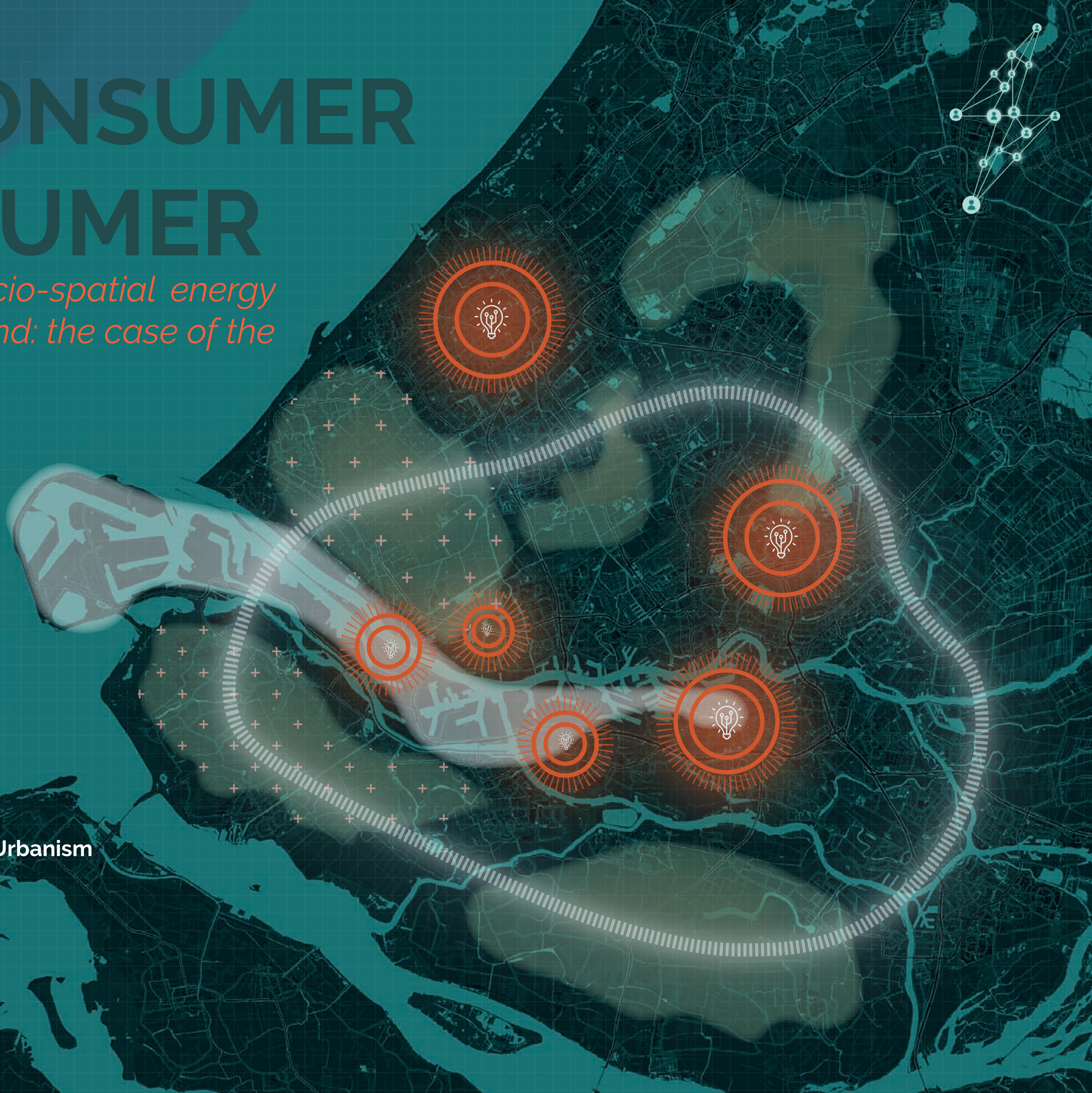
FROM CONSUMER TO PROSUMER

Towards an inclusive socio-spatial energy transition for South Holland: the case of the Rotterdam region.



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CONTENT

Consumer + Producer
= PROSUMER

ABSTRACT

The transition to renewable energy is necessary and urgent. Fossil fuels are depleting, leading to geopolitical instability and are driving climate change. The climate crisis and growing inequalities are among the greatest problems of the 21st century. Temperatures, sea levels and gas prices are rising. This transition poses spatial and economic challenges for the maritime region of South Holland, as the port is a large hub for fossil energy and contributes greatly to the national economy. The social challenge posed, is to create a fair transition. Some groups are more vulnerable to the transition than others, as they are more prone to be subjected to energy poverty and to potentially lose their (fossil related) jobs. Therefore, we conducted a research on how to create socio-economic and spatial justice for the Rotterdam maritime region through a fair distribution of burdens and benefits in the energy transition. This research resulted in a vision for South-Holland in 2050 ,"from consumer to prosumer", proposing a mainframe and a local frame. The mainframe proposal concerns a large renewable energy landscape in South Holland with a central circular hub in the port. The local frame proposal is the main focus of this report and concerns the vulnerable neighbourhoods that become prosumers instead of consumers. This means that they will not only consume energy, but renewable energy systems will be installed to also produce energy, while at the same time improving the quality of living.

New job opportunities will be created in the circular construction and demolition sector in the neighbourhoods as well as in the port. The Rotterdam region will fully transition to renewable energy, while also decreasing inequality, unemployment and poverty.

Key words: Prosumers, energy transition, local frame, mainframe, vulnerable neighbourhoods

1. INTRODUCTION: URGENCY FOR A JUST TRANSITION

1.1 Context setting
1.2 Problem statement
1.3 Challenges & goals

1.1 CONTEXT

Energy transition

Climate change. We cannot get around it, as has been shown in the past few years. Forest fires, floodings, heatwaves and storms, are all due to the high concentrations of greenhouse gasses in the atmosphere. There is only one culprit: the human race.

The discovery of oil, gas and coal was a literal revolution, the second industrial revolution. It is almost impossible to imagine a day we do not use these sources of energy. Cooking, driving, charging our phones, putting the heaters on, even all the products we use are produced using oil and gas. But now we have to do the unimaginable: transform into a renewable energy system with net-zero emissions, to limit the greenhouse effect and the depletion of fossil fuels, also seen as the third industrial revolution.

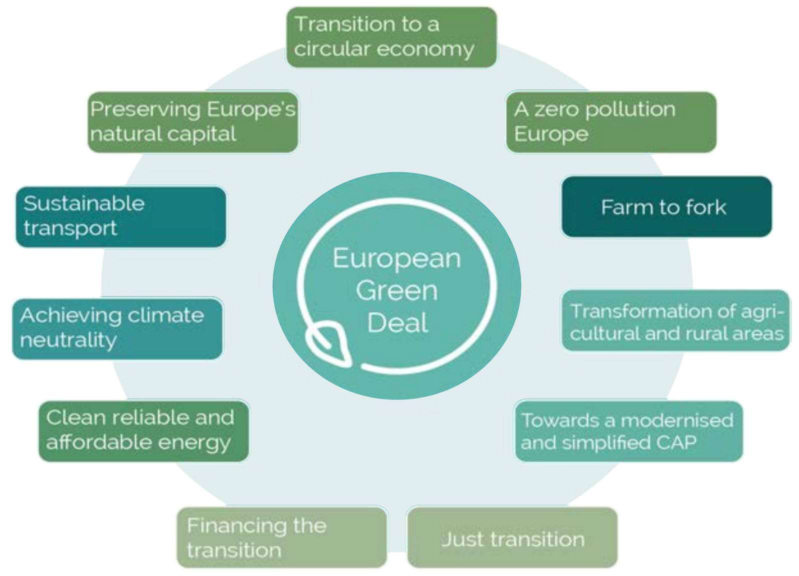

Figure 2

Figure 1: The European Green Deal (adapted from European Commission, 2019)

Figure 2: Share of renewable energy in the Netherlands (data from RIVM, 2021)

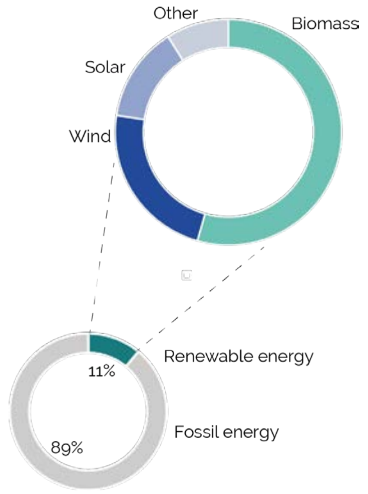

Figure 1

Luckily, the European Union does not step away from such a challenge and came up with an agenda: the European Green Deal. This agenda proposes several actions to decrease greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels and to become 40% renewable in 2030. These plans are adopted in each country with its own strategy. The focus of this report is on the Netherlands. In the figure, there can be seen that at present only 11% of the Dutch energy supply is produced by renewable energy sources, of which most is biomass. In terms of CO_2, the emissions in 2020 were 25,4% lower than in 1990 (RIVM, 2021). This means that there is still a lot of work to do for the Dutch government in the upcoming 8 years to reach these climate goals. Yet, the goals within the agreement do not only take into account environmental externalities, but also the social and economic aspects as shown in the image above. Justice plays an important role in the procedures of the EU, no one is left behind. The most important social question at hand is consequently; tackling energy poverty and the social inequalities that come paired with it (European Commission, 2019).

Energy poverty

But what is energy poverty? Energy poverty is described by the World Economic Forum as the lack of access to sustainable modern energy services and products. Globally, this inequality is especially seen between the western world and third-world countries. However, the current developments in the energy sector add another dimension to this: the people who can afford renewable energy and the ones who cannot within one city (Habitat of Humanity, 2020). Products like solar panels, heat pumps and the insulation of housing are dependent on starting investments, which is possible for private homeowners with a saving account, but not for households with a lower income (Axon & Morrissey, 2020). And that, while recent developments have shown how urgent this transition is: not only for the climate but also for the global economy.

Over the past year, oil and gas prices have been rising to an exceptionally high level. This is due to two main reasons: the demand increases and the supply decreases. On one hand, the expected increase in liquified natural gas (LNG) in the global economy, is not going in the right direction yet and therefore competition for the limited supply of LNG between Asia and Europe is inevitable. On top of that, the Netherlands has closed most of its own gas sources and is slowly phased out. Collectively, this makes the supply shrink.

On the other hand, due to a cold winter, Europe has very limited reserves, which means that the demand increases to build up reserves again (Beukel, 2021). To top it off, the current crisis, the war in Ukraine, has caused one last problem: one of the most important gas suppliers, Russia, has become an uncertain supplier, with a possibility of no supply at all (Powerhouse, 2022). Altogether, this is driving the oil and gas prices up significantly.

These growing prices target all citizens of the Netherlands with higher energy bills. Nonetheless, especially vulnerable groups living in poorly insulated housing, are going to be targeted, to the point that they cannot afford their energy bills anymore. Whereas private homeowners can start investing in renewable energy, more vulnerable groups cannot and are therefore stuck with sky-high energy prices.

As a consequence, the growing gap between the poorer and the richer is a dominant threat in the current economy and the foreseen transition should accordingly be high on the agenda to prevent systematic social inequalities in cities.

Trias Energetica

A well-known approach for dealing with the energy transition is the Trias Energetica. The energy transition is not only about the use of renewable energy sources, but also to reduce demand. In addition to that, the focus should not only be on the end product, but also on the process and therefore the third pillar is the efficient use of fossil fuels. The shift from fossil to renewable will take a long time and therefore this first step can already be taken in order to slow the depletion of fossil fuels.

This Trias framework has expanded itself into the social and material dimensions: Trias Humana and Trias Materia, expressing the need for social incentives and a circular economy.

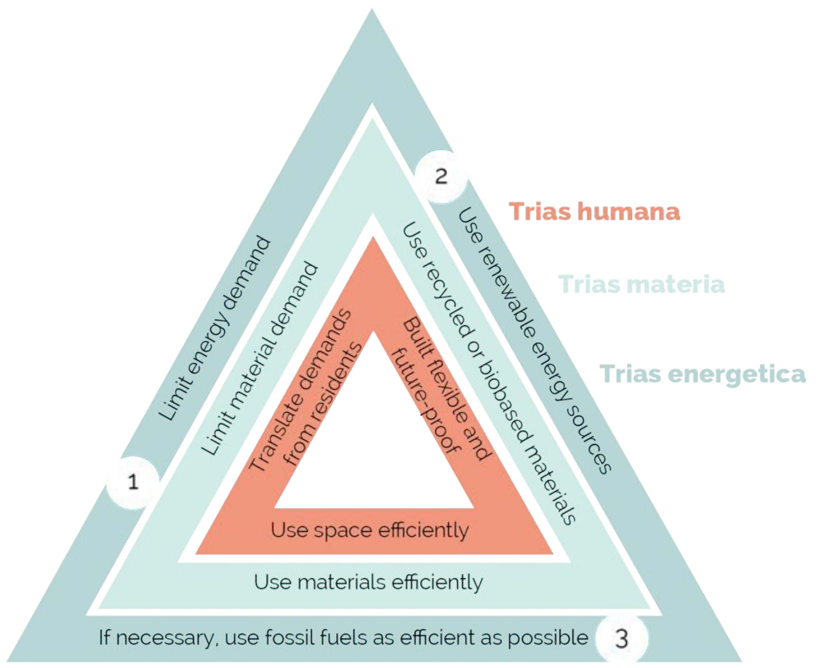

Figure 3

Figure 3: Trias Energetica, Trias Humana and Trias materia (adapted from Nieman, 2022).

Linear economy

Our economy is based on a linear model that extracts natural resources, processing them into materials, which in turn are used to manufacture products, that are discarded after use. To maintain a steady flow of materials for a steadily growing economy, the planet and its resources are exploited. This economic model works to the detriment of our environment and the vulnerable and poorer societies, most of which are located in the global South. Therefore, there is the need to reorient our economy and our so-called throwaway society towards a more sustainable circular economy and society.

Circular economy

A circular economy is based on the reusability of materials and products, as also the conservation of natural resources. Within every process step of the circular economy, there is the pursuit to maintain and create value. This systemic shift encourages conservation of materials and products, less waste generation and a decreased exploitation and pollution of our environment. In addition, it results in a shift away from grey, toward green energy. According to the PBL Environmental Assessment Report, the Netherlands does not have a linear economy, but lies between a linear and circular economy. Currently, 79% of waste is recycled, but a large part concerns low-quality solutions, and the consumption of natural resources is still high. Therefore, a shift is needed to achieve much higher reuse of products (PBL, 2018).

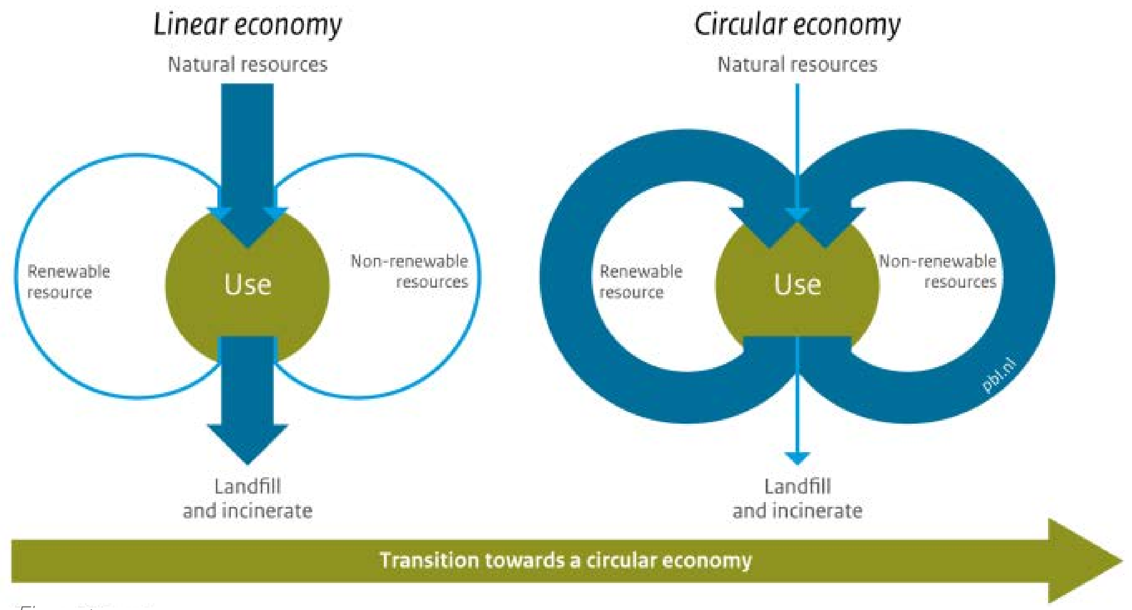

Figure 4

Figure 4: From a linear to a circular economy, Source: PBL, 2018

What about society?

However, circular economy shouldn't be seen as as better waste management in the sense of a recycling economy. Design solutions at the beginning of the value chain are often neglected. Waste is merely reduced instead of avoided. Circular economy visions focus on sustainably circulating resources and see circularity mostly through the lens of business, industrial and technological innovations, rather than from the perspective of a transformative social and solidarity economy (Friant, et al., 2020). The focus on economic value creation and technical innovation fails to recognise the underlying, necessary, massive socio-cultural change, which is a key topic, since cultural barriers are identified from practitioners as main barriers for a circular transition, according to Kirchherr et al. (2018). The social dimension, including a social objective or vision, is missing. Other social aspects such as spatial justice, quality of life and participation in the transformation are only marginally addressed (Hempel et al. 2020).

Circular Society

The model of a circular society envisions not only sustainable circulating resources from an economical perspective but also to circulate ownership, "wealth, knowledge, technology and power in fundamentally redistributive and democratic manners" (Friant et al. 2020). This corresponds to a holistic circular model that includes social and political elements based on participation, solidarity and strong institutions as well as communities.
In concrete terms, this means, among other things, that circularity must become a guiding principle, a structuring principle and a principle of action in numerous areas of society, always keeping the social good in mind. This is the only way to overcome and realign linear rules, forms of organisation, knowledge systems and, above all, values and goals. In order to develop the Circular Society from a position to a transformative concept, an open and transdisciplinary process is needed that consistently brings together actors from all sectors of society, e.g. from research, civil society, politics and business (Hempel et al. 2020).
The term circular society points to the missing societal and socio-political aspects of the circular economy discourse (Friant et al. 2020).

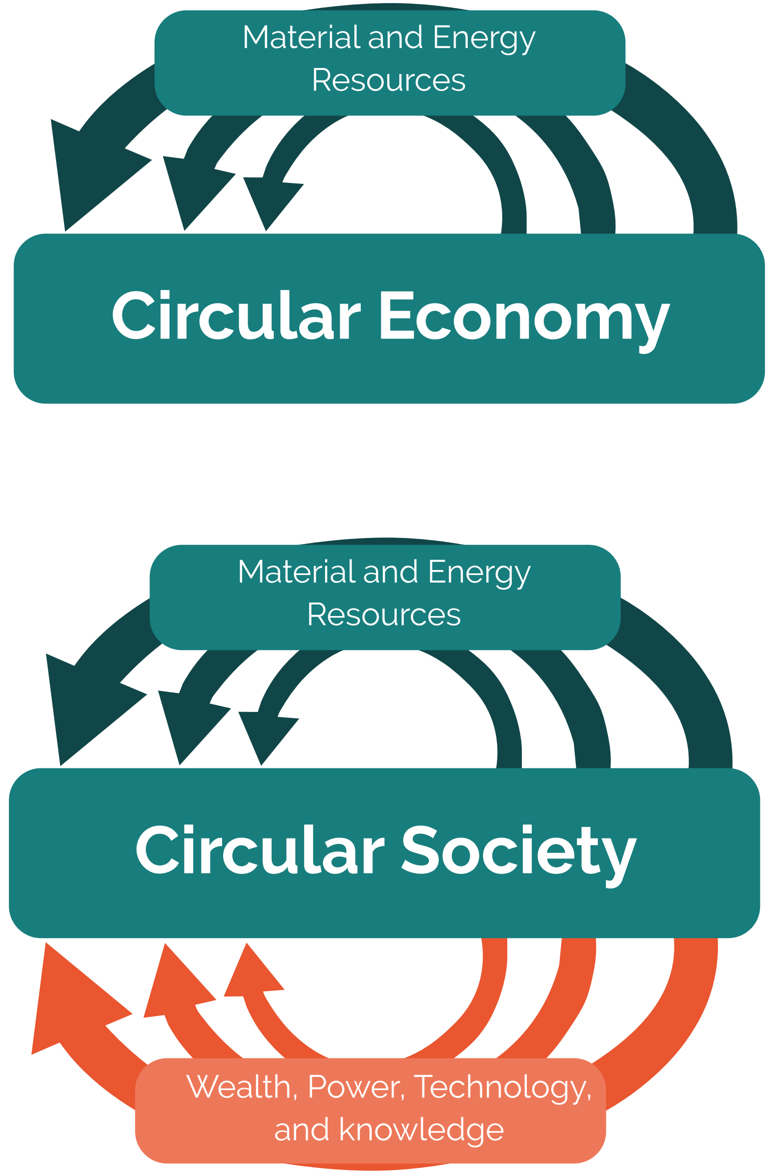

Figure 5

Figure 5: Circular economy and circular society, (adapted from Friant et al. 2020)

Location

The area of focus in this proposal is the province of South Holland in the Netherlands. This area is going to play an essential role in the energy transition, especially the port. The port in Rotterdam is characterised by its global economic position and its connections to Belgium & Germany for oil, gas, bulk and cargo. In addition to that, the main energy supply of the region is organised through the port. The region is thus heavily reliant on the port, but the port is also reliant on the cities around it to fulfil the jobs needed to keep this port going.

Besides the port, important cities like The Hague, the city of the government and the knowledge cities Delft and Leiden are clustered in the area forming a vibrant urban landscape.

+ Figure 6: The province of South Holland

Figure 7: Injustice through the energy transition

Figure 6

1.2 PROBLEM STATEMENT

In the 1860s the first port-related activities arrived in Rotterdam. Throughout the years Rotterdam has developed itself into a global port city, stretching over 40km and accommodating 385,000 jobs (Hein & Van de Laar, 2020; Port of Rotterdam Authority, 2021). Other important industrial areas like the Ruhr area in Germany and the port of Antwerp are dependent on the port of Rotterdam, mainly due to its supply of petroleum and as a transit port of cargo and bulk (Hurenkamp, n.d.). However, the aim of the Port Authority is to stay in line with the Paris Climate Agreement, meaning that the goal for 2050 is to be CO_2 neutral and to decrease greenhouse gas emissions by 95% (in respect to 1995) (Port of Rotterdam Authority & Circle Economy, 2019). Due to these ambitious goals, major changes and shrinkage within the petrochemical, coal and gas industry are expected (Hein & Van de Laar, 2020). This requires a switch to renewable energy, biofuels, a circular economy and many more innovations. Consequently, an economic and spatial change in the Port of Rotterdam is needed. The challenge is to take into account the global dependencies on the port of Rotterdam and to give it a unique profile that does not leave the port behind as a competitor in the world economy (Port of Rotterdam Authority, 2019).

However, to make this transition successful, the social aspect is an essential link. The people, the hands and the brains, are the key to realise this transition. Unfortunately, in the past few decades, technological developments made jobs less labour intensive, but more complex, causing a demand for technically skilled workers, who are difficult to find. With this energy transition in sight, even more turbulence in the labour market is expected, requiring more training and retraining of people employed in the fossil energy sector (Port of Rotterdam Authority, 2019). This shows an imbalance between the people profiting from the energy transition, like large companies benefitting and the vulnerable groups carrying the burden, by losing their jobs (Cozzi & Motherway, 2021).

Historically, the urban region of Rotterdam has always been closely connected to the port area, as it is and was the main place to house the workers of the port. However, these houses were built quick and cheap to house all migrant workers as fast as possible. Back then, this strategy was efficient and it fuelled the expansion of the port, but in the present day, these areas experience a lower quality of living (Tillie et al., 2016).

On top of all this, the energy poverty caused by the rising oil and gas prices and the unaffordability of renewable energy sources adds up to the unfair distribution of the burdens and benefits of the energy transition. This shows that the transition is mainly causing negative externalities for vulnerable groups, facilitating an even more segregated society. Their lack of power in the decision-making process and participation makes it difficult for these people to be heard.

The key in this proposal is to look at these threats, but also at the opportunities arising from this transition and to come to a strategic vision that is not only looking at the large scale structure but one that places the individual, the inhabitant, in the centre.

Figure 7

1.3 CHALLENGES & GOALS

1.3.1 CHALLENGES

Dependency on fossil fuels

Figure 8

Unfair distribution of burdens and benefits

Figure 9

Based on this problem statement, the four main challenges have been identified.

Dependency on fossil fuels
Current developments have shown the issue of being dependent on fossil fuels, which are mainly imported from Russia. Therefore, the first challenge is to make the neighbourhoods independent from fossil fuels and the second part of this challenge is the shift towards renewable energy sources for the industry in the port and for the global trade.

Global and local dependencies
In line with this, the global dependencies are important for the port to keep the economy at the point it is now. Also, this creates a lot of jobs for the people living nearby the port. The challenge is, therefore, to keep the economy in the port going, while making the people less dependent on the port for energy, and keeping the job dependency.

Unfair distribution of burdens and benefits
The third challenge is again a response to the energy transition. The challenge is not to see the social aspect as a separate problem, as an externality of the transition, but to use this energy transition to realise the goals already set out on the social agenda.

Vulnerable neighbourhoods
Overall, the challenge is to incorporate this integrated approach into the vulnerable neighbourhoods of South Holland and to find the vision and strategy fitting to tackle these challenges.

Global and local dependencies

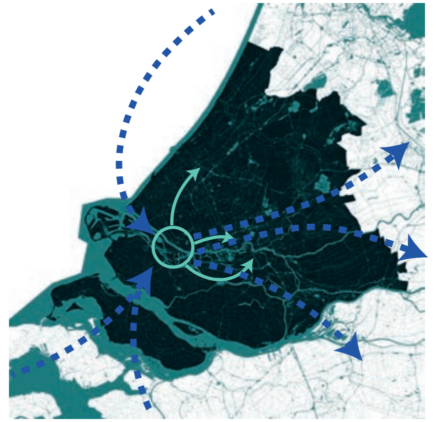

Figure 10

Vulnerable neighborhoods

Figure 11

1.3.2 GOALS

As a response to these challenges, the goals we want to achieve with our proposal can be drawn up. **The focus is on the social dimension of the energy transition.**

Figure 12

Figure 13

1. Socio-economic and spatial justice
The primary goal is to achieve socio-economic and spatial justice for the people most vulnerable to the energy transition. The aim is to use the energy transition as an opportunity to help vulnerable people.

2. Sustainable energy production
The second goal is to switch to sustainable energy production. This does not only mean renewable energy production but also makes the production process of these systems circular. This means that not only the energy flows are taken into account, but also the material side of the energy transition.

2. Circular economy
The second goal is to switch to a circular economy. Meaning, making the switch to renewable energy production but also makes the production process of these systems circular. This means that both energy- and material flows are taken into account.

3. Democratisation of energy access
Thirdly, we aim to democratise energy access by looking into co-ownership and citizen participation in the planning process. In this way, citizens become involved in the decisions made in their neighbourhoods.

4 . Self-sufficiency
The last goal is to reach self-sufficiency for the neighbourhoods. Instead of being dependent on gas and electricity supplied by the port, the neighbourhoods are able to provide their own energy as much as possible. Additionally, financial benefits can be introduced when these neighbourhoods produce extra energy, which can then be distributed to other areas again.

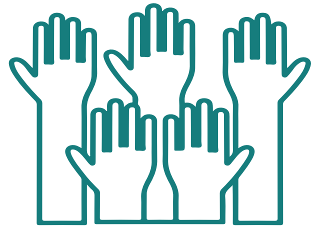

Figure 14

Figure 15

2. METHODOLOGY:

2.1 Context setting
2.2 Conceptual framework
1.3 Methodology structure

2.1 RESEARCH QUESTIONS

How can socio-economic and spatial justice be achieved for South Holland through a fair distribution of burdens and benefits in the energy transition?

What is socio-economic justice?

What opportunities for social and spatially just development arise from the changes by the energy transition?

What are the current working and living conditions related to the port in the region of Rotterdam?

How is the energy transition expected to affect the job opportunities and living quality in the Rotterdam region?

What potential developments in energy localities is seen in the Rotterdam region?

2.2 CONCEPTUAL FRAMEWORK

Socio-economic justice through energy transition

The problem statement and goals stated in the previous sections paved way for the formation of the conceptual framework and the approach in this report to tackle problems in vulnerable neighbourhoods and injustice in the energy transition.

As the anthropogenic climate crisis intensifies across the world, new energy infrastructures are rapidly emerging as an attempt to mitigate the consequences of climate change (Lacey-Barnacle, 2020). The benefits of clean renewable energy are not contested by any research in the concept of energy transition concerning the environment or the economy. However, the social dimension of sustainability is often neglected in the drive for renewable energy, causing both social and spatial inequalities embedded in the energy transition processes (Yenneti et al., 2016). The elimination of this disparity is the driving force in this report's strategic vision. As seen in the conceptual framework, socio-economic justice through the energy transition is the overarching concept in this report. We define socio-economic justice as the fair access of all social classes to a combination of education, income, occupation, and high quality of living.

Multiple core concepts arise from the conceptual framework aimed to achieve socio-economic justice through the energy transition. The following paragraphs explain these concepts in detail.

Circularity
A circular economy is a vital step towards achieving sustainability. This implies radical reforms in the construction sector (Geldermans, 2016), especially in the implementation of new energy infrastructures. This framework aims to shed light on the value of maintaining and reusing renewable materials and energy infrastructures.

Fair distribution of burdens and benefits
The energy transition brings about socio-spatial disadvantages that result in the lack of participation from vulnerable neighbourhoods in the decision-making process, claims of land used for livelihood or recreation in vulnerable neighbourhoods, and an inability for low-income households to afford or access the renewable energy infrastructure needed in the transition. This consequently reinforces existing social and spatial hierarchies (Lacey-Barnacle, 2020).

A fair distribution of burdens and benefits aims to ensure that new energy infrastructures deployed must benefit the vulnerable neighbourhoods and promote procedural engagement in the decision-making process. It also aims to aid the residents of vulnerable neighbourhoods over wealthier neighbourhoods in integrating new renewable energy infrastructures through financial incentives and subsidies.

Mainframe
The mainframe energy system is part of the new energy framework introduced in this report. It is the energy supply of South Holland based on the different potentials and existing resources of the region. The mainframe provides large-scale generation of renewable energy at central power plants and decentralised systems through the whole region that can then be distributed to different end-users such as large industries in the port of Rotterdam that generate large amounts of employment opportunities. The energy generated in this framework will be distributed using a grid (Steekelenburg et al., 2019).

Employment
The energy transition and phasing out of fossil fuel-based industries will lead to job losses and an increase of employment opportunities in the renewable energy and circularity sector, making it necessary to anticipate the changing needs and inclusivity of the labour market (SER, 2018; IEA, 2021). The transition from fossil fuel energy to renewable energy requires a shift in skills that in turn necessitates education of new employees and retraining of existing employees (IRENA, 2020). This is especially important for the Rotterdam region wherein there are local dependencies for employment in the port. It is therefore necessary to consider the existing employees of the port, as well as their accessibility to economic hubs.

Local frame
The local frame energy system is the counterpart of the mainframe wherein small-scale energy production takes place. The contributors to this energy system are mainly neighbourhoods that previously only consumed energy. Through this energy system, small-scale energy players are able to become self-sufficient, while still being linked to the mainframe to exchange energy when possible or needed (Steekelenburg et al., 2019).

Living quality
The energy transition leaves space for new amenities and the renovation of existing properties. The living quality of vulnerable neighbourhoods can be enhanced by simultaneously improving the quality of housing and by improving the public space while new infrastructure for renewable energy is installed. Housing and cultural amenities are vital for the living quality of neighbourhoods (Tillie et al., 2016); therefore, making use of this transition to create a mixed-use space with no segregated functions is a great opportunity

Prosumers
At the core of the conceptual framework are prosumers. Prosumers facilitate socio-economic justice in the energy transition by allowing households in vulnerable neighbourhoods to not only consume but also produce their own renewable energy (Gautier et al., 2018). Prosumers are also able to engage in a circular economy through reuse and recycle. In this way they also become prosumers of products. The production of their own energy benefits these households through reduced energy bills, as well as in being able to sell excess energy back to the grid. The concept of prosumers also promotes a sharing community and neighbourhoods to function as a collective (Lang et al., 2020).

Methodology

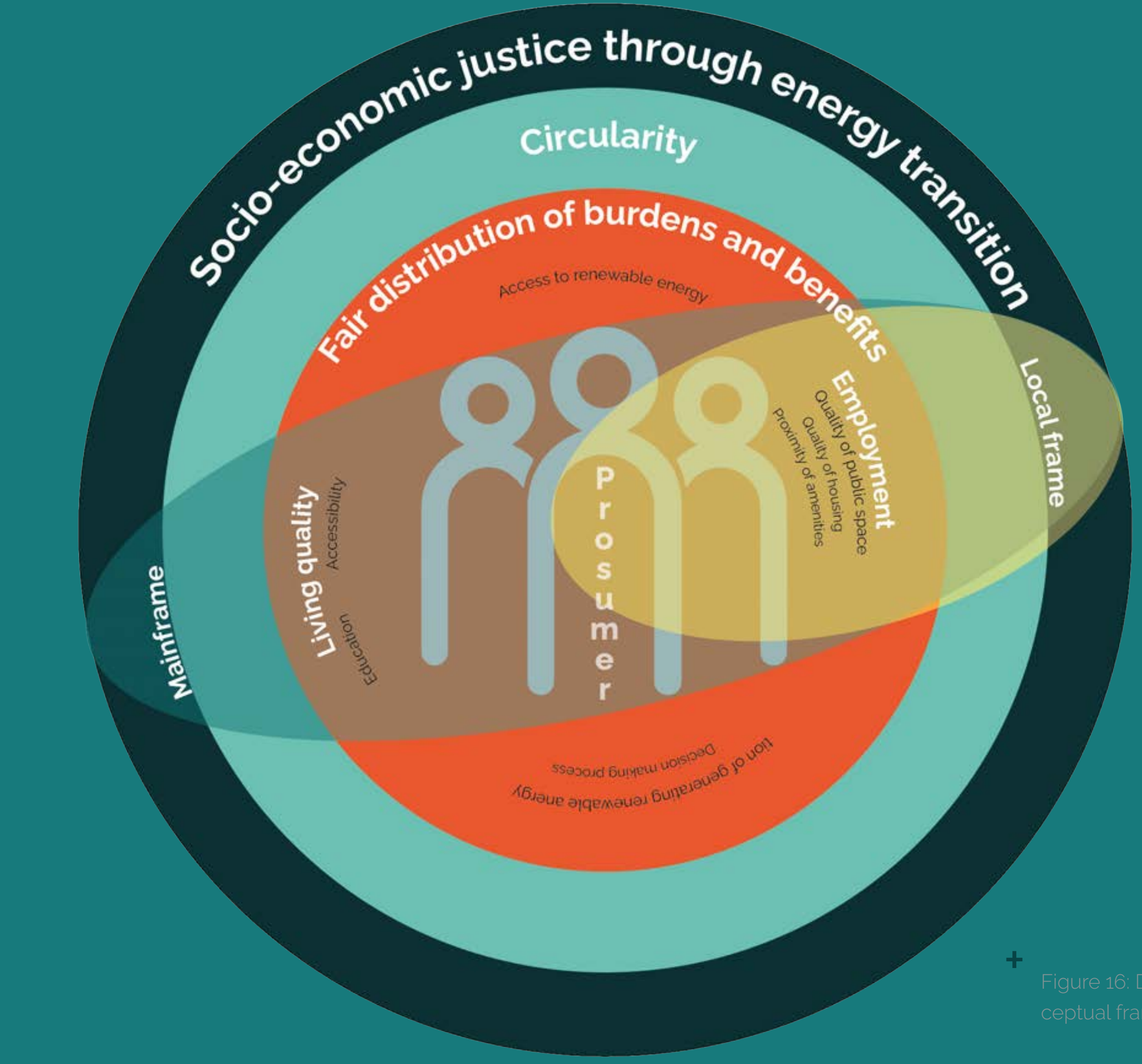

Figure 16

+ Figure 16: Diagram of conceptual framework

2.3 METHODOLOGY STRUCTURE

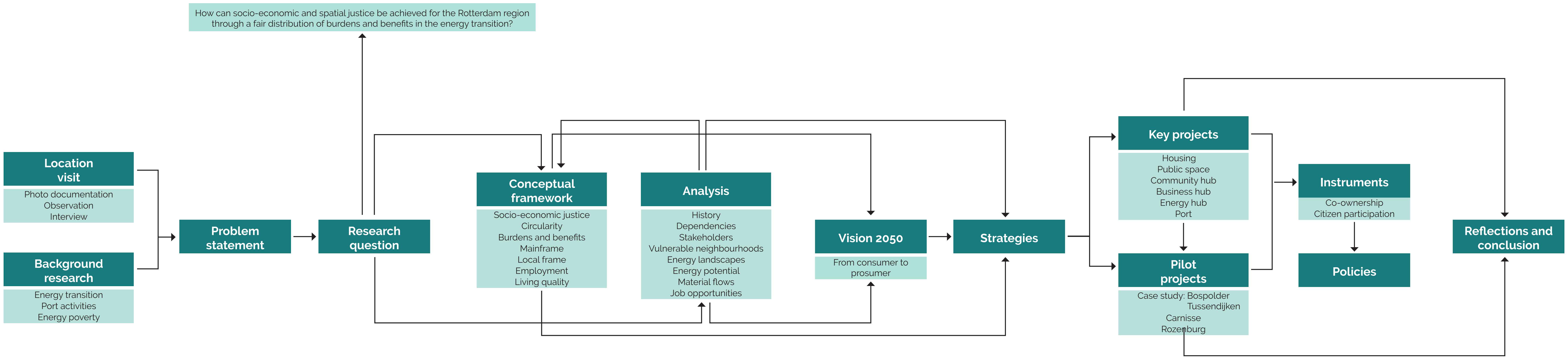

Figure 17

+ Figure 17: Research and methodology structure

3. ANALYSIS: ROTTERDAM REGION FACING SOCIAL INEQUALITIES AND ENERGY TRANSITION

3.1 GENERAL ANALYSIS

3.1.1 HISTORY

Port activities

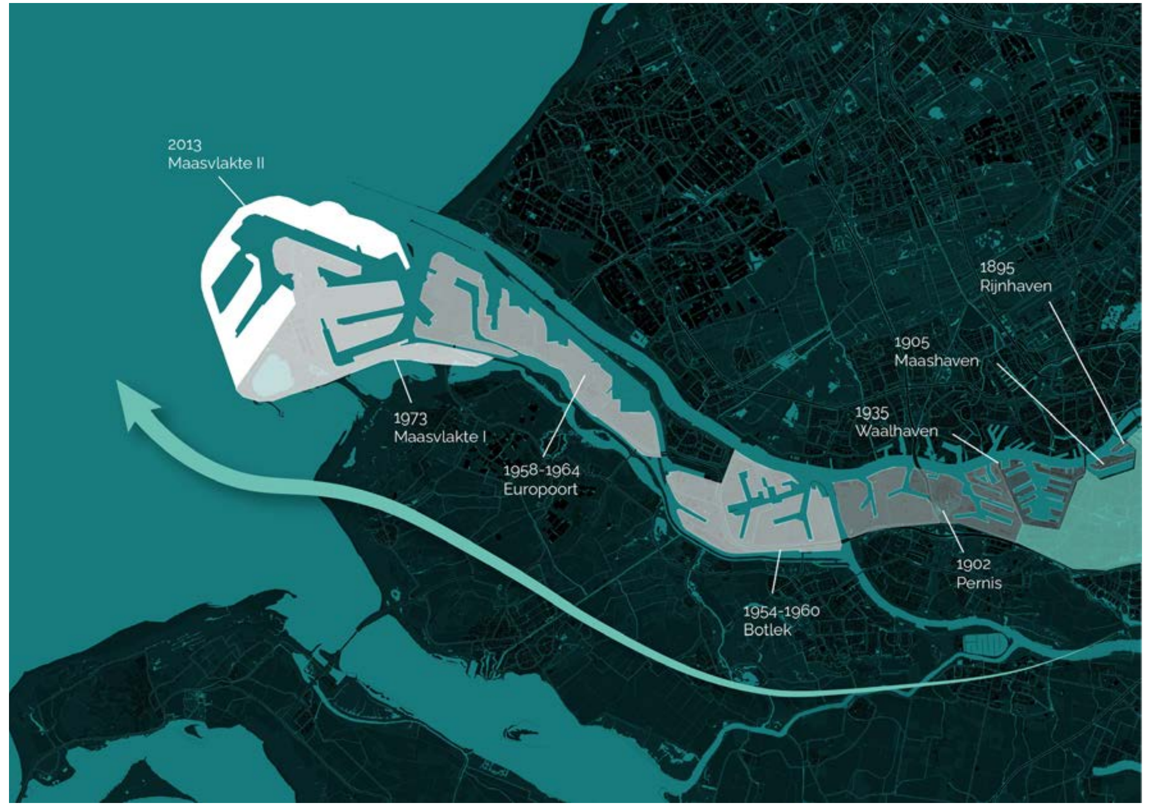

Figure 18

+ Figure 18: History of port activities (data from Hein and van de Laar, 2020)

Main phases

The history of the port and the vulnerable neighbourhoods is an important first step to understand the underlying reasons to today's circumstances. Hein and van de Laar (2020) explored the historical development and transitions of the port that occurred in four main phases indicating the slow separation of the port from the city (figure x). These phases will be elaborated in the next paragraphs.

Phase 1

Separate docklands were created by the city government on the south bank of the river Maas at the turn of the 1860s. This created a port system and a transit economy in Rotterdam that specialized in storage, handling, and transport of bulk commodities such as coal, iron ore, oil, grain.

Phase 2

In the period between 1885 and the 1940s, new canals and docks were developed into wet-dock systems. Simultaneously, between 1910 and 1940, a new port landscape emerged that paved way for a booming oil industry. Port-city relationships were transformed during the inter-war period wherein extension of the transit port occurred. This resulted in the westward expansion of the city, especially when the industrial oil port began emerging in the period building up to the Second World War.

Phase 3

Maritime Industrial Development Areas (MIDAS) were developed between the 1940s and 1970s due to the re-industrialisation of the port and the Second World War. Expansion of the petrochemical and oil industries dominated post-war modern industrial areas, significantly affecting the port region.

Phase 4

Between the 1970's and 2000s, a part of the North Sea was reclaimed for the Maasvlakte area. At the same time, Rotterdam and its post-war expansion had stretched over a distance of 40km.

These phases indicate the spatial and economic shifts in the port that eventually resulted in a change in the living quality and employment opportunities of the residents depending on the port for livelihood. The next section will describe this in detail.

Vulnerable neighbourhoods

A study by Tillie et al. (2016) on the 'Quality of life in Remaking Rotterdam' depicted the economic and socio-spatial history for the vulnerable neighbourhoods that can be found in Rotterdam today, summarized on figure x.

The westward expansion of the port was coupled with the national government appointing of *groeikernen* in several municipalities around Rotterdam. This plan opened centres for population growth that provided attractive housing. The implementation of *groeikernen* provided an ideal alternative to the conditions of living in the city; therefore, households that were able to afford the move left the city.

A prime example for the degradation of living quality in neighbourhoods or districts connected to the port and constructed before 1940 was Bospolder-Tussendijken. At the peak of port activities, many people in this district worked in the port area; therefore, the port area contributed to the presence of local amenities and local purchasing power in the district. Once automation and upscaling of activities occurred, many people lost their jobs. In consequence, unemployment and immigration grew in the district. This then led to a decrease in local purchasing power and degradation in the attractiveness of commercial facilities in the district, which further facilitated local unemployment.

Some of the vulnerable neighbourhoods in Rotterdam were therefore formed due to the westward expansion of the port.

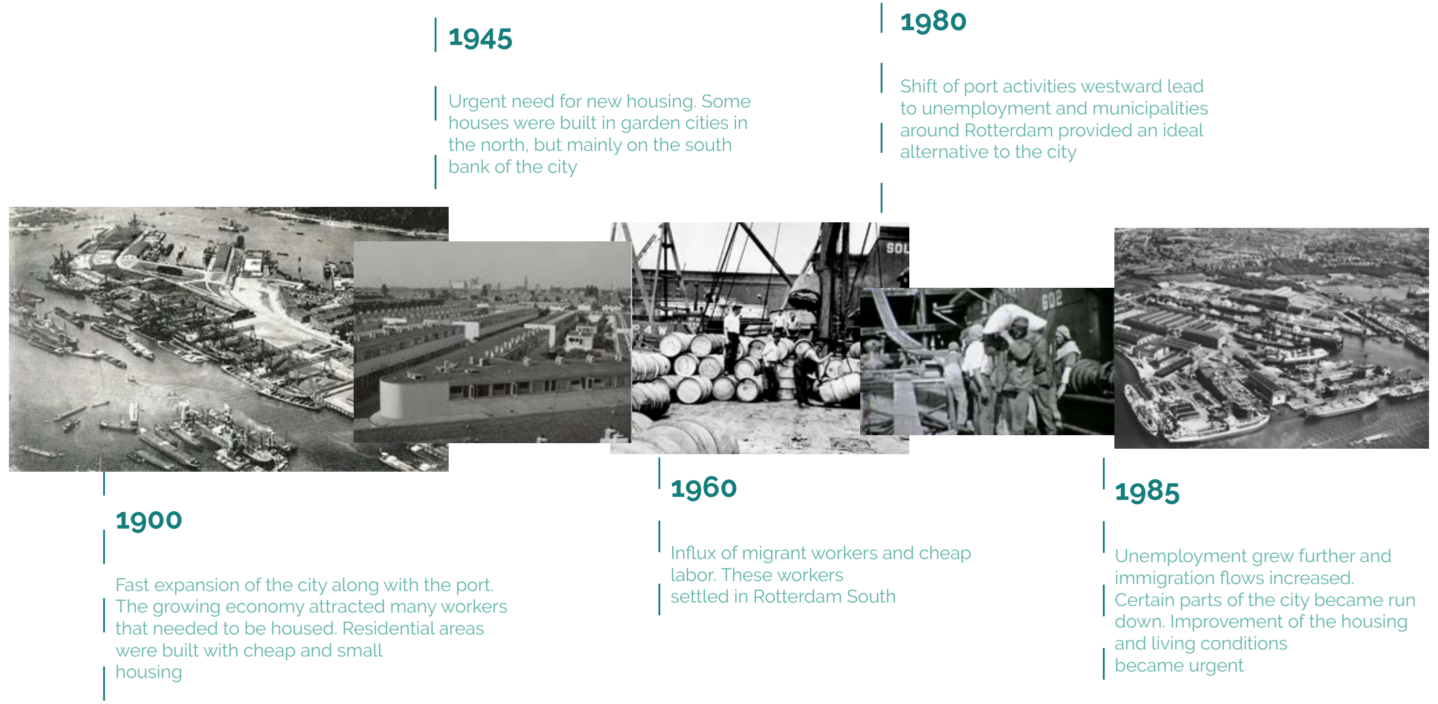

Figure 19

+ Figure 19: Timeline of the development of vulnerable neighbourhoods

3.1.2 GLOBAL - LOCAL DEPENDENCIES

Global material flows and trade

The global market is highly interconnected and based on global dependencies. Due to the outsourcing of production processes to other countries (countries with cheaper labour force), linear economic models and material flows that require a constant supply of resources and sectioning off production steps are reasons for these dependencies. Especially past events (Evergreen) and current crises (Covid pandemic) have revealed this and led to worldwide and local production stoppages, shortages of goods and price increases. In particular, Russia's current, international law violating, invasion of Ukraine, and the resulting gas and energy price explosion show our society's dependence on fossil fuels and their suppliers. The Port of Rotterdam is a key player in this global and dependent market.

Global orientation & dependency

The Port of Rotterdam is Europe's biggest and most important Port. With a yearly throughput of 438,6 million tonnes of dry-bulk, liquid bulk, containers and breakbulk it is a global cargo hub and the gateway to Europe. The Port processes and exports these resources to other European countries through an extensive web of canals, rails and pipes. Belgium and Germany are particularly dependent on this throughput, especially on gas and petrol imports from Rotterdam.
Rotterdam's industry is mainly based on fossil and gas imports. As the current Ukraine war and the current social discourse show us, this dependency is highly problematic, since the port of Rotterdam receives a large part of its fossil fuels from Russia, which are shipped via the Baltic States. This exposes the European dependencies on Russia and the importance of transformation.

Local dependencies

As a global hub and Europe's gateway, the port of Rotterdam also represents a major economic force for the region. As such, the industrialised port offers jobs for skilled workers, but above all also in the low-wage sector. This makes it an important employer for people from the region and results in significant local economic dependencies, especially for people from vulnerable neighbourhoods.

These global, European and local dependencies confirm that the goal should be to become less dependent on natural gas & petrol, but also global and linear production chains. The energy transition is a good start, but the shift to local and circular production processes is also important to reduce dependencies and trigger local economic values.

