Circular Delta 2050: Sowing the seeds for a circular society through a locally-oriented, knowledge based greenhouse horticulture

Delft University of Technology
MSc Urbanism (Architecture, Urbanism, Building Sciences)

Quarter 3 - February - April 2024
AR2U086 R and D Studio
Spatial Strategies for the Global Metropolis
AR2U088 Research and Methodology for Urbanism

Authors: Laura Oosterhoff (4859057), Layne Perry (6111068), Gillian Weber (5864127), Lotte Wiegers (5071569), Yiyan Zhou (5976286)

Tutors: Diego Andres Sepulveda Carmona & Marcin Dabrowski

Sow *implementations for a circular transition*

Grow *ecological and social regenerative practices in peri-urban landscapes*

Connect *neglected actor groups and empower bottom-up and global knowledge sharing*

ABSTRACT

The Dutch greenhouse industry contributing 19% of the national carbon emissions, highlights its significant role in the ever-increasing environmental, social, and political challenges developing from climate change. Geopolitical tensions including the war in Ukraine and the Covid-19 pandemic, coupled with resource scarcity and a world population growth underscore the urgency of transitioning societal practices within the food-energy nexus. Existing policies such as the European Green Deal emphasize the need to transition toward renewable energy. Given the horticulture sector's substantial spatial and global exportation footprint, there is potential to strategically utilize these spaces and economic flows. If successful, Dutch greenhouses can be the catalyst for a circular society model that emphasizes environmental regeneration, peri-urban community empowerment, and representative policy.
This report builds from theories including social justice, circular economy, glocalization, and regenerating peri-urban landscapes. By applying a circular society framework, which prioritizes sustainable consumption patterns, co-created policy, and spatial justice, this report develops a regional strategy for connecting and diversifying greenhouse sub-regions. The goals of this strategy include enhancing community engagement, ecological restoration, innovative knowledge-based production, and fully renewably sourced systems. An analysis through the lens of these intended goals leads to an instruction manual for redesigning industrial landscapes and an index of potential building blocks to implement in the redesign.
This instruction manual offers to scientific relevance through a large-scale combination of innovations, and a circular 15-minute social and 30-minute economic system, and societal relevance through lowering political unrest and the combination of technical and social functions. The manual is useful for a diverse range of parties including municipalities, policymakers, scientists, students, and residents.
Ultimately, SowGrowConnect aims for a future where greenhouse regions are not just endless rows of glasshouses but inclusive and diverse energy and social landscapes.

Keywords: greenhouse horticulture, renewable energy, community engagement, ecological regeneration, knowledge economy, circularity, 15 minute city

TABLE OF CONTENTS

01 INTRODUCTION

1.1 CONTEXTUALISATION

Dutch food & energy nexus

Despite its smaller size, The Netherlands is a global leader in fresh vegetable exports, and in just Northwestern Europe, it supplies 21 percent of peppers, 20 percent of cucumbers, and 17 percent of tomatoes. Besides food, potted plants, and flowers, Dutch horticulture also leads in innovation and the associated exportation of technology and construction materials. On a national level, the greenhouse industry contributes to 2.7 percent of the Dutch GDP (21.1 billion euros), 3.4 percent of jobs, and 4.5 percent of Dutch research and design expenditures (Figure 1).

However, the energy required to run this innovative industry is exhaustive, and for the year 2021, the total energy consumption was 106 petajoules (PJ). The Covenant Energy Transition Greenhouse Horticulture, established in 2022, aims to lower climate impact to neutral while maintaining the same profit by 2040 (Ministerie van Landbouw, Natuur en Voedselkwaliteit, 2022). Despite these policy efforts, the Netherlands continues to work to catch up to the renewable markets established in other European countries (see Figure 2). Dutch energy consumption includes renewables such as geothermal, nuclear, solar, wind, and hydro, and harmful resources such as oil, natural gas, and coal. This energy landscape (including transportation, power production, and industrial processes) contributes to 81% of greenhouse gas emissions produced by the Netherlands (see Figure 3). This landscape's consumption contributes to 6 percent of the EU's greenhouse gas emissions.

Dutch Horticulture not only influences energy consumption and production flows, but also land utilization, ecological resources allocation, societal implications, and policy frameworks. In the following report, we will focus on the nexus between food and energy through the lens of the Dutch greenhouse horticulture industry.

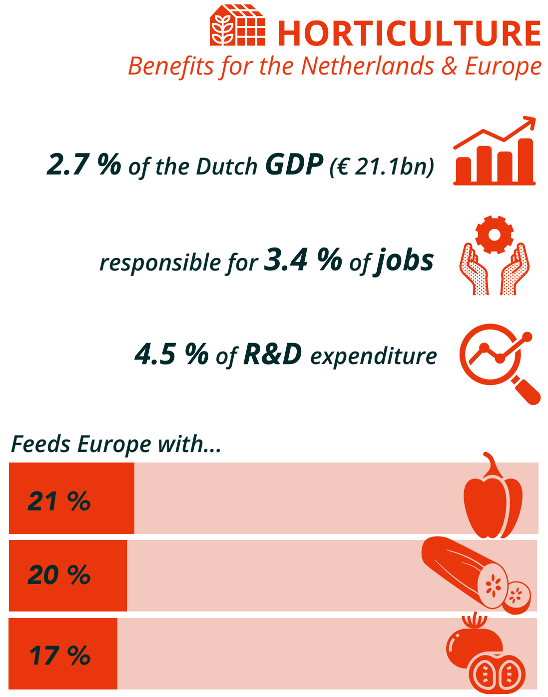


Fig. 1: Horticulture - benefits for the Netherlands & Europe
Data source: LEI Performance and Impact Agrosectors et al., 2023
Image source: own graphic

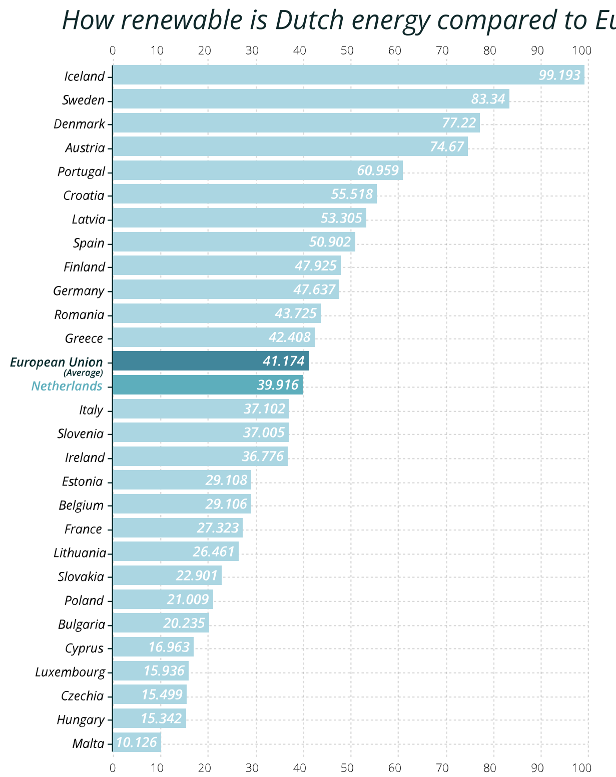


Fig. 2: Share of energy from renewable sources in gross electricity consumption, 2022 (in percentage)
Data source: Statistics / Eurostat, n.d.
Image source: This graph has been created automatically by ESTA/EC software

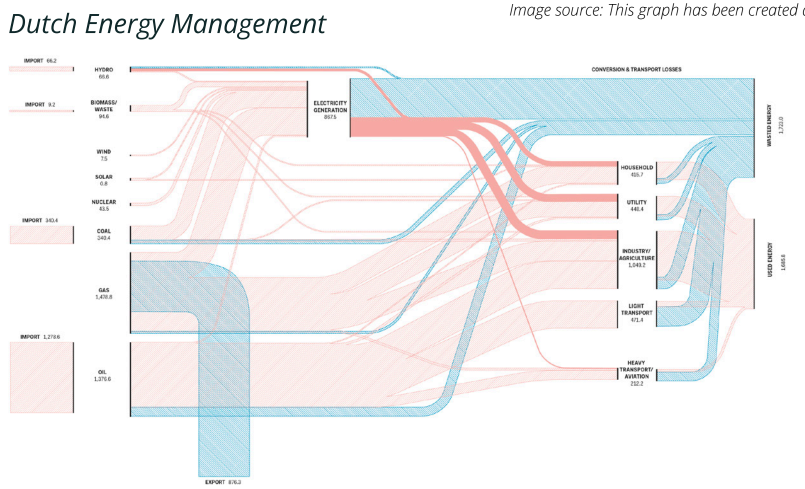


Fig. 3: Energy sources & what they are used for (in the Netherlands)
Data source: CBS data
Image source: Sijmons, 2014

1.2 PROBLEMATIZATION

Hungry energy delta

In 2050, the world population will be approximately 10 billion people, so sustainable growing options need to be a priority. Despite innovations in resource utilization and spatial efficiency, the horticulture sector contributes around 19% of all Dutch CO2 emissions. Greenhouse infrastructure requires energy inputs for climate control and product transportation, and as of 2018, 81% of the consumed energy was supplied by natural gas (Smit, 2023). Consequently, there is a high priority to mitigate the sector's contribution to the greenhouse gas crisis. The figure to the right highlights the challenge of feeding people and the energy resources that are needed for that in addition to the negative externalities on the ecology of the delta.
Sustainability awareness around Dutch Horticulture has grown; however, these greenhouses operate in ecologically vulnerable locations. The Rhine Delta Region faces risks caused by climate change regarding temperature increase, sea level rise, and higher precipitation rates. Since 1940, the Netherlands has experienced a 1.7-degree Celsius temperature rise (Temperature Trends, 2014), which is more than double the global average. The delta region is especially vulnerable to higher frequency and intensity of rainfall because of its lower elevations. Additionally, sea level rise will raise the risk of soil salinization in agriculture and horticulture regions. This industry consumes a large portion of the Dutch spatial landscape.
Dutch greenhouses take up approximately 10,600 hectares of land, and the production yields high results (50 kg per square meter for tomatoes and 68 kg for cucumbers) (Paris et al., 2022). These greenhouses are centralized into dense clusters that add stress to the natural landscape and soil sublayers (LEI Performance and Impact Agrosectors et al., 2023). The Rhine Delta Region also acts as a sink, so upstream pollution accumulates as it travels downstream, which is currently accelerating the ecological vulnerabilities of the region. If no sustainable changes are implemented, this sector could start experiencing economic instability. In these influential times, horticulture infrastructure can either add to the problem or transform into part of the solution.

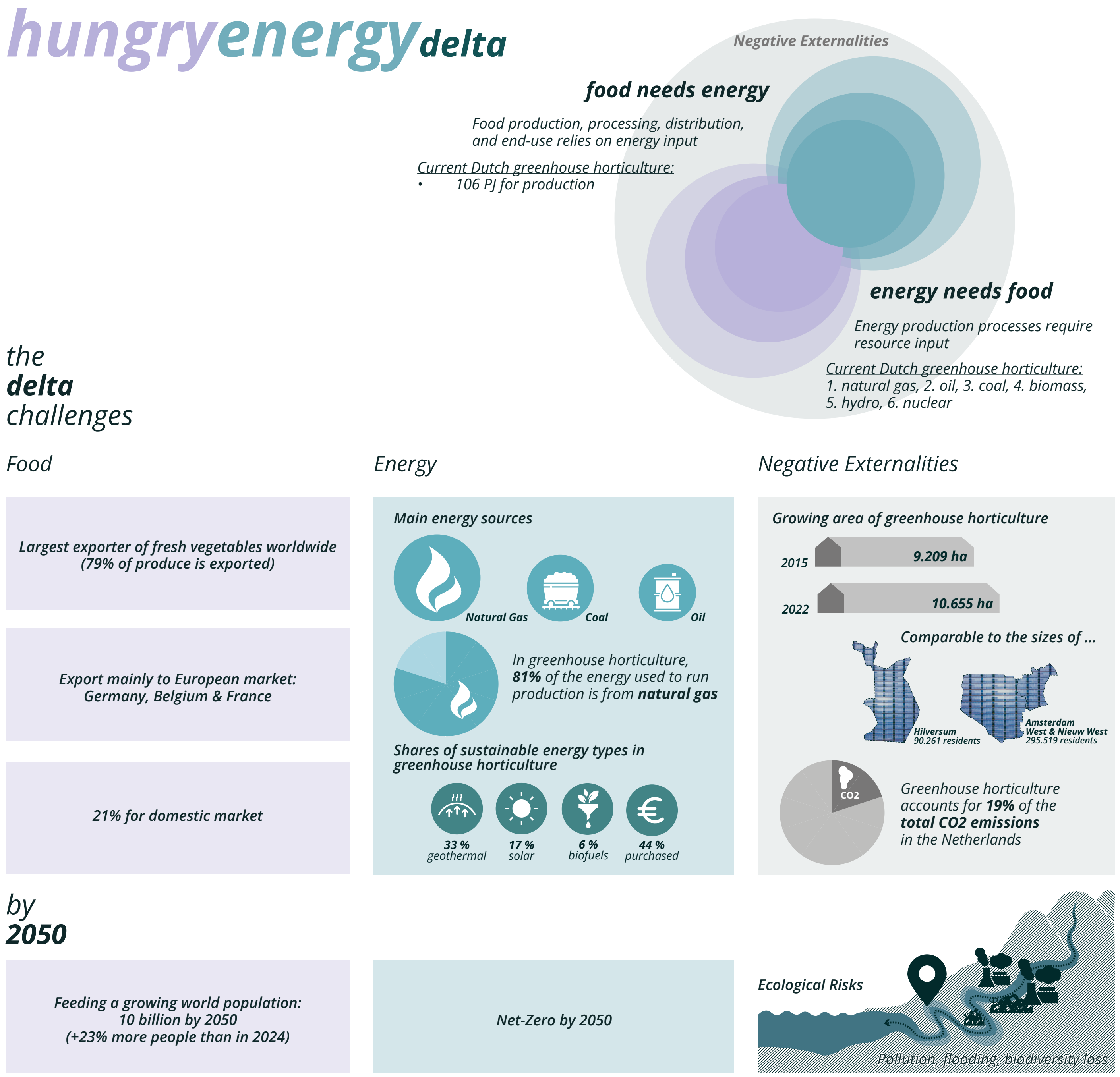


Fig. 4: Overview over challenges in the food-energy nexus
Data source: Smit, 2023; Feeding the world, 2016
Image source: own graphic

Social implications

Peri-urban neglect

Similar to California's Silicon Valley, the Netherlands is a global center for high technology and innovation in horticulture. Despite its shiny exterior, Silicon Valley is known to its neighbors as a complex area of polarized views, contrasting incomes, and polluted landscapes (University, 2021). Dutch horticultural landscapes face the same threat of division and neglect. Although iconic, the greenhouse silhouette is a physical, social, and environmental barrier within Dutch peri-urban areas (see Chapter Analysis p.68 for peri-urban definition). In addition, limited public transportation and access to amenities make moving to urban areas increasingly attractive. It is predicted that more than 65% of the population will live in urban areas by 2050 (Poorthuis & Zook, 2023) (see Figure 5).

For Westland and other municipalities located near greenhouse clusters, the population includes employees (local and migrant), large, small and medium-sized growers, and unaffiliated residents. In South Holland, 30-40% of the agricultural workforce are seasonal migrants (Statistic Netherlands, 2020), creating stress and conflict within the existing infrastructure. For example, up to 16,000 seasonal workers from Eastern Europe move to Westland during the harvest season, but only 866 additional housing units are allocated (Pascoe, 2021). In these peri-urban areas, residents are part of an aging society, leading to an emphasis on social health and connectedness. Enterprises that already connect society to food production include Framblij (fruit picking field), Tomato World (tourable educational center) and BoereGoed (local link between grower and market).

Despite the economic impact of greenhouses on the national and global economy, local communities usually do not see the benefits of these values. Addressing these challenges requires collaborative strategies that prioritize equity, well-being, and sustainability of the peri-urban area.

Fig. 5: Peri-urban landscape

Data source: -
Image source: own graphic

Political unrest

Established agreements

In 2015, the Paris Agreement was presented. The goal is to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels in order to limit the potential impacts of climate change. To achieve this, greenhouse gas emissions must peak before 2025 and decrease by 43% by 2030 (United Nations, n.d.-b). Each country in the EU is developing its own strategy to do its part, and the Netherlands is no exception. The greenhouse horticulture industry is one of the sectors that will be made more sustainable. Several plans and strategies have been developed on different scales and with different stakeholders, such as the Covenant Energy Transition Greenhouse Horticulture 2022-2030 mentioned on page 8. The national government, Greenhouse Horticulture Netherlands (the national greenhouse horticulture organization) and Greenports Netherlands (a national collaboration of greenhouse owners, distributors and the government) all want greenhouse horticulture to be carbon neutral by 2040, while remaining profitable (Ministerie van Landbouw, Natuur en Voedselkwaliteit, 2022). This shows that greenhouse owners as a whole are behind the transition to sustainability and are willing to actively work towards achieving it.

Current unrest

However, in September of last year, a new legislative proposal was presented: the Law on Fiscal Measures for Greenhouse Horticulture. The greenhouse horticulture world reacted rather negatively to this proposal, as it would significantly increase their costs and in some cases even prohibit growers from making a profit. According to Greenhouse Horticulture Netherlands, this new law is not in line with the aforementioned Energy Transition Greenhouse Horticulture 2022-2030 Covenant, as it is too strict (Bakker, 2023). There seems to be a disconnect between the government on the one hand and the greenhouse owners on the other: both want a more sustainable greenhouse horticulture and are willing to actively work towards it, but there is a fundamental disagreement on how to go about it.

1.3 URGENCY

Why we need a circular society

There are several main factors leading to a necessary shift towards a circular society (definition in Theoretical Framework p. 22) ;

- Geopolitical tensions, for example in the aftermath of the war in Ukraine, Europe experienced an increase in energy prices, which is a trend that is expected to increase in frequency (Adolfsen et al., 2022).
- Overconsumption leads to increased climate crisis and resource (land, energy, etc) scarcity.
- Growing world population and securing a sustainable food supply
- Global pandemics, such as the Corona Virus that made dependency on global exports less attractive and self-sufficiency more desirable ("Positive Expectations for Exports of Horticultural Greenhouses despite the Corona Crisis," n.d.).
- Migration away from peri-urban areas

A shift in policy and public perception towards reducing consumption, repairing and remanufacturing waste, and using renewable energy is necessary for this shift. Essentially, when a region transforms into a network of multiple functions and purposes, it creates the possibility of producing something greater (socially, culturally, and economically) than the sum of its separated parts (Jacobs, 1961).

Fig. 6: Greenhouse Power Station
Image source: own photo

1.4 PROBLEM STATEMENT

With the rise of the escalating energy crisis and declining populations in peri-urban areas, the horticulture sector needs to establish an inclusive and circular society model that emphasizes environmental regeneration, peri-urban community empowerment, and representative policy.

Fig. 7: Greenhouse Landscape Sadness
Image source: own photo

02 METHODOLOGY

SowGrowConnect

Circular Delta 2050: Sowing the seeds for a circular society through a locally-oriented, knowledge based greenhouse horticulture

2.1 RESEARCH QUESTIONS

How can scaling up of circular practices from the greenhouse horticulture industry socially activate and ecologically regenerate the vulnerable & neglected peri-urban landscape of the Rhine-Meuse Delta?

What is the current status of stakeholder networks, local community involvement, and governance policy for horticulture in the delta region?

What is the current status of the ecological and energy landscapes and what are the typologies of the existing greenhouses?

How can a circular transformation of the horticulture economy spatially enhance peri-urban lifestyles, and ecologically & economically strengthen the Delta region?

2.2 THEORETICAL FRAMEWORK

Circular society

When transforming an industry to start or expand a circular economy, the following aspects need to be considered: societal dimension, consumption and production patterns, governance, infrastructure and territorialization (Williams, 2023). A circular economy transformation requires close cooperation and interdependence between multiple stakeholders and actors, as well as active and participatory involvement of these actors and stakeholders, and clear policy objectives. Helpful themes and approaches to connect these stakeholders include education and relational issues, such as motivations, loyalties, reputation and customer relationships. This loop starts with internal organized processes, which requires the management team to be aware of sustainability, committed to taking responsibility, and aligned with social change. By providing health, safety and satisfaction, employees have a sense of social justice and empowerment. Through educational initiatives and participation, customers understand the importance of awareness and acceptance. When a company is healthy and aware, the local community can also be involved through communities, policies and communication, which can change attitudes and create overall local empowerment and commitment to sustainable change (Mies & Gold, 2021). Not only must material loops (waste, energy, resources) be closed, but regeneration of the natural ecosystem and physical infrastructure must be included (Williams, 2023). Strategies to achieve this include regenerating the ecology and closing resource loops in a local, flexible and adaptive manner. These strategies are formed by taking into account local knowledge and practices to stimulate innovation and growth, and by recognizing stakeholder groups previously categorized as „nobodies". These „nobodies" are defined as stakeholders focused on small-scale work in the midst of a technocentric urban landscape (Wuyts & Marin, 2022).
The circular society concept is our main end goal in our project, which we will be working towards through more specified values and goals, as will be explained in our vision and strategy.

Social justice

For a society to be rooted in justice, the distribution of resources, opportunities, and privileges among all its inhabitants must be fair. From John Rawl's ideas on social contract theory, the rights of citizens are assumed to be fixed and not subject to political bargaining or social interest. In this system, rights and duties are assigned to individuals and the social (or cooperative) benefits are divided. After these divisions are made (race, privilege, wealth, etc.), it is imperative that these social advantages be taken into account when assigning rights and duties. When distributing this justice, for example in the form of a new innovation or policy, the decision maker or innovator must create the system to accommodate the least advantaged citizen. In this project, this citizen would be a migrant worker, a low-income resident, or an elderly community (Rawls, 1999). By designing the new greenhouse clusters to accommodate the least advantaged in this society, the rest of the communities will benefit as well.

Glocalization

The definition of glocalization is „the idea that globalization must take into account local conditions" (Dictionary, n.d.). Since around the 1980s, several theories have been developed about glocalization and how it works, such as the theories of Robertson and Ritzer. Both, however, reduced glocalization either as a facet of globalization or as a transformation of globalization. A more recent and arguably more complete theory has been developed by Victor Roudometof, who has made the following comparison: globalization is like light waves passing through the lens of the local scale. This local scale refracts the waves of globalization, changing their trajectory, resulting in the phenomenon called glocalization. Here, glocalization is not a facet or transformation of globalization, but becomes an independent phenomenon (Roudometof, 2016). This change in trajectory makes the final product of greater interest to the end user because it is more in line with their wants and needs (Shamsuddoha, 2009).
Examples of conditions at the local level that can have a refractive effect include physical conditions, sociocultural factors, and consumer needs in the specific market. There are different types of glocal strategies, such as product-based, price-based, glocal promotion, and distribution (Grigorescu & Zaif, 2017)
Glocalization has certain principles on which the whole process is based. An important factor is the importance of local actors. These local actors have the knowledge of local conditions, which will influence the outcome of the glocalization process. Therefore, knowledge sharing in the context of a knowledge society is crucial. These local actors should be empowered to share their knowledge with policy makers, for example, so that they can develop well-informed and knowledge-based strategies and policies. Moreover, these local actors are also the most motivated to make the new glocal strategies/policies/approaches work because they are the most affected by them (Shamsuddoha, 2009).
The theory of glocalization becomes the basis of our economic approach, transforming not just the Dutch horticulture but taking the first steps towards regionalizing food chains globally.

R-ladder

The R-ladder concept is a sustainable framework that organizes circular economy actions into a hierarchical prioritization. The top of the ladder represents the design phase, where ideas of overconsumption and waste are rejected, rethought, or reduced. Starting at the top emphasizes shifting the consumer mindset to purchase sustainable, durable, valuable, and ethically made products, thereby reducing the frequency of purchases. The following practices, during the consumption phase, implement reusing, repairing, refurbishing, remanufacturing, and repurposing, which extends the life of products and discourages premature disposal. Subsequent actions are in the end-of-life or take-back phase, which includes recycling and recovery efforts. These processes aim to turn waste into a valuable resource. For example, converting bio-waste into biogas instead of using natural gas. As a last resort, products end up in landfills or incinerators, where all future value is lost. By implementing these measures, especially at higher levels, economies can move from linear to circular systems of resource use and waste management (Malooly & Daphne, 2023).

We use the R-ladder concept in our project to change the way waste is treated in the greenhouse horticulture. We aim to not just recycle, which is low on the ladder, but also start at the very beginning, by rethinking the industry itself.

15-min city / 30-min territory

The goal of the 15-minute city (the urban model) and the 30-minute territory (the territorial model), popularized by Professor Carlos Moreno, is the immediate (or at least space/time-optimized) provision of all six social functions: living, working, shopping, care/health, learning and enjoyment. These functions should be accessible via active mobility routes, especially cycling and walking, and/or decarbonized public transport. This means reorganizing the use of the city and territories in a polycentric way. The aim is to provide, in any place and at any time, different functions that meet the essential needs of the inhabitants, while consuming fewer resources and preserving useful time. This means making changes in the organization of work, such as job relocation, remote work, desynchronization and desaturation; in the urban form, such as compactness and despecialization; in the management of commerce, such as diversification, circular economy and short-circuiting; and in digitalization, such as e-commerce, e-medicine and teleworking.

This model is essentially a combination of three concepts: chrono-urbanism, which is the study of time in urban planning; chronotopia, which is used to describe the evolution of a place over time; and topophilia, which describes the bond between people and their environment, especially their attachment to specific places and the way these places influence their identity (Moreno et al., 2023).

We transfer this model for our circular approach. We expand on it by adding certain ecological „demands“ and economic resource flows, in addition to the social demands. Our goal here is limiting resource cycles within this travel time to limit CO2 emissions for transportation. This is because, within circular economy, distance matters.

2.3 CONCEPTUAL FRAMEWORK

Through the windows of Dutch greenhouse horticulture

The lens of our project is the Dutch greenhouse horticulture, as can be seen in our conceptual framework in Figure 8. Our goal on a global scale is a circular society (as explained in the Theoretical Framework, p. 22). This concept is based not only on the pursuit of a circular economy, but also on the pursuit of a balanced ecosystem and social justice. A coherent policy framework and effective communication are essential for this transition.

Three main pillars
To achieve these three aspects (social, environmental and economic), we intend to pursue three main strategies that are highly interrelated and mutually supportive. For the social pillar, we rely on co-creation, which means engaging and activating local communities. For the environmental pillar, the strategy is ecological regeneration by improving the quality and capacity of soil, air and water. In addition, the pursuit of renewable energy will conserve valuable fossil resources. Finally, the economic strategy is based on the theory of glocalization (as explained in the Theoretical Framework, p. 23), which means relying more on local knowledge for an innovation-based economy rather than production-for-export practices. Closing the loop on various resource flows is a fundamental strategy for achieving a circular economy.

Spatial goal
The spatial objective on a regional scale is the self-regeneration and activation of the peri-urban landscape in the Dutch Delta. At the local level, this means the implementation of 15- and 30-minute circulatory systems that respond to the three pillars mentioned above. The social aspect is access to cultural facilities and recreational nature within 15 minutes. The ecological aspect is access to renewable energy sources and the creation of a network of regenerated nature. Finally, in terms of the economy, this means localized material and energy supply chains within 30 minutes.

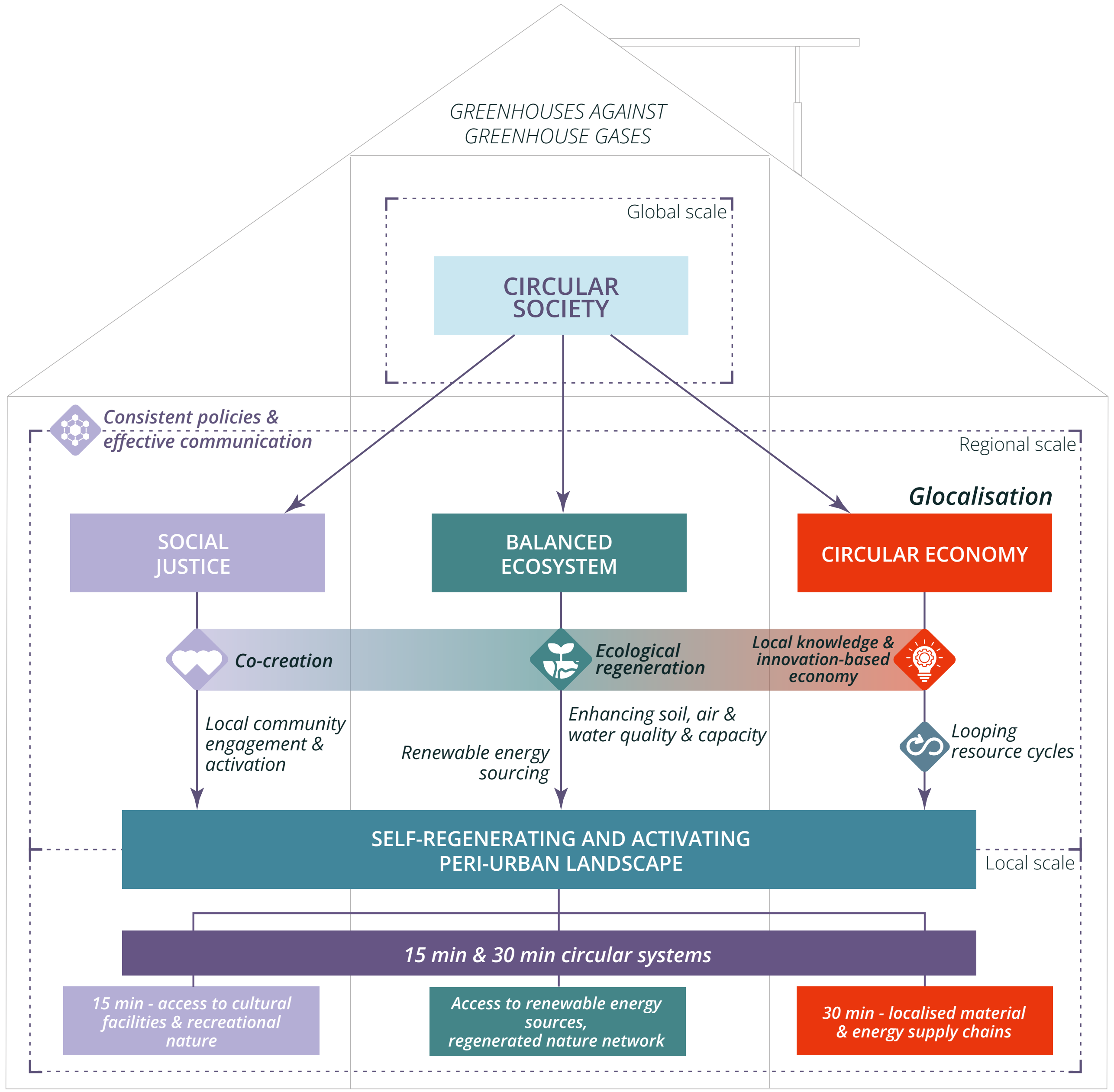


Fig. 8: Conceptual framework
Image source: own graphic

2.4 METHODOLOGY FRAMEWORK

Project outline

To give an idea of the structure of our project, we have created a methodological framework as shown in Figure 9. There is a chronological order of all these aspects, from left to right. This is also reflected in the layout of the entire report. However, there is also a non-chronological aspect, in that findings from one of the later stages can (and should) have an impact on the earlier stage. This is also reflected in the framework.

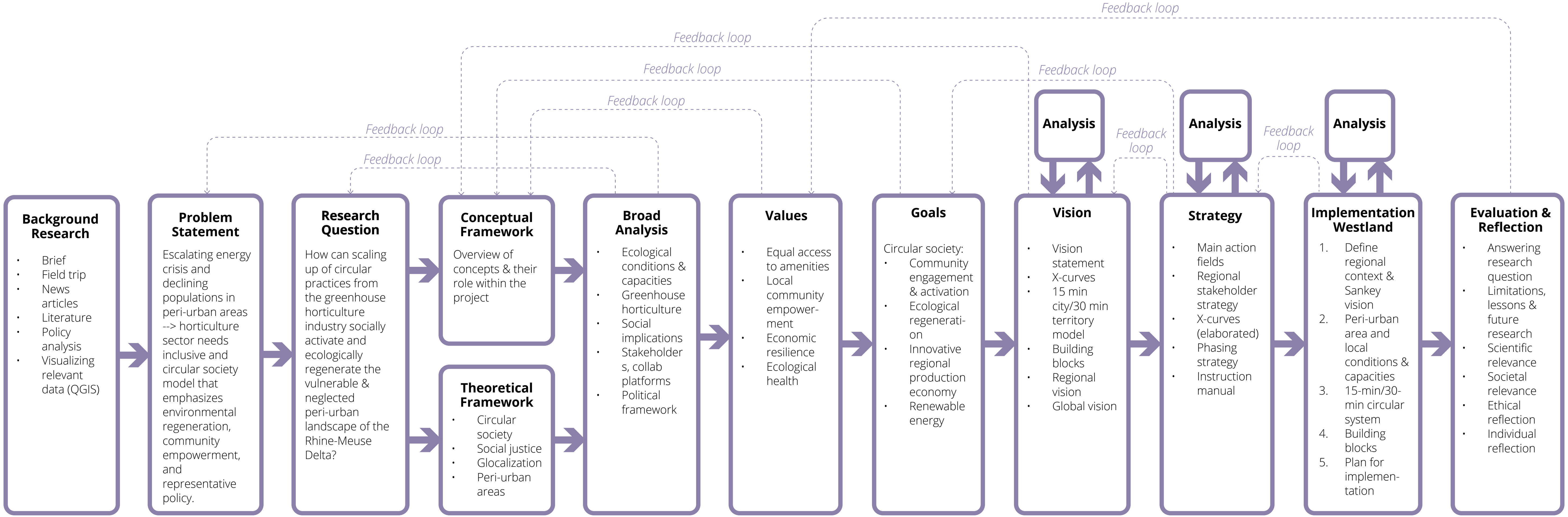


Fig. 9: Method flowchart
Image source: own graphic

03 ANALYSIS

3.1 ANALYTICAL FRAMEWORK

Analysis through scales & sectors

For this project, we will investigate and analyze data regarding greenhouse horticulture along the Rhine River in South Holland. An overview is given in Figure 10.

Ecological conditions & capacities

This will start with a look at the environmental risks in the areas where greenhouses take up a spatial footprint, which includes soil types, flood risk, and pollution from the greenhouses. Continuing with the natural landscape, Land use is important to analyze the ability to connect and regenerate the existing land functions with envisioned land uses. The next step is to look at the capacity and function of the energy grid, which will influence the potential for the regions of greenhouses to be an energy source.

Greenhouse horticulture

The actual greenhouses will be analyzed to determine how they work, what they consume, where they are mostly located, what they produce, where they export to, and how they export. This system is then visualized to show the connection between the natural environment, greenhouse industry, energy industry, and consumers in a section view.

Social aspects

This project emphasizes the importance of incorporating the people that live, work, and interact with the greenhouse industry as well, so an analysis of the social aspects, including accessibility and demographics, will be included.

Stakeholders and political framework

Not only is the local resident or temporary worker important, but governmental politicians and energy providers, so specific roles (based on interest and power) of each stakeholder and actor involved in this process are analyzed. As well as the policies and procedures that drive or hinder progress in these sectors.

Conclusion

It is important to see these connections throughout each scale, so a summary of each of the local, regional, and international situations and how the economics, social, and ecological aspects change throughout them will be described. To wrap up the analysis we will provide a strength, weakness, opportunities, and threats (SWOT) and a summary of the existing values of the horticulture sector.

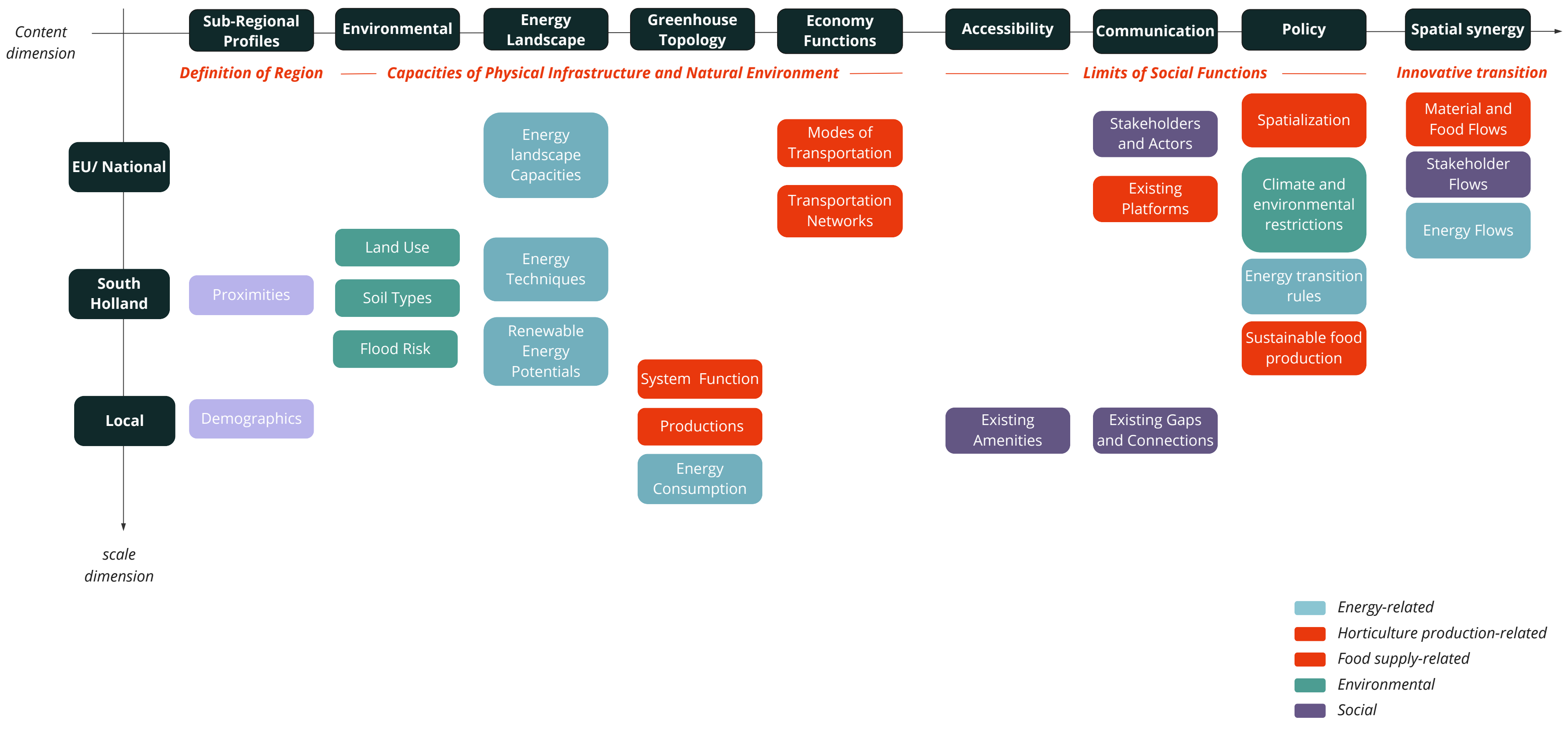


Fig. 10: Analysis overview
Image source: own graphic

3.2 GREENHOUSE HORTICULTURE

Highly intensive production in the Delta

The map in Figure 11 shows the four largest greenhouse hotspots in the Netherlands: Westland, Arnhem, Den Bosch and Venlo, and their main type of production. Within these different clusters there are three types of production: vegetables, flowers and plants. For each of these clusters, the exact ratio between these different types is different. Westland has the most even distribution of the different types of production, while the other three all have one type of production accounting for a large percentage of the production. However, about 50% of all greenhouses in all four clusters produce vegetables, which is the most common type of production nationwide.

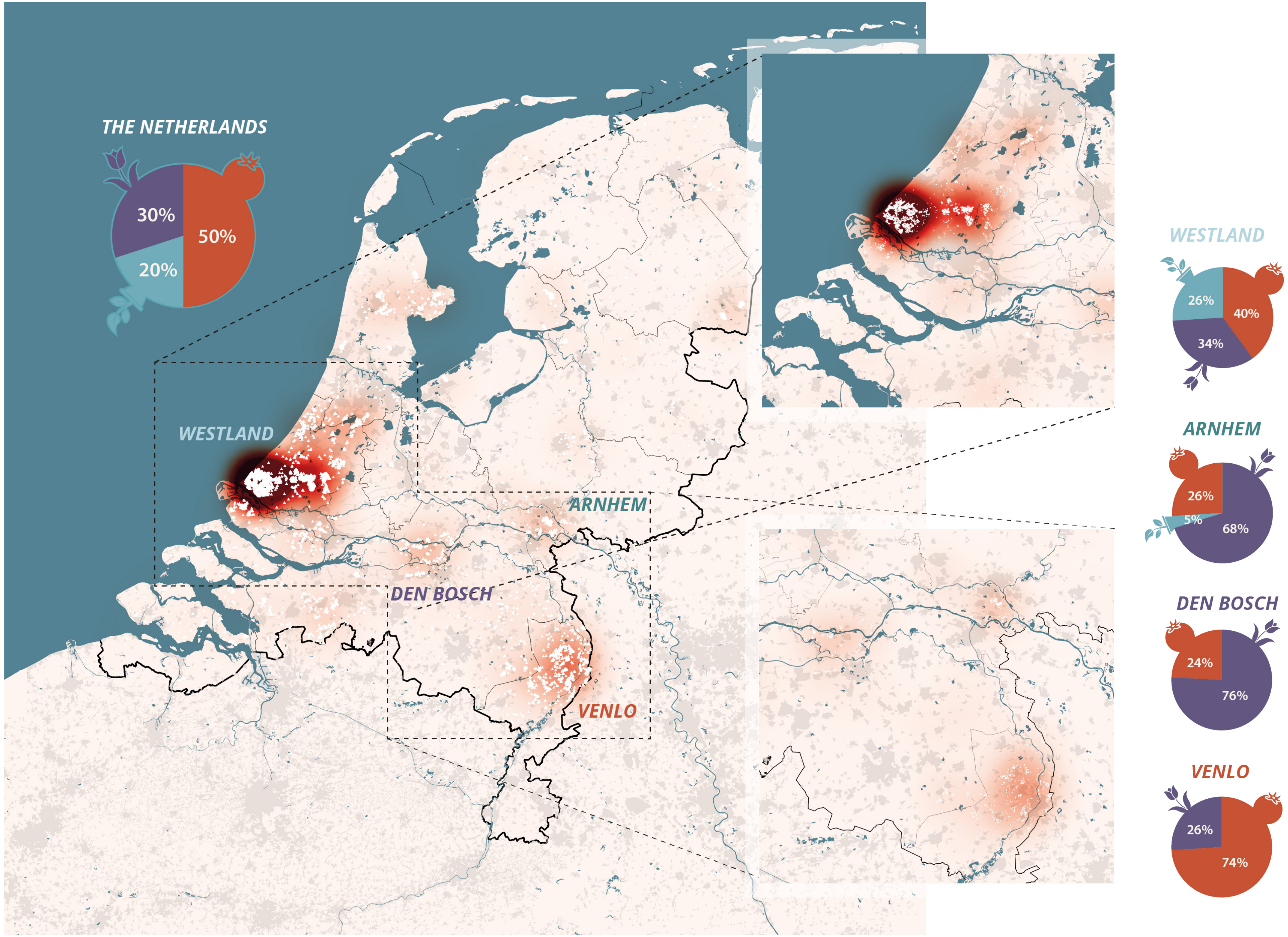


Fig. 11: Dutch greenhouse horticulture density
Data source: OpenStreetMap, n.d.
Image source: own graphic

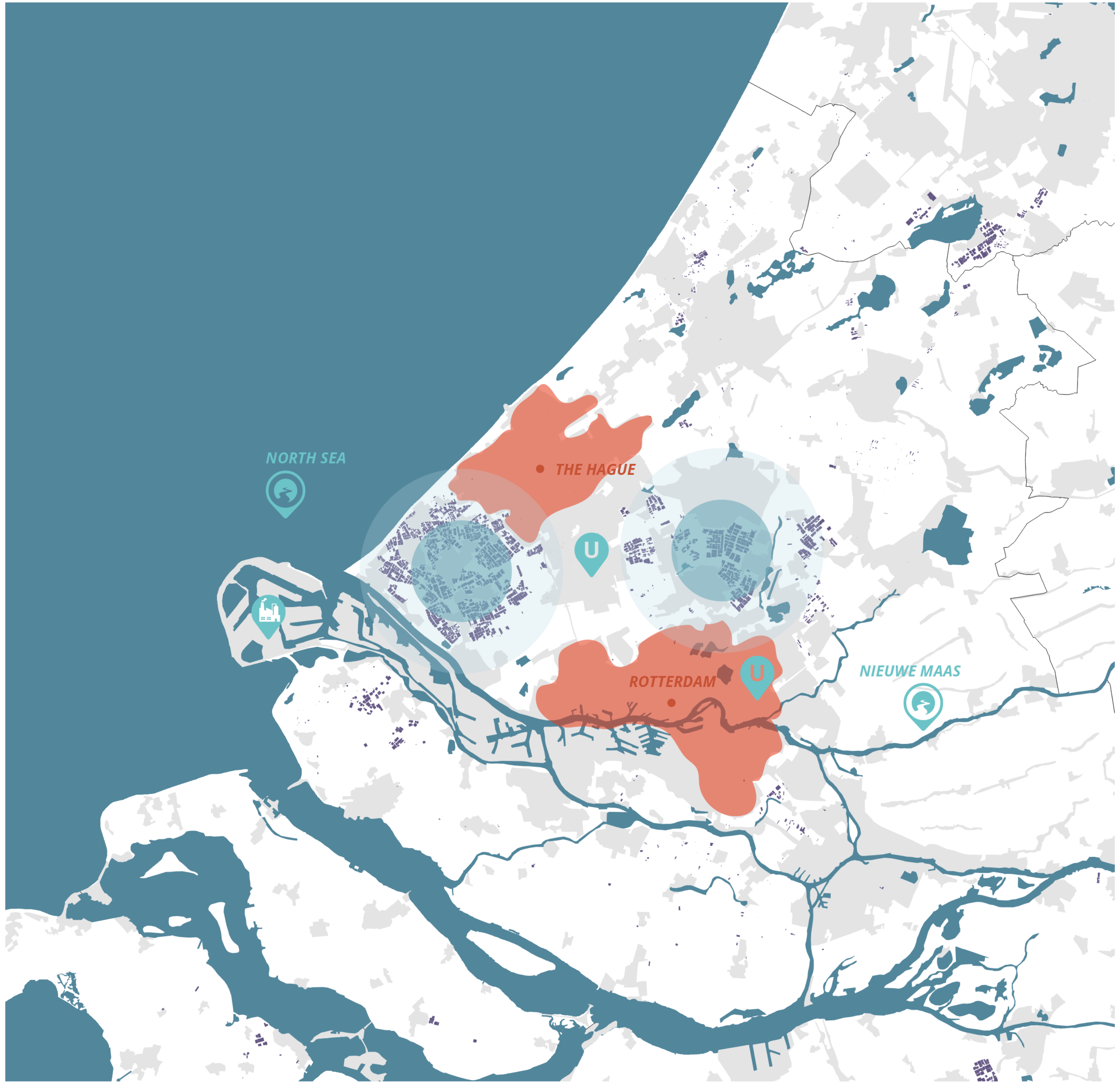
- Urban areas
- Oceans and water bodies
- Greenhouse location
- Density greenhouse cluster
- Dutch border
- Distribution of production type

0 20 40km

Classifying the greenhouse clusters

When proposing a transition, it is important to keep the local context in mind. As shown on this and the following pages, all four greenhouse clusters have different demographics and a different context.

