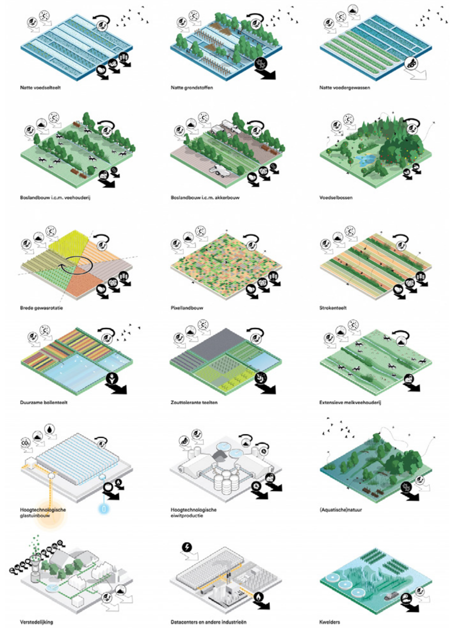


Atlas From 7 case interviews to recurring strategies and PED relevant aspects, by Cities4PEDS
(https://www.architectureworkroom.eu/en/projects/4561/positive-energy-districts)

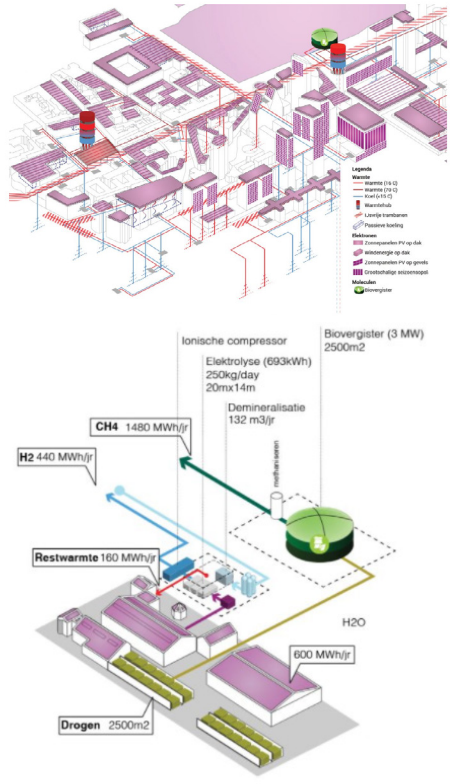


Energy Infrastructure North Holland, by Studio Marcovermeulen
(https://marcovermeulen.eu/en/projects/energy+infrastructure+noord+holland/)



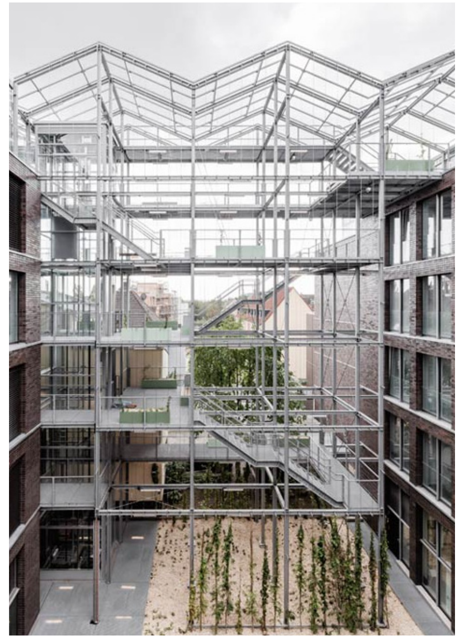
Completing the cycle?, by Studio Marcovermeulen
(https://marcovermeulen.eu/en/projects/completing+the+cycle/)

"Closing cycles: The smart interweaving of the raw material, energy, water and waste cycles on a provincial scale could well provide the foundation on which Noord-Holland prepares itself for the future. In other words: the cycle between the two area transitions can contribute to completing the circle at provincial level. This research shows that the by-catch of closing the cycle between city and countryside is a more attractive, more biodiverse and also more productive landscape."



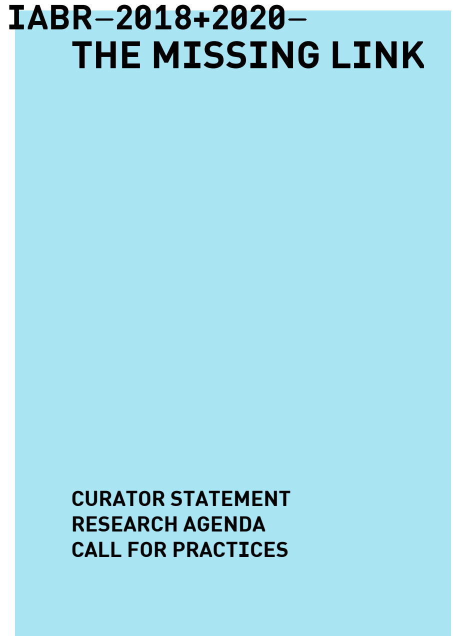
Deltagrid 2050 - Zuid Holland, by FABRICations
(https://www.fabrications.nl/portfolio-item/deltagrid-2050/)

"High-dense mixed urban environments offer many opportunities to balance different demand-profiles. In order to generate enough electricity and heat, energy harvesting infrastructure will be omnipresent."



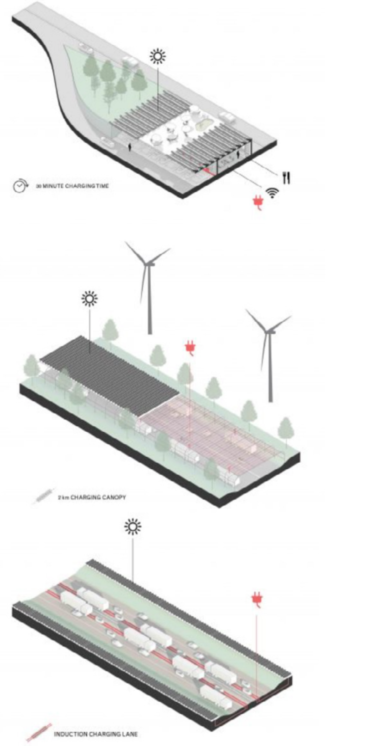
Rooftop Greenhouse: Two Different Uses in a New Way, by Kuehn Malvezzi
(https://urbannext.net/rooftop-greenhouse/)

"For the first time in Germany, a building is being constructed that combines functions as diverse as a job center and a rooftop greenhouse where the possibilities of urban agriculture are practiced and researched. The building technology integration makes the office building, located on the central market square of the old town, usable as a resource for agricultural production."



IABR-2018+2020 The Missing Link
(IABR%202018-2020-%20The%20Missing%20Link%20%20(2).pdf)

"Adapting our way of life and consumption and production patterns to the finite capacity of our planet requires a fundamental socioeconomic transition that cannot 'take place' if we do not first and quite literally 'make place' for it. There can be no transition to renewable energy, no resilient ecosystem and no caring and solidary living environment without the actual transformation of our urban landscapes."



Environmental effects of the Climate Agreement, by FABRICations
(https://www.fabrications.nl/portfolio-item/energy-and-the-mobility-transition/)

The biggest opportunities for combining mobility and energy infrastructure are on a regional level, for instance with regional heat networks and cycling highways. On a national level, energy infrastructure has its own pipe system which is on a distance from highways and railroads. On a lower scale level the distances and destinations of energy flows match the ambitions for many new bike-highways and provincial roads.

TRANS TOPIA