+ Figure 20: Global and local dependencies

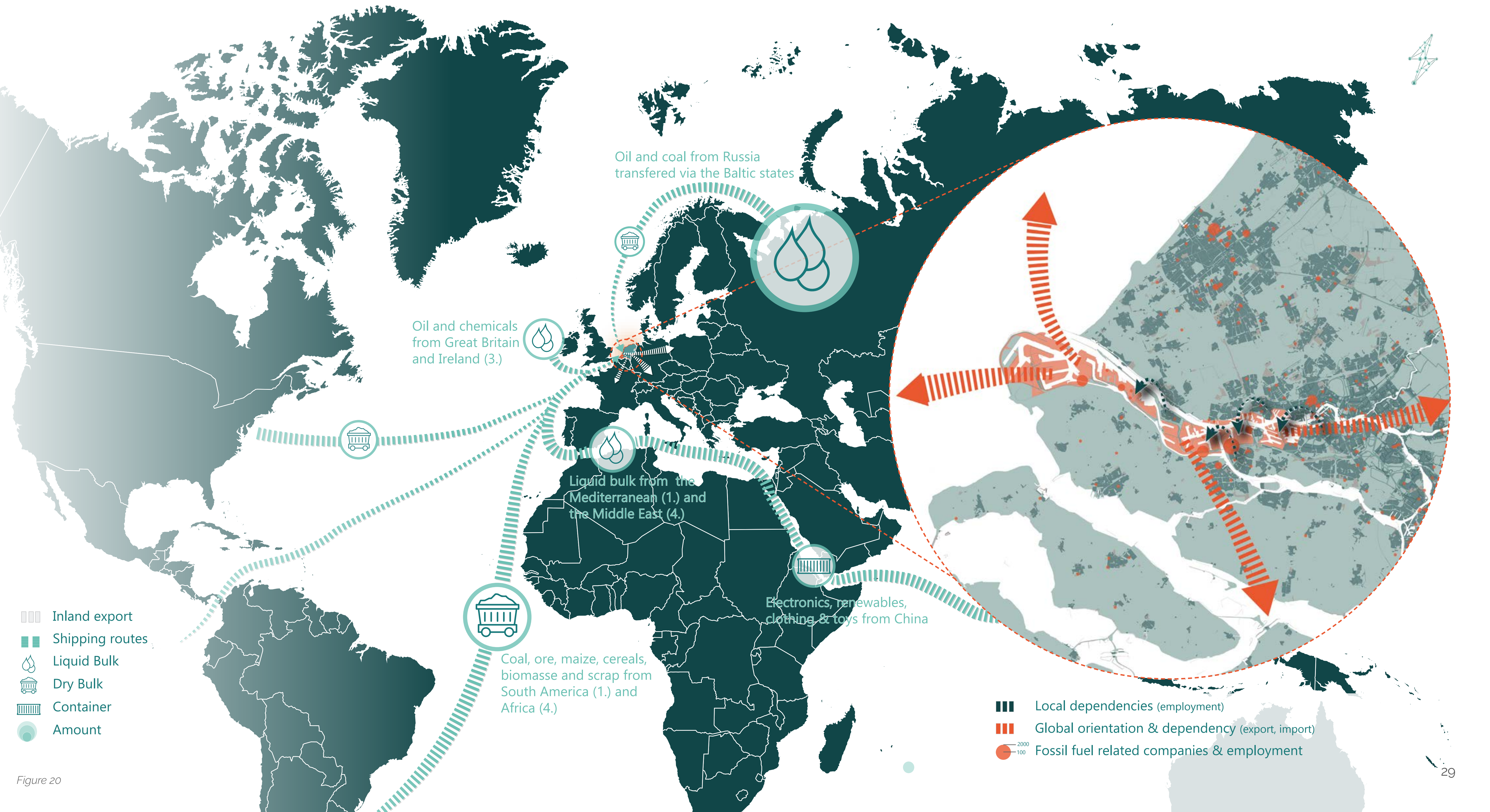

Figure 20

3.1.3 GOVERNANCE AND STAKEHOLDERS

Governance levels

Dutch governance is multi-layered with the national level at the first layer, followed by the 12 provinces at the second layer, and municipalities at the last third layer. The structure of the Dutch governance landscape is both an advantage and a disadvantage for energy transition governance (Feenstra et al., 2021), as explained in the next paragraphs.

At the national level, energy poverty lacks official definition or policies that leads to a neglect of the interests of the energy poor (Straver et al., 2020). The central government holds a political position that reducing or eliminating energy poverty should be addressed through social welfare policies instead of energy policies, in the same approach to mitigating general poverty. The energy transition policy and its agendas, however, are well-established and shaped at the national level with a participatory approach to include the civil society (Feenstra et al., 2021).

In contrast, the second layer of Dutch governance has a more structured energy poverty agenda. The provinces of Utrecht and South Holland, in particular, have programs to stimulate research and allocate funds and support to municipalities in their projects on energy poverty. There is also an existing collaboration between the provincial and local government with citizens, companies, and utilities in the forms of decarbonisation in their region (Feenstra et al., 2021).

The third layer, the municipalities, are considered to be directors of the heat energy transition. The Participation Law of 2010 led to the delegation of power from the national level to the municipal level with regards to poverty alleviation and provision of decentralized social services. This includes customized policy solutions to different local households' needs (Dijkhof, 2014). Despite this, the lack of a clear mandate and allocation of adequate resources from a national framework, the efforts of municipalities to address energy poverty is limited (Feenstra et al., 2021).

The role of the European Union is especially formidable in raising the energy poverty agenda for a country like the Netherlands. The European Commission (2018) effectively mandated the Netherlands to define energy poverty, report transparently on it, and create both objectives and policies to address it accordingly.

Tackling energy poverty through energy policies is therefore relatively new and remains a work in progress in the Netherlands. Neighbourhoods in the country still require interventions in the alleviation of energy poverty and allocation of adequate support, funding, and resources is still needed to start the movement.

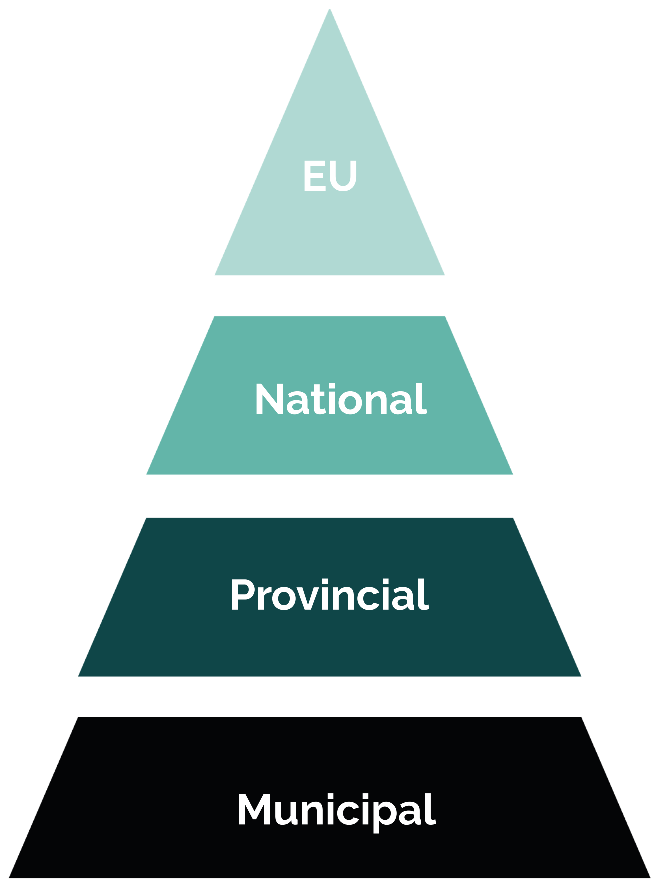

Figure 21

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Figure 21: Hierarchy of governance levels in the Netherlands

Stakeholder power matrix

The stakeholders involved in ths project are identified and divided into three categories: public parties, private parties, and civil society. Each of these categories have their own agendas, aims, and involvement in the energy transition. The different organizations involved in each category differ in influence or power with regards to the decision-making process, as well as in their interest regarding the energy transition. This is illustrated in figure xx, indicating the position of different organizations in the power matrix.

The matrix depicts the need to satisfy organizations with high influence but low interest such as fossil fuel companies and housing associations. These organizations need to be satisfied in order to comply with the energy transition.

Conversely, organizations with high influence and large interest such as public parties, renewable energy companies, and environmental organizations need to be managed to contribute to the energy transition.

On the other end, organizations with low influence and interest need to be monitored so that they do not go against the energy transition. These are organizations currently highly dependent on fossil fuel such as logistics and storage companies, employees of the fossil fuel industry, and owner-occupied housing residents.

In contrast, companies and civil society members that have high interest but relatively low influence need to be informed and empowered in order to make a change. Thus, they are the main focus of this project.

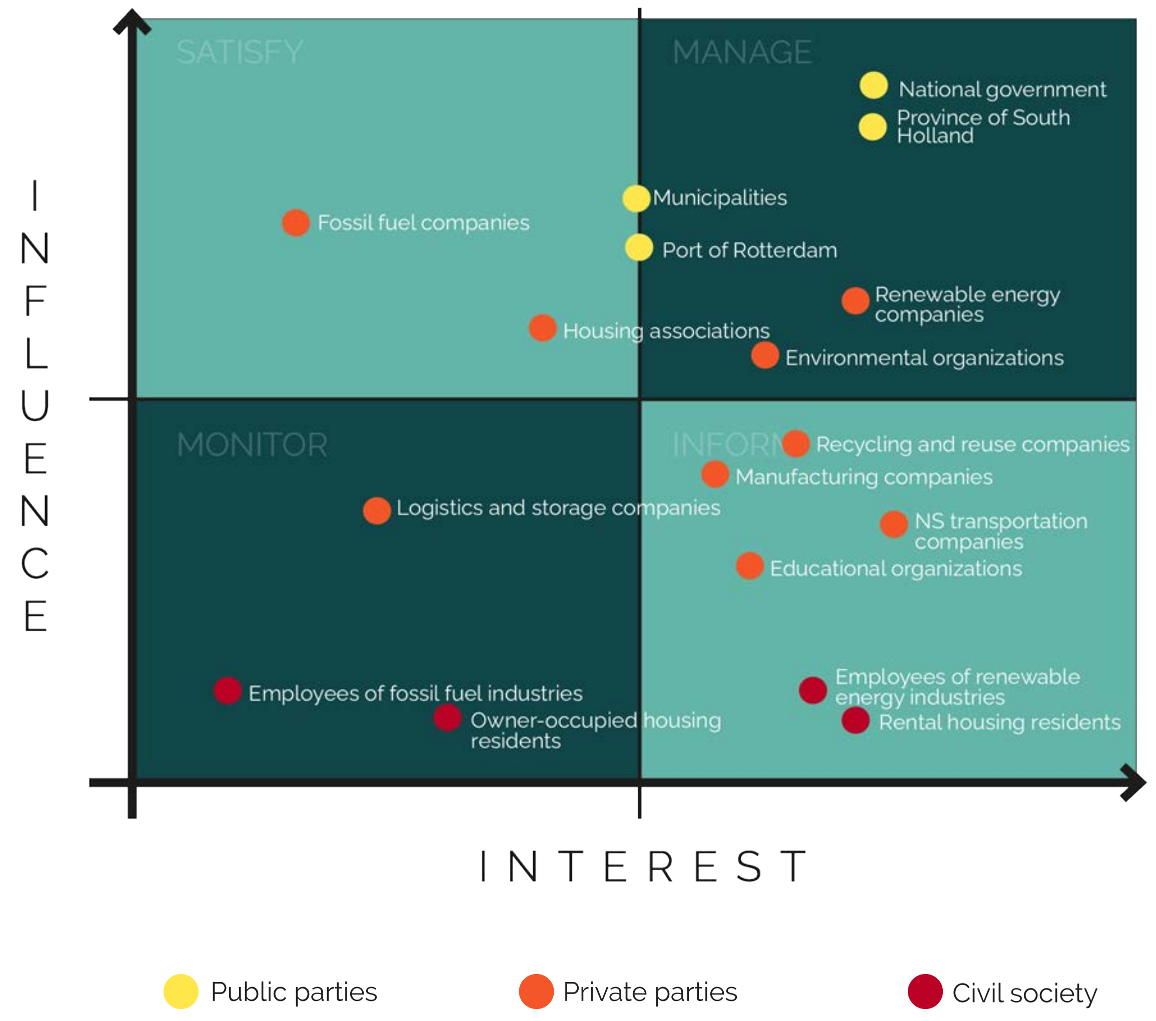

Figure 22

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Figure 22: Stakeholder power matrix

3.2 VULNERABLE NEIGHBOURHOODS

3.2.1 SELECTION CRITERIA

Selection process

In order to determine which neighbourhoods will be focused on, a set of criteria regarding the availability of public transportation, amount of social housing, amount of people receiving unemployment benefits, livability score, and amount of fossil fuel-based companies.

Determining vulnerable neighbourhoods is important to locate which areas are more likely to feel the consequences of the energy transition. By doing so, social help and financial incentives can be provided to those that may potentially lose their jobs and are unable to cope with the necessary starting capital for the installation of renewable energy infrastructure.

The criteria used to select vulnerable neighbourhoods also provide preliminary insight into what social and spatial interventions these neighbourhoods need in order to improve their living quality. The different criteria will be expanded on in the next paragraphs. The analysis is based on the spatial conditions of different neighbourhoods in South Holland.

Figure 23: Public transport routes (data from Nationaal Georegister, 2021)

Figure 24: Percentage of social housing per neighbourhood (data from CBS, 2018)

Figure 25: Amount of people receiving unemployment benefits per neighbourhood (data from CBS, 2018)

Figure 26: Neighbourhoods with low livability scores (data from Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2020)

Figure 27: Location and number of employees per fossil fuel-based companies (data from Lisa Foundation, 2018)

Public transport

Accessibility in the form of public transport stops and lines are important in the living quality of an area as it can potentially determine the capability of people to reach essential amenities such as their workplaces, hospitals, grocery stores, and other cultural spaces.

As seen on figure 23, the amount of public transportation significantly decreases towards the port, thus putting neighbourhoods in proximity to the port at a disadvantage in reaching amenities provided in the centre of Rotterdam. Furthermore, households living in the city face difficulties in reaching employment opportunities available in the port.

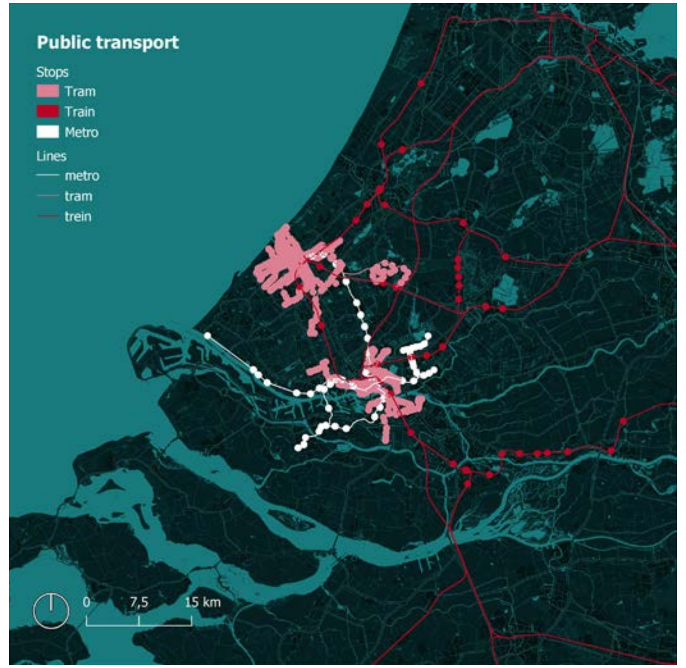

Figure 23

Social housing

The amount of social housing in an area (figure 24) is indicative of the amount of people with low-income, making it an important criterion in determining vulnerable neighbourhoods.

Furthermore, the number of residential properties owned by housing corporations gives an indication of which properties or housing types can integrate renewable energy infrastructure comparatively easier than privately owned houses. In this way, an integral approach is therefore possible.

Figure 24

Unemployment

The amount of people receiving unemployment benefits (figure 25) is an important criterion in determining vulnerable neighbourhoods as it indicates which areas need aid in entering the labour market, especially with changes brought upon by the energy transition.

Furthermore, unemployment rates are also indicative of low-income households which in turn affects their purchasing power.

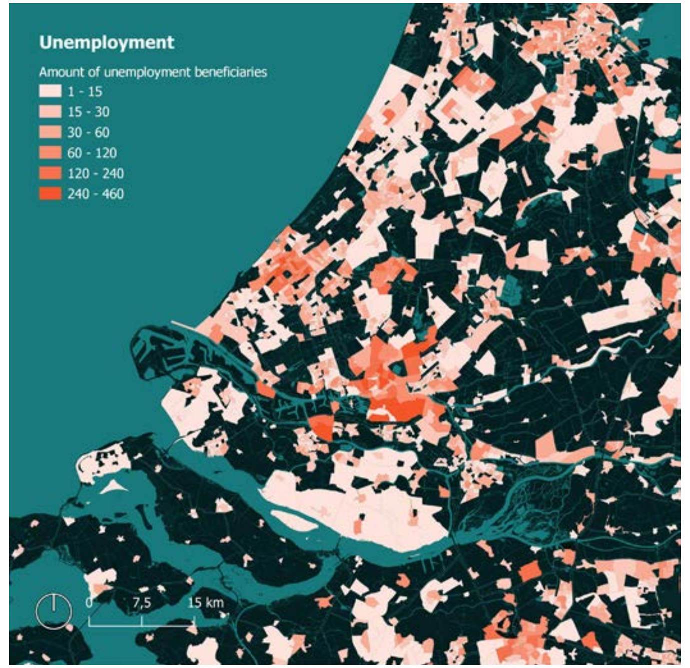

Figure 25

Livability

The livability score of neighbourhoods is based on a variety of factors such as the housing stock, physical environment, services, social cohesion, nuisance, and insecurity. The score of each neighbourhood is determined by the average of these categories.

The overall livability of each neighbourhood indicates the satisfaction that residents hold over their living space and surroundings. Figure 26 indicates where neighbourhoods with low livability scores are concentrated in, such as Rotterdam and The hague.

Figure 26

Fossil fuel-based companies

The proximity of neighbourhoods to fossil-fuel based companies (figure x) gives insight on which neighbourhoods are potentially most affected by changes to the labour market. Furthermore, neighbourhoods close to fossil fuel-based companies may experience low levels of air quality due to fumes emitted from factories and industries.

Other than the location of companies, figure x also indicates the number of employees in these companies. This provides insight into which companies could potentially reduce or provide employment opportunities after the energy transition.

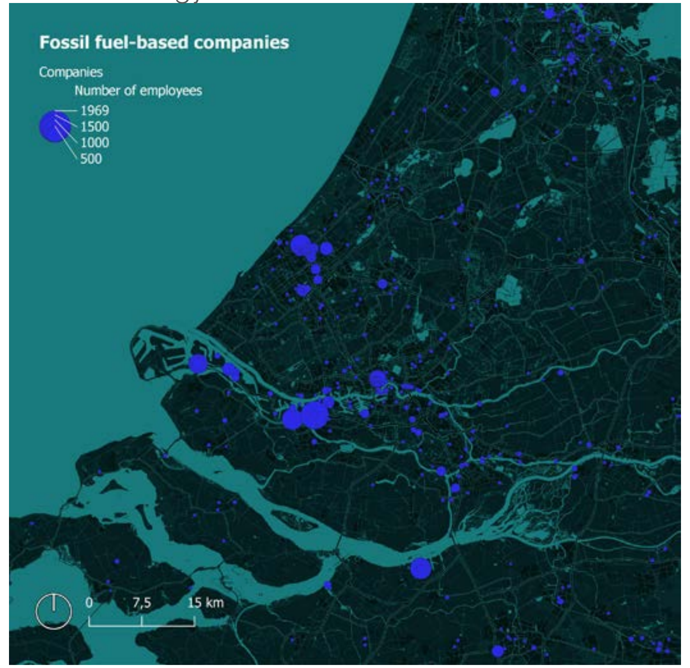

Figure 27

3.2.2 SELECTED NEIGHBOURHOODS

On the basis of the selection criteria elaborated on in appendix, different districts were categorized as vulnerable. This was weighed out and determined according to their performance on the categories of accessibility, unemployment, social housing, livability, and fossil fuel companies.

Different specific neighbourhoods were further chosen with the lowest scores in the selection criteria. The vulnerable neighbourhoods tackled in the strategic vision are therefore:

1. Hoogvliet Zuid
2. Zuidwijk
3. Pendrecht
4. Lombardijen
5. Groot Ijsselmonde
6. Beverwaard
7. Oud Charlois
8. Tarwewijk
9. Carnisse
10. Bloemhof
11. Hillesluis
12. Vreewijk
13. Rozenburg
14. Nieuwe Westen
15. Ommord
16. Zevenkamp
17. Schildersbuurt-west
18. Laakkwartier-Oost
19. Bospolder Tussendijken
20. Bouwlust en Vrederust

Figure 28: Selected neighbourhoods

Figure 28

3.2.3 ATTRACTIVE WORKING AND LIVING ENVIRONMENT

Principles of attractive urban areas

It is essential to follow a people centric planning approach at all planning levels and all timeframes. This approach is based on safety, well-being, empowerment and participation, social inclusion of all people and the health of the residents/ community.

Easy accessible public & private transport takes into account proximity to public transport, but also affordability. In addition, improving intermodality, pedestrian-friendliness and a sufficient network of cycle paths is important.

Circularity means local circular waste streams that can be used for local food or energy production, but also promoting the sharing economy, as there is a shift from selling goods to selling services.

The accessibility of a digital infrastructure means accessibility to a wide range of jobs and services. Furthermore, a digital infrastructure can promote participation and open decision-making processes and thus lead to digital empowerment. Data measurement tools and smart technologies are needed to increase energy efficiency.

Affordable housing is key to an attractive living and working environment, also experimentations with new housing concepts. Affordable space for young companies is important to attract young innovative companies, new work typologies and flexible office/lab space can promote this.

To archieve a resilient approach and plan for the unexpected it is important to build a culture of flexibility (IVA 2017).

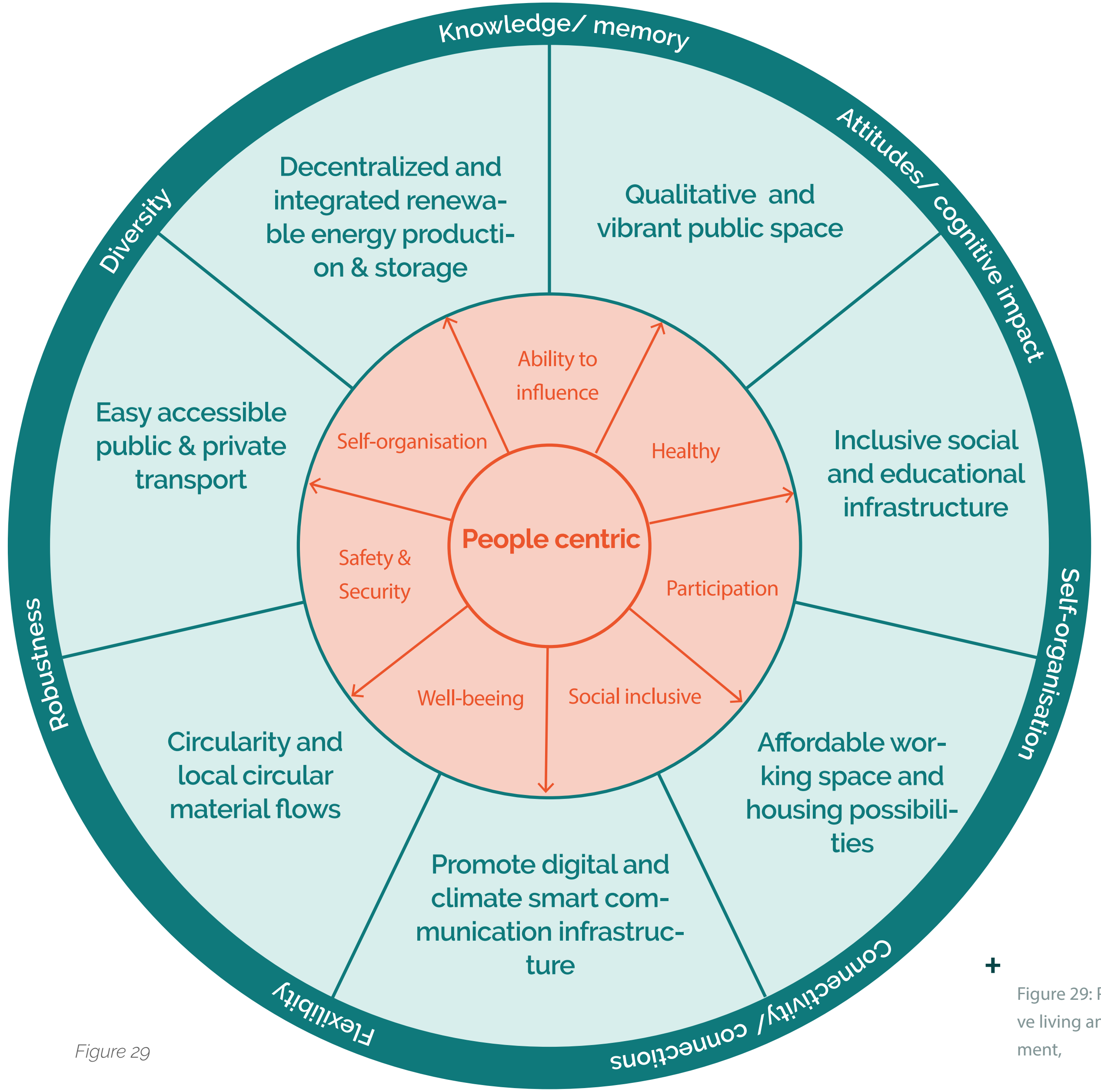

Figure 29

Figure 29: Promoting attractive living and working environment,

3.3 ENERGY

3.3.1 CURRENT SITUATION

Port industries

The port of Rotterdam is one of the biggest ports in the world and the biggest in Europe. The location and position played an important role in the development of the port as it is well-connected to shipping lines, but also to the big cities in Europe. Therefore, as seen earlier, the port has undergone explosive growth to become the port it is now.

The port serves several industries. In the diagram, the total throughput of 2020 is visible. This shows that especially liquid bulk meaning crude oil, mineral oils and liquified natural gas, takes up a large portion of space. The next significant part is dedicated to container shipping. The third main product is dry bulk, under which we consider coal, scraps, ore and agri bulk. These products are either processed inside the port or exported again to other industrial areas.

This enormous throughput serves a total of 385,000 direct and indirect jobs. Simultaneously it has an added value of 45,6 billion euro's to the GDP, which is 6,2% of the total GDP of the Netherlands. Accordingly, the port authority is aware of the influence the energy transition will not only have on the spatial and economic dimensions but also on the social dimension. A lot of these jobs will be replaced or lost and a lot of jobs will be created. The authority expects to create 10.000-25.000 new job opportunities (Port of Rotterdam, 2021). As a response to this transition, the port is investing in an educational climate that will foster these changes. An example of this is P-TECH, an educational programme that brings together education, businesses and governmental institutions. In this way, youth is educated to be employed in the innovative port.

In the map on the right, the zoning of the port is shown, with a few companies highlighted that are influenced by the transition. The zone around the Maasvlakte is dedicated to several coal-fired power plants, which are owned by the companies Riverstone and Uniper. One other important company is AVR, a waste-burning plant. Nevertheless, most space is dedicated to the oil industry, owned by different parties of which Shell is one of the most well-known ones (Port of Rotterdam, 2016).

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Figure 30: The total throughput in the port of Rotterdam in billions of tons (data from Port of Rotterdam, 2021).

Figure 31: The zoning of the different industries in the port (data from Port of Rotterdam, 2016)

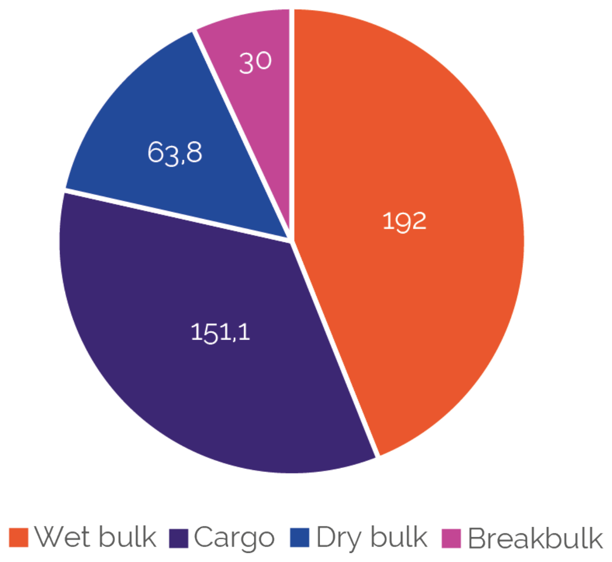


Figure 30

Figure 31

The oil industry in the port

Oil is one of the most important industries for the economy in the port of Rotterdam. In total, 8,970,000 m2 is dedicated to the oil refineries, which serve a total of 3,271 jobs. In addition to that, 3,680,000 m2 is reserved for oil terminals, which covers 142 jobs (Port of Rotterdam, 2016).

Crude oil is refined in one of the five oil refineries in the port or transported to other places in Europe like Germany or Belgium (Port of Rotterdam, n.d.-b). The crude oil is refined in the port to create a variety of products like diesel, naphtha or gasoline. The uses of these different products can be seen in the figure below. The possible future replacements for these products can also be seen.

Important to acknowledge is the variety in the uses of oil. Oil is not only used to produce petroleum gas: all cars, trucks, ships and aeroplanes are dependent on it, as well as plastics and the road we are driving on. This versatility makes it difficult to find a direct replacement and therefore it complicates the process of eventually phasing out the oil refineries: we need cheap, efficient and suitable replacements (EIA, 2020).

The first developments in this transition have already started in the shape of bio-refineries. Shell is building a new refinery that can produce 820,000 tons of biofuels a year on the Pernis site, one of the first of its kind in the Europe (Rani, 2021).

+ Figure 32: The current and future use of oil (data from Meyers, 2013).

Figure 33: Current electricity grid (data from Provincie Zuid-Holland, 2022)

Oil

Product	Petroleum gas	Gasoline	Naphtha	Paraffin	Diesel	Fuel oil	Bitumen
Application	Heating	Cars	Plastics	Aeroplanes	Ships & trucks	Industry	Asphalt
Possible replacement	Geothermal, residual & hydrogen	Electricity & biofuels	Bioplastics	Biofuel or hydrogen	Biodiesel or elecricity	Hydrogen	Bio-based

Figure 32

Current electricty system

The current electricity network is mostly based on generators in the port. Most of the electricity is generated through coal or natural gas plants (Port of Rotterdam, n.d.). Coal plants are considered one of the most polluting industries and as a result, most of these are already being transformed or replaced (NOS, 2021). The Onyx plant has been subsidised by the government to be closed due to the massive emissions. However, still, this coal plant is refusing to close due to the current economy: they can make lots of money with the high demand at the moment (Ministerie van Economische Zaken en Klimaat, 2021).

Gas plants, on the other hand, are still widely implemented. A few renewable alternatives, like biomass plants, wind turbines and solar panels, are implemented, but only on a very small scale.

Figure 33

Current heating system

The main heating system in the province of South Holland is still mostly based on gas. This gas is then distributed from the port onto the gas grid towards the housing where it is used through boilers. However, a part of the province is also covered by district heating. In this system, residual heat from the AVR plant is used. The plant burns household waste and through this, a lot of heat builds up, which is then transported through this network, visible in the diagram below. Other industries, like Shell, are starting to connect to this district heating too, as all industries produce a lot of heat, for which there is no other use (Stichting Warmtenetwerk, 2022)

The total heat demand for the province of South Holland is 282,358 TJ. Of this 282,358 TJ, only 12,643 TJ is produced by a renewable source. Most of this demand comes from the urban district of Rotterdam and The Hague in which 234,120 TJ is needed (Staat van Zuid-Holland, 2022).

A quick calculation shows that 1 TJ of energy is equal to 25,500m^3 of gas. This means that a total of 7,2km^3 of gas is needed to supply the entire province with enough heat. This shows the scope of the assignment: a lot of alternatives are needed to reach this demand.

Figure 34: Heat demand per region in South Holland (data from Staat van Zuid-Holland, 2022).

Figure 35: The district heating system (adapted from Eneco, 2017)

Figure 36: Current heating system in South Holland (data from Provincie Zuid-Holland, 2022)

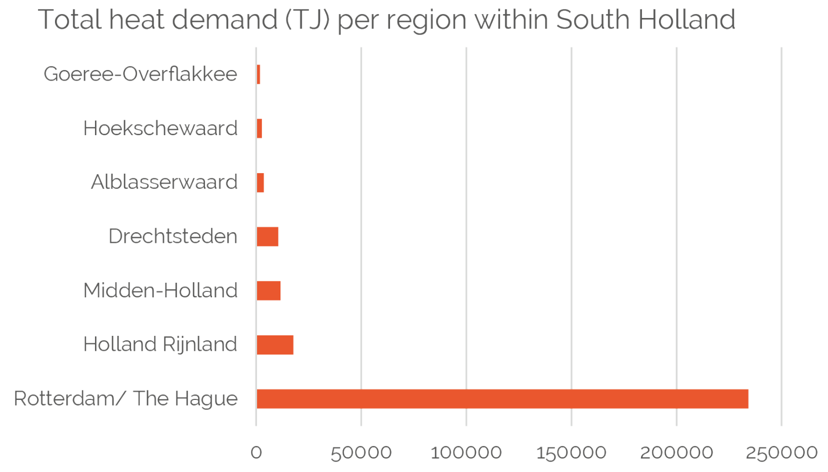


Figure 34

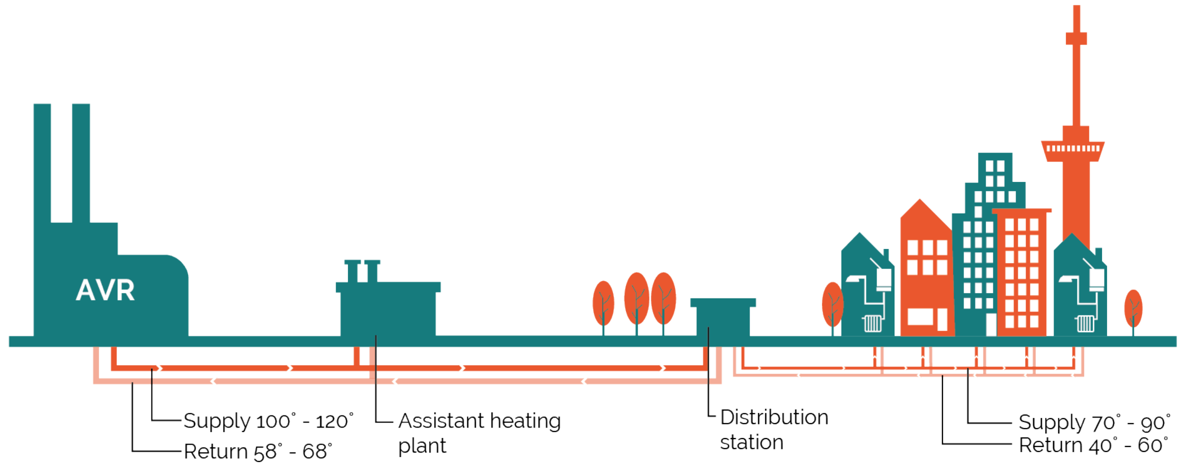


Figure 35

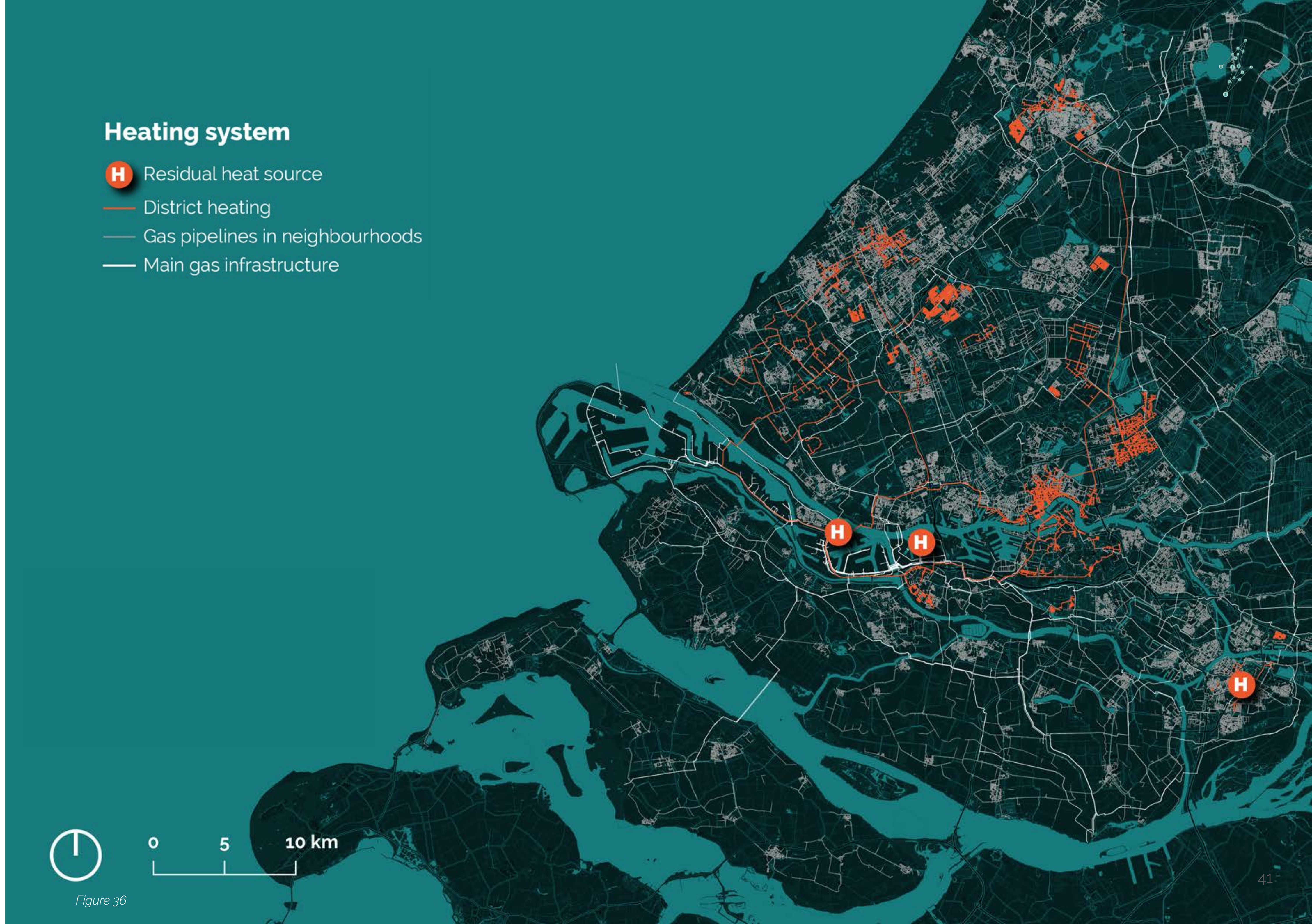


Figure 36

3.3.2 ENERGY POTENTIAL

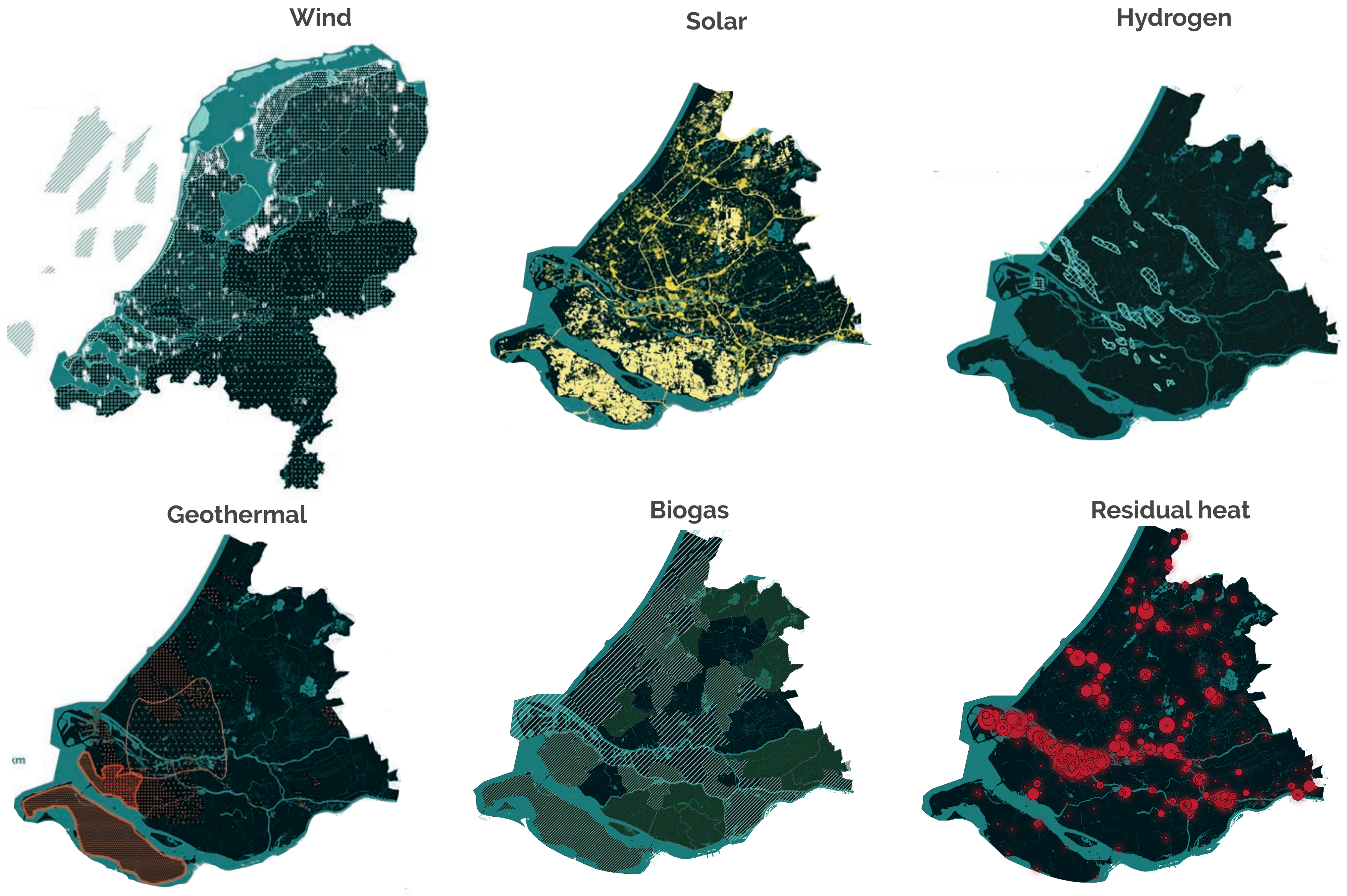


Figure 37: Overview of potential energy sources in South Holland

Figure 37

Renewable energy potential

The spatial impact of the energy transition will be huge. The renewable energy sources are much less energy dense than the current fossil energy infrastructure and therefore require more space (Sijmons et al., 2014). This chapter explores the potential of different energy sources (wind, solar, hydrogen, geothermal, biogas and residual heat) in South Holland and its potential spatial implementation. Figure 38 shows the potential energy sources in 2050 with their related use and the associated numbers.

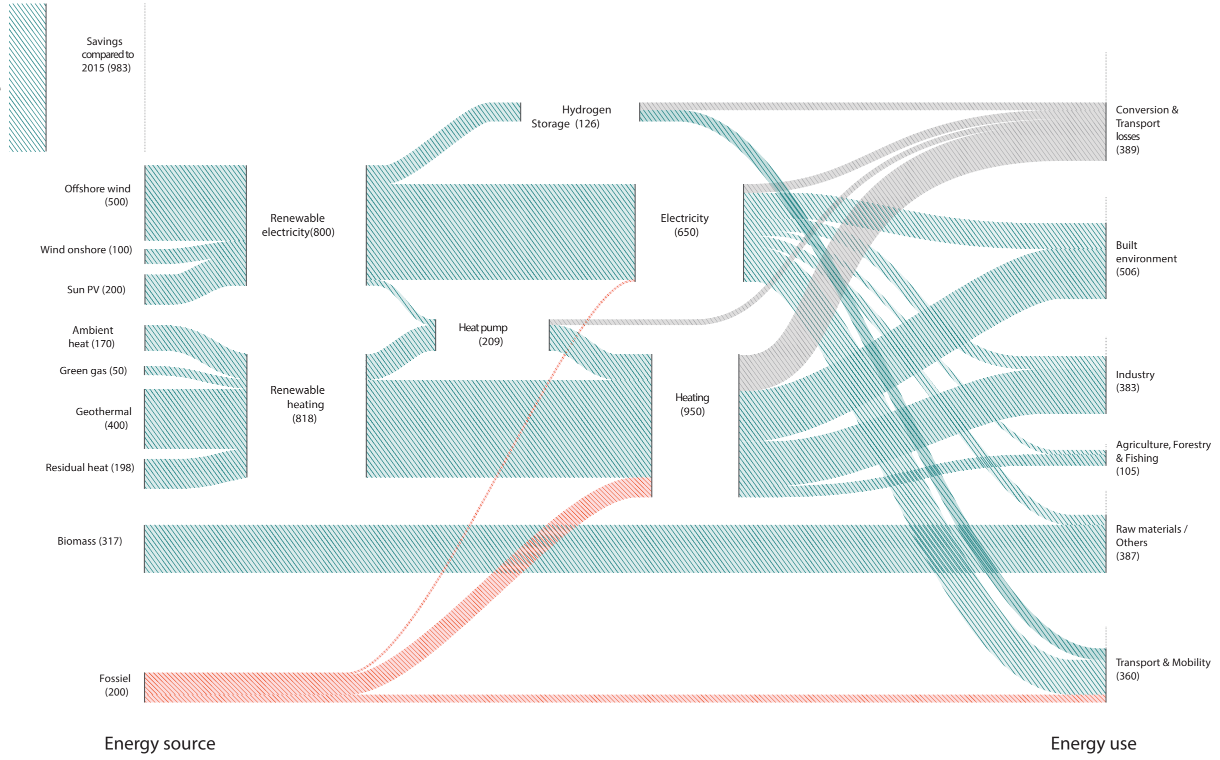


Figure 38

Figure 38: Energy sources with their related uses Adapted from Sijmons et al. (2017)

Solar energy

Solar energy can be converted into electricity and heat. Solar energy is abundant in South Holland, and on the planet for that matter. There are no significant differences in sunshine hours within the province, the potential depends mostly on the landscape. However, solar energy has a large spatial footprint and a great amount of money and energy have to be invested per unit of delivered energy (Sijmons et al., 2014). As land is scarce, solar panels have great potential to be implemented on roofscapes.

Implementation in space

With solar panels, it is cheapest to place them close to the final user, as infrastructural costs are limited in that case. Therefore, urban areas hold great potential to house solar panels on its roofscapes, however it depends on private initiatives. The integration of solar panels in the surrounding of infrastructure holds great potential as well, as it is often surrounded by large areas of unused space.

With the rising efficiency of agriculture, 10% of the agricultural fields could be sacrificed for the placement of solar panels without jeopordizing the food production. Solar panels can also be implemented on roofs of glasshouses that switched to hydroponic food production. With the huge pressure on land, the implementation of off-shore solar parks can also be further investigated (Sijmons et al. 2017).