Westland
The Westland cluster is within the municipality of Westland, and near the cities of The Hague and Rotterdam. The largest age groups are 25-45 years old (The Hague and Rotterdam) and 45-65 years old (Westland itself). About a quarter/one-third of the inhabitants in this area voted for PVV (right-wing liberals) last national elections. The cluster is near the beach and the river Nieuwe Maas, different universities (Delft and Rotterdam) and the industry of Rotterdam Port, where the greenhouse produce is also exported. (see Figure 12)



GREENHOUSE CLUSTER WESTLAND

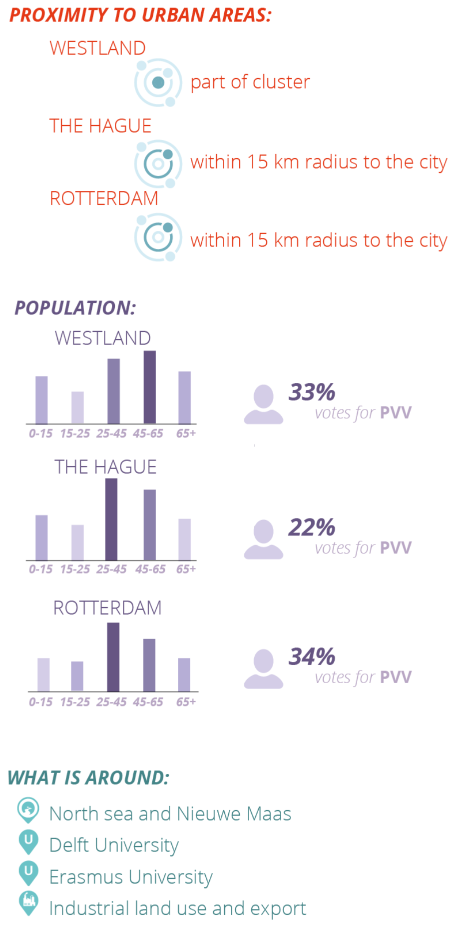
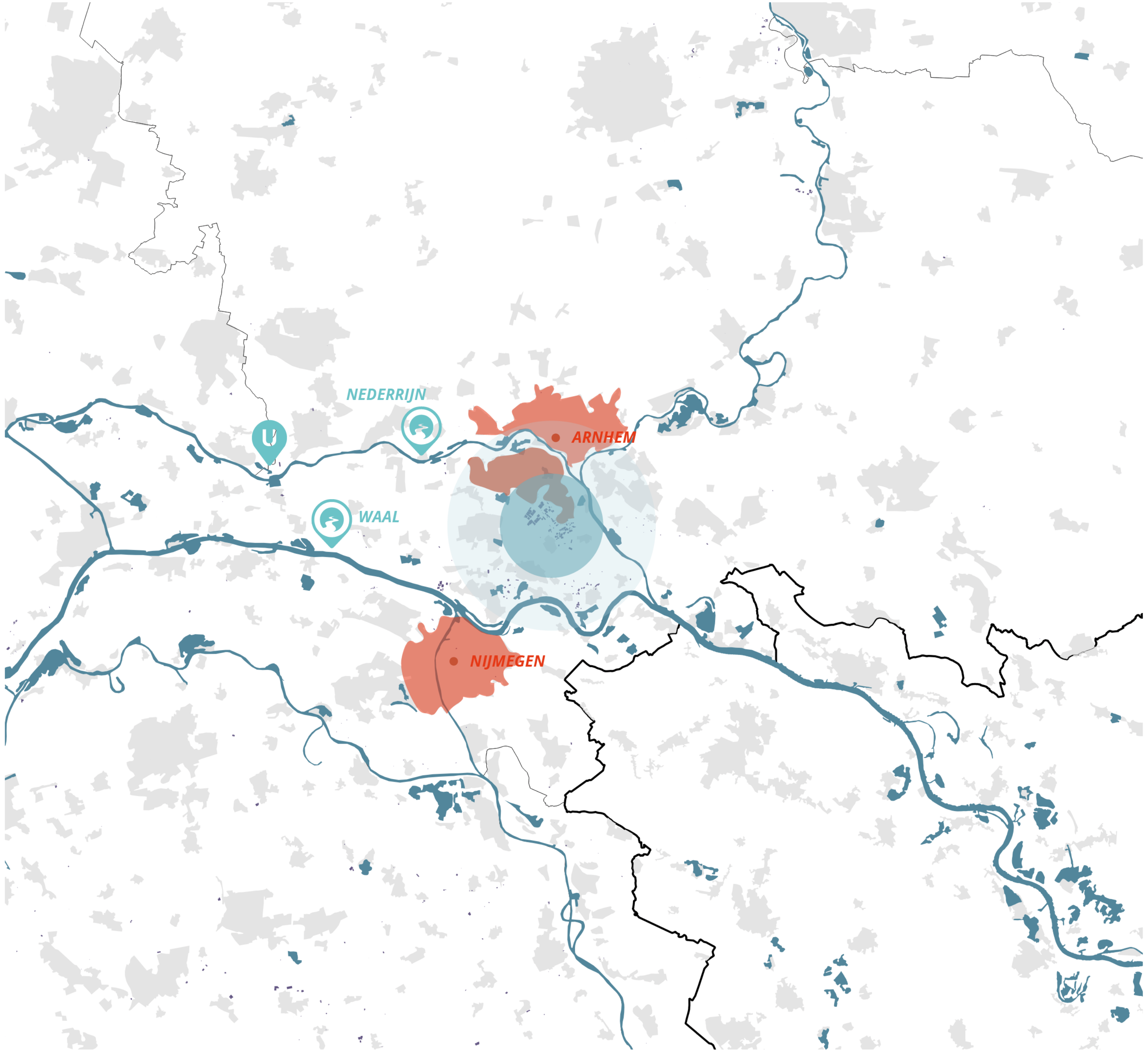


Fig. 12: Greenhouse Cluster Westland
Data source: Allecijfers.nl, 2024
Image source: own graphic

Urban areas
Oceans and water bodies
Greenhouse location
Nearest city
Radius (7,5 and 15 km)

0 5 10km



GREENHOUSE CLUSTER NEAR ARNHEM

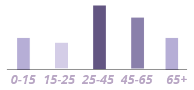
PROXIMITY TO URBAN AREAS:

ARNHEM — within 7,5 km radius to big city

NIJMEGEN — individual greenhouses closer than cluster

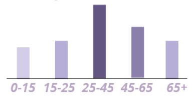
POPULATION:

ARNHEM



25% *votes for* **GL-PVDA**

NIJMEGEN



34% *votes for* **GL-PVDA**

WHAT IS AROUND:

- Nederrijn and Waal
- Wageningen University
- Border to Germany

Fig. 13: Greenhouse Cluster Arnhem
Data source: Allecijfers.nl, 2024
Image source: own graphic

- Urban areas
- Oceans and water bodies
- Greenhouse location
- Nearest city
- Radius (7,5 and 15 km)

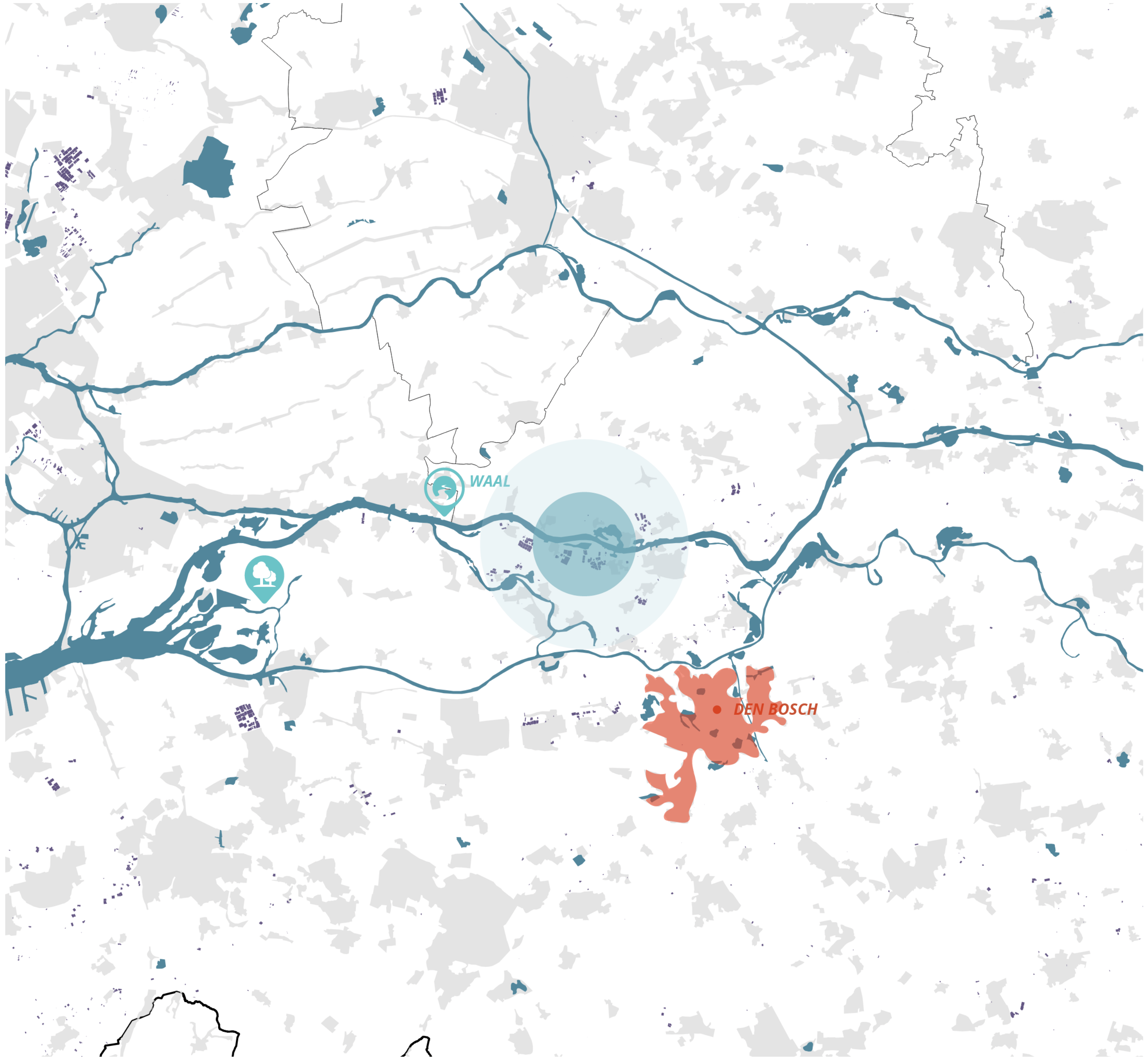
0 5 10km

Arnhem

This cluster is between the cities of Arnhem and Nijmegen. Within these cities, the largest age group is 25-45 years old and around a quarter/one-third of the residents voted for GroenLinks-PvdA (left-wing democrats) last national elections. The Nederrijn and Waal rivers are nearby, as is the Wageningen University. It is also near the Dutch-German border. (see Figure 13)

Den Bosch

This cluster is near Den Bosch, just within the province of Gelderland. 25-45 and 45-65 years old are the most prevalent age groups, and a quarter of the residents voted for PVV. The river Waal is nearby, as is the nature reserve The Biesbosch. (see Figure 14)



GREENHOUSE CLUSTER NEAR DEN BOSCH

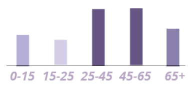
PROXIMITY TO URBAN AREAS:

DEN BOSCH

not within 15 km radius to the city

POPULATION:

DEN BOSCH



24% votes for PVV

WHAT IS AROUND:

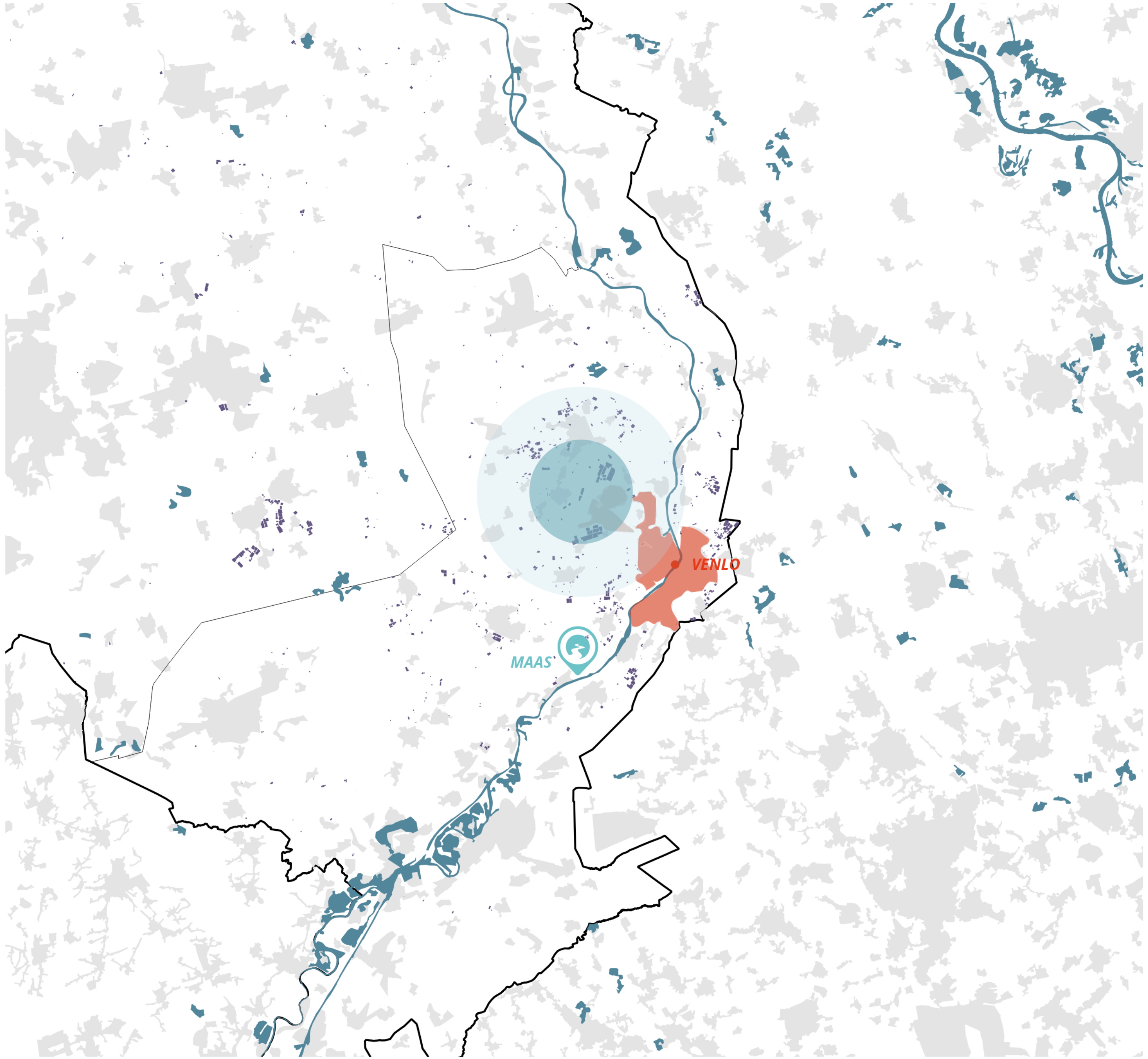
CLOSE BY WAAL

BIESBOSCH

Fig. 14: Greenhouse Cluster Den Bosch
Data source: Allecijfers.nl, 2024
Image source: own graphic

Urban areas
Oceans and water bodies
Greenhouse location
Nearest city
Radius (7,5 and 15 km)

0 5 10km



GREENHOUSE CLUSTER NEAR VENLO

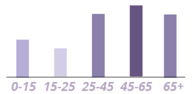
PROXIMITY TO URBAN AREAS:

VENLO

within 15 km radius to the city

POPULATION:

VENLO



36% votes for PVV

WHAT IS AROUND:

Maas

Border to Germany

Fig. 15: Greenhouse Cluster Venlo
Data source: Allecijfers.nl, 2024
Image source: own graphic

Urban areas
Oceans and water bodies
Greenhouse location
Nearest city
Radius (7,5 and 15 km)

0 5 10km

Venlo

Lastly, the cluster near Venlo. The most prevalent age group is 45-65 years old. Around one-third of the inhabitants of the city voted for PVV. The river Maas flows by this cluster, and it is near the Dutch-German border. (see Figure 15)

European and regional food distribution network

Modes of transportation

There are multiple modes of transportation methods and routes in the Northwest European networks such as road, rail, and waterways. Figure 16 shows the gross weight and share of transportation means for international trade to and from the Netherlands. It becomes clear that maritime transport and inland shipping along rivers such as Rhine and Meuse are the most dominant flows. Additionally, road transport with trucks takes up a big share of good transportation, specifically between larger cities in the Netherlands and Germany, Belgium or France, along major highways such as the A1, A2, A3, and E19. Freight railways are less important facilitators for trade connections, even though they pose a less air emitting way of transportation. See Figure 17 for the routes described above.

Emissions

Between 2007 and 2019 CO2 emissions have increased because of international trade and transit, and as of 2021 these flows contribute to 23.1% of the total mobility emissions. By 2050, The European Commission aims to establish a fully circular economy by decreasing greenhouse gas emissions to zero, so international export flows will require cooperative efforts to meet this requirement (Hilz, 2021).

Fig. 16: International goods flows to and from the Netherlands, in gross weight (2019)
Data source: CBS, n.d.
Image source: CBS, n.d.

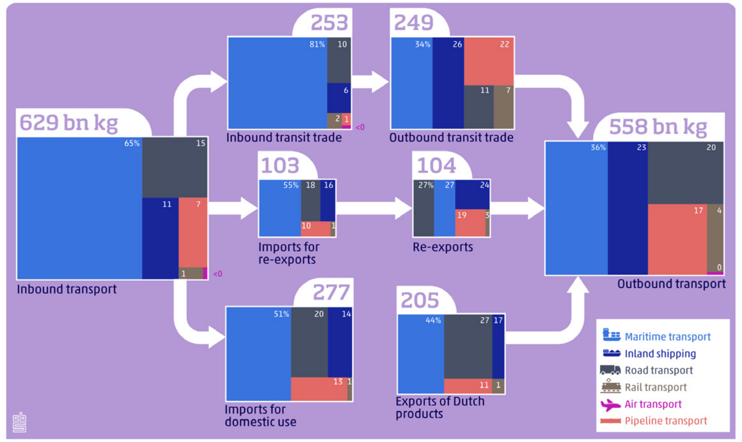


Fig. 17: Main Distribution Network N-W Europe
Data source: OpenStreetMap, n.d.
Image source: own graphic

Urban areas
Main ports
Main waterways
Freight railways
Main road network

0 75 150 km

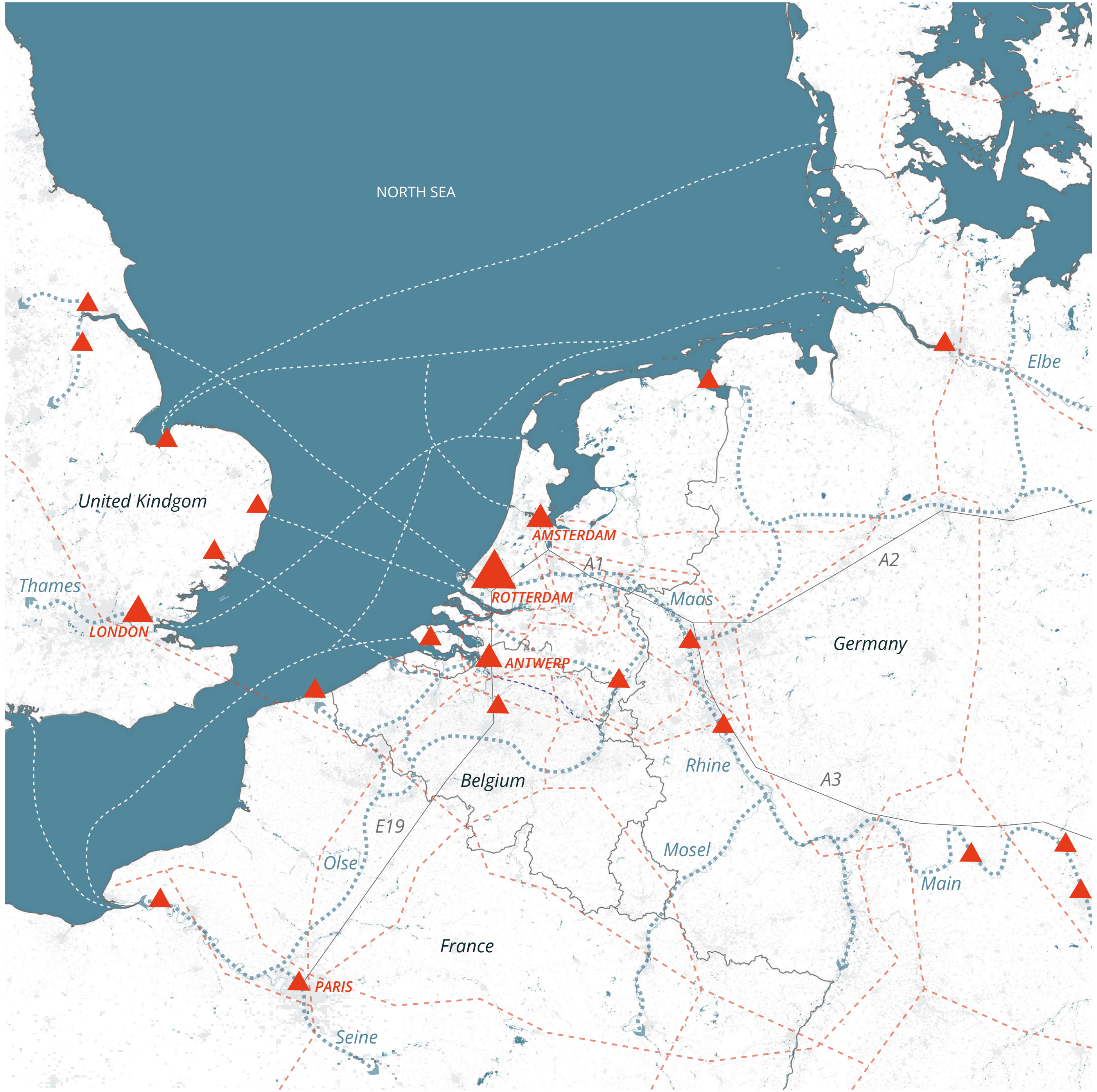


Fig. 18: Regional Main Distribution Network
Data source: OSMF, 2024
Image source: own graphic

Urban areas
Greenhouse cluster
Main ports
Main freight waterways
Freight railway network
Main road network

0 10 20km

Regional waterways

At the regional scale, the Netherlands is home to a dense network of waterways (approximately 6000km of rivers and canals) that connect domestic and international trade, increase flood resilience, and provide recreational opportunities. However, this multi-functionality can cause the busiest locks to transport over 50,000 boats per year. This creates a challenge in balancing the logistics of different uses and interests throughout the water network (World Canals, n.d.). (see Figure 18)

3.3 ECOLOGICAL CONDITIONS & CAPACITIES

Soil types & their relation to agroforestry

The five prominent soil types in this region are: thin peat soils, clay soils, silt soils, and heavily loamy sand soils (see Figure 19). We see that regions such as Arnhem and Den Bosche, which are located along the river, are on thin peat and clay soils. While Westland has a good balance of all types, and Venlo is mostly located on muddy soils and heavily loamy sandy soils.
Each of these types has specific qualities and capacities that can be regenerated and revitalized through different practices. For this project, we see that agroforestry techniques can be a practice that strengthens and diversifies the soil while providing multifunctionality within the greenhouse regions. See Figure 20 for more information on which techniques work best in which soil types.

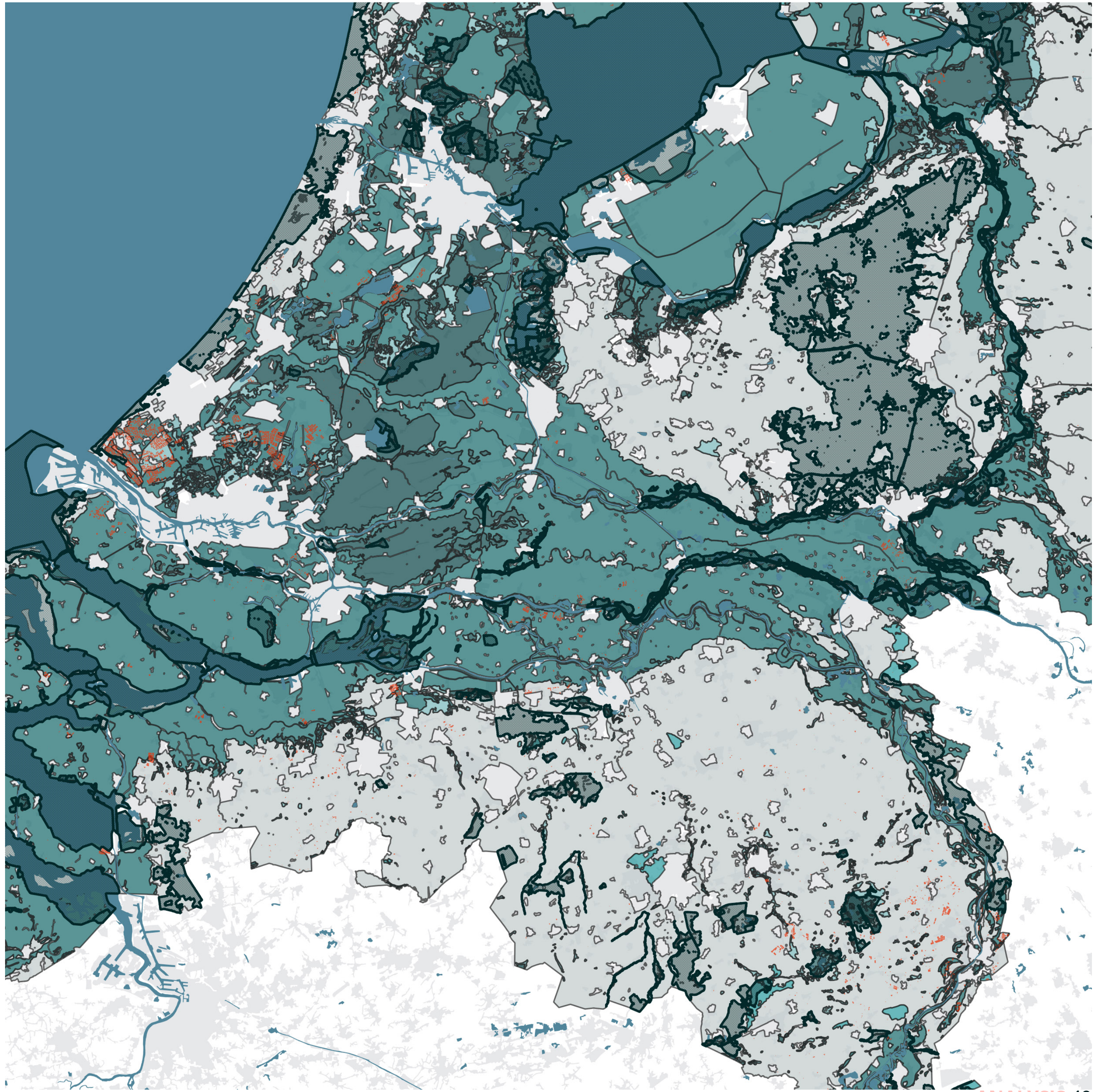
Fig. 20: Soil Types with best fit agroforestry types
Data source: provided in table
Image source: own graphic

Soil Type	Characteristics	Agroforestry Types	Sources
Thin peat soils: clayey top soil on peat on sand	Higher water retention, but poor drainage, lower nutrient levels, and prone to erosion. can hold significant belowground carbon stocks. Pathogen free, so suitable for seed starting. Acidic plants thrive here. Applicable shrubs include: Blueberry and cranberry bushes or other diverse crop species.	Hedgeros and shelterbelts, wetland agroforestry, agroforestry buffer strips	(Smith et al., 2022) (Freeman et al., 2021) (Schreefel et al., 2020)
Clay soils (light sand) on homogeneous subsoil II	Clay has high water retention, but substrate has poor drainage, clay is prone to surface crusting and erosion, also prone to higher nutrient retention, but might have nutrient imbalances. Applicable trees include: alder, cornus, magnolia, apple, apricot, plum, and pear	Alley Cropping, multistrata Agroforestry	(Smith et al., 2022) (Schreefel et al., 2020)
Moist soils with clay cover and sandy subsoil	Clay retains moisture, while sandy substrate is good drainage, but prone to surface runoff and erosion, higher nutrient retention, Incorporate woody perennials with other crops or lifestock. Alder, willow, cypress. Fruit trees only grow well in sandy clay or clay loam. Not heavy clay	Silvoarable, silvopasture, agroforestry riparian buffers	(Smith et al., 2022) (Freeman et al., 2021) (Self, 2022) (Schreefel et al., 2020)
Very loamy sandy soils III	Good drainage, but overtime should have reduced tillage or no-till practices, prone to erosion, lower nutrient retention, so fertilizer is helpful. Applicable Trees include: eucalyptus, pines, maple, oak, red cedar, and jujube	Silvopastoral, agroforestry windbreaks	(Smith et al., 2022) (Schreefel et al., 2020)

Fig. 19: Regional Soil Types
Data source: BRO Soil Map- PDOK, 2021
Image source: own graphic

- Natura 2000
- Urban Areas
- Greenhouse Locations
- Oceans and Water Bodies
- Thin Peat Soils: Clayey topsoil on peat on sand
- Clay Soils: light sand on homogeneous subsoil II
- Loamy Soils: Silty Loam
- Muddy Soils: clay cover and sandy subsoil
- Heavy Loamy Sandy Soils: Type II

0 10 20km



Vulnerabilities, limitations & pollution

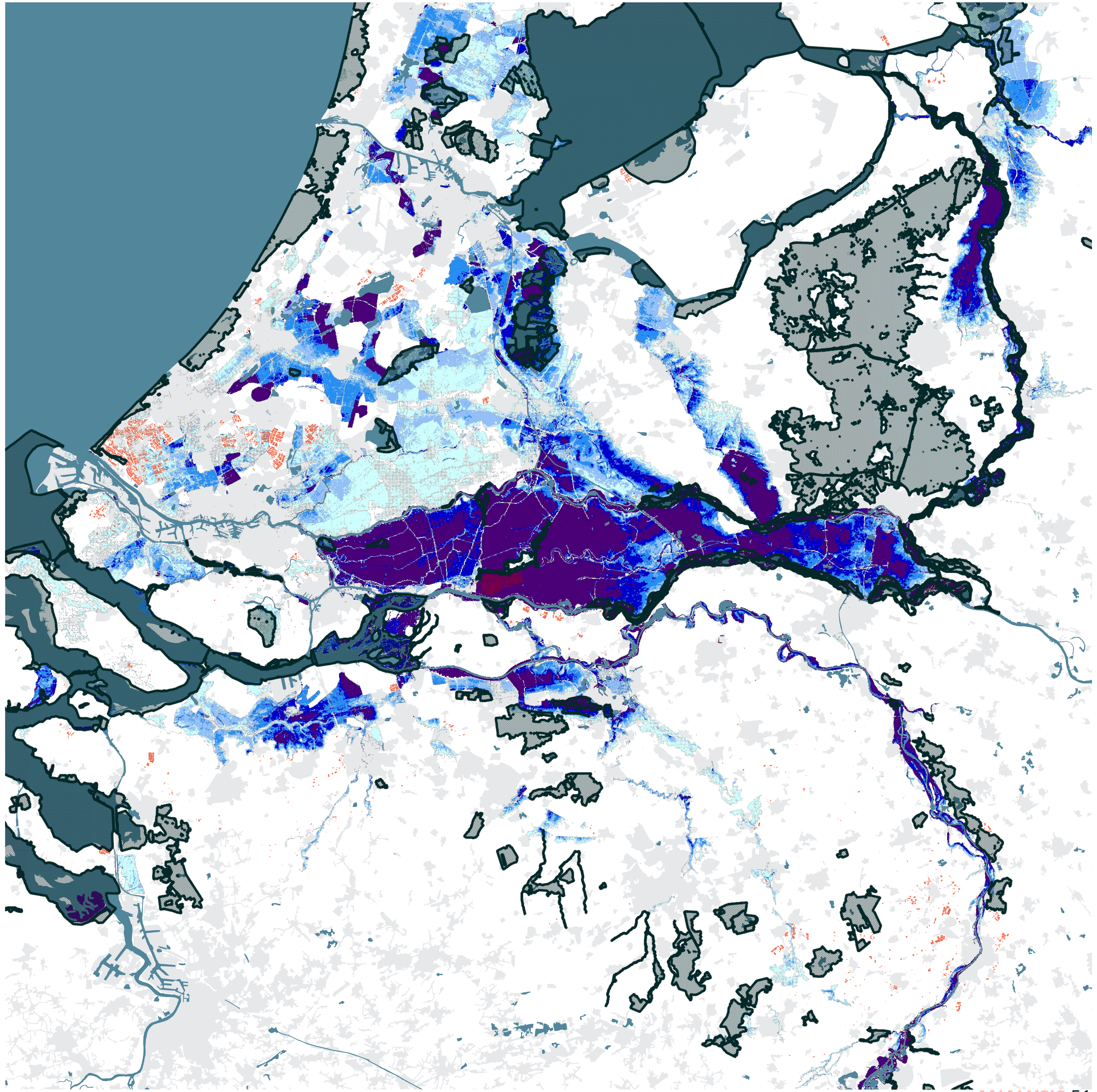
Flood Risk

The Netherlands will feel the effects of climate change in the next 50-100 years, and despite efforts to protect the land from the sea, the land near the rivers will be at high risk of flooding. Figure 21 shows the most likely scenarios of flood risk in the South Holland region, and it is clear that areas along the river will have a higher risk of flooding. Many of the existing greenhouses are located in these high-risk areas, so preventive flood measures will need to be implemented in these areas to counteract the future flood areas. Arnhem and Den Boshe are most at risk due to their vulnerable geographical location between the forks of two rivers.

Fig. 21: Medium flood risk in the region
Data source: Rijksoverheid, 2019
Image source: own graphic

- Natura 2000
- Urban Areas
- Greenhouse Locations
- Oceans and Water Bodies
- Medium Probability: <0.5 Meter
- Medium Probability: 0.5 - 1.0 Meter
- Medium Probability: 1.0 - 1.5 Meter
- Medium Probability: 1.5 - 2.0 Meter
- Medium Probability: 2.0 - 5.0 Meter
- Medium Probability: > 5.0 Meter

0 10 20km



Soil limits and light pollution

As seen in Figure 22, the soil depletion rates are higher in areas where there is a lot of stress, so urban areas, industrial areas, or heavy land uses. There is also a correlation between the more recently built greenhouses and higher soil depletion rates.

The greenhouses use lamps and heavy lighting to keep the plant habitats well lit, warm, and climate regulated. These lighting techniques produce a large amount of light pollution that has a negative impact on the surrounding biodiversity, wildlife, and residential areas, which can be seen in Figure 23.

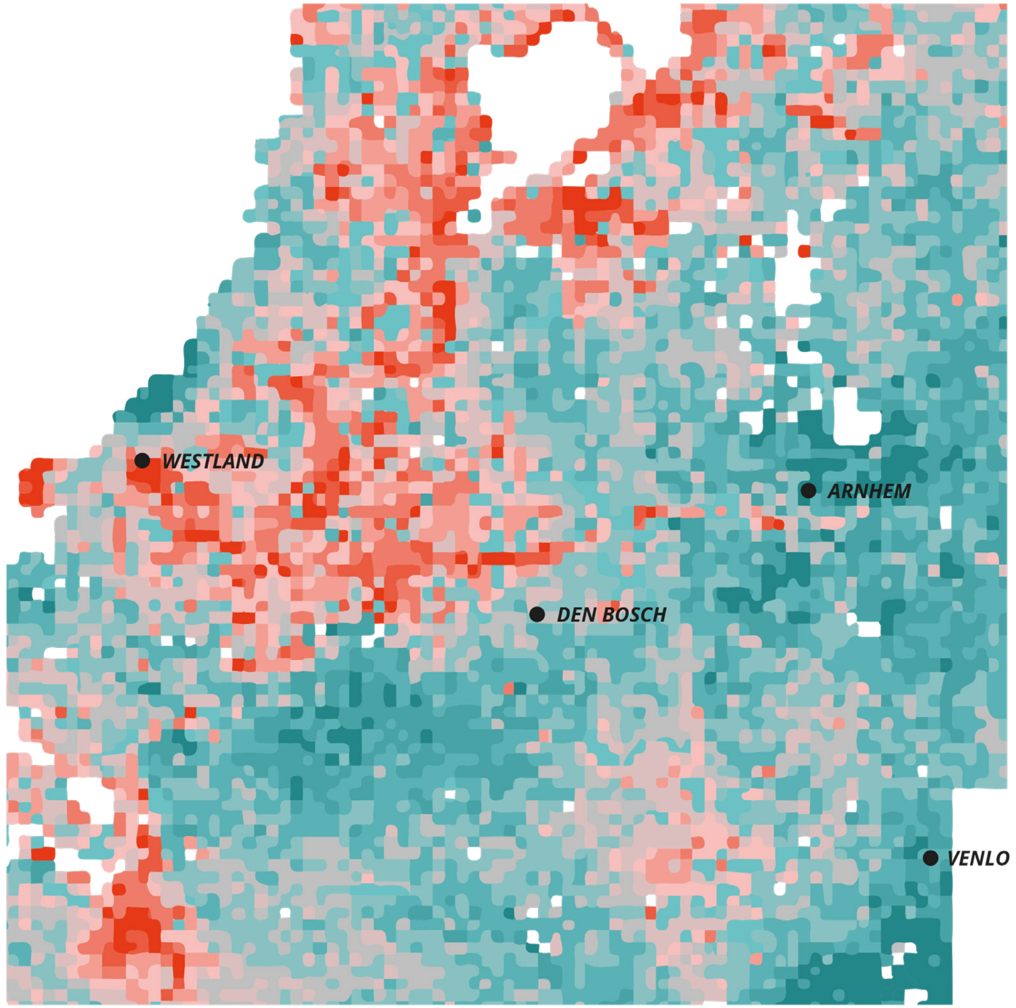


Fig. 22: Soil depletion
Data source: Atlas Leefomgeving
Image source: own graphic

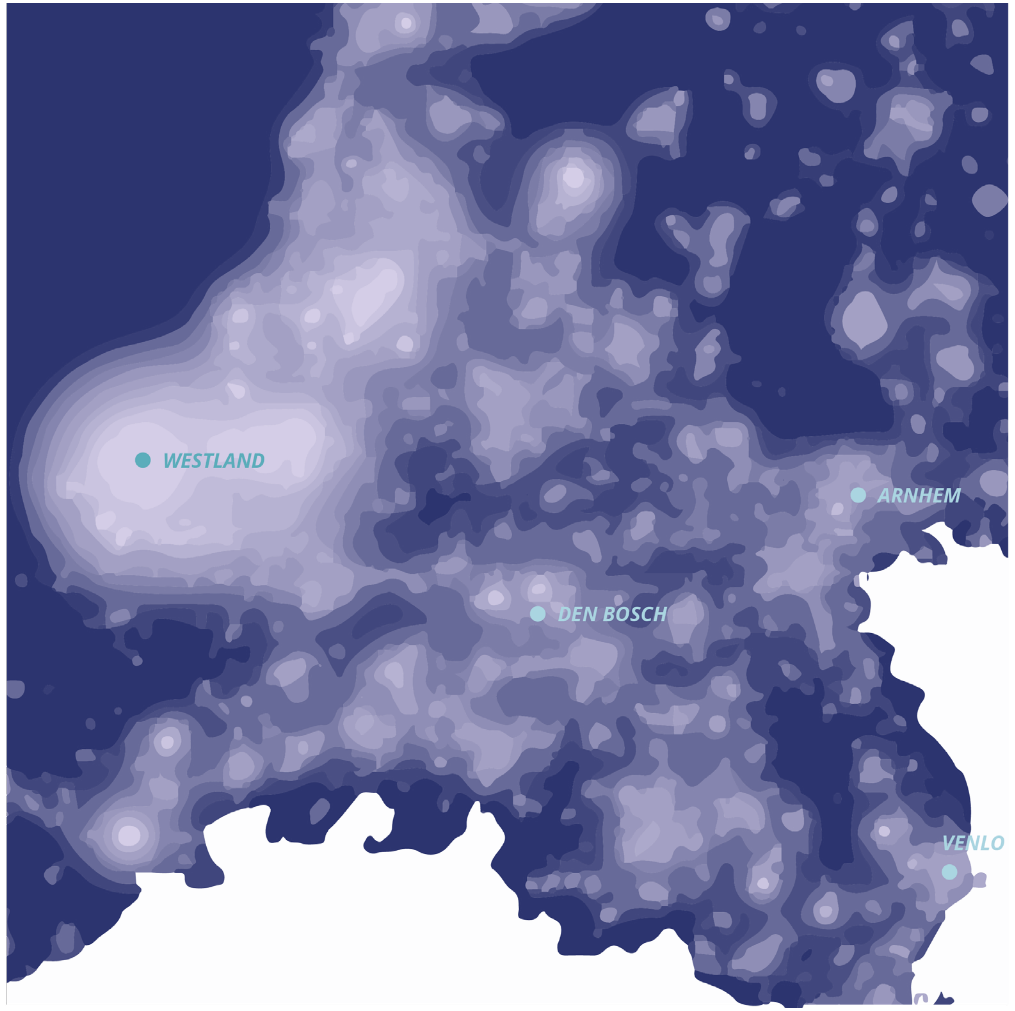


Fig. 23: Number of visible stars
Data source: Atlas Leefomgeving
Image source: own graphic

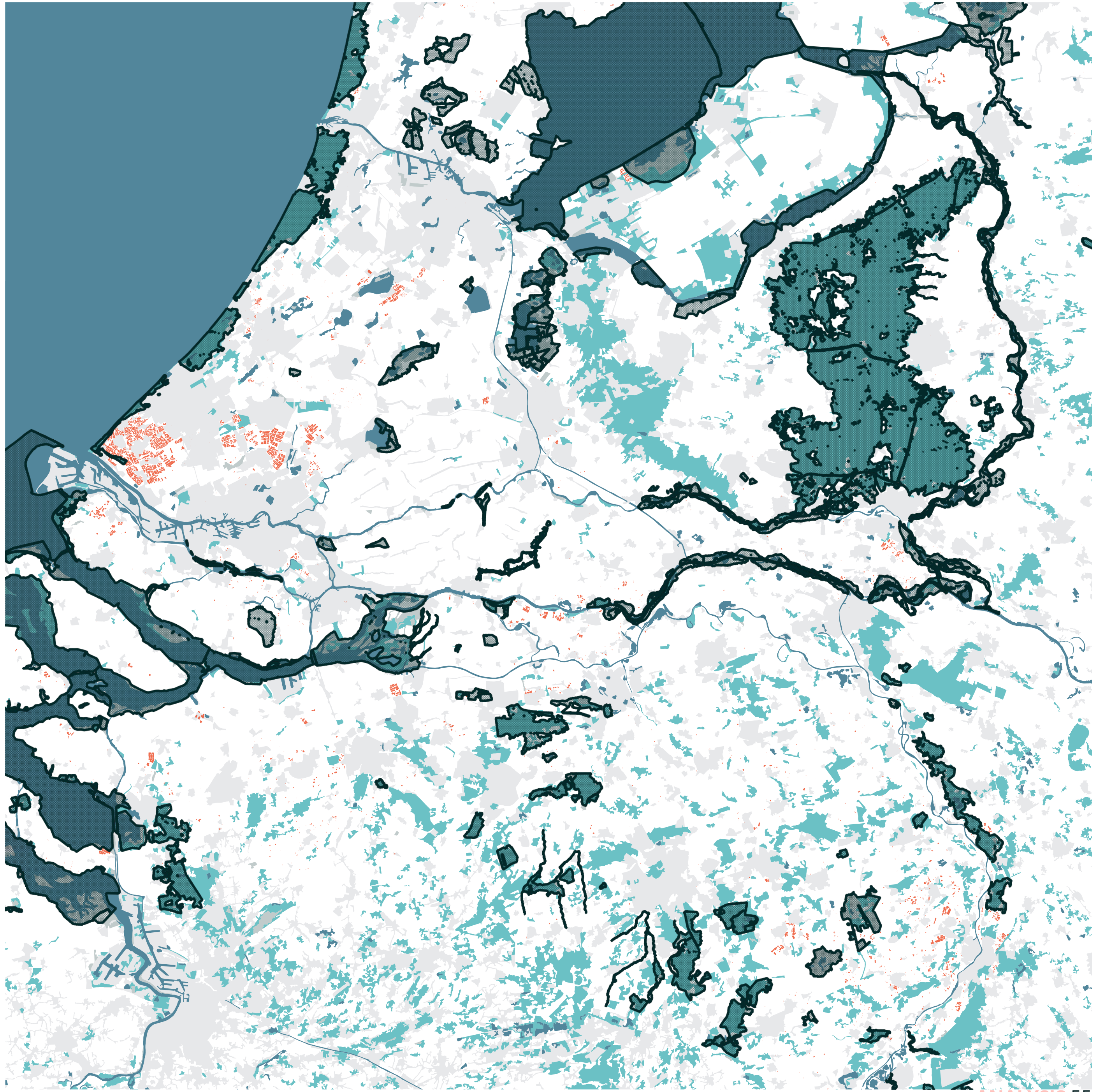
Land use

Urban, agricultural, wetland, and forest areas are shown in Figure 24. Westland is mostly surrounded by urban areas and some forest, while Den Bosche, Arnhem, and Venlo are surrounded by agriculture and forest. From the current analysis there are no natural or manmade ecological connections to naturally protected areas (Natura 2000). There is also room for using the current forest and wetland areas to envision a regenerated and connected ecological network that strengthens the soil, lowers the erosion risk, and protects against flooding. All areas lack in wetland proximity, so a large driver in our vision will be increasing the biodiversity, CO2 absorption, and flood prevention through added wetland areas in all greenhouse regions.

Fig. 24: Land use in the region
Data source: Corine Land Cover 2012 Database of the Netherlands, 2014
Image source: own graphic

Natura 2000
Urban Areas
Greenhouse Locations
Oceans and Water Bodies
Forest
Wetland

10 20km



Renewable energy potentials

In Figure 25 we see wind speeds are highest along the coast, from this, the limited space, and the resistance from the public, a different approach to wind energy will be taken in this project. Instead of trying to incorporate large in-land wind farms, sleek, modern, and smaller wind turbines can be an alternative to activate and encourage public participation in wind energy. This can look like nature-like wind trees along urban streets or do-it-yourself backyard wind turbines. For solar, see Figure 26, there is a lot of sun potential in all of the greenhouse regions, so agrivoltaics and rooftop solar will be an emphasized alternative. In the third map, Figure 27, the current main renewable energy techniques are represented by location, which includes using solar, wind, both wind and solar, or using rooftops to absorb solar.

