FEATHERS & FUEL

MERGING PERSPECTIVES

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Spatial Strategies for the Global Metropolis

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ABSTRACT

The Port of Rotterdam is currently undergoing a crucial energy transition, promoting the production of sustainable energy in the port to provide the Netherlands with clean energy. In current approaches, though, non-human species are severely underrepresented in the spatial design of the port. This makes the port inherently unsustainable because this approach destroys current ecosystems that are beneficial for the well-being of the space and the well-being of humans living and working in these spaces. (Jørgensen, 2009; Latour, 2012). This research builds on the Post-Anthropocene philosophy and expands on this concept by integrating spatial justice and an ecosystem approach into it. In this approach, we aim to create a design that considers humans and seagulls as inhabitants of one ecosystem. Based on spatial data about seagulls and humans, we create an analysis of the spatial needs of the two species. In the analysis, we also investigate differences in energy production sources and discuss which sources are spatially and ethically just. These analyses combined form the base of a just vision of the Port of Rotterdam during the energy transition. After this, we visualize the feasibility of the new vision for the port by creating a potential strategy to achieve the created vision. This strategy visualizes the timeline in which future policies and spatial interventions are represented. We zoomed in on three key projects, which we based on key principles our strategy aims to represent spatially. The report concludes with a discussion on how the research has impacted current energy transition approaches and reflects on the conceptual foundation this research builds upon. The reflection will additionally cover ethical constraints, this research's impact on the Sustainable Development Goals (United Nations, n.d.), its relevance to science and society, the incorporation of public goods, and recommendations for further research.

Key words: Energy Transition; Post-Anthropocene; Spatial Justice; Ecosystem Approach; Non-Human Agency

THE PARTY OF THE ANTHROPOCENE
- ACT 1 -

Welcome to the glamorous Party of the Anthropocene, organized by humans for humans.
We are going to celebrate the supremacy of the human, achieved after centuries of poverty, disease, and labour.
We made it.
After the death of God and the death of Man, whoever is left can dance wildly on their ashes.

This is going to be once in a lifetime. Excess will rule.
We are going to drink all the bottles of alcoholic and non-alcoholic beverages ever produced; we are going to eat all the lobsters, cows, and chickens left on Earth.

Everything will be provided: oak tables sustained on elephant tusk legs to dine under the stars, plastic flower seats designed by the most famous brands, personalized polystyrene plates to eat as much as you wish.

And ... guess what? We are going to live forever!

Alive non-human animals are not allowed.
Robots are allowed, if accompanied by humans – they need tickets too.

A poem by
Francesca Ferrando

(Ferrando, 2016)

CONTENT

00. Glossary

DEFINITIONS

Affordance scape

Using the definition of Philipp Gruber, “affordances are possibilities for action provided to an animal by the environment, by substances, objects, and other living creatures that surround it.” Therefore, affordance scape is the sum of all affordances provided in a space. (Growing Residency, 2023)

Anarcho Capitalism

Political philosophy and political-economic theory that advocate the voluntary exchange of goods and services in a society broadly regulated by the market rather than by the state (Britannica Money 2025).

Anthropocene

The era we are currently living in. Geologically defined as the period in which the collective action of man began to alter the biosphere (Oxford Languages). Psychologically defined as the era in which the centralization of the human perspective neglects human interconnectedness with its surroundings (Staying with the Trouble, 2016).

CCS

Is the underground storage of captured carbon dioxide gas that is released during the combustion of (fossil) fuels. CCS (Carbon Capture and Storage) is a technique that allows the use of fossil fuels to be (almost) climate-neutral. By capturing the greenhouse gas CO_2 produced during the combustion of these hydrocarbons and storing it in underground reservoirs, the CO_2 is prevented from entering the atmosphere (Wikipedia, 2024).

Coexisting

The state or fact of living or existing at the same time or in the same place (Oxford Dictionary, 2025). In the context of the report, this applies to non-humans, humans, and energy implementations.

DAC

Direct air capture, technology extracting CO_2 directly from the atmosphere, for CO_2 storage or utilization (Iea, n.d.)