+ Figure 39: Implementation of solar panels in landscape (data from Sijmons et al. ,2017)

Figure 40: Solar potential (data from OverMorgen (2022), OverMorgen (2017b), Over-Morgen, 2017c))

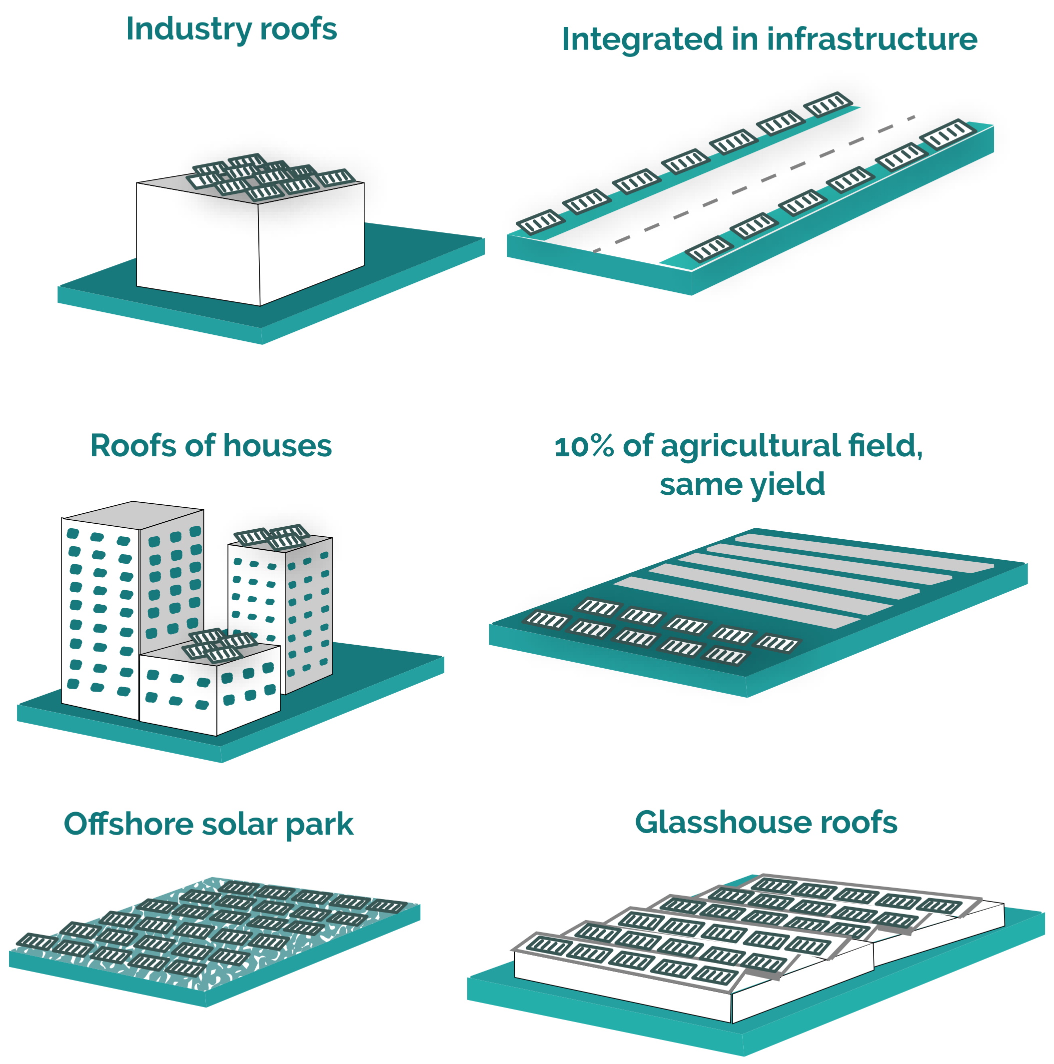


Figure 39

Figure 40

Wind energy

Wind turbines convert the kinetic energy of air into electricity using a generator. The demand for electricity can partly be supplied by onshore wind energy and increasingly by offshore wind energy.

The direct spatial footprint of windturbines is small, however there are some regulations on distance in between windturbines and on the distance between the turbines and houses depending on the size of the turbines (Sijmons et al., 2014). The potential of windenergy differs, depending on the windspeed. The map shows that South Holland has good potential to produce windenergy. The largest potential is alongside the coast, as the windspeed is highest there.

Implementation in space

The increasing visibility of windturbines in our landscape over the years, as free standing turbines or in a windpark, providing hundreds of megawatts, are a topic of the public debate. They can be integrated alongside infrastructure, in horticulture, agriculture, industry and in urban areas, depending on the size of the turbines , functions surrounding the turbines and amount of open space.

\+ Figure 41: Implementation of windturbines in landscape based on Sijmons et al. (2017)
Figure 42: Wind potential (data from KNMI, 2015, Nationale Energieatlas, 2021 and Rijksoverheid, 2018)

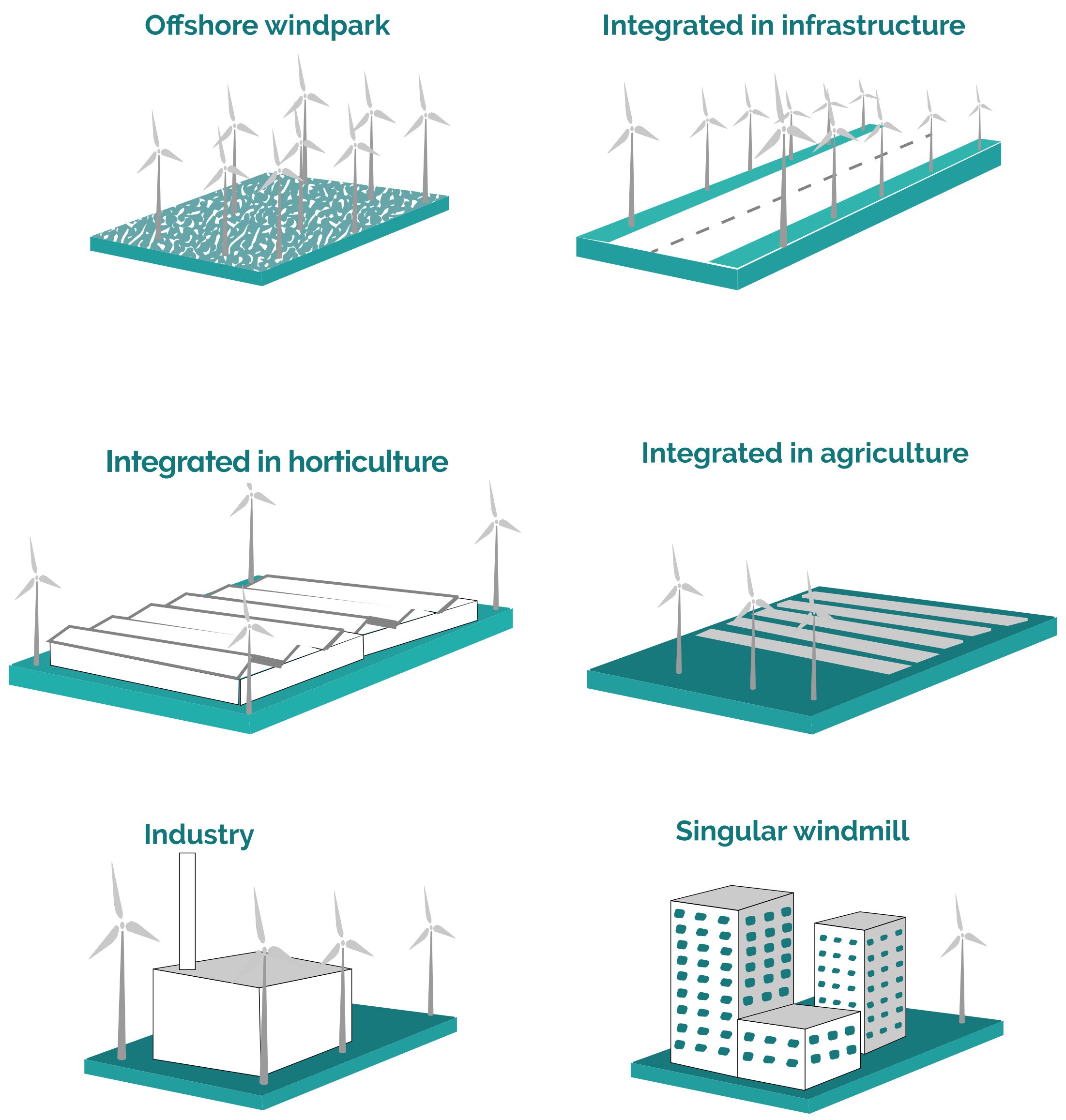


Figure 41

Figure 42

Hydrogen

Given the intermittency of renewable energy sources, and the geopolitical unfair distribution of energy sources, energy storage and transmitters have an essential role to play in this transition. Hydrogen technology is recognized to be the most promising potential (Kovač et al., 2021). This is because hydrogen has potential to store, distribute and to be used as raw material. It can be produced out of natural gas and used to store CO_2 at sea (blue hydrogen), but it could later on also be produced by electrolysing water, using renewable energy (green hydrogen), to prevent a lock-in (Steekelenburg et al., 2019)
The current development of the technology is not far enough to realise large scale implementation, but because there is now a lot of ongoing research on this topic, it is expected to be possible in the coming decades (Kovač et al., 2021).

Implementation in space

As shown on the map, the port could house a hydrogen hub to import and export hydrogen. The electrolysis of water for green hydrogen could possibly also happen there. The oil and gas fields surrounding to port could be used to store hydrogen.

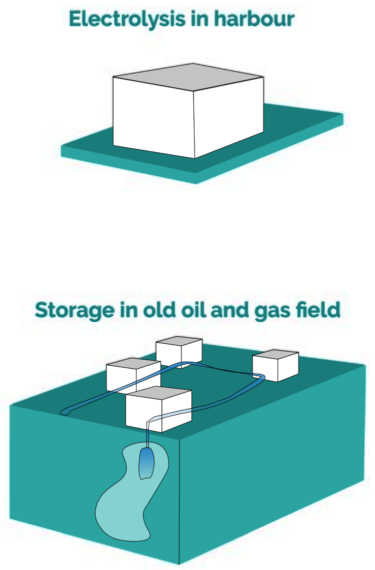


Figure 43

Figure 43: Spatial implementation hydrogen based on Sijmons et al. (2017)
Figure 44: Hydrogen potential map (data from TNO Geologische Dienst Nederland , 2015)

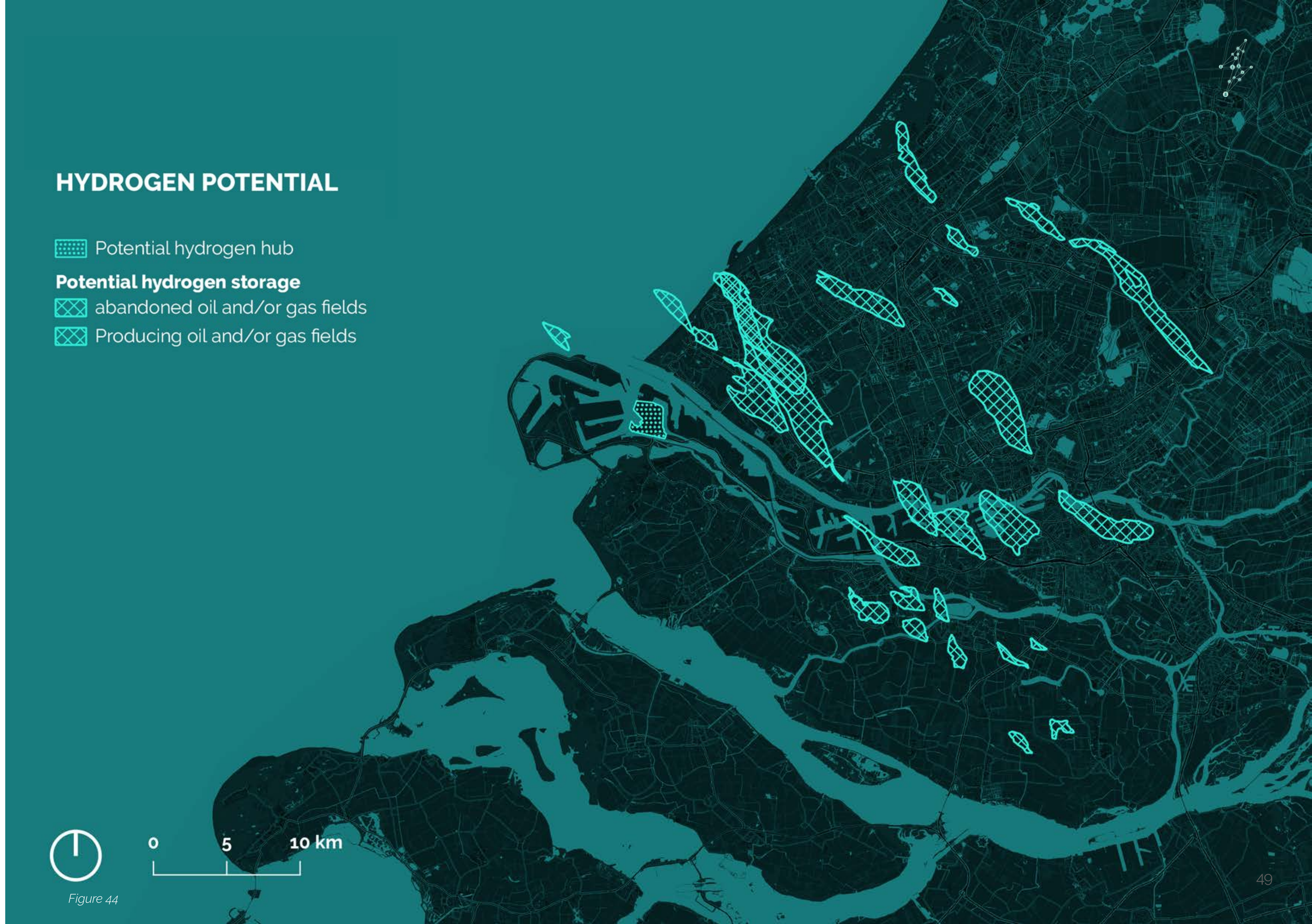


Figure 44

Biogas

An interesting potential in the energy transition is to feed the current gas infrastructure with biogas, the renewable version of natural gas. The two forms of gas can be mixed and can still be used as usual, therefore, it could play an essential role in phasing out natural gas. However, the production of biogas is by far not efficient enough to fully replace natural gas and bio gas is not as sustainable as it may sound. Although it is a renewable source, methane gets burned in the production process, which leads to CO2 emissions. However, on the bright side, the CO2-cycle of biogas is way shorter than the CO2-cycle of natural gas, as it concerns waste products of plants or processes that have captured CO2 out of the atmoshpere and now emit it again (Sijmons et al., 2017).

Spatial implementation

The spatial footprint of the gas that is generated by biomass is very small, the harvesting area it quite large on the other hand. Biomass from agricultural waste, glasshouse waste, household waste or production forests could be used to produce biogas. We only use waste, as a risk of using green raw materials for biogas is that it competes with the biobased economy. Another risk posed by Sijmons et al. (2017) of using agricultural waste for biogas, is creating a 'lock-in' of dependence on the unsustainable agricultural business. Therefore, the energy transition and the transition to a more sustainable agricultural practice require an integrated approach (Sijmons et al., 2017).

The map shows that there is quite some potential to produce biogas in South Holland, due to the large amount of agricultural fields. Because the companies are clustered, there is potential to produce biogas there locally, thus creating biogas hubs.

+ Figure 45: Biogas spatial implementations (data from Sijmons et al., 2017)

Figure 46: Biogas potential (data from PDOK, 2016)

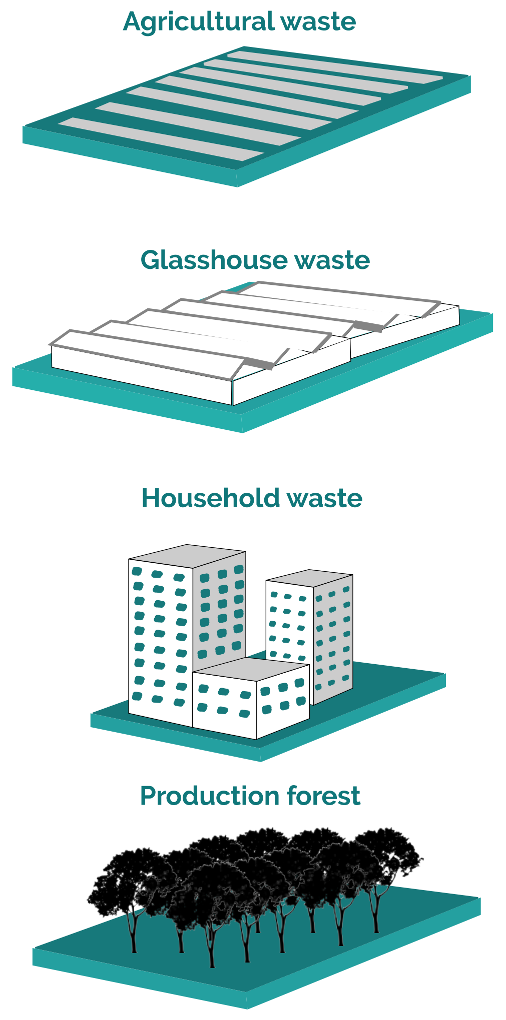


Figure 45

Figure 46

Geothermal heat

Geothermal energy holds great potential in the energy transition to replace natural gas in heating houses, greenhouses and to be applied in industry (Schoof et al., 2018). The globe holds a huge amount of thermal energy (heat). The temperature increases towards the core, but it is already possible to tap geothermal energy at relatively shallow depths. To extract the heat ,a 'doublet' and a heatpump are used. These doublets typically have a lifespan of +/-30 years, it is therefore important to make sure that it will remain possible to add new doublets to the heat network over the course of time (Sijmons et al., 2014).

Shallow geothermal heat is extracted at depths until 1.500 meters below groundlevel with a temperature between 20 and 40˚C . Deep geothermal heat is extracted at depths between 1000 and 4000 meters below groundlevel with temperatures between 40 and 100 ˚C and can be distributed through district heating (Buik, de Jonge and de Boer, 2016).

Ultra-Deep Geothermal energy is extracted at depths of over 4.000 meters below groundlevel and is used for producing heat with temperatures above 100 ˚C. The heat can be used for industrial processes, or to generate electricity (Schoof et al., 2018).

Spatial implementation

The potential for geothermal energy is unevenly distributed, geographically. South Holland is lucky to hold great geothermal potential at different depths. Geothermal heat has minimal visible spatial impact, as its infrastructure is mostly underground. However, significant changes are needed to adapt the underground infrastructure to this source.

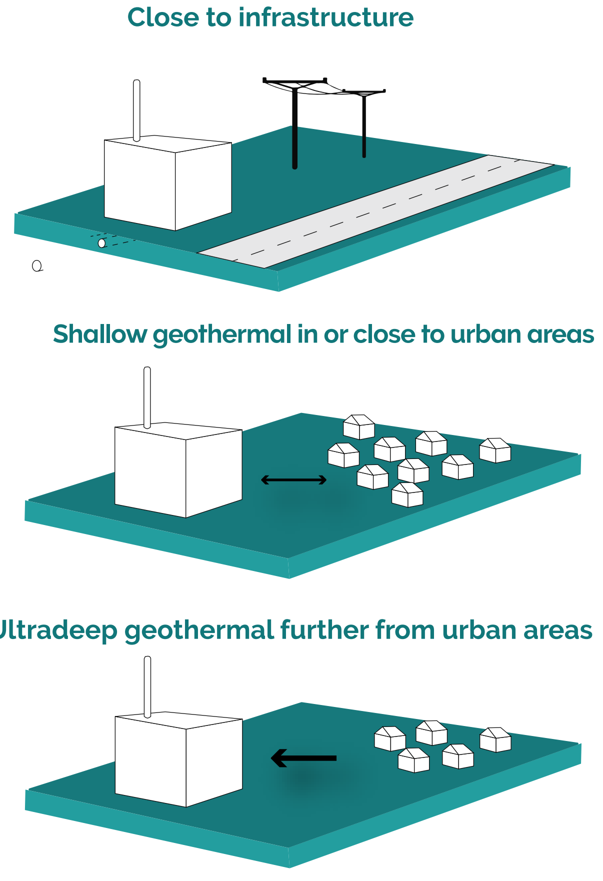


Figure 47

+ Figure 47: Implementation of geothermal sources in landscape based on Schoof et al. (2018)

Figure 48: Geothermal potential (data from IF-Technology , 2016a, IF-Technology 2016b, and IF-Technology, 2018)

Figure 48

Residual heat

The Netherlands has a large amount of unused residual heat available from the petrochemical industry, power plants and waste processing plants (Sijmons et al., 2017). Strictly, residual heat is not a renewable energy source, however, it makes it possible to make use of fossil fuels more efficiently (Sijmons et al., 2014). Thus, residual heat can have an important contribution in the energy transition, at least on the short term. In addition, even a completely circular and biobased industry will still have residual heat in the future (Sijmons et al., 2017).
In the built environment in general, there is often a lot of residual heat in different forms. However, this often concerns low grade heat, which makes it more difficult to utilize (Sijmons et al.,2014).

To maximise the use of residual heat it is important to align the supply and demand in terms of quantity and temperature, as this is now often not the case.
Secondly, industries that produce residual heat are often not nearby the consumer, which means that is has to be transported. However the effective distance that it can cover is limited. Therefore, distribution mostly happens on urban scale, regional at most (Fremouw, 2012). It could also be desirable to place functions that require a lot of heat near the sources (Sijmons et al.,2014).
Thirdly, the production of residual heat fluctuates. The supply is highest in summer and lower in winter, while the demand follows the opposite sequence. For this reason, it is important to have the possibility to store the heat, even though storage and transport come with efficiency losses (Sijmons et al.,2014).

Spatial implementation

As visible on the map on the right page, the industries in the port hold a lot of potential to make use of residual heat.

+ Figure 49: Implementation of residual heat based on Sijmons et al. (2014)
Figure 50: Residual heat potential (data from RVO warmteatlas , 2018)

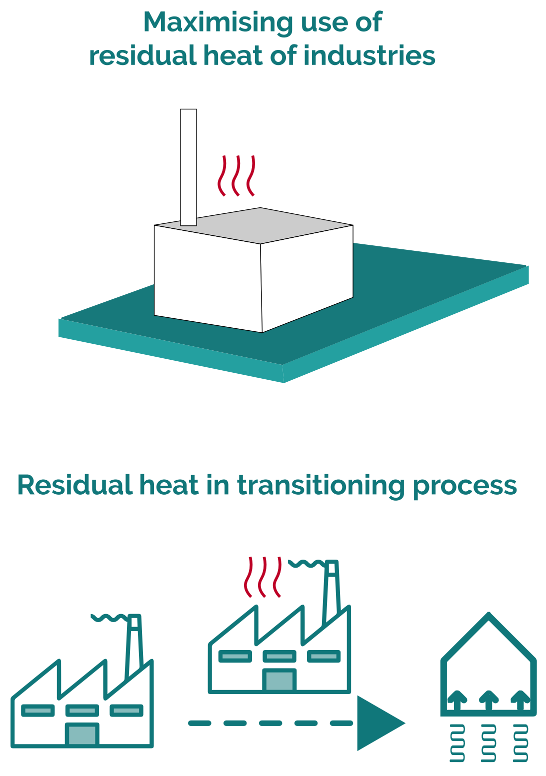


Figure 49

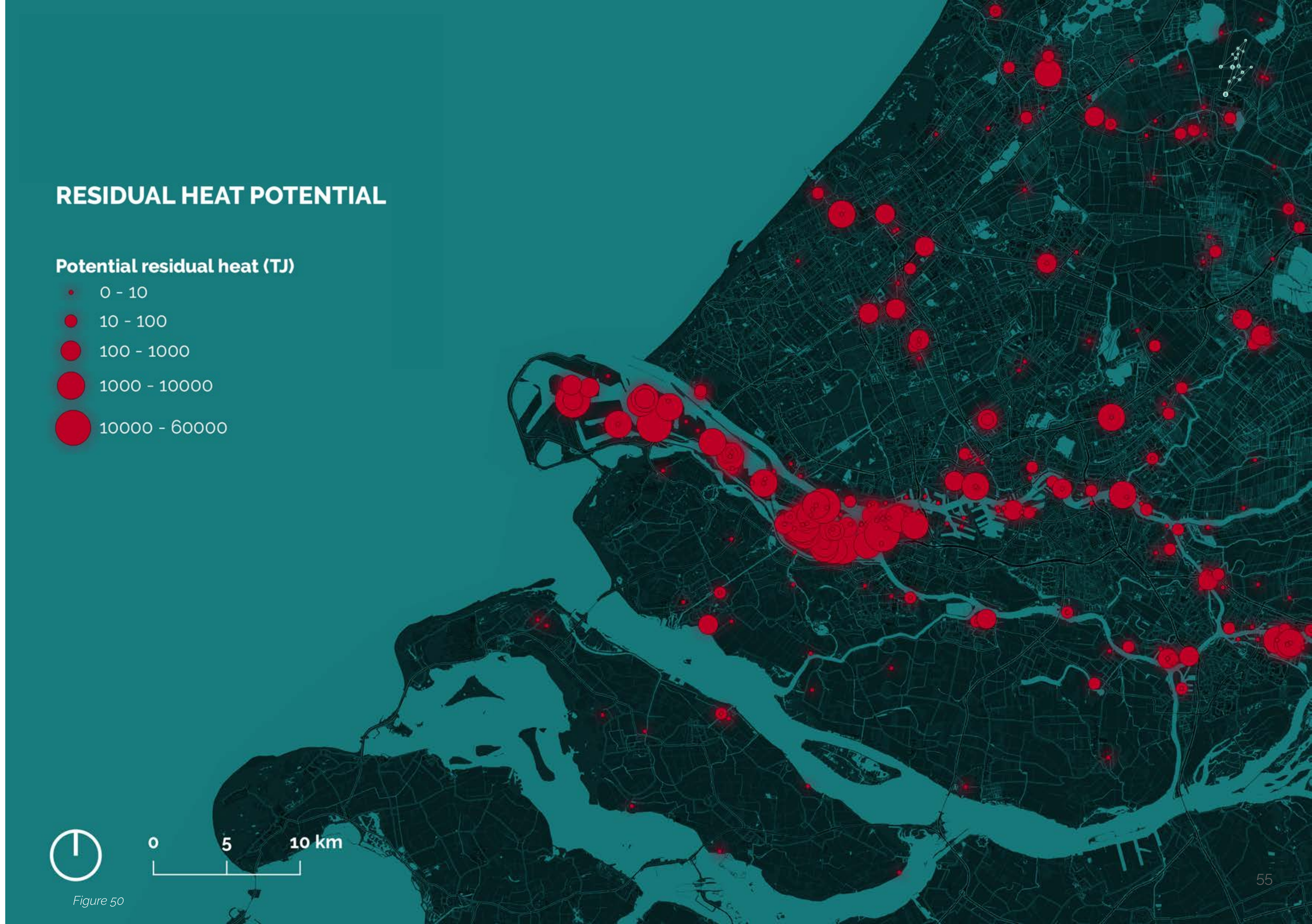


Figure 50

3.4 CIRCULARITY IN THE RENEWABLE INDUSTRY

3.4.1 CURRENT & FUTURE FLOWS

+ Figure 51: Expected growth of waste materials generated by the clean energy infrastructure (EEA, 2021)
Figure 52: Material recovery opportunities arising annually from the clean-energy sector by 2030 (EEA 2021)

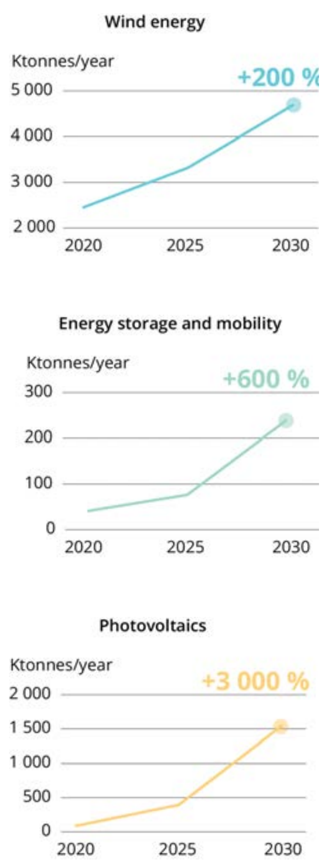


Figure 51

Growth of waste materials

The Port of Rotterdam's economy has so far been based on fossil fuels, which has created a dependency on them. Therefore, the port is already undertaking efforts to shift to a circular port industry, based on renewable energies.

However, renewable energy carriers are themselves linear and non-renewable in their design. Due to the significant demand for renewable energies needed to meet the European Union's targets of carbon neutrality by 2050 (European Green Deal, 2021) and their short lifetime compared to conventional energy sources (wind turbines and solar panels 20 years), significant amounts of resources are needed and substantial waste flows are generated (Carrara et al. 2020).

Photovoltaics are estimated to generate a 3000% growth of waste materials towards 1500 kilotonnes per year, while wind energy is expected to grow by 200% from an already high amount of 2500 kilotonnes of waste material per year. These amounts of waste materials are problematic if the foundation and the framework are not set to make renewable energies more sustainable and circular now. However, they also offer an opportunity to implement a local value chain that uses these material flows, processes them and thus becomes less dependent on global material and product flows, especially with regard to renewable energies (EEA 2021).

Material recovery opportunities

The increase in waste materials from renewable energies offers a particular opportunity, as some of the wastes arising either belong to established recycling systems (e.g. steel, glass, aluminium) and can therefore be recycled up to 90% to 100%; or are high-value critical raw materials that create revenue and therefore offer more incentives for companies to exploit the value chain (EEA 2021).

However, with the recovering of these materials come challenges, such as:

- logistical problems due to remote locations of energy infrastructure,

- presence of hazardous substances,

- lack of design to facilitate end-of-life/ recyclability aspects

- underdeveloped recycling capacity and technologies (EEA 2021).

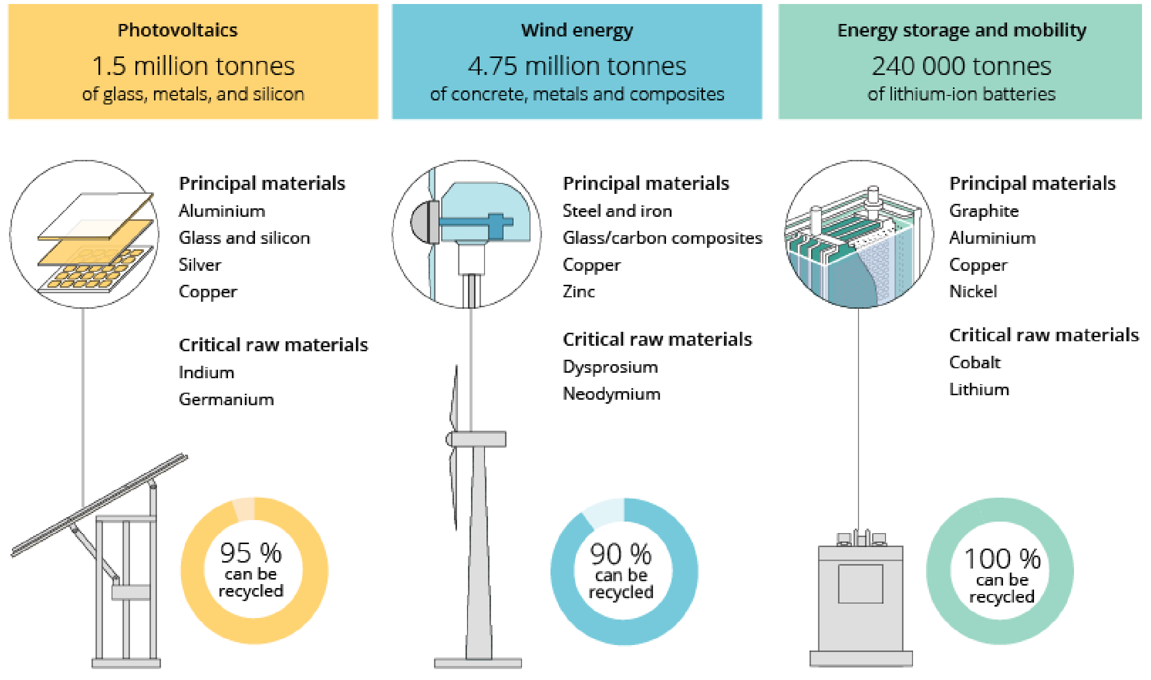


Figure 52

Circular clean-energy system

Due to these challenges, principles need to be established to address these challenges:
1. Supporting the development of recycling processes
2. Developing infrastructure with a circular approach
3. Implementing circular business practices that increase production responsibility.

These principles should be established throughout life cycle of energy supply technologies to make the clean energy system more circular and increase their lifespan (EEA 2021).

In terms of size and strategic location, the Port of Rotterdam is strategically well-positioned to develop into a circular (renewable energy) hub. The fossil-based industry is in need of an reorientation towards future-oriented energy production, the port is a already a key player in Europe as a hydrogen hub and involved in several on-shore and off-shore wind projects, due to the great potential for wind energy in proximity to the harbour. In addition, the port is already incolved in several circular (renewable energy) projects. Therefore, the port represents the interface for installation and maintenance of these wind parks and offers lots of potential for synergies and the promotion of local circuar processes in terms of wind turbines and solar plants.
The industry here generates a wide variety of waste flows. The beneficial use and recycling fits in with the broader transition to a new system of raw materials and offers Rotterdam new economic and social opportunities, in terms of employability and spatial justice.

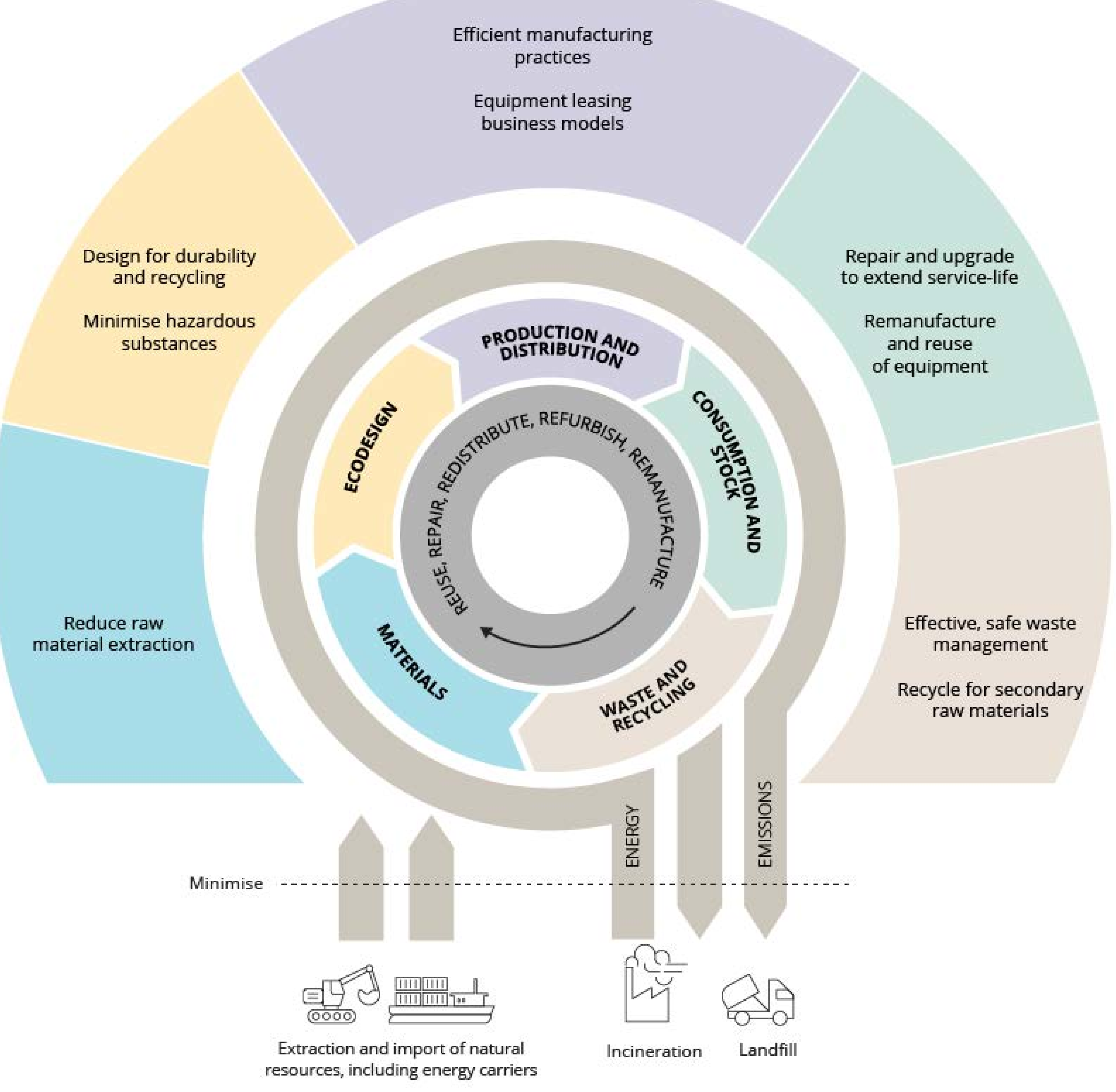


Figure 53

+ Figure 53: Circular clean-energy system (EEA, 2021)

3.4.2 EMPLOYMENT OPPORTUNITIES

Job types

As previously mentioned, employment opportunities arise from circularity and the energy transition.

Transfer of skills from conventional energy sectors are particularly easier for graduates in Science, Technology, Engineering and Mathematics (STEM) fields. Along with this, soft skills such as problem solving, customer awareness, communication, and application of IT are also in high demand. In Europe, employment in the energy transition is expected to be filled by low to medium educated employees able to perform less advanced tasks by 2030. Transferrable skills also include, construction and mechanics, safety experience, operating under difficult conditions, and digital jobs (Czako, 2020).

The labor intensity of the renewable energy sector is comparatively higher in all stages of the value chain than the conventional energy sector. This is expected to remain the same in the coming years as the renewable sector is less prone to automation. This is due to the process of installation, operation, and maintenance of renewable energy infrastructure occurring in places that are confined and harder to access (Czako, 2020). Sectors expected to benefit in terms of employment from the energy transition include manufacturing, construction, renewable energy production, transport and services, electrical machinery manufacturing, and biomass crop cultivation (ILO, 2018)

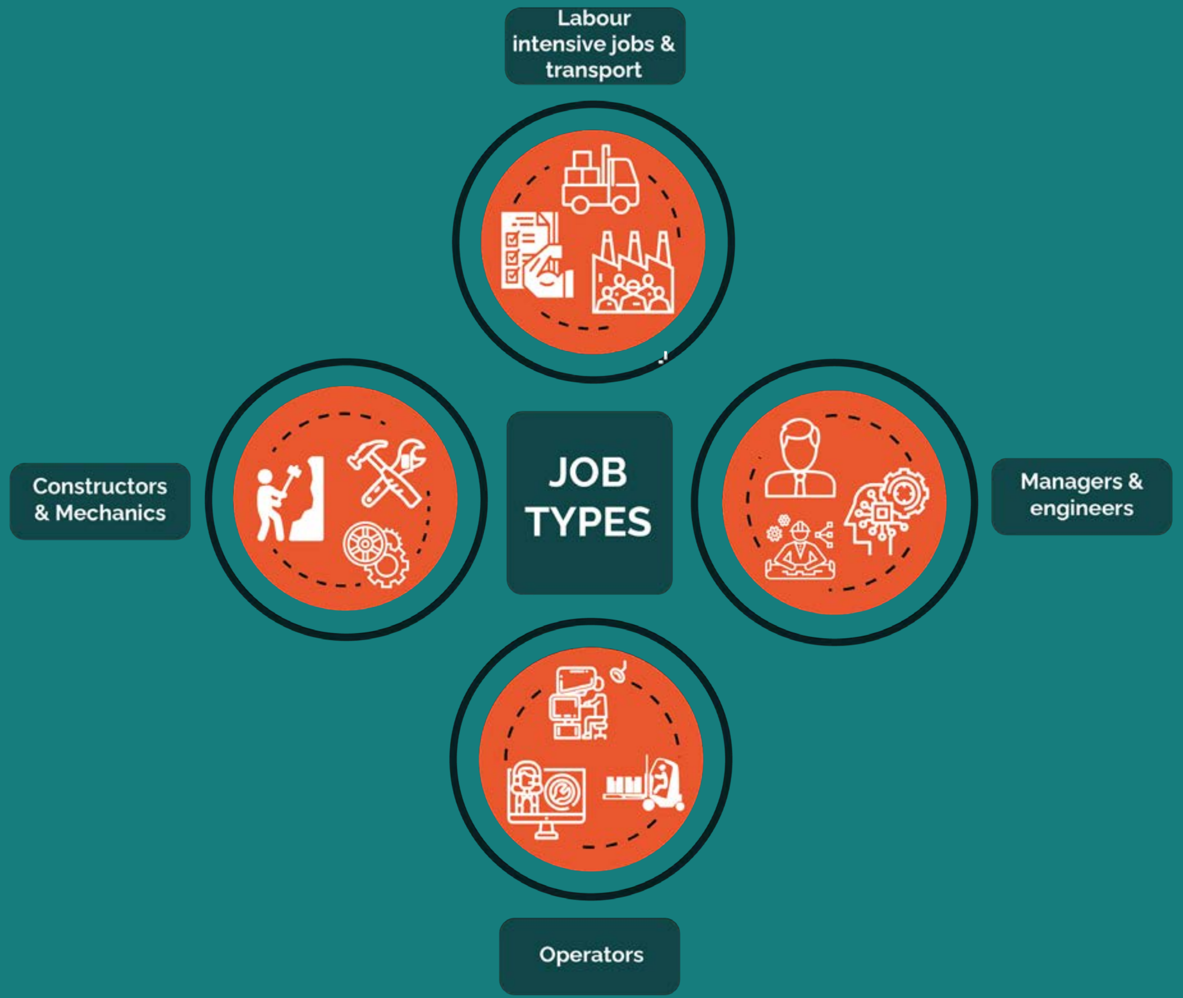


Figure 54

Figure 54: Diagram of job types arising from circularity and the energy transition

Facilitating employment

The circularity aspect of the energy transition offers opportunities for a sustainable economy with future-oriented jobs. However, this necessitates the labour market to have an integrated approach that brings together education and training institutions, companies, employees, and public authorities. The energy transition therefore requires investments in education and training, human capital, aiding people to transition from different jobs, and negating negative social consequences (SER, 2018). Figure 55 indicates spatial interventions as to how employment can be facilitated in vulnerable neighbourhoods that are most affected by the energy transition.

Figure 55

Figure 55: Diagram facilitating employment

Educational institutions and re(training) opportunities can be given to people in the vulnerable neighbourhoods to entice new employees into the renewable energy sector and provide flexibility to employees of the fossil fuel energy sector who are at risk of losing their jobs due to the energy transition. Furthermore, social guidance is available for those seeking a job or higher education level.

Working conditions are enhanced by providing easy accessibility to jobs in the port. Currently, the port is primarily car-dominated and inaccessible by other forms of transportation. New public transport lines and stops, as well as a stronger cycling and pedestrian infrastructure will be integrated into the current mobility infrastructure to ensure inclusivity in the labour market, especially towards larger industries in the port that provide the largest amount of employment opportunities.

An attractive living environment for employees can potentially make the prospect of working in and living in close proximity to the port more desirable. This aids the labour intensity required in new jobs in the renewable energy sector. Furthermore, an attractive living environment ensures the well-being of employees and the provision of a safe, healthy, and active environment.

In 2050, Zuid Holland will be transformed into a region completely relying on renewable energy, creating more **socio-economic justice** by creating **prosumers** of energy instead of just consumers.

Figure 56: Abstracted vision

4. VISION: FROM CONSUMER TO PROSUMER

4.1 VISION 2050

The vision for 2050 is to create socio-economic and spatial justice in South Holland. The proposed vision is centralised around the residents of currently vulnerable neighbourhoods: the prosumers. These prosumers of energy will not only consume energy, but they will also produce energy. In this way, the residents become more self-sufficient and energy-independent. These prosumers are localised in the vulnerable neighbourhoods which were analysed earlier. Within this selection, the most vulnerable are selected to function as pilot projects.

By tackling the energy transition in these neighbourhoods, we see the potential to improve the overall living quality of the neighbourhoods in terms of housing, public space, accessibility and amenities. Consequently, boosting the neighbourhoods spatially, but also socio-economically.

The large scale energy production, also called the mainframe, takes place across the province, at sea and in the port. Visible is that agriculture plays an important role in this energy production.

In the central hub, the port, the circular hub is positioned that deals with the manufacturing of renewable energy systems.

In the following pages, the envisioned system will be explained further.

Figure 57: Vision map 2050 for the province of South Holland

4.2 MAIN PRINCIPLE

The main principle of the proposed energy system is a mainframe and a local frame, with the port in the middle. The first fundamental principle is the global economic position of the port. To stay prominent on the global market, a circular manufacturing hub for renewable energy systems will be introduced and a shift is made toward a hydrogen and biofuel based economy. In this way, it can be ensured that the port will also remain important as an export hub for Germany and Belgium.

Thereupon, we distinguish two main flows: material flows and energy flows. The energy flows are related to the energy transition and the material flows are related to the circular economy.

The right side is the mainframe: a provincial renewable energy system. In this system, large scale installations are used to produce energy which is then used in the province. On the other side, we have the local frame, which is vested in the vulnerable neighbourhoods. The people in these neighbourhoods will become prosumers of energy, they will become empowered and able to generate their own energy. However, the large-scale infrastructure will still be necessary to store and distribute the energy generated by local energy communities, resulting in an open energy network, in which citizens can benefit financially from the extra energy produced.

By implementing this local frame, we see the potential to further improve the living quality and to include residents in the process. To facilitate this, a community hub is envisioned to bring the people together. A business hub is needed to realise these spatial interventions. It promotes local circularity, thereby enhancing the lifespan of products and enabling urban production. By doing this, the citizens do not only become prosumers of energy, but also of materials. Material flows from energy systems are connected to the port again, as it has a circular manufacturing hub for renewable energy systems. The business hub is facilitated with infrastructure that makes it attractive for local installation and construction companies to settle there.

With this system, a lot of new employment opportunities arise in the port as well as in the neighbourhoods themselves. These different systems will now be discussed in more detail to see how this principle contributes to the revitalisation of these neighbourhoods and the self-development of the society.

+ Figure 58: The main principle in the vision

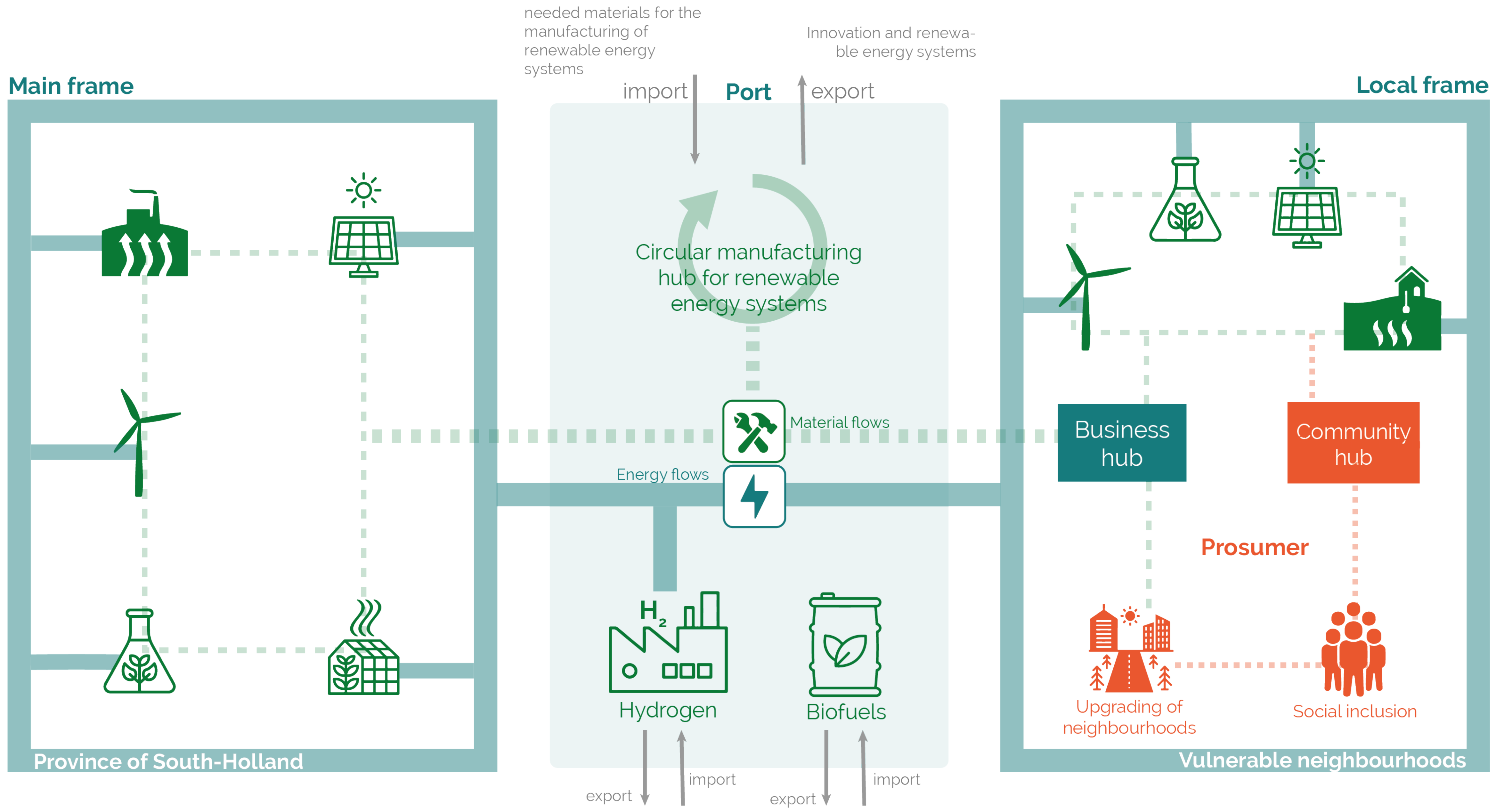


Figure 58

4.3 LOCAL FRAME

4.3.1 PROSUMER

Liveable and empowered neighbourhoods

Communities are empowered, through decentralized & co-owned energy production, higher local economic value and democratization of energy access. This is accompanied by upgrading the quality of space, housing and the accessibility of mobility & education. The results are liveable neighbourhoods, self-sufficient communities as circular societies, and increased spatial justice in South Holland.