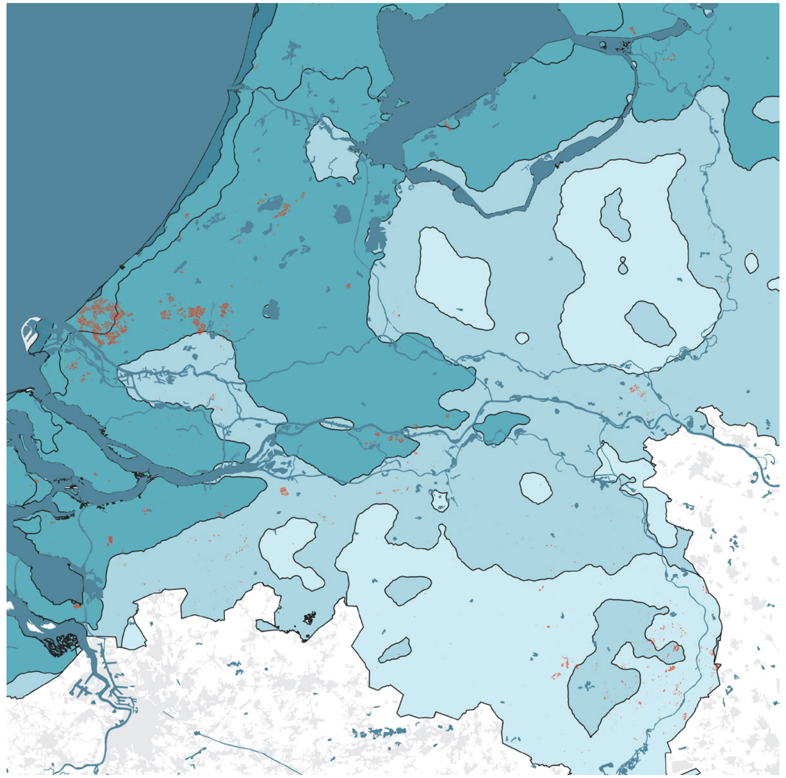


Fig. 25: Wind speeds at 100m altitude
Data source: Introduction - PDOK, 2020
Image source: own graphic

Urban Areas
Greenhouse Locations
Oceans and Water Bodies
<2.4 m/s
2.4-3.8 m/s
3.8-5.2 m/s
5.2-6.6 m/s

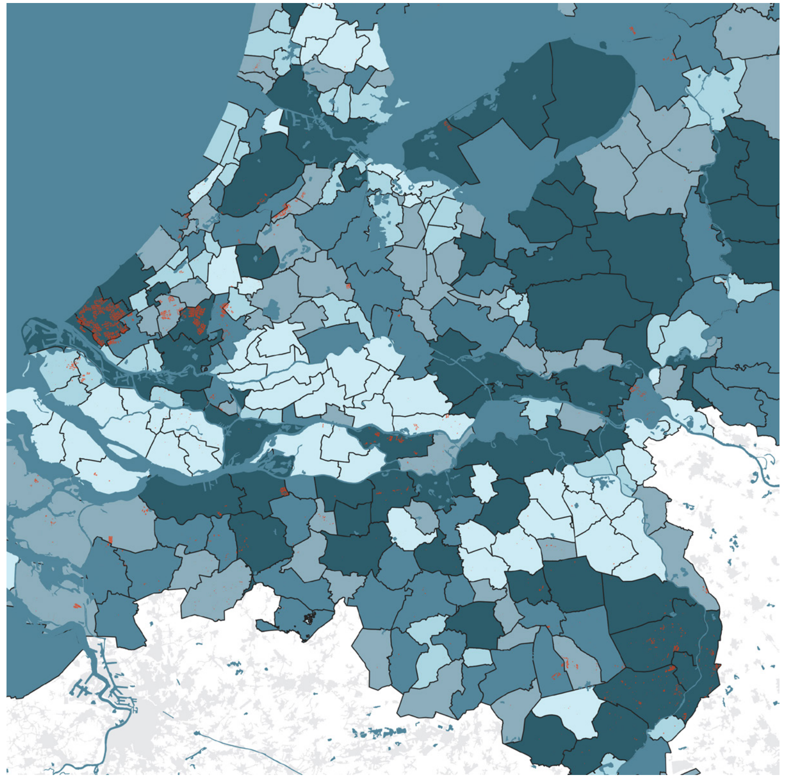


Fig. 26: Solar potential
Data source: Statistics Netherlands, 2023
Image source: own graphic

Urban Areas
Greenhouse Locations
Oceans and Water Bodies
0 MW
<1.1 MW
1.1-2.4 MW
2.4 - 5.3 MW
>5.3 MW

Fig. 27: Main energy techniques
Data source: NPRES_AMBITIE_FGDB - Overzicht, 2022
Image source: own graphic

Urban Areas
Greenhouse Locations
Oceans and Water Bodies
Solar
Wind
Solar and Wind
Solor from Rooftop Panels

Energy grid capacity

Data from Netbeheer Nederland, shown in Figures 28 and 29, visualizes the output (the energy used by a consumer usually through utility companies) and input (capacity to take in energy generated from renewable energy sources) of the energy grid. In Westland, the output is at full capacity even after running a congestion management test in the southwest area while the rest has capacity available. For the input, Westland currently has no capacity, but a congestion management investigation can occur. In Arnhem for both input and output, there is no capacity and some areas have already investigated the congestion. For both Den Bosch and Venlo also has no capacity for input and output and all areas have gone through a congestion management analysis. For our project, this analysis points to the importance of retrofitting the energy grid as well as increased energy storage units in the areas of full capacity.

Fig. 28: Energy grid capacity: input potential
Data source: Capaciteitskaart Invoeding Elektriciteitsnet, 2023
Image source: own graphic

Urban Areas
Greenhouse Locations
Oceans and Water Bodies
Congestion Management: Limited Capacity
Congestion Management: No Capacity at this Time
Congestion Management: No Capacity
Limited Capcaity
Pending Management Study
No Capacity

0 10 20km

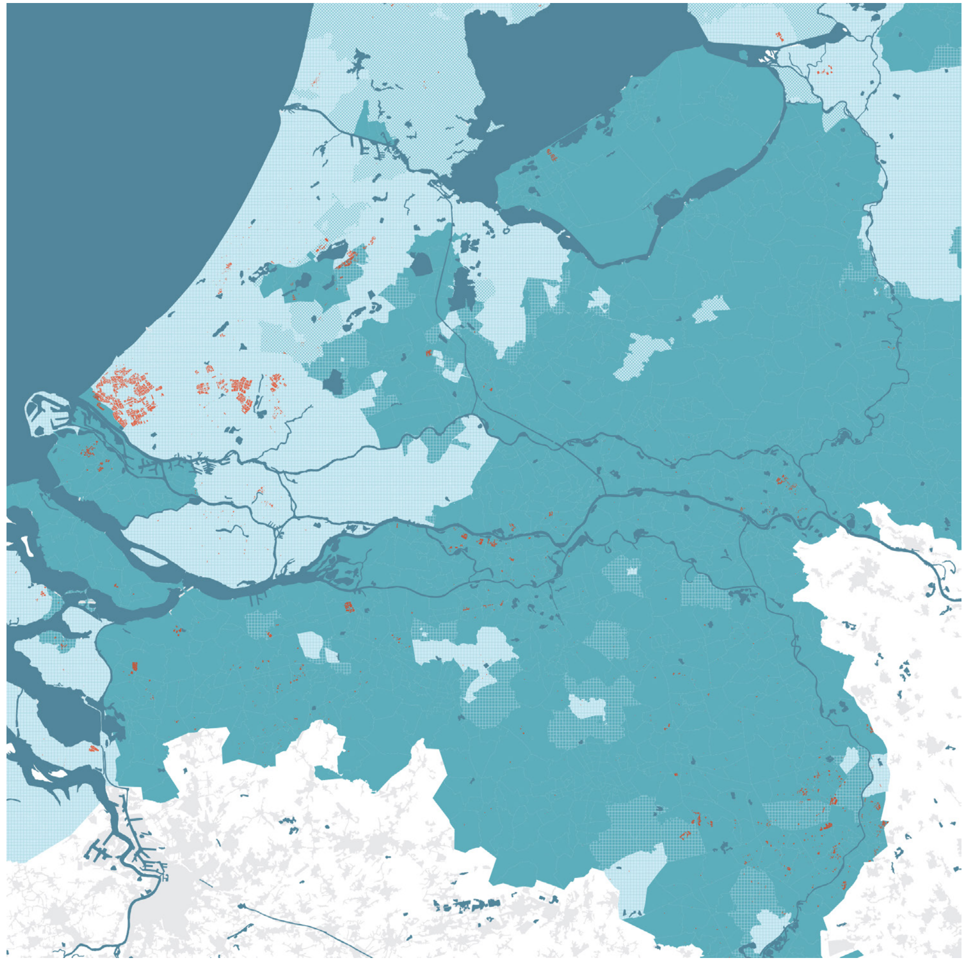


Fig. 29: Energy grid capacity: output potential
Data source: Capaciteitskaart Invoeding Elektriciteitsnet, 2023
Image source: own graphic

Urban Areas
Greenhouse Locations
Oceans and Water Bodies
Congestion Management: Limited Capacity
Congestion Management: No Capacity at this Time
Congestion Management: No Capacity
Limited Capcaity
Pending Management Study
No Capacity

0 10 20km

Biowaste potential

Currently and at the beginning of the phasing, biowaste can play a role as a cleaner energy alternative to natural gas. South Holland, especially in the areas around the port of Rotterdam, already has a storage of biomass from wood, manure, forestry and households as shown in figures 30-32. In the beginning of our vision, bio-waste can be used to produce biogas to power the greenhouses, but as renewable resources and consumer awareness of waste increases, we envision bio-waste being used as a feedstock for sustainable biomaterial plants that produce bio-based construction materials, clothing fibers or insulation.

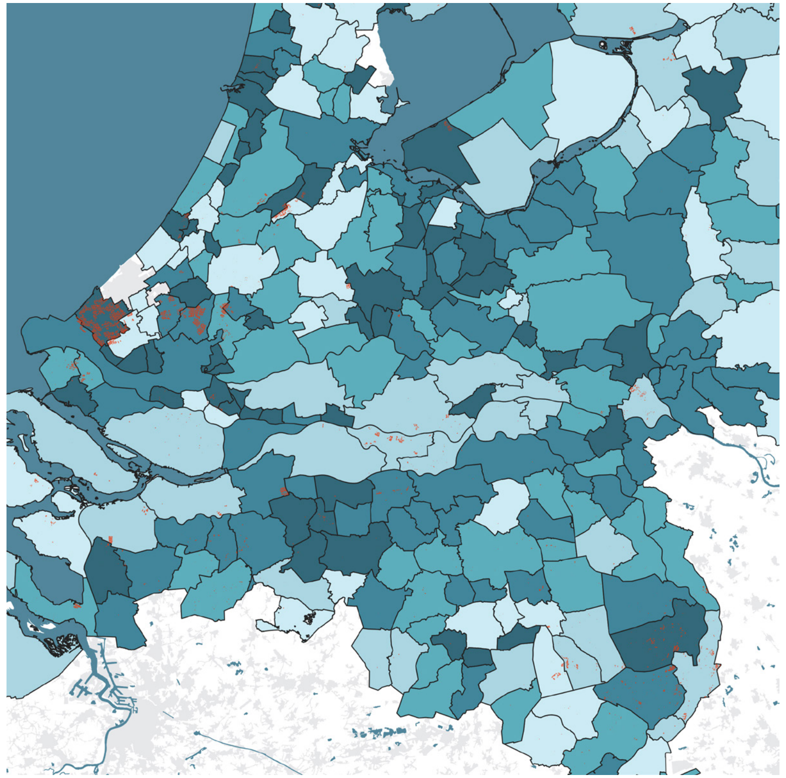


Fig. 30: Biomass potential
Data source: WarmteAtlas, n.d.
Image source: own graphic

Urban Areas
Greenhouse Locations
Oceans and Water Bodies
<2.0 kton
2.0-4.3 kton
4.3-6.7 kton
6.7-12.1 kton

0 10 20km

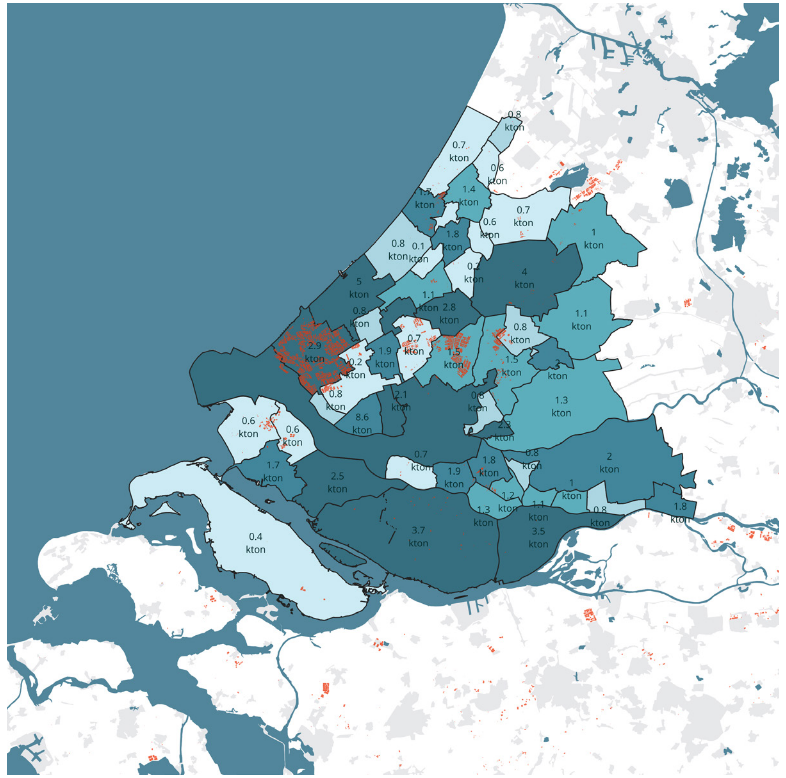


Fig. 31: Waste from households
Data source: WarmteAtlas, n.d.
Image source: own graphic

Urban Areas
Greenhouse Locations
Oceans and Water Bodies
<0.7 kton
0.7-0.9 kton
0.9-1.5 kton
1.5-2.0 kton
>2.0 kton

0 10 20km

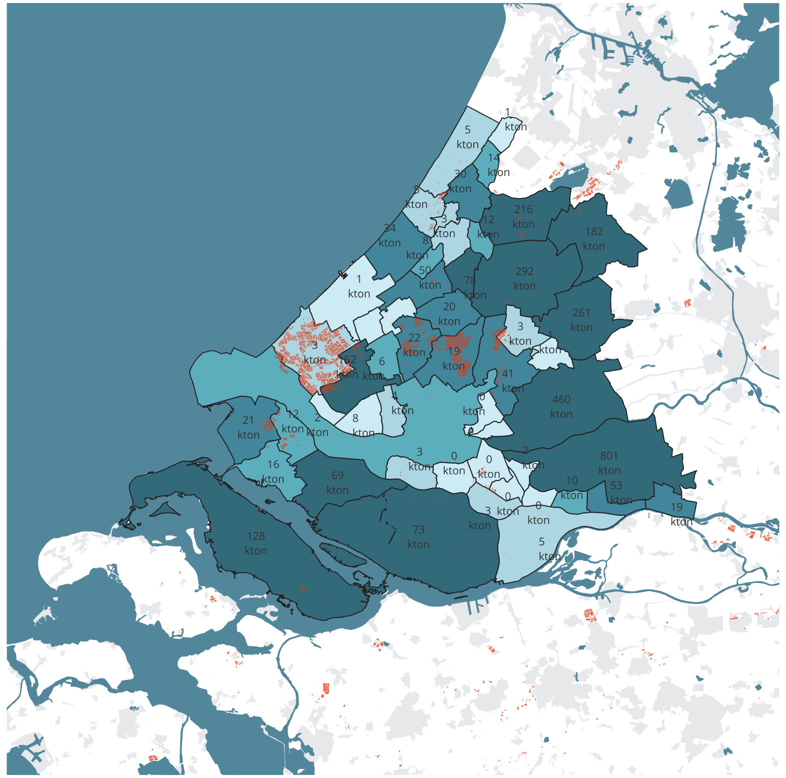


Fig. 32: Waste from manure
Data source: WarmteAtlas, n.d.
Image source: own graphic

Urban Areas
Greenhouse Locations
Oceans and Water Bodies
<2.0 kton
2.0-5.0 kton
5.0-17.8 kton
17.8-65.8 kton
>65.8 kton

0 10 20km

3.4 GREENHOUSES UNDER THE LENS

The workings of a greenhouse explained

To better understand the energy usage of a single greenhouse system, we analyzed the water system, heating/cooling system, and all of the flows. Figure 33 shows a schematic view of the water system within a greenhouse. Ground water is pumped up into the day tank, along with surface water, rainwater, and drainage water, which is collected in a basin. Nutrients are added to the water, after which this water is led into the substrate of the greenhouse, to water the plants. The water is then led back from the greenhouse into the rainwater basin, in the form of condensation, to be used again later. Most of the water is led back into the system, though some leakes and some is drained. The leaked water is lost and can't be reused in the greenhousee. The drained water is filtered, and then part of it goes to the sewer, while another part is led into the day tank to be used to water the greenhouse again.

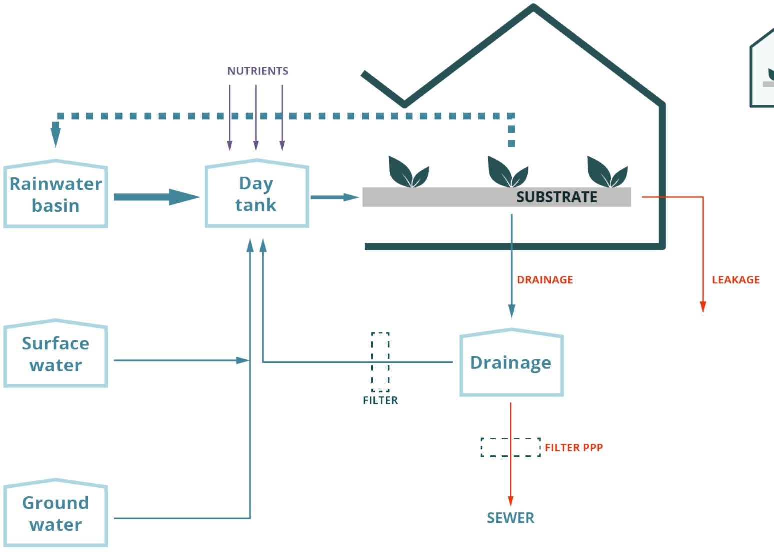


Fig. 33: Water system in greenhouse
Data source: van Tuyll et al., 2022
Image source: own graphic based on van Tuyll et al., 2022

Water equipment
Water input
Condensation
Loss of water
Low temperature

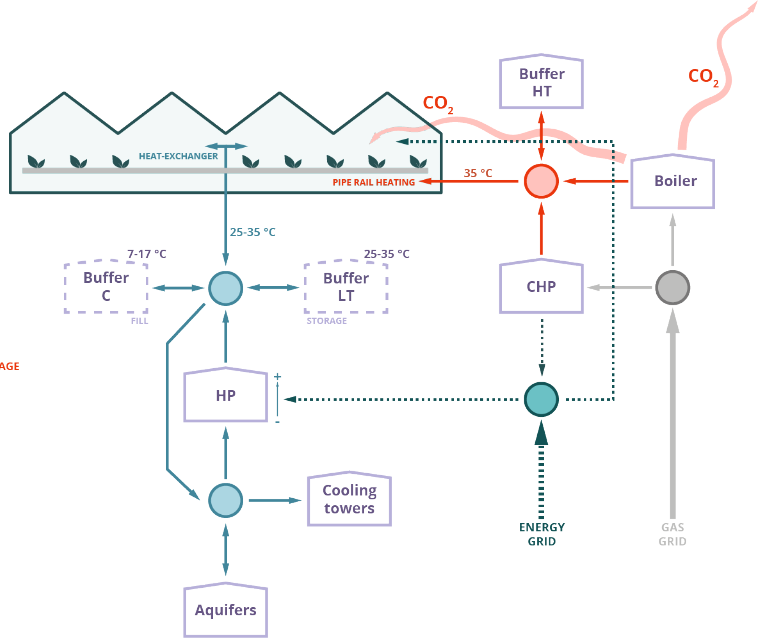


Fig. 34: Heating/cooling system in greenhouse
Data source: van Beveren et al., 2020
Image source: own graphic based on van Beveren et al., 2020

Energy equipment
System component
Heating
Cooling
Energy

Gas
Underground
LT Low temperature
HT High temperature
C Cold water

FLOWS IN CLOSED GREENHOUSE SYSTEM

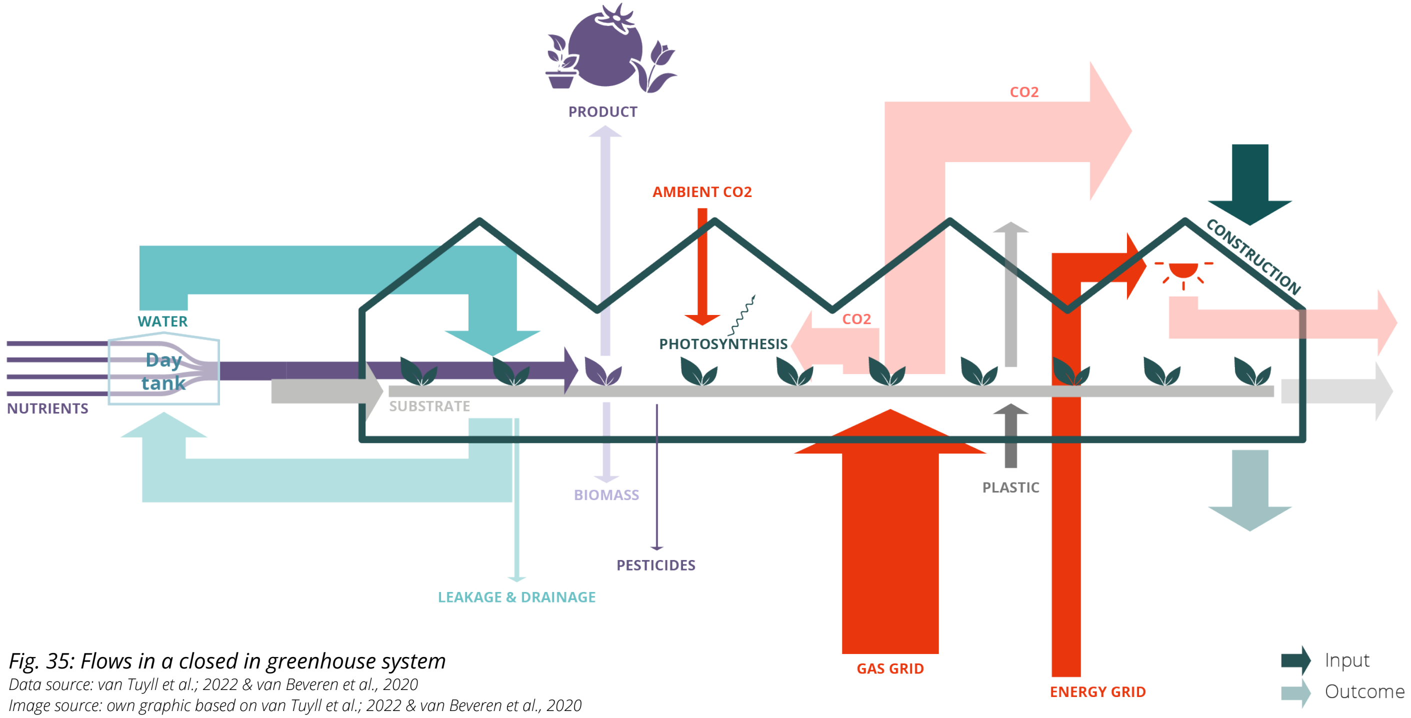


Fig. 35: Flows in a closed in greenhouse system
Data source: van Tuyll et al.; 2022 & van Beveren et al., 2020
Image source: own graphic based on van Tuyll et al.; 2022 & van Beveren et al., 2020

Figure 34 shows the process of using energy. Heating, shown to the right of the greenhouse, can be applied with a pipe rail heating system under the crops (above 35 degrees Celcius) or with heat-exchangers above the crops (25-35 degrees Celcius). High temperature heat comes either from the boiler of the CHP, or both. The Cold water Buffer and Low-Temperature heat Buffer are two large water storages under the greenhouse floor. The Cold water Buffer is for cold water storage (7-17 degrees Celcius), and the low-temperature heat buffer is for Low-Temperature heat storage (25-35 degrees Celcius). The Heat Pump brings Low Temperature water to a High Temperature, for heat exchangers or for storage in the Low-Temperature buffer. This water can come from the buffers, from the aquifers, of the greenhouse itself. The Aquifer is a water-bearing sand layer, used to store warm or cold water. The cooling towers are used to dispose of heat from the water. Electricity is used for lighting, the Heat Pump, and the Cooling towers.

Figure 35 shows the resource flows of energy, water, waste and materials and processes in a greenhouse which is a closed system.

The energy-hungry greenhouse

To gain a better understanding of the energy consumption of greenhouses, we have performed a number of related analyses. Figure 36 shows the distribution of costs for Dutch greenhouse farms. The total costs have increased considerably since 2001. The proportions of the individual costs have remained more or less the same. Energy has always been a large part of the costs.
The number of greenhouses in the Netherlands has decreased quite significantly, while the average area per farm has increased, as can be seen in Figure 37. The two curves almost mirror each other.

As can be seen in Figure 38, energy use in the Netherlands has mainly decreased over the last 20 years. The use of heat has declined quite steadily, and while the use of electricity first started to increase around 2010, it has started to decline again since around 2019.
Figure 39 shows the comparison of energy usage for traditional greenhouses compared to vertical farms. We can see that the energy use per hectare is four times as high for a vertical farm in comparison to a traditional greenhouse, while the land use is only twice as small. This means that vertical farming is essentially half as effective as traditional greenhouses in terms of energy usage alone.

Fig. 36: Average cost component of greenhouse vegetable farms in the Netherlands
Data source: Ruijs & Benninga, 2020
Image source: colors adapted from Ruijs & Benninga, 2020

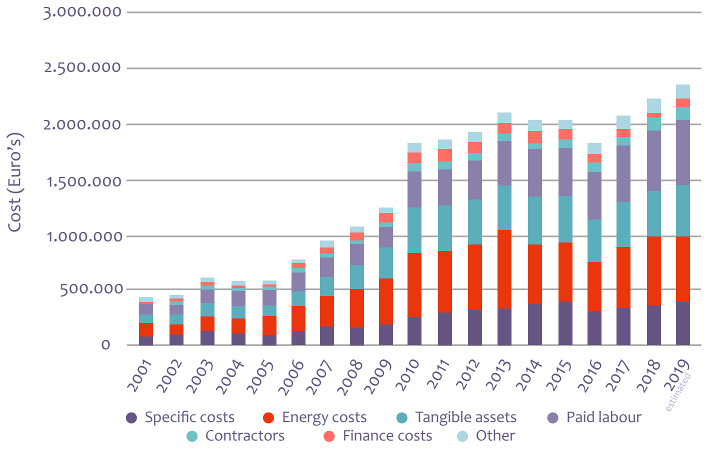


Fig. 37: Number of greenhouses and average hectare in the Netherlands
Data source: Agrofoodportal, 2023
Image source: colors adapted from Agrofoodportal, 2023

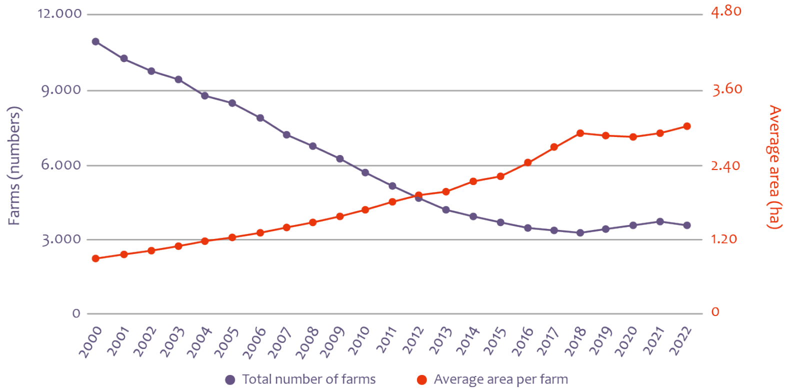
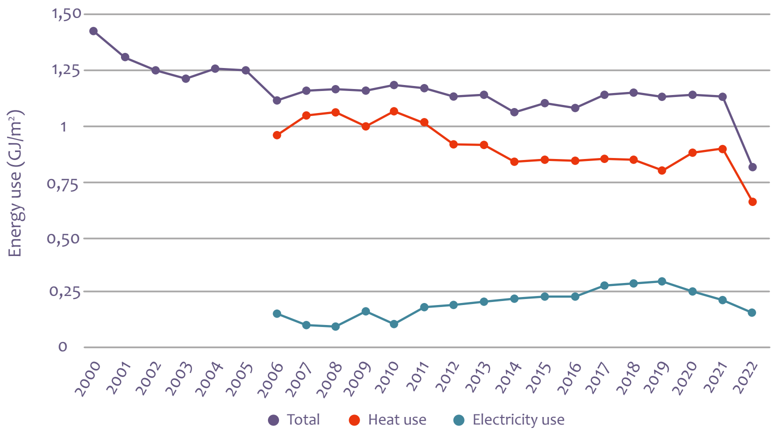


Fig. 38: Energy use of greenhouses in the Netherlands
Data source: Smit, 2023
Image source: colors adapted from Smit, 2023



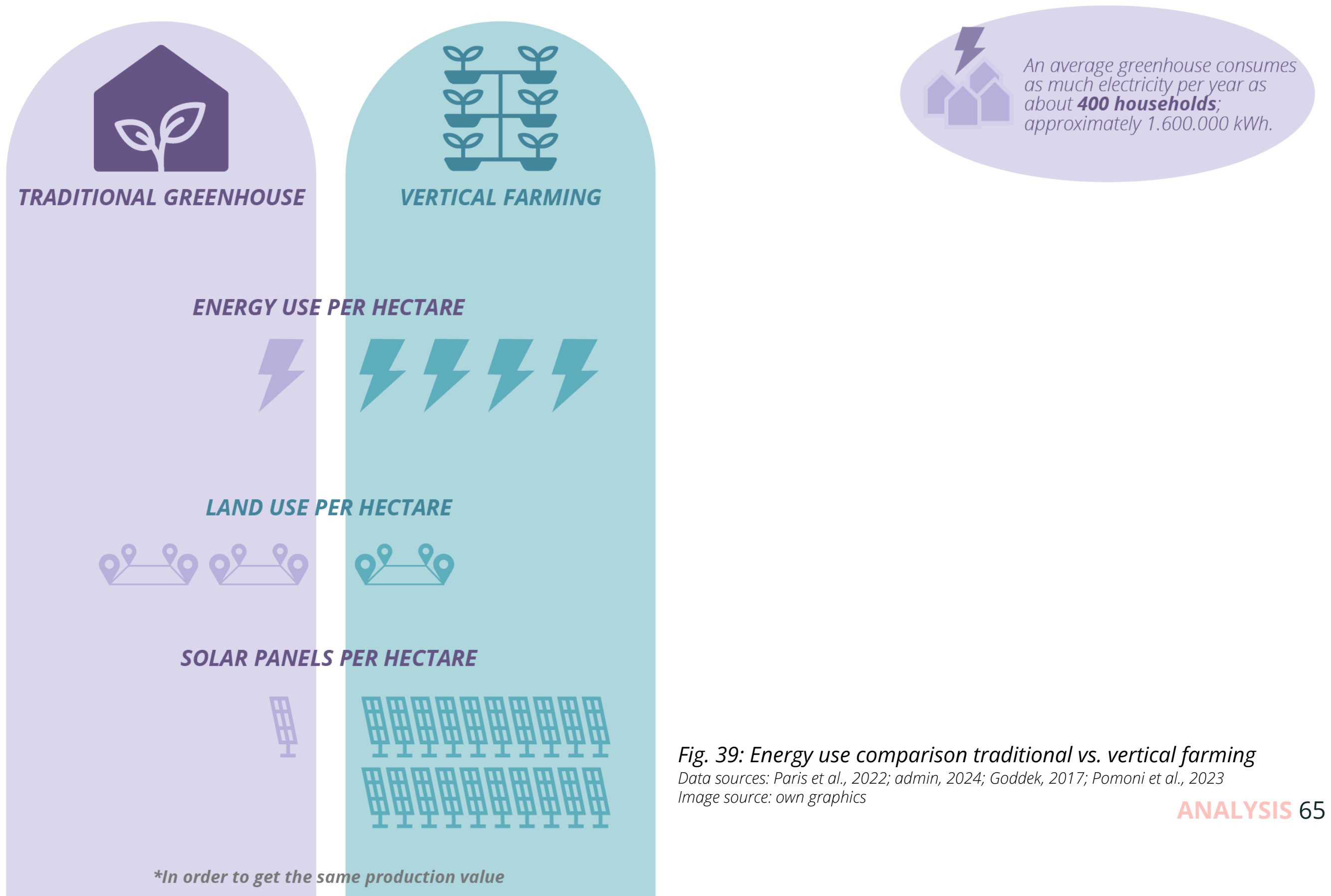


Fig. 39: Energy use comparison traditional vs. vertical farming
Data sources: Paris et al., 2022; admin, 2024; Goddek, 2017; Pomoni et al., 2023
Image source: own graphics

Systemic flows of resources in the food sector

Figure 40 shows a systemic view of the flows within the greenhouse sector to provide an overview of the inner workings of the greenhouse industry. It shows recycling, vegetable, waste, energy, and water flows.
The process starts with production, first of energy and then within the greenhouses. It then moves to consumption, both public and private. The waste that comes from both production and consumption is managed, separated by whether it is hazardous or not, heat and energy, and water. Finally, all waste is treated and, where possible, returned to the system.
We see that there is a lot of waste, especially in the early stages of production. There are several opportunities for more circular practices.

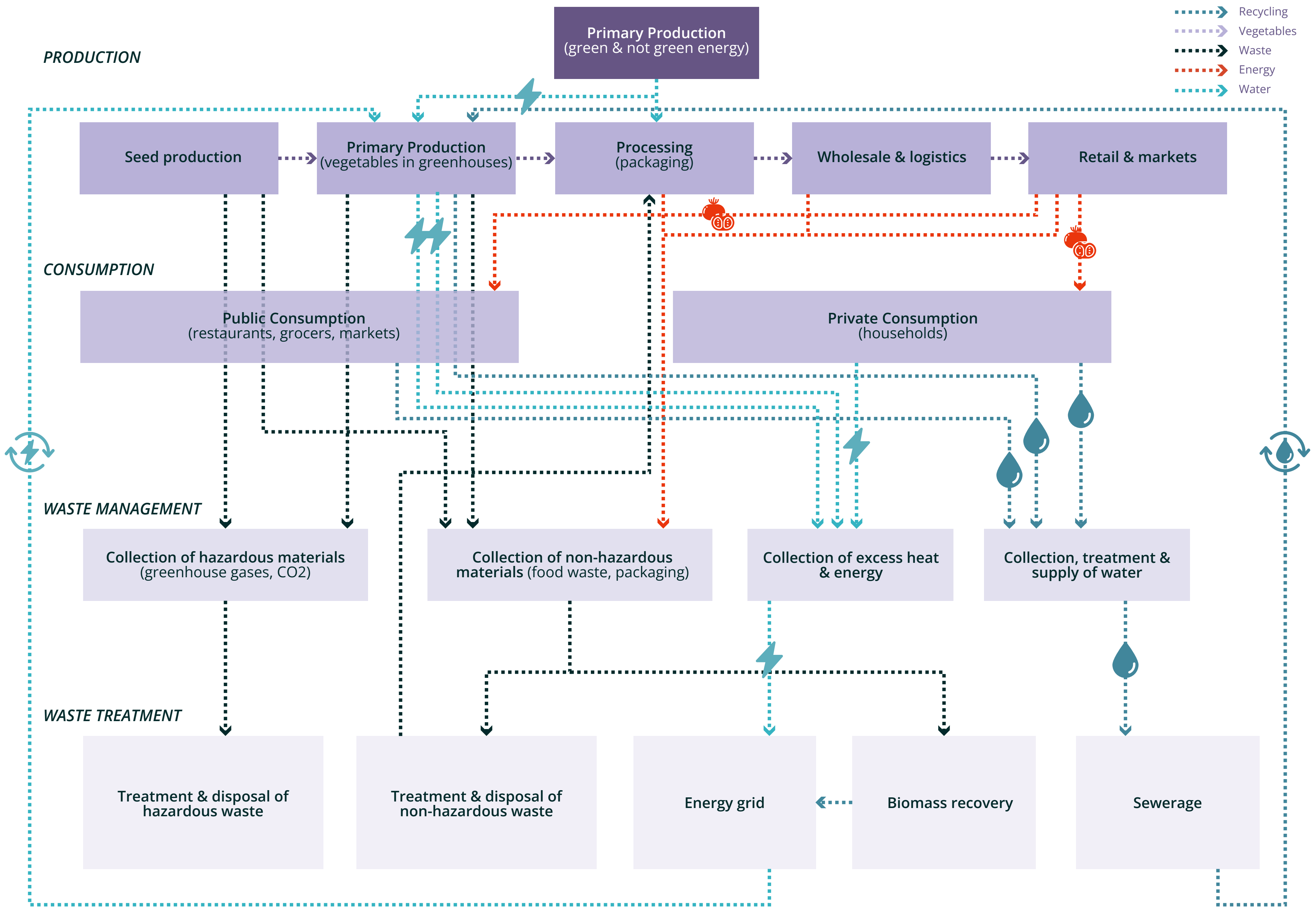


Fig. 40: Resource flows of the Dutch food sector
Data source: -
Image source: own graphic

3.5 SOCIAL CONDITIONS & CAPACITIES

Focus on peri-urban areas

From Alexander Wandl's paper on territories in between, the peri-urban spaces are defined as a "wide territory of urban diffusion around urban centers (Wandl, 2020)," which is further characterized by the proximity to urban centers, mixed land uses, fragmented governance, environmental interface, and socio-economic diversity. Additionally, in a typical polycentric city region, multiple dimensions, flows, relationships, and attributes build the framework for peri-urban areas (Sahana et al., 2023). Examples of peri-urban characteristics in The Netherlands include:

- High dependency on cars because of the lack of accessibility to public transportation.
- Multiple land uses such as the coexistence of glasshouses adjacent to residential areas in Westland or tulip fields alongside village homes in Lisse.
- Industrial Zones that coexist with residential areas and employ workers across various economic brackets such as Rozenburg and Europort.
- Political fragmentation such as the imbalance between small and medium-sized greenhouse growers and politicians after the energy costs were increased in September of 2023.
- Environmental "eco-peri-urban" options such as the potential connection between the Natura 2000 restricted area southwest of Westland and the beach near Hoek van Holland.
- Specific social groups such as the migrant workers that seasonally live in South Holland to harvest in the greenhouses.
- Logistic hubs such as Venlo where many trains, trucks, and boats stop before crossing the border and where companies run their distribution under Greenport regulations

Figure 41 shows the general definitions and criteria for peri-urban areas within the context of our research project, drawing upon foundational theories from Sahana et al. and Wandl.

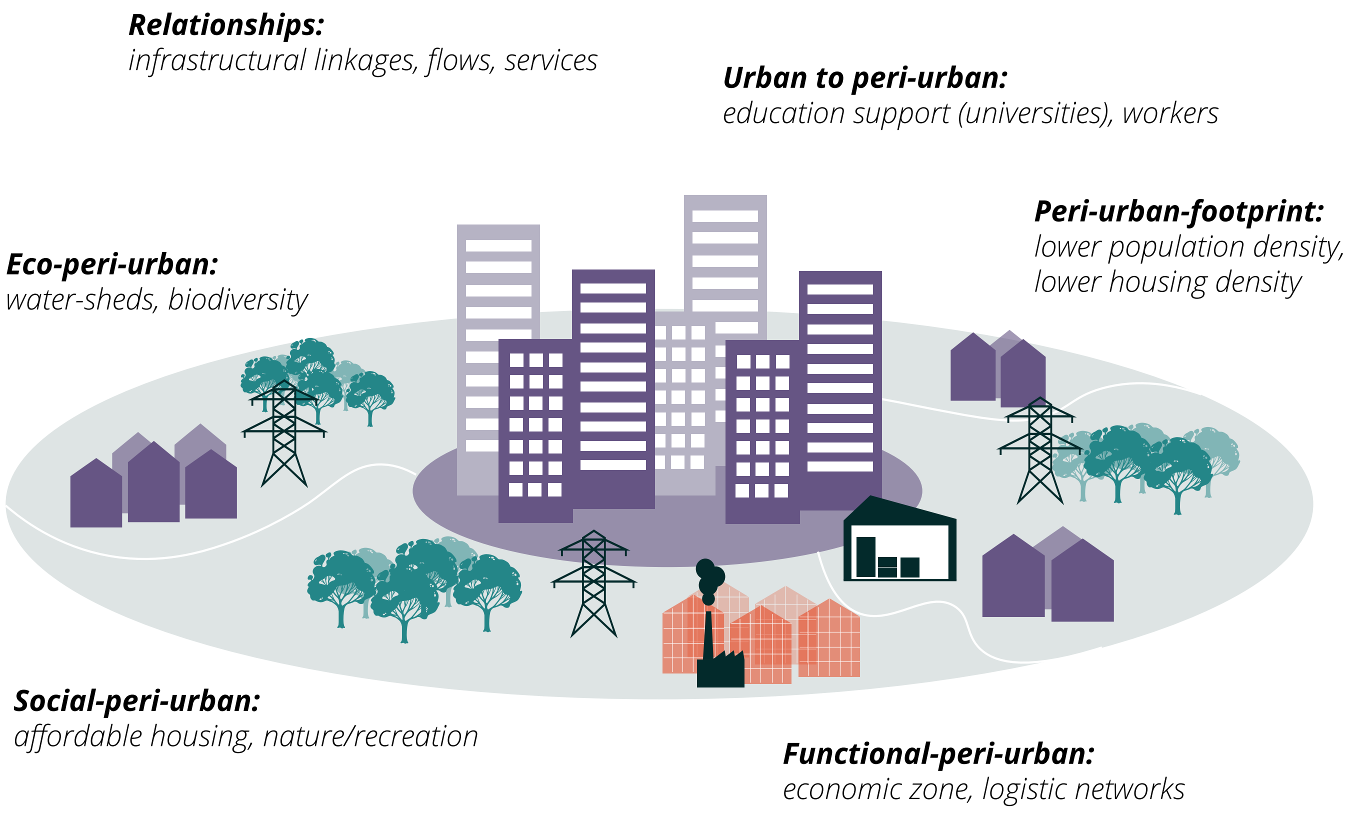


Fig. 41: Characteristics & links between peri-urban / urban landscapes
Data source: Sahana et al., 2023; Wandl, 2020
Image source: own graphic

Accessibility of the peri-urban areas

To get a better idea of the social conditions within the peri-urban areas, we analyzed different social facilities within the area, as shown in the following Figures. These facilities were based on the 15-minute city model, which states that there are six social functions that should be within 15 minutes of walking, biking, or public transportation: housing, work, shopping, care/health, learning, and entertainment (Moreno et al., 2023). The facilities analyzed all fit into one or possibly more of these categories.

Cultural accessibility
Cultural facilities include facilities such as bookstores, cinemas, libraries, museums, or theaters. There are quite a lot of cultural facilities within the analyzed area. However, within the area that is within 15 minutes of the peri-urban areas, the offer is much smaller. The cultural facilities are mostly located in the urban areas, such as The Hague and Rotterdam, and in the municipalities surrounding the peri-urban areas. There are very few cultural facilities within (the vicinities of) the peri-urban areas themselves. (see Figure 42)

Fig. 42: Cultural accessibility
Data source: OpenStreetMap, n.d.
Image source: own graphic

Fig. 43: Sports accessibility
Data source: OpenStreetMap, n.d.
Image source: own graphic

Sports accessibility
Sports facilities, such as soccer fields and gyms, are also mostly located in urban areas, both cities and smaller towns. There are only a handful of sports facilities within 15 minutes of the peri-urban areas. (see Figure 43)

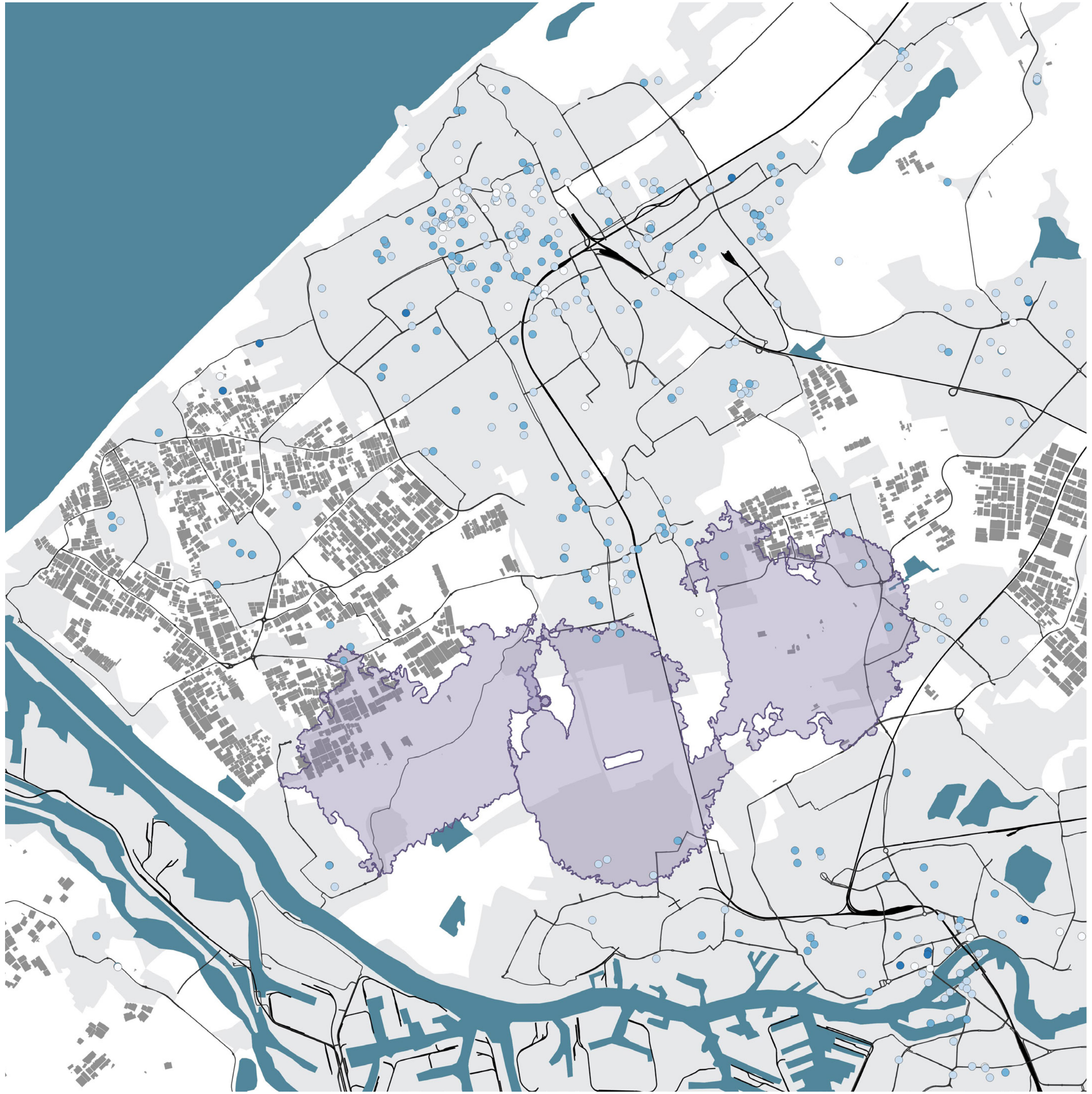


Fig. 44: Medical accessibility
Data source: OpenStreetMap, n.d.
Image source: own graphic

Medical accessibility

There are very few medical facilities, such as hospitals and general practitioners, within reach of the peri-urban areas. The vast majority of these are located in the nearby large cities of The Hague and Rotterdam. There are a few facilities within a 15-minute drive, but none are closer to the center of the peri-urban area. (see Figure 44)

Fig. 45: Recreational accessibility
Data source: OpenStreetMap, n.d.
Image source: own graphic

Recreational accessibility

There are very few recreational facilities in the study area. They are very scattered and quite well distributed when considering the whole area. Almost none of them are located in the vicinity of the peri-urban areas, and those that are are on the very outer edge of the 15-minute circle. (see Figure 45)

3.6 WHO IS INVOLVED IN THIS TRANSITION?

Stakeholders in the Dutch greenhouse horticulture

These are the stakeholders involved in Dutch greenhouse horticulture (see Figure 46). They have been placed in a power/sustainability interest matrix in order to be able to identify the key stakeholders later in the process. We have also defined the influences they have on each other, both one-way and two-way (regulations, knowledge, job opportunities, voice / power and demand).