Entities

According to Latour, neglecting the subject-object division, entities are everything that is connected in a network of relations (We Have Never Been Modern, 1991).

Greenifying

Humans actively plant vegetational species to increase the amount of planted space in an area.

Habitat

The natural home or environment of an animal, plant, or other organism (Oxford Dictionary, 2025).

Non-humans/Other

The process by which a mass of air is lifted by a geographical feature (Skybrary, 2025).

PBL

Planbureau voor de leefomgeving: Dutch National Office that researches the living environment within the Netherlands and beyond its borders.

Post-Anthropocene

Post ‘after’ in ancient Greek. Therefore, the term entails the time after the Anthropocene. An era in which humans are decentered and are no longer crossing planetary limits.

Posthumanism

A philosophy that focuses on the narratives intersecting human, non-human, and technological worlds (Oxford Bibliography, 2025). It is also used as a concept to identify the inequalities and limitations interwoven with currently dominant worldviews.

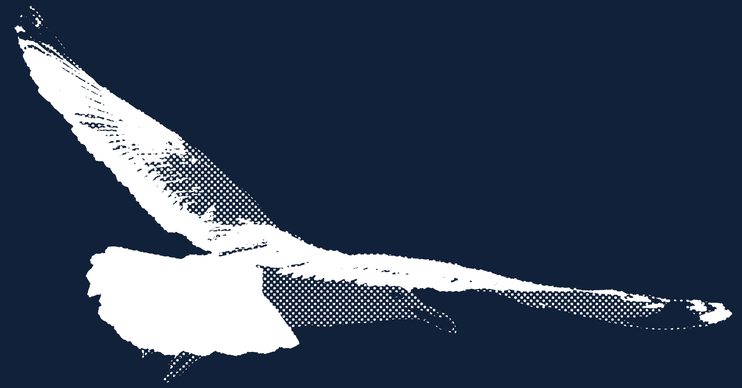
Rewilding

Non-humans take over a space that is no longer dominated by human activity. Expanding and creating new habitats.

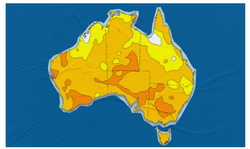
Spatial Justice

The concept refers to the fair and equitable distribution of space, resources, and decision-making power (Lefebvre, 2003).

01.
INTRODUCTION



More than 150 'unprecedented' climate disasters struck world in 2024, says UN



Australia weather

'Same shit, different year': Australia records hottest 12 months and warmest March on record

7h ago

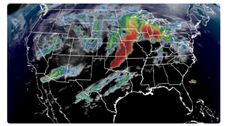
Pollution

US could see return of acid rain due to Trump's rollbacks, says scientist who discovered it

Humans are responsible for the vast majority of out-of-control wildfires in the US.

INCREASED DROUGHT

More severe storms



Forecasters warn of an impending outbreak of long-lasting, strong tornadoes and once-in-a-lifetime flooding

85% of all global air pollution comes from burning fossil fuels and biomass

LOSS OF SPECIES

1. *Australia records (Readfearn, 2025)*
2. *Acid rain (Milman, 2025)*
3. *Climate disasters 2024 (Carrington, 2025)*
4. *Temperatures rise (United Nations, z.d.)*
5. *Forecasters warn (Tsui, 2025)*
6. *Flooding (Vernick 2024)*
7. *Air pollution (Climate And Air Pollution - Clean Air Fund, 2025)*
8. *Text (United Nations, z.d.-a)*

01. INTRODUCTION

THE ISSUE OF THE PRESENT

The Port of Rotterdam

The Port of Rotterdam is Europe's largest and one of the world's most vital ports, playing a key role in global trade and national energy production. Situated at the mouth of the Rhine-Meuse-Scheldt delta, it handles millions of tons of goods and raw materials such as coal, oil, and gas, making it a crucial hub for energy and industry. The energy transition, driven by climatic urgency, inevitably demands structural changes in energy production, which currently depends mainly on the fossil fuel industry. (CBS, 2024a). Consequently, renewable energy sources such as solar and wind power are realized and planned to be integrated, replacing current fossil fuels for a green future. These developments, although they're intending to reduce climate impact, remain rooted in an anthropocentric perspective. Through this perspective the ability to truly reduce the human impact on the earth's ecosystem is limited.