The energy transition and the necessary decentralisation of energy production enable everyone to produce their own energy. The small renewable energy generation units are managed by small economic units where the users become prosumers and the generation units are connected to a local energy grid. By feeding surplus energy into the main grid, new sources of income and employment opportunities are created. The operation of local energy sources and an innovative character tackle energy poverty and attract businesses, leading to community prosperity. The local energy production enables the democratisation of energy access, promoting inequality reduction, community self-sufficiency and self-governance in the selected neighbourhoods in and later throughout South Holland. This cooperation and collaboration as an energy community promote various social values such as awareness, responsibility, emancipation and participation, which leads to identification with the community.

Figure 59:
Figure 60: Systemic section local frame

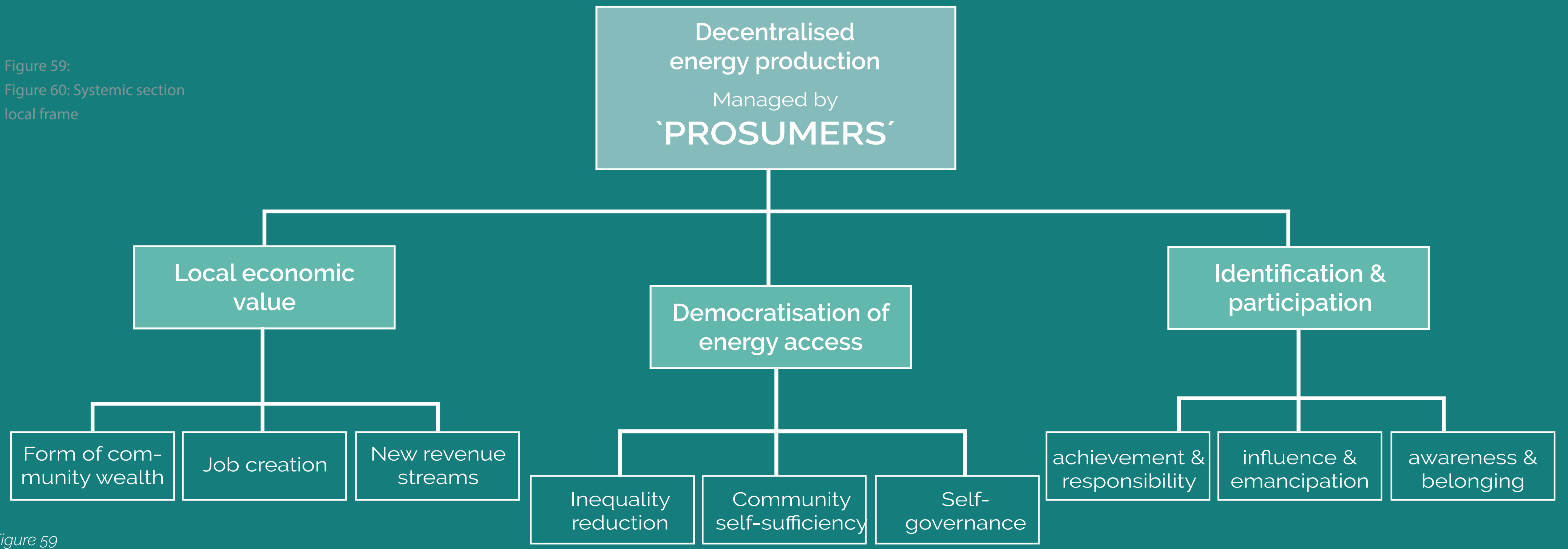


Figure 59

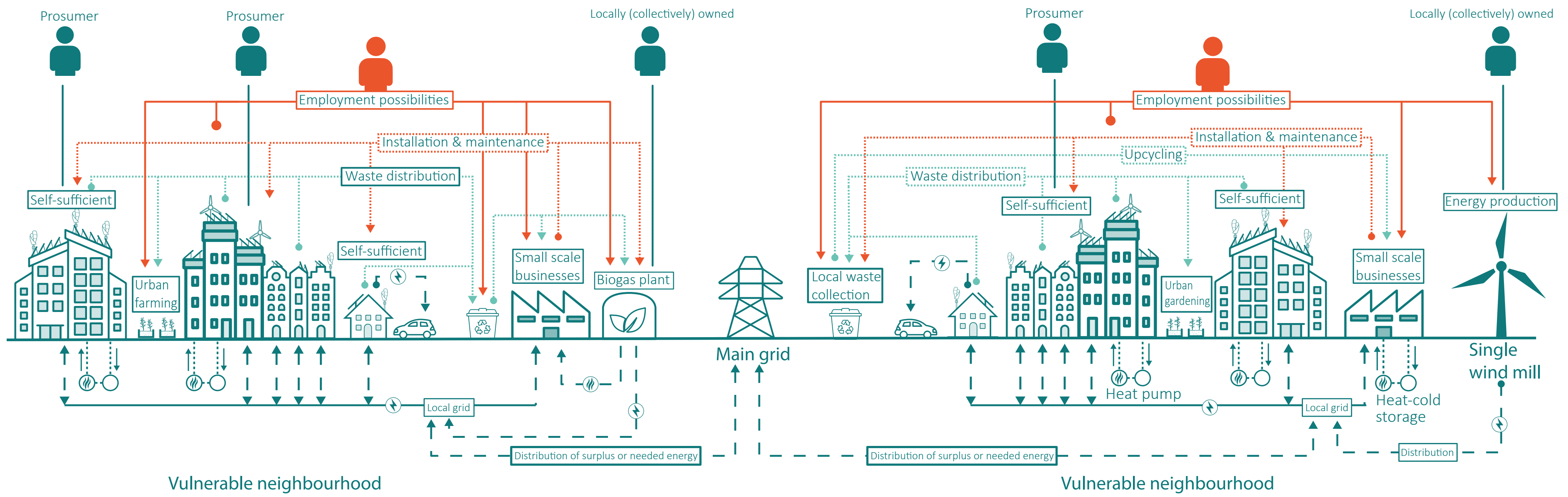


Figure 60

Prosumer communities

Through the cooperation of users, collaborations of property associations and cooperations of residents initiatives or housing corporations, more and more energy consumers will become energy producers.

By using the concept of prosumers, through interventions developed for, by and with the neighbourhood - resulting in active co-ownership of energy sources - neighbourhoods are empowered to shape the energy transition themselves. This allows them to develop from socially deprived neighbourhoods into self-sufficient and self-governance energy communities.

This is made possible through a step-by-step process, building a local movement and dividing the investments required for the transition into viable segments. Drawing on existing initiatives, residents and networks are made aware of their potential role within the mainframe and are placed at the centre of decision-making processes. Opportunities for forms of collective ownership will be established, leading to a true energy community, enhancing the local economy and enriching local socio-economic values.
The simultaneous transformation, modernization and upgrading of housing and public space leads to an innovative and attractive living and working environment in the originally disadvantaged neighborhoods.

+ Figure 61: Actors in prosumer communities
Figure 62: Abstract visualisation prosumer communities
Figure 63: Collage prosumers

Figure 61

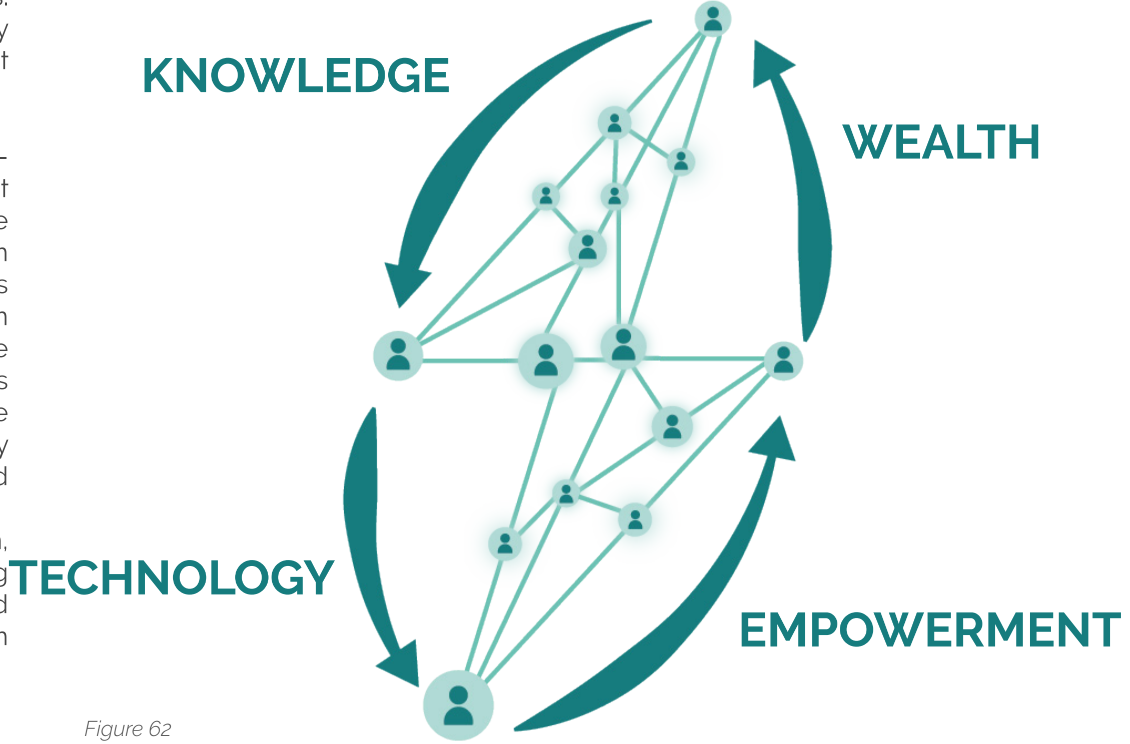


Figure 62

Figure 63

Vision

4.4 MAINFRAME

4.4.1 ENERGY TYPOLOGIES

The vision for the mainframe is to create different energy typologies. On the basis of the analysis of the energy potential, the main sources were defined. Nonetheless, we see that the potential is linked to the potential a site offers. Based on this, six main typologies have been identified. The first one is the prosumer neighbourhood, also known as the 'local frame', as described earlier.

The next ones are agri- and horticulture. Farmers are usually seen as massive consumers of energy, but we believe that these farmers can also become prosumers. For agriculture, a part of the land can either be dedicated to solar or vulnerable plants can be placed underneath solar panels, whereas in horticulture, solar panels can be placed on top of the roofs. Another potential is the placement of wind turbines on large agricultural or horticultural sites. Biomass can be collected to produce biogas and lastly, residual heat from greenhouses can be used to heat housing.

The sea and waterways are highly suitable for wind turbines and the production of blue hydrogen which can act as a step stool to a fully-green hydrogen industry. Lastly, roads and railways offer the possibility to install solar panels or wind turbines.

By combining these typologies we maximise the potential of the area to supply the province with renewable energy.

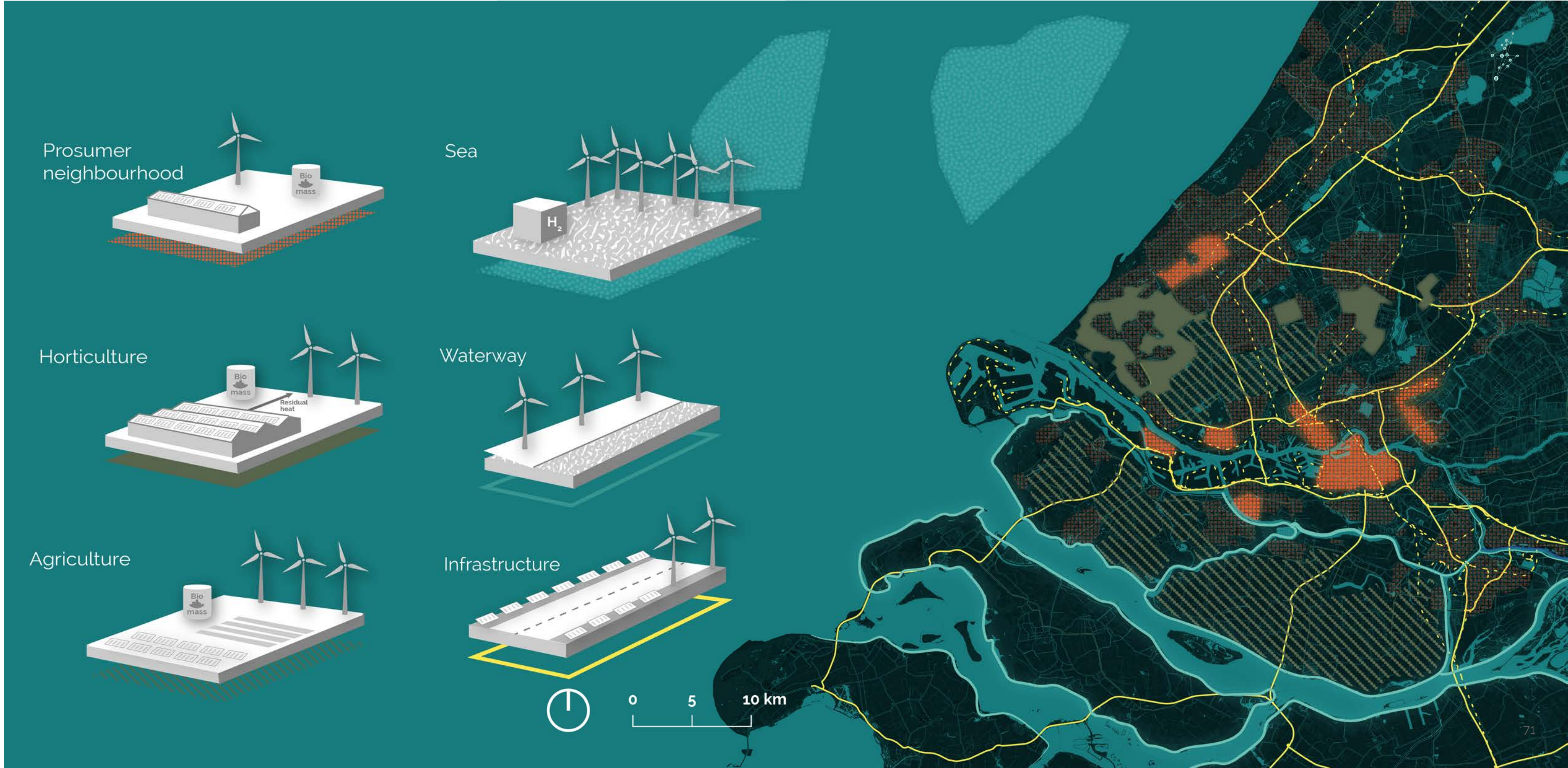


Figure 64: Energy typologies in the province of South Holland

4.4.2 JOB OPPORTUNITIES

This new decentralised energy system causes more flows throughout the province. New job opportunities arise in the operation of the new power plants. Therefore, employees have to be re-schooled in order to work in the new power plants.

As a consequence, in the operation itself, a shift in labour will be seen, however, in the construction of these sites, the labour intensity will increase, which we will go deeper into on the next page.

Systemic section solar energy

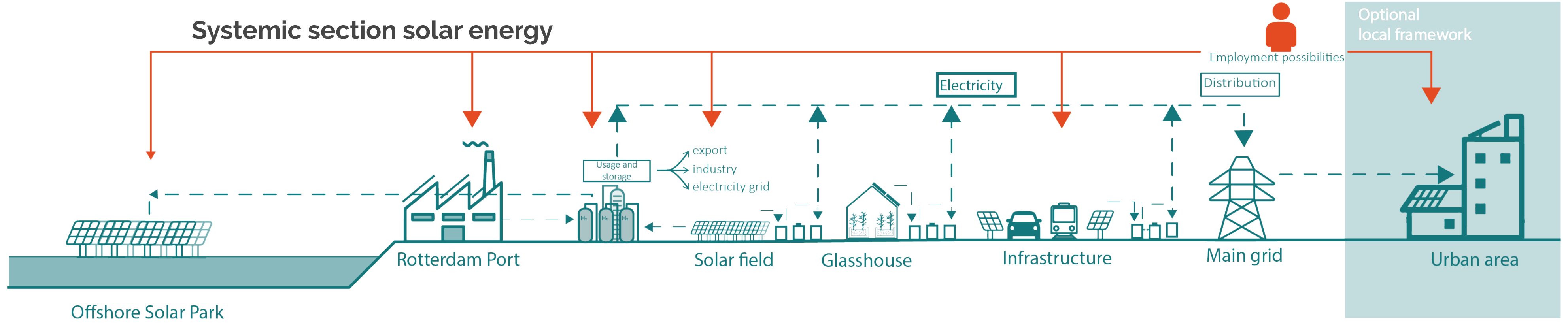


Figure 65

Systemic section biomass

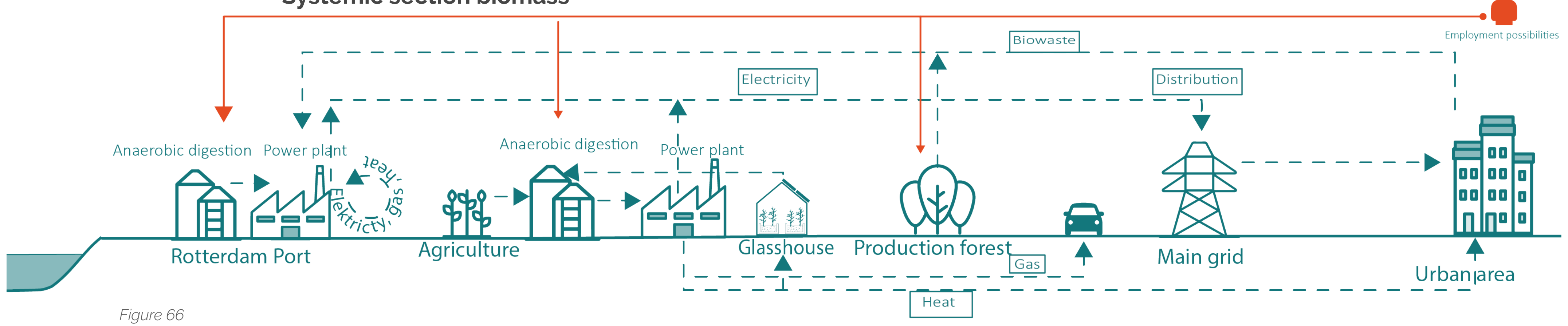


Figure 66

Systemic section wind energy

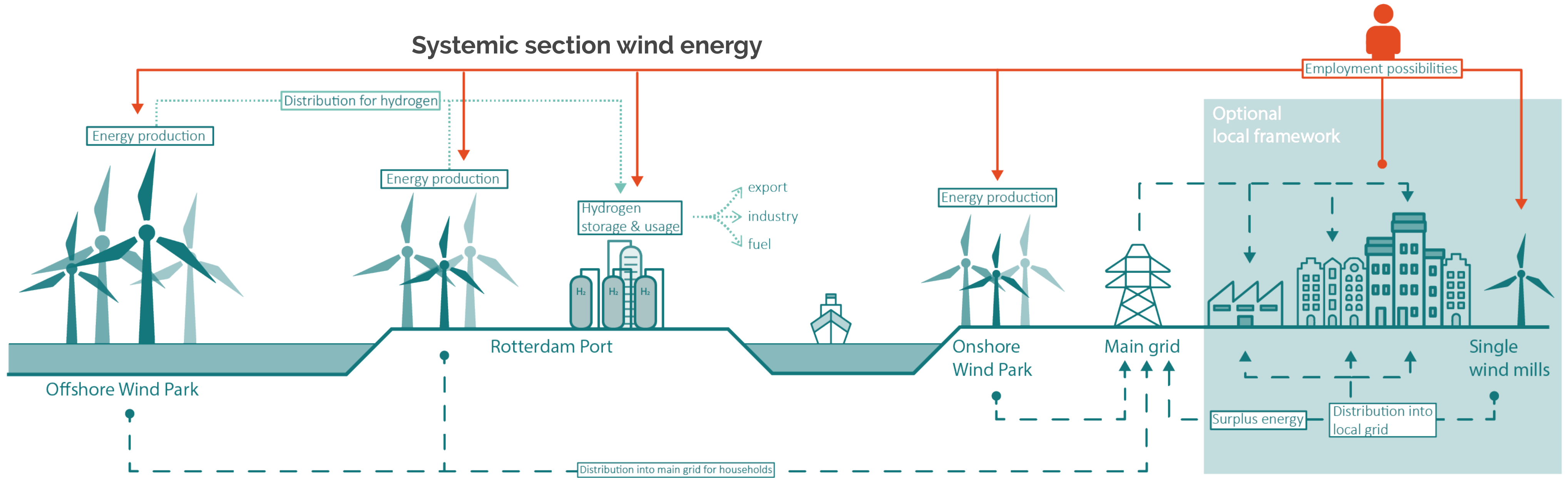


Figure 67

Systemic section geothermal

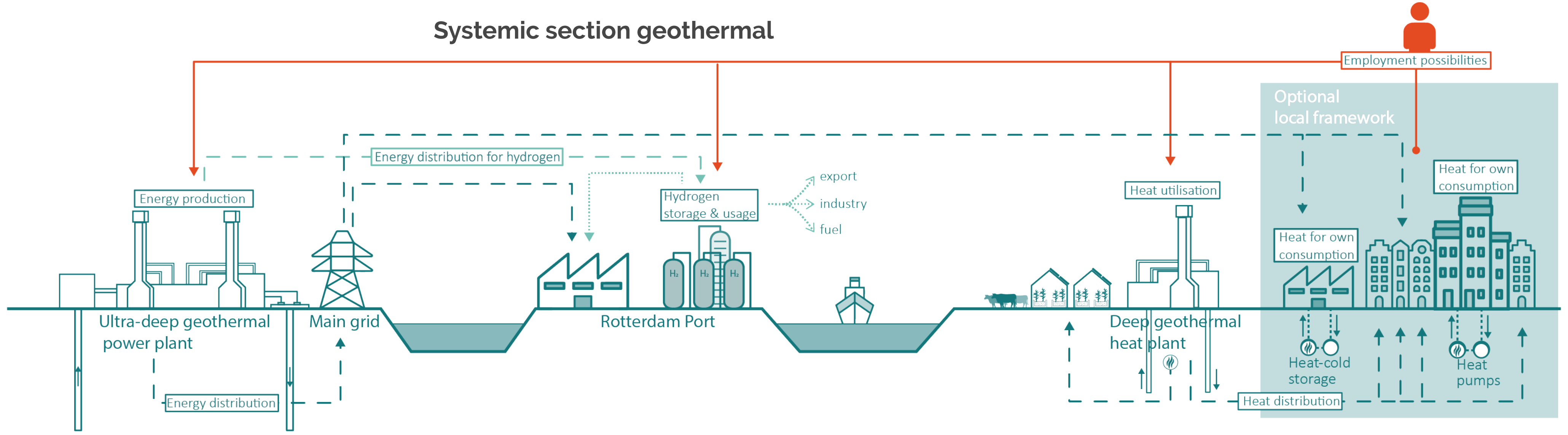


Figure 68

4.4.3 THE NEW PORT

+

Figure 69: The new zoning of the port

Figure 70: The circular flows of wind turbines

Figure 71: The circular flows of solar panels

The port hubs

As mentioned in the main principle, the future port of Rotterdam will have three main pillars: hydrogen, biofuel and the circular manufacturing of renewable energy systems. In this way, the port will not be dependent on one product or service which makes it more resilient to changes in the global economy or global crises. The new hubs are placed in the areas where oil refineries and terminals are positioned right now.

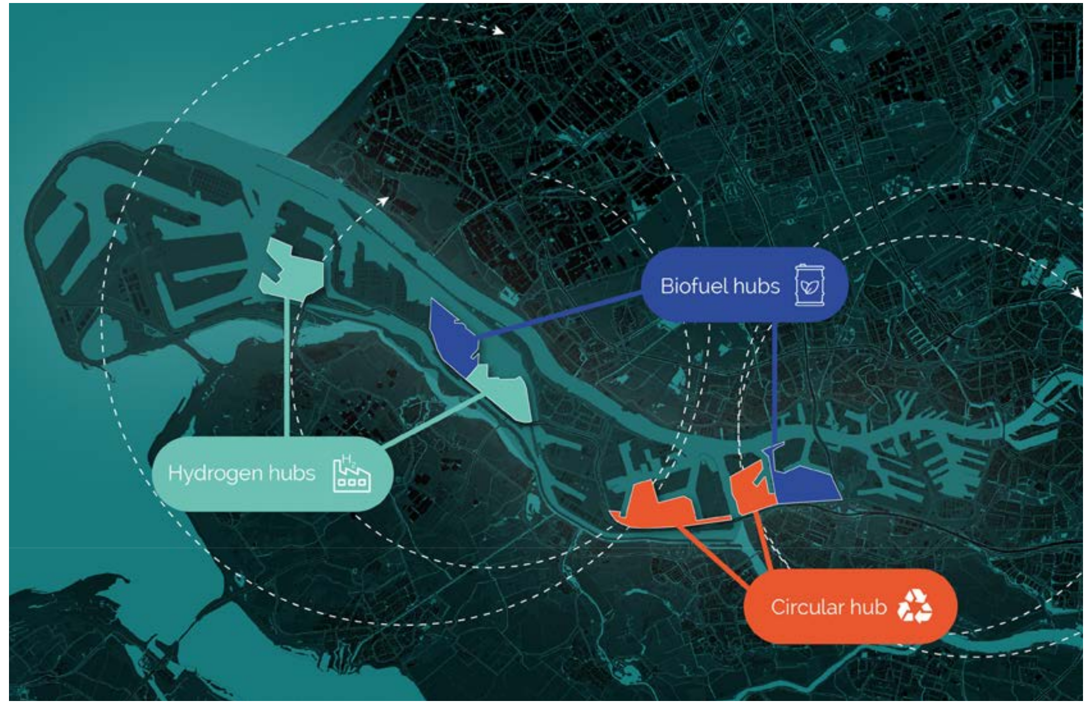


Figure 69

In this system, the hydrogen hubs are positioned relatively closer to the sea as this industry is strongly dependent on other countries. Hydrogen production is expected to be especially high in countries with high solar or wind potential, especially around the equator. This hydrogen is then transported to Rotterdam to be used there or to be transported in-land. For biofuel the same could be said, however, this industry is expected to be a little more labour intensive and as Shell is already working on biofuels, these sites have been chosen. Lastly, the circular hub is placed slightly closer to the city. This industry is expected to be labour intensive.

Circular flows

In the two sections, the circular flows of wind- and solar energy systems are shown. In the systemic section of wind, we can see that especially the (de-)construction and maintenance is labour intensive. The decentralised system ensures that instead of everything in one place, everything is spread over the province and the sea. Added to that, is the fact that the lifespan of turbines is relatively short and therefore more maintenance and also replacement is needed. In the solar energy system, we see something similar happening. The installation and maintenance are decentralised and therefore more labour-intensive.

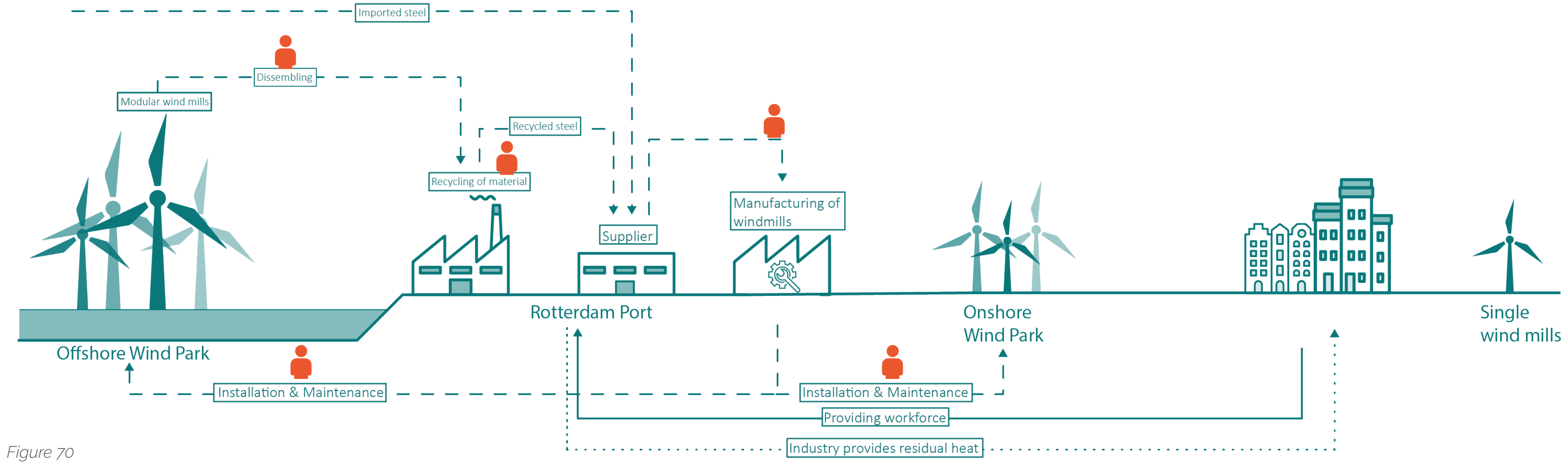


Figure 70

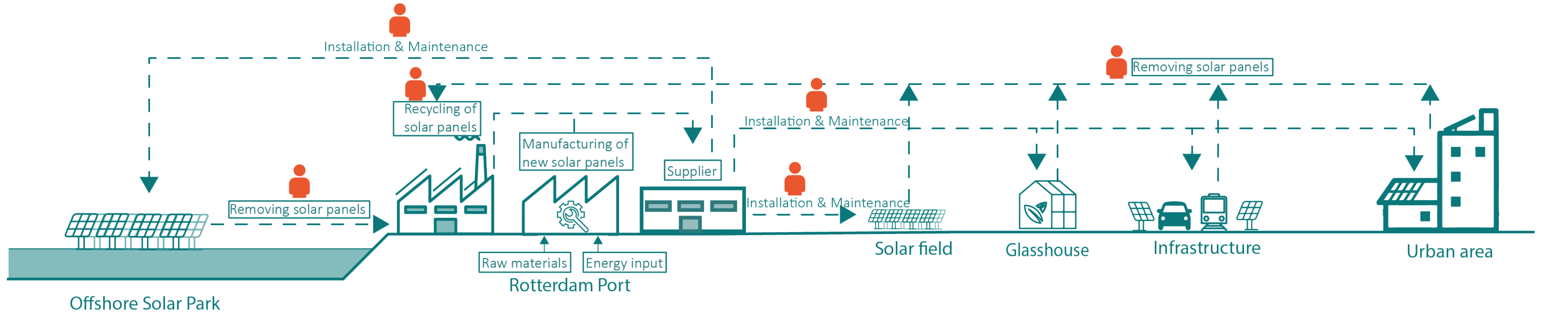


Figure 71

4.5 ENERGY FRAMEWORK

The mainframe, local frame, and the role of the port come together in the energy framework (figure 72). The energy framework consists of the mainframe wherein large-scale energy production occurs and the local frame wherein consumers are able to produce their own energy. Thus, households and farmers that were previously only consumers become prosumers capable of self-sufficiency in energy production. In the middle of the mainframe and local frame, the port functions as a centre for hydrogen storage of excess energy, as well as a circular hub for renewable energy infrastructure.

The mainframe energy production occurs in different typologies as previously described. As seen on figure 64, the electricity produced from these different typologies are transferred to large-scale geothermal and biomass power plants, as well as agricultural land capable of producing large amounts of biomass. The excess energy produced by the mainframe is stored in the hydrogen plant in the port. Furthermore, electricity in the mainframe grid can also be transferred to households using electricity towers.

From large-scale power plants and agricultural land, gas can also be converted into heat which can then be used in the hydrogen power plant.

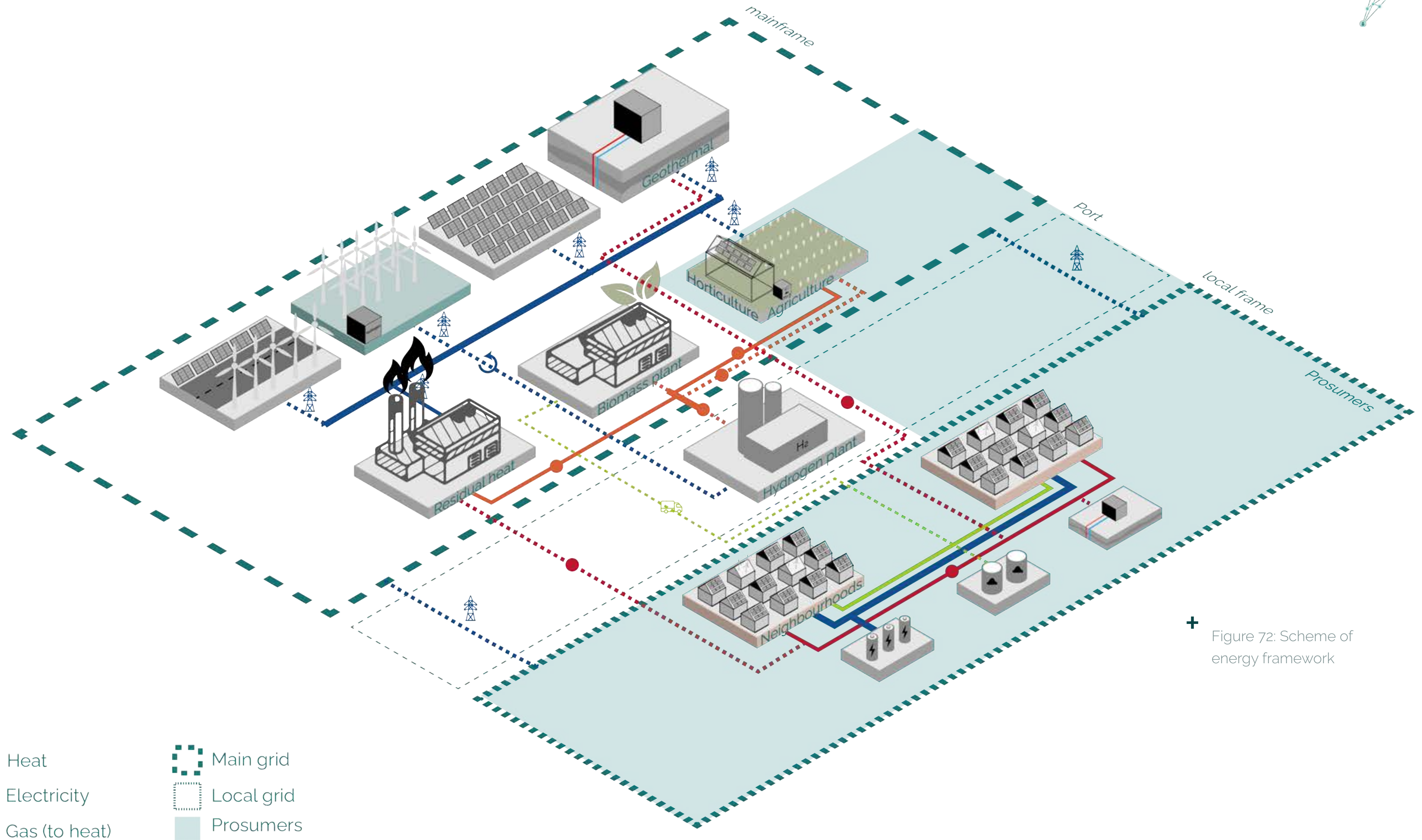
In contrast to the mainframe, the local frame consists entirely of small-scale energy production in neighbourhood households and farms mainly through solar panels and solitary windmills.

Within the local frame, households are able to produce electricity for themselves and also share with one another as a collective. Excess electricity can then be stored in batteries. Furthermore, biomass from household waste can be collected and stored in neighbourhood collection sites and then transferred into a biomass plant via trucks.

The local frame can also make use of small-scale geothermal heat pumps that can produce and transfer heat to households. Moreover, residual heat from industries in the mainframe can also be used and transferred using district heating pipelines to provide neighbourhoods with heat.

Small-scale energy producers such as households and solitary farms are all prosumers that can produce their own energy. In times of excess, energy can then be sold back to the mainframe grid. Producing sufficient and even excess energy is easier achieved as a collective of neighbourhoods and farmers, thus promoting a sharing economy in the energy framework.

The connection between the mainframe and local frame is vital in unprecedented times where households are unable to produce sufficient energy. Additionally, being able to sell excess energy back to the mainframe grid also creates a business and economic model for different households of vulnerable neighbourhoods. thereby incentivizing households to partake in the energy transition.



Heat
Electricity
Gas (to heat)
Biomass

Main grid
Local grid
Prosumers
District heating
Output
Input
In- and output

+ Figure 72: Scheme of energy framework

Figure 72

5. STRATEGY

5.1 GOALS AND PHASES

Goals

The overarching goals of the strategy from a sustainable perspective, is in terms of environmental sustainability to reduce pollution of the planet through Co2, but also through waste/ hazardous materials. This will be arcieved through a transition towards renewable energies and a circular use of materials.
In terms of economic sustainability, the goal is to enable revenue streams through the sale of renewable, especially surplus, energy. Aditionally, the creation of job opportunities through a strengthend renewable energy based economy, in terms of energy production, but also circular processes. Affordable energy prices are a result of the energy production of small energy entities, especially in low-income neighbourhoods.
From a social sustainable perspecive, the goal is to democratize the access to renewable enrgy and empower communities through the approach of energy prosumer entities.

Renewable energy & circular use of materials
ENVIRONMENTAL
Reduced pollution and exploitation of the environment

Renewable based economy & energy communities
ECONOMIC
Energy revenue, job opportunities & affordable energy prices

Prosumer communities
SOCIAL
Democratic access to renewable energy & community empowerment

Figure 73

+ Figure 73: Environmental, economic and social goals
Figure 74: General timeline

Phasing of the frames

In the mainframe, wind, solar and geo-thermal projects are established. These elements are planned project-based. At first instance, a plan is drawn up to indicate where these projects are planned and then project by project they are realised to divide the heavy workload over time and to prevent peaks. Geothermal is still under development and is, therefore, planned at a later phase.

In the port two things happen: coal, gas and oil are phased out and hydrogen, bio-fuels and the circular hub are introduced. This again happens step-by-step to make sure that there are alternatives for the sources that are phased out. In the end, the goal is to completely phase out fossil fuels. However, for 2050 this might still be a bit too ambitious, but with this phasing, we do put some pressure on it.

For the local frame, some general phases are mentioned that are important in the process. However, this phasing is much more complex than depicted here and therefore later, a more detailed phasing will be presented.

Between the separate parts, there are two important dependencies: the new energy installations are dependent on alterations of the infrastructure and without the new energy infrastructure, fossil fuels cannot be phased out.

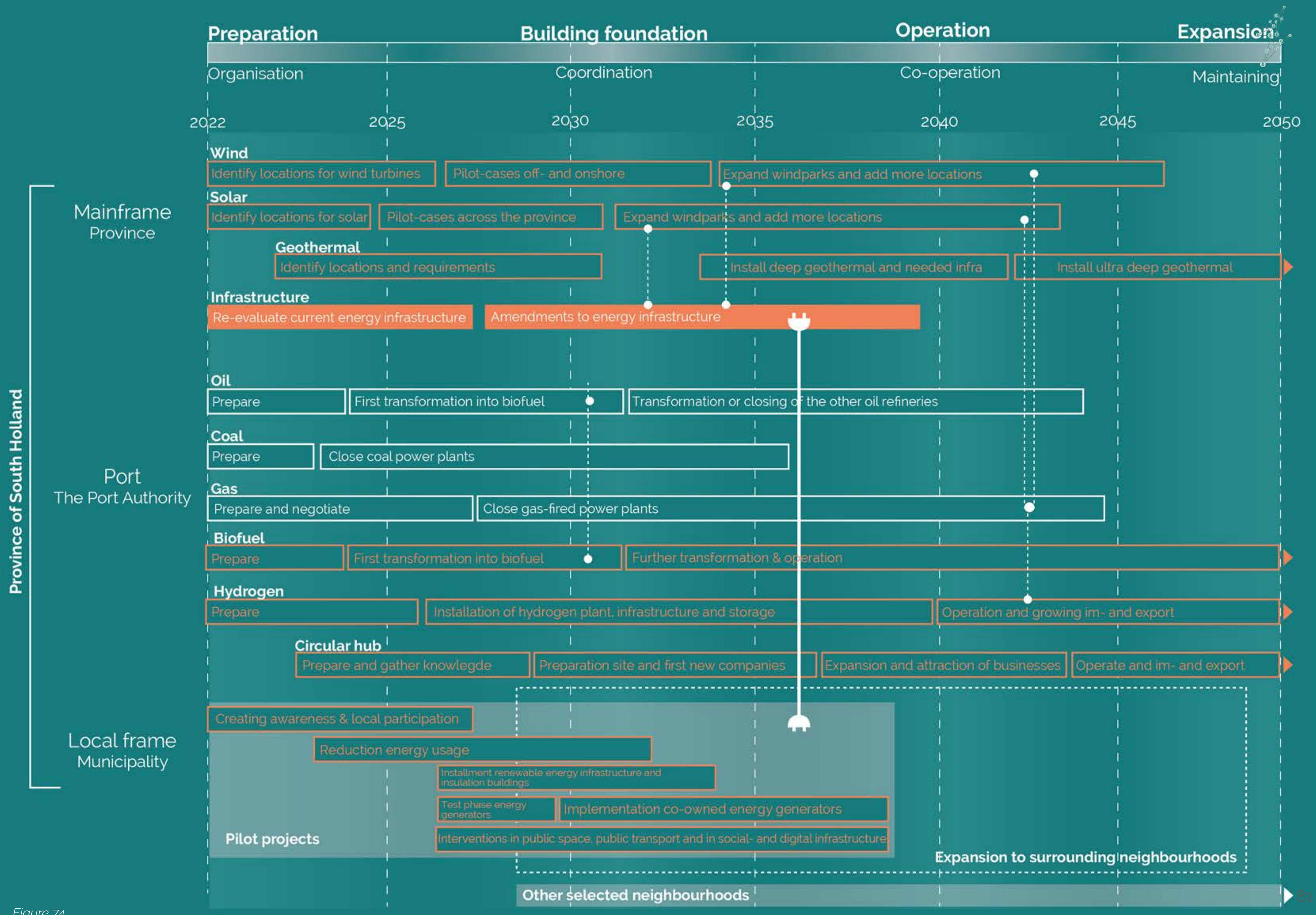


Figure 74

5.2 A STRATEGY FOR THE FUTURE PORT

5.2.1 ECONOMIC DIVERSIFICATION

Diversification port

The three main pillars of the port are introduced to diversify the port. In the scheme below three scenarios are shown that could take place. In the first case, the circular manufacturing of renewable energy systems becomes the prominent market in the port. In the second scenario, hydrogen becomes the most dominant industry and in the third biofuels. The expectation is that the third scenario is unlikely to happen as oil can be replaced by hydrogen in several different ways and it is, therefore, more likely that the hydrogen industry will dominate. However, the other two are both possible, but can also act along with each other, as the two industries do not influence each other negatively.

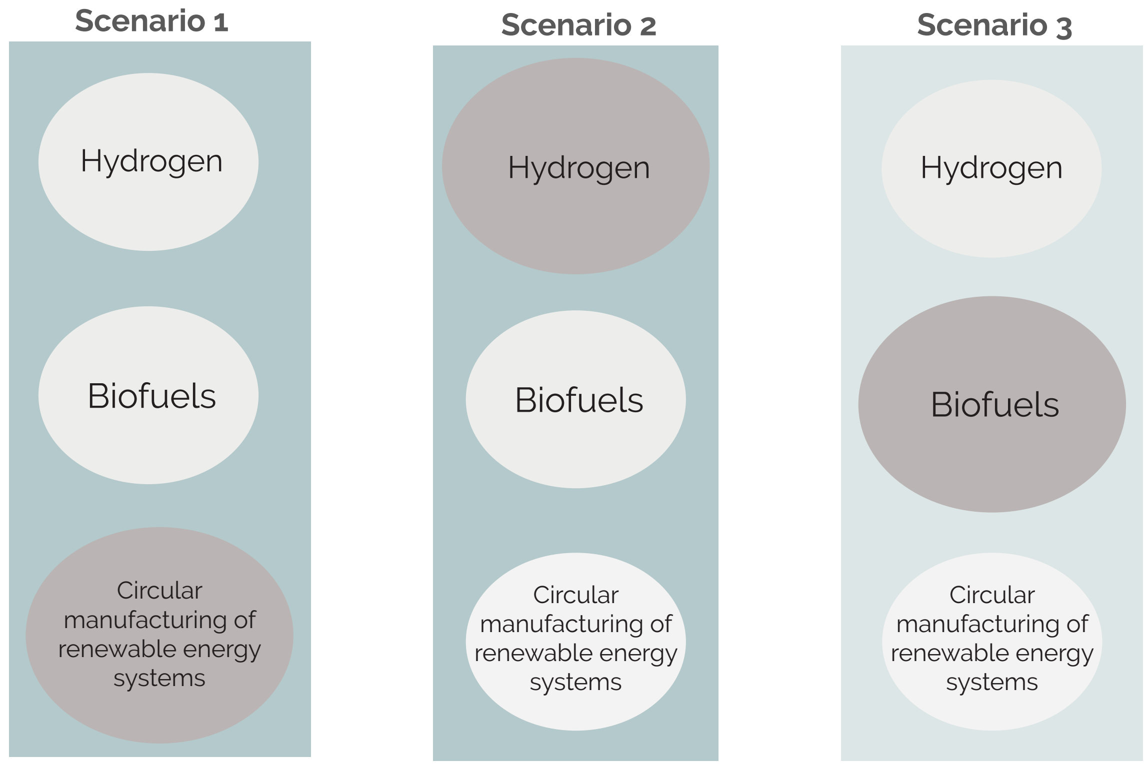


Figure 75

\+ Figure 75: Different scenarios of development of the port
Figure 76: Circular hub as key project

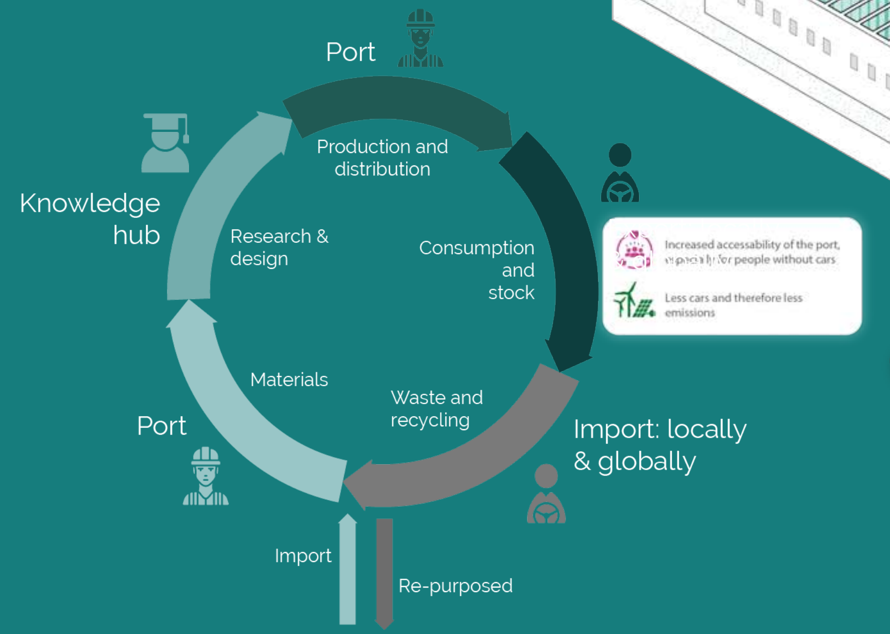
5.2.2 CIRCULAR HUB

Circular renewable energy hub

The main focus in the strategy is, however, on the circular hub since it is essential for the circular aspect of our vision. In the literature by EEA (2021), the circular clean-energy system was shown, which is applied here spatially. The ideal place for a hub like this is in the port. As large objects have to be transported over longer distances. In the beginning, raw materials need to be imported to create these circular systems, later there will be more returns flows from used materials, instead of new materials.

The knowledge hub is needed to fuel the research and design of the new circular systems, as the current solar panels and wind turbines are difficult to re-use or recycle. The production takes place in this hub itself. From here on, it is either stored or transported back over the sea or over land to be installed in the planned area. After that, maintenance and eventually the deconstruction of these products becomes important and the products end up in the port hub again.

Access to the sea, the regions technological expertise and the harbours already existing invovement in renewable energy and circular industries offers the port the potential to become a global exporter of renewable energys and innovation of their circular use, once the right infrastructure and technology are in place. As mentioned before, especially jobs within the transport, installment and production of these products will be created, offering new job opportunities for people living in the nearby neighbourhoods. The innovation hub offers possibilities for higher educated engineers to participate actively in the renewable energy industry. Accessibility is therefore important, which means that the improvement of public transport is an essential intervention.