Different roles

They have been arranged according to their role within the production process: the supply/ preparation of production, the production itself, and the distribution & consumption of the products afterwards. There are some outliers that don't fit into any particular phase, they have a separate category (other stakeholders). All phases have been further subdivided to further categorize and specify the stakeholders.

Supply/preparation for production

In the supply phase, the EU, the national government and the local municipality provide the rules and regulations. The gas and renewable energy suppliers provide electricity, as do the grid operators. Finally, universities and academia provide knowledge.

Production

The greenhouse owners, in all their various forms, have a leading role, and the workers provide the physical labor.

Distribution & consumption

For distribution and consumption, logistics companies and grocery stores provide the distribution that allows consumers and local residents to consume the products.

Other

The traditional media is an outlier because it is not actively involved in any of the phases, but is a spectator in all of them. The Greenports and civil organizations fight for the rights of the greenhouse owners, so they don't actively participate in the production either. The environmental management is ecological and environmental, so it is not necessary in the greenhouses themselves, but more in the effects they have on their surroundings.

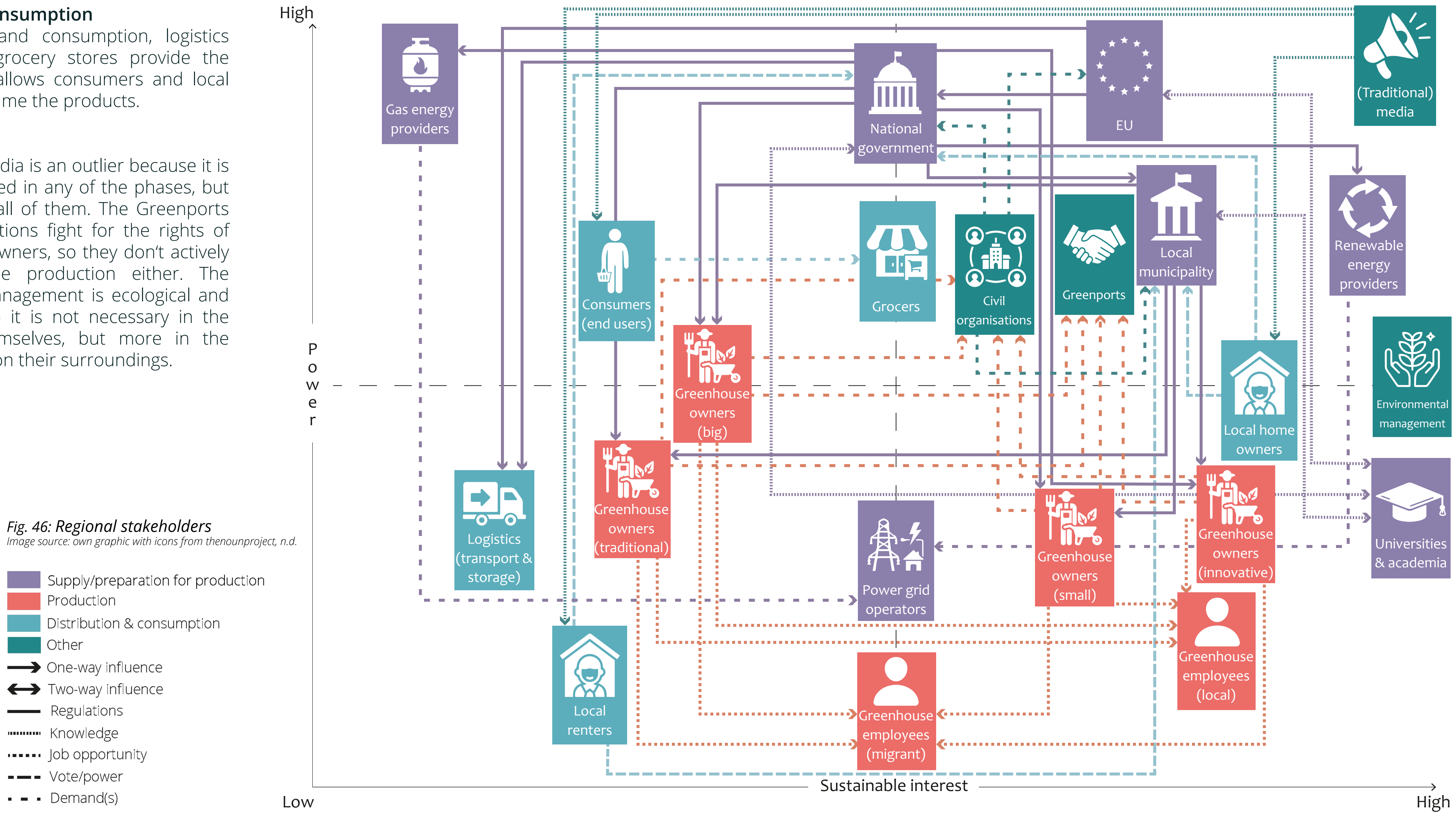


Fig. 46: Regional stakeholders

Image source: own graphic with icons from thenounproject, n.d.

Identifying the „key gaps“ in communication

As shown in Figure 47, the main gap within the stakeholder network seems to be between the government, both national and local, on the one hand, and the greenhouse owners on the other. Both want a more sustainable greenhouse horticulture, as agreed in the Covenant Energy Transition Greenhouse Horticulture (Ministerie van Landbouw, Natuur en Voedselkwaliteit, 2022). However, the way the government is currently going about this, by implementing strict rules, especially regarding energy consumption, is hurting many greenhouse growers. The new regulations will cause energy costs to rise so steeply that the majority of greenhouses won't be able to make a profit (WOS, 2023). Small and medium-sized businesses will be the main victims, as they will have fewer resources to fall back on (Bakker, 2023).

Collaboration platforms insufficient

There are platforms for collaboration with these stakeholders, as shown on page 82, but they seem to be used in a top-down way by the government, which makes greenhouse owners feel that they are not being listened to. The new policies and regulations do not seem to be based on knowledge from actual greenhouse practice, resulting in serious problems for greenhouse owners (Omroep West, 2024).

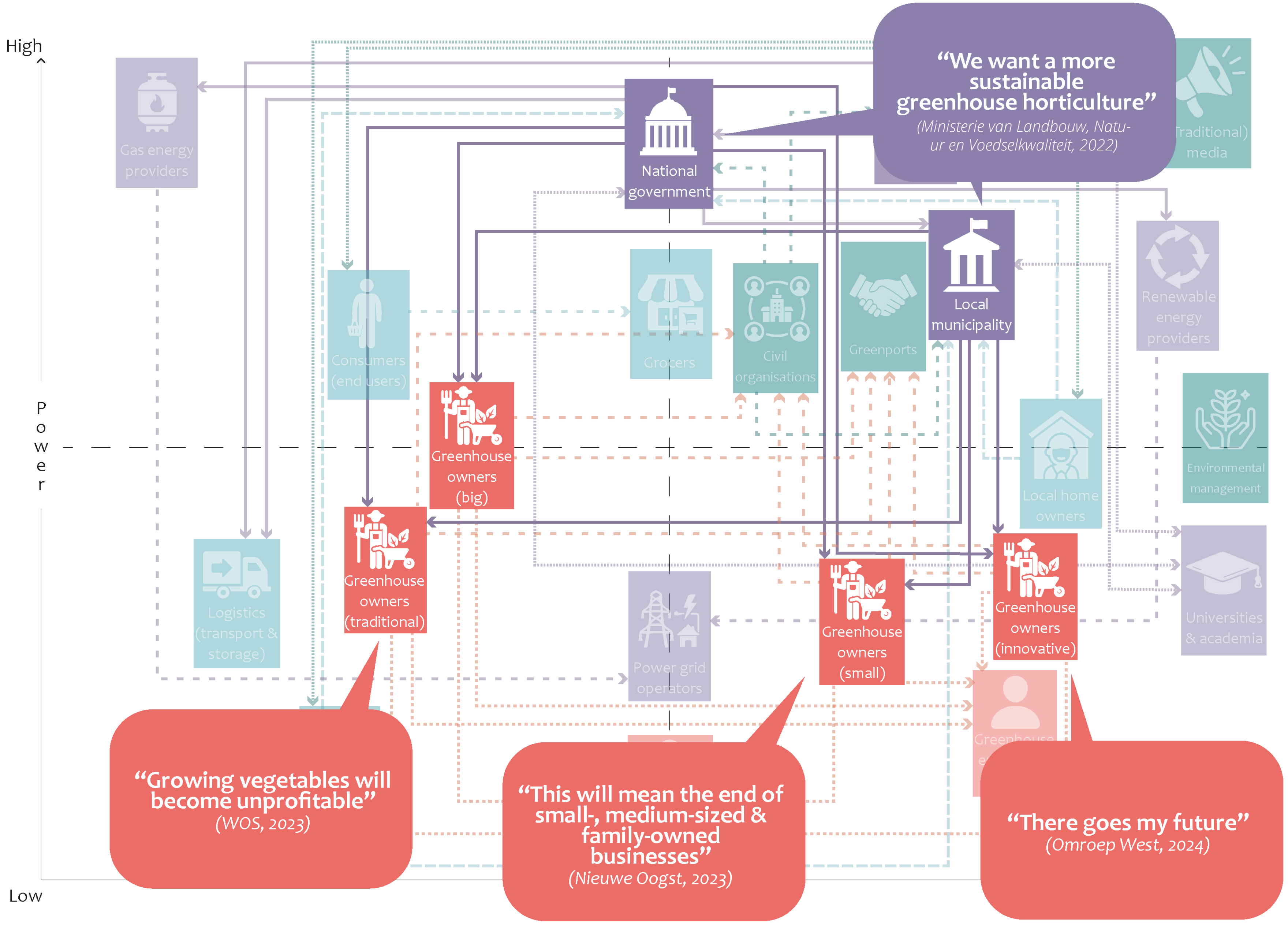


Fig. 47: Regional stakeholders with opinions
Image source: own graphic with icons from thenounproject, n.d.

- Supply/preparation for production
- Production
- Distribution & consumption
- Other
- One-way influence
- Two-way influence
- Regulations
- Knowledge
- Job opportunity
- Vote/power
- Demand(s)

Existing platforms to connect

There are several existing collaboration platforms between different stakeholders, at different scales, and with different functions, as shown in Figure 48.

World Horti Center
The World Horti Center near Westland is a knowledge and innovation center. Greenhouse owners collaborate with each other and with universities and academia to research sustainable innovations in greenhouse horticulture. They also share this information with visitors. The municipality plays an organizational role (World Horti Center, n.d.)..

Greenports Netherlands & per location
Greenports Netherlands is a national network organization in which the government, greenhouse owners, universities and academia, and logistics work together towards a common approach to resilient and sustainable greenhouse horticulture. There are several Greenports with different contexts, of which West-Holland, Gelderland and Venlo) are relevant for our region. They do the same work as the national organization, but more specifically tailored to local circumstances (Greenports Nederland, n.d.).

Horticulture Youth Netherlands
Horticulture Youth Netherlands is a national organization where young greenhouse owners share knowledge about their greenhouse systems (Von Bannisseht, n.d.).

SIGN
SIGN (Establishment Innovation Greenhouse Horticulture) is an initiative of Greenhouse Horticulture Netherlands in which greenhouse owners work together with universities and research institutes to research innovations in greenhouse horticulture. The government plays an organizational role and sometimes provides subsidies for research projects (Glastuinbouw Nederland, n.d.).

Come to the Greenhouse
Finally, Come to the Greenhouse is an annual weekend where people can visit greenhouses around the country to see how they work, creating a greater connection and insight into where their food comes from (Kom in de Kas, n.d.).

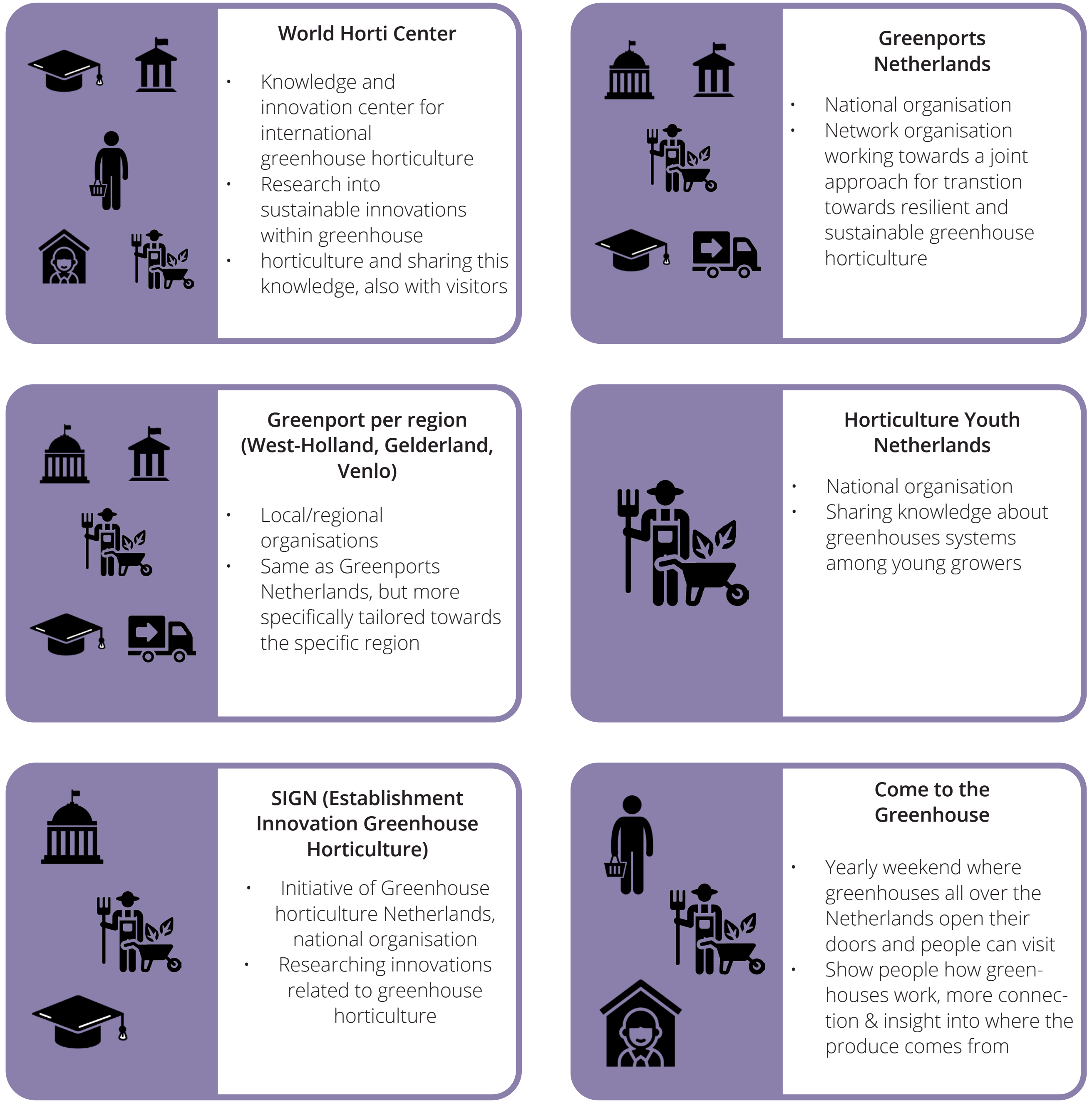


Fig. 48: Existing collaboration platforms
Image source: own graphic with icons from thenounproject, n.d.

3.7 POLITICAL FRAMEWORKS

Identifying relevant policies & organizations

There are many policies and strategies that affect Dutch greenhouse horticulture in one way or another and at different scales, as shown in Figure 49. These policies and strategies can be restrictive (rules), regulatory (strategies for transition) or focused on innovation (development and/or sharing of new ideas).

European Union
At the European level, there is the Paris Agreement, which concerns greenhouse gas emissions (United Nations, n.d.-b), and Natura 2000, which designates certain natural areas as protected (Ministerie van Landbouw, Natuur en Voedselkwaliteit, n.d.). Both are restrictive. In terms of regulation, there are the Sustainable Development Goals (United Nations, n.d.-a).

The Netherlands
The first restrictive policy is the Law Fiscal Measures Greenhouse Horticulture. The changes proposed in this law are likely to result in high energy costs for greenhouse owners (Bakker, 2023). The National Climate Agreement does not only concern greenhouses, but proposes strategies to limit greenhouse gas emissions for many different sectors, of which greenhouse horticulture is one (Rijksoverheid, 2019). Finally, the Living Environment Act sets rules for what can and can't be built in the living environment (Rijksoverheid, n.d.-b). There are three national strategies for greenhouse horticulture. The Horticulture Agreement & Agenda 2019-2030, which sets out a timeline for the transition within this industry (Greenports Nederland, 2019). Climate-Neutral Greenhouse by 2040, which outlines a strategy to make greenhouses climate-neutral by 2040 through a combination of sustainable measures (Glastuinbouw Nederland, 2023). The Covenant Energy Transition Greenhouse Horticulture is an agreement between the national government and the organizations Greenhouse Horticulture Netherlands and Greenports Netherlands to make greenhouse horticulture sustainable while remaining profitable (Ministerie van Landbouw, Natuur en Voedselkwaliteit, 2022).

Region
There is one regional restriction: the environmental regulation. These are rules for the living environment, like the national Living Environment Act, but specified per province (Informatiepunt Leefomgeving, n.d.-c). In terms of strategies, we first have the Regional Energy Strategies. These are strategies per region for the energy transition (Unie van Waterschappen, n.d.). Then there are the provincial energy strategies: Provincial Multi-Year Program Infrastructure, Energy & Climate. These are plans for the energy transition per province (Netbeheer Nederland, 2023). The Environmental Vision and Program are ambitions and goals for the living environment, both plans for the long term (Informatiepunt Leefomgeving, n.d.-e) and how these will be achieved (Informatiepunt Leefomgeving, n.d.-d). The province of Zuid-Holland has developed a vision for achieving a circular society by 2050 that is unique to this province (Provincie Zuid-Holland, n.d.-b). Finally, there is the Energy & Climate program, which is a regional innovation program to promote and help implement sustainable innovation (Rijksoverheid, n.d.-c).

Local
There is one local restriction: the environmental plan. This is similar to the national Living Environment Act and the provincial environmental regulation, but more specific for each municipality (Informatiepunt Leefomgeving, n.d.-b). Westland has a Greenhouse Horticulture Vision 2040, as it has the largest greenhouse horticulture industry in the country (Gemeente Westland, n.d.). Each municipality has an Environmental Vision, which is a strategic vision for the physical living environment (Informatiepunt Leefomgeving, n.d.-a). Finally, Greenport Westland Oostland has a sustainability project that focuses on greenhouse horticulture in the area (Programmabureau Taskforce Duurzame Greenport Westland Oostland, n.d.).

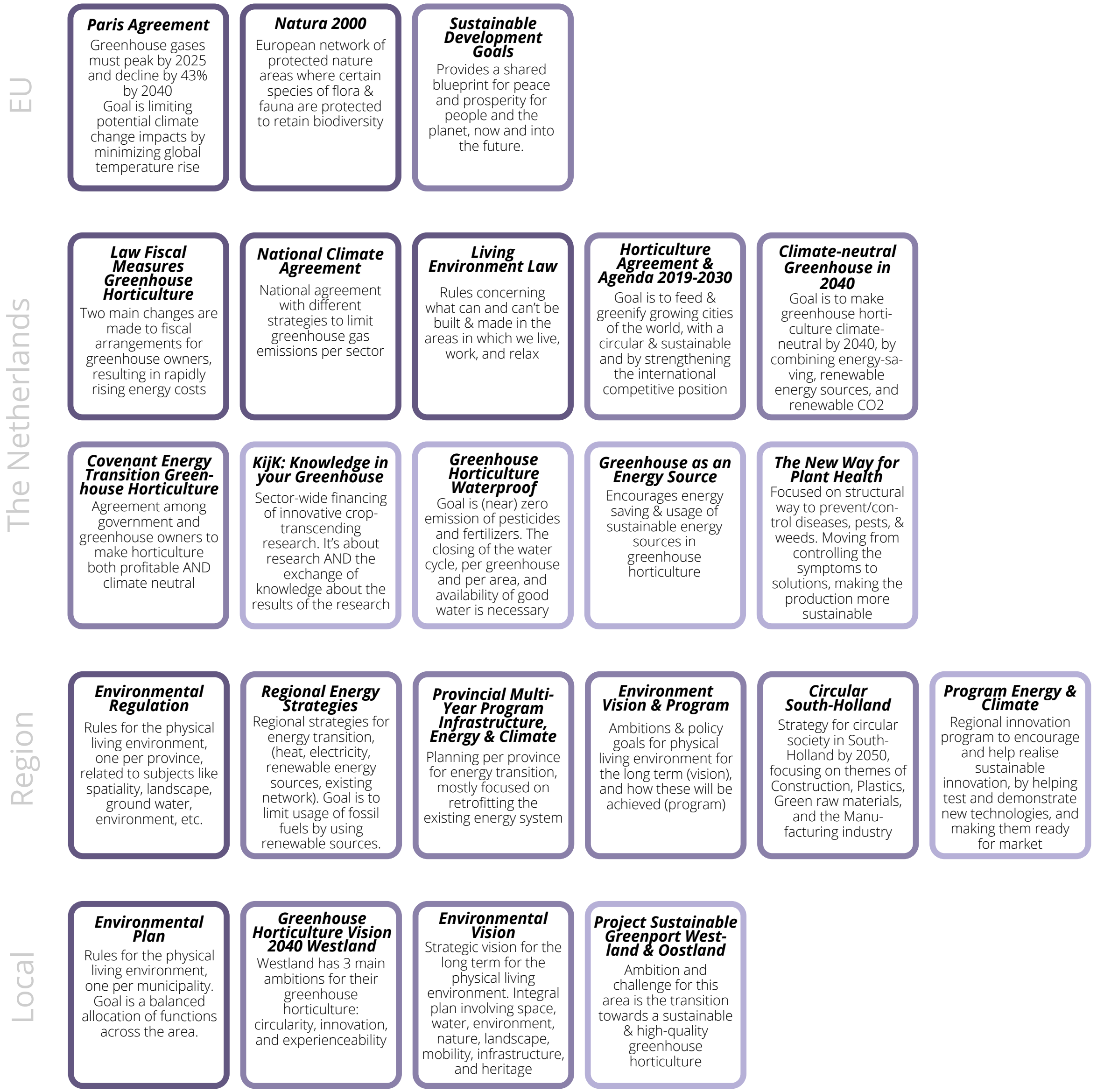


Fig. 49: Policies & organizations
Image source: own graphic

Restricting
Regulating
Innovation

Localizing policies in the region at hand

We have spatialized some policies within our defined region, as shown in Figure 50, to see where developments are/will take place.

Novex Rotterdam Port

The Port of Rotterdam is a Novex area, which means that the national government and the provincial/regional government are working together to create a sustainable port. An important part of this is the energy transition within the port. As the port is close to Westland, we could possibly be involved in these developments, or at least be aware of them (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, n.d.).

Housing projects

Due to the housing shortage in the Netherlands, there are several national housing projects. Shown here are the large-scale housing projects planned between now and 2030, both within cities and outside of them. Also included are locations where infrastructure will be improved to ensure that the new housing is accessible (Rijksoverheid, n.d.-a).

RES

The RES (Regional Energy Strategies) for Rotterdam-The Hague and Arnhem-Nijmegen are relevant for our region. First, Arnhem-Nijmegen: there is a high potential for wind and/or solar energy in the vicinity of these cities (Team RES Regio Arnhem Nijmegen, 2021). There is also great potential in Rotterdam-The Hague. In addition, the province is planning to expand the existing heat network to include more municipalities near the large cities of Rotterdam and The Hague. This includes the inclusion of Westland's greenhouses in the network. Residual heat from industry in the port of Rotterdam will be reused (Stuurgroep Energiestrategie regio Rotterdam Den Haag, 2021), as will residual heat from industry in the Arnhem area (Team RES Regio Arnhem Nijmegen, 2021).

Environmental Vision

The environmental vision of Zuid-Holland has some relevant elements, such as plans to increase geothermal projects throughout the province, many of which are near Westland. Some water sources will be changed and some new water sources will be added. Underground water storage will also be added (Province of South Holland, n.d.-a).

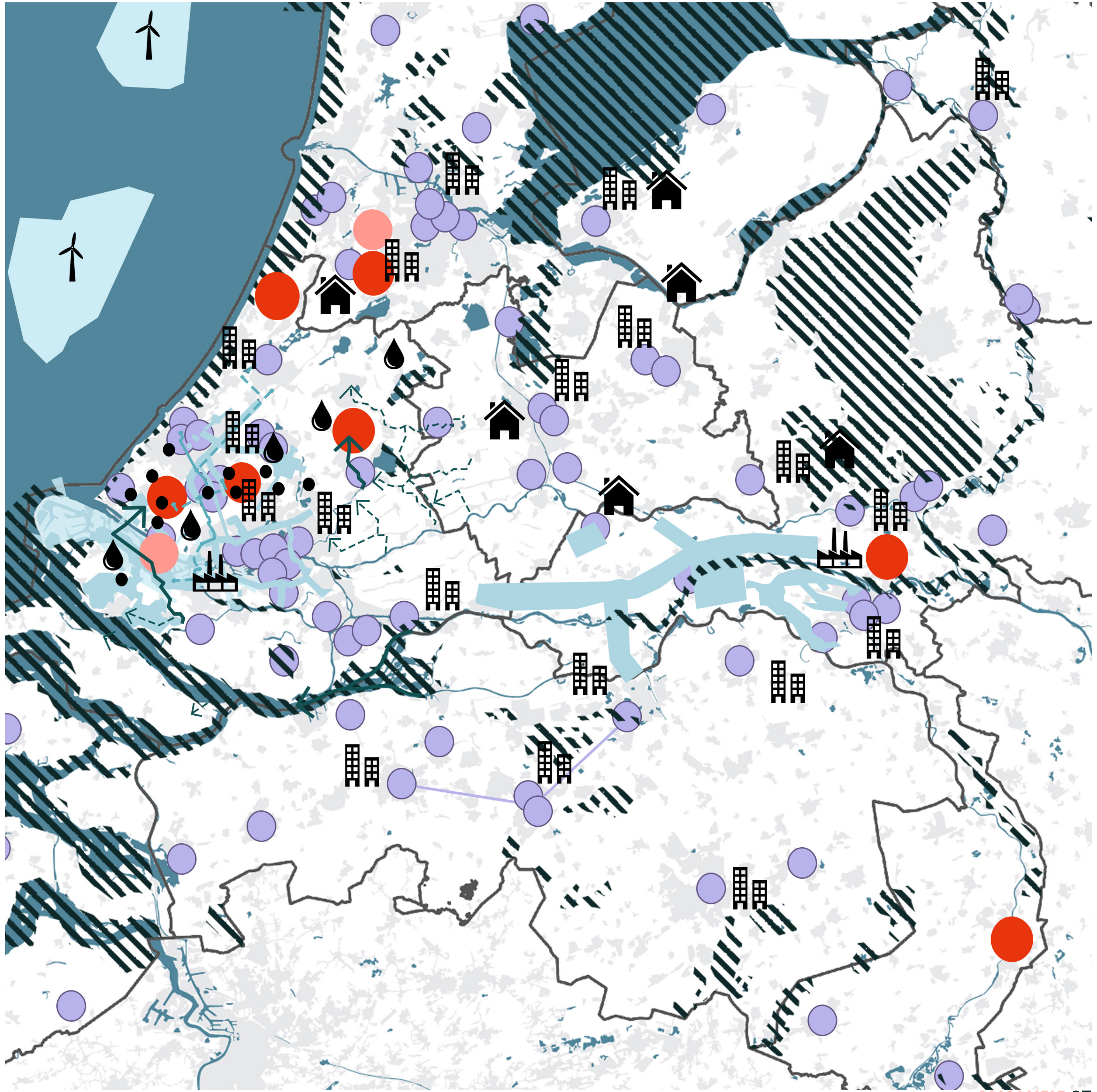
Natura 2000 & wind parks

The protected Natura 2000 areas were highlighted because they are off limits for many activities that would disturb the wildlife there (Ministerie van Landbouw, Natuur en Voedselkwaliteit, n.d.). Finally, the current and planned wind farms at sea were highlighted (Rijksoverheid, n.d.-d).

Fig. 50: Localizing policies
Image source: own graphic

National wind parks
Existing wind farm
Greenports
Greenport
Mainport
Natura 2000
Protected area
Environmental vision
Geothermal project
Water source
New water source
Water storage
RES
Heat network
New heat network
Reuse industry heat
High wind/solar energy potential
Housing projects
Housing (city)
Housing (village)
Better infrastructure
Novex Rotterdam Port
Energy transition
Background
Provinces
Urban areas
Water bodies

0 10 20km



3.8 CONCLUSION

Urgencies through scales

Overall, we found that the economic benefits from the international greenhouse export do not reach the lower scales and the communities there. Furthermore, there is ecological vulnerability across all three scales. We also looked into the relations between the scales, to see where the challenges and/or opportunities are. (see Figure 51)

International & regional scale
The international economic strength is at the expense of the environment at the regional scale, resulting in enviromental degradation. There is severe resource exhaustion and pollution on the scale of the Delta region. Moreover, habitats and communities are fragmented on this scale, due to the large-scale logistics network of roads, railways, ports, and distribtion centers.

International & local scale
The strong international economic position does not reach the local communities and does not result in spatial qualities there. The accessability of greenhouse areas is low, due to the greenhouse structures forming a barrier of sorts. There are also small-scale ecological burdens for the locals, such as light pollution. The highly intense landuse can cause damage to the soil and native biodiversity.

Local & regional scale
The pollution from the greenhouses on local scale pose ecological challenges f the vulnerable Delta region. Greenhous horticulture account for around 20% of th Dutch CO2 emissions, due to the relience c non-renewable energy sources.

Stakeholders
The main weakness in relation to stakeholde across all scales is the communication ga between policy makers on one hand ar greenhouse owners on the other. There see to be ample communication and collaboratic platforms, both more local and nation between the two but these are mostly use top-down by the government and the poli makers aren't (actively) involved in the exchang of knowledge, resulting in a mismatch betwee policies and actual greenhouse practice. This, turn, results in tension between government stakeholders and greenhouse growers, as th latter feel like they are not being listened t On the local scale, this concerns municipalitie on a regional scale, this more so concerr provinces, and on a national scale, it is abo the national government.

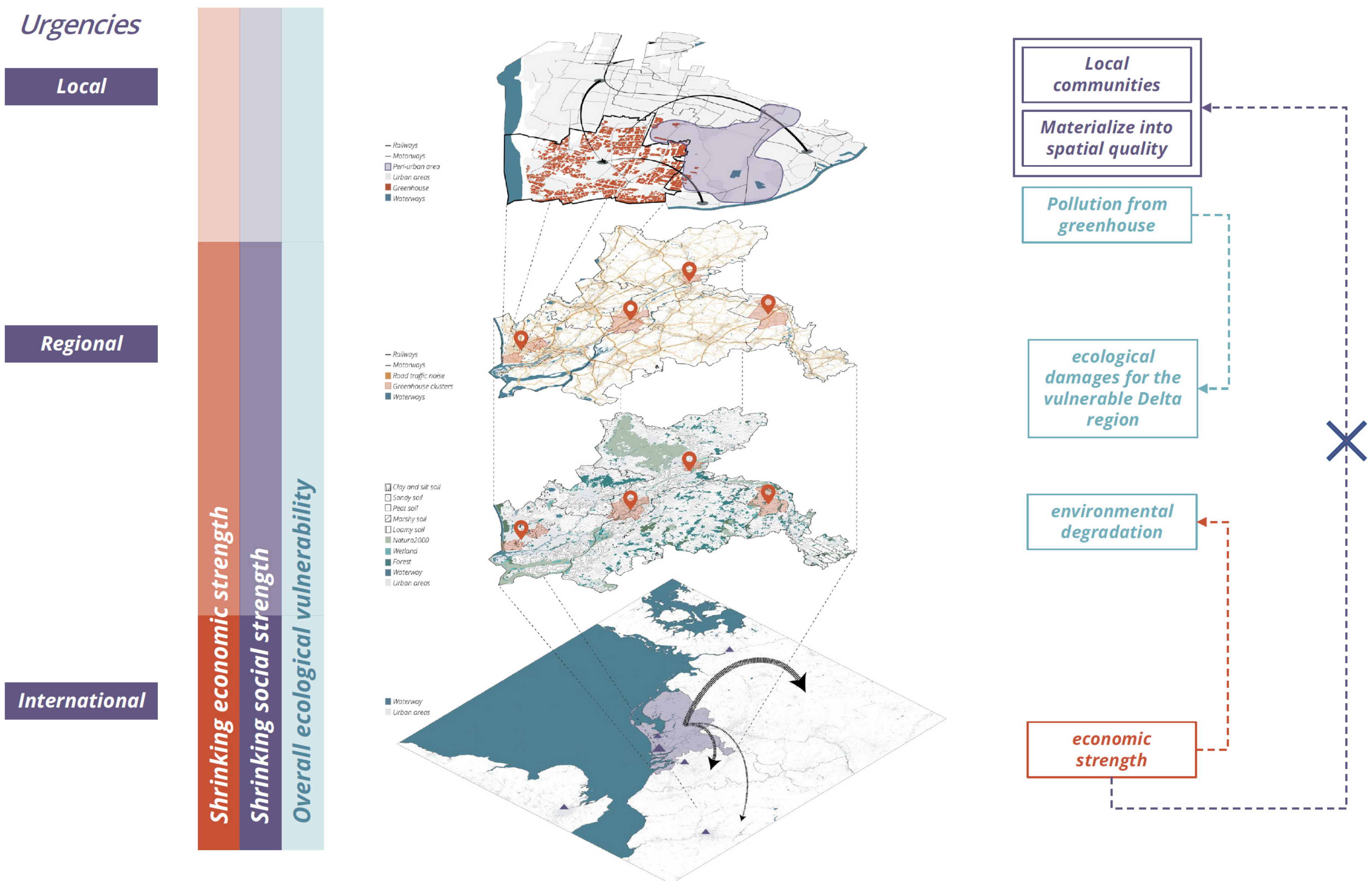


Fig. 51: Urgencies through the scales
Image source: own graphic

Systemic perspective

To deepen our understanding and overview of the greenhouse horticulture industry, we have made a systemic overview of the different flows, chains, and contexts of this industry, as shown in Figure 52. From right to left, there are the oil platforms that provide fossil fuels and wind farms that provide wind energy, the greenhouses themselves, farmland, villages, cities, industrial areas, and finally the port. All of these different areas experience unique consequences of greenhouse horticulture, from preparation to production to distribution. These are both spatial conditions & qualities and environmental impacts. They are largely negative. It is a mostly linear system with waste production at different points that is not recycled/recovered. Some of the energy used in greenhouses comes from renewable sources, but there is still a large dependence on fossil fuels.

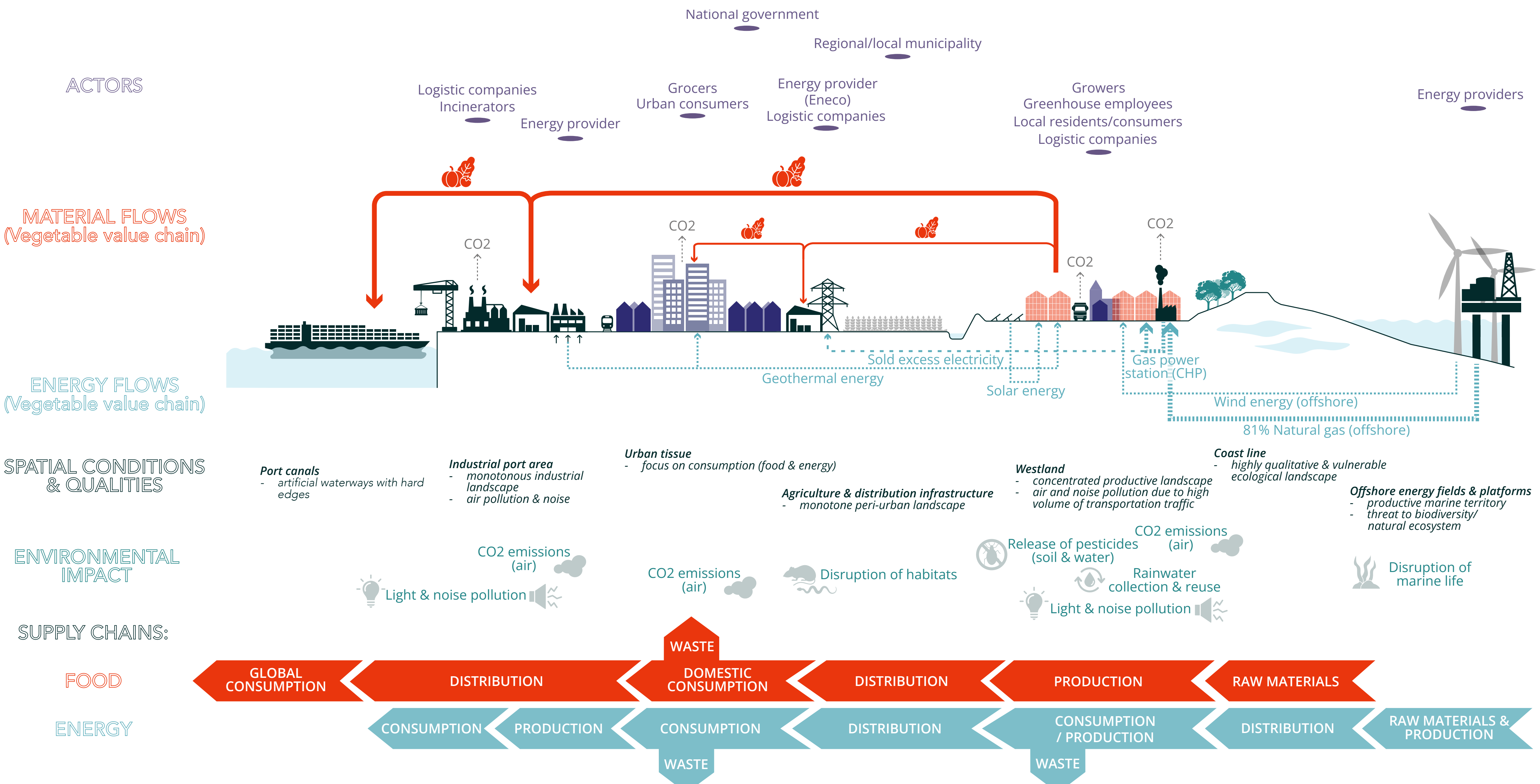


Fig. 52: Systemic Section through the sub-region of Westland
Image source: own graphic with icons from thenounproject, n.d.

SWOT

The current strengths and weaknesses of the region can be used to deal with opportunities and threats, as shown in Figure 53.

Combining with strengths
A current strength of the business is its global position as a knowledge and innovation hub for greenhouse horticulture. We want to strengthen this position and take advantage of opportunities to develop it further. We also want to use this innovation and knowledge to help reduce rising costs for growers, especially energy costs, which is a current threat. We can also use the knowledge and innovation to improve communication channels and education between different stakeholders.

Combining with weaknesses
One of the region's current weaknesses is high emissions from energy use, due to its reliance on natural gas. We want to move to fully renewable energy sources to eliminate this weakness. Another weakness is monofunctional land use. So we want to move to multifunctionality and involve the surrounding areas. This will also help to reduce competition for land use. Finally, we want to improve communication between stakeholders to reduce the current tensions between growers and policy makers.

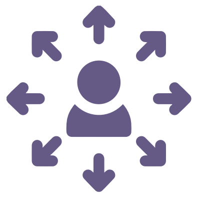
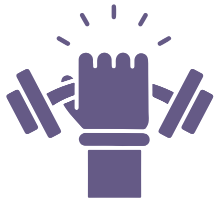
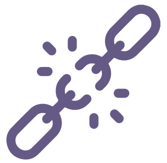
		
	further strengthening global position as knowledge & innovation hub in horticulture	using innovation and knowledge to help lower rising costs for growers & to improve communication channels and education
	from high emissions through energy use to fully renewable energy sources & from monofunctional land use to multifunctionality, engaging the surroundings	steering away from monofunctional land use to elleviate competition & improving communication to eliminate tension between growers and policy makers

Fig. 53: Combined SWOT
Image source: own graphic with icons from thenounproject, n.d.

Current value system

The current values are shown in Figure 54 and are the following: an emphasis on top-down communication, economic growth, a strong global position for exports, and sustainable greenhouse horticulture. The combination of these values creates some conflicts. First, while it is true that the government is working towards a more sustainable greenhouse horticulture, the emphasis on top-down communication and the lack of bottom-up knowledge exchange results in a noticeable mismatch between the new regulations and actual greenhouse practice. Small- and medium-sized enterprises are most often the victims of this, as they are the most vulnerable because they have fewer resources, but they are also not seen as a priority because they are a smaller part of the national export position. Finally, while attention is being paid to making the greenhouse horticulture industry itself more sustainable, too little attention is being paid to the landscape surrounding the greenhouses and its ecological health.

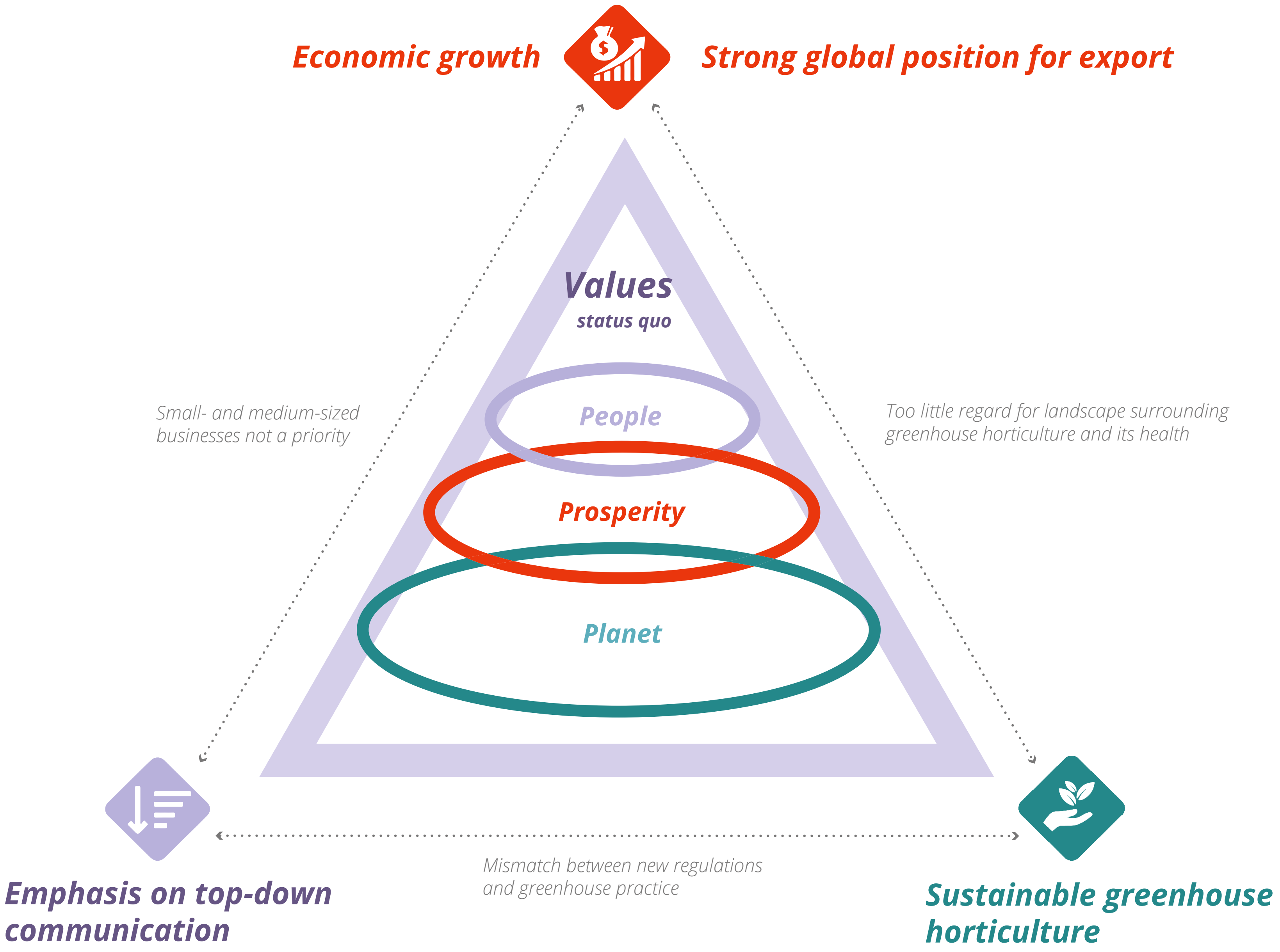


Fig. 54: Current value triangl
Image source: own graphic with icons from thenounproject, n.d.

04 VISION

4.1 VISION STATEMENT

Vision statement: „In 2050 we envision the Delta region as a pioneer for a zero-emission circular society rooted in diverse horticulture practices that:

***Sows** implementations for a circular transition*

***Grows** ecological and social regenerative practices in peri-urban landscapes*

***Connects** neglected actor groups and empowers bottom-up and global knowledge-sharing*

Fig. 55: Vision collage for the region
Image sources: own graphic with images from vecteezy, n.d.

4.2 VALUES

Translating values to goals

We have developed a set of values and corresponding goals for our project, shown in Figure 56. The values are more general, the goals more specific and action-oriented. The overarching goal is a circular society.