Anthropocene

This limitation is created by the cultural dichotomy between nature and culture, which places entities outside the human justice system. This also challenges the validity of the term 'sustainability' as its definition solely focuses on human perspectives. This separation is artificial, in reality, cities consist of hybrid networks in which human and non-human entities continuously interact with each other. (Latour, 2012). Neglecting these non-human entities and their interdependency with humans doesn't allow the comprehension of the complexity of the critical zone, necessary to develop processes as the energy transition that truly reduce human impact on the environment. (Latour, 2012; Stefanova, 2021).

Feathers

Taking Seagulls as a case study, this project explores the possibility of post-anthropocentric urban design practice for the energy transition. Seagulls, being a common species in the port of Rotterdam, are greatly influenced by spatial development in the area. The seagull is currently obstructed by harbor activities and harbor workers preventing nesting of seagulls. New harbor projects improve human affordances while hindering seagulls' affordances of the port space, such as breeding, flying, nesting, and resting zones. Additionally, the seagull is an endangered species, so by neglecting their spatial needs in the harbor, the risk of extinction is present. This will have massive impacts on the port's ecosystem. By integrating seagulls into spatial planning processes in the port of Rotterdam through spatial conditions that support the seagulls' living conditions and life cycle, this research aims to create an improved understanding of how post-anthropogenic urban design can contribute to the creation of a more sustainable and ecologically just energy transition in the port, and in the world.

Research questions

This paper employs a central research question and several guiding sub-questions as the backbone for our research and design. These questions are based on the problem statement and aim to answer the problem stated in there.

The main research question is:

How can we create a strategy for the green energy transition in the Port of Rotterdam, considering non-human species, such as seagulls?

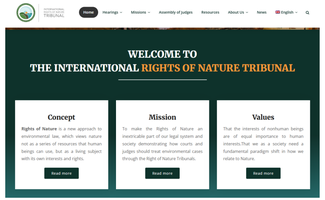
The Port of Rotterdam is a complex and large place, with a lot of stakeholders having their own spatial needs and priorities. As this question thus can't be answered by solely reading literature and past research, we created three sub-questions that have guided us through our research process. The sub-questions will also guide you through the report, and as smaller problems get solved throughout the report, we get closer to the answer of the main question step by step.

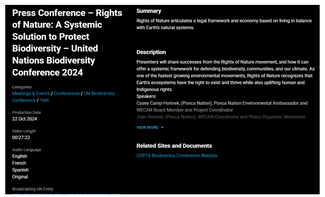
The three sub-questions are:

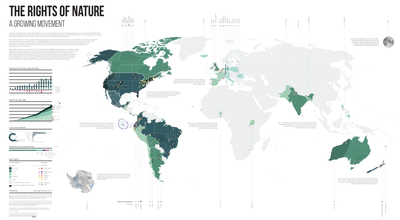
1. ***What are the spatial needs of humans and seagulls?***
2. ***Which energy system is spatially and ethically just for humans and seagulls?***
3. ***How can the spatial needs of humans, seagulls, and a new energy system be combined in the Port of Rotterdam?***

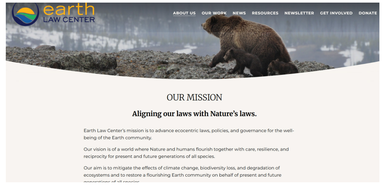
In the analysis chapter of the report, these questions are analyzed based on scientific literature and data, visualized in maps. Based on this analysis, we created a vision of the port of Rotterdam in 2050 and a strategy of how this vision could be achieved. The conclusion will reflect on the vision and the strategy and describe how we came to the answer of the one question:

How can we create a strategy for the green energy transition in the Port of Rotterdam, considering non-human species, such as seagulls?