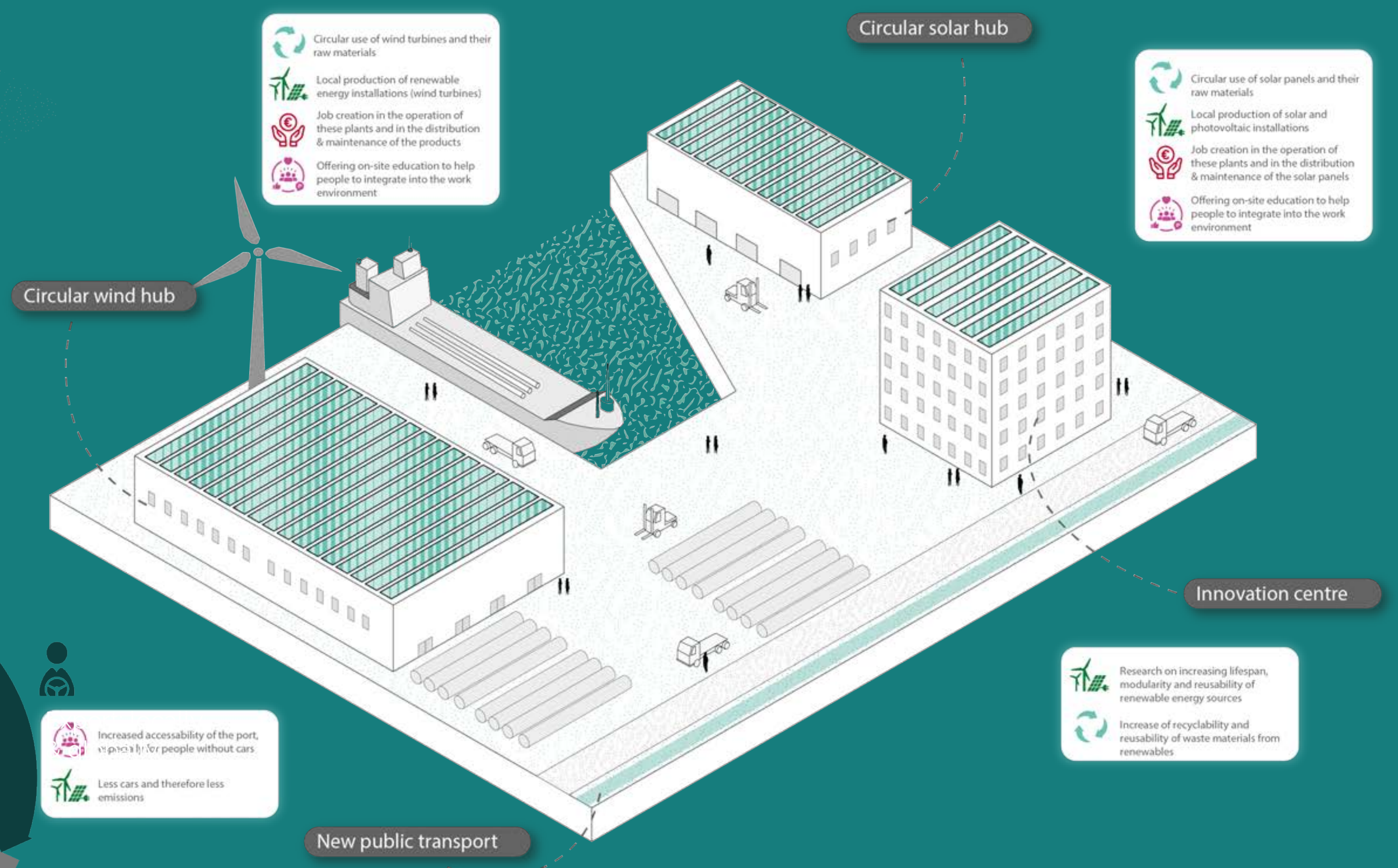


Figure 76

5.3 CONSUMER TO PROSUMER

5.3.1 ENERGY PROSUMER COMMUNITIES

A stratgey to upgrade and empower neighbourhoods

The development of energy prosumer communities is a strategy for the energy transtion, but also to upgrade and to empower the selected neighbourhoods.

After or within the process of taking spatial actions, later further explained in key projects, this strategy aims for a step-for-step development of neighbourhoods to become more self-organized, self-sufficient and self-develop. Outside actors provide tools in form of technology, capacity and knowledge, to get the ball rolling on their self-development, and to promote the residents as main coordinators of their own neighbourhood and scietal development.

For the establishment of energy communities, a democratisation of energy access and a financial viability is necessary. Both is ensured with the means of energy co-ownership models.

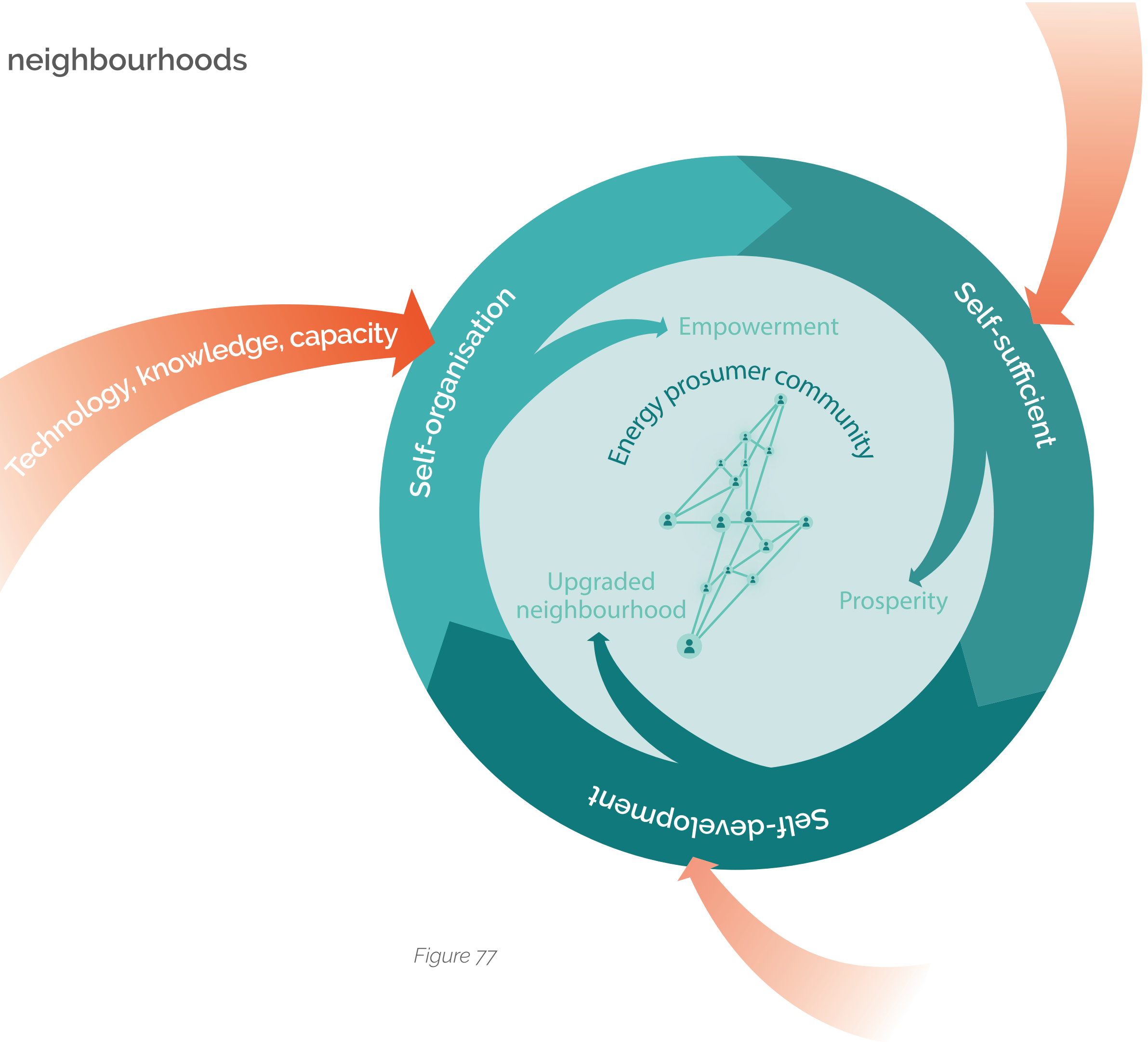


Figure 77

+ Figure 77: Strategy energy prosumer community

5.3.2 ENERGY CO-OWNERSHIP

A tool to upgrade and empower neighbourhoods

Co-ownership models are a tool to enable communities to take part in the energy transition. Local ownership of energy projects is combined with financial support schemes, that enable investments needed for this transition to be broken down into tangible, low-risk segments.

This type of structure creates a double benefit, as it enables local engagement and acceptance of projects, as well as lower energy bills for all participating consumers. By that, the community-ownership projects are focused on generating benefits to the community (economic, social, environmental) in addition to financial profits (IRENA 2020).

Every neighbourhood is built up in another way, be it the built environment, influenced by density, history and location, or the social fabric, influenced by income, demographics and migration background. Each neighbourhood has a different potential for renewable energy production. Therefore, each neighbourhood needs a customised concept for the community energy project, which also means an individual or adapted ownership concept. Of course, the purpose of a community-ownership project also influences its implementation, as different models are more suitable for different objectives (IRENA 2020). Key criteria are the level of democratic governance, local distribution of profits, the purpose of the organisation and the ownership structure (IRENA 2020).

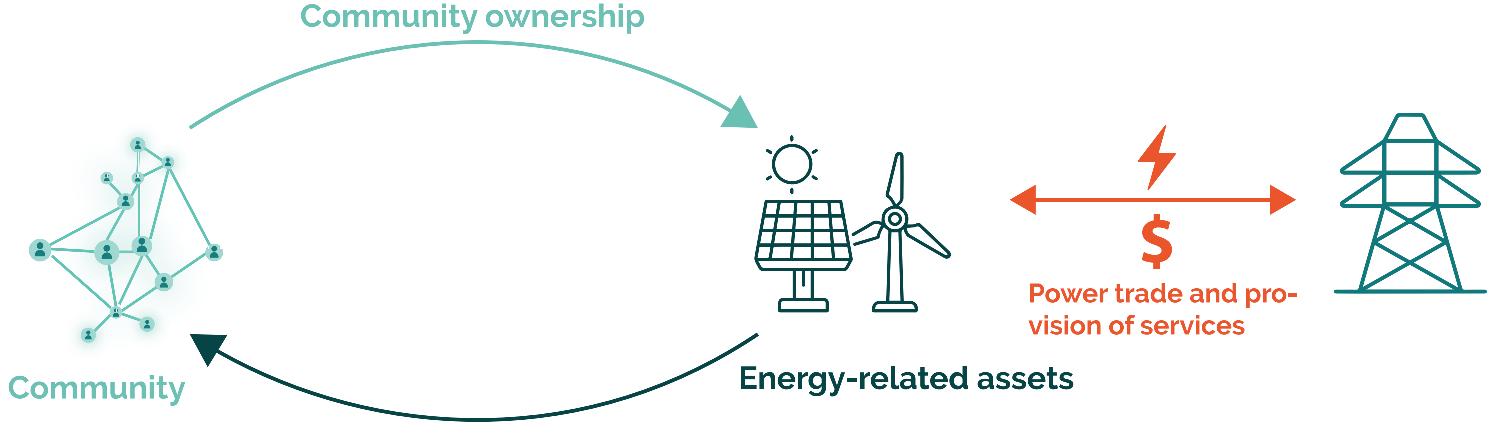


Figure 78

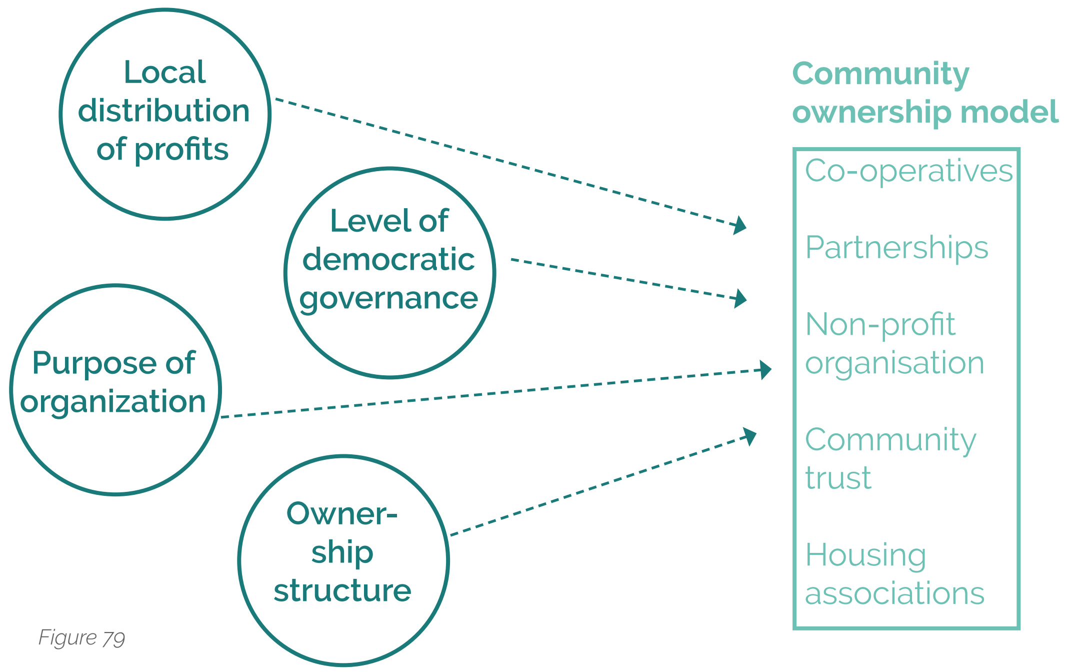


Figure 79

+ Figure 78: System of community co-ownership (adapted from IRENA 2020)

Figure 79: Key criteria for ownership selection (adapted from IRENA 2020)

Accessability for vulnerable neighbourhoods and low-income households

Facilitating the ability of vulnerable consumers to acquire ownership of renewable energy is a key element in enabling them to make the transition. However, there are barriers in terms of financing, knowledge and capacity. The implementation of the appropriate ownership model also depends on the financial capabilities of the participants. However, as described above, community and capacity building is also essential for the implementation of community energy projects and the selection of the right tools (Lowitzsch & Hanke 2019).

Based on research from case studies, financing and organisational models were discussed that eliminate or overcome financial, capacity and knowledge barriers. As well as reflect our objectives of collective citizen ownership, local distribution of profits, an open, cooperative and participatory shaped governance approach and the purpose to empower the neighbourhood for self-development.

It has been shown that a co-ownership hybrid model of community trust and cooperative model can be useful for a low-income neighbourhood.

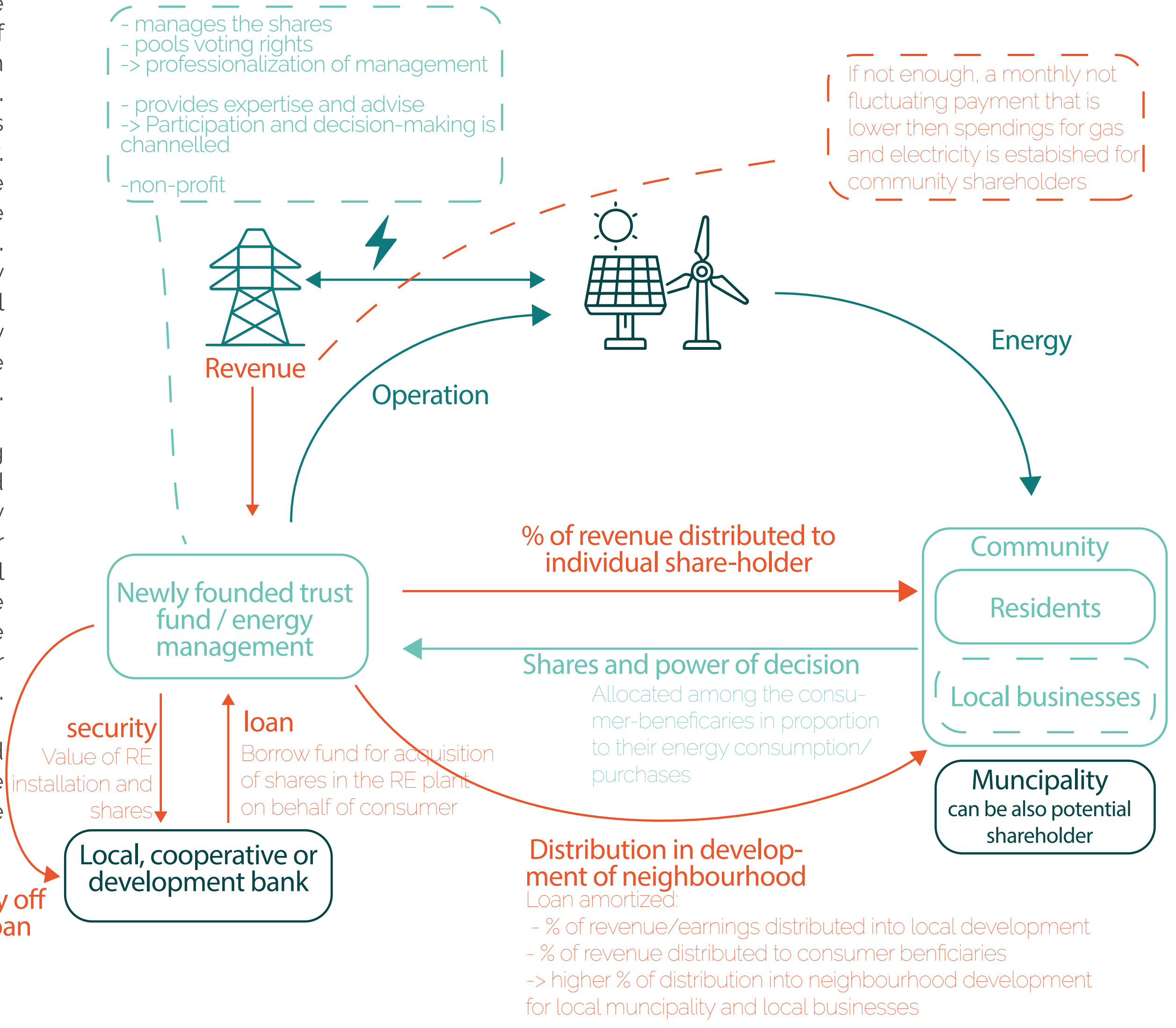


Figure 80

Figure 80: Organizing and financing concept energy community project

Foundation for policy framework

Different organisational and administrative models for capacity building and financing go hand in hand with innovative policy shaping and joint decision-making processes. A policy framework that provides (vulnerable) communities and low-income households with the opportunity for community energy projects is based on the pillars listed here (IRENA 2020).

This is complemented by a range of technological and environmental infrastructure interventions, which are described in more detail in the key projects.

Enabling long-term and stable policy frameworks for energy communities

Financial incentives are key to stimulating further investment

Clear regulatory frameworks for community-ownership projects' participation in power markets

Regulatory provisions need to be developed for community owned projects to enable energy supply arrangements

Simplification of administrative processes

Processes for obtaining permissions is streamlined for community-owned projects to bring down capacity, knowledge and cost barriers as well as development time.

Access to finance for community ownership projects

Providing symplified business model for better access with immediate benefits

Facilitate consumer ownership for low- income by low equity contribution with low risk

Capacity building and technical assistance within the community

Success of community-ownership projects depends on access to information and technical expertise

Creating awareness and motivation for participation in co-ownership (Low income households)

Figure 81

Figure 81: Policy framwork pillars for community owned energy projects (based on: IRENA 2020 and Lowitzsch & Hanke 2019)

5.3.3 TIMELINE LOCAL FRAME

Encouragement

In the encouragement phase, residents are informed about their role and the benefits of the energy transition. Local energy coordinators and responsible actors are also appointed. The province and municipality act as the main coordinator with technical support from the RES Region who frame an accessible transformation to a prosumer society with an adapted regulatory, subsidised and policy framework. Through an open local participation, the foundation is laid for the second phase of empowerment.

Empowerment

Empowering means providing citizen tools, an co-owned energy fostering framework, and space to implement self-organizing structures. Cooperations and neighbourhood networks based on existing initiatives are established in this phase. After evaluating renewable energy potentials and communication with energy system distributors, customized ownership and business models are created. The first co-owned energy project is then established. The municipality will have diminishing involvement while the main coordinators are the energy management and the residents.

Prosumption

The prosumption phase means having established prosumer communities, that are mainly energy self-sufficient and enabled to self-govern and self-realise projects with an established local circular approach. This means not only prosumtion in terms of energy, but also in terms of goods and services. The main coordinator are the empowered citizen.

+

Figure 82: Timeline local frame

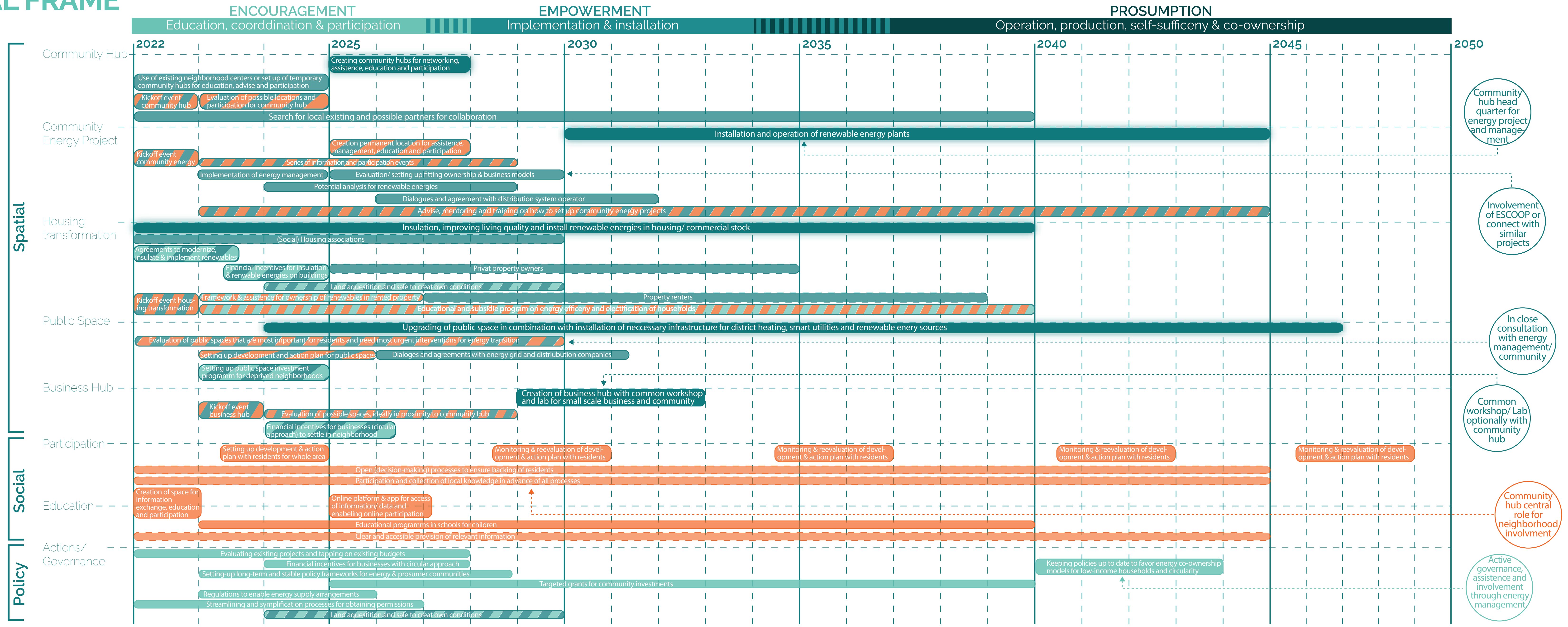


Figure 82

5.3.4 PRINCIPLES AND KEY PROJECTS

Principles

To upgrade vulnerable neighborhoods, encourage participation in energy transition and establish prosumer communities, a set of key projects, which are essential for the strategy, are developed.
This set of spatial interventions, promotes different principles that function as measurement to what extend the actions and interventions contribute to the vision. The principles are further explained here.

+ Figure 83: Principles

Social inclusion

Social inclusion is a broad topic and an essential element in creating socio-economic and spatial justice. We see social inclusion as the involvement of all different groups in the transition. This means that they participate in the eventual system (main- and local frame), but also that they are educated and informed on the transition, stimulated to participate in the decision-making process and financially supported in terms of subsidies, loans and shared ownership. They become participants instead of bystanders.

Sense of community

The sense of community is an essential element in succeeding in this transition. The approach is based on the concept of collectiveness and being part of something bigger. The idea is not only to create this sense of community through the transition but also to facilitate the sense of community before and during the process. In this way, the support base for the transition is strengthened and the chance of success increases.

Local economic value

The local economic value is essential in describing the socio-economic improvement due to the transition. The value is used to describe the financial incentives, loans or funds needed to employ this transition, but also to show the new employment opportunities and the possibility for small businesses to settle. By investing in these neighbourhoods, the spatial quality of the areas does not only improve but also other economic opportunities arise to ensure that the neighbourhood becomes more economically stable on its own.

Living quality

The improvement of living quality, especially in vulnerable neighbourhoods, is an important task on the agenda of the vision. However, this problem is usually seen as an isolated issue. In this process, the living quality becomes part of the energy transition and the strategy. By improving the living quality, the overall quality of life for these groups improve.

Energy production

The local energy production helps residents to become more independent, especially financially. Besides that, they get the opportunity to be part of something bigger and to contribute to the energy transition. While implementing these systems in housing, other problems like insulation issues should be solved, too. Another advantage is the creation of a new market and therefore new jobs that open up due to this decentralised system.

Circularity

A circular economy ensures that fewer raw materials are used, less waste is produced and a circular value chain is created. The approach encourages people to repair, reuse and recycle products instead of throwing them away. This creates new business possibilities, but also enables the transformation of citizen into prosumer in terms of repair instead of rebuy, which is economically beneficial. Since circularity is a labour intensive procedure it is beneficial in creating new job opportunities, too

Figure 83

Planning instruments

These projects bundle a set of main interventions. In order to archieve these, a number of instruments are applied, mainly by the public sector as initial main coordinator in cooperation with other actors.
Within these soft-hard steering as well as distance-consultation steering instruments, a number of tools have been presented in connection with different actors that contribute to implement these key projects and eventually empower citizens to become the main actors/ coordinators.
In order to ensure participation and an attractive living and working conditions for the implementation of these projects, design guidelines for a call for proposals for these projects were established.

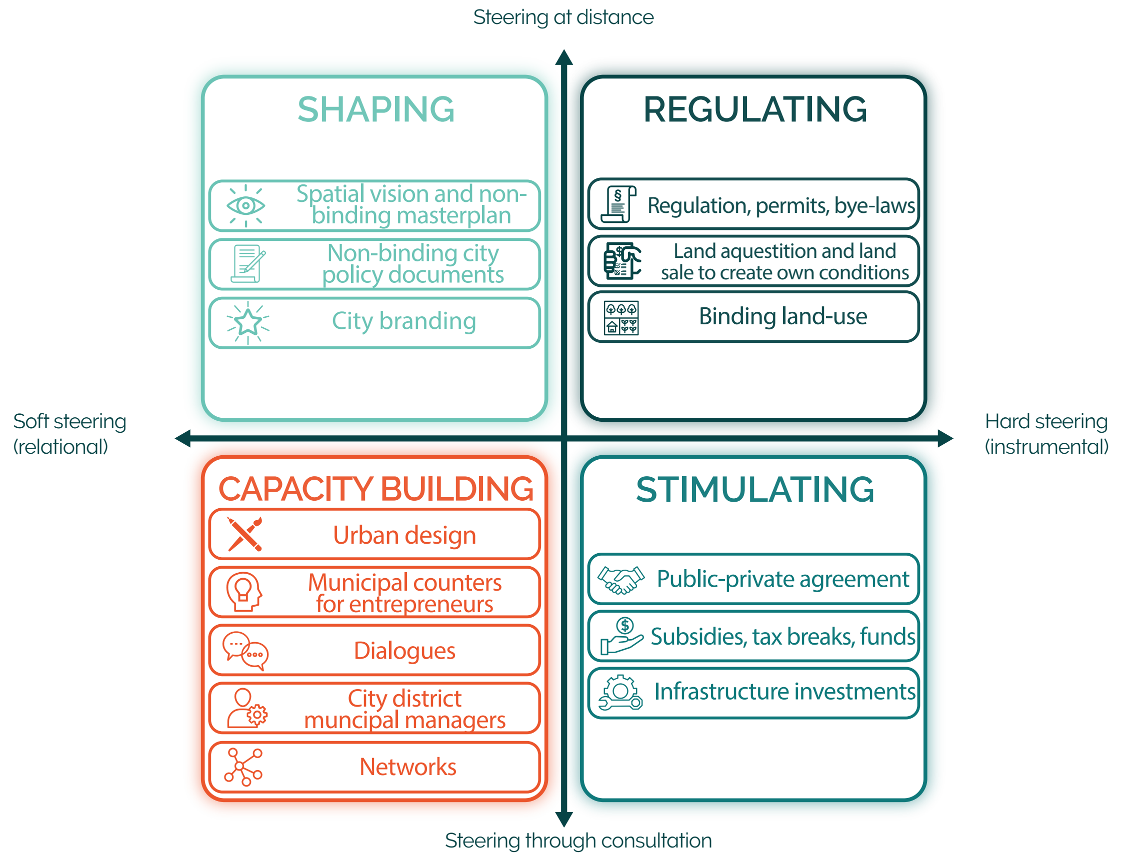
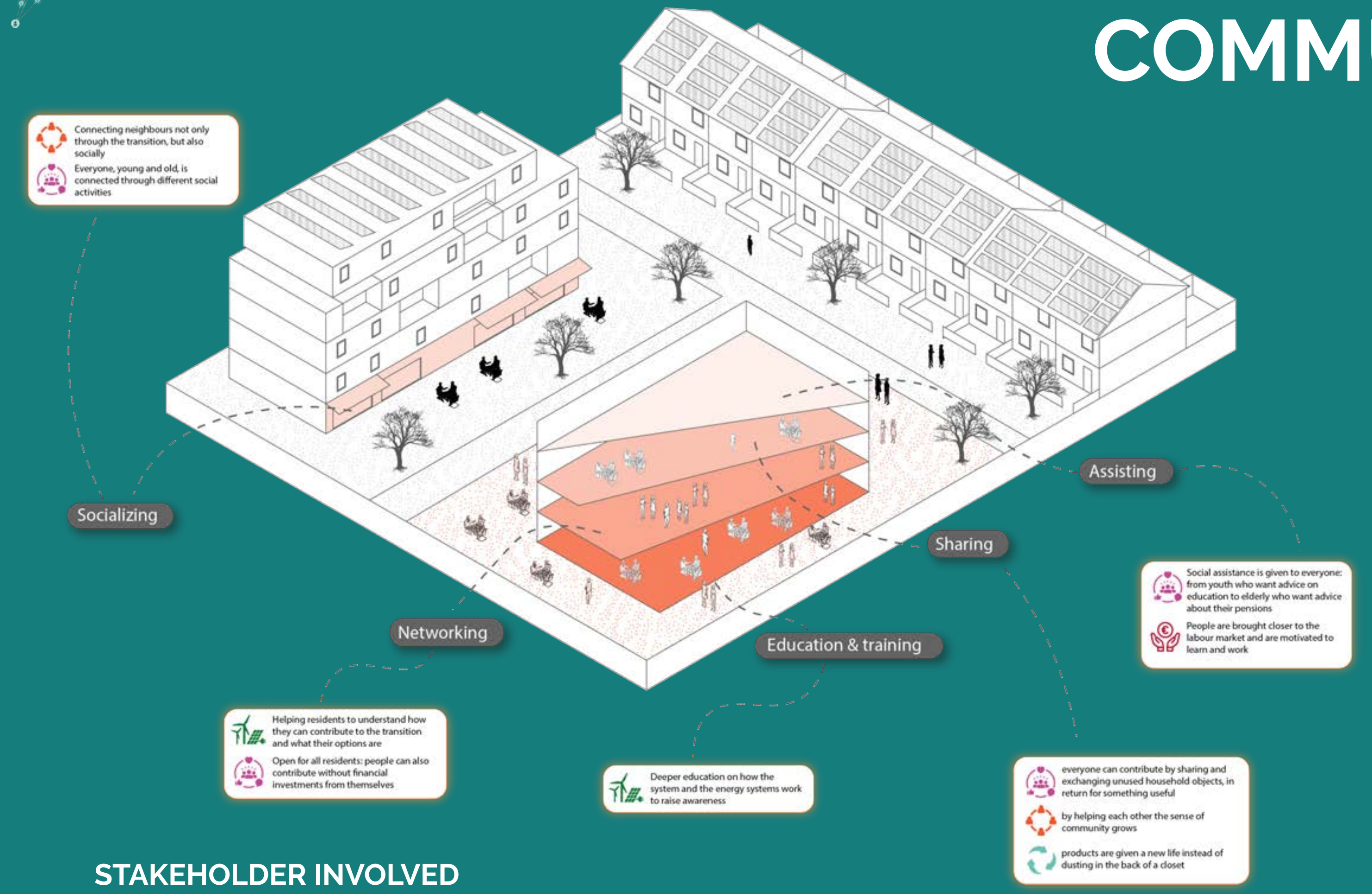


Figure 84

+ Figure 84: Planning instruments

COMMUNITY HUB



Role of Community hub

The Community hub plays a key role in enabling the community to participate actively in the energy transition and become prosumers. It is headquarter of a communal energy involvement and operation and a tool to make the implementation accessible.

To build up a local movement at the beginning of the process, the community hub functions as a central meeting point and provides frequent events for the neighbourhood to collect local knowledge and boost community involvement as well as provide knowledge about their role and their benefits in the energy transition. To empower the residents of the neighbourhood the community hub offers expertise, advice, mentoring and assistance on administrative, financial as also technological questions of renewable energies and co-ownership. The hub functions as a platform that enables open networks with local and regional (main grid) market actors, public actors and the community through frequent events and an active administration. It connects the neighbourhood to existing initiatives and neighbourhoods involved in energy prosumption. Finally, the community hub hosts and channels administrative, management and participational processes when the community-owned energy projects are operating. The main coordinators of these various fields of activity are an energy & neighbourhood management, supported through the RES Region and RESCOOP, initiated by the municipality of Rotterdam. Within time the community hub's purpose is to function as a hub for self-governing processes.

STAKEHOLDER INVOLVED

Private Sector

1. Energy management (also public sector)
   - Advising, financing and managing renewable energy projects
2. RESCOOP (also civil society)
3. Renewable energy companies (small+middle)
4. Local businesses
5. Citizen of neighbourhood

Public Sector

1. European Union
2. Dutch national government
3. Province of Zuid-Holland
4. RES-Regions
5. Muncipality
6. Port of Rotterdam

Civil Society

1. Interests organisation
2. Education facilites
3. Cultural Institutions
3. Energy management (also public sector)
   - Advising, financing and managing renewable energy projects
4. Local social/ neighbourhood organisations
6. RESCOOP (also privat sector)

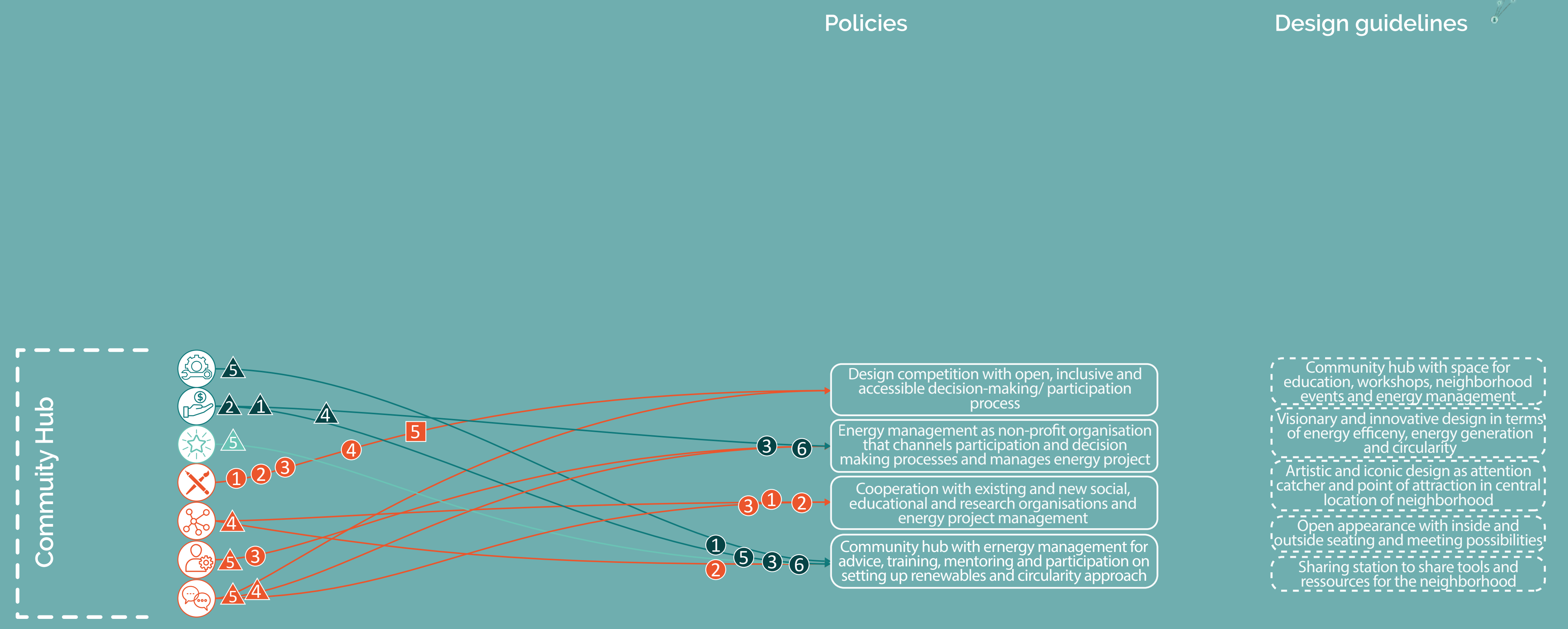
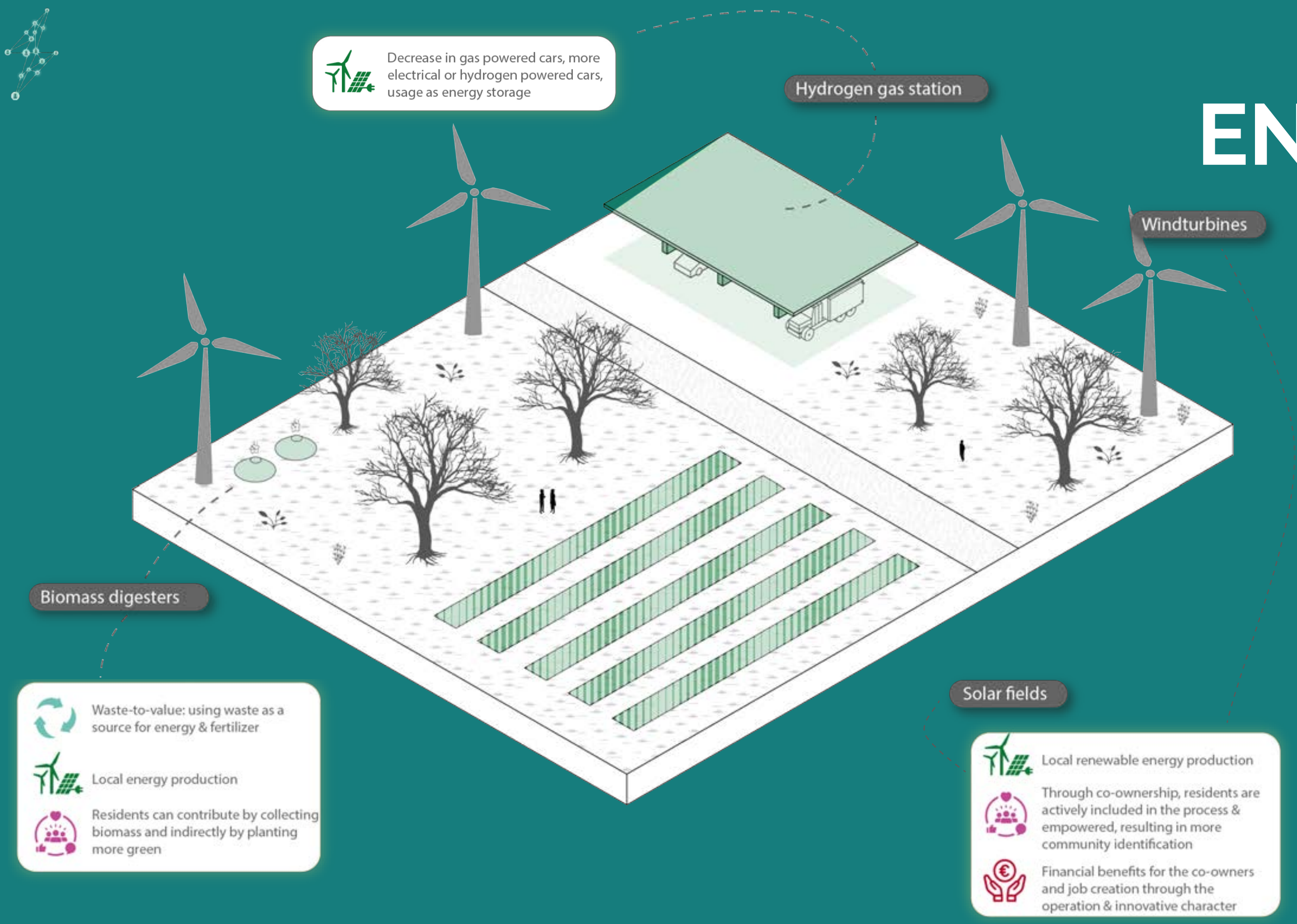


Figure 86

Figure 85: Community hub as key project

Figure 86: Community hub policies and design guidelines



ENERGY HUB

Role of Energy Hub

The energy hub is the heart of community-owned energy production. These larger community energy installations in the form of wind turbines, solar fields, biogas plants and/or district heating through geothermal energy tend to create significant revenue streams that contribute to the further development of the neighbourhood.

The energy projects should be built in proximity to the neighbourhood, however, they are more likely to be located on the periphery of the neighbourhood as space is often limited. The energy plants are designed to fit into the surroundings and not diminish the spatial quality in their vicinity, based on social and environmental sustainability. The biogas plant is fed with (bio-)residual waste as well as bio-waste that accumulates in the public space. This leads to an increased circular economy or waste-to-energy processes. However, a tailor-made energy concept for each neighbourhood is needed, based on the energy potentials and participation of the neighbourhood. The involvement of or cooperation with local/regional market players in the form of existing renewable energy companies, the Port of Rotterdam or energy utilities is possible. However, the principle of leaving the community as majority shareholder of energy projects must be fulfilled.

The main coordinators are the energy management and the residents, the RES region is involved through an advisory role. The community centre acts as the operational hub. Operation and support in terms of financing, expertise and implementation can be provided by ESCOOP, especially at the beginning, or by a non-profit organisation set up by the community to manage shares and operate the facility. The Dutch government, the province of South Holland and the municipality make an important contribution by establishing a regulatory, policy and subsidy framework.

STAKEHOLDER INVOLVED

Private Sector

1. Renewable energy companies (small+middle)
2. Energy distribution company
3. Energy network company
4. Renewable energy componenets manufacturer
5. Fossil fuel companies
6. Regional energy companies
7. Biofuel companies
8. Credit Institute
   - cooperative, local or development bank
9. Citizen of neighbourhood
10. Land owner
11. Local businesses

Public Sector

1. European Union
2. Dutch national government
3. Province of Zuid-Holland
4. RES-Regions
5. Muncipality
6. Port of Rotterdam

Civil Society

1. Interests organisation
2. Education facilites
3. Energy management (also public sector)
   - Advising, financing and managing renewable energy projects
4. RESCOOP (also privat sector)
5. Community

Policies

Design guidelines

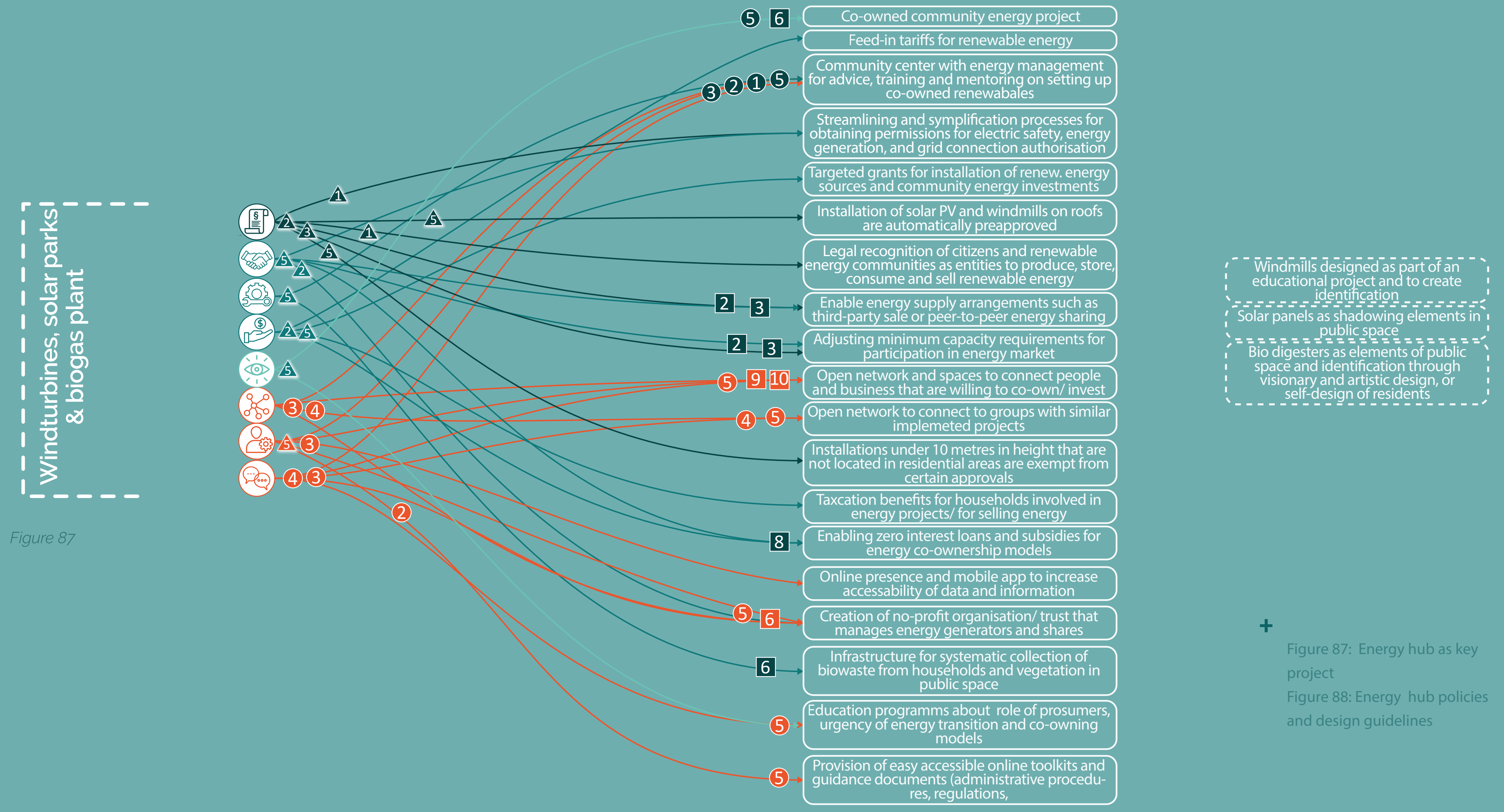


Figure 87

Figure 87: Energy hub as key project
Figure 88: Energy hub policies and design guidelines

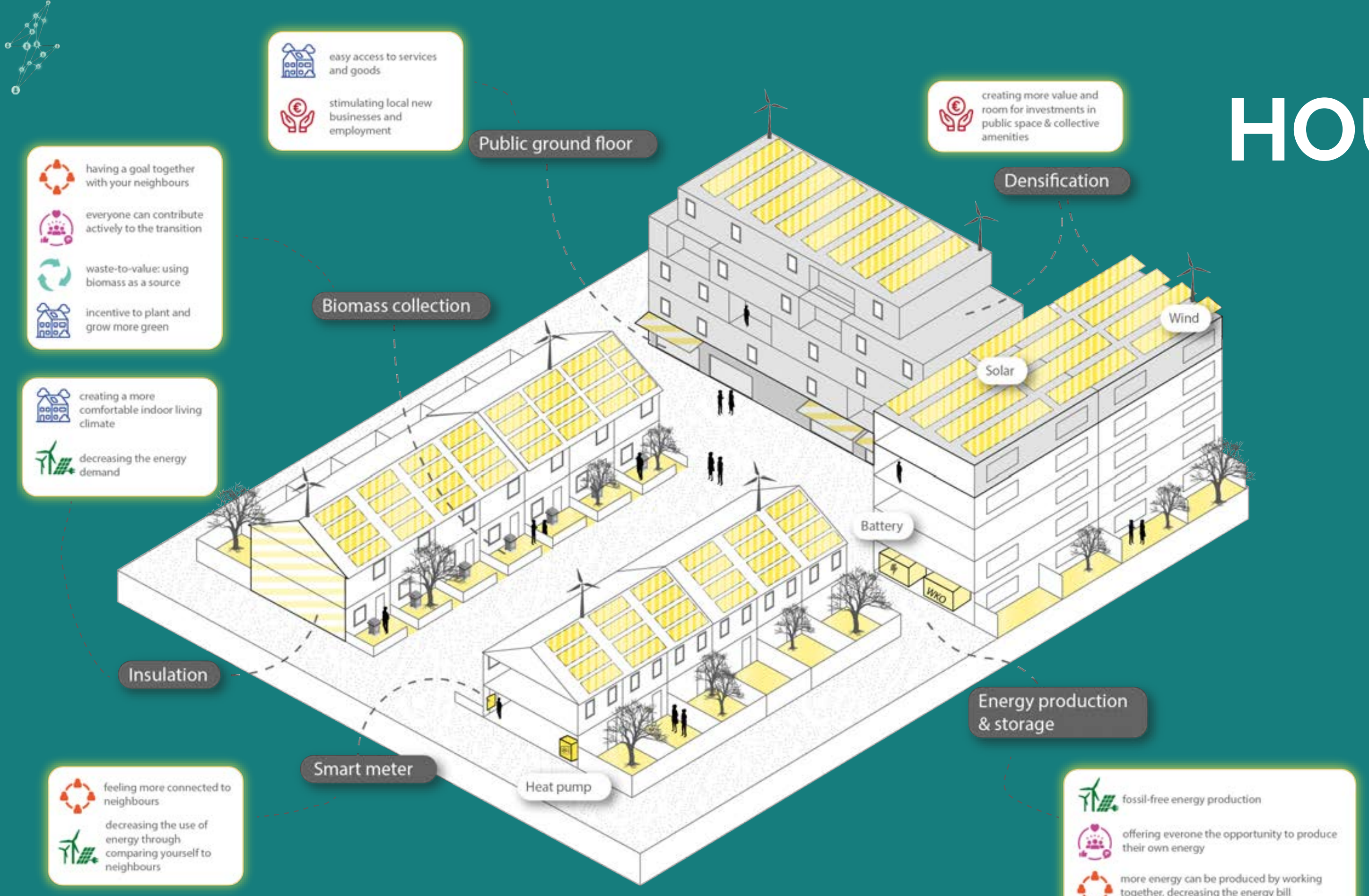


Figure 89

HOUSING

Housing transformation

The housing transformation is a crucial step toward a self-sufficient community, to boost the appearance and living quality of the neighbourhood and provide more (affordable) housing for the residents.