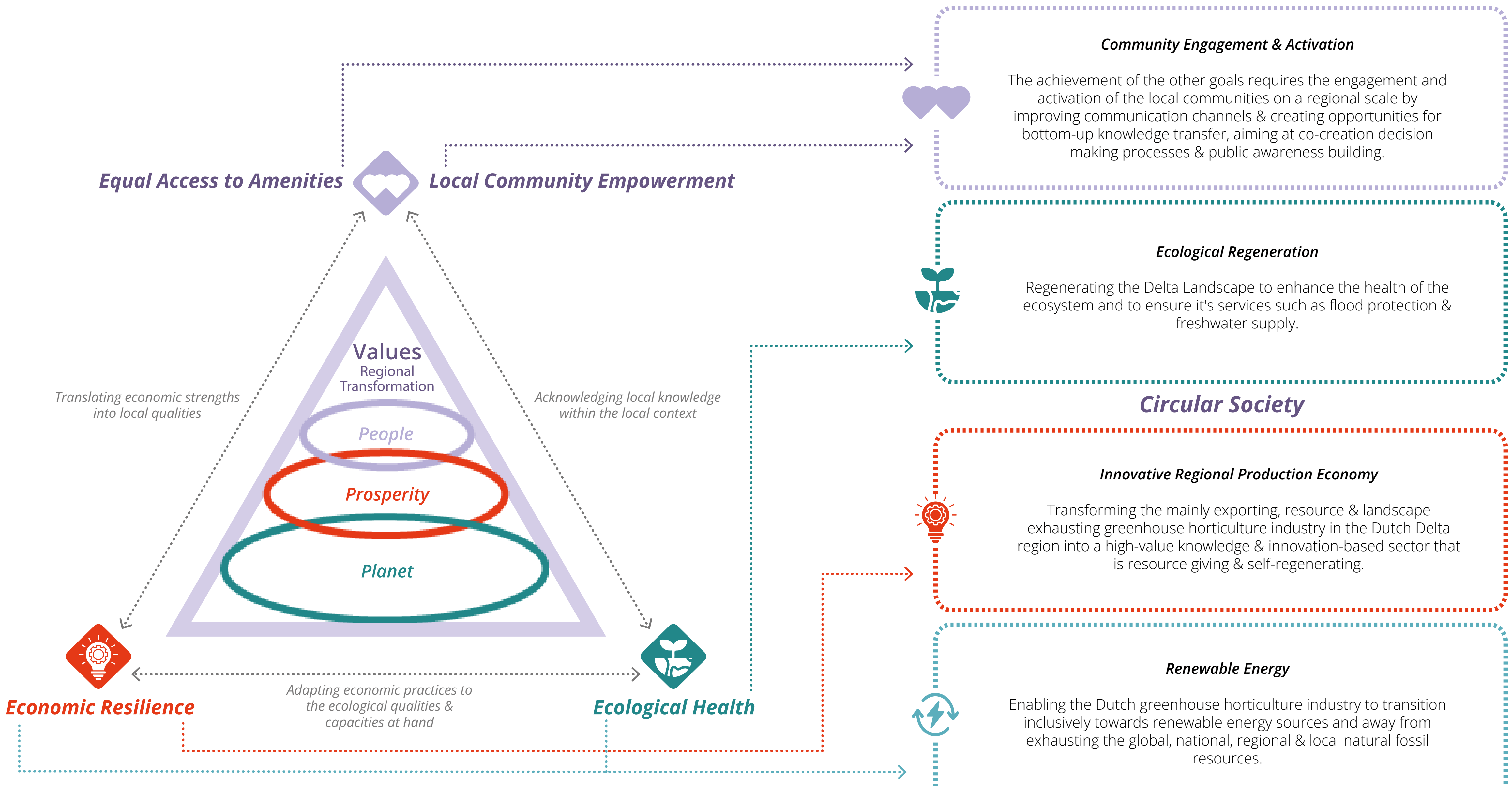


Fig. 56: New value triangl
Image source: own graphic with icons from thenounproject, n.d.

4.3 X-CURVE

From linear to circular

This X-curve (see Figure 57) shows what we intend to phase in and phase out, including some targets along the way, to achieve the goals on page 101. Our overarching goal is to move from a linear to a circular system. The phasing in and out are coordinated: as we phase out fossil energy sources, we phase in renewable energy sources, and as we phase out production for export, we phase in an innovative regional production economy. One aspect of this innovative regional production economy is the reduction of imports along with the reduction of exports. The aim here is to limit the CO_2 emissions caused by transporting products from other regions to ours. Ecological regeneration will be phased in along with the other transitions.

Community engagement & activation

Community engagement and activation is an important value in our project. However, it is very much integrated with the other goals (renewable energy, innovative regional production economy, and ecological regeneration). Therefore, we have added the community engagement curve that weaves along all three goals to show that it is integrated into all of them.

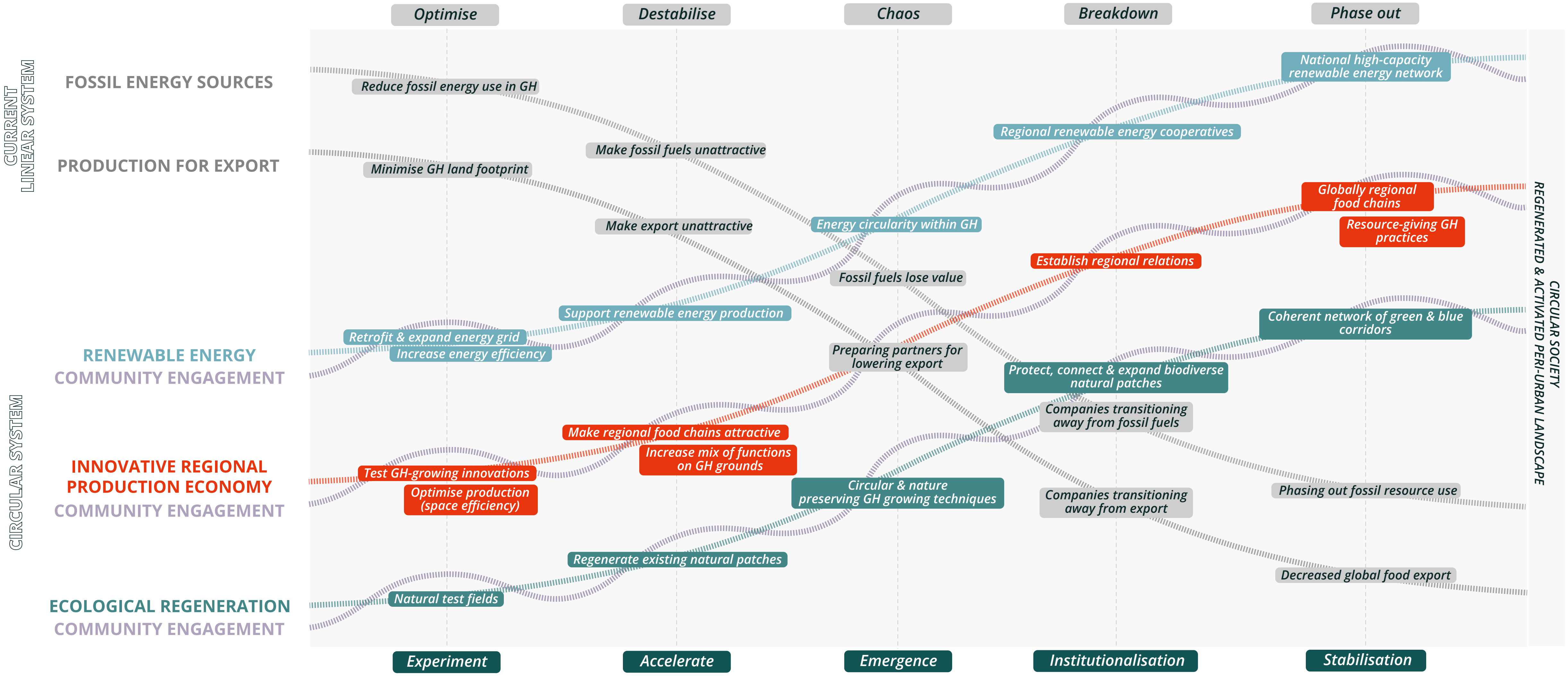


Fig. 57: X-curves
Image source: own graphic

4.4 CIRCULAR SYSTEM

Combining economy, society & ecology

Figure 58 shows the circular system that we envision to create with our proposal. We combine elements from the R-ladder, which defines a hierarchy of desirable circular economy strategies (1=most desirable) with the circular approach to urban resource management by J. Williams (2019), which specifically enriches our concept by the ecological and social perspectives.

1. ***Ecological regeneration*** (Williams, 2019) practices are fundamental, because they restore the functioning of the natural ecosystem in the Delta, which deliver important ecosystem services such as flood protection and good water quality. Therefore, the future economic stability of the local greenhouse horticulture industry relies heavily on creating a healthy regional landscape.
2. ***Revising*** the current (mostly) linear and intensive greenhouse production system includes **refusing** (2) the use of fossil energy sources and striving towards renewables & circular resource flows. Secondly, **rethinking** (2) the functioning and use of greenhouses Both practices aim at protecting the natural ecosystem and tackling the challenges mentioned in Chapter XY (analysis).
3. ***To support*** (Williams, 2019) the aims of the revised circular system, and therefore **reducing** resource use (2) **localizing, sharing, optimizing and substituting** practices (Williams, 2019) can be applied.
4. ***Looping*** (Williams, 2019) practices such as **reusing, repairing and recycling** (2) bring used resources back into the system.

This conceptualization lacks the spatial component to locate the proposed actions and flows. This will be added on the next page with the 15 & 30 minute circular systems.

Fig. 58: Circular system model for sowgrowconnect
Image source: own graphic based on Williams, 2019 & R-ladder principles; with icons from thenounproject, n.d.

4.5 ROLE OF THE PERI-URBAN

Increasing the value of the peri-urban

The current role of the Peri-Urban areas affected by Dutch horticulture are stagnant and rigid. Employees of the greenhouses travel straight from home to work, maybe by car or a long bike ride with a lunch from home. No economy for the local area is generated because there is no where for these employees to drop in for lunch or light shopping. The residents in these areas do the opposite; they leave during work hours and maybe stop for groceries or essentials in urban areas on their way back. SowGrowConnect sees potential for the old greenhouses to provide dynamic liveliness into these peri-urban areas. For example:
Westland: Old greenhouse could be retrofitted into a walk and bike trail alongside a wetland that directly connects with the beach. Or retrofitted into repair cafes where residents can come together to learn, build, and connect with one another.
Venlo: Currently a logistical hub, but only as a necessity, not a destination or a location you would want to linger around. Instead, old greenhouses can be retrofitting into expo centers, hotels, or coworking retreats where scientists, companies, researchers, or students from the region interact to connect and share knowledges.
Den Bosch: Located in a high flood risk zone because of proximity to river. Old greenhouses can be retrofitted into intertwined wetland areas where biodiversity from the Biesbosch can expand. Or retrofitted into recreational league facilities for activities such as bowling, paddel, or mahjong where neighbors can meet and develop connections.
Arnhem: Closely located to Wageningen University and within a flood risk zone, so old greenhouses can be retrofitted into testing sites for innovative aquaponic practices that experiment with wetland fish nutrients and plant productivity.

Fig. 59: Peri-urban / urban landscape
Image source: own graphic with icons from thenounproject, n.d.

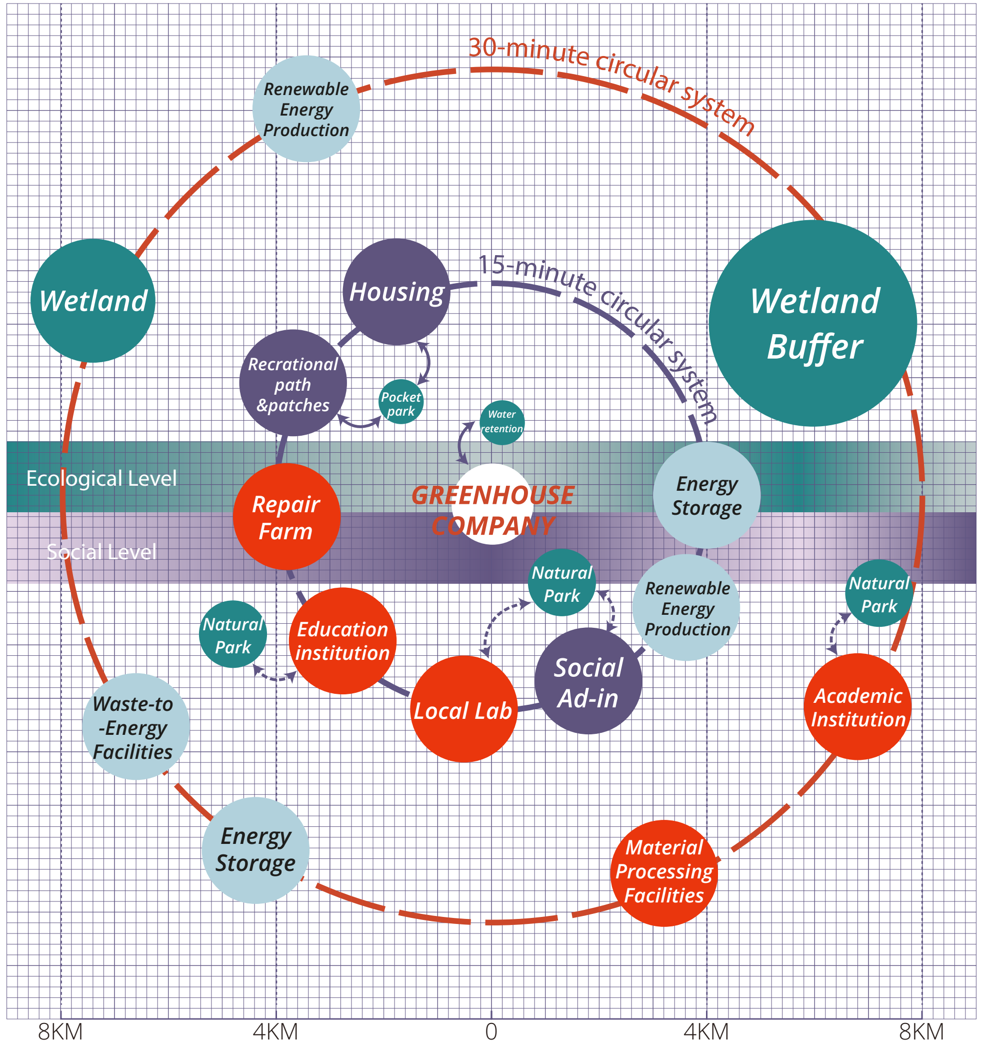


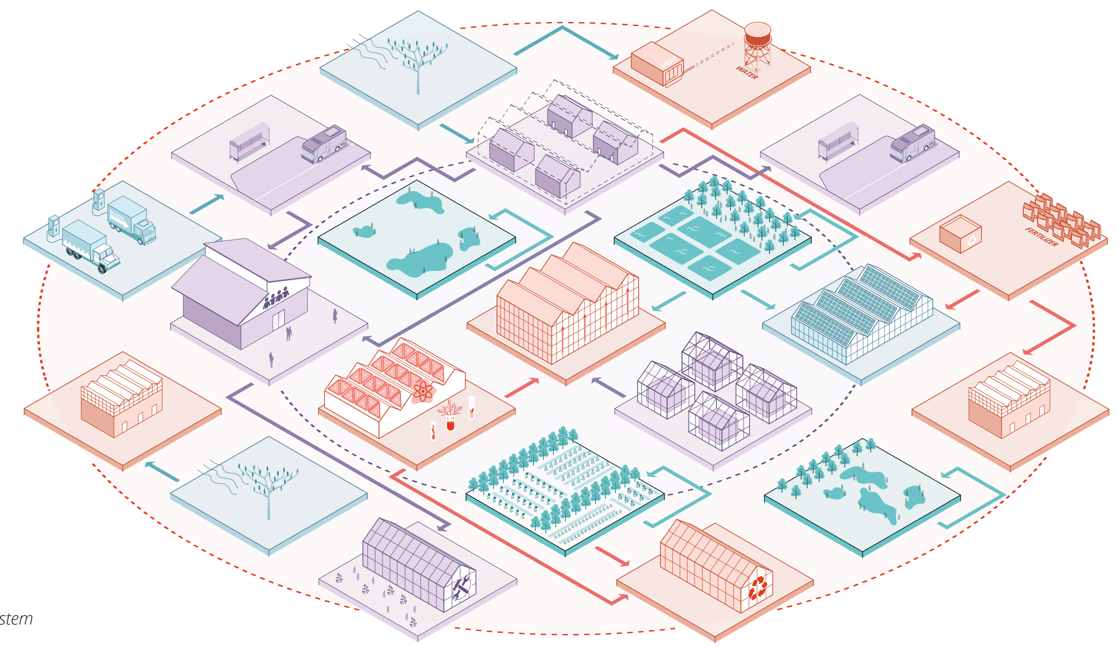
Fig. 60: 15 & 30-min circular system model
Image source: own graphic

- Economic Functions
- Social Functions
- Energy Functions
- Multifunctional ecological patches & areas

4.6 BUILDING BLOCK INDEX

Transitioning to multi-functionality

To transition away from the mono-functional, highly industrial greenhouse horticulture, towards a multi-functional, diverse horticulture, we propose a set of building blocks with varied functions. These building blocks are patches varying in function, size, and involved stakeholders. The right page shows an overview of all the building blocks, sorted by theme (our goals). Our ideal greenhouse landscape is a varied patchwork of all different types of building blocks. Figure 61 shows a schematic view of the different flows between the building blocks.



People movement
Energy flows
Regenerative flows
Economy flows
15 min social system
30 min circular economic system

Fig. 61: Isometric showing the relations between our building blocks
Image source: own graphics

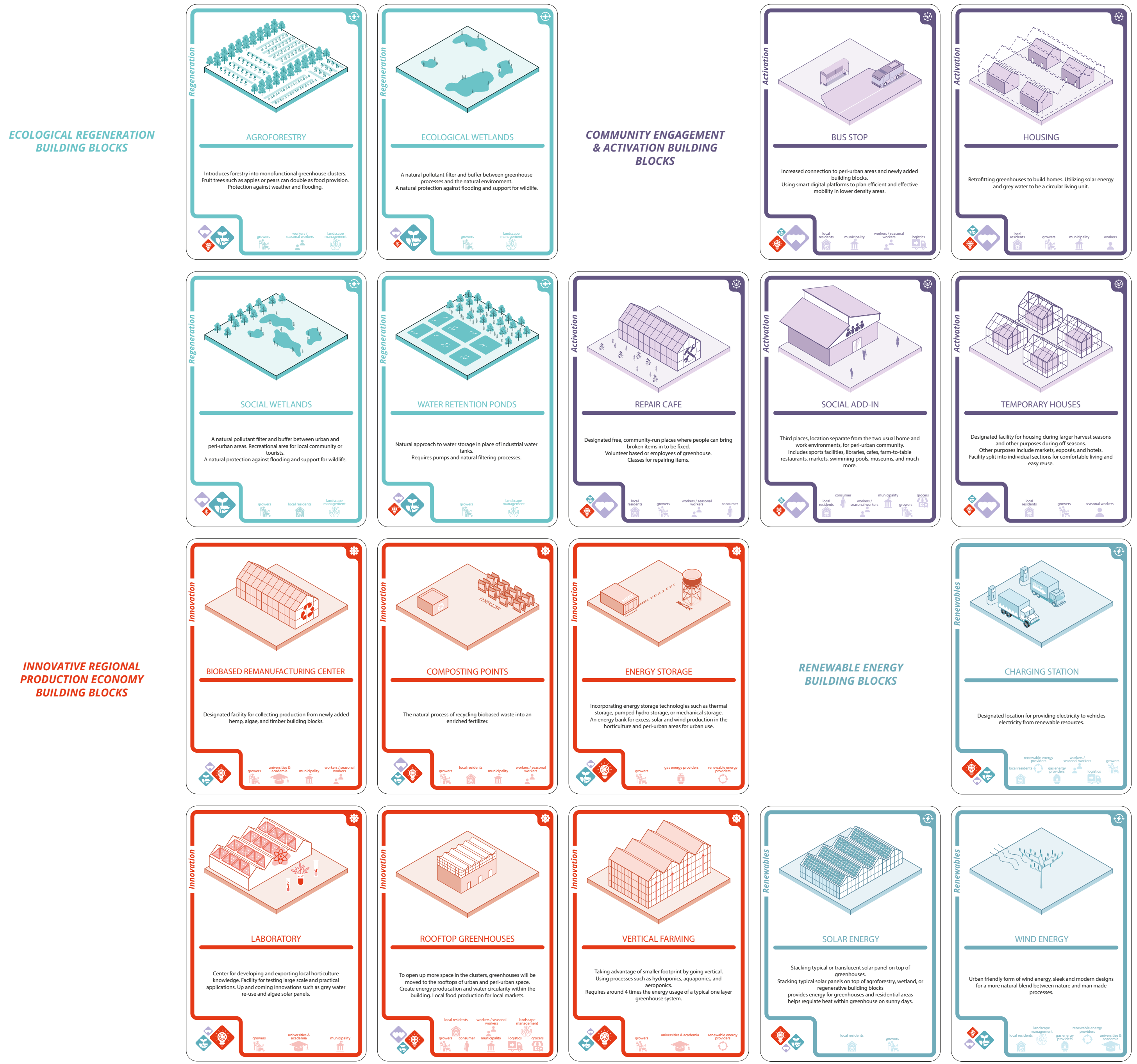


Fig. 62: Building blocks index
Image source: own graphics

4.7 CIRCULAR SECTION

Flows to activate and regenerate

As shown in Figure 63, we envision to activate communities and regenerate the Delta region.

Community engagement & activation
We want to increase community engagement and local activation by implementing an open and strong communication loop. This communication circle will include many different stakeholders involved in all parts of the production process, from preparation to production, distribution and consumption, with different levels of power and sustainable interest. This will facilitate bottom-up knowledge transfer, from greenhouse owners to government stakeholders, and enable knowledge-based policies. It will also help to generate sustainable interest among stakeholders less involved in the production process and its rules, such as distributors and consumers. Consumers and local residents will be attracted to visit greenhouse areas by adding different social functions.

Innovative regional production economy
We also want to foster an innovative regional production economy where products are distributed to local people, waste is reused close to where it originated, and knowledge is exported across the region and beyond.

Renewable energy
There will be an emphasis on using renewable energy instead of fossil fuels. This includes the use of various renewable energy sources such as wind, solar, and geothermal. Excess energy will be distributed to nearby residential areas. The CO2 needed for greenhouse production will be sourced from nearby industrial areas and captured from the outside air surrounding the greenhouses themselves.

Circularity
By implementing and promoting CO2, water, energy and food/waste recycling, we aim to work towards an ecologically regenerated Delta.

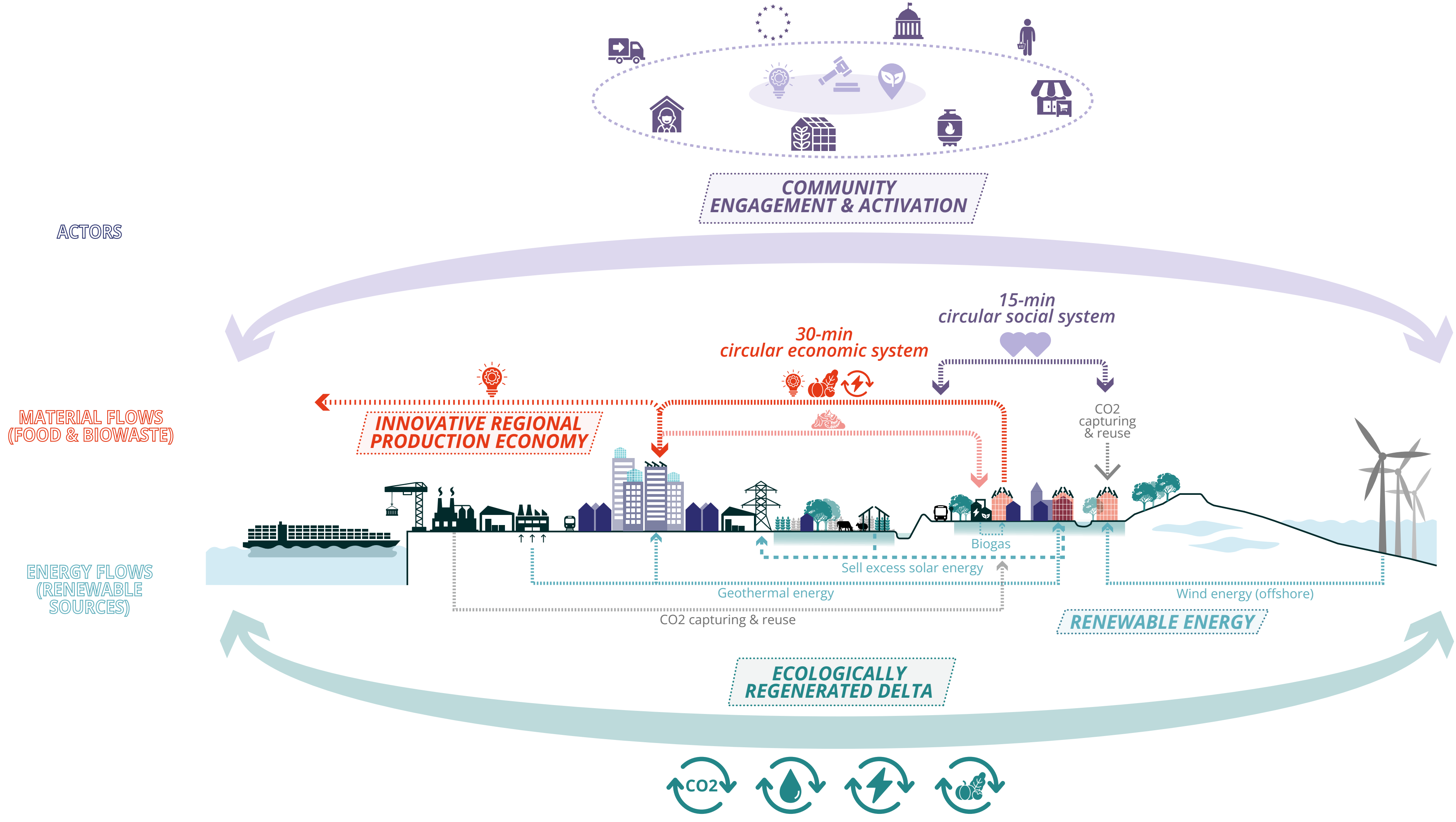


Fig. 63: Systemic vision section
Image source: own graphic with icons from thenounproject, n.d.

4.8 CIRCULAR DELTA

Regional vision

15- Minute Social System
By freeing up space through vertical farming or rooftop greenhouses, social add-ins can be supplied into peri-urban areas to enhance the lifestyle and sustainability of the community. Amenities such as repair cafes, farm-to-table markets, and natural walking areas can encourage community building and social engagement. Laboratories can be the center for knowledge accumulation, large-scale implementation, and niche experimentation.

30-Minute Economic System
Connections to urban areas, transportation networks, and academic support are aspects of the 30-Minute Economic system. At this level, biomaterial processing facilities can provide materials for new developments in the sub-regions. Wetland buffers act as a connection between the peri-urban areas, existing land uses, and urban areas.

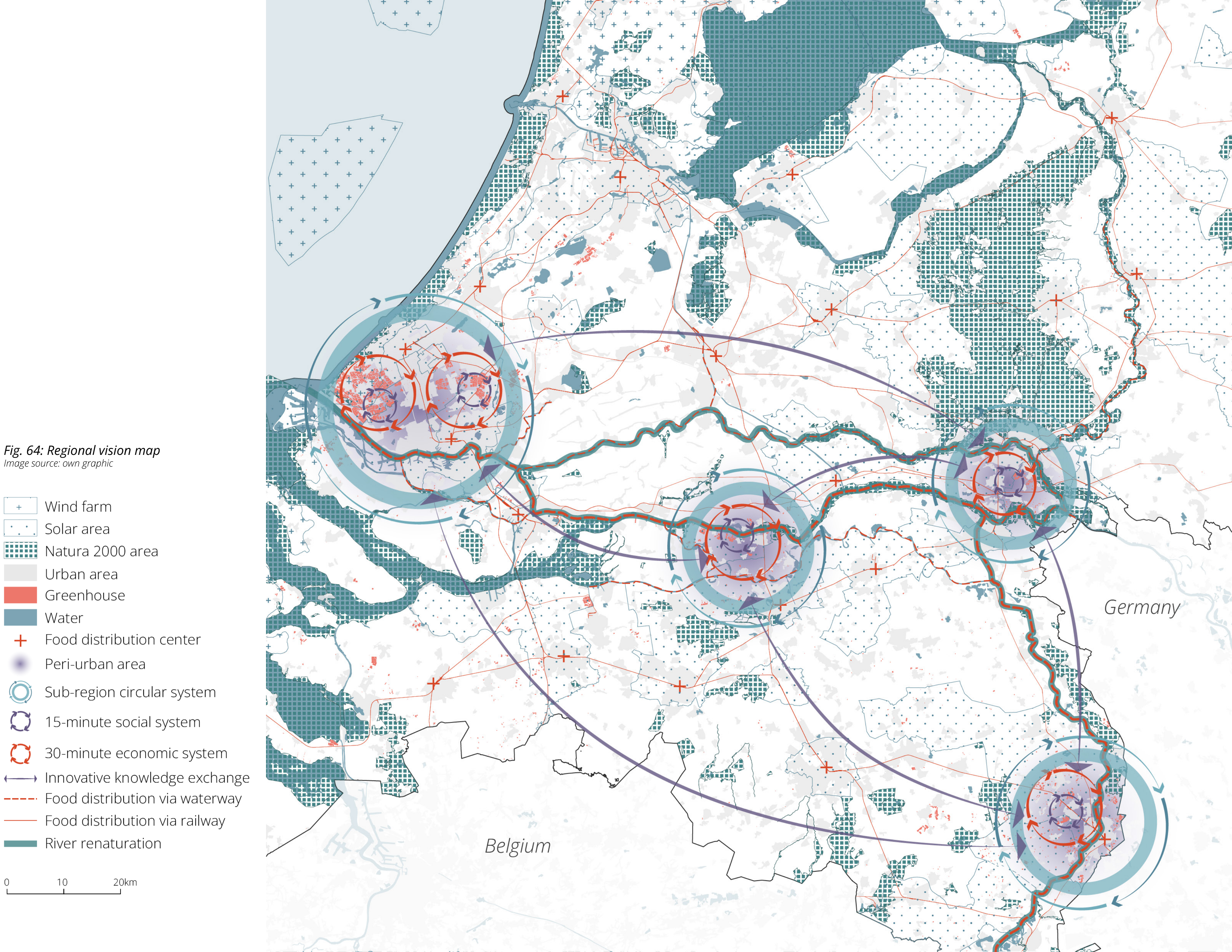
Sub-Regional Circular System
The transformation of greenhouse regions into energy production landscapes can provide an alternate energy source for greenhouse processes and residential communities. Agrivoltaics, urban or residential wind turbines, and energy storage techniques can shift the energy dependence from natural gas to renewable sources.

Knowledge Exchange
Boat tours and field trips along the river can encourage community participation and tourism across neglected areas in the Netherlands. Local knowledge practices from each sub-region can be shared between areas to broaden perspectives on innovation, social connection, and successful policy.

Food Distribution
Transferring mobility logistics from roadways to waterways and railways allows for more environmentally friendly modes of travel because of sustainable energy sources and larger cargo capacities. Electric boats such as the Roboat can operate during off hours to help distribute and balance dense waterway traffic. Dutch trains were the first to run solely on wind energy, so not taking advantage of this system is a shame. Therefore, passenger train routes can be used by attaching freight cars to the end of passenger trains to distribute goods between large hubs of cities. Alternatively, Large stations can be retrofitted to pick up and drop off cargos of food production. This transition opens roadways and encourages less dependence on CO_2-emitting trucks.

River Renaturation
Efforts to regenerate the riverways will help cultivate the connection between the greenhouse sub-regions. The overall river system can be revitalized and unified by preventing pollution build-up in upstream locations and absorbing pollution at downstream locations.

Fig. 64: Regional vision map
Image source: own graphic



4.9 EUROPEAN VISION

How to scale up innovation?

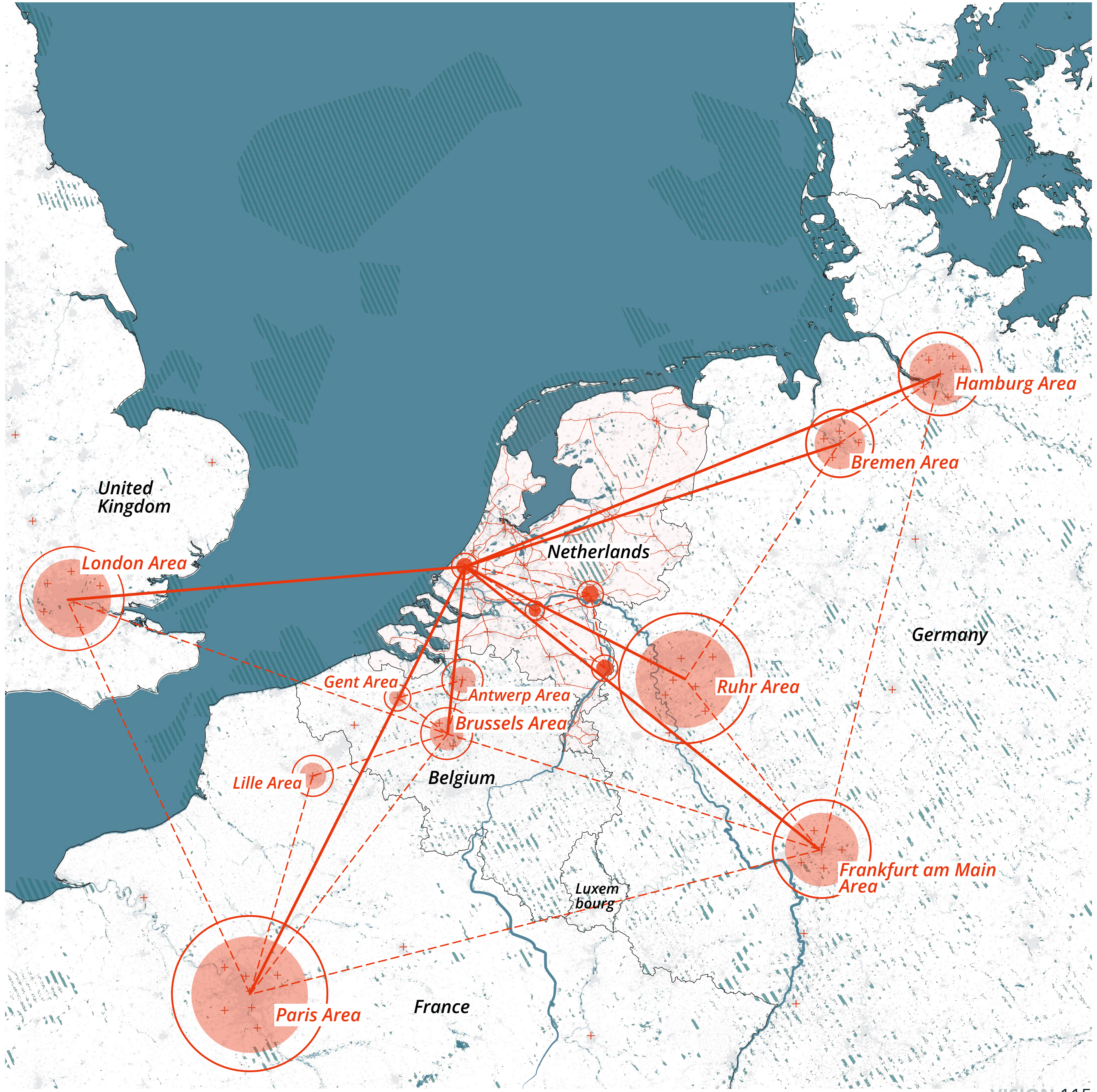
Knowledge-sharing network
On a larger scale, we want to shift the emphasis away from global food exports and establish a knowledge sharing economic system across national borders, with a focus on sharing knowledge related to greenhouse horticulture. The map in Figure 65 shows possible knowledge linkages across Western Europe, connecting innovative knowledge centers in different countries. The countries indicated (Germany, Belgium, France and the United Kingdom) are currently the main export partners of Dutch horticulture. The main knowledge link is between the Netherlands and the other countries, as the Netherlands is the global innovation center for greenhouse horticulture. Secondary knowledge links are also established between the other countries, where they can exchange knowledge with each other.

Lowering dependence
The new economic knowledge sharing network will include knowledge sharing on greenhouse innovations, ecological connectivity and energy systems. By shifting from exporting food to exporting high-value knowledge and technology, the other countries will be able to develop their own greenhouse horticulture using our region's greenhouse horticulture as a reference and example. They will be able to build their own regional circular food production systems, similar to ours, but adapted to their local conditions. This is an example of glocalization, where a widespread phenomenon is adapted to local circumstances in order to most accurately meet the wants and needs of local people (Roudometof, 2016). In this way, we can reduce the large-scale dependence of neighboring countries on production from an ecologically fragile place like our Delta region, and regionalize food chains globally.

Fig. 65: N-W Europe innovative system
Image source: own graphic

Urban area
Waterway
Natura 2000
Food distribution center
Initial innovation center
New circular regions
Regional food chain via railways
Primary knowledge sharing
Secondary knowledge sharing

0 75 150km



4.10 VISION CONCLUSION

Imagining the future

From our analysis, we found that although greenhouses are a technological advancement, there is still room for improvement to optimize the food-energy nexus while taking into account the people in the vicinity of greenhouse infrastructure. Through the lens of social theories such as circularity, social justice, and glocalization, we developed a vision where Dutch horticulture is the catalyst for a circular society through renewable sources, energy efficiency, and reduced consumption. In addition, the retrofitting of greenhouse infrastructure can improve ecological and social systems in peri-urban areas by providing communal, cultural, recreational, regenerative and transport facilities. SowGrowConnect sees an alternative for greenhouse regions to transform from rows and rows of greenhouses to integrated areas of energy production, pedestrian paths, community engagement, and cooperative policies.

Fig. 66: Vision collage for Westland
Image source: own graphic with images from vecteezy, n.d.

05 STRATEGY

5.1 MAIN ACTION FIELDS

Towards a regional circular society

Our strategy can be aligned with existing Development Goals, those being the Sustainable Development Goals (for the goals and values) and the Inner Development Goals (as our drivers towards achieving those).

Sustainable Development Goals
The Sustainable Development Goals are „a shared blueprint for peace and prosperity for people and the planet, now and into the future“ (United Nations, n.d.-a). We consider a selection of them for our values, as has been indicated in Figure 67:
4 Quality education: we want to educate the greenhouse growers through knowledge-sharing, and educate local residents and consumers through field trips and visits to the greenhouse areas.
7 Affordable and clean energy: we want to transition from fossil energy to renewable energy sources to support the energy transition. Throughout this change, we want to make and keep the renewable energy affordable for greenhouse growers. The end goal is scaling up the energy transition from greenhouse horticulture to other sectors.
9 Industry, innovation and infrastructure: we want to make the greenhouse industry more innovative, so we will need less space and resources to achieve more in the end. We also aim to improve the infrastructure networks for better accessibility.
11 Sustainable cities and communities: we work towards improved accessibility by building up more public transport connections. This is according to (a modified version of) the 15 minute city-approach (Moreno et al., 2023). We transition away from mono-functional greenhouse hubs to multifunctional patches to improve quality of life for the surrounding communities.
12 Responsible consumption and production: we propose circular flows for food, waste and energy, and want to increase awareness of consumers about the energy used for their food. Not just recycling and/or recovering, but starting with reducing waste from the very beginning of the greenhouse production process.
13 Climate action: through our proposal, we can reduce CO_2 emissions from greenhouse horticulture by moving away from fossil energy and towards renewable energy.
15 Life on land: we strive for ecological regeneration by implementing wetlands and planting regenerative plant species. We also decrease highly intensive land use, by decreasing the land footprint of greenhouse horticulture, allowing for the soil and life dependent on it to flourish once more.
17 Partnership for the goals: Finally, we aim for partnership on different scales. On the local and regional scale, this means improving existing networks and platforms. On the global scale, this means exporting knowledge about zero-emission greenhouse horticulture techniques, so different countries can work together towards a sustainable greenhouses.

Inner Development Goals
There are three Inner Development Goals that can be seen as drivers for our project, to help us achieve the aforementioned Sustainable Development Goals. These are the following:
Relating: we aim to empower stakeholders that now are neglected/not heard, like the small and innovative greenhouse owners. We propose ways to empower them. We aim for more connectedness between stakeholders, and want to lower the currently rising tensions. A harmonious stakeholder network is key for a smooth and just transition.
Collaborating: our goal is an open communication circle, where stakeholders openly share knowledge. We want stakeholders to be actively involved in the sustainability transition of greenhouse horticulture, and focus on co-creation. This does not just mean greenhouse owners, but policy makers, local residents, and consumers, too. The governmental stakeholders have to trust the intentions of the less powerful stakeholders, and vice versa, and they all have to work together towards a sustainable greenhouse horticulture.
Acting: a big transition in a highly intensive industry that accounts for a large part of the national export, will not be easy. Daring to make this transition, working hard to achieve it and not giving up, is key. We should not be afraid to try new things, to dare doing something different.
We have highlighted the IDGs we address in Figure 68.

Fig. 67: Sustainable development goals
Image source: United Nations, n.d.

Fig. 68: Inner development goals
Image source: Framework – Inner Development Goals, n.d.

5.2 REGIONAL STAKEHOLDER STRATEGY

How to engage & activate them?

Stakeholder attitude

In the greenhouse horticulture energy transition, there are opponents who are not in favor of the transition, proponents who are in favor of the transition, and fence sitters who are unsure or have mixed feelings. For each stakeholder, we have indicated how they feel about our vision and strategy. For the opponents, we must work to convince them. For the fence sitters, we will not need to convince them as much; the focus will be on creating awareness. We can use the advocates to our advantage by having them help convince others.

Position shift

There are a few key stakeholders whose position we want to shift, either on the sustainable interest axis or on the power axis, as shown in Figure (X).

Heighten sustainable interest

We want to increase the sustainable interest of consumers, large greenhouse owners and traditional greenhouse owners. For consumers, this means raising awareness and educating them: sharing knowledge about how greenhouses work, how we are going to transform them, about the energy transition, and so on. For the large and/or traditional greenhouse owners, it's not so much about raising awareness, because they are already largely aware of the importance of sustainability and the energy transition. For them, it is more about supporting innovation and providing incentives to show them the benefits of sustainable greenhouse horticulture and help them put it into practice. There will also be an emphasis on sharing knowledge, especially about sustainable innovations.

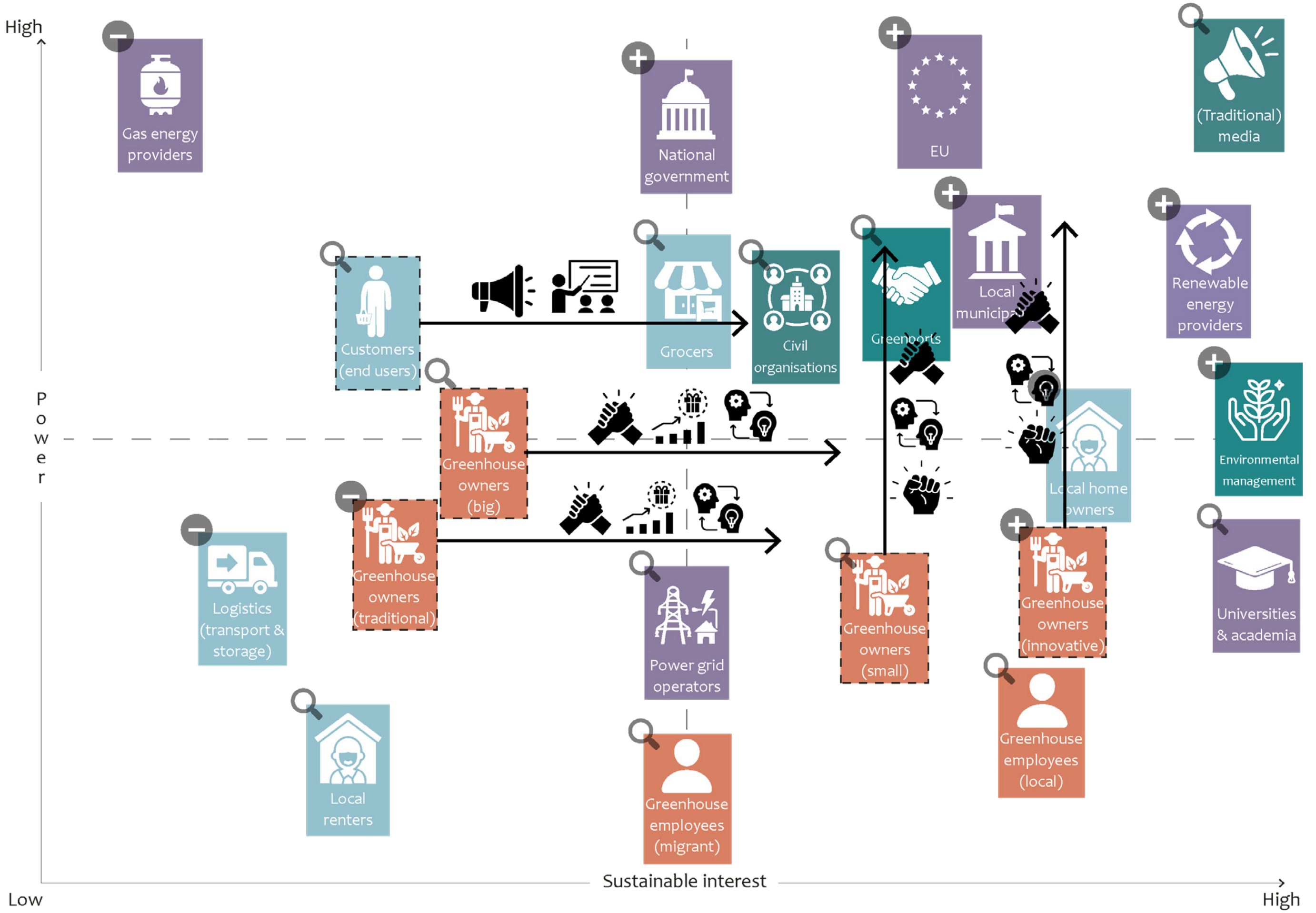
Empower

The smaller and more innovative greenhouse owners are already quite interested in sustainability. For them, the focus is more on empowerment so that they don't bear the brunt of the energy transition and sustainable transformation of greenhouse horticulture. By improving bottom-up knowledge transfer from small and innovative greenhouse owners to governments at different levels, new policies can be better aligned with actual greenhouse practice, as they are knowledge-based. We also want to support innovation for these greenhouse owners, who often have the will to innovate but don't have the resources to do so.

Fig. 69: Regional stakeholder engagement

Image source: own graphic with images from thenounproject, n.d.

- Supply/preparation for production
- Production
- Distribution & consumption
- Other
- Opponents
- Proponents
- Fence-sitters
- Raise awareness
- Educate
- Support innovation
- Incentives
- Knowledge-exchange
- Empower



5.3 X-CURVE

Adding implementations

To visualize our approach, we have elaborated on the X-curves on pages 102-103, as seen in Figure 70.