9. *Rights of nature tribunal (Communications, 2025)*
10. *Biobio River; (Iarmani, 2024)*
11. *UN press conference (Press Conference - Rights Of Nature: A Systemic Solution To Protect Biodiversity – United Nations Biodiversity Conference 2024, 2024)*
12. *Moot court (Ambassade van de Noordzee, 2024b)*
13. *Confluence of European water bodies (Ambassade van de Noordzee, 2024)*
14. *Growing movement (Putzer et al., 2025)*
15. *Earth law center (To Give Nature A Seat On The Board — Earth Law Center, z.d.)*

02.
THEORY

02. THEORY

THEORETICAL FRAMEWORK

Theorethical framework

To create a truly inclusive and sustainable design vision for the Port of Rotterdam, this research draws on a multi-dimensional theoretical framework that critically engages with both human and non-human perspectives. Grounded in post-anthropocenic thinking, the framework challenges the dominant human-centered logic of urban development and emphasizes a more equitable relationship between people, nature, and space. By integrating theories of spatial justice, ecosystem interdependence, and more-than-human design, we aim to reconceptualize how urban areas, such as the port of Rotterdam, can be shaped in ways that support both ecological health and human and non-human well-being. This theoretical lens forms the foundation of this research, giving it a theoretical base built upon current scientific knowledge. It provides a framework for what we consider to be just, on which we have built massively when creating a vision and a strategy.

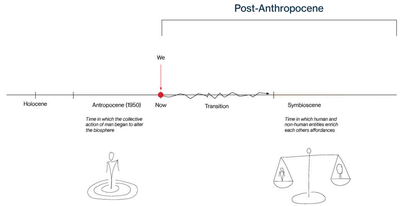
To create a truly inclusive and sustainable design vision for the Port of Rotterdam, this research draws on a multi-dimensional theoretical framework that critically engages with both human and non-human perspectives. Grounded in post-Anthropocenic thinking, the framework challenges the dominant human-centered logic of urban development and emphasizes a more equitable relationship between people, nature, and space. By integrating theories of spatial justice, ecosystem interdependence, and more-than-human design, we aim to reconceptualize how urban areas can be shaped in ways that support both ecological health and social well-being. This theoretical lens not only critiques current systems of environmental degradation but also opens up

The anthropocene and the post-anthropocene

Take a look around you. Truly observe your surroundings. What do you see? And what do you hear, feel, and smell? Everywhere around us, there are objects and spaces that are designed for us. We live in an age where design is based on the needs of humans. Whole cities have been built so humans have a place to live, work, and be entertained. Consequently, humans break the world where they and all non-humans live in. This time is defined as the Anthropocene.

The term Anthropocene implies that humans as a whole are responsible for environmental degradation, deriving from the Ancient Greek anthropos (ἄνθρωπος) meaning 'human' and kainos (καινός) meaning 'new' or 'recent'. (Lidell & Scott, 1843). However, critics argue that it is not humanity as a whole but rather systems such as industrial capitalism, colonialism, and global inequality that have driven ecological destruction. (Haraway et al., 2016; Moore, 2014). Moore, for instance, proposes the term Capitalocene to emphasize that not all humans share equal responsibility. Ignoring these underlying systems and histories of injustice—such as colonial exploitation and socio-economic disparities—erases the unequal burdens and roles different communities have played in both causing and suffering from environmental harm. (Haraway et al., 2016). We thus define the Anthropocene as the age in which humans have destroyed the world, but we don't aim to claim that all humans and all communities have an equal part in this destruction.
Now that we have created a clear definition of the term Anthropocene, we can transition away from this concept towards the Post-Anthropocene. Post means 'after' in ancient Greek. The term therefore entails that we are entering a time after the Anthropocene, where humans are not the central focus in design and policies are shaped around the well-being of the Earth as a whole, instead of solely by the human role in it. Several scientists claim that a transition towards an age in which humans are not the center of design is crucial for the survival of the Earth and its inhabitants, including humans. (Ferrando, 2016; Kohn, 2022; Latour, 2012; Moore, 2014). The Earth, in its current state, is past its state of being a passive and natural backdrop. Human disruptions have caused the Earth to react. (Latour, 2017). The Actor-Network Theory, proposed by Latour (2017) dissolves boundaries between humans and non-human entities, recognizing oceans, weather, and technology as agents shaping the world. Climate change is not just an environmental but a political crisis, revealing the struggle between those who accept planetary interdependence and those who resist it. Latour calls for governance that includes non-human considerations, rejecting Anthropocene narratives that assume humans are the sole actors in shaping planetary futures. To implement this, a new form of democracy is necessary, where humans and non-humans are co-authors in decision-making processes.