The needed insulation of the housing, to reduce energy consumption, and the installation of renewable energies, to enable residents to generate their energy, is taken as an opportunity to modernize comprehensively and to improve the overall living quality. The reduction of energy consumption will be achieved through workshops for households on consumption reduction, modernization of the buildings and smart systems, that help residents to reduce and control the demand.

Affordable and energy-efficient housing characterised by a high quality of living is created through densification by housing associations. As well as land acquisition and subsequent conditional allocation to (shared) property owners by the municipality. The government is a important actor of the transition through funding promotions and subsidies. The municipality is the main coordinator via active land policies and dialogue with housing associations and real estate associations. Actors from the real estate sector are important public partners in this process. In addition, cooperations between housing associations, residents' initiatives or housing associations enable energy consumers to use and implement renewable energies.

STAKEHOLDER INVOLVED

Private Sector

1. Housing corporations & associations (social, etc.)
2. Shared property owner
3. Private property owner
4. Property renter

5. Renewable energy companies (small)
6. Energy distribution company
7. Energy network company
8. Construction companies

9. Credit Institute
   - cooperative, local or development bank

Public Sector

1. European Union
2. Dutch national government
3. Province of Zuid-Holland
4. RES-Regions
5. Muncipality

Civil Society

1. Interests organisation
2. Education facilites
3. Cultural institutions
4. Local social/ neighbourhood organisations
5. Community

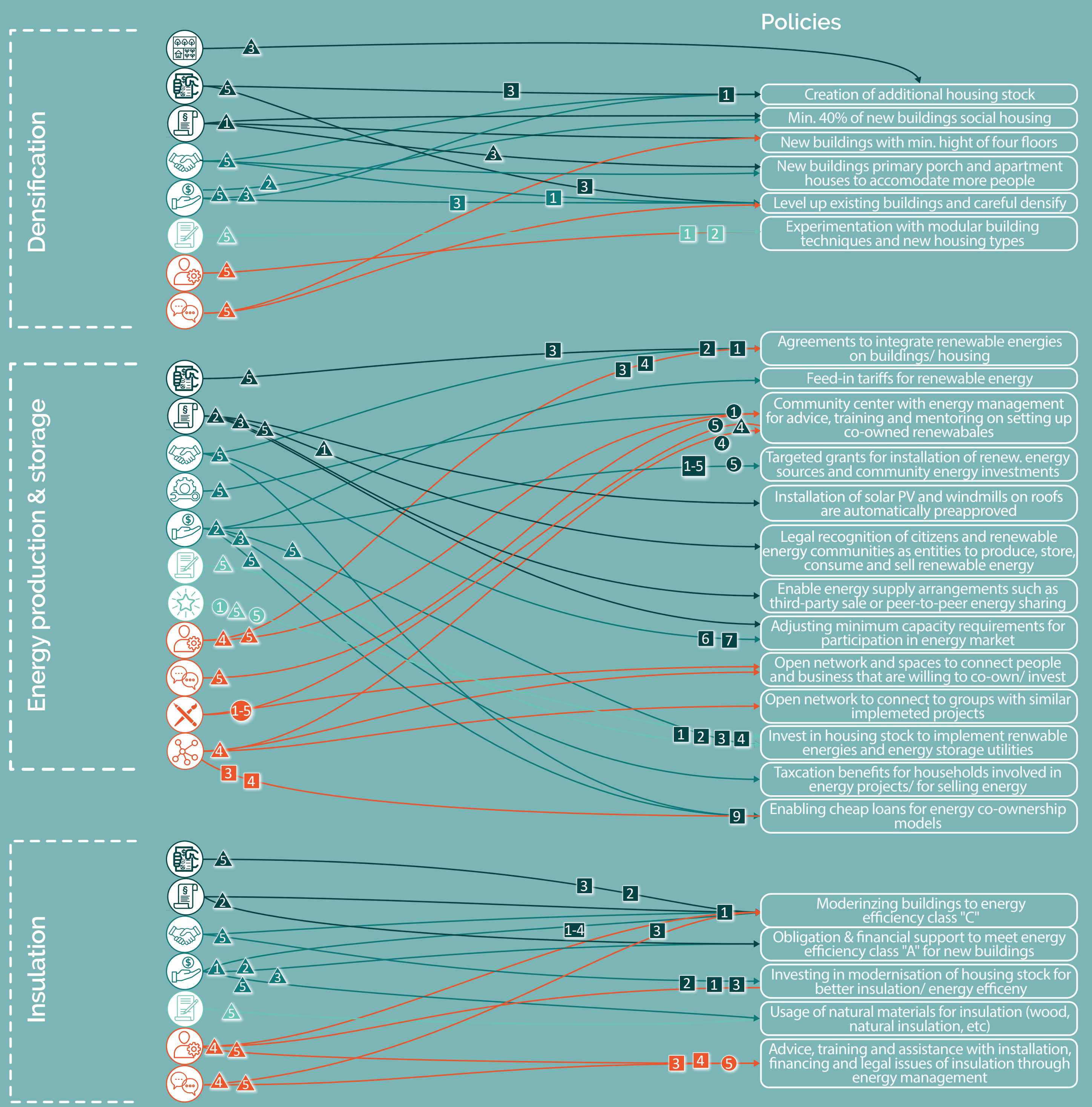


Figure 90

Design guidelines

- Active ground floors through commonly used, social or public usages
- Usage of recyclable and natural materials (wood, natural insulation, etc)
- Architecturally diverse and pleasant housing buildings (Colouring, street art)
- Commonly used areas/ terraces
- Balconies mandatory to improve living
- Modular building techniques and new housing types
- Different apartment types for different living situations
- Level up existing buildings

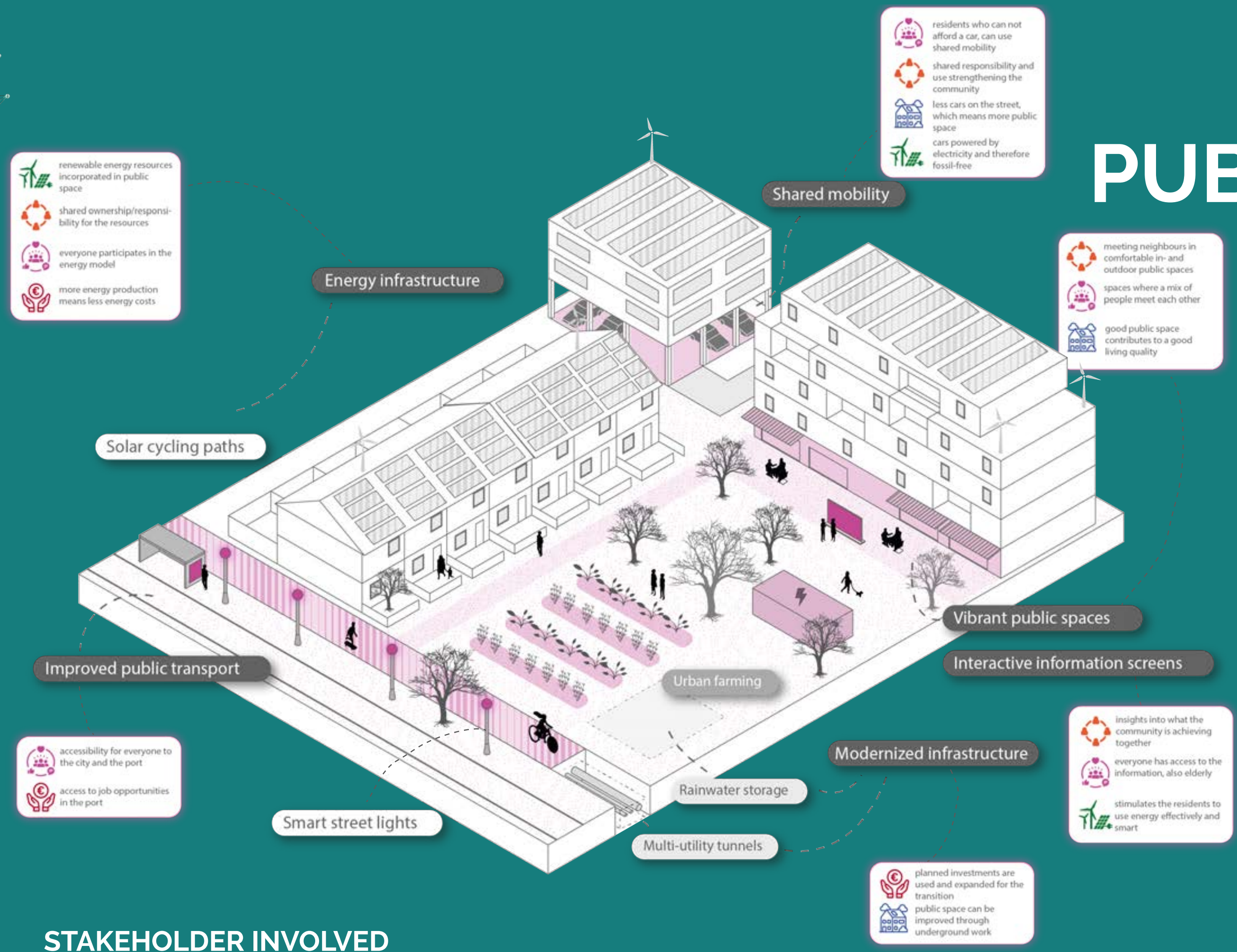
- Integrate renewable energies on buildings/ housing
- Solar panels on roofs and if sufficient insolation on facades
- Rooftop windmills not exceeding 2,5 m additional hight on roofs
- WKO and heat pumps in basement or integrated in property
- Batteries integrated in property (basemen or ground floor)

+

Figure 89: Housing as key project
Figure 90: Housing policies and design guidelines

- At least energy efficiency class "C" for modernized buildings
- At least energy efficiency class "A" for new buildings
- Usage of recyclable and natural materials (wood, natural insulation, etc)

PUBLIC SPACE



STAKEHOLDER INVOLVED

Private Sector

1. Housing corporations & associations (social, etc.)
2. Private property owner

3. Renewable energy companies (small)
4. Energy distribution company
5. Energy network company

6. Planning/ architecture offices
7. Public transportation operator (also public sector)
8. Local retail businesses

Public Sector

1. European Union
2. Dutch national government
3. Province of Zuid-Holland
4. Muncipality

Civil Society

1. Interests organisation
2. Education facilites
3. Energy management (also public sector)
   - Advising, financing and managing renewable energy projects
4. Local social/ neighbourhood organisations
6. Cultural institutions
7. Citizen

Role of public space

An important aspect of upgrading neighbourhoods to achieve an attractive living and working environment, and thus spatial justice in the region, is the provision of quality public space. The energy transition entails a comprehensive modernisation of the infrastructure and requires major investments in these. This modernization is taken as an opportunity to upgrade the public space simultaneously.

The enhancement of meeting places for the community through a qualitative and lively public space promotes dialogue, co-creation and well-being. It is important to ensure spaces for self-design, adaptation and interaction. Creating a variety of public spaces that is inclusive for all citizens, regardless of their background, is vital for an accessible city. This also means, ensuring accessible public transport & walkability. However, also a publicly accessible digital infrastructure that digitally empowers residents and acts as a tool for participation. The concentration of retail and restaurants and a more diverse cultural offer provides more mixed milieus and a more vibrant community. Renewable energies are integrated and function as elements of the public space, through an innovative and artistic design.

The main coordinator, initiator and financier is the municipality, but the design process is characterised by a cooperative and participatory approach, strongly influenced by the community. Influential and important dialogue actors for the redesign and upgrading of the public space are the energy network and distribution companies.

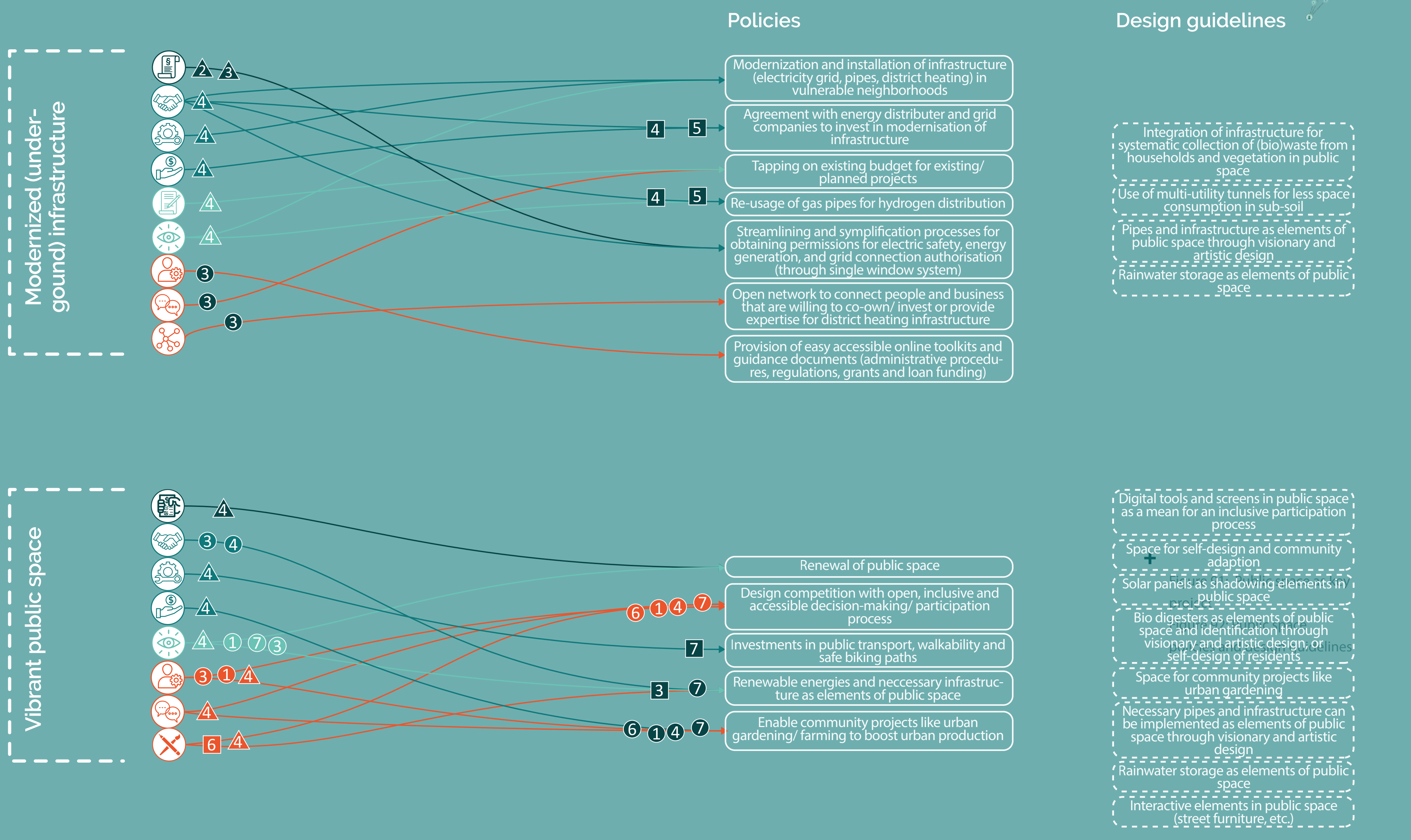
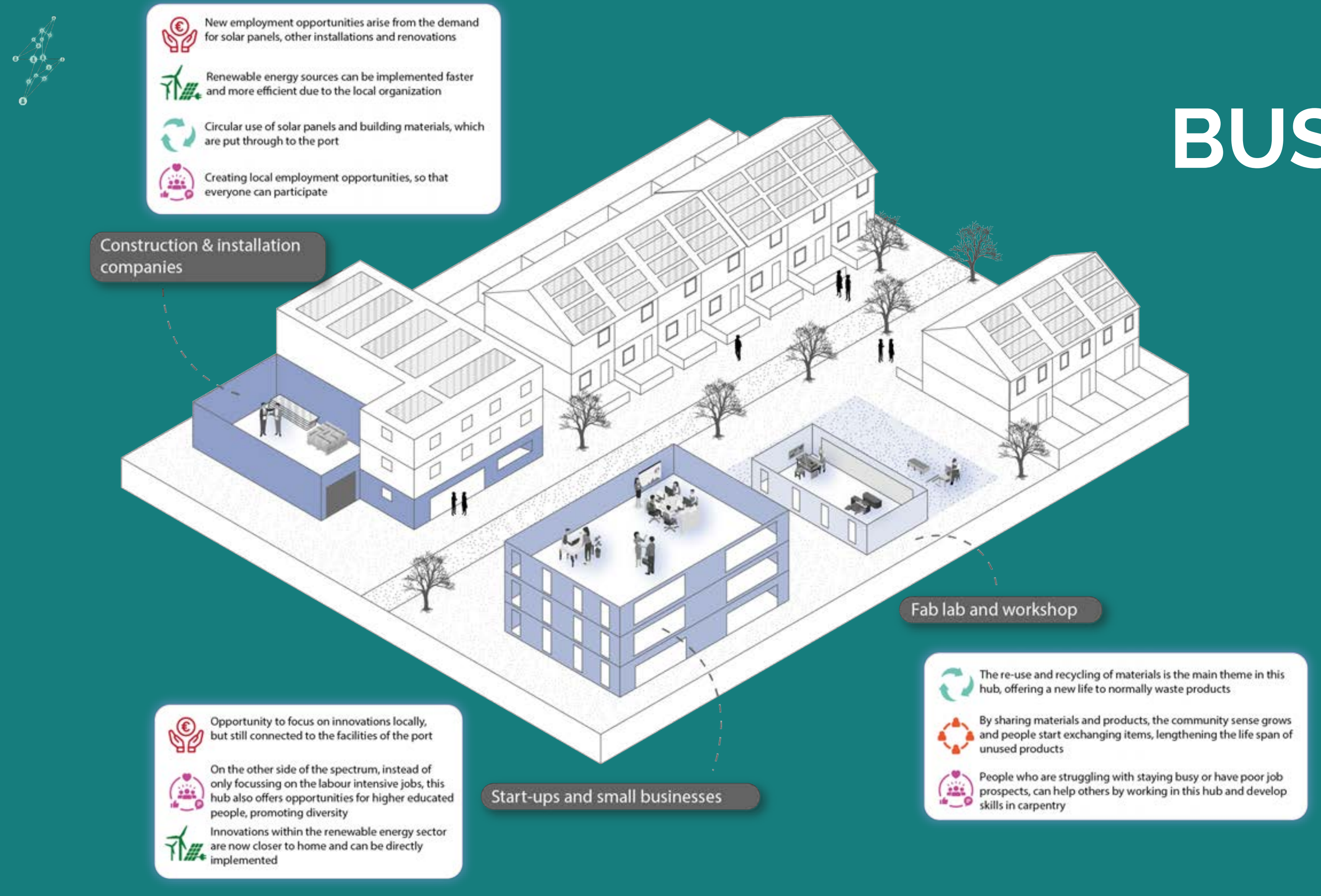


Figure 92



BUSINESS HUB

Role of Business Hub

The Business hub plays a key role in the neighbourhood to boost local circular processes. economical activity and employment opportunities.

This is mainly achieved through the provision of affordable working space, an innovative and attractive work environment and the implementation of fab lab and workshops that promote the maker movement. The workshops can be used by local companies on weekdays and during regular working hours, promoting urban production. On weekends and evenings, the lab and workshop can be used by residents to promote upcycling processes and encourage residents to become DIY prosumers. There are also cooperations with social incentives and organisations to provide workshops or re-school unemployed people or people with no prospects.

The neighbourhood (management) is the main coordinator. The municipality heavily supports the project through:
- subsidies for the workshop/ lab space,
- financing of re-schooling programmes and involved social incentives,
- taxation breaks for local business, especially with a circular approach,
-landacquisitionandlandsaleincombinationwith setting conditions to enable space for businesses
- infrastructural investments in form of the workshop/ lab space.

STAKEHOLDER INVOLVED

Private Sector
1. Private property owner
2. Property renter
3. Renewable energy companies (small)
4. Renewable energy componenets manufacturer
5. Upcycling businesses
6. Construction businesses
7. Local tech business
8. Private research organisations

Public Sector
1. European Union
2. Dutch national government
3. Province of Zuid-Holland
4. Muncipality
5. Port of Rotterdam

Civil Society
1. Interests organisation
2. Education facilites
3. Local social/ neighbourhood organisations
4. Neighbourhood management

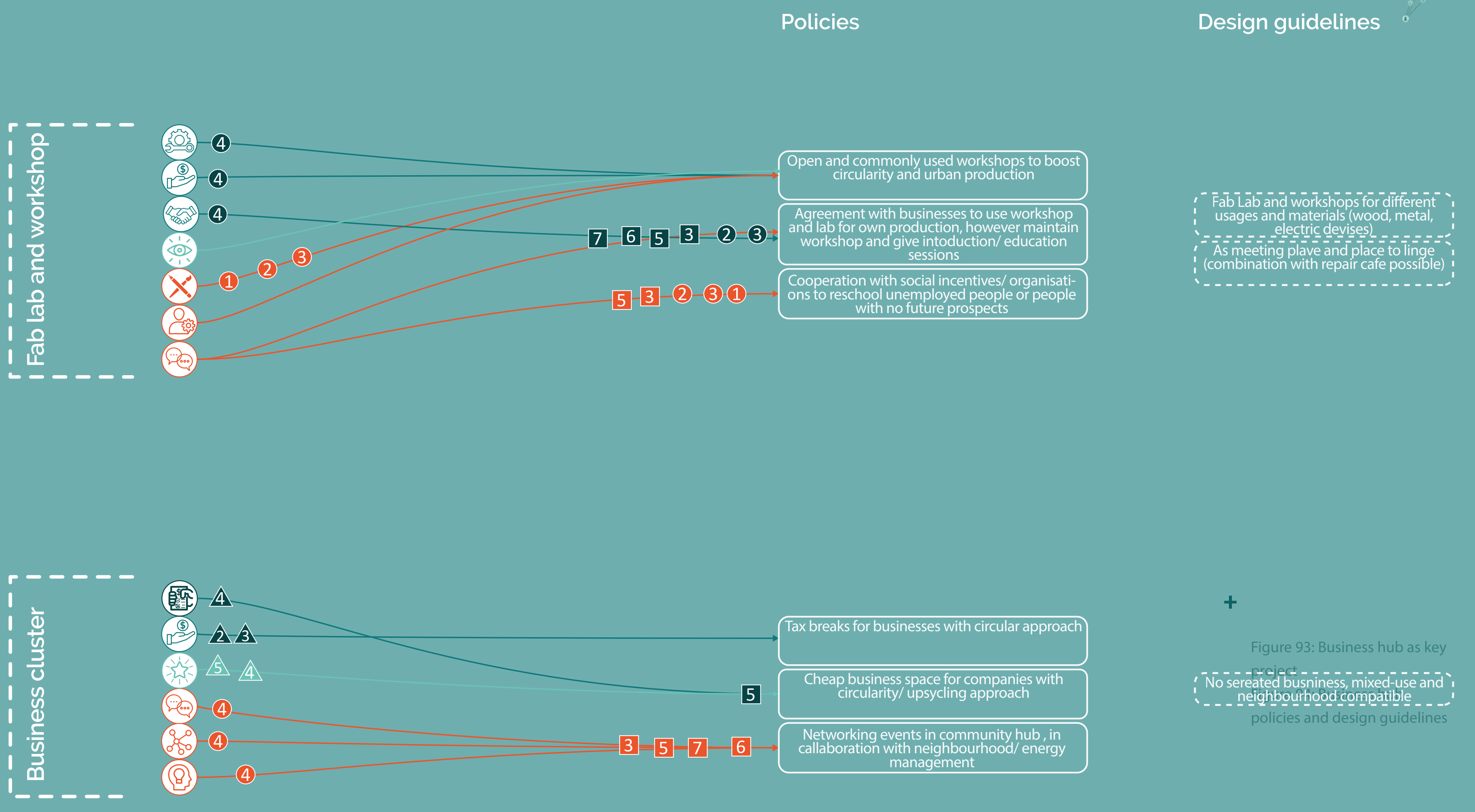


Figure 93: Business hub as key project policies and design guidelines

Figure 94

Complexity

This diagram shows that the different key projects cannot be considered independent and separate interventions. The projects and different interventions, are closely linked and influence each other. They all relate and include several actors, who need to be involved in the process to realise the intervention and foster collaboration and open networks. This, the satisfaction of their needs and the consideration of their opinions make their organisation a complex venture. It takes capable coordinators and strong institutions to manage this time-consuming and elaborate process. Often the municipality is the initiator at the beginning of this process. As the process progresses and the neighbourhood and its residents are empowered, the initiating and coordinating role is taken over by them.

The five main groups involved in the overall process are next to the municipality and the residents, housing associations, renewable energy-related companies and energy distribution companies.

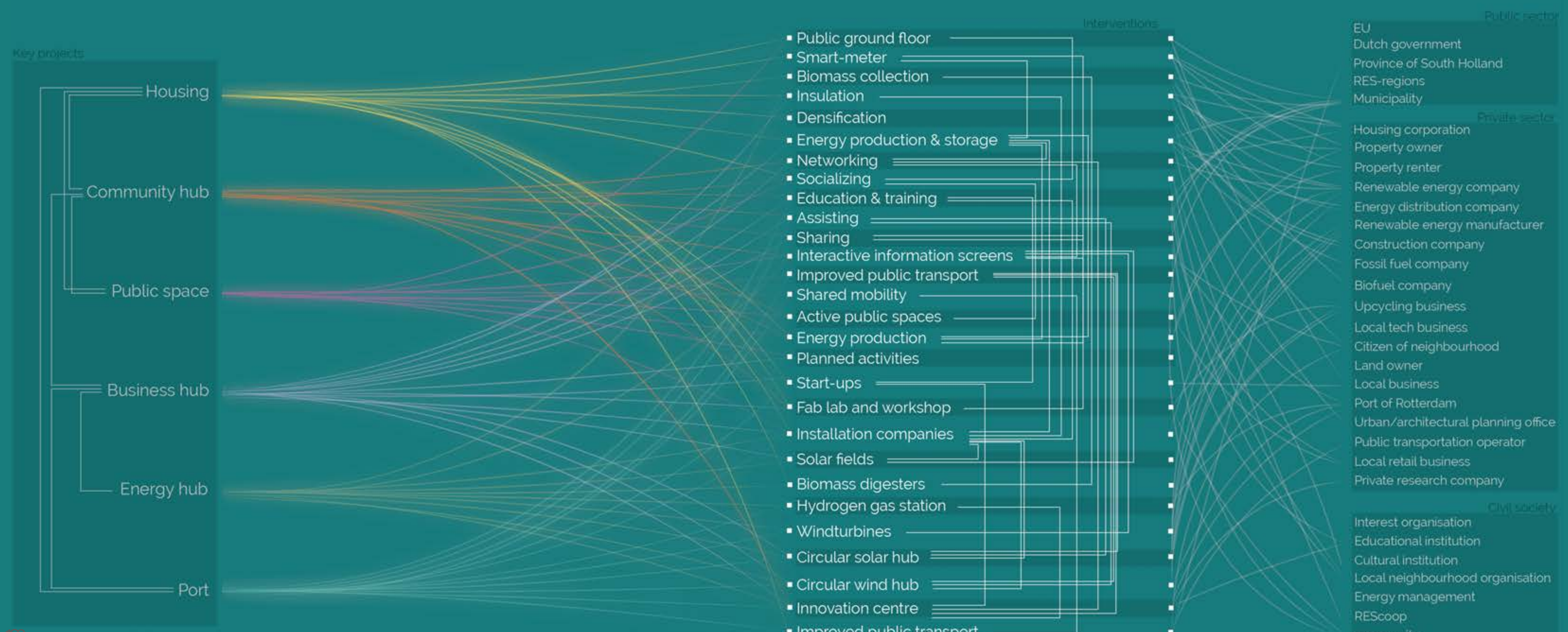


Figure 95

5.3.5 STAKEHOLDER TRANSITION

Complexity

The implementation of the strategic projects aims to create a transition in the role of stakeholders in the power matrix.

Namely, members of the civil society or the residents of both owner-occupied and rental houses are empowered to have more influence and power in the energy transition, as well as to have more interest in the consequences of the energy transition in their neighbourhoods. Additionally, employees of fossil fuel industries will transition into the role of employees in renewable energy industries with their high interest in the energy transition.

Private party organisations such as housing associations, renewable energy companies, and environmental organisations are also expected to have more interest and influence once the key projects are implemented by giving them more incentives and informing them of the benefits of the energy transition. Fossil fuel companies are also expected to transition into the role of renewable energy companies and are expected to steer the employment opportunities within the energy transition.

Lastly, public party organisations or governing bodies such as municipalities and the port of Rotterdam will have higher influence and interest in the energy transition and what this entails for other neighbourhoods both in and outside of Rotterdam. Empowering these organizations even more ensure that the key projects can be integrated into the whole of South Holland.

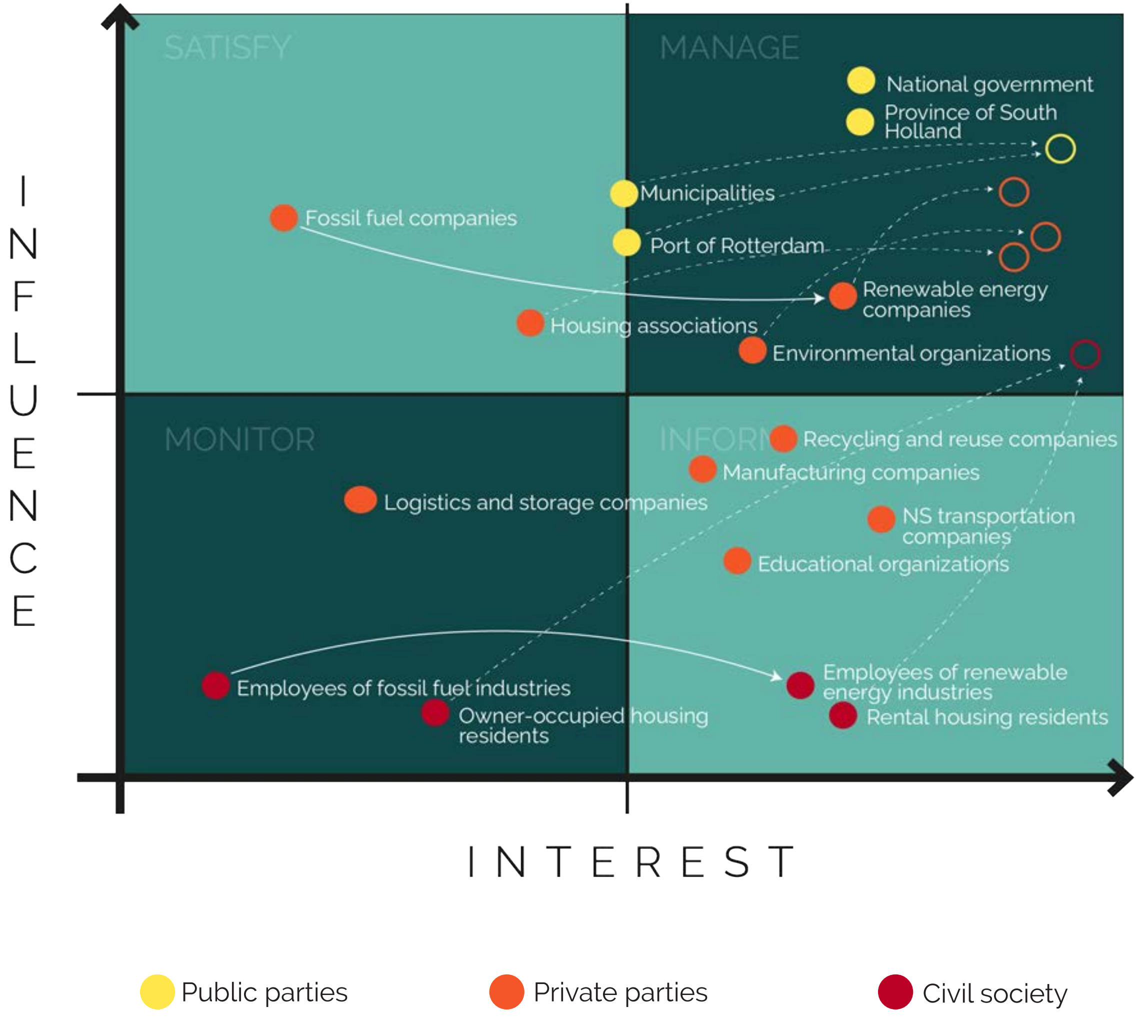


Figure 96

Figure 95: Complexity and interrelations of key projects
Figure 96: Transitions in the stakeholder power matrix

Legend
Shift in position
Shift in role

6. STRATEGIC PROJECTS

6.1 SELECTION CRITERIA

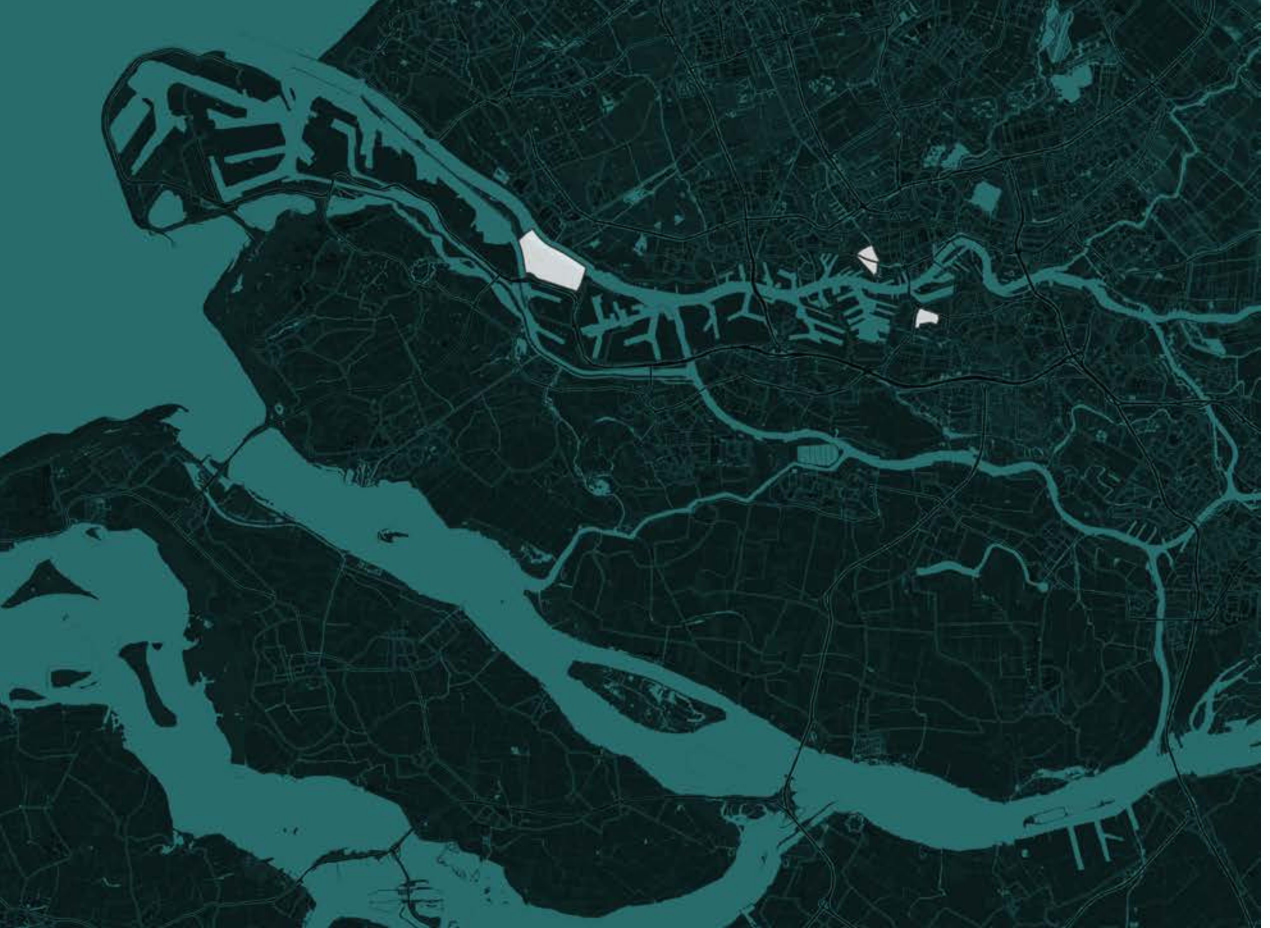
Introduction

We have selected three neighbourhoods as strategic projects to showcase how the principle of the local frame can be applied and thus how they can become prosumers. The selected neighbourhoods are Rozenburg, Carnisse and Bospolder-Tussendijken. Bospolder-tussendijken functions as a case study, as it was appointed as one of the five neighbourhoods for an integrated sustainability approach in the summer of 2018 in the agreement of "Nieuwe Energie voor Rotterdam" . IABR-atelier, in collaboration with POSADMAXWAN (2019), researched what this transition could look like and what the socio-economic added value could be for Bospolder Tussendijken. As this goal is very similar to ours, their research is verry fitting as a case study.

The neighbourhoods are selected on the basis of the criteria shown in the table on the right. These criteria were chosen as they all influence how easily the local frame can be implemented. The density, amount of open space, energy potential and building typologies influence how big the energy demand is, but also how much energy can be generated. The WOZ-value and percentage of people with low income indicate the welfare and quality of buildings in the neighbourhood. The housing ownership and percentage of people with low income also influence the needed way of financing the transition to self-sufficiency.

The three neighbourhoods all have different characteristics to ensure the projects showcase how the principle can be applied on other vulnerable neighbourhoods.

For the strategic projects, the energy demand, potential energy production, strategy, phasing, implementation and visualisation are shown.



+ Figure 97: Strategic neighbourhoods (data from CBS Wijken En Buurten 2021 Versie 1 WFS, 2021)

Figure 97

	Rozenburg	Carnisse	Bospolder Tussendijk
Density	2766/km²	20227/km²	20636/km² 19985/km²
WOZ value	181000	114000	165000 153000
Low income	35%	61%	69% 74%
Age 65+	20%	9%	10% 12%
Open space			
Energy potential	Shallow geothermal potential Wind potential Solar potential	Wind potential Solar potential	Shallow geothermal potential Wind potential Solar potential
Housing ownership	54% / 40% / 4% Social rental Private rental Owner-occupied	36% / 17% / 47% Social rental Private rental Owner-occupied	19% / 18% / 63% ; 13% / 26% / 61% Social rental Private rental Owner-occupied
Building typologies	Row houses	Porch houses	Apartments, Row houses, and Porch houses

+ Figure 98: selection criteria strategic projects Based on CBS, 2018

Figure 98

6.2 BOSPOLDER TUSSENDIJKEN CASE STUDY

6.2.1 ENERGY DEMAND

In their research IABR-atelier Rotterdam and POSADMAXWAN (2019) calculated the heat and electricity demand of Bospolder-Tussendijken. The energy demand of a building depends on its function (figure 101), construction year (figure 99) and typology (figure 100). The year of construction influences to the energy use, as older buildings often are not insulated very well and use a lot of gas compared to newer buildings. The building typology influences the energy use as well. Different lay-outs of space require different heating. To calculate the total energy demand for Bospolder Tussenwijken, they firstly calculated the surfaces of buildings divided on function, typology and year of construction. Secondly, they multiplied it with key figures for the energy demand per square meter per function, typology and year of construction (see appendix). They calculated the demand for the current situation and for the situation after renovating the buildings. The heat demand largely decreases after improving the insulation, while the electricity demand stays more or less the same, but it increases a bit as new buildings sometimes have installations (like mechanical ventilation) that require electricity. As there is potential for densification, and there are already ongoing projects to realise this, they have also calculated the demand after new buildings are added (IABR-atelier Rotterdam & POSADMAXWAN, 2019). We used the same approach to calculate the energy demand of Rozenburg and Carnisse.

+ Figure 99: Construction year Bospolder - Tussendijken (IABR-atelier Rotterdam and POSADMAXWAN 2019)
Figure 100: housing typologies Bospolder - Tussendijken (IABR-atelier Rotterdam and POSADMAXWAN 2019)
Figure 101: Funtion map Bospolder-Tussendijken (IABR-atelier Rotterdam and POSADMAXWAN 2019)

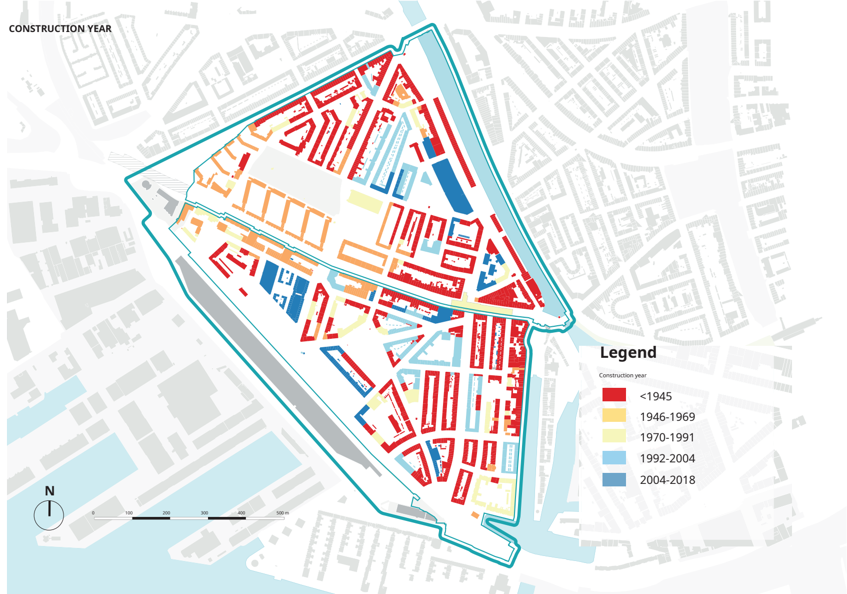


Figure 99

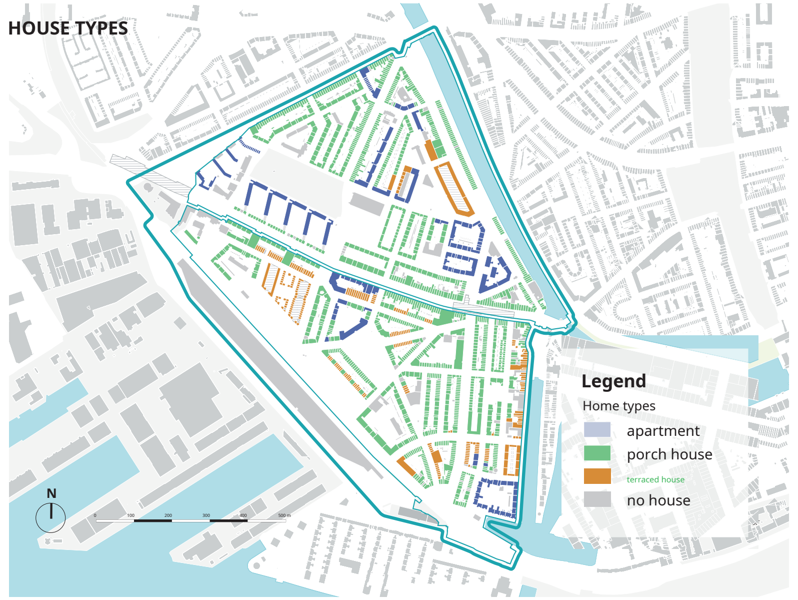


Figure 100

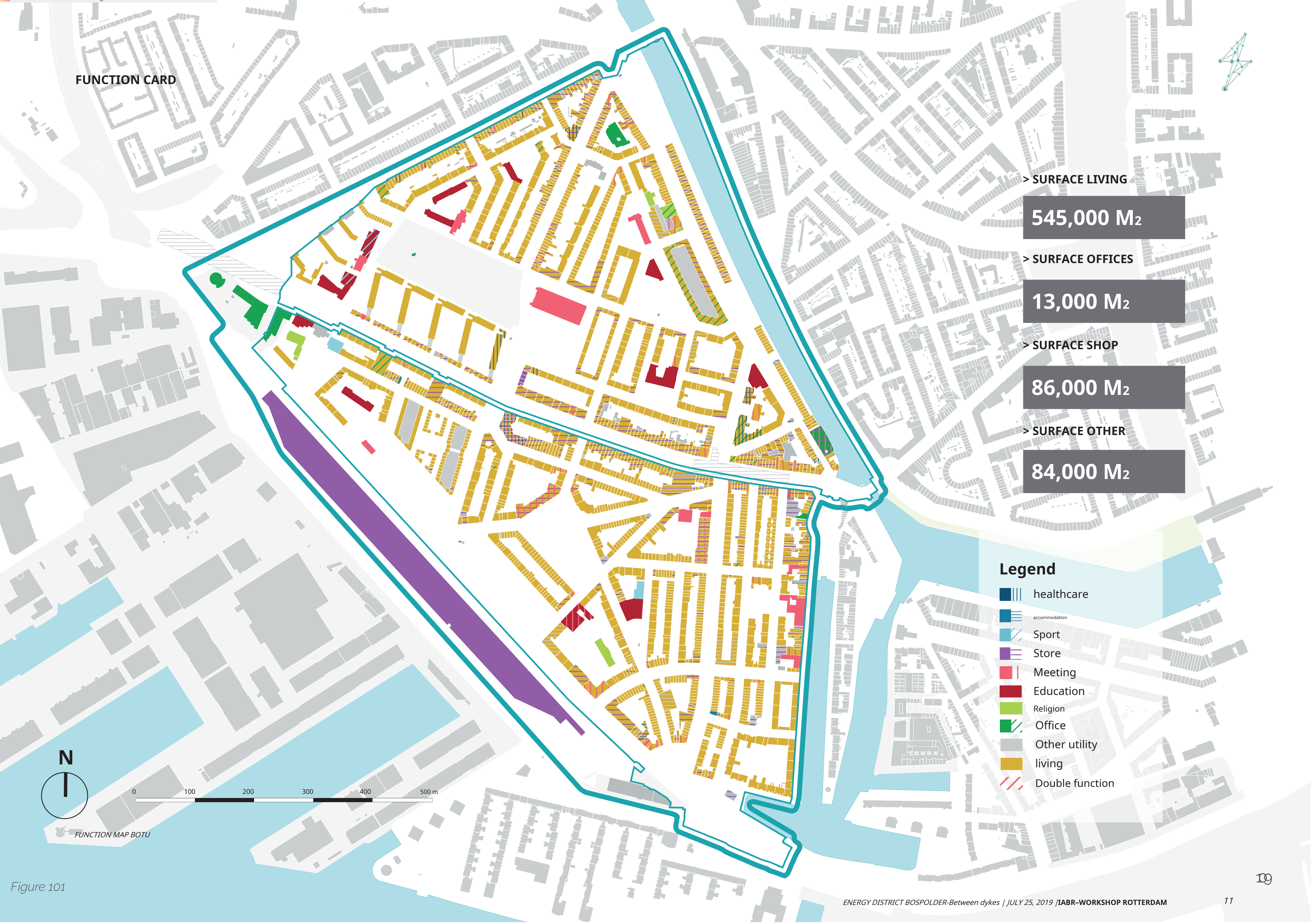


Figure 101

CURRENT SITUATION

> TOTAL BUILT AREA

727,000 M2

> TOTAL HEAT CONSUMPTION

77.4 GWH

> TOTAL ELECTRICITY CONSUMPTION

36.2 GWH

WITH NEW HOMES
WITHOUT RENOVATION

727,000 M2 TOTAL EXISTING AREA GO
-
8,400 M2 DEMOLITION
+
36,700 M2 NEW

> TOTAL BUILT AREA

755,300 M2

> TOTAL HEAT CONSUMPTION

81.9 GWH

> TOTAL ELECTRICITY CONSUMPTION

37.6 GWH

+ 4.5 GWH

+ 1.4 GWH

AFTER RENOVATION HOUSES
INCL NEW/ADDITIONAL HOUSES

> TOTAL BUILT AREA

755,300 M2

> TOTAL HEAT CONSUMPTION

58.7 GWH

> TOTAL ELECTRICITY CONSUMPTION

38.0 GWH

- 23.2 GWH

+ 0.4 GWH

Figure 102

\+ Figure 102: Total energy demand Bospolder-Tussendijken (IABR-atelier Rotterdam and POSADMAXWAN, 2019)

6.2.2 ENERGY PRODUCTION

In their research they have also calculated the amount of heat and electricity that could be generated in Bospolder-Tussendijken. The potential heat sources are residual heat, biogas from organic waste, thermal heat out of water (TEO/TEA/TED), geothermal heat and solar energy. Resulting in a total of 87,6 GWH. Solar energy is not used here to generate heat. PVT panels are required to convert the solar energy to heat, but since the roofscape can only be used once and already more heat can be generated then demanded, it is wiser to use the roofscape for PV panels. IABR-atelier and POSADMAXWAN (2019) propose PV panels as the the only potential for Bospolder-Tussendijken to generate electricity. The PV panels could generate up to 14,6 GWH. Unfortunately, this is not enough to meet the demand (IABR-atelier Rotterdam & POSADMAXWAN, 2019). Therefore, it is important to stay connected to the mainframe. However, we also see potential to add wind turbines in the nearby port, which could generate extra electricity.