Push and pull measures

Along the curves, we have added references to specific push and pull actions, which are discussed in more detail in the Phasing Strategy on page 126. These actions will help support the intended phasing in and out and the specific milestones along the way. Pull measures are designed to incentivize and persuade people. These are things like programs, subsidies, and events. Pull measures are more direct and mandatory, such as policies and regulations. The push and pull measures related to community engagement are shown next to the curve they are most related to, because community engagement is related to all three of the other changes we are phasing in.

RE1

The first renewable energy measure, RE1, requires some explanation because it has been added twice along the renewable energy curve. As can be seen in the phasing on page 127, RE1 refers to „Promote Energy Efficiency Practices & Research“. Initially, this education and research is more general, as the goal is energy efficiency in general. Later, toward the chaos phase of the renewable energy curve, the goal is energy circularity. Here the education and research is specifically focused on energy circularity.

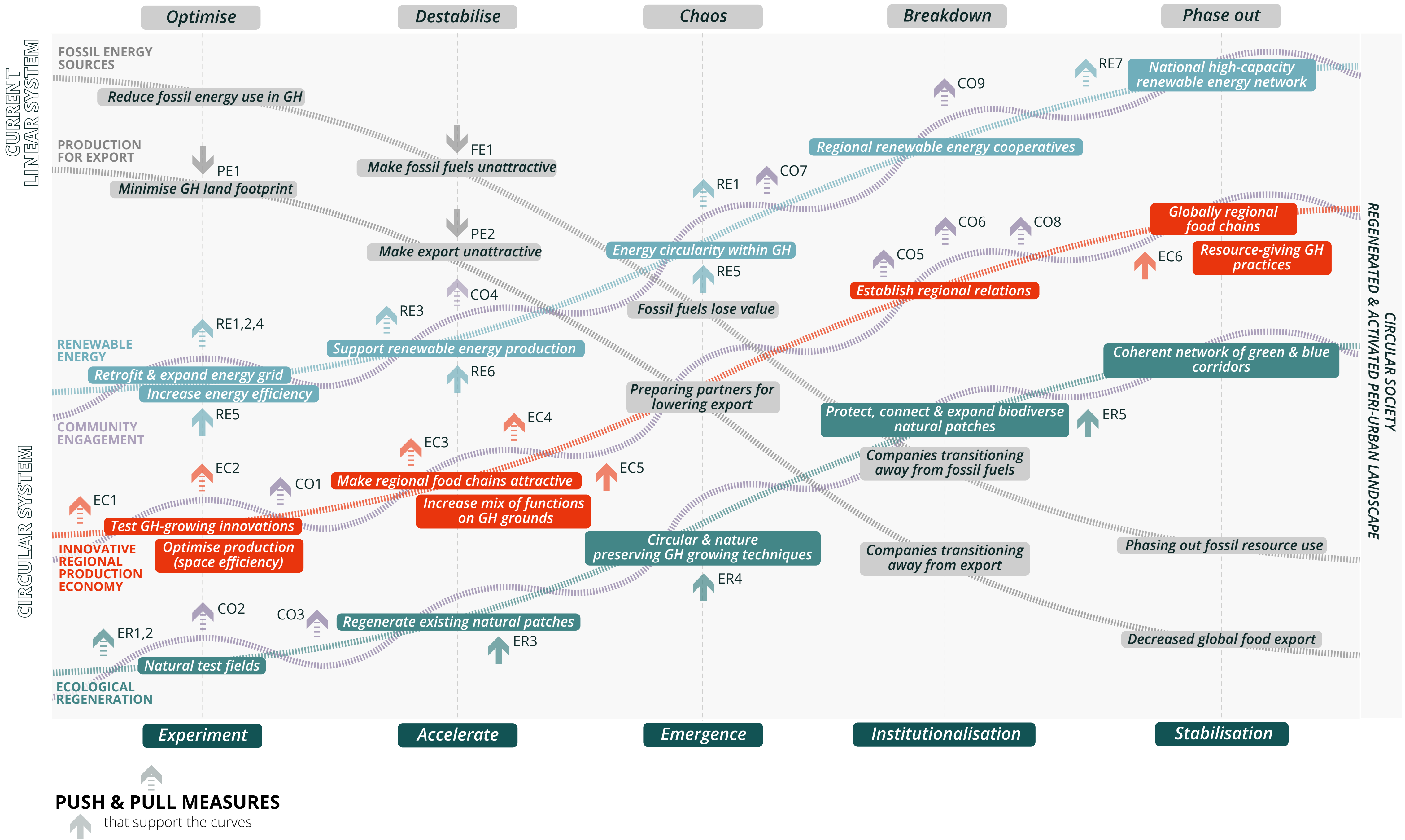


Fig. 70: X-curves with measures
Image source: own graphic

5.4 PHASING STRATEGY

Transitional timeline

Figure 71 shows our phasing in more detail, with a time scale. This is essentially a roadmap from the status quo to our eventual goals in 2050.

Drivers

The first driver, socio-economic damage from natural disasters, relates to the effects of climate change in the region. As explained in chapter 1.2, the Netherlands will feel the full impact of climate change, and the Rhine Delta region is ecologically vulnerable due to the accumulation of pollution downstream. The damage that will result from these facts will help to emphasize the importance of the transition to sustainability. Another contributing fact is the dependence of greenhouse horticulture on fossil fuels and how the supply and price of these fuels are dependent on global politics. The importance of the transition to a circular society is also being recognized more recently. For example, the province of Zuid-Holland wants to become circular by 2050.
(Provincie Zuid-Holland, n.d.-b). This awareness will help drive our transition. Finally, the regionalization of resource chains to reduce emissions through distribution is the final driving factor.

Position shift

There are a few key stakeholders whose position we want to shift, either on the sustainable interest axis or on the power axis, as shown in Figure (X).

Spatial interventions

Some spatial interventions require additional explanation. „Transform obsolete facilities into thermal & energy storage“ refers to transforming obsolete cogeneration plants into thermal & energy storage. As we transition from fossil fuels to renewables, these plants will become obsolete. At the same time, we need storage for the renewable energy sources, which can be realized in these desolate stations. Second, „retrofitting existing facilities for circular practices“ refers in part to the implementation of MIT's carbon-absorbing plates in Europort's industrial facilities. This means that CO_2 from industry in the port of Rotterdam can be transferred to the greenhouses and used in the production process.

Relation to X-curves

The policies and programs are closely related to the X-curve on pages 124-125. Some policies and programs are more short-term and occur at specific points in time. These have a code that indicates the category they belong to and the order in which they will be implemented (for example, RE1 refers to Renewable Energy (RE) and is the energy-related measure that will be implemented first). These are the push and pull actions, shown next to the X-curve, that help work toward specific goals along the way. Some policies and/or programs will continue throughout the entire timeframe, starting in 2024 and continuing through 2050. These don't have a code and aren't shown next to the X-curve, but they support the entire phase-in process and help work toward all/most of the goals.

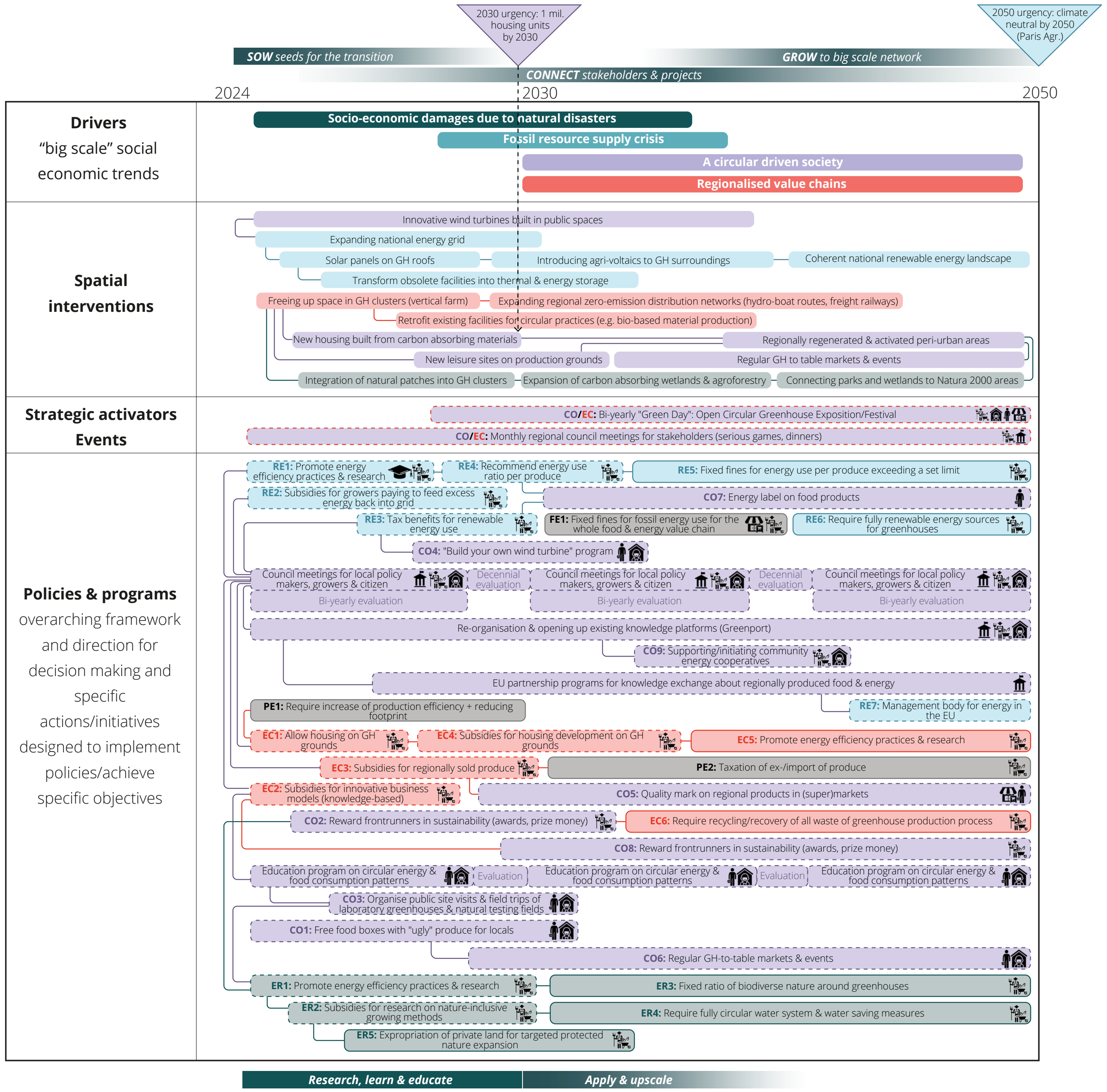


Fig. 71: Regional phasing of measures
Image source: own graphic with images from thenounproject, n.d.

- Renewable Energy
- Community Engagement & Activation
- Innovative Regional Production Economy
- Ecological Regeneration
- Fossil Energy Sources/Production for Export
- Push measure
- Pull measure
- Governmental
- Grocers
- Universities & academia
- Local residents
- Consumers
- Greenhouse growers

5.5 INSTRUCTION MANUAL

Steps for applying our concept

To put our strategy into action, we have established an instruction manual to apply our circular concept, as can be seen in Figure 72. It consists of five steps, which are to be followed in order. The conditions and capacities of the area are defined, both regionally and locally. Then, the 15 minute + 30 minute systems are applied. Then, the right building blocks (which are elaborated on page 130-131) are chosen. Finally, a plan for implementation is made.

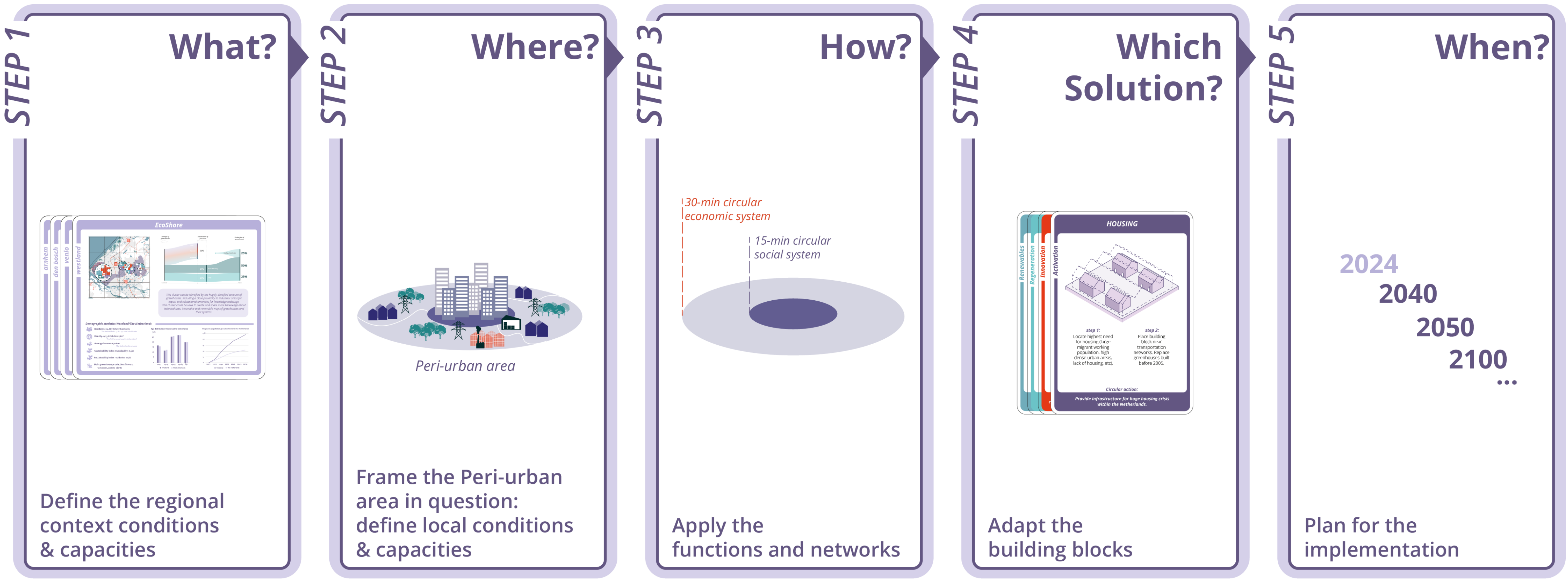


Fig. 72: Instruction manual
Image source: own graphic

Building blocks for retrofitting

To spatialize our circular concept and apply it to different areas, we have a collection of building blocks, as shown on the right page. These building blocks are the solutions mentioned in step 4 of the Instruction manual on pages 128-129. They have been categorized according to the goal they help work towards: Ecological regeneration, Community engagement & activation, Innovative regional production economy, or Renewable energy. These building blocks are the specific spatial components of our strategy, and make up the patches that can be added to transform mono-functional greenhouse areas into multi-functional and diverse greenhouse areas. Figure 73 shows how these building blocks can work together within our 15/30-minute system concept. It shows the different building blocks and the relation between them.

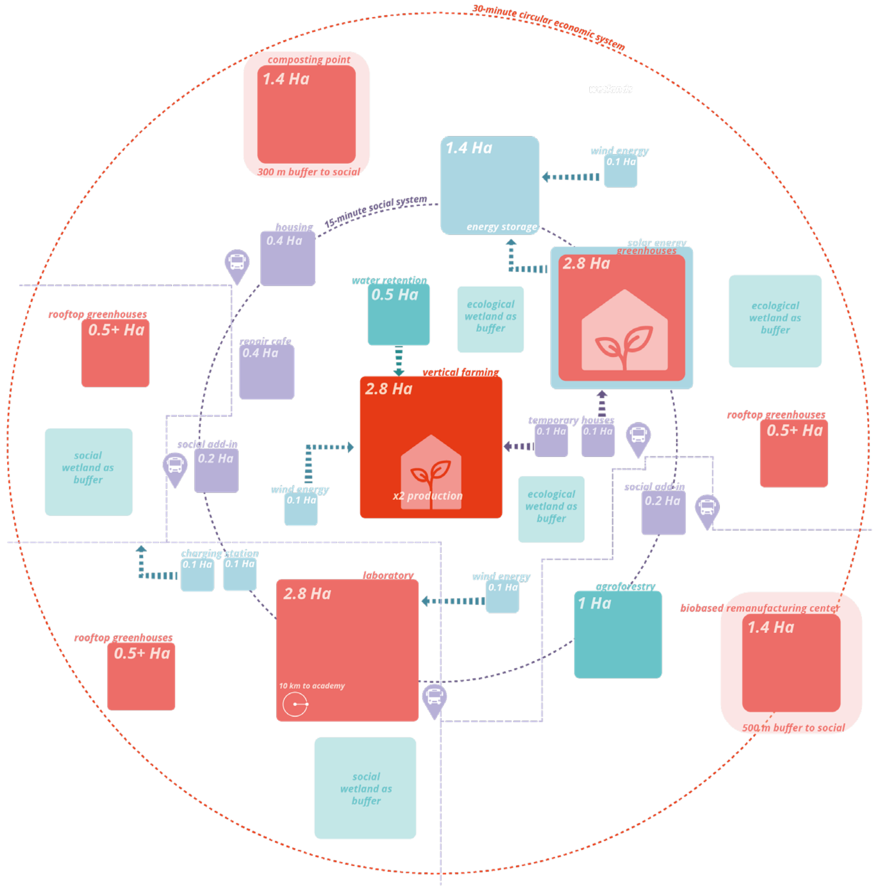


Fig. 73: Building block sizing
Image source: own graphic

- community building block
- energy building blocks
- economic building blocks
- regenerating building blocks
- buffer
- relation between blocks
- concept busline
- busstop
- 15/30 min concept

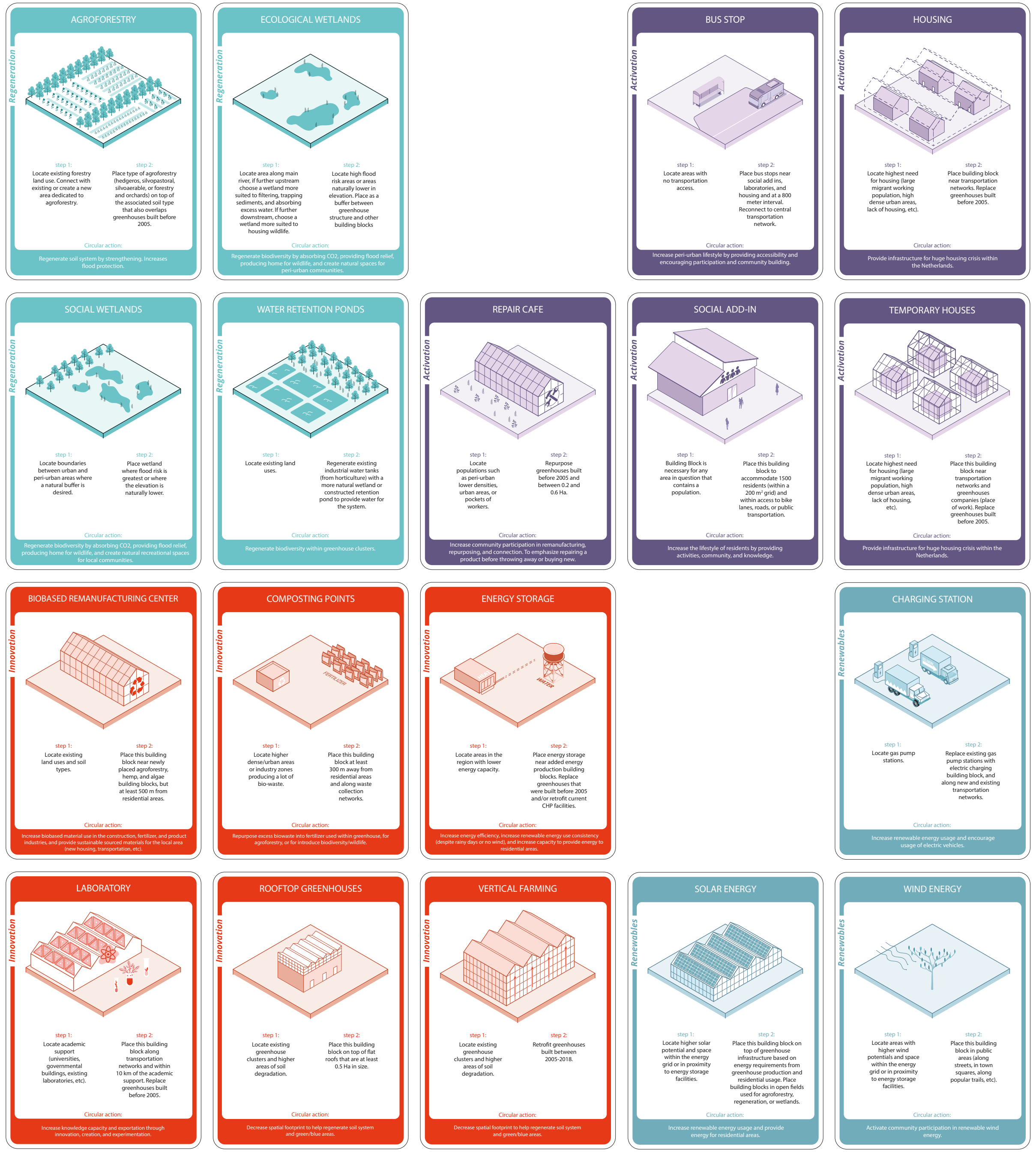
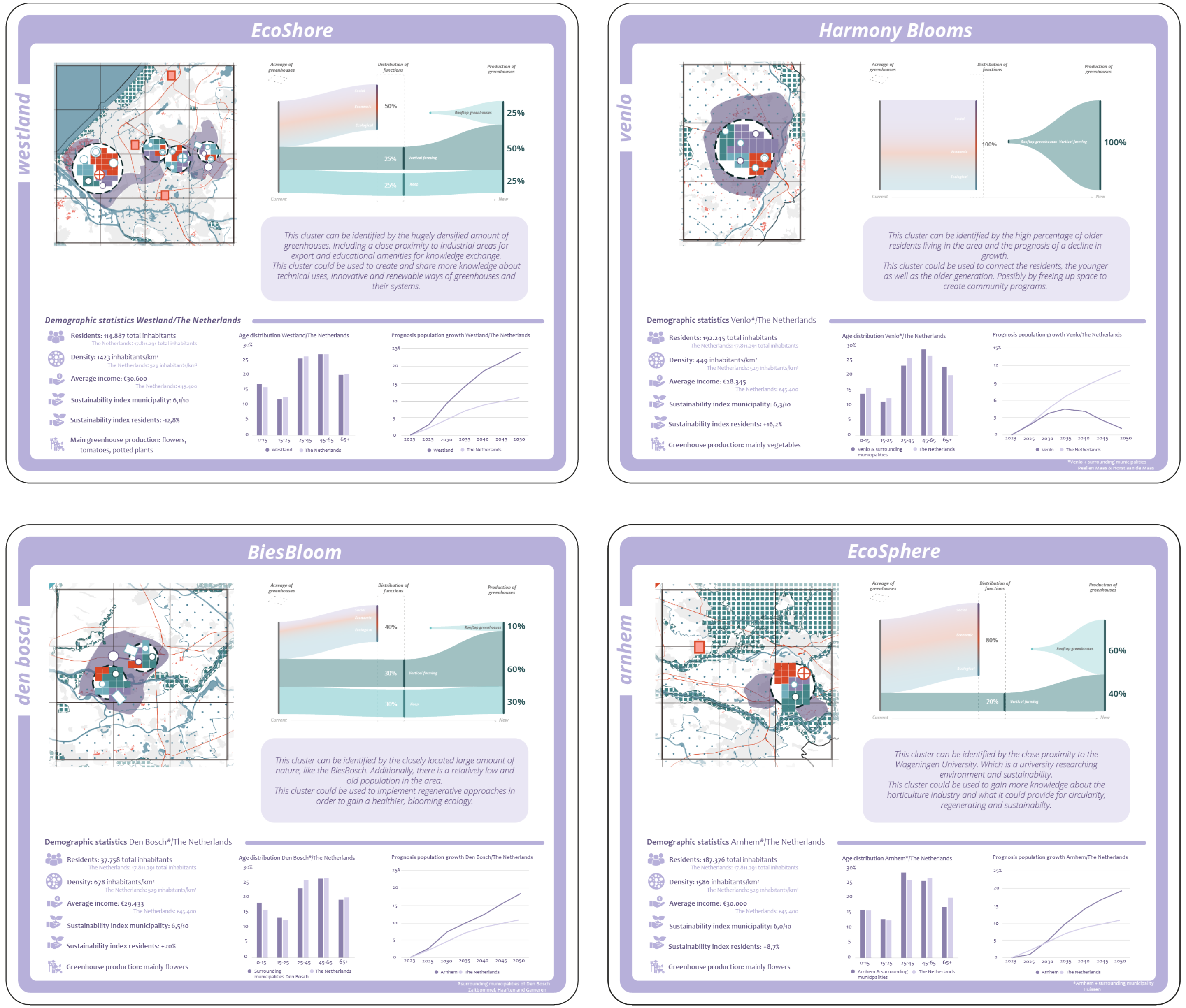


Fig. 74: Building block index
Image source: own graphic

5.6 STEP I - What?

Profiling greenhouse sub-regions

Fig. 75: Cluster profiles
Data sources: Vattenfall, n.d., Onderzoekcentrum Drechtsteden, n.d., AlleCijfers, 2024
Image source: own graphic



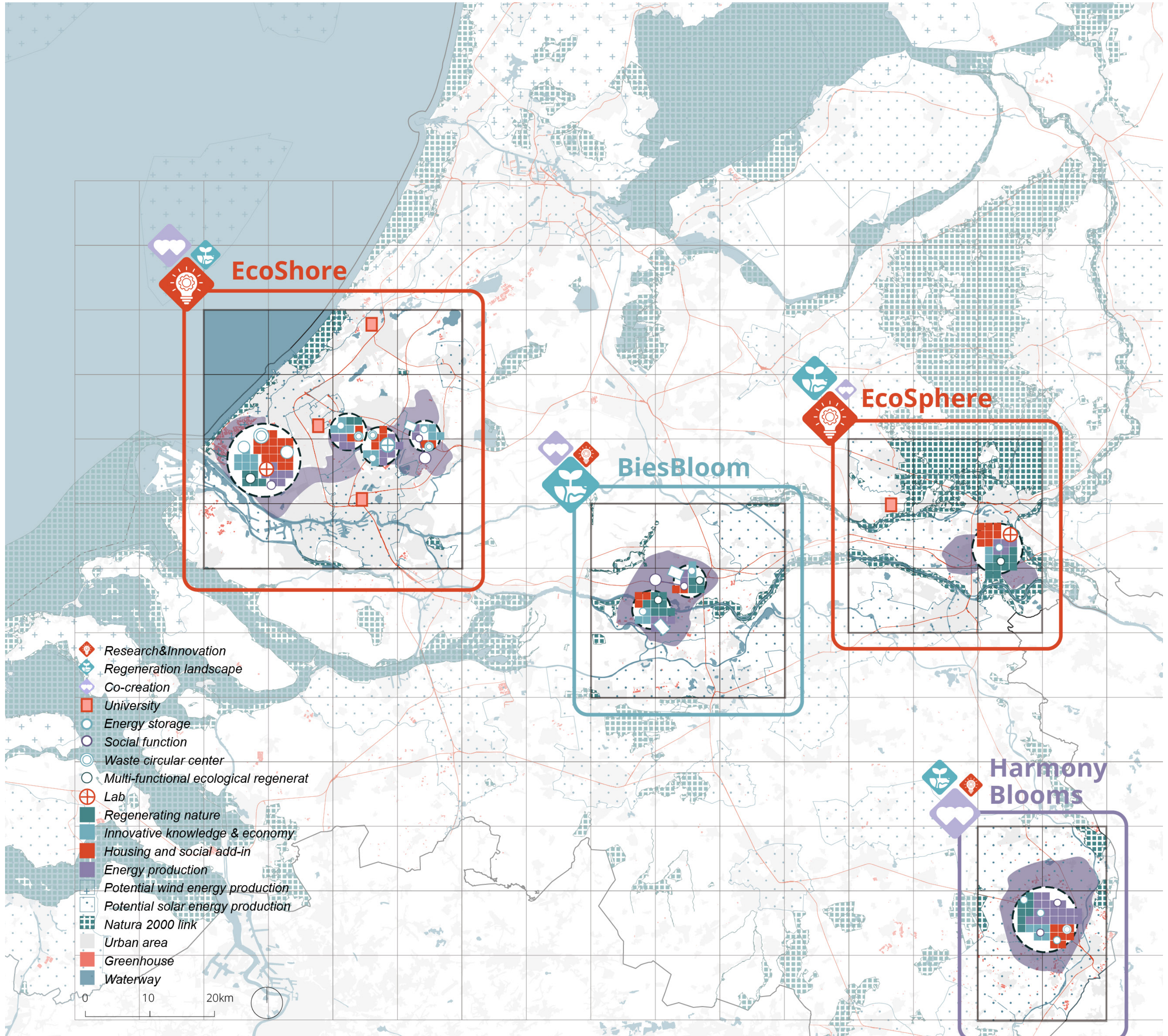


Fig. 76: Cluster locations
Image source: own graphic

5.7 STEP II - Where?

Local scale analysis - Westland

To frame the peri-urban area in question, look into the population density, landscape capacities, and built environment conditions. Useful data sets include population density (100m by 100m grid), soil types, amenity locations, land use, natura 2000 restrictions, greenhouse start dates, flat roofs over 0.5 hectares, and bike and walk networks. Potential indicators for peri-urban centers: medium population density islands within low density areas, multiple land uses, low access to transportation and amenities, between urban areas, adjacent to ecological features. After choosing a peri-urban center, frame the 15-minute boundary based on bicycle infrastructure.

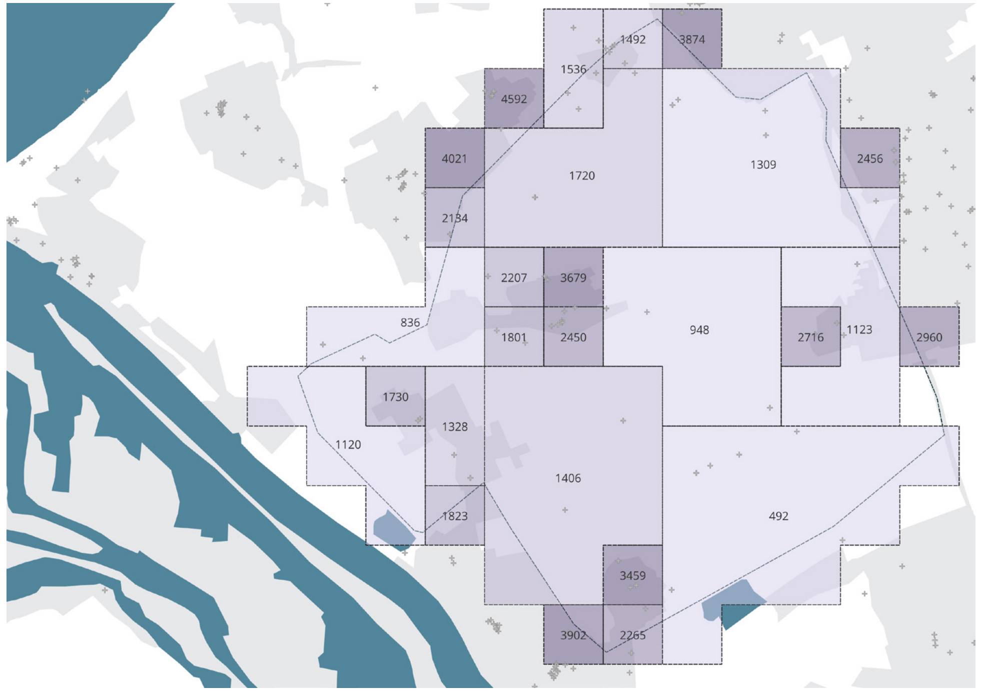


Fig. 77: Population Density
Data Source: pdok, 2023
Source: own graphic

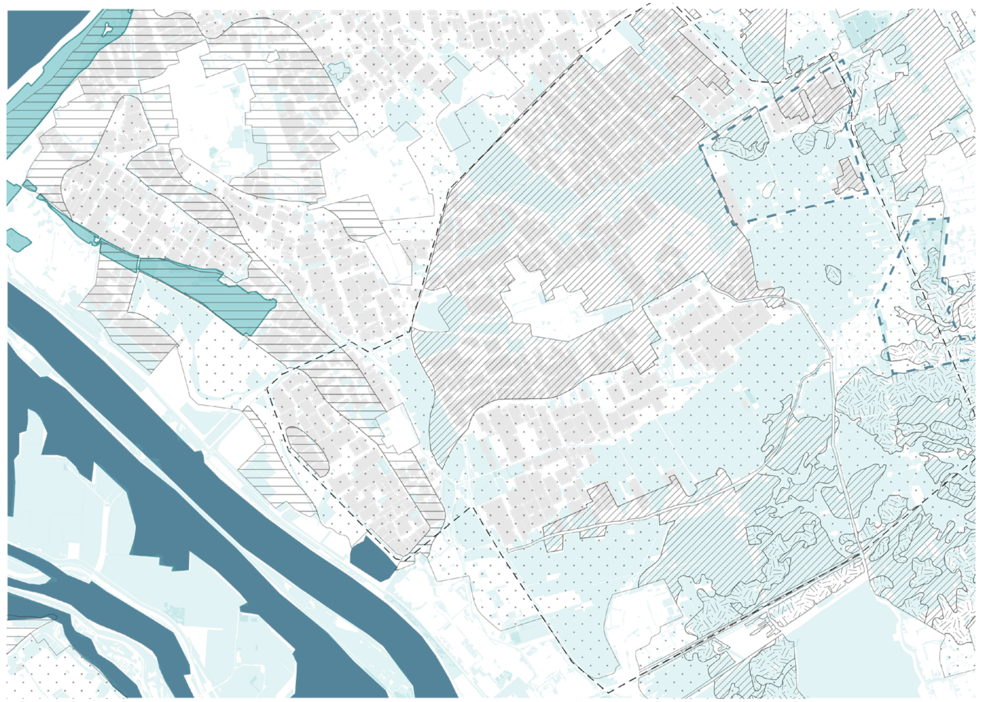


Fig. 78: Conditions Natural Landscape
Data Source: Corine Land Cover 2012 Database of the Netherlands, 2014; Rijksoverheid, 2019
Source: own graphic

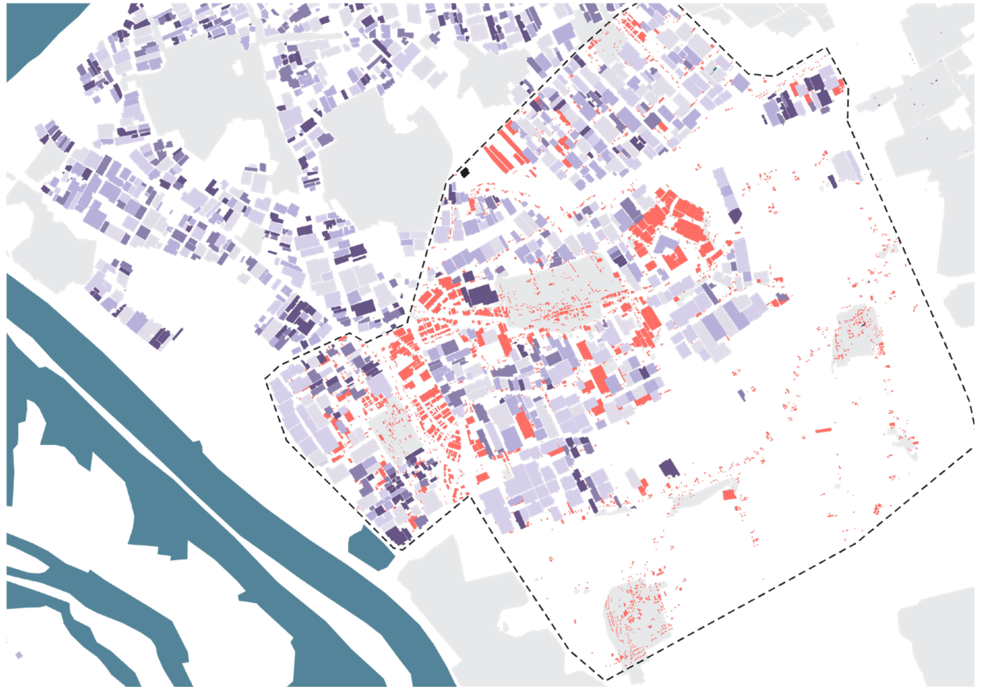


Fig. 79: Conditions Built Environment
Data Source: OpenStreetMap, n.d.
Source: own graphic

Sub-regional scale analysis - Westland

For the sub-regional scale it is important to look at networks, logistics, and connections. Useful data sets include location of education institutions, energy grid capacities, and transportation networks. Potential aspects to look for:

- Lack of public transportation accessibility
- Available input or output capacities, and if no capacity then locations of CHP or energy storage potentials
- Transportation networks that connect to academic institutions, urban areas, or ecological attractions

Fig. 80: Education Facilities around Westland
Data Source: OSFM, 2024
Source: own graphic

Urban areas
Oceans and water bodies
Greenhouse location
Educational facility

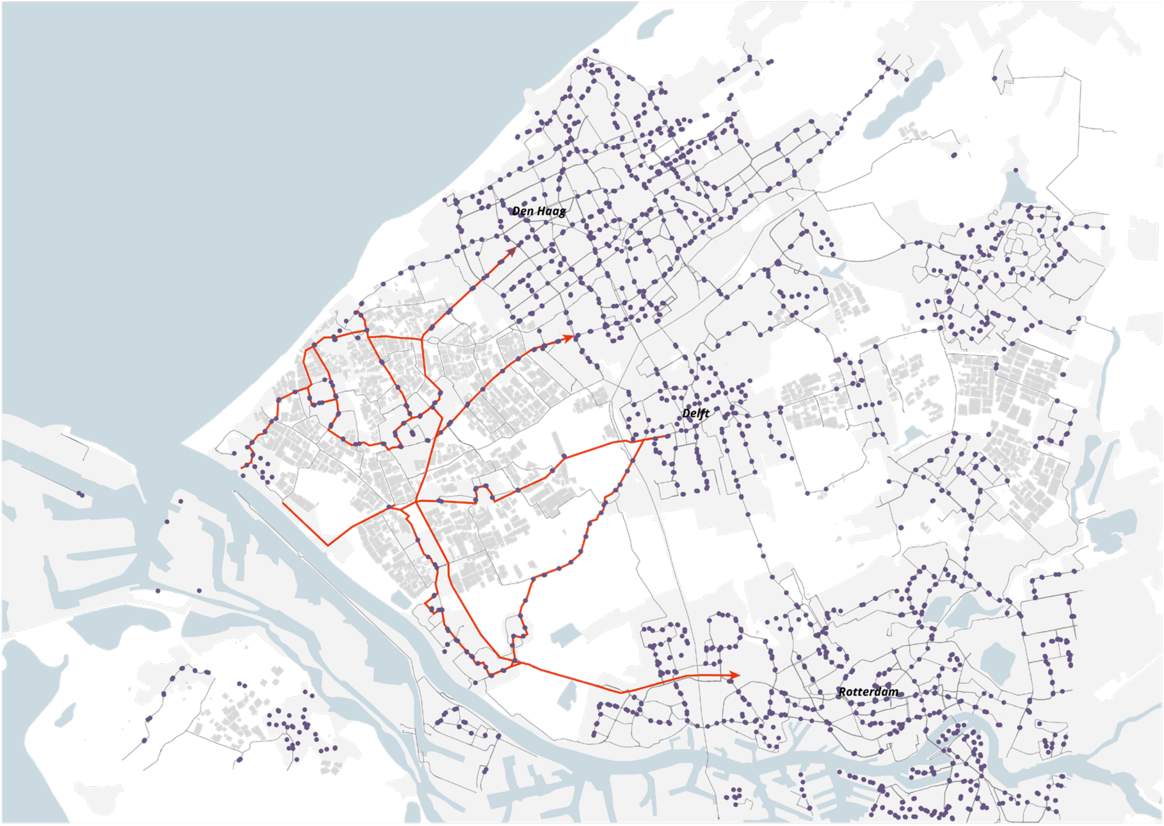


Fig. 81: Transportation Network around Westland
Data Source: OSFM, 2024; EBS OV, 2024
Source: own graphic

Urban areas
Oceans and water bodies
Greenhouse location
Road
Busstop
Existing busline

Local stakeholders - Westland

These are the local stakeholders for Westland (see Figure 82). They have again been divided into categories based on the production process and placed within a power/sustainability interest matrix.

Supply/preparation for production
The electricity grid operators in this area are Stedin and Westland Infra. The municipality of Westland has a sustainability score of around 6 (Onderzoekcentrum Drechtsteden, n.d.). The main energy suppliers for South-Holland are Eneco and Vattenfall, both of which are relatively sustainable compared to other energy suppliers (Van der Wilt, 2021). The province of South-Holland has plans to become circular by 2050, which gives them a fairly high sustainable interest (Provincie Zuid-Holland, n.d.-b). They also have a lot of power compared to the other stakeholders. The educational institutions in and around the cities around Westland have a fairly high sustainable interest.

Production
The larger and more traditional greenhouse owners have a little more power than the smaller and more innovative owners, and also a lower sustainable interest. The workers have less power than all of them.

Distribution & consumption
Westland is located near the port of Rotterdam, which is undergoing an energy transition, which gives it a fairly high sustainable interest (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, n.d.). The inhabitants of Westland are below average in terms of sustainability compared to the national average (Vattenfall, n.d.).

Other
Greenport West-Holland has concrete plans to become more sustainable (Programmabureau Taskforce Duurzame Greenport Westland Oostland, n.d.). The World Horti Center is an innovation center and therefore has a strong interest in sustainability (World Horti Center, n.d.). The landscape of South-Holland is managed by Landschap Zuid-Holland, which is ecologically oriented and therefore has a high sustainable interest.

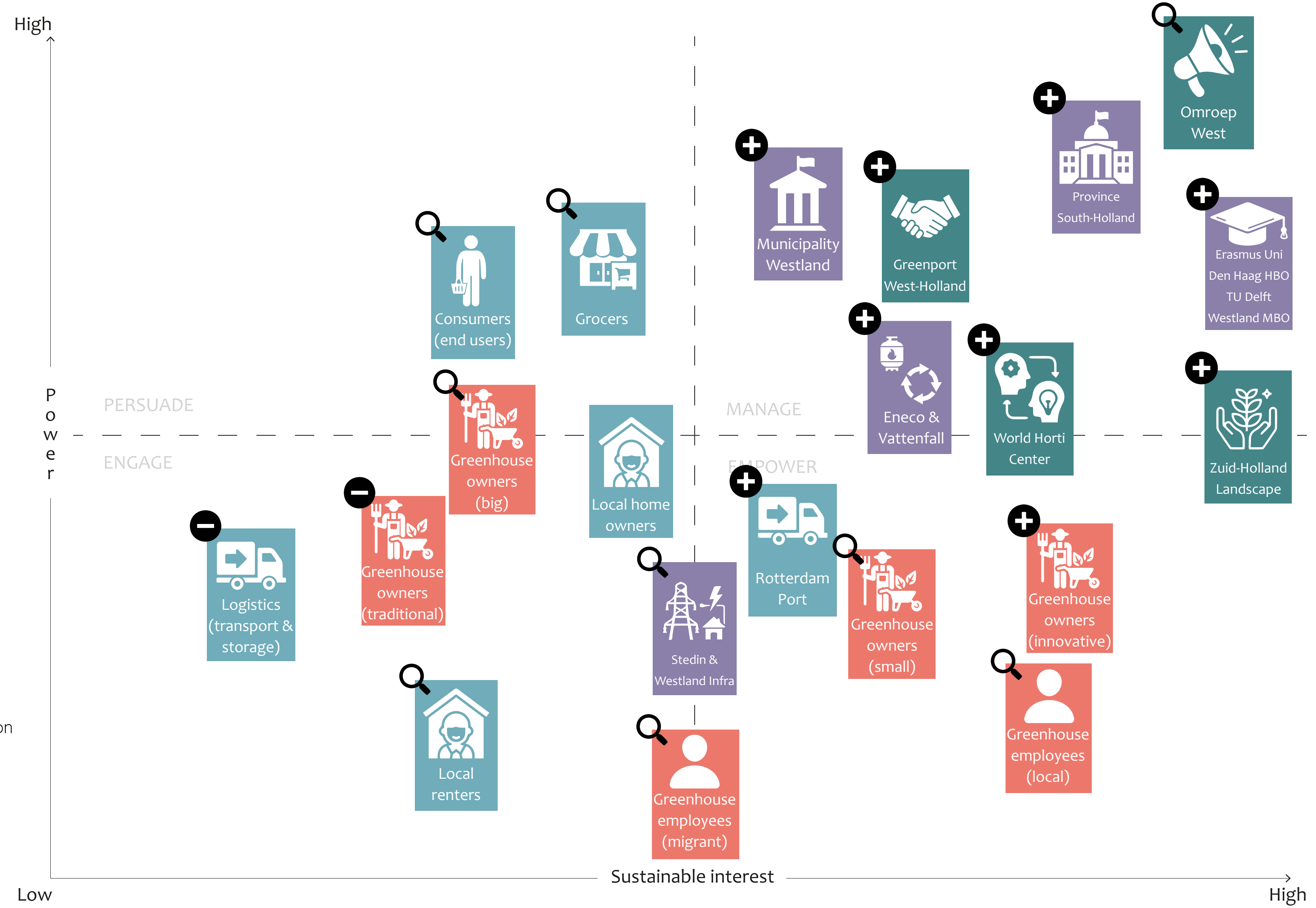


Fig. 82: Local stakeholders
Source: own graphic

- Supply/preparation for production
- Production
- Distribution & consumption
- Other
- Opponents
- Proponents
- Fence-sitters
- Raise awareness

5.8 STEP III - How?

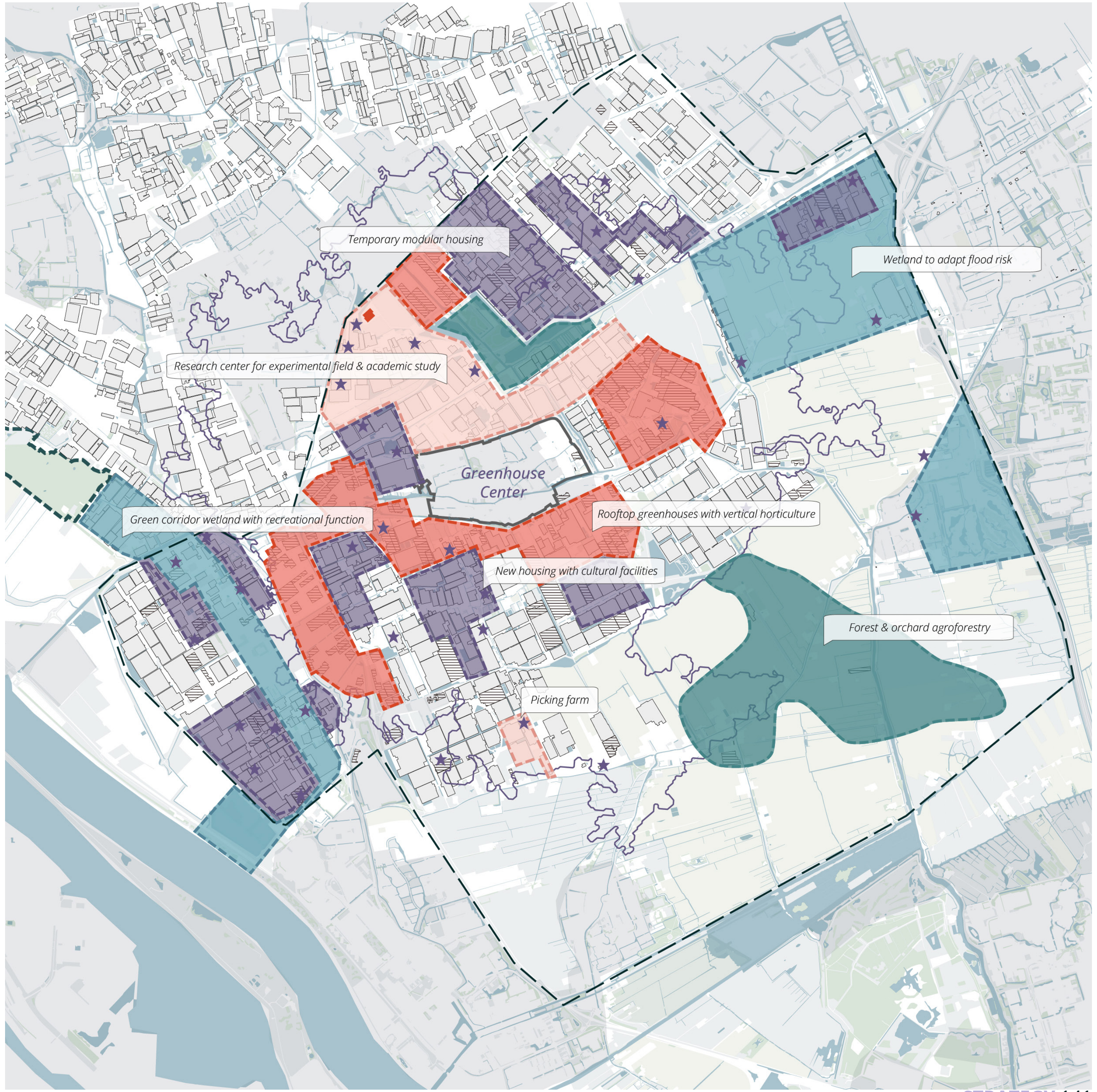
Applying functions - Westland

For this step, we investigate the proximity of different amenities, land uses, and networks. Step three's goal is to provide alternatives for 15-minute and 30-minute layouts as the limits to close social, economic, and ecological cycles. This holistic and inclusive approach to zoning should include considerations for community engagement, equity impact, affordable housing, green infrastructure, transportation, food access, environmental justice, and public health. By using these principles and the building block steps, alternatives for a redistributed peri-urban area can be developed. To the right is one example of a zoning alternative for a 15-minute Westland peri-urban social system.