Albrecht (2020) introduces the concept of Symbiocene. Which reshapes the Post-Anthropocene view. Instead of humans just stopping with their corruption of the Earth, this concept entails a view in which a future where human activity is reintegrated with Earth's ecosystems is strived upon. It offers an optimistic view of the role humans can have in the future. In this future, humanity will share all space and resources in the world equally with non-humans. Humans, therefore, have a part in this balance as well. Our views for the Port of Rotterdam are in line with this perspective. When we thus refer to the post-Anthropocene, we also consider the human as a stakeholder of the great pie of resources the world offers. In addition to balancing out resources between humans and non-humans, our theory also builds on the concept of affordance. This concept entails that spaces all create certain opportunities of use. (Gibson, 1979). A space might offer different use opportunities for humans and non-humans. In our Post-Anthropocene design, we will take into account the needs of humans and seagulls and create affordances according to these needs. By designing space with this worldview, we can shape a future where human and non-human entities coexist in more just and sustainable ways.



16. *Post anthropocene timeline*

Spatial justice

On top of building on a Post-Anthropogenic fundament, this research will also be built on the concept of Spatial Justice. The concept refers to the fair and equitable distribution of space, resources, and decision-making power. (Lefebvre, 2003). In traditional frameworks, spatial justice focuses on social inequalities. The focus lies on which actors or communities have access to land, mobility, and housing. (Fainstein & DeFilippis, 2016; Soja, 2009). Newer frameworks claim that justice is not seen as a concept with one universal meaning because it is seen as being constituted geographically on different scales. (Brown et al., 2019; Massey, 2005). Critiques suggest that the concepts of space and justice are deeply intertwined with each other. (Soja, 2009). Space has agency as it shapes behavior, opportunities, and inequalities. Because of that, we can't see justice as an abstract term, as it is always tied to real-world places and contexts. When discussing justice, we must, therefore, also consider geography.

In the Post-Anthropocene framework we use in this paper, spatial justice must also consider non-human actors, including animals, plants, water bodies, and microscopic life. In current scientific development, non-human actors are being more involved in the spatial justice framework. (Brown et al., 2019). Several scholars already claim that non-human entities should have rights and spatial rights to improve the spatial justice system. (Brown et al., 2019; Latour, 2012, 2017).

Fieuw et al. (2022) have designed a framework that gives humans an approach towards a more sustainable development system that considers More-than-Human perspectives. This framework provides strategies with which humans can create spatial justice for humans and non-humans. We see this as a more all-encompassing way to look at the concept of spatial justice. This framework envisions urban planning systems as the foundation that makes flora and fauna in a place possible, creating a More-than-Human city. The implementation of plants and animals inside a city also simultaneously influences the human habitat. To create spatial justice between humans and non-humans, humans should have the right to influence non-human habitats as much as non-humans influence human habitats.

Ecosystem

The concept of ecosystems has been used in various research, and different scholars also use the term differently. (Tsujimoto et al., 2018). An ecosystem is generally seen as a community of organisms that interact with each other and rely on each other. It can consist of plants, animals, and other organisms that keep the ecosystem healthy and balanced by providing to and using resources from the system. With the extinction of one of the species in an ecosystem, the balance of the whole ecosystem can change, which can have detrimental results for the ecosystem. (Benbow et al., 2020). The health of ecosystems has a positive correlation with human quality of life and well-being. Green design processes have been demonstrated to increase the sense of community security in cities, and aggression and crime rates are lower in areas with some greenery. (Summers et al., 2012).
Humans have a great impact on existing and past ecosystems. Throughout human history, ecosystems have been altered by humans. (Jørgensen, 2009). Humans have often taken too many resources from an ecosystem, causing the balance of the ecosystem to disappear. Humans are therefore in research often considered as the destroyers of ecosystems. (Jørgensen, 2009; Lu et al., 2015). Although many researchers see humans as the actor that influences current ecosystems. A counterargument for this view is that humans are part of the ecosystems they use. Biologically speaking, humans are seen as animals, making them one of the ecosystems' actors. (Link et al., 2017).