Figure 103

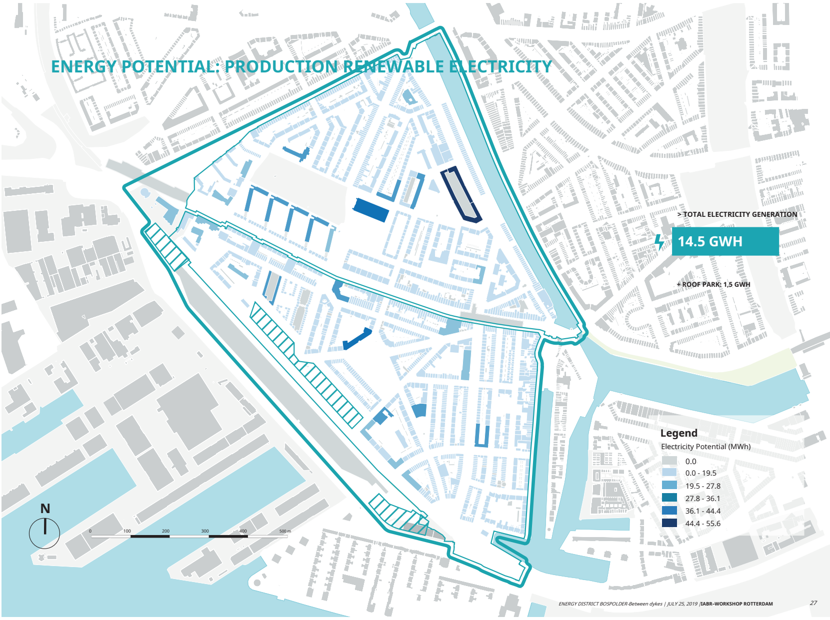


Figure 104

\+ Figure 103: potential heat sources (IABR-atelier Rotterdam and POSADMAXWAN, 2019)
Figure 104: Potential electricity sources (IABR-atelier Rotterdam and POSADMAXWAN, 2019)

6.2.3 PHASING

The existing plans brought upon by IABR (2018) can be easily integrated into the strategies and proposals of implementing the key projects. Despite the existing plans to turn Bospolder Tussendijken into a sustainable neighbourhood with added socio-economic value, the proposal in this paper aims to integrate the concept of prosuming, community energy projects, and business hubs to engage the community even more with the energy transition.

Resilient School De Dakpark school is an example for the appropriation of the energy transition in a neighbourhood setting wherein the indoor climate and schoolyard is improved (IABR, 2018). The roof of the school will also be used to collect energy for the residents. This resilient school is a place to also educate students about resilience and the energy transition, providing an opportunity for this space to temporarily be used as a center for networking, education, and participation. A community hub will then be combined at a later phase with the existing cultural center 'Pier 80' (Rotterdam Delfshaven, N.D.) to improve the quality of the building while maintaining the existing social networks formed within it.

The community energy project also makes use of the existing Dakpark for the collection of biomass while the proximity of the neighbourhood to the port provides an opportunity to locate larger energy infrastructures such as geothermal plants, wind turbines, and solar fields. Furthermore, residual heat can be provided to the neighbourhood from the large industries in the port.

The existing energy plans will pioneer the prosuming aspect of the housing transformation while densification for social housing can occur in open spaces to aid an easier implementation of renewable energy infrastructures in a neighbourhood with a high percentage of low-income households.

The construction and installation of new hubs, as well as energy infrastructure both on roofscapes and on the ground, provides opportunities to improve the quality of the public space. The community hub can also be located in a public space to introduce more activities and dynamics.

In combination with this community hub, spaces for workshops and labs will also be provided for small-scale circular businesses and residents interested in starting their own businesses related to the energy transition. Furthermore, available space from beneath the Dakpark can also be used for installation and construction businesses.

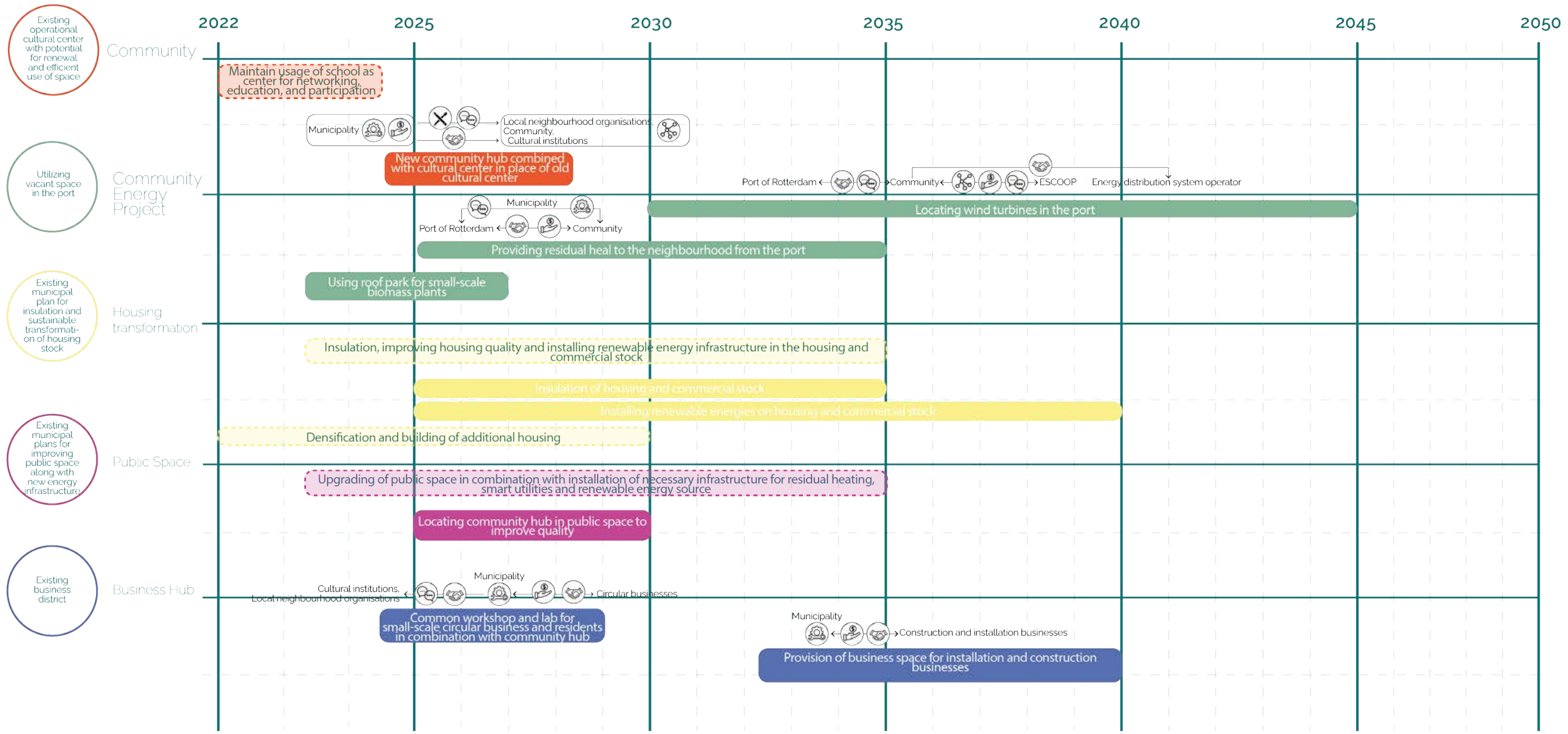


Figure 105

+ Figure 105: Phasing Bospol-der-Tussendijken

6.2.4 IMPLEMENTATION

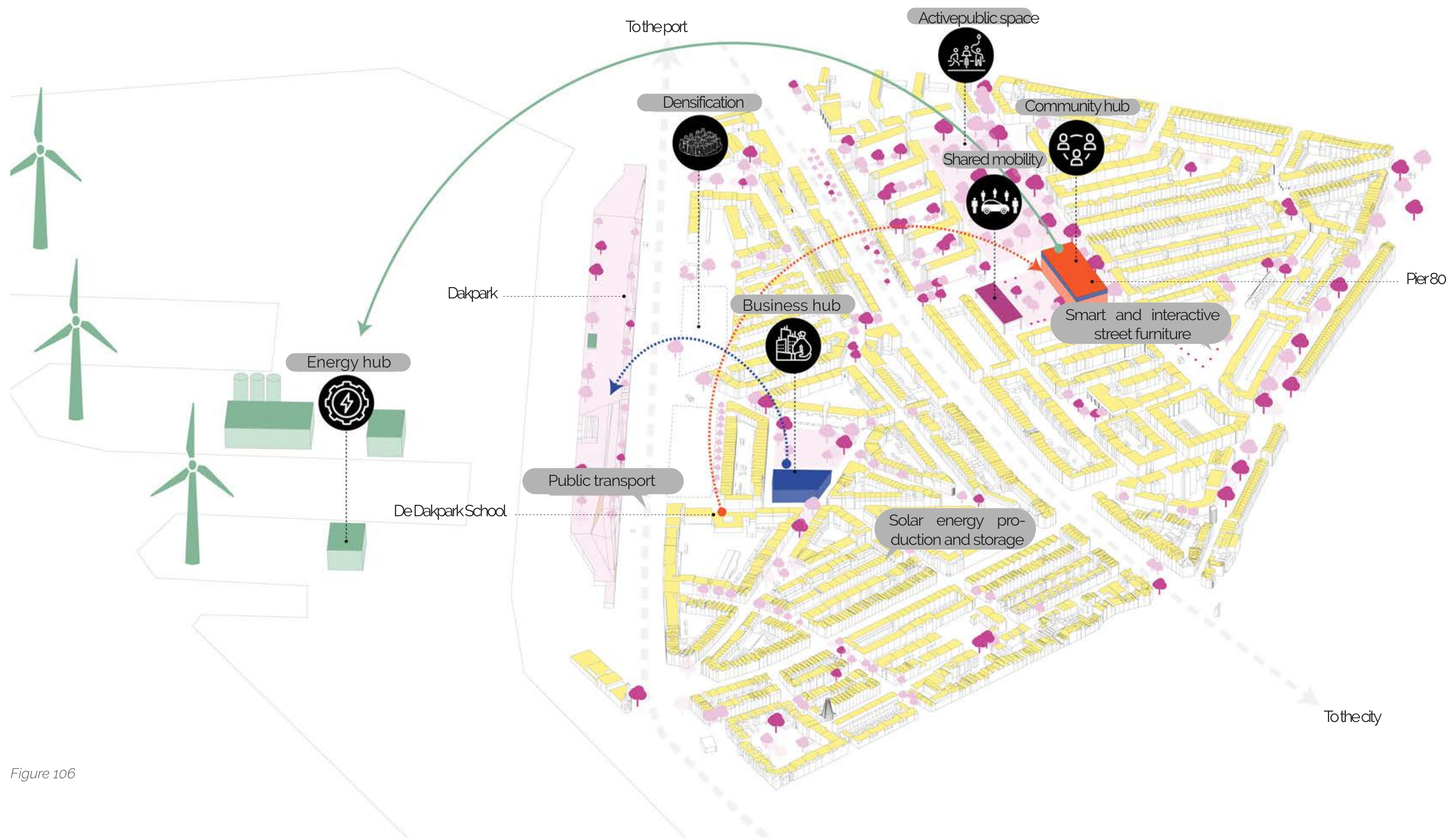


Figure 106

Figure 106: Implementation of key projects in Bospolder Tussendijken

Figure 107: Collage of future vision for Bospolder Tussendijken (Stoele, 2019)

Legend:

Temporary Permanent

Connection

The proposal for the implementation of the phasing and key projects, along with the plans of IABR (2018) can be seen on figure 106.

Residences will have improved insulation and solar panels on the roofs for energy production and storage. The transformation of the housing stock not only improves housing and living quality, but also allows for residents to gain extra income from selling back to the mainframe grid, thus prodiving more incentive for households to produce and conserve energy efficiently.

The community hub as a center for networking, education, and participation will be moved from De Dakpark School to the location of 'Pier 80' where it will be integrated into existing cultural activities and social networking in this space. Business spaces will also be integrated into this community hub to encourage residents into entrepreneurship for jobs in circularity and the energy transition.

Another business hub for larger scale businesses and companies can also be located in the neighbourhood or integrated within the businesses underneath the Dakpark. A new business hub can be located in existing open spaces so long as it contributes to a higher quality of public space. Other open spaces can also be densified into energy efficient buildings.

The proximity of Bospolder Tussendijken to the port allows for the construction and installation of larger renewable energy infrastructure such as a geothermal plant or windmills to meet the energy demand of the neighbourhood.

Figure 107

The implementation of new renewable energy infrastructure can allow for the simultaneous upgrading of the public space, an intervention also highlighted by IABR (2018). The public spaces can be re-activated and include smart and interactive furniture to educate residents about the energy transition and as a means to provide opinions regarding the neighbourhood.

Other interventions such as shared mobility spaces and the improvement of public transport systems also reduces the dependency of residents on fossil fuel and cars. The combination of interventions makes the neighbourhood more lively and promotes a sense of community.

The future vision for Bospolder Tussendijken can be seen on figure 107 by Stoele (2019) which also represents the vision of the key projects.

6.3 ROZENBURG

6.3.1 ENERGY DEMAND

Introduction

Rozenburg, with 2.766 inhabitants per km2, has the lowest density of the three neighbourhoods. With 35% it has the lowest percentage of people with low-income, however, with 40% it has a high percentage of social rent, which could be beneficial for the investments needed for renovations and renewable energy sources. Geographically, Rozenburg has the potential to generate wind, solar and shallow geothermal energy. There is also quite some open space, which makes it possible to place wind turbines.

In Rozenburg, the main function is living with a total surface of 446.428 m2. You will find mostly rowhouses and a mix of detached houses, semi-detached houses and appartments. The vast majority of houses are built post-war. To calculate the energy demand, the approach of IABR-atelier Rotterdam and POSADMAXWAN from the case study is used (for calculations see appendix).

+ Figure 108: Year of construction on Rozenburg (data from BAG WFS 2022)
Figure 109: Typology Rozenburg (data from BAG WFS 2022)
Figure 110: Functions Rozenburg (data from BAG WFS 2022)

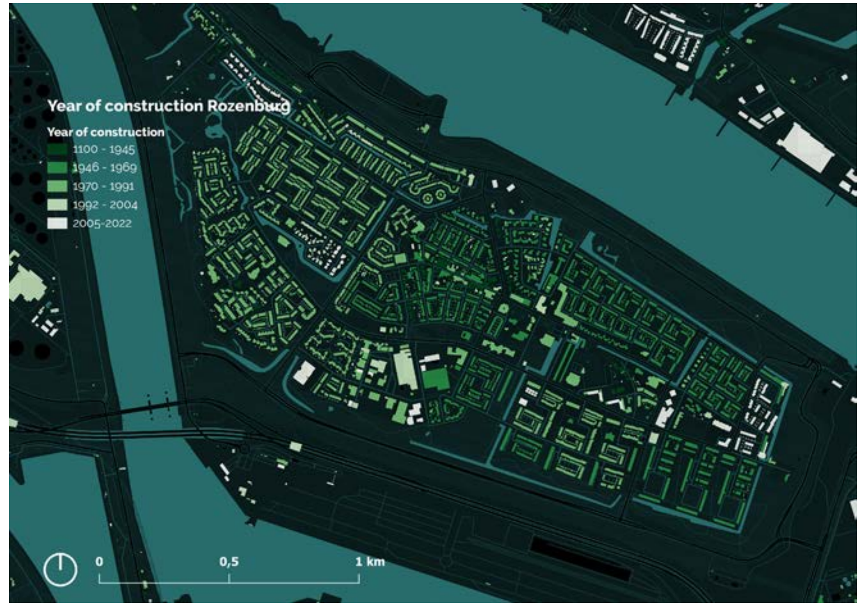


Figure 108

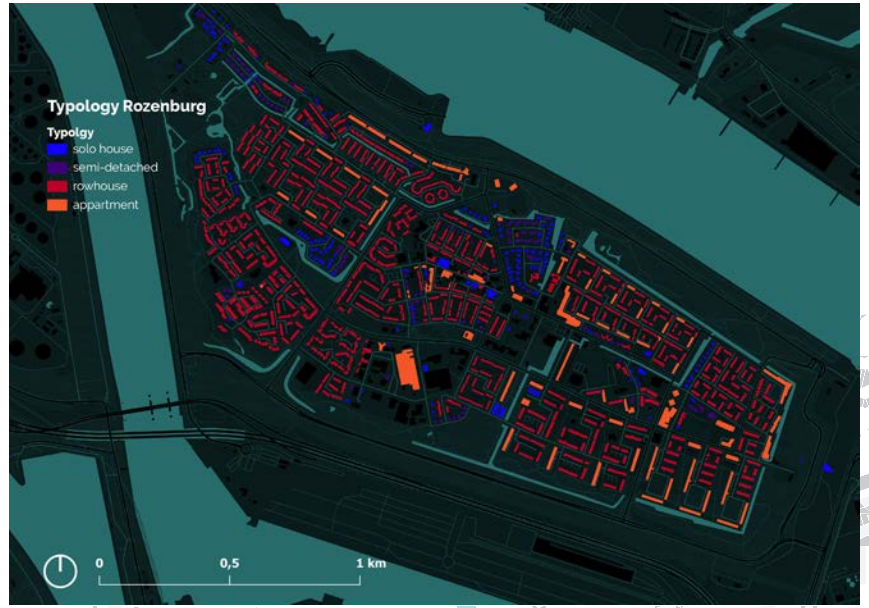


Figure 109

Figure 110

Calculation demand

Based on the construction year, typology and function, the calculations for the energy demand were done. As the key figures (see appendix) were not given for the semi-detached and detached houses, an assumption was made for the energy use per m2 based on the TNO report 'Validatie Vesta MAIS model schilisolatie Woningen' (Rovers & Tigchelaar, 2019) and the key figures for the rowhouses.

The Rijksoverheid stimulates reducing energy use, to reduce CO2 emissions (Ministerie van Economische Zaken en Klimaat, 2020) . It can be seen in figure 111 that the heat demand, with a loss of with 23.76 GWH, will decrease enormously after renovation. The electricity demand stays more or less the same. It is important to mention that these numbers have been calculated roughly and are also based on some assumptions (full calculations can be found in appendix). .

Total built area:

519.876 M2

Total current heat demand: 60,02 GWH

-23,76

Total heat demand after renovation: 36,26 GWH

Total current electricity demand: 29,98 GWH

-0,45

Total electricity demand after renovation: 29,53 GWH

Figure 111

+ Figure 111: Calculation total energy demand (data from (IABR-atelier and POSADMAX-WAN, 2019 and BAG WFS, 2022)

6.3.2 ENERGY PRODUCTION

In order to become self-sufficient, Rozenburg has to produce its own heat and electricity. Different buildings/functions require different temperatures of heat, figure 112 shows the needed temperature level per building. The potential heat sources are shallow geothermal heat, biogas from organic waste and residual heat from the supermarkets in the neighbourhood. The shallow geothermal heat has the potential to produce 154 GWH low temperature heat per year, which is a lot, however, most houses require a higher temperature. To get the heat on the right temperature, heat pumps can be used.

The residual heat of cooling installations of supermarkets in the neighbourhood can produce 4,6 GWH low temperature heat per year and 5,84 medium temperature per year (warmteatlas, n.d.a.) (Kok, 2013).

In order to generate electricity Rozenburg can place wind turbines and solar panels. In the North-Western part of Rozenburg there is quite some open space, which makes it possible to add up to 10 2 MW wind turbines with a height of 80 meters to the already existing turbines. The distance between the turbines has to be at least 400 meters in order to profit from the wind optimally (Bureau Nieuwe Gracht, 2008). One windturbine will produce 2MW*2250h = 4500 MWh = 4,5 GWH (Slimster, n.d.a.) We can place around 10 wind turbines, which could produce 45 GWH per year in total.
In total, 78.457 panels could be placed on top of roofs in Rozenburg, which could generate 18,6 GWH of electricity (Provincie Zuid-Holland, 2017). PV panels could also be used to generate heat.

In theory, Rozenburg can produce more than enough energy to become self-sufficient. In terms of energy production and open space we therefore see potential to densify in Rozenburg. We advice to densify with apartments, but to preserve the position of producing more energy then demanded, so there has to be a limit on densifying.
Additionally, in order to deal with the intermittency of the sources, it is important to have the possibility to store the energy when there is an excess of energy.

Figure 112

Electricity sources

45 GWH
10 2MW
turbines

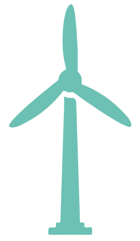


Figure 113

18,6 GWH
78.457 panels
on suitable
roofs

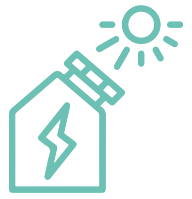


Figure 114

+ Figure 112: Map potential heat sources Rozenburg (data from WarmteTransitieMakers (2022), RVO warmteatlas. (n.d.a) , RVO warmteatlas. (n.d.b) , Allecijfers (2022b) and Vlaco & Attero (2016)

Figure 113: wind turbines Data from (Slimster, n.d. a.) and Bureau Nieuwe Gracht, 2008)

Figure 114: Solar panels (data from OverMorgen, 2017a)

6.3.3 PHASING

What sets Rozenburg apart from Carnisse and Bospolder Tussendijken are the location of the existing Educational Information Centre that educates people about the port (EIC, N.D.), wind potential along with existing windmills for energy production, and large amounts of open and public spaces. The phasing of Rozenburg is therefore tailored to existing infrastructures, potentials, and spaces. This is detailed in figure 115 along with the actors and types of interventions involved in important phases.

The Educational Information Centre in Rozenburg pioneers the social network intended to be formed in the community hub. It can therefore serves as a centre for networking, assistance, and participation in the first phase before a new community hub is built at a central location to the neighbourhood.

The community energy project also utilizes the existing windmills owned by the Port of Rotterdam Authority in the Landtong Rozenburg area (Port of Rotterdam, N.D.) through collaboration with the community. New windmills will also be installed and operated to further meet the electricity demand in Rozenburg. The existing hydrogen heating project by Stedin will pioneer the transition of Rozenburg to hydrogen heating that can use existing natural gas pipelines in the neighbourhood (Stedin, N.D.).

Additionally, solar panels on roofs will also be installed in collaboration with Ressort Wonen, a housing corporation with future plans of transforming the housing stock by making them more energy efficient and sustainable (Ressort Wonen, N.D.).

In the construction and installation process needed to realize this energy transition, the quality of the public space can simultaneously be improved. A new community hub can contribute to a higher quality of public space by making it more attractive to residents and by providing liveliness and activities in the space. A new metro connection to the harbour and the port also improves accessibility in the neighbourhoods which is currently lacking. Rozenburg is segregated from the city; therefore, a new public transport line reconnects the neighbourhood to amenities and job opportunities in the port and in Rotterdam.

The existing companies in the business district of the neighbourhood can then be stimulated to have a circular approach, especially with new renewable energy infrastructure in the neighbourhood. Furthermore, a new business hub can be constructed for small-scale businesses and residents to participate in renewable energy projects and entrepreneurship.

+ Figure 115: Phasing Rozenburg

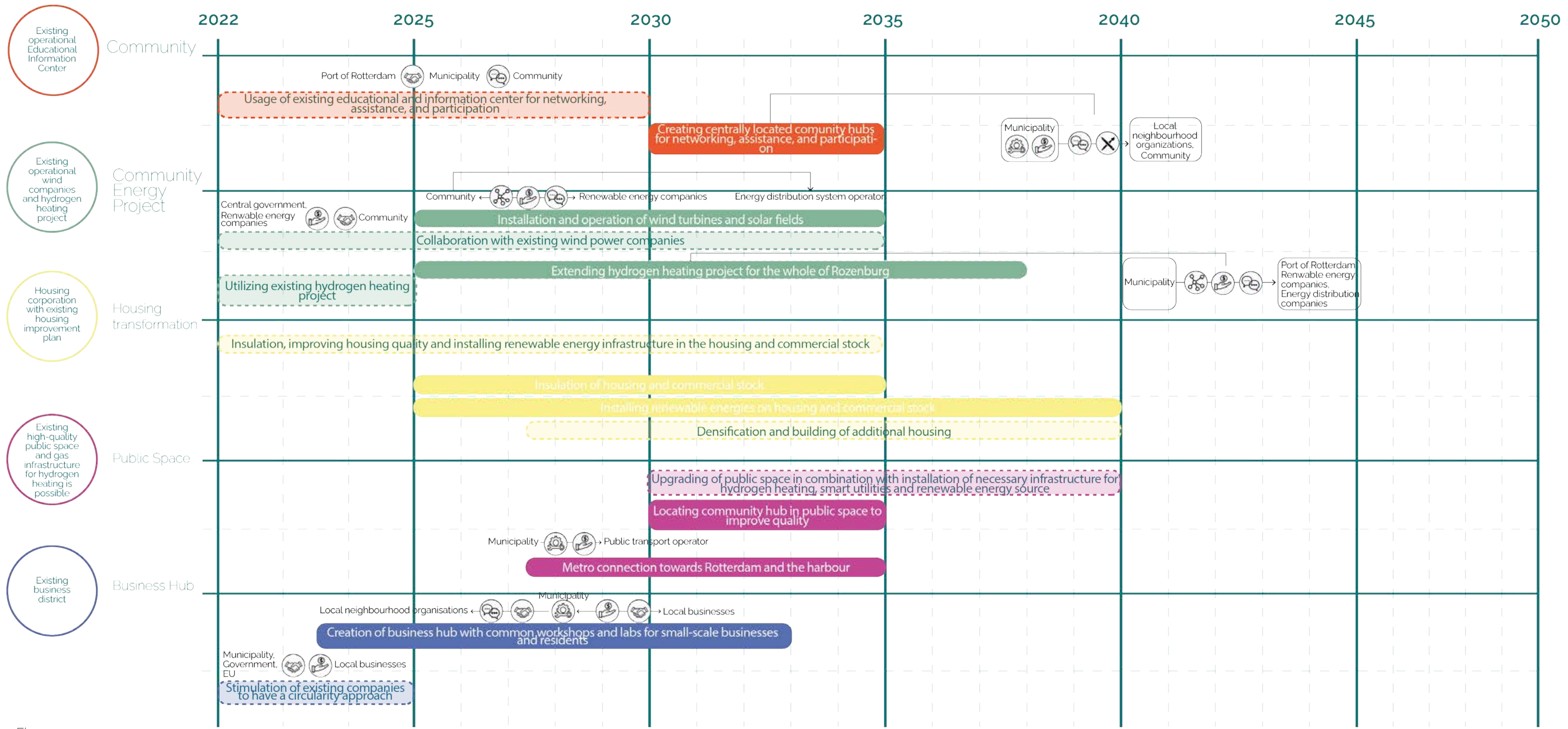
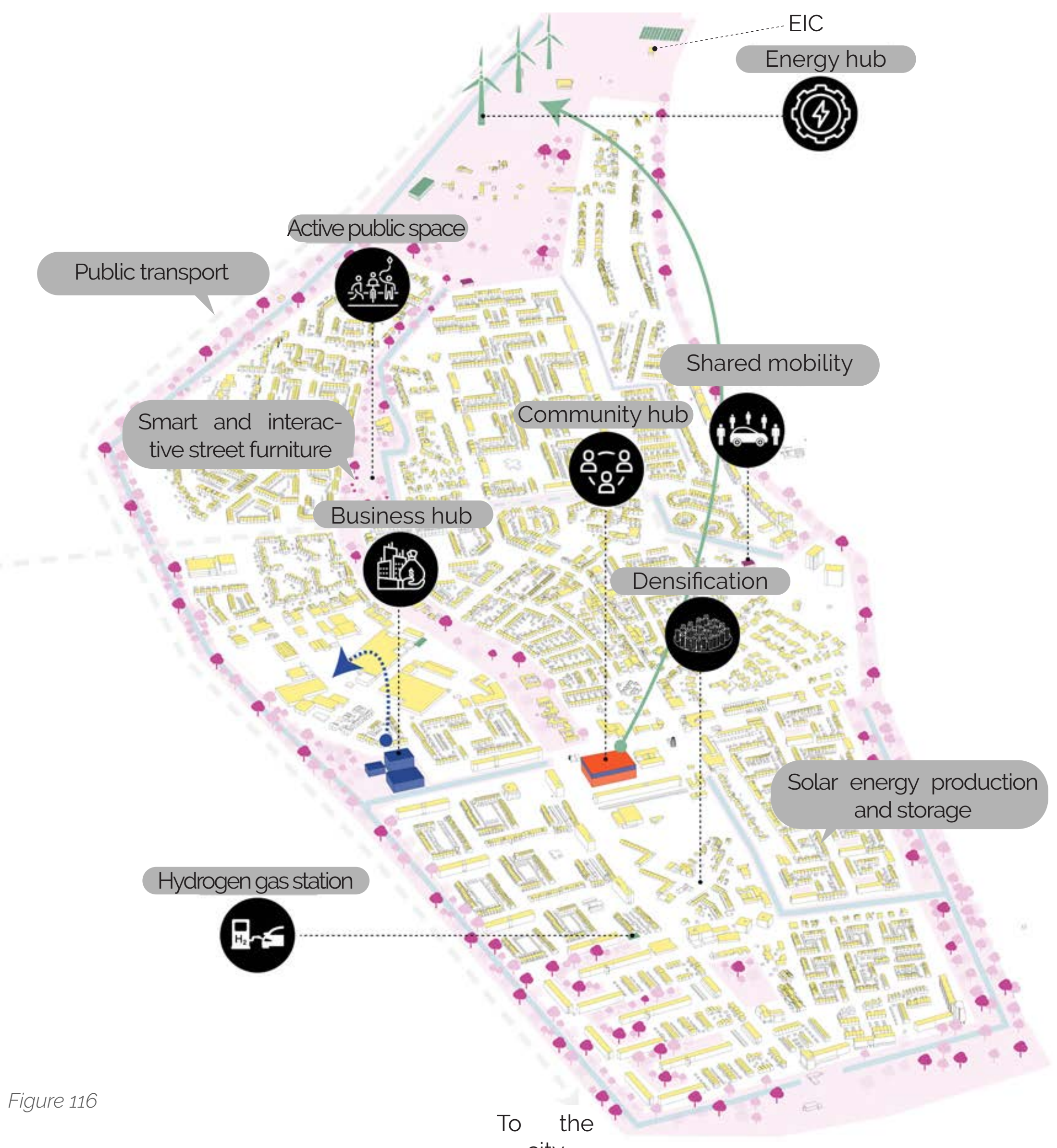


Figure 115

6.3.4 IMPLEMENTATION



To the port

Figure 116: Implementation of key projects in Rozenburg

Figure 117: Collage of future vision for Rozenburg ((Pictures from Google Earth, n.d.b.).

Legend:

Temporary — Permanent

Connection

Figure 116

The phasing and strategic projects previously explained will be implemented in Rozenburg to aid the neighbourhood energy transition. The proposal for implementation in this neighbourhood is seen on figure 116.

The strategic project proposes to utilize an existing business district in the neighbourhood that provides open space, as well as opportunity to integrate new functions within the existing buildings. There is also an opportunity to integerate this proposed business space into a new community hub located in the center of the neighbourhood. This allows for people to socialise and network within their community.

As Rozenburg is abundant in public and open space, there are plenty of opportunities to activate the public space and introduce smart and interactive street furniture to educate people about sustainability and the energy transition where possible. This creates a lively and active neighbourhood, as well as promotes a sense of community. Furthermore, this open landscape and the proximity of Rozenburg to the port provides opportunities for new windmills, solar fields, and biomass collection points in the open space to produce energy for the neighbourhood along with solar panels on the roofs of households. Larger energy infrastructures are located further away from households to avoid nuisance. This ensures that the energy demand in Rozenburg is met without disturbing the living quality.

Shared mobility stops and hydrogen gas stations are also proposed to replace existing gas stations and parking spaces. This is done to encourage less dependency on fossil fuels and car dependency. Public transport infrastructure also aids this transition and allows residents to easily reach the city and economic hubs in the port.

This vision for the future of Rozenburg can be seen in figure 117.

Figure 117

6.4 CARNISSE

6.4.1 ENERGY DEMAND

Introduction

Carnisse, with 20.227 inhabitants per km2, has quite a high density. With 61% it has a very high percentage of people with low-income, however, almost half of the houses are private rental, which could be a challenge for the investments needed for renovations and renewable energy sources. Geographically, Carnisse has the potential to generate wind, solar and shallow geothermal.energy, although the windspeed is not very high, but because there is very little open space, it would be practically impossible to place wind turbines.In Carnisse, the main function is living with a total surface of 166.255 m2. You will find mostly portico houses. Quite some houses were built pre-war and are therefore expected to have a higher energy demand because of bad insulation. To calculate the energy demand, the approach of IABR-atelier Rotterdam and POSADMAXWAN from the case study is used (for calculations see appendix).

+

Figure 118: Year of constructi-on Carnisse (data from BAG WFS 2022)
Figure 119: Typology Carnisse (data from BAG WFS 2022)
Figure 120: Functions Carnisse (data from BAG WFS 2022)

Figure 118

Figure 119

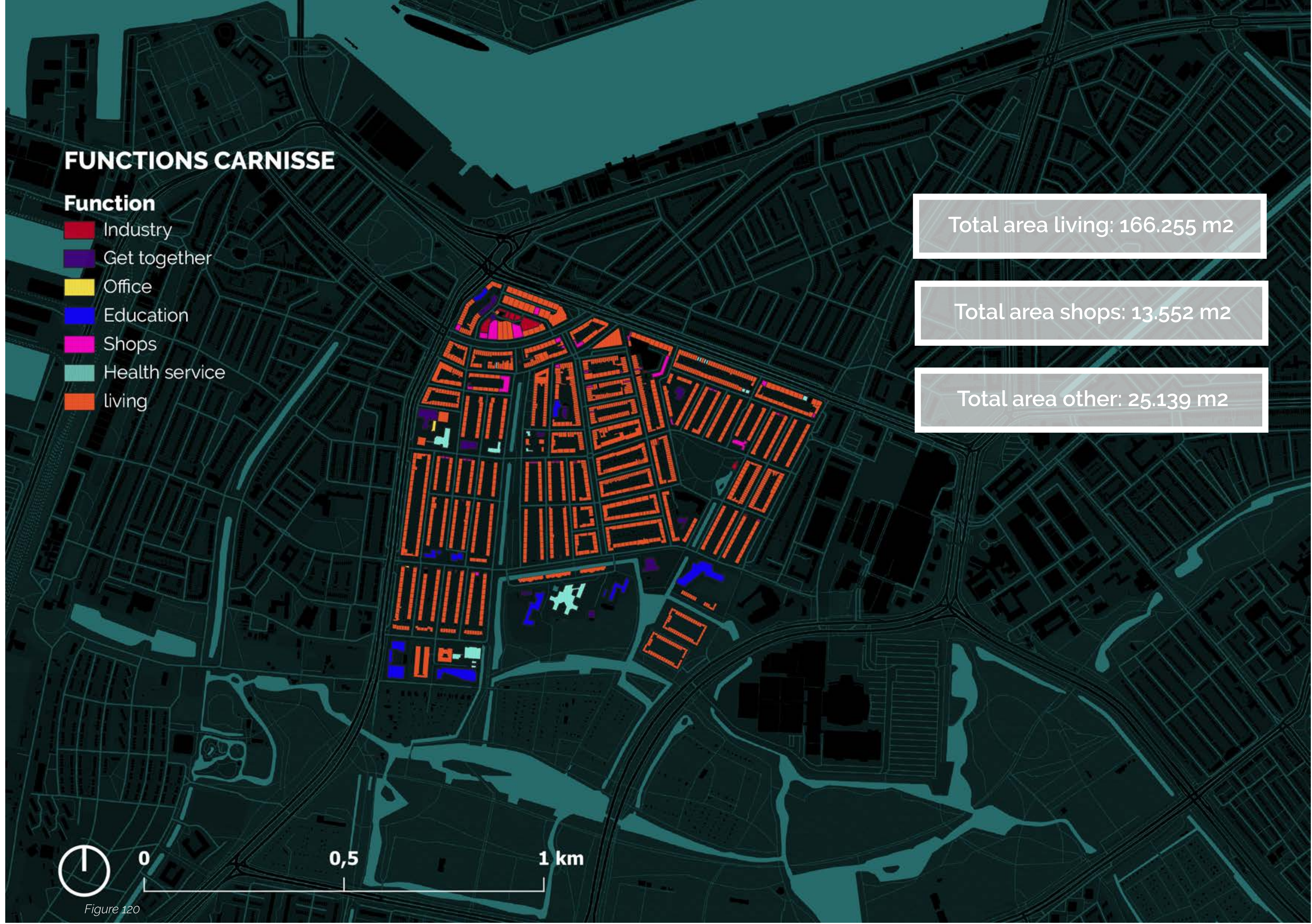


Figure 120

Calculation demand

Based on the construction year, typology and function, and the key figures (appendix) , the calculations for the energy demand were done. As the key figures (see appendix) were not given for the semi-detached and detached houses, an assumption was made for the energy use per m2 based on the TNO report 'Validatie Vesta MAIS model schilisolatie Woningen' (Rovers & Tigchelaar, 2019) and the key figures for the rowhouses. It can be seen again, that after renovating the total heat demand will decrease with an enormous amount. The electricity demand stays more or less the same. It is important to mention that these numbers have been calculated roughly and are also based on some assumptions (full calculations can be found in appendix).

Total area:

205.000 M2

Total current heat demand:

24,06 GWH

-8,39

Total heat demand after renovation:

16,21 GWH

Total current electricity demand:

9,75 GWH

-0,05

Total electricity demand after renovation:

9,70 GWH

Figure 121

+ Figure 121: Calculation total energy demand (data from (IABR-atelier and POSADMAX-WAN, 2019 and BAG WFS, 2022)

6.4.2 ENERGY PRODUCTION

The potential heat sources are shallow geothermal heat, biogas from organic waste and residual heat from the supermarket in the neighbourhood. The shallow geothermal heat has the potential to produce 21,5 GWH low temperature heat per year, however, most houses require a higher temperature. To get the heat on the right temperature, heat pumps can be used.

The residual heat of cooling installations of the supermarket in the neighbourhood can produce 1,09 GWH low temperature heat per year andd 1,36 GWH medium temperature per year (warmteatlas, n.d.a.) (Kok, 2013).

In order to generate electricity, Carnisse can place solar panels on the roofs. In total,43.361 panels could be placed on top of roofs in Carnisse, which could generate 10,3 GWH of electricity (Overmorgen, 2017a). Additionally, 5.200 solar panels with a power of 2.200 MWp could be placed on the conference centre, generating 1,87 GWH electricity per year (Stultiens, 2021) (Tenten Solar, n.d.).

In theory, Carnisse can produce enough energy to become self-sufficient, however this requires optimal use of all potenital, which may be difficult to achieve.
Aditionally, in order to deal with the intermittency of the sources, it is important to have the possibility to store the energy when there is an excess.

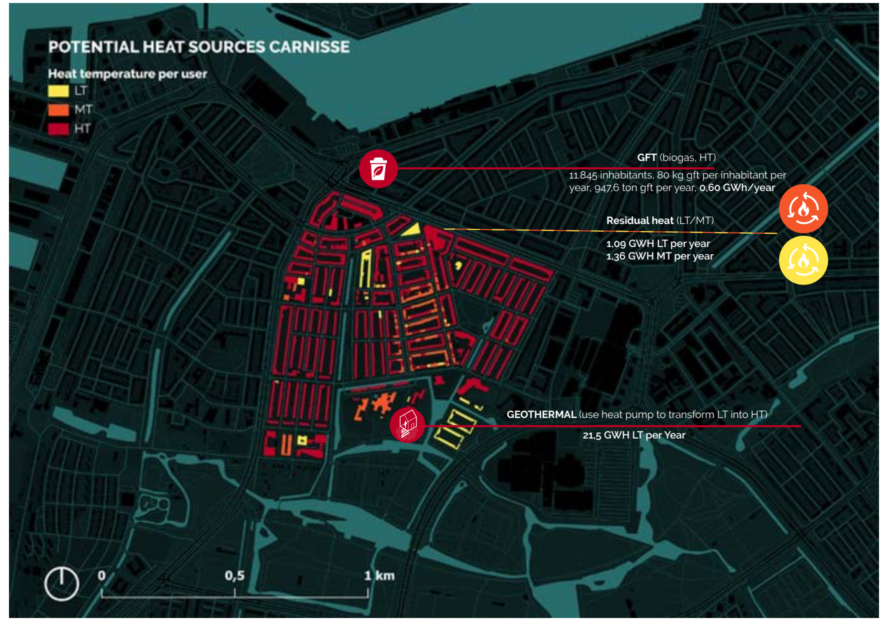


Figure 122

Electricity sources

12,17 GWH
48.561 panels on suitable roofs

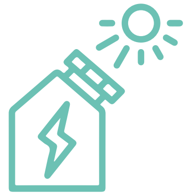


Figure 123

+ Figure 122: Map potential heat sources Carnisse (data from WarmteTransitieMakers (2022), RVO warmteatlas. (n.d.a) , RVO warmteatlas. (n.d.b) , Allecijfers (2022a) and Vlaco & Attero (2016)

Figure 123: Solar panels (data from OverMorgen, 2017a, Stultiens, 2021, Tenten Solar, n.d.)

6.4.3 PHASING

Carnisse is a neighbourhood known for the high number of private rental households. The lack of social housing in the neighbourhood has resulted in exceedingly high rental prices and deteriorating housing quality due to a number of private landlords taking advantage of the housing crisis (Rijnmond, 2021). This is the reason that transforming the housing stock to be more livable and sustainable, as well as densifying for more social housing, is paramount in a neighbourhood like Carnisse. The housing tranformation project is therefore prioritized in the implementation of the key projects in this neighbourhood (figure 124).

A new densification plan in Carnisse Eiland by the municipality of Rotterdam (Gemeente Rotterdam, 2021) also allows for the integration of a new community hub combined with business spaces, labs, and workshops in close proximity to existing households in Carnisse. Temporarily, the existing cultural center 'Productiehuis FLOW' will be used as a center for networking, education, and participation before relocating the community hub to Carnisse Eiland.

There is also an opportunity for Carnisse to receive residual heating from large industries in the port. The necessary infrastructure required to do this, along with the transformation of the housing stock to install renewable energy infrastructure such as solar panels can act as an opportunity to upgrade the quality of the public space.

An existing conference center 'Rotterdam Ahoy' on the outskirts of the neighbourhood also provide large amounts of open space and roof space on existing buildings for the installation of solar panels and solar fields. This gives an opportunity to connect Carnisse to other neighbourhoods and the potentials as well as opportunities these adjacent neighbourhoods may bring.

The phasing for Carnisse makes use of existing plans and aims for an integrated approach of the energy transition with the densification strategy of Carnisse Eiland by the municipality of Rotterdam.

+ Figure 124: Phasing Carnisse

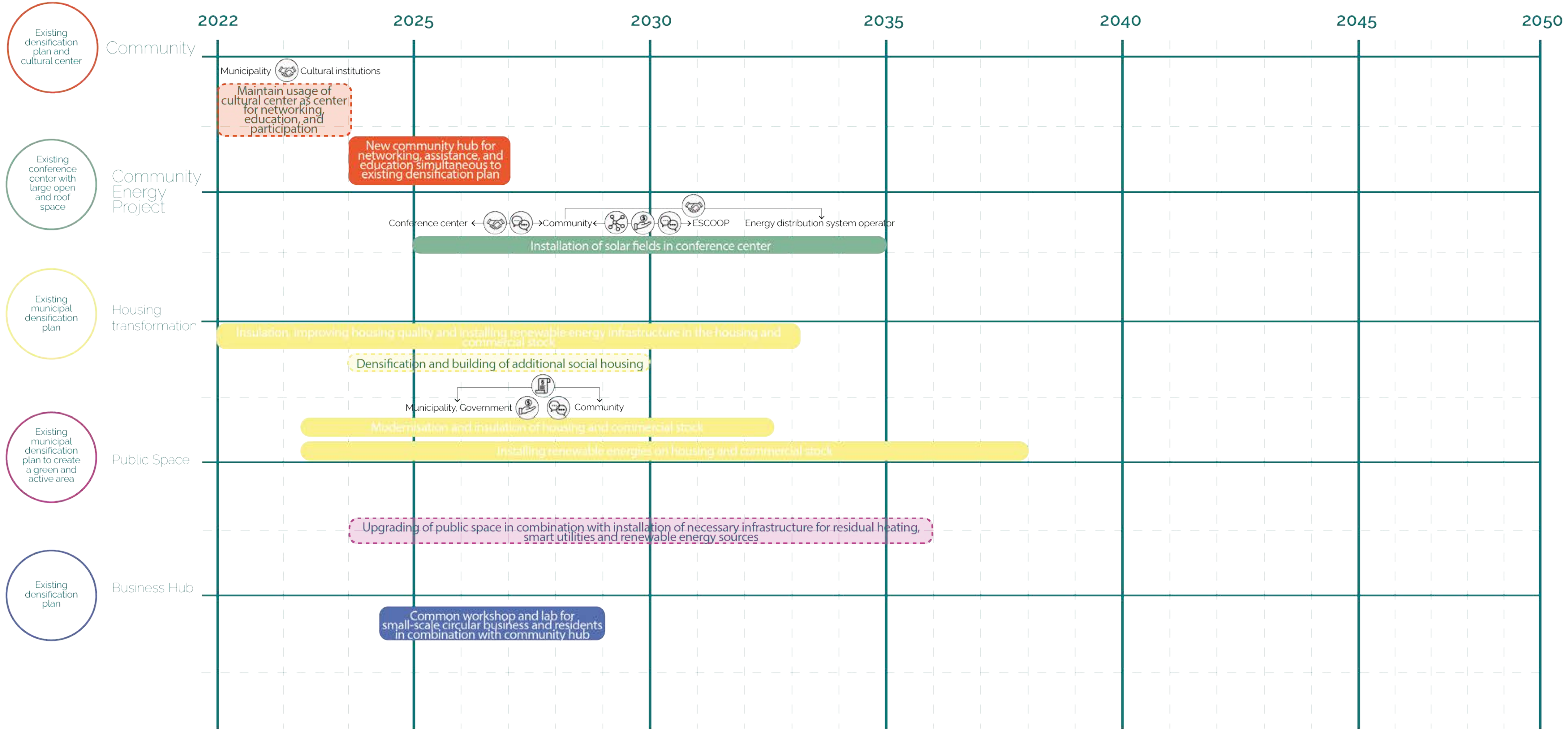


Figure 124

6.4.4 IMPLEMENTATION

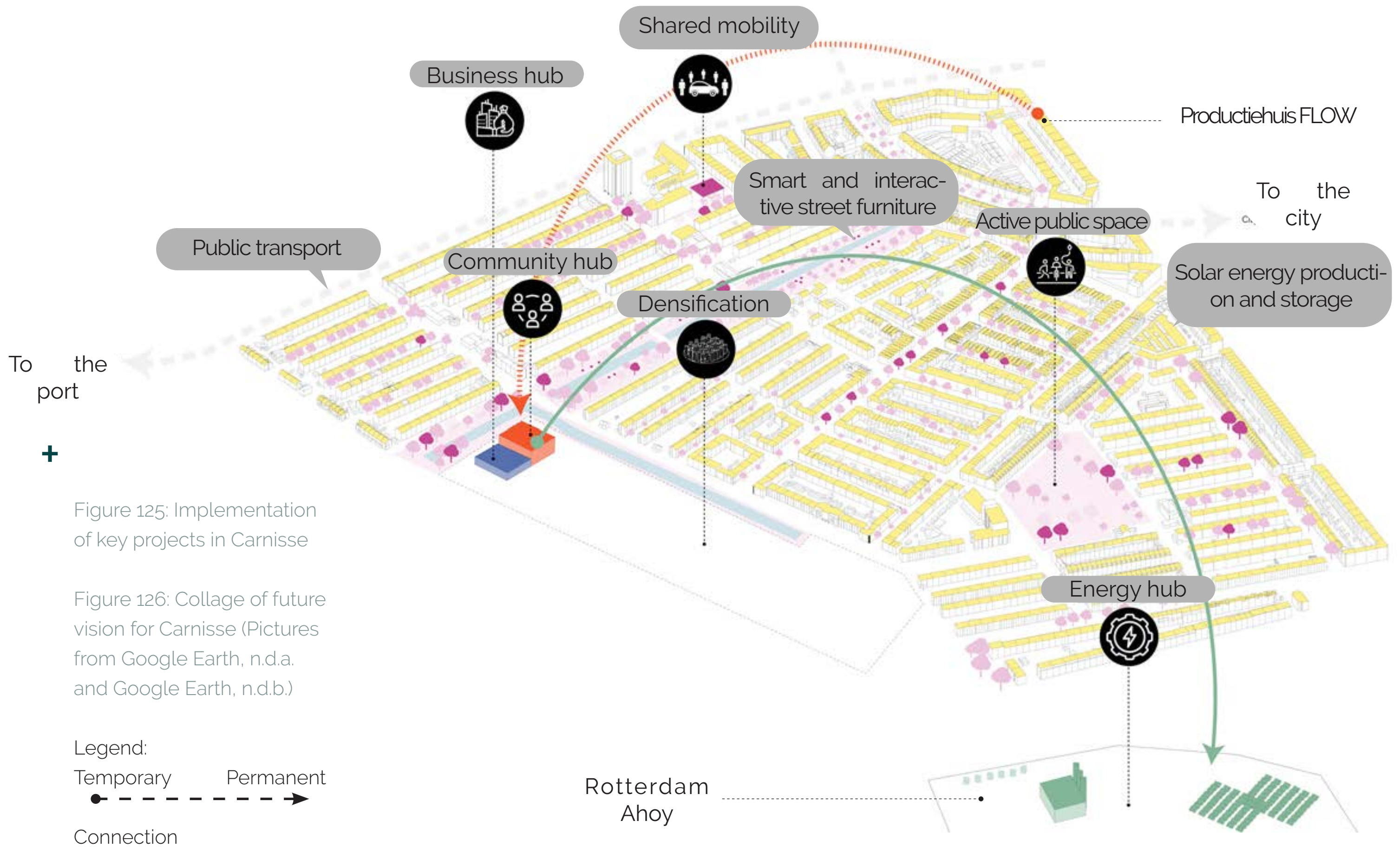


Figure 125: Implementation of key projects in Carnisse

Figure 126: Collage of future vision for Carnisse (Pictures from Google Earth, n.d.a. and Google Earth, n.d.b.)