Fig. 83: Local scale interventions
Source: own graphic

- Interest area
- Natura 2000
- Social integration zone
- Innovative horticulture zone
- Vertical and rooftop zones
- Ecological regeneration zone I
- Ecological regeneration zone II
- Greenhouse
- Flat roofs
- Urban area
- Meadow
- Forest
- Grass
- Waterways
- Bus routes
- Social add-in

0 1 2km



Applying networks - Westland

With the same principles as the last page, to the right is one example of a zoning alternative for a 30-minute Westland peri-urban economic system.

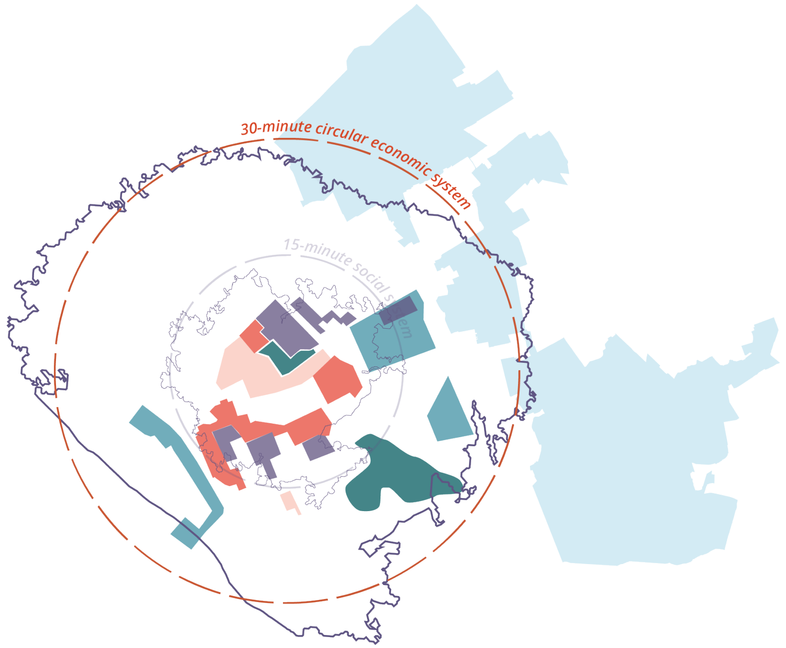


Fig. 84: Sub-regional scale interventions
Source: own graphic

- CO2 & Heating from industry
- Energy production from greenhouse
- Greenhouse
- Urban area
- Energy consumption hub
- Water
- 15-minute radius
- 30-minute radius
- Energy flow
- Origional bus routes
- New bus routes
- Urban markets
- Electic charing station

0 2.5 5km

Local Stakeholder Engagement - Westland

We intend to shift the position of some key stakeholders on the Power/Sustainable Interests matrix, similar to the regional stakeholder strategy explained on page (x). In this section, we will elaborate on this at the local level, according to local circumstances (see Figure 85).

Heighten sustainable interest

We want to increase consumer interest in sustainability through awareness raising and education. For Westland, where the sustainable interest of residents is relatively low (Vattenfall, n.d.), this will include the local population. The strategy for the large and traditional greenhouse owners is the same as the regional strategy: support innovation, provide incentives and share knowledge. At the local level, this means working with the community and the province to provide incentives, financial or otherwise, and to support innovation. We can work with the World Horti Center, the educational institutions and Greenport West-Holland to share knowledge, which will also help to support innovation.

Empowerment

The small and/or innovative greenhouse owners will be empowered by strengthening their connection with the policy makers of the municipality and involving them more in the policy making process through bottom-up knowledge sharing. They will also participate in knowledge sharing with the World Horti Center, educational institutions and Greenport West-Holland, just like the large and traditional owners.

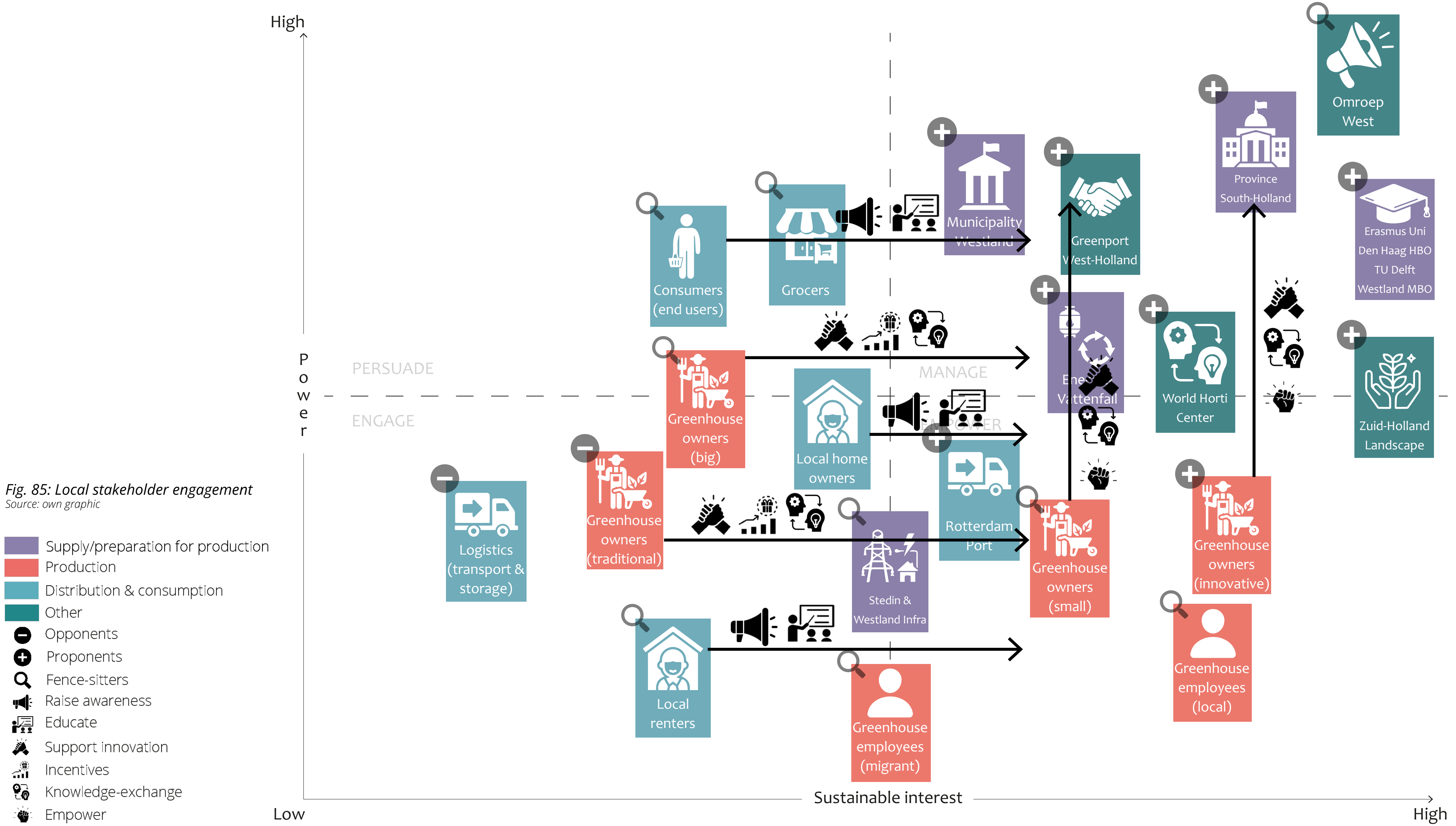


Fig. 85: Local stakeholder engagement
Source: own graphic

System and flows - Westland

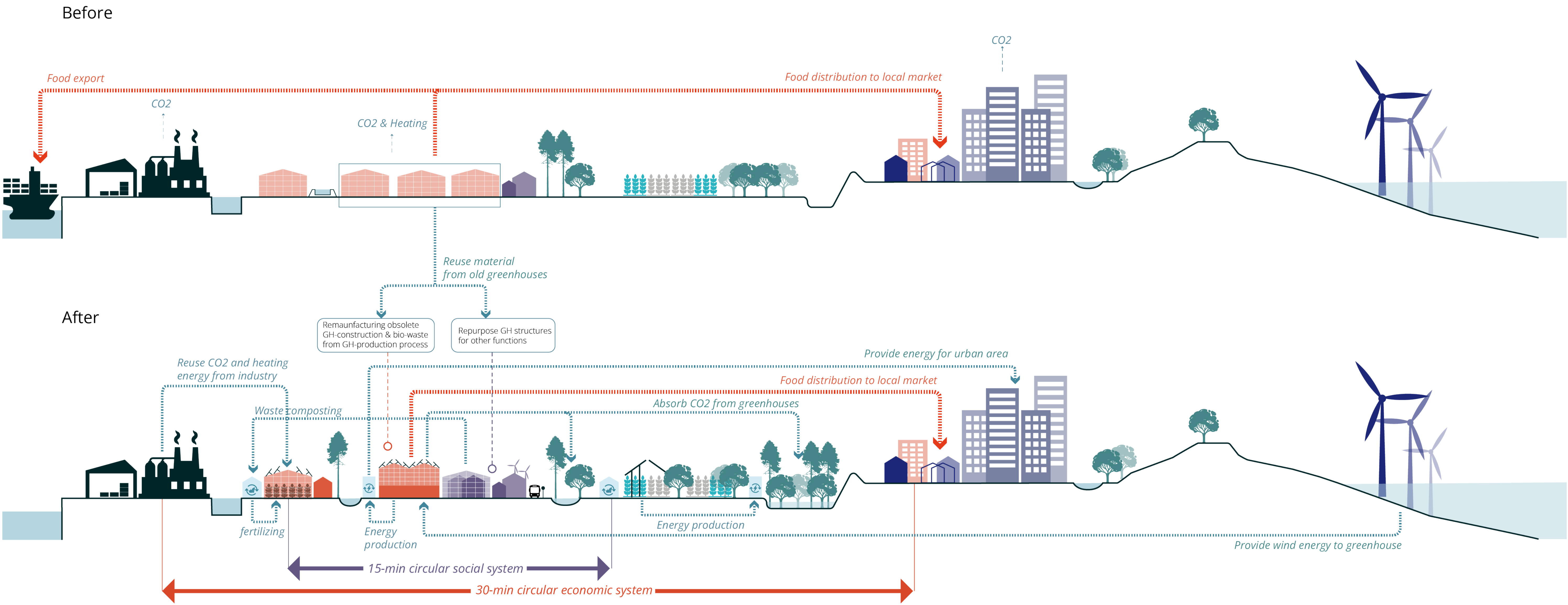
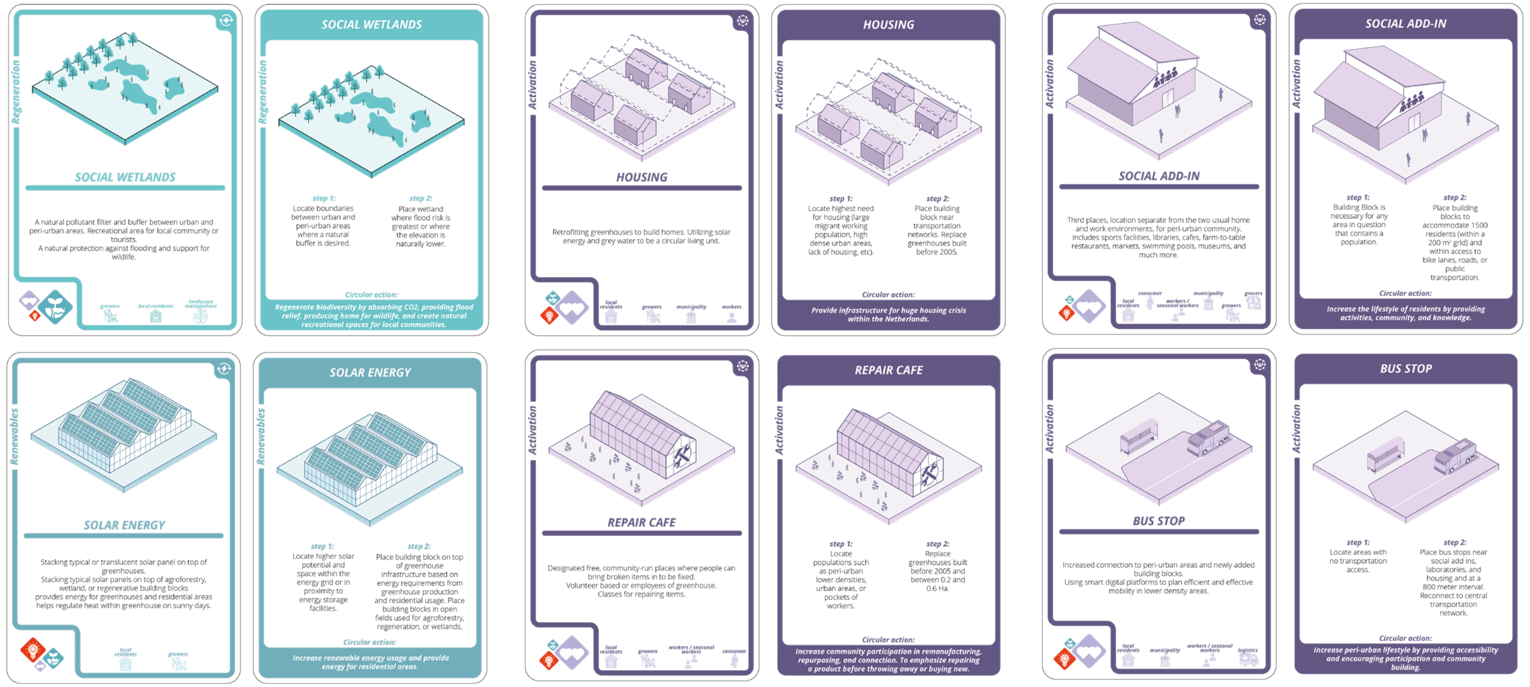


Fig. 86: Systemic sections (before & after interventions)
Source: own graphic

5.9 STEP IV - Which solutions?

Zoom-in I: Westland Eco Corridor

Step four zooms in even further where building blocks are strategically placed. This step adopts a user-centric perspective. In Figure 87, the commuting patterns of both weekday and weekend users influence the design process. This approach encourages a diverse and intricate system that never sits idly. Instead of having a fully residential area that is quiet during work hours and a fully greenhouse area that is quiet during lunch hours, there is an integrated system that encourages continuous activity and diverse use throughout the day.



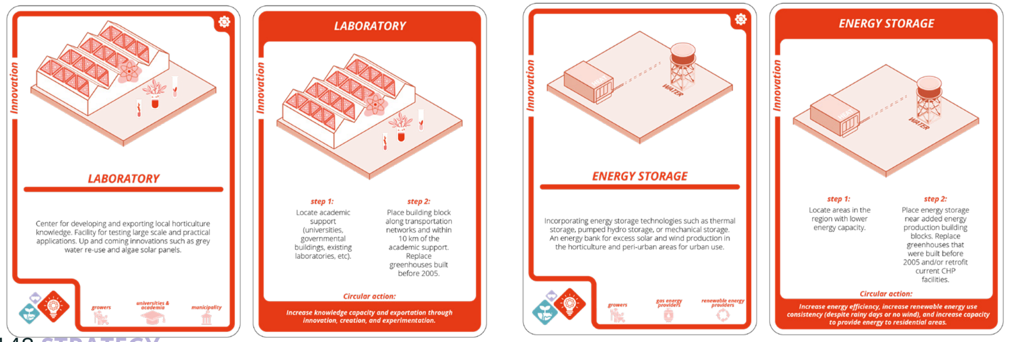
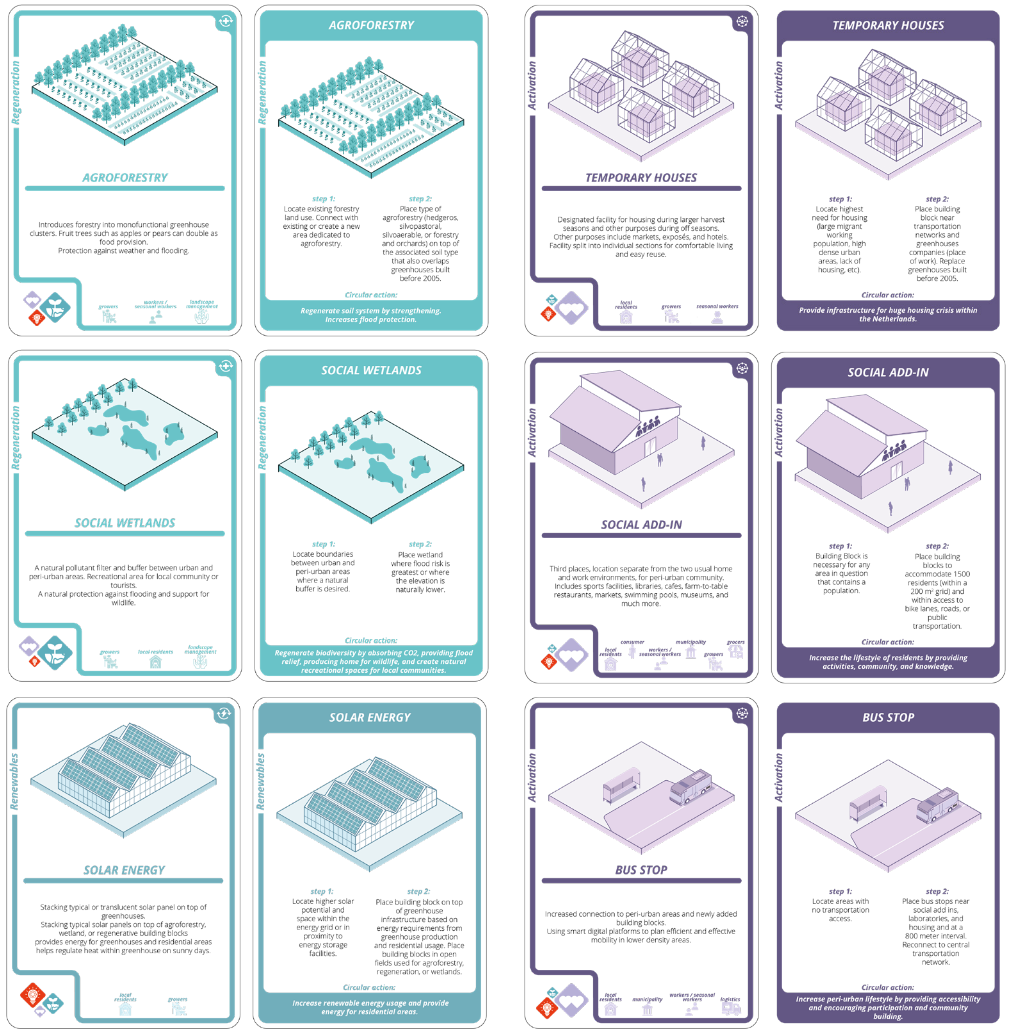


Fig. 87: Building block implementation 1
Source: own graphic

- Weekday route for workers
- Weekend route for residents
- Housing
- Social add-in
- Innovative function
- Energy storage
- Ecological function

Zoom-in II: Westland Innovation Hub

Using the same principles as the page before, Figure 88 shows an additional zoom in with different purposes and functions



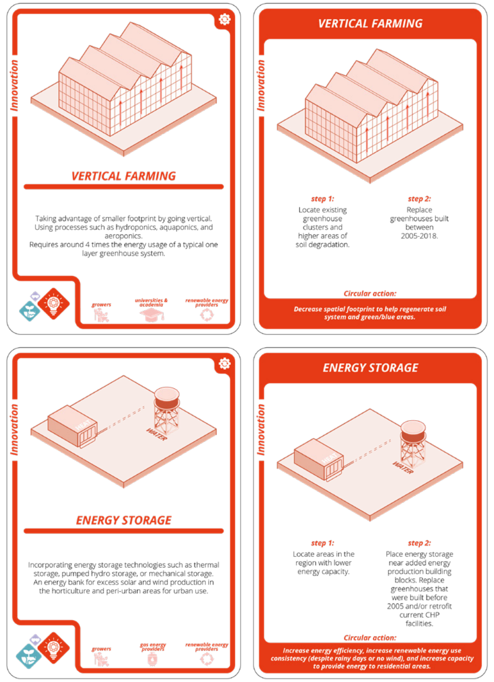


Fig. 88: Building block implementation 2
Source: own graphic

- Daliy route for researchers
- Daliy route for employees
- Housing
- Social add-in
- Greenhouse company
- Innovative function
- Ecological function

5.10 STEP V - When?

Phasing the local transition - Westland

To show the transition of Westland, we have elaborated on the phasing on page 127, specifically for this location. It shows some general spatial phasing, which are less specific for Westland itself, but are still relevant (such as the expansion of the energy grid). It also shows the phasing of the implemented building blocks, as shown in Step 4.

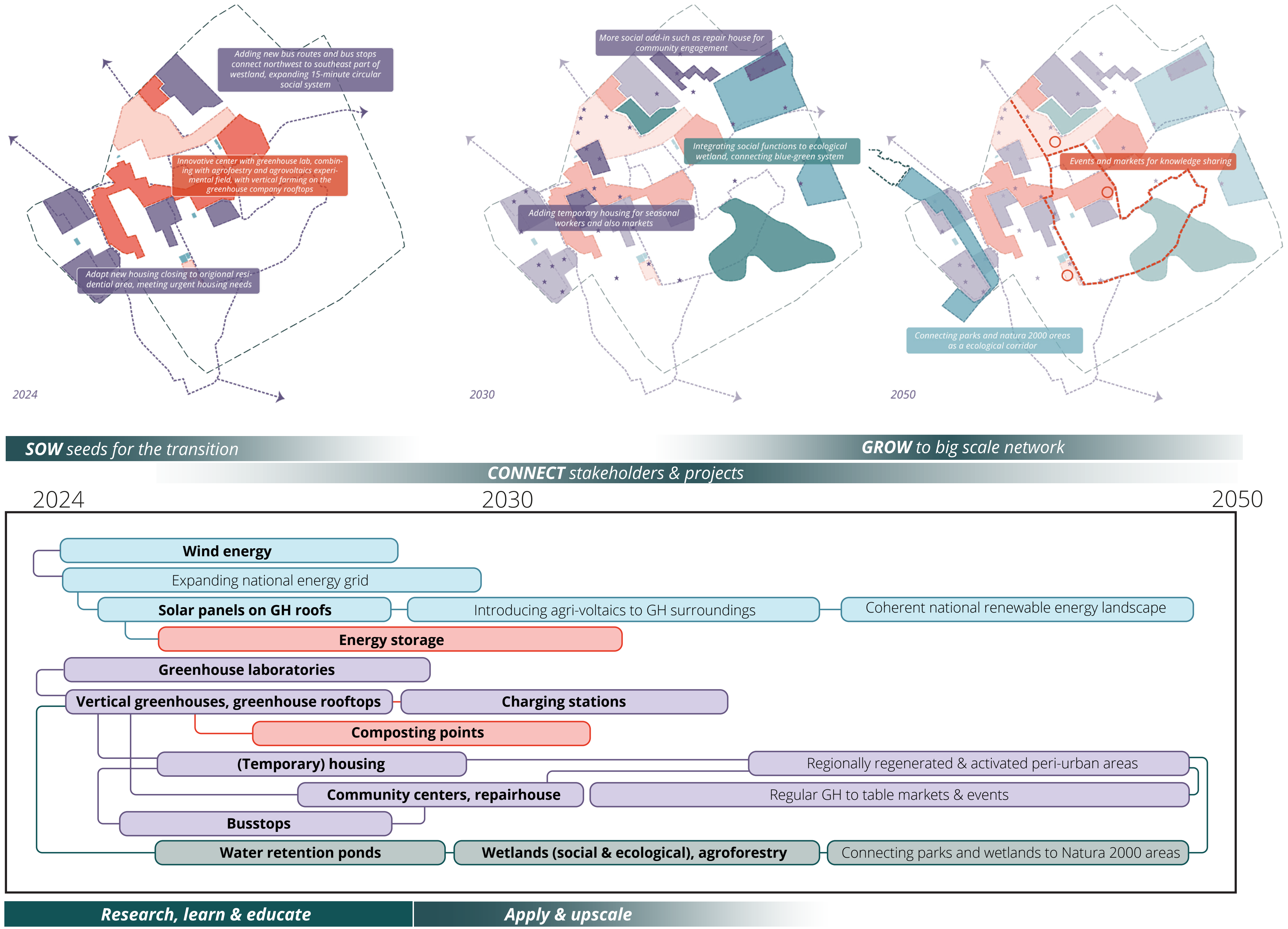


Fig. 89: Phasing the change in Westland
Source: own graphic

▭	Renewable Energy
▭	Community Engagement & Activation
▭	Innovative Regional Production Economy
▭	Ecological Regeneration
▭	Fossil Energy Sources/Production for Export
Bold	Building blocks
Light	General spatial phasing

5.11 STRATEGY CONCLUSION

Potential applications

Participation game
We have come to the conclusion that the present handbook, with its transition steps and building blocks, could be used as a participatory game with different stakeholders, either online or in real life (or a combination). We have deliberately designed the handbook in such a way that it can be applied to many different areas with monofunctional industry in/around/near peri-urban areas, such as the four greenhouse hubs (Westland, Arnhem, Den Bosch and Venlo), but also to other areas that fit this description.

Real life game
In a real-life scenario, the game provides a hands-on opportunity for community engagement and activation by having different stakeholders play it together. They would have the manual as a step-by-step guide, the building blocks as cards, and the cards as a board. Ideally, the stakeholders playing would have different levels of power and sustained interest, such as policy makers, greenhouse owners, and local residents. This would (temporarily) nullify the power differential between these stakeholders and hopefully help them to see the different thoughts and considerations behind the opinions of other stakeholders. This would give policy makers insight into greenhouse practices and the wants and needs of both greenhouse owners and local residents, as their participation in any transition will be crucial. It would also give greenhouse owners and residents insight into the thinking of policymakers, who often have many more things to consider when making plans. Playing the game with different stakeholders requires a lot of practical coordination, but could be really valuable and part of the transition towards community engagement and activation.

Online game
Another option is to make the manual an online game, like a suggestion box. This would make it easier to reach a wider audience and get more input, as there would be less coordination required. The threshold to participate is also lower, which would probably increase the response compared to the real life version. However, if the game is online, we lose the relationship-building quality of the real-life game because there is no real face-to-face contact between stakeholders. This could mean that the stakeholders still feel a distance between them, and the greenhouse owners and local residents could still feel unaddressed. An advantage of the real life game is a stronger engagement and activation of the community.

Fig. 90: Future-collage of Westland
Source: own graphic

06 EVALUATION

6.1 DISCUSSION

Research Questions

The aim of our project was to answer the following research question: How can scaling up circular practices from the greenhouse horticulture industry socially activate and ecologically regenerate the vulnerable & neglected peri-urban landscape of the Rhine-Meuse Delta? To be able to answer that question, we also posed some subquestions:
What is the current status of stakeholder networks, local community involvement, and governance policy for horticulture in the Delta region?
What is the current status of the ecological and energy landscapes and what are the topologies of the existing greenhouses?
How can a circular transformation of the horticulture economy spatially enhance peri-urban lifestyles, and ecologically & economically strengthen the Delta region?
Through answering those questions, we answer our overall research question. The last paragraph specifically talks about the possibilities for scaling up the circular practices.

Current status community engagement
The greenhouse horticulture industry in the Netherlands currently faces geopolitical challenges, including disconnected domestic communication channels and potential tensions across international borders. The rows of greenhouse infrastructure are a barrier to residents in adjacent peri-urban areas, physically impeding access to ecological features and socially fragmenting connections between communities. As a result, residents migrate to urban areas where opportunities and amenities are more readily available.

Ecology and energy landscape, greenhouse typology
In addition, Dutch horticulture faces significant environmental and energy challenges due to its contribution to land scarcity, overconsumption and CO2 emissions. Despite their high production, greenhouses still run primarily on natural gas, contributing to the region's overall carbon footprint.

Benefits of a circular transformation
However, there are opportunities for innovative solutions for energy and space efficiency. Practices and processes for phasing in renewable energy, innovative regional production, ecological regeneration, and community engagement promote a societal shift toward circularity. SowGrowConnect envisions a greenhouse landscape that uses less land for production and more land for innovation and community building, while operating on a fully renewable system. By reducing dependence on non-renewable energy sources, glocalizing production, and integrating social and ecological building blocks, the greenhouse sector increases economic, environmental, and social stability for the future.

Scaling up
In the end, the goal is to achieve a circular society. This means moving beyond the scope of the greenhouse horticulture and scaling up the circular transition of this industry to other sectors, too. We have found that our strategy is applicable to other highly intensive industries too, not just greenhouse horticulture. We also found opportunities for local residents to get involved, such as sharing excess energy from greenhouses with nearby urban areas. This is also a way to scale up the sustainable transition from just greenhouses to a larger scope.

Limitations, lessons & future research

Limitations

We recognize that there are certain limitations to our project, mostly due to the short timeframe. Ideally, there would have been more opportunity for real stakeholder participation. During the field trip to Westland, we conducted interviews with people in De Lier. Their input was very useful and we gained some helpful insights, such as the lack of connection to the beach and the fact that not everyone in Westland felt that the greenhouses were part of the identity of the area. More stakeholder input throughout the process would have been helpful, as we had to make assumptions about the needs and desires of stakeholders such as local residents and greenhouse owners. We based these assumptions on extensive research, but hearing it directly from the stakeholders themselves would have added some certainty. We also had to generalize stakeholder groups and their needs and wants, such as the consumers. We recognize that these stakeholder groups are very diverse and that conducting surveys, for example, would have enriched our strategy.

More research into the different countries and how we can help them move towards sustainable greenhouse horticulture would have been valuable. We are proposing a knowledge-sharing network to help our export partners develop their own sustainable greenhouse horticulture so that they are less dependent on our horticultural production. However, not all of these countries have such an established greenhouse horticulture industry, and we can expect that this transition will be more difficult for these countries than for those that are already partially dependent on their own greenhouses. We did not have enough time to really look beyond our own region and across the border, in addition to the research we did. We assume that the knowledge exchange network is supporting them enough, but we did not have the opportunity to verify this in depth.

Possibilities for upscaling

Our strategy ended up in the form of an instruction manual for implementing our circular concept, which we then implemented in Westland to show how it works. This manual could be used in all kinds of greenhouse areas, both nationally and internationally, to transform them from mono-functional intensive industrial areas into multi-functional areas that add value to the surrounding area, both socially and environmentally. In addition, it could theoretically be applied to other mono-functional intensive industrial areas, not just greenhouses. This would make our strategy very broadly applicable to industrial areas surrounded by peri-urban areas.

The knowledge-sharing network we propose is based on the top export partners for our vision. The network could be extended beyond these boundaries to other countries and possibly outside Western Europe. It should be said that not every country and every part of the world has the resources for greenhouse horticulture on the scale that the Netherlands currently has. However, we could share the knowledge around the world and every country could establish greenhouse horticulture to the extent that they have the means to do so.

Future research

Our project could be followed up with further research in the future to complement and enrich our proposal. For one, the manual and the building blocks could be used as an actual participatory game with different stakeholders, as a means of co-creation. This could show possible improvements for the manual and how it works in real life, and then modify it accordingly. It could help different government bodies to establish a fair and just transition.

It could also help test whether the 15 and 30 minute limits for resource cycles are feasible, not jusy in Westland but also in the other clusters. All the clusters (Westland, Arnhem, Den Bosch and Venlo) and their peri-urban areas have different geographical contexts. Within the scope of our project, we only had time to apply the manual to Westland. In further research, the manual could be applied to the other three areas and possibly to other areas that fit the criteria.

As mentioned above, more research could (and should) be done on the international/global implications of our project. Looking at the status quo of greenhouse horticulture in the countries that are our major export partners, and thinking about how best to help those countries transition based on those exports, is a possibility for future research.

6.2 RELEVANCE OF OUR RESEARCH

Scientific relevance

Large-scale combination of innovations
An important part of this project is the technological transformation of greenhouses, such as the introduction of vertical farming, various energy-saving measures and the sourcing of CO_2 for the production process from industrial sites. These proposals for technical progress are not necessarily new: we have based them on developments that have already started, both in the Netherlands and in other countries. Our proposal is not innovative in the sense that we have developed new technologies, but it is innovative in the sense that we have combined all these different technologies into one overarching proposal. For example, vertical farming on its own is less energy efficient than traditional greenhouses, but by combining it with various energy saving measures, our proposal is still efficient on the bottom line. The combination of these different technological innovations into a diverse and multifunctional greenhouse landscape is unique. Our plan is also larger than our reference projects for current technological developments, which is another novelty of our project.

15 minute city/30 minute territory
A starting point for this project was the implementation of the 15-minute city model, with the goal of improving accessibility to basic amenities. However, this model was based on a dense city center (in Paris) (Moreno et al., 2023), and our focus is on peri-urban areas, which are on the periphery of urban areas. Their population and building densities are lower, making the implementation of this model difficult, if not impossible, in its current form. In addition, the model focuses solely on the social needs of people in the vicinity of their homes, without considering economic and environmental aspects. We have modified the model to make it more applicable to our project. The center is not the house of a city dweller, but a greenhouse company in the peri-urban landscape. The functions that should be within 15-30 minutes of these businesses are not only social, but also related to circular economy practices, renewable energy production and storage, and ecological functions such as wetlands and parks. We used the existing model as a springboard and then made it our own, tailored to our own project, thus adding value to the existing concept.

Societal relevance

Current political unrest
There is currently a lot of political unrest within the Dutch greenhouse horticulture industry, mostly due to newly announced/implemented regulations and the feeling of not being listened to among greenhouse owners. By implementing an open communication loop, where the emphasis is no longer on top-down communication, but on open and fair communication all around, we can help alleviate these tensions. By ensuring that policy makers actually know what is going on in greenhouses, both by hearing from growers and by going there themselves, policy can become knowledge-based, reducing the gap between new regulations and actual practice. We propose practical ways for policymakers and greenhouse growers to connect and strengthen the connection and cooperation.

Combining innovation & social functions
The current greenhouse landscape is largely a monofunctional landscape, focused on production, with little to no room for social functions. When we interviewed the residents of Westland, we found that most of them had little connection to the greenhouses other than a possible job there. By freeing up space within the greenhouse clusters and implementing social functions, we can help (re)connect residents to the greenhouses around their homes. We show through our project that it is possible to combine a production area like greenhouses with social functions, and that this actually adds value to the area. This sense of connection is also created by educating the locals and raising awareness through projects like building their own wind turbine and energy labels on produce. While most residents didn't feel personally connected to the greenhouses, they valued them as part of the area's identity. By involving the locals in the transition, we increase their sense of connection to the greenhouses. By creating a less monofunctional industrial landscape, we also help to break down the disconnection between the residential areas within the greenhouse clusters and the surrounding context, such as the beach and other nearby nature.

Reflection on established development goals

In our project, we address both the Sustainable Development Goals and the Inner Development Goals as parts of our approach, as addressed op pages 120-121. The SDG's act as the base for our values and goals, the IDG's as a means to achieve them.

Sustainable Development Goals
The Sustainable Development Goals act as a „shared blueprint for peace and prosperity for people and the plante, now and into the future" (United Nations, n.d.-a). Therefore, we believe it is important to address them in every project, so it contributes to the greater good. Not just on a small scale and in the here and now, but on a larger scale and over a longer timeframe, too. Based on our analysis of the Dutch greenhouse horticulture, we decided to focus on the following goals:
4. Quality education
7. Affordable and clean energy
9. Industry, innovation and infrastructure
11. Sustainable cities and communities
12. Responsible consumption and production
13. Climate action
15. Life on land
17. Partnership for the goals
These goals took shape for our project in the overarching goal of achieving a circular society, through Renewable energy, Community engagement and activation, Innovative regional production economy, and Ecological regeneration.

Inner Development Goals
In our project, we address the Inner Development goals as a part of our strategy, too. This is because we believe „a foundational shift in human values and leadership capacities" (Framework – Inner Development Goals, n.d.) is necessary to support working towards achieving the SDGs. We found during our research that one of the main challenges in the Dutch greenhouse horticulture is lack of communication. The policy makers don't know much about the ins and outs of the greenhouse practice and in an effort to make the greenhouse horticulture more sustainable, they propose policies and strategies that cause big problems for many growers, therefore achieving the opposite. Consumers are also very distant from the greenhouse production, both physically and mentally, as there is nothing of interest for them there. By creating an open communication circle which actively involved all of the stakeholders, where knowledge is shared in a just manner, we address the following IDGs: relating, collaborating, and acting. These help work towards the goal of creating a smooth(er) transition towards a circular regional society.

Fig. 91: Sustainable development goals
Image source: United Nations, n.d.

Fig. 92: Inner development goals
Image source: Framework – Inner Development Goals, n.d.

Ethical reflection

When working on a project, it is important to reflect on its ethical implications. Within the project itself, but beyond its borders, too. For this, we use the spatial justice-triangle, as presented by Roberto Rocco in one of the Methodology lectures (Roberto Rocco, 2024). This presents the idea of spatial justice having three components, all of which are needed to achieve true spatial justice: recognition justice, procedural justice, and distributive justice. We will consider these aspects within the project and beyond its bounds.

Recognition justice

This means recognizing needs, interests, histories and aspirations. When we look at our stakeholder strategy, both regionally and locally, one important aspect is the empowerment of small and innovative growers who have been largely ignored by government in recent years. Another is to increase the sustainable interest of larger and more traditional producers. We recognize the different needs of these different groups of farmers and have tailored our approach to these groups based on their aspirations and interests. We also recognize that individual growers don't always have the resources and/or knowledge to make the transitions we propose. Therefore, we also intend to support innovative transitions through grants and increased knowledge sharing.

We intend to create a knowledge-sharing network across national boundaries to help other countries transition to sustainable greenhouse horticulture and reduce their dependence on our industry. We know that many other countries don't have the knowledge we have, because the Netherlands is the global innovation center for greenhouse horticulture. If we want to reduce their dependence on us, they need sufficient knowledge to build their own systems on which they can depend.

Procedural justice

Procedural justice means fairness in decision making. In our project, this is most visible in the fact that we want to increase co-creation and move away from an emphasis on top-down communication to a more open circle of communication. We are particularly focused on empowering stakeholders that have been largely neglected, such as the small and innovative greenhouse owners. They are often the hardest hit when there is a mismatch between new policies and greenhouse practices. By empowering them and involving them more in policy making, through more bottom-up knowledge sharing and a more equal relationship with policy makers, we aim to increase procedural justice.

Due to the limitations of this project, we have only been able to touch briefly on the international aspects of this transition. While we want to prepare our export partners for the transition and the fact that Dutch greenhouse gas exports will decrease, these partners have no say in the matter. We are essentially forcing these other countries to develop greenhouse horticulture themselves, with a regionalized food chain, or to look for alternatives. While the Netherlands has a well-established greenhouse horticulture, most other countries don't. It is difficult to say how well these countries will be able to adapt, especially given the relatively short timeframe. In order to accommodate them as much as possible (within the scope of the project), we are setting up a framework for knowledge exchange involving these stakeholders. An intelligent and extensive use of this framework is essential to support the transition of the exporting partners.

Distributive justice

This last component refers to a fair distribution of burdens and benefits. The greenhouse areas currently don't experience the benefits of the greenhouses, because Dutch horticulture is mostly export-oriented. They do, however, experience the burdens. The greenhouses separate them from the surrounding nature, there is a lot of traffic due to the transportation of products, and there is a lot of light pollution from the greenhouses, to name a few. By implementing social functions within the greenhouse areas and regionalizing the food chains, local residents will be able to experience the benefits of the greenhouses. By making the greenhouses more sustainable, we will also reduce the burden and increase distributive justice under the line.

Global distributive justice is a more complex issue. Renewable energy is an important aspect of our project, including the large-scale implementation of solar panels. However, the materials for these panels will have to come from other parts of the world, outside the global West. So while we reap the benefits of these solar panels, other parts of the world will have to pay the price. Within the scope of this project, this is not something that we have been able to consider too much, but it is a very sensitive issue that we are aware of and should not be ignored.

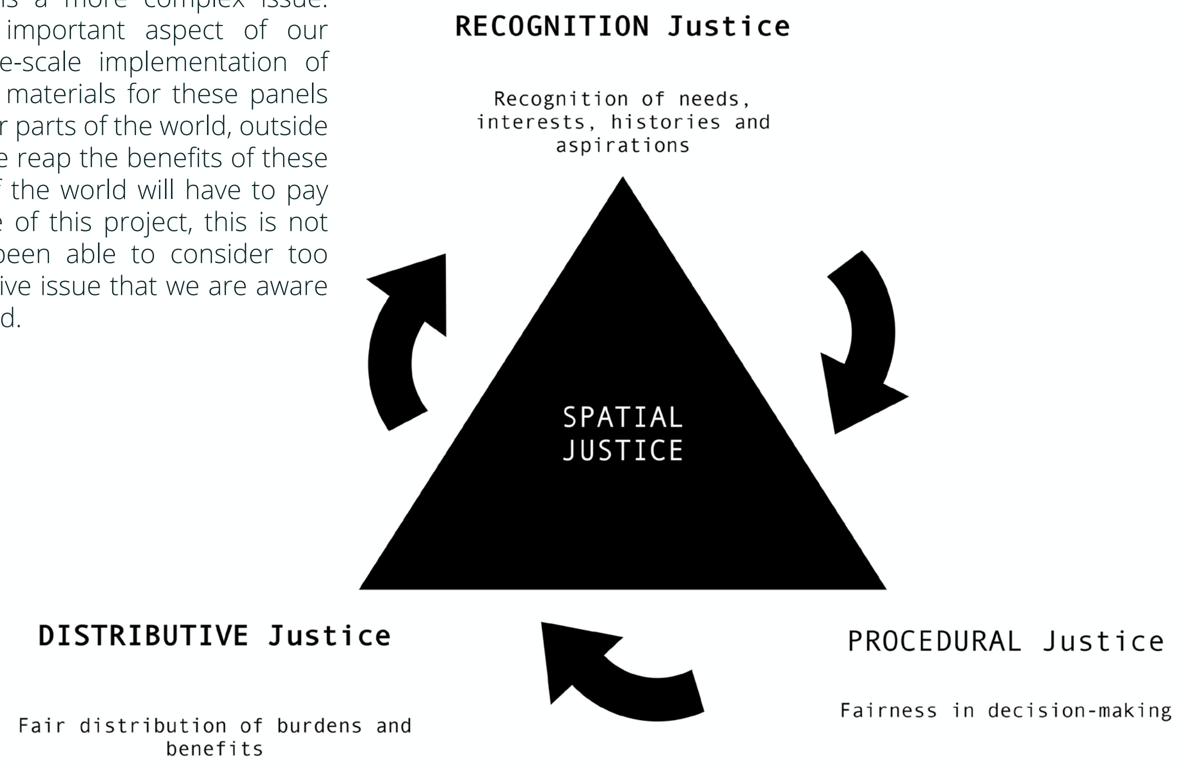


Fig. 93: Triangle of justice
Image source: Rocco 2024

07 APPENDIX

INDIVIDUAL REFLECTIONS

Layne

Before starting this master's program, I worked as a civil engineering designer for water and wastewater projects in Austin Texas. The frustrating part of this job was being limited to the provided scope and approved practice methods. For example, when designing drainage systems, instead of implementing creative solutions like drainage pavement the option was to increase the size of piping. This project was a great change of pace because as a student the possibilities and limits can be endless. This allowed for flexibility and movement when implementing creative ideas into a report.

Our research helped highlight the ecological capacities and the societal limitations which showed us the middle zone where design should occur. Our research helped us find new technologies and reference projects for similar situations, but our design allowed for the intermingling and intertwining of these ideas, as well as the proposal of new ideas (such as wetland to greenhouse aquaponics or recycling greenhouse glass for translucent solar panels). In another example, the research on 15-minute cities showed us the importance and benefits of accessibility, but we adapted this idea with designs using the lens of our region.

A vision, unlike the scopes I am used to, allows for boldness and creativity because it is not a checklist but a dynamic and evolutionary process. It is a visualization of a brainstorm not directions or a checklist. Our vision highlights areas where our group hopes to expand capacities by transitioning from linear to circular economy practices. In practice, the

expand capacities by transitioning from linear to circular economy practices. In practice, the vision narrowed our search to an energy and food nexus, but new findings such as energy efficiency practices, 15-minute city theory, and types of agroforestry inspired a new kind of vision that was more encompassing of the people as well as the environment and economy. Unsuccessful projects that I have experienced in the past fail because the general public does not understand or agree with the purpose of the projects. We also saw the threat of non-transparent governments in the class discussion around flat earthers. For our project, we used governance and policy to act as the communicative bridge between public acceptance and governmental action. The use of co-creation, collaboration, and incentives in our project hopes to make our idea more approachable for a broader group of people, not just academics or politicians. For example, spatial justice and societal shifts were interesting topics from class, and in our project some shifts include public view on waste, lowering the attraction of global exportation, and increasing the attraction of living in peri-urban areas.