Legend:
Temporary Permanent

Connection

Figure 125

The implementation of the phasing and the key projects is brought together in a proposal plan for the neighbourhood of Carnisse, as seen on figure 125.

Due to the density of the neighbourhood and lack of open spaces, the main renewable energy installation is in the form of solar panels on household roofs. This is also due to the number of portico houses with flat roofs in the neighbourhood that enables the installation of solar panels. Additionally, biomass collection can also happen within the neighbourhood in smaller scales. The conference center provides an opportunity to install larger infrastructures such as solar fields. If space allows, a geothermal plant could also be located in Carnisse due to its high potential for shallow geothermal heat.

The community hub and business hub can be integrated in the location for the densification plan of Carnisse Eiland which is more visible and central than the current location of 'Productiehuis FLOW' cultural center.

The housing transformations and construction of the new hubs allows for the transformation of the public space to be more active, lively and contain smart and interactive furniture to educate people about the energy transition.

Empowering residents to produce their own energy and providing clean energy activities such as shared mobility and active public spaces provides an opportunity for residents to stand up together as a collective against unfair treatment from private landlords and seek to have more voice regarding their living situations as a neighbourhood and create a sense of community.

The imagined future of Carnisse is visualized on figure 126, highlighting the main key projects.

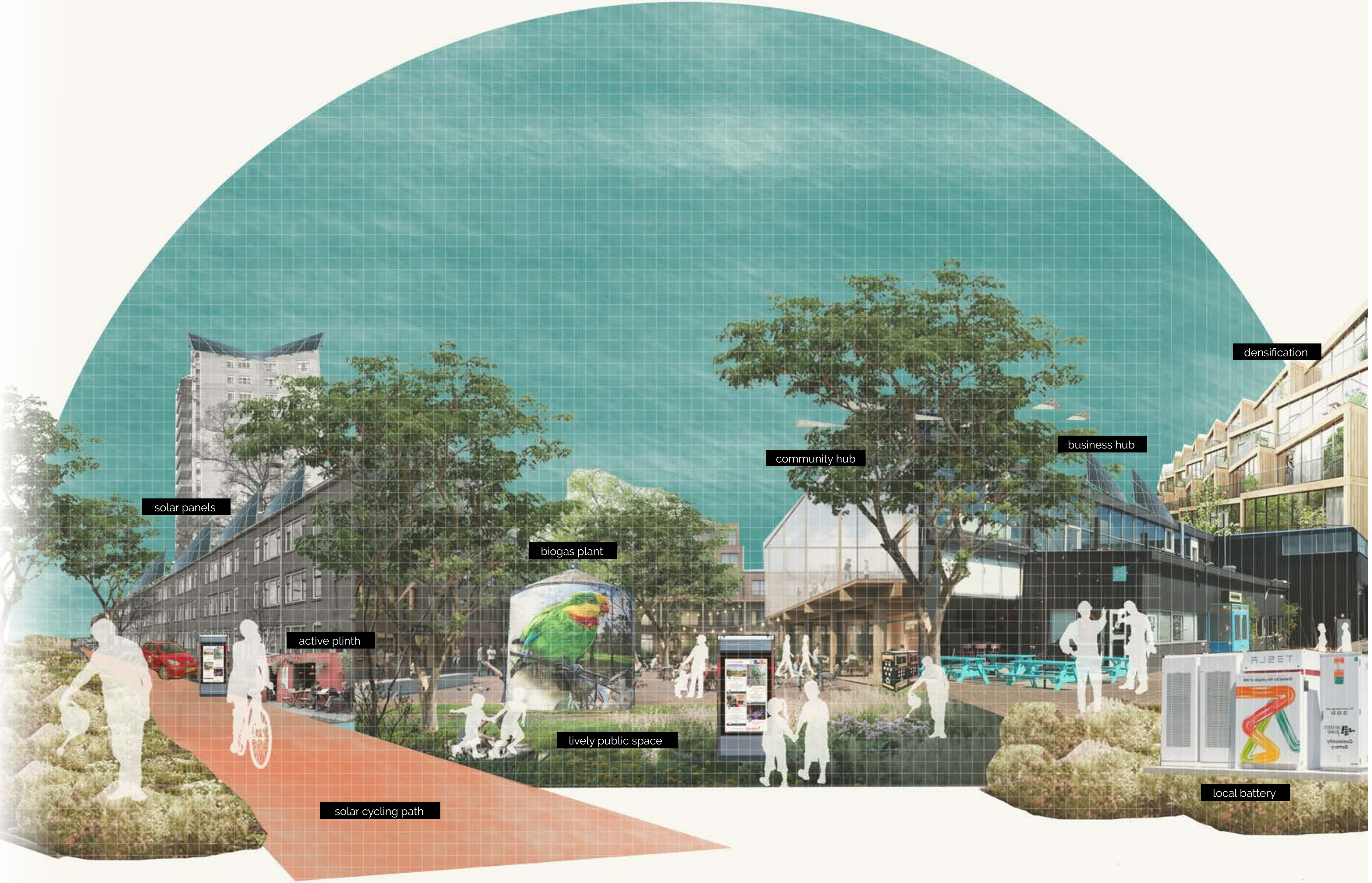


Figure 126

7. CONCLUSIONS AND DISCUSSIONS

7.1 CONCLUSION

The transition to renewable energy is necessary and urgent. Fossil fuels are depleting, are leading to geopolitical instability and are driving climate change. The climate crisis and growing inequalities are among the greatest problems of the 21st century. Temperatures, sea levels and gas prices are rising. The transition will happen and it poses spatial and economical challenges for the maritime region of South-Holland, as the port is a large hub for fossil energy and contributes greatly to the national economy. The social challenge posed, is to create a just transition. Some groups are more vulnerable to the transition than others, as they are more prone to be subjected to energy poverty and/or to lose their (fossil related) jobs.

This project aims for an inclusive socio-spatial energy transition for South Holland.
In our vision for South-Holland in 2050 ,"from consumer to prosumer", we propose a just energy framework that consists out of a mainframe and a local frame. The mainframe concerns a large-scale renewable energy landscape in South-Holland. The energy sources in the mainframe are wind, solar and geothermal energy and biogas, hydrogen and residual heat.

The local frame is the most relevant in our vision and concerns a plan to transform the vulnerable neighbourhoods in South-Holland from consumers into prosumers by generating energy themselves while also improving the quality of living. The energy sources in these neighbourhoods depend on the characteristics of the neighbourhoods, but typically consist out of solar panels, residual heat, biogas and occasionally geothermal heat and wind turbines. By investing in those neighbourhoods, they become the drivers of the energy transition and inequality decreases.
Inbetween the local frame and the mainframe is the port. The port will have three main pillars: hydrogen storage, biofuel and and the circular manufacturing of renewable energy systems.

The core values leading from the vision by which we measure the planned interventions are: social inclusion, a sense of community, living quality, local economic value, energy production and circularity. The interventions are organised in interrelated key projects. The key projects are housing, community hub, public space, business hub, energy hub and port. The interventions for the local frame are strategically planned in roughly three phases: preparation, coördination and participation (1) , installation and implementation (2) and production and co-owning (3). Each intervention has its own related stakeholders and required actions. The sum of interventions is expected to result in an inclusive socio-spatial energy transition for South Holland.

7.2 LIMITATIONS AND RECOMENDATIONS

The neighbourhoods have been chosen strategically to represent the province of Rotterdam. Therefore, the solutions found here can be applied everywhere with slight alterations to implement this strategy in the entire province.

In the strategy the main focus is on the implementation of the local frame, hence we see potential in expanding this strategy to a larger scale and including the provincial energy production and port in an integrated strategy. However, due to the limited time, we focussed on the local frame as it is an unique profile, while it takes into account existing research for the mainframe.

We believe that the concept of the prosumers can also be used in other projects. However, we are aware of the political privileges that we have in the Netherlands and acknowledge that in countries where there is less or no welfare state, this concept becomes more difficult to apply. Even in western countries, a difference can be seen in the extent of the welfare state. The Netherlands, together with Scandinavian countries, are more steered by the state, while countries like the US or Australia are more market-steered. Germany and France are examples of countries that fall in between these two categories. The literature by van Voorhis (2002) describes western countries by classifying them in degrees of decommodification: to what extent are people able to function without participating in the labour market. Whereas Sweden and the Netherlands are closer to the top of this list, the US and France fall further back.

This information shows that the welfare state in the Netherlands is organised differently than in countries like the US and France. The government is more prone to help vulnerable groups in terms of benefits and social assistance. Adopting such a strategy in a country where this is not the case, becomes more complex. Simultaneously, in Scandinavian countries, this strategy could be applied.

Additionally, spatial characteristics play an important role. The Netherlands is relatively dense, in the sense that people live close together, in comparison to, for example, suburbs. However, the building typologies in the Netherlands are relatively low, which means that there is more roof available in relation to the number of inhabitants. These spatial characteristics make it possible to place a lot of renewable energy sources in a location, but also to create a community within the neighbourhood, as people are likely to see each other relatively often. In dispersed areas or intensely populated areas, this strategy becomes more difficult to apply as either implementing the social aspect or the technical aspect.

7.3 SOCIETAL RELEVANCE AND ETHICAL ISSUES

The climate crisis will remain a pressing issue without the energy transition. In an environmental perspective, the energy transition is a requirement in order to ensure that global CO_2 emissions are halved by 2030 (UN, 2021). The energy transition is necessary to avoid the severity and frequency of weather extremes, rising sea levels, heatwaves, population displacement, and loss of lives and livelihoods.

According to the Royal Netherlands Meteorological Institute, sea level rise in the Dutch coast has increased by 50% compared to the rate of sea level rise in the 20th century (KNMI, 2014). Along with this, the subsidence of the Dutch soil is expected to continue up to several mm's due to human activities (Stouthamer et al., 2020). These are the reasons the energy transition is especially relevant for a country like The Netherlands.

One of the greatest societal challenges of today is the prevalence of growing inequalities, to which energy has the possibility to create transformational opportunities. There are 759 million individuals worldwide who have inadequate access to electricity due to energy poverty or unavailability of necessary infrastructure (UN, 2021). This is why this project strives for socio-economic justice through the energy transition.

Renewable energy solutions have the possibility to ensure essential services such as better education, new jobs, improved healthcare, and sustainable economic value to alleviate impoverished neighbourhoods (UN, 2021). The provision of these services is how urban space can play a role in justice The potential of an energy revolution, that shifts conventional energy to renewable energy in order to accelerate development and economic progress, makes it enormously relevant to societies that are not only at risk of the rapid warming of the planet, but are also vulnerable due to structural injustices that stem from long-standing historical trends

Despite the benefits of the energy transition and predicted contribution of the transition towards economic development, the ethics of the topic at hand is still inevitably complex and multi-faceted. Important aspects to ethically evaluate on consider the distribution of burdens and benefits, participation of all social classes, systemic injustices, and organizational values and practices such as rights and responsibilities of employers, employees, and so forth (Miller, 2014).

In the distribution of burdens and benefits, it is important to note that livelihoods may be lost in the process of phasing out fossil fuel-based industries and the installation of renewable energy infrastructure may further disadvantage those living in already vulnerable neighbourhoods. The choice regarding energy is therefore not between ethical and unethical forms of energy, but rather the types of outcomes these systems produce. The concept of NIMBYism plays an influencing role towards the acceptance of new renewable energy infrastructure in vulnerable neighbourhoods. Households may not be willing to allow these infrastructures in close proximity to their place of residence. An ethical issue of whether these households should have the option to opt out of the energy transition despite its benefits, arise. In this regard, communicative planning is necessary in order to inform residents and also listen to their opinions. Furthermore, the strategic approach in this paper highlights the provision of flexibility and compensation for the jobs lost in the energy transition, as well as the benefits that the energy transition can bring to the vulnerable neighbourhoods in order to combat the ethical issue of a fair distribution of burdens and benefits.

The participation of all social classes in the transition is also considered. In this paper, priority is given to households in vulnerable neighbourhoods in the form of financial incentives, subsidies, and guidance to aid them in the transition. This was done in order to ensure that vulnerable groups more likely to not be heard are given more voice and participation in the decision-making process In doing so, democracy building or strengthening becomes easier while an active and robust civil society is promoted.

However, in doing so, an ethical question of whether wealthier neighbourhoods should be given the same incentives and aid arise. The argument requires the concept of equity, wherein people receive what they need in order to be successful according to their situation (LeadMN, 2018). Through prioritizing vulnerable neighbourhoods first, it is ensured that people of all social classes get access to the same opportunities, regardless of barriers created through history with regards to participation. In doing so, systemic injustices are also tackled.

The practices of organizations also raise an ethical issue as they are required to shift from conventional practices that provide economic value and a sense of identity. To this end, the inclusivity of shared responsibility is brought forth along with the distribution of burdens and benefits in the energy transition. In mitigating the climate crisis, all people should bear the responsibility and subsequently the burdens of the transition. Further designs for the energy transition should therefore consider what the shift means for already existing organizations and the people or livelihoods attached to them.

The question of ethics in this report boils down to the need for communicative planning that includes citizen participation and also allows for the design of an urban space to contribute to a fair and just society.

7.4 SUSTAINABLE DEVELOPMENT GOALS

The sustainable development goals provide a basis for the approach in any project. In this report, 9 out of the 17 goals were considered.

In this section, the contribution of the project to the SDG goals will be explained in detail.

1 NO POVERTY — Through employment and educational opportunities, along with aiding prosumer neighbourhoods, we tackle poverty.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE — We stimulate companies to convert to renewable energies and have a circular approach, as well as create energy and knowledge hubs in the port.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION — Introduction of a circular economy and society, as well as promoting energy efficiency and reducing demand creates responsible consumption and production.

7 AFFORDABLE AND CLEAN ENERGY — Producing energy on local land and on sea results in less dependency on other countries and having constant and affordable energy.

10 REDUCED INEQUALITIES — By uplifting vulnerable neighbourhoods through energy investments and access to renewable energy, we reduce inequality and boost deprived areas.

13 CLIMATE ACTION — Phasing out fossil fuels decreases CO_2 emissions and the circularity of materials leads to less depletion of resources, thus mitigating the climate crisis.

8 DECENT WORK AND ECONOMIC GROWTH — We keep the global position of the port and therefore stimulate employment and economic growth.

11 SUSTAINABLE CITIES AND COMMUNITIES — By turning vulnerable neighbourhoods into prosumer neighbourhoods that produce renewable energy, we create sustainable cities and communities.

17 PARTNERSHIPS FOR THE GOALS — An open and participatory approach between public parties, private parties, and civil society is promoted in the decision-making process.

Figure 127

+ Figures 27 of Sustainable Development Goals (data from OECD, 2020)

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APPENDIX

INDIVIDUAL REFLECTIONS

Daniëlle Lens 4841484

"Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody." -Jane Jacobs

A famous quote that will always be relevant for all urban planners, in whatever context it is used. In the time of Jane Jacobs, the energy transition was not a thing yet, but all complex problems ask for a well-considered response that takes into account all people. In my opinion, this is the strength of our strategic vision for the province of South Holland. The social problems that arise through the energy transition are usually considered negative externalities that have to be limited. However, for us, the social problems that are already existing and expected to develop are put in the centre. In this way, we do not only see the energy transition as an environmental solution but also as a socio-economic one.

In the world of urban (re-)development, 'list-making' is a frequently used practice: lists of problems that have to be tackled. During the process, priorities are set and a lot of problems get lost: they are not solved at all. And when looking at urban development, money is one of the main factors that determines what has to be on top of the list. Coincidentally, solving social problems is usually seen as a lost investment, resulting in even more social problems.

By incorporating the social aspect, especially vulnerable groups, as the fundament of the vision, we can not get around it. That's how we come back to Jane Jacobs, by including everyone in the process of the energy transition, we create a region that provides a good living quality for everyone.

As a group, I believe we have done a good job in expressing this way of looking at problems. The vision is seriously ambitious, but I do believe that we evoke a certain awareness that the energy transition does not necessarily cause negative externalities for these vulnerable groups. The process of doing this was not always easy, as we are a group with different opinions, but I believe that despite minor compromises, we still reached a strong vision that is coherent and clear.

The main struggle I experienced was the difference in working style between the group members, which collided sometimes. I personally prefer working alone at times to get more work done, but now I'm aware that that is not the case for everyone and that it is important to compromise sometimes to optimize everyone's workflow.

Therefore, I think all of us have learned a lot about the process of working in a group and on the topic of the energy transition. If I speak for myself, I can say that none of the courses I had until now have given me this many new insights into the problems and complexity of our discipline. I have worked on research on the operation of coal plants, but also on the employment opportunities arising from the energy transition. I believe this course is essential for designers to provide a wider worldview.

Overall, I am very proud of the strategy we have presented and I will take all the information acquired with me for the rest of my master's degree. I am very thankful for the dedication my team members have shown and for the hard work they have put in, because, in the end, we would not have gotten this far without a team effort.

Barbara de Meijer 4850734

'From consumer to prosumer: an inclusive socio-spatial energy transition for South Holland' is the vision we created for South Holland in 2050. It is not the typical 'smart city' and renewable energy plan you have seen a few times already. What makes our vision special is its strong emphasis on social justice and really creating an integrated approach to tackle the problems society faces today, instead of seeing them as separate topics. Working on this topic was a really inspiring and a valuable learning experience to me. It taught me how complex regional planning, and the socio-economic and spatial impact of the energy transition in particular, is. There are so many stakeholders with different interests involved, so many different sectors that put claims on land, so many spatial changes leading from the energy transition, and so many uncertainties, even on a global scale, which makes it very hard to coordinate. However, our design proposal is very much research based and well thought out, which I strongly value and will pursue for the rest of my career.

One of the questions of the methodology course was why supercomputers can't model our cities and the answer is: because there is no perfect model. There is a strong political aspect in the planning process, as there are many different interpretations of what the actual problems are and there is no 'best' scenario. In this project we positioned ourselves as advocacy planners from the beginning on. Our objective was to advocate for the interests of those who are most vulnerable to the energy transition and to make sure there was a fair distribution of burdens and benefits through the energy transition. For our proposal we have designed through different scales: from the regional scale with its global dependencies to neighbourhood scale in order to make sure we give those people the voice we want them to have and to see what the concrete implications are of our design interventions.

Throughout the process I felt very supported by my group mates and tutors. In our group we each brought our own strengths to the table. We didn't always share the same opinions, luckily, because discussing this has helped us to sharpen our arguments. The methodology course along the design course also facilitated this. Our tutors enthusiasm was inspiring and they have guided us through a sometimes difficult process. I am very proud of the end result.

Jasmine Bacani 5609267

It is easy to get lost in considering individuals with their sentiments and backgrounds as mere figures and statistics when tackling regional planning and large-scale issues as urban planners. This tendency is what drives the need to approach strategies like the energy transition from a societal perspective. Ensuring that stakeholders, especially those that may be negatively affected by interventions, such as vulnerable neighbourhoods, increasingly become the just approach to designing cities. The strength of this project lies in using vulnerable neighbourhoods as an opportunity rather than a hindrance in implementing renewable energy.

Despite the recency of a fair and just energy transition, it is not a completely new perspective. Particularly, the United Nations (2021) has put not only the economic and environmental benefits of the energy transition at the forefront, but also the social consequences of this shift. Our project brings us back to this approach and allows us to keep the Sustainable Development Goals in mind. Upon completion of the project, we have ensured that justice is central to our proposals, visions, and strategies that can be built upon by future projects.

I believe that the end product of this project reflected the commitment and keen interest all group members had for the topic we have selected. It was due to this that despite having an ambitious plan, we were able to contribute to giving vulnerable neighbourhoods a voice in the energy transition.

The teamwork required to make this project possible was an enormously humbling and enlightening experience, not only due to the vast information from the topic at hand, but also in group dynamics that was essential in ensuring that our approach was as complete as possible. Similar to any groupwork, a smooth journey is almost always never guaranteed and bumps along the way can be faced. This was particularly due to the differences in styles of working and approach to the project. A group of four people may lead to a clash of opinions and working styles that may require compromises.

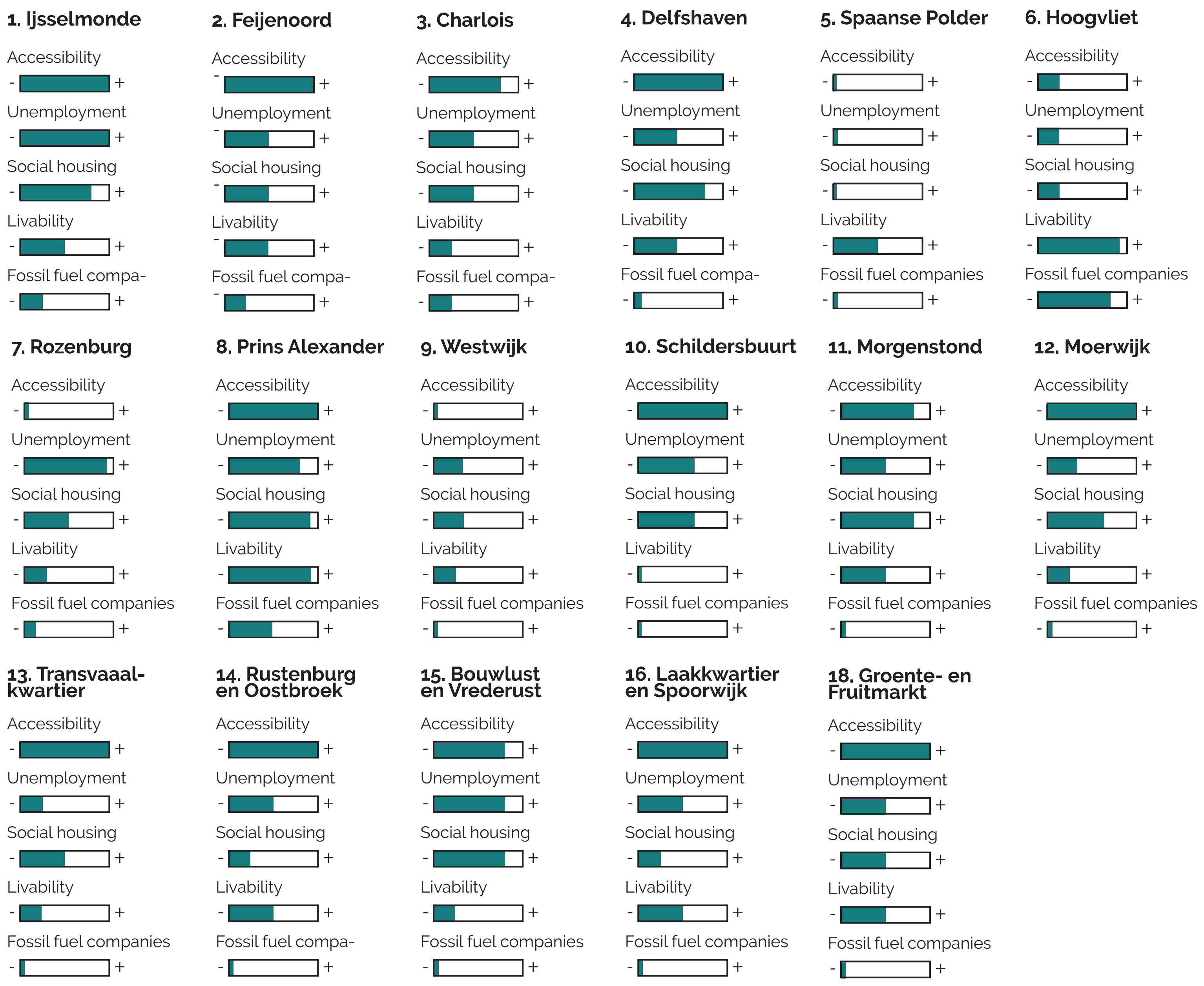
Despite initial difficulties in tackling certain topics, we were able to overcome them by considering everyone's opinions and preferences, as well as putting the quality of the project first.

All in all, I believe that we have learnt a lot that we can apply to future projects. Despite being exceedingly challenging, the project has allowed us to grow in our abilities as regional planners and has created a bond between the group members. Considering our end product, I am proud of our project and would like to extend my gratitude to my group members without whom the quality of this project could not have been achieved.

Leon Morscher 5634393

Russia's illegal invasion of Ukraine and the associated energy price explosion have catapulted the issue of our dependence on gas and oil, especially from Russia, into the public discourse. Of course, it would be a must to immediately stop this trade relationship and steady flow of money to a warring country. Of course, it is easy for me as a privileged student to demand this. On the other hand, the issue is much more complex and not only black or white. After all, the resulting explosion in energy prices and cost of living is affecting those who already have the least. Energy poverty is an acute and significant problem in our society, the current crisis has only pushed it into the public discourse. Provided we do not rethink how we shape it. We, the co-creators of this energy transition, must work to ensure that it not only means a change in our economy, a shift away from fossil fuels, but also a change in our society. This is necessary, but also achievable. After all, the energy system is much more than a technical infrastructure: the energy transition is generating new organizational forms and business models, changing landscapes, requiring new ways of living and behaving, and creating new responsibilities, regulatory requirements, and distributions of power. I found the semester's exploration of the energy transition very valuable. It showed me that it allows us to shape our living spaces and thus society more equitably. Exploring the topic in the methodology course showed me how important governance and our role as urban planners are to work towards improving socio-economic and spatial justice. In quarter one and two, these topics, in my opinion, took up too little space and had a very technical-design focus. Especially since I lived and work previously in Berlin, where topics like inclusion, participation and cooperative planning are very present. On the other hand, I found the SDS courses very instructive, as they gave us tools to use policy design and planning to address mentioned problem areas. The scale is very interesting for me because we have a much larger planning area and sphere of influence. However, in the beginning, it was difficult to change from the small scale of the last semester to this regional one, and to keep the overview, because of the large research area, the overwhelming information and the many investigation directions. However, the work as a group and the guidance of the courses and tutors helped me to frame the topic and work out together a subject, on a scientific basis. The long discussions and conversations about the direction of our topic were exhausting, but sharpening our argument and in the end, also brought us forward as a group and personally in my communication.

SELECTION CRITERIA



KEY FIGURES HEAT

Utility Buildings

(source: ECN)

	existing*	after renovation**	% after renovation compared to old situation
office	113 kWh/m2	88.1 kWh/m2	78
stores	99.4 kWh/m2	78.0 kWh/m2	78
health	121 kWh/m2	99.3 kWh/m2	82
catering	238 kWh/m2	206 kWh/m2	87
Education	100 kWh/m2	88.6 kWh/m2	87
meeting	238 kWh/m2	206 kWh/m2	87
hotel	176 kWh/m2	158.3 kWh/m2	90
Industry***	99.4 kWh/m2	78.0 kWh/m2	78

* the average of the different year classes
** Renovation to current status
* * * objects marked as industry are often shops in BOTU

living

(source old: VESTA and Nieman* , source new: BENG)

home typing		construction year	existing gas_kwh/m2	gas_after_renovation (kWh/m2)	new	% after renovation compared to old situation
apartment	1	< 1925	92.6 kWh/m2	81.0 kWh/m2	36.1 kWh/m2	87%
	2	1925 - 1945	161.3 kWh/m2	66.7 kWh/m2		41%
	3	1946 - 1960	117.6 kWh/m2	53.30 kWh/m2		45%
	4	1961 - 1970	124.3 kWh/m2	69.80 kWh/m2		56%
	5	1971 - 1980	143.2 kWh/m2	87.10 kWh/m2		61%
	6	1981 - 1990	143.2 kWh/m2	87.10 kWh/m2		61%
	7	1991 - 2000	94.3 kWh/m2	66.25 kWh/m2		70%
	8	2001 - 2018	55.8 kWh/m2	55.84 kWh/m2		100%
terraced house	1	< 1925	149.1 kWh/m2	57.30 kWh/m2		38%
	2	1925 - 1945	144.7 kWh/m2	61.00 kWh/m2		42%
	3	1946 - 1960	140.3 kWh/m2	64.70 kWh/m2		46%
	4	1961 - 1970	140.3 kWh/m2	64.70 kWh/m2		46%
	5	1971 - 1980	98.75 kWh/m2	60.95 kWh/m2		62%
	6	1981 - 1990	98.75 kWh/m2	60.95 kWh/m2		62%
	7	1991 - 2000	57.2 kWh/m2	57.20 kWh/m2		100%
	8	2001 - 2018	55.84 kWh/m2	55.84 kWh/m2		100%
porch house	1	<1900	120.6 kWh/m2	95.10 kWh/m2		78%
	2	< 1925	92.6 kWh/m2	81.00 kWh/m2		87%
	3	1925 - 1945	161.25 kWh/m2	66.70 kWh/m2		41%
	4	1946 - 1960	117.6 kWh/m2	53.30 kWh/m2		45%
	5	1961 - 1970	105.8 kWh/m2	47.70 kWh/m2		45%
	6	1971 - 1980	143.2 kWh/m2	87.10 kWh/m2		61%
	7	1981 - 1990	143.2 kWh/m2	87.10 kWh/m2		61%
	8	1991 - 2000	94.3 kWh/m2	66.25 kWh/m2		70%
	9	2001 - 2018	45.4 kWh/m2	45.40 kWh/m2		100%
Other	1	1946 - 1960	223.1 kWh/m2	101.1 kWh/m2		100%
	2	2001 - 2018	192.7 kWh/m2	192.7 kWh/m2		100%

KEY FIGURES ELECTRICITY

Utility Buildings

(source: ECN)

	existing*	after renovation	new**	% after renovation compared to old situation
office	80.8 kWh/m2	→	84.9 kWh/m2	105
stores	137 kWh/m2	→	135 kWh/m2	98
health	76.9 kWh/m2	→	80.2 kWh/m2	104
catering	281 kWh/m2	→	263 kWh/m2	94
Education	37.3 kWh/m2	→	44.5 kWh/m2	120
meeting	281 kWh/m2	→	263 kWh/m2	94
hotel	112 kWh/m2	→	92.2 kWh/m2	83
Industry***	137 kWh/m2	→	135 kWh/m2	98

* the average of the different year classes
** Renovation to current status
* * * objects marked as industry are often shops in BOTU

living

(source old: Nieman, source after renovation: Nieman source new: VESTA)

home typing		construction year	existing kWh/m2	after renovation kWh/m2 *	% after renovation compared to old situation*	after renovation electric heating one tap water per home	new
apartment	1	< 1925	18.1 kWh/m2	18.1 kWh/m2	100	645	13.9 kWh/m2
	2	1925 - 1945	43.2 kWh/m2	43.2 kWh/m2	100	406	
	3	1946 - 1960	29.86 kWh/m2	29.86 kWh/m2	100	374	
	4	1961 - 1970	28.07 kWh/m2	28.07 kWh/m2	100	457	
	5	1971 - 1980	25.58 kWh/m2	25.58 kWh/m2	100	468	
	6	1981 - 1990	25.58 kWh/m2	25.58 kWh/m2	100	468	
	7	1991 - 2000	52.51 kWh/m2	52.51 kWh/m2	100	473	
	8	2001 - 2018	24.83 kWh/m2	24.83 kWh/m2	100	513	
terraced house	1	< 1925	17.85 kWh/m2	17.85 kWh/m2	100	512	
	2	1925 - 1945	33.41 kWh/m2	33.41 kWh/m2	100	458	
	3	1946 - 1960	48.98 kWh/m2	48.98 kWh/m2	100	403	
	4	1961 - 1970	48.98 kWh/m2	48.98 kWh/m2	100	403	
	5	1971 - 1980	38.65 kWh/m2	38.65 kWh/m2	100	484	
	6	1981 - 1990	38.65 kWh/m2	38.65 kWh/m2	100	484	
	7	1991 - 2000	28.32 kWh/m2	28.32 kWh/m2	100	564	
	8	2001 - 2018	24.83 kWh/m2	24.83 kWh/m2	100	513	
porch house	1	<1900	31.38 kWh/m2	31.38 kWh/m2	100	447	
	2	< 1925	18.06 kWh/m2	18.06 kWh/m2	100	645	
	3	1925 - 1945	43.17 kWh/m2	43.17 kWh/m2	100	406	
	4	1946 - 1960	29.86 kWh/m2	29.86 kWh/m2	100	374	
	5	1961 - 1970	31.97 kWh/m2	31.97 kWh/m2	100	425	
	6	1971 - 1980	25.58 kWh/m2	25.58 kWh/m2	100	468	
	7	1981 - 1990	25.58 kWh/m2	25.58 kWh/m2	100	468	
	8	1991 - 2000	52.51 kWh/m2	52.51 kWh/m2	100	473	
	9	2001 - 2018	24.83 kWh/m2	24.83 kWh/m2	100	513	
Other	1	1946 - 1960	16.7 kWh/m2	16.7 kWh/m2		†	
	2	2001 - 2018	15.8 kWh/m2	15.8 kWh/m2		†	

CALCULATIONS ROZENBURG

Education				
total area (m2)	current heat demand (kwh/m2	renovation heat demand (kwh/m2)	current elektricity demand (kWh/m2)	renovation elektricity demand (kWh/m2)
7183	100	88.6	37.3	44.5
	total current heat demand (kW	total heat demand after renovation (kWh)	total current elektricity demand (kWh)	total elektricity demand after renovation (kWh
	718300	636413.8	267925.9	319643.5
	in GWh	in GWh	in GWh	in GWh
	0.7183	0.6364138	0.2679259	0.3196435

Healthcare				
total area (m2)	current heat demand (kwh/m2)	renovation heat demand (kwh/m2)	current elektricity demand (kWh/m2)	renovation elektricity demand (kWh/m2)
843	121	99.3	76.9	80.2
	total current heat demand (kWh)	total heat demand after renovation (kWh)	total current elektricity demand (kWh)	total elektricity demand after renovation (kWh)
	102003	83709.9	64826.7	67608.6
	in GWh	in GWh	in GWh	in GWh
	0.102003	0.0837099	0.0648267	0.0676086

Office				
total area (m2)	current heat demand (kwh/m2)	renovation heat demand (kwh/m2)	current elektricity demand (kWh/m2)	renovation elektricity demand (kWh/m2)
3331	113	88.1	80.8	84.9
	total current heat demand (kWh)	total heat demand after renovation (kWh)	total current elektricity demand (kWh)	total elektricity demand after renovation (kWh)
	376403	293461.1	269144.8	282801.9
	in GWh	in GWh	in GWh	in GWh
	0.376403	0.2934611	0.2691448	0.2828019

Shops				
total area (m2)	current heat demand (kwh/m2)	renovation heat demand (kwh/m2)	current elektricity demand (kWh/m2)	renovation elektricity demand (kWh/m2)
6786	99.4	78	137	135
	total current heat demand (kWh)	total heat demand after renovation (kWh)	total current elektricity demand (kWh)	total elektricity demand after renovation (kWh)
	674528.4	529308	929682	916110
	in GWh	in GWh	in GWh	in GWh
	0.6745284	0.529308	0.929682	0.91611

Meeting				
total area (m2)	current heat demand (kwh/m2)	renovation heat demand (kwh/m2)	current elektricity demand (kWh/m2)	renovation elektricity demand (kWh/m2)
19103	238	206	281	263
	total current heat demand (kWh)	total heat demand after renovation (kWh)	total current elektricity demand (kWh)	total elektricity demand after renovation (kWh)
	4546514	3935218	5367943	5024089
	in GWh	in GWh	in GWh	in GWh
	4,546514	3,935218	5,367943	5,024089

Industry				
total area (m2)	current heat demand (kwh/m2)	renovation heat demand (kwh/m2)	current elektricity demand (kWh/m2)	renovation elektricity demand (kWh/m2)
36202	99.4	78	137	135
	total current heat demand (kWh)	total heat demand after renovation (kWh)	total current elektricity demand (kWh)	total elektricity demand after renovation (kWh)
	3598478.8	2823756	4959674	4887270
	in GWh	in GWh	in GWh	in GWh
	3.5984788	2.823756	4.959674	4.88727

+ Calculation total energy demand

Based on: (IABR-atelier and POSADMAXWAN, 2019),(BAG WFS, 2014), (Rovers & Tigchelaar, 2019) and xxx

Appartments					
Construction year	total area (m2)	current heat demand (kwh)	renovation heat demand (kwh/m)	current elektricity demand (kWh)	renovation elektricity demand (kWh)
<1925	0	0	0	0	0
1925-1945	466	75165.8	31082.2	20131.2	20131.2
1946-1960	547	76744.1	35172.1	16333.42	16333.42
1961-1970	2541	356502.3	164402.7	71325.87	71325.87
1971-1980	1550	153062.5	94472.5	39649	39649
1981-1990	397	39203.75	24197.15	10155.26	10155.26
1991-2000	0	0	0	0	0
2001-2022	1117	62373.28	62373.28	27735.11	27735.11
	total area	total current heat demand (kwh)	total renovation heat demand (kwh)	total current elektricity demand (kWh)	total renovation elektricity demand (kWh)
	6618	763051.73	411699.93	185329.86	185329.86
		in GWh	in GWh	in GWh	in GWh
		0.76305173	0.41169993	0.18532986	0.18532986

Rowhouses					
Construction year	total area (m2)	current heat demand (kwh)	renovation heat demand (kwh)	current elektricity demand (kWh)	renovation elektricity demand (kWh/m2)
<1925	723	107799.3	41427.9	12905.55	12905.55
1925-1945	2840	410948	173240	94884.4	94884.4
1946-1960	27296	3829628.8	1755132.8	1364254.08	1364254.08
1961-1970	100808	14143362.4	6522277.6	4937575.84	4937575.84
1971-1980	172399	17024401.25	10507719.05	6663221.35	6663221.35
1981-1990	64128	6332640	3908601.6	2478547.2	2478547.2
1991-2000	3948	225825.6	225825.6	111807.36	111807.36
2001-2022	15993	893049.12	893049.12	397106.19	397106.19
	total area	total current heat demand (kwh)	total renovation heat demand (kwh)	total current elektricity demand (kWh)	total renovation elektricity demand (kWh)
	388135	42967654.47	24027273.67	16060301.97	16060301.97
		in GWh	in GWh	in GWh	in GWh
		42.96765447	24.02727367	16.06030197	16.06030197

Other typologies (semi-detached and detached)					
Construction year	total area (m2)	current heat demand (kwh) *	renovation heat demand (kwh) *	current elektricity demand (kWh)	renovation elektricity demand (kWh)
<1925	2509	426530	188175	44785.65	44785.65
1925-1945	5436	913584	380660	181683.58	181683.58
1946-1960	4599	735840	344925	225259.02	225259.02
1961-1970	12123	1939680	909225	593784.54	593784.54
1971-1980	4530	543600	312570	175084.5	175084.5
1981-1990	7255	870600	500595	280405.75	280405.75
1991-2000	973	58380	58380	27555.36	27555.36
2001-2022	13850	817150	817150	343895.5	343895.5
	total area (m2)	total current heat demand (kwh)	total renovation heat demand (k	total current elektricity demand (kWh)	total renovation elektricity demand (kWh)
	51277	6305364	3511680	1872453.9	1872453.9
		in GWh	in GWh	in GWh	in GWh
		6.305364	3.51168	1.8724539	1.8724539

*based on (Rovers & Tigchelaar, 2019) we came up with assumption for classification comparing the detached houses and semi-detached with the rowhouses

Total built area:

519.876 M2

Total current heat demand: 60,02 GWH

-23,76

Total heat demand after renovation: 36,26 GWH

Total current electricity demand: 29,98 GWH

-0,45

Total electricity demand after renovation: 29,53 GWH

CALCULATIONS CARNISSE

Industry				
total area (m2)	current heat demand (kwh/m2)	renovation heat demand (kwh/m2)	current elektricity demand (kWh/m2)	renovation elektricity demand (kWh/m2)
3770	99.4	78	137	135
	total current heat demand (kWh)	total heat demand after renovation (kWh)	total current elektricity demand (kWh	total elektricity demand after renovation (kWh)
	374738	294060	516490	508950
	in GWh	in GWh	in GWh	in GWh
	0.374738	0.29406	0.51649	0.50895

Meeting				
total area (m2)	current heat demand (kwh/m2)	renovation heat demand (kwh/m2)	current elektricity demand (kWh/m2	renovation elektricity demand (kWh/m2)
7091	238	206	281	263
	total current heat demand (kWh)	total heat demand after renovation (kWh)	total current elektricity demand (kW	total elektricity demand after renovation (kWh)
	1687658	1460746	1992571	1864933
	in GWh	in GWh	in GWh	in GWh
	1.687658	1.460746	1.992571	1.864933

Office				
total area (m2)	current heat demand (kwh/m2)	renovation heat demand (kwh/m2)	current elektricity demand (kWh/m2)	renovation elektricity demand (kWh/m2)
943	113	88,1	80,8	84,9
	total current heat demand (kWh)	total heat demand after renovation (kWh)	total current elektricity demand (kWh)	total elektricity demand after renovation (kWh)
	106559	83078,3	76194,4	80060,7
	in GWh	in GWh	in GWh	in GWh
	0,106559	0,0830783	0,0761944	0,0800607

Health				
total area (m2)	current heat demand (kwh/m2)	renovation heat demand (kwh/m2)	current elektricity demand (kWh/m2)	renovation elektricity demand (kWh/m2)
6040	121	99.3	76.9	80.2
	total current heat demand (kWh)	total heat demand after renovation (kWh)	total current elektricity demand (kWh)	total elektricity demand after renovation (kWh)
	730840	599772	464476	484408
	in GWh	in GWh	in GWh	in GWh
	0.73084	0.599772	0.464476	0.484408

Education				
total area (m2)	current heat demand (kwh/m2	renovation heat demand (kwh/m2)	current elektricity demand (kWh/m2)	renovation elektricity demand (kWh/m2)
11431	100	88.6	37.3	44.5
	total current heat demand (kW	total heat demand after renovation (kWh)	total current elektricity demand (kWh)	total elektricity demand after renovation (kWh)
	1143100	1012786.6	426376.3	508679.5
	in GWh	in GWh	in GWh	in GWh
	1.1431	1.0127866	0.4263763	0.5086795

Shops				
total area (m2)	current heat demand (kwh/m2)	renovation heat demand (kwh/m2)	current elektricity demand (kWh/m2)	renovation elektricity demand (kWh/m2)
9872	99.4	78	137	135
	total current heat demand (kWh)	total heat demand after renovation (kWh	total current elektricity demand (kWh)	total elektricity demand after renovation (kWh)
	981276.8	770016	1352464	1332720
	in GWh	in GWh	in GWh	in GWh
	0.9812768	0.770016	1.352464	1.33272

+ Calculation total energy demand

Based on: (IABR-atelier and POSADMAXWAN, 2019),(BAG WFS, 2014), (Rovers & Tigchelaar, 2019) and xxx

Rowhouses					
Construction year	total area (m2)	current heat demand (kwh)	renovation heat demand (kwh)	current elektricity demand (kWh)	renovation elektricity demand (kWh)
<1925	27655	4123360.5	1584631.5	493641.75	493641.75
1925-1945	2652	383744.4	161772	88603.32	88603.32
1946-1960	4936	692520.8	317384.8	248701.28	248701.28
1961-1970	0	0	0	0	0
1971-1980	0	0	0	0	0
1981-1990	0	0	0	0	0
1991-2000	468	26769.6	26769.6	13253.76	13253.76
2001-2022	5296	295728.64	295728.64	131499.68	131499.68
	total area	total current heat demand (kwh)	total renovation heat demand (kwh)	total current elektricity demand (kWh)	total renovation elektricity demand (kWh)
	41007	5522123.94	2386286.54	973699.79	973699.79
		in GWh	in GWh	in GWh	in GWh
		5.52212394	2.38628654	0.97369979	0.97369979

Portico houses					
Construction ye	total area (m2)	current heat demand (kwh)	renovation heat demand (kwh)	current elektricity demand (kWh)	renovation elektricity demand (kWh)
<1925	26152	3153931.2	2487055.2	472305.12	472305.12
1925-1945	42022	3891237.2	3403782	1814089.74	1814089.74
1946-1960	46454	5632547.5	3098481.8	1387116.44	1387116.44
1961-1970	240	25392	11448	7672.8	7672.8
1971-1980	0	0	0	0	0
1981-1990	631	90359.2	54960.1	16140.98	16140.98
1991-2000	4695	442738.5	311043.75	132962.4	132962.4
2001-2022	4165	189091	189091	103416.95	103416.95
	total area	total current heat demand (kwh	total renovation heat demand (kwh)	total current elektricity demand (kWh)	total renovation elektricity demand (kWh)
	124359	13425296.6	9555861.85	3933704.43	3933704.43
		in GWh	in GWh	in GWh	in GWh
		13.4252966	9.55586185	3.93370443	3.93370443

Other typologies (semi-detached and detached)					
Construction year	total area (m2)	current heat demand (kwh)	renovation heat demand (kwh)	current elektricity demand (kWh)	renovation elektricity demand (kWh)
<1925	0	0	0	0	0
1925-1945	0	0	0	0	0
1946-1960	453	72480	33975	22187.94	22187.94
1961-1970	0	0	0	0	0
1971-1980	0	0	0	0	0
1981-1990	0	0	0	0	0
1991-2000	436	26160	26160	12347.52	12347.52
2001-2022	0	0	0	0	0
	total area	total current heat demand (kw	total renovation heat demand (kwh)	total current elektricity demand (kWh)	total renovation elektricity demand (kWh
	889	98640	60135	34535.46	34535.46
		in GWh	in GWh	in GWh	in GWh
		0.09864	0.060135	0.03453546	0.03453546

*based on (Rovers & Tigchelaar, 2019) we came up with assumption for classification comparing the detached houses and semi-detached with the rowhouses

Total area:

205.000 M2

Total current heat demand:

24,06 GWH

-8,39

Total heat demand after renovation:

16,21 GWH

Total current electricity demand:

9,75 GWH

-0,05

Total electricity demand after renovation:

9,70 GWH