In conclusion, this project showed the importance of creative thinking, communicating, trusting, and encouraging in a group setting. We would not have been able to create a report we were proud of if we hadn't implemented these values from the beginning. Overall, I learned the difficulty and importance of designing projects not just for efficiency and cost, but for the people, place, and environment, and this will be embedded in my mind for future projects I work on.

Yiyan

In this reflectiion I will address the relationship between research and design in this project.

In our project, we commenced with one overarching theoretical concept of the circular society (Williams, 2023), aiming to explore the relationship between urban and peri-urban areas, as well as the role of the peri-urban area within the context of achieving zero-emission Dutch greenhouse horticulture across the delta region.

In response to our main objective of a zero-emission society, we devised three hierarchical frameworks to establish the comprehensive logic of the project, aiming to reach a systematic, multi-scale spatial design. Initially, we employed the theoretical framework not only as a fundamental overview but also as a guide for its integration across various stages of our project. For instance, to apply the 15-minute city concept inspired by Paris (Moreno et al., 2023), we tried to adapt the daily travel time distances for different basic demands and facilities accessibility to essential amenities within the circular society framework. Consequently, we expanded the 15-minute radius from addressing daily basic needs to encompass both circular economy and circular society approaches, resulting in creating two levels of radius: 15-minute circular social system and 30-minute circular economic system, to meet limited CO_2 emissions from social and economic activities within a daily travel distance. Secondly, we introduced a conceptual framework to show the main purpose of integrating circular society principles into greenhouse horticulture across various scales. Finally, we represented the project's methodology framework, which formulated multiple feedback loops from one process to another, reflected in the group work processes as well.

Among them, spatial design was a special catalyst to be involved in all the processes, as a reflection of not only the political but also the social engagement practices. For example, to apply our strategy to different kinds of context locations, we built up an instruction manual to define the region step by step, providing a way to integrate the political methods with spatial impact together. From this instruction manual, stakeholders will find their positions and focus in each step, scaling up the impact not only from local to regional but from regional to local.

To conclude, what I learned most from this quarter was how to form a discerning and coherent narrative in our design project. It was very important to learn how to design by research, highlighting a non-linear thinking process and the generation of corresponding feedback for different parts at different stages. Especially for the vision and value part, they were influenced much by the strategy part and then built up with a synergy conclusion.

Williams, J. (2023). Circular cities: planning for circular development in European cities. European Planning Studies, 31(1), 14-35.

Moreno, C., Gall, C., Chabaud, D., Garnier, M., Illian, M., & Pratlong, F. (2023). The 15-minute City model: An innovative approach to measuring the quality of life in urban settings 30-minute territory model in low-density areas WHITE PAPER N° 3 (Doctoral dissertation, IAE Paris-Université Paris 1 Panthéon-Sorbonne).

Laura

For the individual reflection, I will reflect on the question: What is the role of a vision in the planning and design proposal of your group project and how has it influenced your development strategy?

During the Q3 studio, the course was roughly split into two: the weeks before the midterm and the weeks after the midterm. During the first part, the focus was more on developing a vision, while during the second part, the focus was more on developing a strategy. In general, a vision can be a bit more broad, while the development strategy needs to be more specific and more actionable, as stated in the Quarter Guide and explained in the lectures. The vision is meant to paint a desirable picture of the future and should be persuasive, therefore it can be it bit more vague. The strategy identifies concrete actions to be taken according to the vision, and is therefore more specific, building upon the vision.

During the first few weeks of our project, while doing the analysis and developing the vision, our group sometimes left things open-ended and instead of focusing on one or a few themes, we continued to look at new things. We found a variety of different themes interesting and tried to incorporate almost all of them. This resulted in a very rich, but also maybe slightly surface-level vision around the time of the midterm. During the feedback session for our midterm presentation, we got the feedback that we needed to go more in depth, be more specific, especially spatially, and should not just use buzzwords like "15 minute city" and "glocalization" without explaining exactly what their role is in our project. In short, we needed to be more precise concerning our vision.

When diving into the strategy, which was based on our vision, we were confronted with some of the ends that were left open and (too) vague during the development of the vision. Working on the application of our concept in Westland meant that we had to be more precise. For example, we had thought about incorporating the concept of the 15 minute city into our project, but had not thought it out further. When working on Westland, we found that the concept needed to be specified to actually apply it. In fact, we ended up really making the concept our own, by adjusting it to our theme and adding to it. Working more precisely in turn helped us sharpen our vision too, and helped us define suitable values and goals, that properly summarized our vision and linked it to our development strategy.

So while the vision worked a stepping stone towards our strategy, it was also the other way around. Our project was not just a linear, chronological process, but contained feedback loops too, where working on the strategy also helped us tweak our vision. A reciprocal process, where both vision and strategy helped shape the other. In the end, this resulted in a coherent, rich, and well-thought-out project.

Gillian

As nations around the world struggle to balance environmental conditions and capacities with social and economic demands accelerated by globalization, my team and I decided to delve deeper into these challenges related to the food-energy nexus, driven by the fundamental question of how to feed the world with limited environmental, material, and human resources. Therefore, the highly efficient „machinery" of greenhouse horticulture in the Dutch Delta was an interesting system for us to tackle in this course.

The design studio process led us to understand the interconnections behind this intensive economic system across scales - from local to global. Northwestern Europe is heavily dependent on food supplies from the Dutch Delta region, which is in an extremely fragile geographic location. It became clear to us that the current value system privileges global economic strength over recognition of ecological and social capacity at the local and regional level. Although the scope of the assignment was the regional scale, we realized the importance of examining the pressing social and environmental challenges from the smallest to the largest scale, which revealed even more complex conditions and capacities that needed to be addressed in our proposal for a transformative vision. For my team and I, this meant boldly deconstructing an existing system, finding opportunities and weaknesses, and transforming them into qualities that would define a fundamentally new value system. One that inspired our vision of a self-regenerating and resource-giving circular system and society.

In order to translate our broad vision into a development strategy and design interventions, we developed a comprehensive conceptual framework that combines approaches from the theories and concepts of the circular society, glocalization, and the 15-minute city / 30-minute territory. As a result, we conceptualized both a systemic and a spatial model with design interventions. The combination of both gives our project an edge, as the spatial component is often neglected in circular economy concepts. Our proposed circular system model not only focuses on circular material flows, but also includes socially inclusive and ecologically regenerative practices. Our own adaptation of the 15/30-minute model responds to this systemic model with spatial design implications for circular practices - because we have learned that time and space is immensely important in designing circular resource cycles. In addition, with the emphasis on the social aspect of our goal to achieve a circular society, it was immanent in our strategy to propose actions that would change the current governance model by activating and empowering local communities, because they are the groups that can actually change things in practice at the local level - which can potentially trigger change at a larger scale.

In conclusion, I have learned that the "research by design" approach in practice helps to refine study questions and focus, as one loops not only the resource flows in theory, but also the design process, cycling between researching relevant theories and concepts, assessing the spatial capacities and conditions at hand, and developing design ideas as solutions.

Lotte

For the individual reflection I will reflect on the question: What is the relationship between research and design in your group project?
Starting this course I had no previous experience on the subject or the scale. In my bachelors this large of a scale was never used, and while sustainability did play a role, the more extensive subjects like energy, emissions and justice were not involved. On top of that, are those subjects relevant in the current society. All of this did however mean that there were enough opportunities to learn new things and gain more knowledge of the systems on the different scales.
Research and acquiring knowledge was not only necessary on my part, but for the whole group. Eventhough our different backgrounds did ensure that each of us had different strengths and weaknesses. We mostly tried to use our strengths, but also give opportunity to improve the weaknesses where possible and with help of other group members. This included the research part. So while finding the topic and later information about the greenhouse systems, stakeholders and other regional aspects we distributed it accordingly.
The part of the design was alternating with the SDS course, which gave components useful for making the vision and strategizing. This course gave me personally a lot of new information, like urban sustainability or spatial justice. But also how to create and visualize frameworks.
The relationship between research and design for this project was a circulating flow, just like how the project focuses on circular economy and greenhouse flows. Urbanism is an interdisciplinary field, in which both activities are necessary and intertwined with each other. The process between the two is not linear, where the conclusion of the research conventionally leads to a design. But it is rather circular, where you constantly need to go from researching to gain knowledge to designing for applying the knowledge. This was something we had to do during our own process. After gaining the initial knowledge, the next step was to make our ideas spatial. The spatial design and vision led to rethinking our previous steps and thus researching more for the strategy.

To conclude, I have learned many new things during these past nine weeks. Every element of the process we did needs research. And to bring research and design together is a hard task at hand, but nonetheless an important one for strategizing.

REFERENCES

Adolfsen, J. F., Kuik, F., Schuler, T., & Lis, E. (2022). *The impact of the war in Ukraine on euro area energy markets*. https://www.ecb.europa.eu/press/economic-bulletin/focus/2022/html/ecb.ebbox202204_01~68ef3c3dc6.en.html

Bakker, K. (2023, September 23). *Enorme lastendruk dreigt voor glastuinbouw*. Nieuwe Oogst. https://www.nieuweoogst.nl/nieuws/2023/09/29/enorme-lastendruk-dreigt-voor-glastuinbouw

CBS. (2011). *Land- en tuinbouwcijfers 2011*. https://www.cbs.nl/nl-nl/publicatie/2011/39/land-en-tuinbouwcijfers-2011

Dictionary, C. (n.d.). *GLOCALIZATION - English meaning*. Cambridge Dictionary. Retrieved March 13, 2024, from https://dictionary.cambridge.org/dictionary/english/glocalization

Framework – Inner Development Goals. (n.d.). Retrieved April 8, 2024, from https://innerdevelopmentgoals.org/framework/

Gemeente Westland. (n.d.). *Glastuinbouwvisie 2040*. Retrieved March 3, 2024, from https://www.gemeentewestland.nl/aanvragen-en-regelen/ondernemen-en-arbeidsmigratie/glastuinbouw/glastuinbouwvisie-2040#:~:text=we%20werken%20in%202040%20zoveel,planten%20en%20algen%20ons%20bieden

Glastuinbouw Nederland. (n.d.). *Stichting Innovatie Glastuinbouw (SIGN)*. Glastuinbouw Nederland. https://www.glastuinbouwnederland.nl/sign/

Glastuinbouw Nederland. (2023). *Visiedocument Energie 2023*. https://www.glastuinbouwnederland.nl/geavanceerd-zoeken/?q=visiedocument_energie_2023#search

Greenports Nederland. (n.d.). *Greenports Nederland*. Greenports Nederland. https://www.greenports-nederland.nl/

Greenports Nederland. (2019). *Nationale Tuinbouwagenda 2019-2030*. https://www.greenports-nederland.nl/nl/tuinbouwagenda

Grigorescu, A., & Zaif, A. (2017). The concept of glocalization and its incorporation in global brands' marketing strategies. *International Journal of Business and Management Invention*, *6*(1), 70–74.

Hilz, P. (2021). *International trade and transit flows; emissions to air on Dutch territory—Dutch Trade in Facts and Figures | CBS* [Webpagina]. International trade and transit flows; emissions to air on Dutch territory - Dutch Trade in Facts and Figures | CBS. https://longreads.cbs.nl/dutch-trade-in-facts-and-figures-2021/international-trade-and-transit-flows-emissions-to-air-on-dutch-territory

Informatiepunt Leefomgeving. (n.d.-a). *Gemeentelijke omgevingsvisie: Dit staat er in*. Retrieved March 3, 2024, from Gemeentelijke omgevingsvisie: dit staat er in

Informatiepunt Leefomgeving. (n.d.-b). *Omgevingsplan op hoofdlijnen*. Retrieved March 3, 2024, from https://iplo.nl/regelgeving/instrumenten/omgevingsplan/omgevingsplan-hoofdlijnen/

Informatiepunt Leefomgeving. (n.d.-c). *Omgevingsverordening*. Retrieved March 3, 2024, from https://iplo.nl/regelgeving/instrumenten/omgevingsverordening/

Informatiepunt Leefomgeving. (n.d.-d). *Programma*. Retrieved March 3, 2024, from https://iplo.nl/regelgeving/instrumenten/programma/

Informatiepunt Leefomgeving. (n.d.-e). *Provinciale omgevingsvisie*. Retrieved March 3, 2024, from https://iplo.nl/regelgeving/instrumenten/omgevingsvisie-provincie/

Jacobs, J. (1961). *The death and life of great American cities*. New York : Random House. http://archive.org/details/deathlifeofgreat0000jaco_n0t5

Kom in de Kas. (n.d.). *Kom in de Kas—Hét glastuinbouwevenement van het jaar!* https://www.komindekas.nl/

LEI Performance and Impact Agrosectors, LEI International Policy, Jukema, G., Ramaekers, P., & Berkhout, P. (2023). *De Nederlandse agrarische sector in internationaal verband: Editie 2023*. Wageningen Economic Research. https://doi.org/10.18174/584222

Malooly, L., & Daphne, T. (2023, November 9). *R-Strategies for a Circular Economy*. Circularise. https://www.circularise.com/blogs/r-strategies-for-a-circular-economy

Mies, A., & Gold, S. (2021). Mapping the social dimension of the circular economy. *Journal of Cleaner Production*, *321*, 128960. https://doi.org/10.1016/j.jclepro.2021.128960

Ministerie van Binnenlandse Zaken en Koninkrijksrelaties. (n.d.). *Rotterdamse haven*. De nationale omgevingsvisie. Retrieved March 3, 2024, from https://www.denationaleomgevingsvisie.nl/novex/aanpak+per+gebied/rotterdamse+haven/default.aspx

Ministerie van Landbouw, Natuur en Voedselkwaliteit. (n.d.). *Natura 2000*. Natura 2000. Retrieved February 12, 2024, from https://www.natura2000.nl/

Ministerie van Landbouw, Natuur en Voedselkwaliteit. (2022). *Convenant Energietransitie Glastuinbouw 2022-2030*. https://open.overheid.nl/Details/ronl-2b15b6c2504f87d0fcd6bf3e80bcbf94c7455830/2?hit=2&text=convenant+glastuinbouw

Moreno, C., Gall, C., Chabaud, D., Masson, I., Garnier, M., & Pratlong, F. (2023). *ETI Chair White-Paper-3 EN*. https://www.researchgate.net/publication/369943086_ETI_Chair_White-Paper-3_EN

Netbeheer Nederland. (2023, September 1). *Provinciaal Meerjarenprogramma Infrastructuur Energie en Klimaat*. https://www.netbeheernederland.nl/artikelen/nieuws/provinciaal-meerjarenprogramma-infrastructuur-energie-en-klimaat

Omroep West. (2024, March 2). *Tuinders vrezen levenswerk door strenge regels en hoge prijzen: "Daar gaat m'n toekomst."* Omroep West. https://www.omroepwest.nl/nieuws/4813051/tuinders-vrezen-levenswerk-door-strenge-regels-en-hoge-prijzen-daar-gaat-mn-toekomst

Onderzoekcentrum Drechtsteden. (n.d.). *Hoe duurzaam is mijn gemeente*. Retrieved March 29, 2024, from https://gdindex.nl/content/mijn-gemeente

Paris, B., Vandorou, F., Balafoutis, A. T., Vaiopoulos, K., Kyriakarakos, G., Manolakos, D., & Papadakis, G. (2022). Energy Use in Greenhouses in the EU: A Review Recommending Energy Efficiency Measures and Renewable Energy Sources Adoption. *Applied Sciences*, *12*(10), Article 10. https://doi.org/10.3390/app12105150

Pascoe, R. (2021, September 20). *Local councils are failing to develop enough seasonal worker housing*. DutchNews.Nl. https://www.dutchnews.nl/2021/09/local-councils-are-failing-to-develop-enough-seasonal-worker-housing/

Poorthuis, A., & Zook, M. (2023). Moving the 15-minute city beyond the urban core: The role of accessibility and public transport in the Netherlands. *Journal of Transport Geography*, *110*, 103629. https://doi.org/10.1016/j.jtrangeo.2023.103629

Positive expectations for exports of horticultural greenhouses despite the corona crisis. (n.d.). *Omniplast*. Retrieved April 8, 2024, from https://omniplast.nl/en/project/positive-expectations-for-exports-of-horticultural-greenhouses-despite-the-corona-crisis/

Programmabureau Taskforce Duurzame Greenport Westland Oostland. (n.d.). *Greenport Duurzaam*. Retrieved March 3, 2024, from http://greenportduurzaam.nl/

provincie Zuid-Holland. (n.d.-a). *Omgevingsbeleid*. Retrieved March 3, 2024, from https://www.zuid-holland.nl/onderwerpen/omgevingsbeleid/

provincie Zuid-Holland. (n.d.-b). *Onderweg naar een circulair Zuid-Holland*. Retrieved March 3, 2024, from https://circulair.zuid-holland.nl/

Rawls, J. (1999). *A Theory of Justice: Revised Edition*. Harvard University Press. https://doi.org/10.2307/j.ctvkjb25m

Rijksdienst voor Ondernemend Nederland. (2020). *R-ladder—Strategieën van circulariteit*. https://www.rvo.nl/onderwerpen/r-ladder

Rijksoverheid. (n.d.-a). *Nieuwe woningen bereikbaar maken*. Retrieved March 3, 2024, from https://www.rijksoverheid.nl/onderwerpen/volkshuisvesting/nieuwe-woningen-bereikbaar-maken

Rijksoverheid. (n.d.-b). *Omgevingswet*. Retrieved February 12, 2024, from https://www.rijksoverheid.nl/onderwerpen/omgevingswet

Rijksoverheid. (n.d.-c). *Programma Klimaat en Energie*. Retrieved March 3, 2024, from https://www.rijksoverheid.nl/ministeries/ministerie-van-onderwijs-cultuur-en-wetenschap/programmas/programma-klimaat-en-energie

Rijksoverheid. (n.d.-d). *Waar staan en komen de windparken op zee?* Retrieved March 3, 2024, from https://windopzee.nl/onderwerpen/wind-zee/waar/

Rijksoverheid. (2019). *Klimaatakkoord*. https://www.rijksoverheid.nl/documenten/rapporten/2019/06/28/klimaatakkoord

Roberto Rocco. (2024, February 29). *INTRO TO SPATIAL JUSTICE*. https://brightspace.tudelft.nl/d2l/le/content/594263/viewContent/3623289/View

Roudometof, V. (2016). Theorizing glocalization: Three interpretations. *European Journal of Social Theory*, *19*(3), 391–408. https://doi.org/10.1177/1368431015605443

Sahana, M., Ravetz, J., Patel, P. P., Dadashpoor, H., & Follmann, A. (2023). Where Is the Peri-Urban? A Systematic Review of Peri-Urban Research and Approaches for Its Identification and Demarcation Worldwide. *Remote Sensing*, *15*(5), Article 5. https://doi.org/10.3390/rs15051316

Shamsuddoha, M. (2009, February 25). *Glocalization: A Theoretical Analysis*. CONFERENCE OF SOUTH ASIAN MANAGEMENT FORUM 2009. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1409561

Smit, P. (2023). *Energiemonitor van de Nederlandse glastuinbouw 2022*. Wageningen Economic Research. https://doi.org/10.18174/641047

Statistic Netherlands, C. (2020, April 10). *Nearly 30 thousand contract workers in agriculture* [Webpagina]. CBS: Statistics Netherlands. https://www.cbs.nl/en-gb/news/2020/15/nearly-30-thousand-contract-workers-in-agriculture

Stuurgroep Energiestrategie regio Rotterdam Den Haag. (2021). *RES 1.0 Regionale Energiestrategie Rotterdam Den Haag*. https://www.resrotterdamdenhaag.nl/over+de+res/res-1-0/default.aspx

team RES Regio Arnhem Nijmegen. (2021, June). *RES 1.0 | RES Regio Arnhem Nijmegen*. https://prvgelderland.maps.arcgis.com/apps/MapSeries/index.html?appid=e0b3c4dc3dac443db3a300e0094c5447

Temperature trends: The Netherlands and worldwide, 1906-2013 | Compendium voor de Leefomgeving. (2014, June 25). https://www.clo.nl/en/indicators/en022611-temperature-trends-the-netherlands-and-worldwide-1906-2013

Unie van Waterschappen. (n.d.). *Nationaal Programma Regionale Energiestrategie*. Retrieved March 3, 2024, from https://regionale-energiestrategie.nl/default.aspx

United Nations. (n.d.-a). *The 17 Goals*. Retrieved February 12, 2024, from https://sdgs.un.org/goals

United Nations. (n.d.-b). *The Paris Agreement*. Retrieved February 22, 2024, from https://unfccc.int/process-and-meetings/the-paris-agreement?gad_source=1&gclid=CjwKCAiAopuvBhBCEiwAm8jaMcejWzp5gmAS0_Y_c9O0sYIcL_KW-CJ8vDbSmB02cbI6FyHvli60TRoCoMcQAvD_BwE

University, S. (2021, May 4). Revealing the complexities of life in Silicon Valley. *Stanford News*. https://news.stanford.edu/2021/05/04/revealing-complexities-life-silicon-valley/

Van der Wilt, P. (2021, December 14). *De groenste energieleverancier*. https://www.consumentenbond.nl/energie-vergelijken/de-groenste-energieleverancier

Vattenfall. (n.d.). *Duurzaamheidsindex Nederlandse Gemeenten: Hoe duurzaam zijn Nederlanders?* Vattenfall.Nl. https://www.vattenfall.nl/over-vattenfall/wat-we-doen/vattenfall-duurzaamheidsindex/

Von Bannisseht, Q. (n.d.). *Tuinbouw Jongeren Nederland verdiepen zich in het thema Water*. Glastuinbouw Nederland. https://www.glastuinbouwnederland.nl/nieuws/tuinbouw-jongeren-nederland-verdiepen-zich-in-thema-water/

Wandl, A. (2020). Territories -in- between: A Cross-case Comparison of Dispersed Urban Development in Europe. *A+BE | Architecture and the Built Environment*, *02*, Article 02. https://doi.org/10.7480/abe.2019.14.4340

Williams, J. (2019). Circular cities. *Urban Studies*, *56*(13), 2746–2762.

Williams, J. (2023). Circular cities: Planning for circular development in European cities. *European Planning Studies*, *31*(1), 14–35. https://doi.org/10.1080/09654313.2022.2060707

World Canals. (n.d.). *Inland waterways of Netherlands*. World Canals. Retrieved April 7, 2024, from http://worldcanals.org/english/netherlands.html

World Horti Center. (n.d.). *Over ons—World Horti Center*. World Horti Center. https://www.worldhorticenter.nl/over-ons/

WOS. (2023, September 20). *Glastuinbouw Nederland over nieuwe wet: "Onrendabel om nog groente of planten te telen."* WOS. https://wos.nl/nieuws/artikel/glastuinbouw-nederland-over-nieuwe-wet-onrendabel-om-nog-groente-of-planten-te-telen

Wuyts, W., & Marin, J. (2022). "Nobody" matters in circular landscapes. *Local Environment*, *27*(10–11), 1254–1271. https://doi.org/10.1080/13549839.2022.2040465

FIGURE REFERENCES

Collages:
(*Download Free Vectors, Images, Photos & Videos*, n.d.)

Icons:
(*Noun Project: Free Icons & Stock Photos for Everything*, n.d.)

Agrofoodportal. (2023). *Number of greenhouses and average hectare in the Netherlands*. https://agrofoodportal.com/SectorResultaat.aspx?subpubID=2232&sectorID=2240

AlleCijfers. (2024). *AlleCijfers*. https://allecijfers.nl/

Bakker, K. (2023, September 23). *Enorme lastendruk dreigt voor glastuinbouw*. Nieuwe Oogst. https://www.nieuweoogst.nl/nieuws/2023/09/29/enorme-lastendruk-dreigt-voor-glastuinbouw

BRO Soil Map- PDOK. (2021). Pdok.Nl. https://www.pdok.nl/introductie/-/article/bro-bodemkaart-sgm-

Capaciteitskaart invoeding elektriciteitsnet. (2023, June 28). https://capaciteitskaart.netbeheernederland.nl

CBS. (n.d.). *International trade and transit flows; emissions to air on Dutch territory—Dutch Trade in Facts and Figures | CBS* [Webpagina]. International trade and transit flows; emissions to air on Dutch territory - Dutch Trade in Facts and Figures | CBS. Retrieved April 8, 2024, from https://longreads.cbs.nl/dutch-trade-in-facts-and-figures-2021/international-trade-and-transit-flows-emissions-to-air-on-dutch-territory

CBS. (2011). *Land- en tuinbouwcijfers 2011*. https://www.cbs.nl/nl-nl/publicatie/2011/39/land-en-tuinbouwcijfers-2011

Corine land Cover 2012 database of the Netherlands. (2014, July 1). Nationaal Georegister. https://www.nationaalgeoregister.nl/geonetwork/srv/api/records/2269c48e-330f-4f29-bfef-f309f81aee07

Feeding the world. (2016, November 3). WUR. https://www.wur.nl/en/themes/from-hunger-to-food-security.htm

Framework – Inner Development Goals. (n.d.). Retrieved April 8, 2024, from https://innerdevelopmentgoals.org/framework/

Freeman, B., Tular, B., Sitadevi, L., & Jessup, T. C. (2021). Application of agroforestry business models to tropical peatland restoration | Ambio. *Kungl. Vetenskaps-AKademien*. https://doi.org/10.1007/s13280-021-01595-x

Goddek, S. (2017). *Opportunities and Challenges of Multi-Loop Aquaponic Systems* [Wageningen University]. https://doi.org/10.18174/412236

Introduction—PDOK. (2020, December 1). https://www.pdok.nl/introductie/-/article/windsnelheden-100m-hoogte

Kaarten | Atlas Leefomgeving. (n.d.). Retrieved April 9, 2024, from https://www.atlasleefomgeving.nl/kaarten?config=3ef897de-127f-471a-959b-93b7597de188&gm-x=150000&gm-y=455000&gm-z=3&gm-b=1544180834512,true,1;1544716174078,true,0.8;&activateOnStart=info&deactivateOnStart=layercollection

LEI Performance and Impact Agrosectors, LEI Innovation, Risk and Information Management, Ruijs, M., & Benninga, J. (2020). *Market potential and investment opportunities of high-tech greenhouse vegetable production in the USA: An exploratory study for Midwest and East Coast regions and the state of California*. Wageningen Economic Research. https://doi.org/10.18174/526843

LEI Performance and Impact Agrosectors, LEI International Policy, Jukema, G., Ramaekers, P., & Berkhout, P. (2023). *De Nederlandse agrarische sector in internationaal verband: Editie 2023*. Wageningen Economic Research. https://doi.org/10.18174/584222

Lijnennetkaarten. (n.d.). Retrieved April 10, 2024, from https://www.ebs-ov.nl/haaglanden/reizen/lijnennetkaarten

Map Viewer—Climate Impact Atlas. (n.d.). Retrieved March 7, 2024, from https://www.klimaateffectatlas.nl/nl/

FIGURE REFERENCES

Ministerie van Landbouw, Natuur en Voedselkwaliteit. (2022). *Convenant Energietransitie Glastuinbouw 2022-2030*. https://open.overheid.nl/Details/ronl-2b15b6c2504f87d0fcd6bf3e80bcbf94c7455830/2?hit=2&text=convenant+glastuinbouw

NPRES_AMBITIE_FGDB - Overzicht. (2022, May 4). https://ez.maps.arcgis.com/home/item.html?id=4c304ea8ce1149388f6ee667b4178e4c

Omroep West. (2024, March 2). *Tuinders vrezen levenswerk door strenge regels en hoge prijzen: "Daar gaat m'n toekomst."* Omroep West. https://www.omroepwest.nl/nieuws/4813051/tuinders-vrezen-levenswerk-door-strenge-regels-en-hoge-prijzen-daar-gaat-mn-toekomst

Onderzoekcentrum Drechtsteden. (n.d.). *Hoe duurzaam is mijn gemeente*. Retrieved March 29, 2024, from https://gdindex.nl/content/mijn-gemeente

OpenStreetMap. (n.d.). *Open street map*. https://www.openstreetmap.org/#map=7/52.154/5.295

Paris, B., Vandorou, F., Balafoutis, A. T., Vaiopoulos, K., Kyriakarakos, G., Manolakos, D., & Papadakis, G. (2022). Energy Use in Greenhouses in the EU: A Review Recommending Energy Efficiency Measures and Renewable Energy Sources Adoption. *Applied Sciences*, *12*(10), Article 10. https://doi.org/10.3390/app12105150

pdok. (2023, June). *(CBS Square Statistic 100m*. (OGC) Web Services - PDOK. https://www.pdok.nl/ogc-webservices/-/article/cbs-vierkantstatistieken-100m#f897cf1bb5ab8db2dc81034a23ba18ab

Pomoni, D. I., Koukou, M. K., Vrachopoulos, M. G., & Vasiliadis, L. (2023). A Review of Hydroponics and Conventional Agriculture Based on Energy and Water Consumption, Environmental Impact, and Land Use. *Energies*, *16*(4), Article 4. https://doi.org/10.3390/en16041690

Rijksdienst voor Ondernemend Nederland. (2020). *R-ladder—Strategieën van circulariteit*. https://www.rvo.nl/onderwerpen/r-ladder

Roberto Rocco. (2024, February 29). *INTRO TO SPATIAL JUSTICE*. https://brightspace.tudelft.nl/d2l/le/content/594263/viewContent/3623289/View

Sahana, M., Ravetz, J., Patel, P. P., Dadashpoor, H., & Follmann, A. (2023). Where Is the Peri-Urban? A Systematic Review of Peri-Urban Research and Approaches for Its Identification and Demarcation Worldwide. *Remote Sensing*, *15*(5), Article 5. https://doi.org/10.3390/rs15051316

Schreefel, L., Schulte, R. P. O., de Boer, I. J. M., Schrijver, A. P., & van Zanten, H. H. E. (2020). Regenerative agriculture – the soil is the base. *Global Food Security*, *26*, 100404. https://doi.org/10.1016/j.gfs.2020.100404

Self, R. (2022, April 13). *15 Trees For Wet Clay Soil That Are Great For Landscaping*. Garden Tabs. https://gardentabs.com/trees-for-wet-clay-soil/

Sijmons, D. F. (Ed.). (2014). *Landscape and energy: Designing transition*. Nai010 Publ.

Smit, P. (2023). *Energiemonitor van de Nederlandse glastuinbouw 2022*. Wageningen Economic Research. https://doi.org/10.18174/641047

Smith, M. M., Bentrup, G., Kellerman, T., MacFarland, K., Straight, R., & Ameyaw, Lord. (2022). Agroforestry Extent in the United States: A Review of National Datasets and Inventory Efforts. *Agriculture*, *12*(5), 726. https://doi.org/10.3390/agriculture12050726

Statistics | Eurostat. (n.d.). Retrieved April 6, 2024, from https://ec.europa.eu/eurostat/databrowser/view/NRG_IND_REN__custom_10734763/default/bar?lang=en

Statistics Netherlands. (2023, June 19). *46 percent more solar energy production in 2022* [Webpagina]. Statistics Netherlands. https://www.cbs.nl/en-gb/news/2023/24/46-percent-more-solar-energy-production-in-2022

United Nations. (n.d.). *The 17 Goals*. Retrieved February 12, 2024, from https://sdgs.un.org/goals

FIGURE REFERENCES

van Beveren, P. J. M., Bontsema, J., van ’t Ooster, A., van Straten, G., & van Henten, E. J. (2020). Optimal utilization of energy equipment in a semi-closed greenhouse. *Computers and Electronics in Agriculture*, *179*, 105800. https://doi.org/10.1016/j.compag.2020.105800

van Tuyll, A., Boedijn, A., Brunsting, M., Barbagli, T., Blok, C., & Stanghellini, C. (2022). Quantification of material flows: A first step towards integrating tomato greenhouse horticulture into a circular economy. *Journal of Cleaner Production*, *379*, 134665. https://doi.org/10.1016/j.jclepro.2022.134665

Vattenfall. (n.d.). *Duurzaamheidsindex Nederlandse Gemeenten: Hoe duurzaam zijn Nederlanders?* Vattenfall.Nl. https://www.vattenfall.nl/over-vattenfall/wat-we-doen/vattenfall-duurzaamheidsindex/

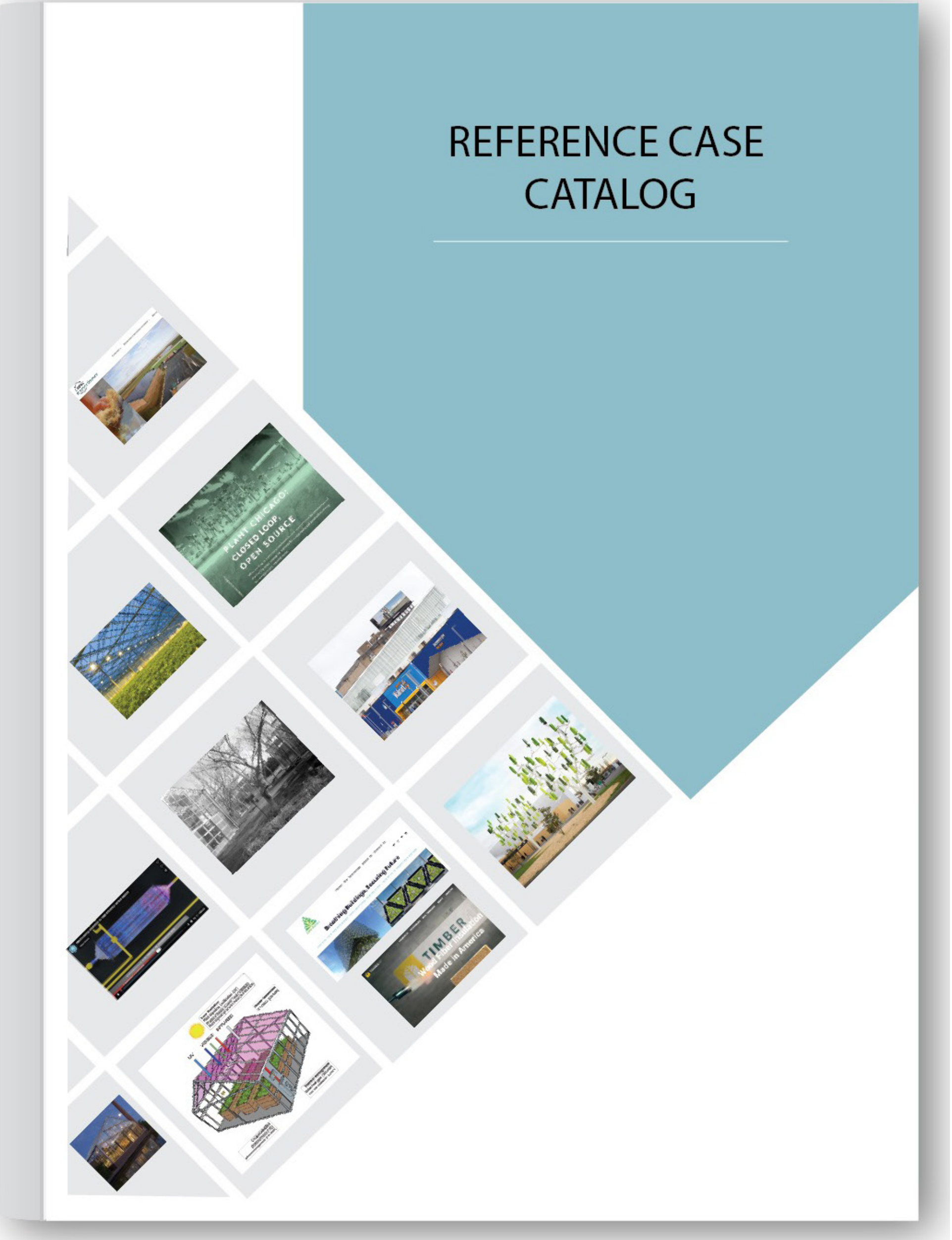
Wandl, A. (2020). Territories -in- between: A Cross-case Comparison of Dispersed Urban Development in Europe. *A+BE | Architecture and the Built Environment*, *02*, Article 02. https://doi.org/10.7480/abe.2019.14.4340

WarmteAtlas. (n.d.). *Heat atlas*. Retrieved April 8, 2024, from https://www.warmteatlas.nl/viewer/app/Warmteatlas/v2

Williams, J. (2019). Circular cities. *Urban Studies*, *56*(13), 2746–2762.

WOS. (2023, September 20). *Glastuinbouw Nederland over nieuwe wet: “Onrendabel om nog groente of planten te telen.”* WOS. https://wos.nl/nieuws/artikel/glastuinbouw-nederland-over-nieuwe-wet-onrendabel-om-nog-groente-of-planten-te-telen

REFERENCE CASES



Semi-Transparent Solar

Semitransparent organic solar cells that were tested in greenhouse glass. Located at North Carolina State University, and production of lettuce plants stayed consistent with normal glass panes. A portion of the light is capture by solar cells while the rest is used as heat for the plants. During especially hot days, instead of the greenhouse overheating, more percentage of solar can be capture by the cells.

MIT CO2 Remover

New method based on passing air through a stack of electrochemically charged plates (basically a large battery that attracts CO2 particles). Can operate at any concentration level, while current methods require a higher concentration to be effecient. This method is less energy-intensive and less expensive.

Thermal Storage in CHP

Many scientific papers are researching the possibilities of implementing thermal storage were CHP systems already exist. Benefits include economics, balancing the variability in renewable energy, and progress towards 100% renewably sourced systems. This project proposes the idea to completely transition CHP systems to thermal storage instead of biogas production. Reports have only experimented in conjunction with normal CHP processes, not as thermal storage as primary function

The Reuse People

A business in California that reclaims materials from commercial and residential deconstruction sites. This has included industrial greenhouses in the past, where they collected metal frames, glass panels, soil, plastic sheeting, piping, and wood components.

Repurposed Zones

Many Industrial Port areas have repurposed their areas into more environmentally friendly features. For example turning water tanks into natural ponds, rain collection units, and wetlands. These areas include Brooklyn Navy Yard and Gowanus Canal in New York, Kings Cross Pond Club in London, and Docklands in Melbourne.

Solar Co-Ops

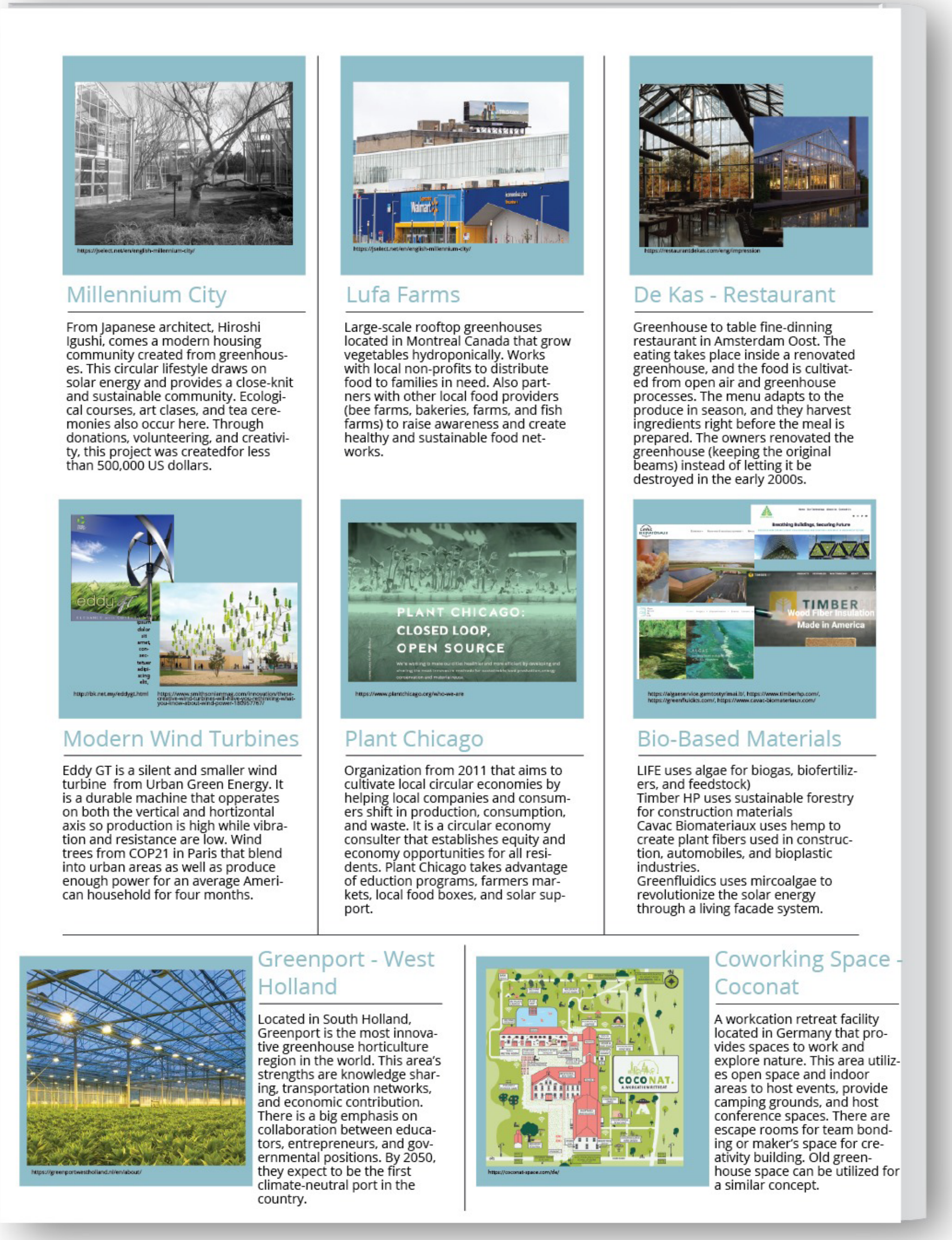
Solar United Neighbors is an example of a solar co-op that helps fight for renewable energy justice for everyone. It allows neighborhoods and groups of people invest in solar power together. The groups allow for individual contracts but without the financial burden of investing individually.

Repair Cafe

A space where neighbors and friends can come together to build and create. It emphasizes repairing and revitalizing products instead of throwing away, recycling, or purchasing new. Adding this facility as a social add in will also promote connection and rebuilding as a community rather than continuing to add to the waste build-up.

EVgo

Company leading in electric charging corridors. Has experience voncerting gas pump stations in to electric stations, and has experience partnering with companies like Nissan to incentivize thier customers to purchase electric vehicles. There are also examples of EVgo partnering with natural grocers to give thier customer a more fulfiling experience. The same would be accomplished within this project's boundaries.



Millennium City

From Japanese architect, Hiroshi Igushi, comes a modern housing community created from greenhouses. This circular lifestyle draws on solar energy and provides a close-knit and sustainable community. Ecological courses, art clases, and tea ceremonies also occur here. Through donations, volunteering, and creativity, this project was createdfor less than 500,000 US dollars.

Lufa Farms

Large-scale rooftop greenhouses located in Montreal Canada that grow vegetables hydroponically. Works with local non-profits to distribute food to families in need. Also partners with other local food providers (bee farms, bakeries, farms, and fish farms) to raise awareness and create healthy and sustainable food networks.

De Kas - Restaurant

Greenhouse to table fine-dinning restaurant in Amsterdam Oost. The eating takes place inside a renovated greenhouse, and the food is cultivated from open air and greenhouse processes. The menu adapts to the produce in season, and they harvest ingredients right before the meal is prepared. The owners renovated the greenhouse (keeping the original beams) instead of letting it be destroyed in the early 2000s.

Modern Wind Turbines

Eddy GT is a silent and smaller wind turbine from Urban Green Energy. It is a durable machine that opperates on both the vertical and horizontal axis so production is high while vibration and resistance are low. Wind trees from COP21 in Paris that blend into urban areas as well as produce enough power for an average American household for four months.

Plant Chicago

Organization from 2011 that aims to cultivate local circular economies by helping local companies and consumers shift in production, consumption, and waste. It is a circular economy consulter that establishes equity and economy opportunities for all residents. Plant Chicago takes advantage of eduction programs, farmers markets, local food boxes, and solar support.

Bio-Based Materials

LIFE uses algae for biogas, biofertilizers, and feedstock)
Timber HP uses sustainable forestry for construction materials
Cavac Biomateriaux uses hemp to create plant fibers used in construction, automobiles, and bioplastic industries.
Greenfluidics uses mircoalgae to revolutionize the solar energy through a living facade system.

Greenport - West Holland

Located in South Holland, Greenport is the most innovative greenhouse horticulture region in the world. This area's strengths are knowledge sharing, transportation networks, and economic contribution. There is a big emphasis on collaboration between educators, entrepreneurs, and governmental positions. By 2050, they expect to be the first climate-neutral port in the country.

Coworking Space - Coconat

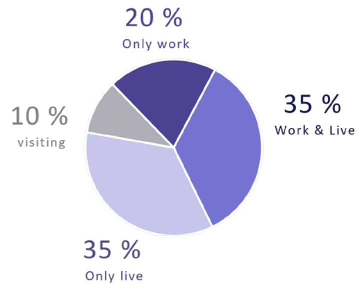
A workcation retreat facility located in Germany that provides spaces to work and explore nature. This area utilizes open space and indoor areas to host events, provide camping grounds, and host conference spaces. There are escape rooms for team bonding or maker's space for creativity building. Old greenhouse space can be utilized for a similar concept.

INTERVIEW RESULTS

Informal 5-min Interviews

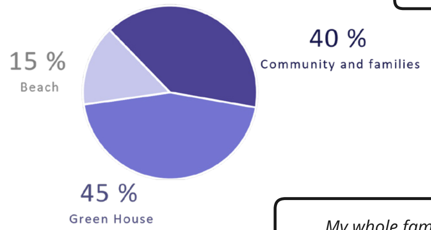
19/02/2024 from 10 am to 2 pm in De Lier (Westland), 20 interviewees

Do you live, work or visit Westland?



Most of them live and work there.

What do you associate most with Westland?

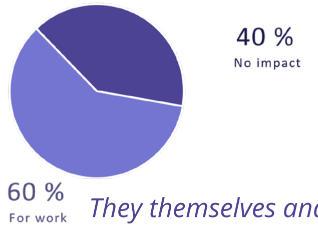


*We are a tight knit **community**.*
A woman, that lives her whole life in Westland
Values → ***social life with family and friends***

*I think the **green houses** are **iconic** for Westland.*
A man who works and lives in Westland his whole life
Values → ***local identity***

My whole family works in the greenhouses!
A woman who works and lives in Westland her whole life
Values → ***Making a living, job opportunities***

What is the impact the surrounding greenhouses have on your daily life here?



No impact but they enjoy the life in Westland

They themselves and their families work in greenhouse-related jobs

What challenges do you see for Westland in the future?

6/20

Lack of housing

- *mainly for short- and long-term workers*

There is a competition for housing, we need to think about where the workers live, there are not enough houses.

4/20

Lack of diversity in the economy & land use

- *cultural heritage*
- *production not only for export*

The greenhouses will have to make room for other uses, like housing or something cultural ...

I hope the production for export will be less in the future

5/20

Disappearance of greenhouses

- *positive emotional connection*
- *negative attitude towards them (visitors)*
- *wish for multi-functional transformation*

The greenhouses might disapper in the future, but I hope they stay.

6/20

Other challenges

- energy transition - rising prices
- bad public transportation
- adaptation to new technology
- migration / cultural differences

Westland needs to be more open and less greenhouses, and the local industry needs to diversify .