Ground use mapping is essential for gaining insights into the structure and function of ecosystems, as it allows researchers to understand the spatial distribution of natural and human-made elements within a landscape. (Maes et al., 2016). However, effective ecosystem management must go beyond relying solely on static maps and designated zones. As Blew (1996) argues that a more dynamic, process-oriented, and organism-centered approach is needed. One that recognizes ecosystems as constantly evolving through flows, feedback loops, and interdependent relationships between organisms and their environment.

Energy transition

The energy transition refers to the global shift from fossil fuel-based energy systems, such as coal, oil, and natural gas, toward more sustainable and renewable energy sources like wind, solar, hydro, and geothermal power. (Leach, 1992). This transition is driven by the urgent need to reduce greenhouse gas emissions, mitigate climate change, and create a more resilient and equitable energy future. It involves not only technological change but also social, economic, and political transformation. (Rijksoverheid, 2017, 2021). The energy transition requires rethinking how energy is produced, distributed, and consumed, with a focus on decentralization, efficiency, and inclusivity. It also entails the redesign of infrastructures, policies, and behaviors to support long-term sustainability. Beyond environmental concerns, the energy transition raises questions about who benefits and who bears the cost of change, making it a deeply spatial and justice-related issue. (Bouzarovski & Tirado Herrero, 2017; Patel et al., 2024; Schlesewsky & Winter, 2018). In the end, the goal of the transition is to create a clean source of energy for everyone, which is a just goal, but research has shown that current capitalist systems are still unable to create truly just energy transitions. (Patel et al., 2024).

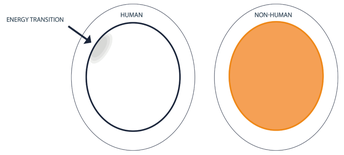
CONCEPTUAL FRAMEWORK

The conceptual framework shows the relationship between the concepts addressed in the theoretical framework and visualizes its purpose for this research. To make the transition we want to undergo with this research visible, we have chosen to split up the conceptual framework into three different phases. The first one addresses the current situation with an anthropogenic view, the second one shifts to new perspectives, and the third one, being our final conceptual framework, shows the full framework and its conceptual base.

Phase 1: The anthropocene

Currently, humans design space, putting humans in the middle, seeing non-human ecosystems as separate beings we can make or break. Many designs consider non-humans because they seem important for the design and the people who will eventually use this. (Stern & Kaufmann, 2014; Summers et al., 2012). Humans do thus recognize non-human communities and often take these communities into account when a species beneficial to humans is being threatened. (Groot et al., 2022; Uzunov et al., 2017).

The problem with this view is that currently, humans still put humans in the middle, neglecting many species when designing new futures. The energy transition currently has a large influence on human urban planning systems, and although greenifying the energy system is important, it often reinforces anthropocentric priorities. This risks repeating extractive and exclusionary practices, this time under the guise of sustainability. Non-human entities such as animals, ecosystems, and landscapes are frequently treated as passive backdrops or resources to be managed rather than as active participants in shaping energy futures.

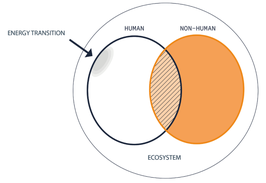


17. *Conceptual framework, Anthropocene*

Phase 2: The shift

Our framework, therefore, combines the human and non-human into one ecosystem. Humans are part of the ecosystem and have an important role in protecting and shaping it. Besides humans having this role, this new framework also aims to give non-human actors the same role, actively participating in design. Practices to make this practically possible include creating advocators for non-humans in design processes that speak for the non-human stakeholders involved or giving rights to non-human communities and entities. (Latour, 2017).

The energy transition in the second phase presses on the ecosystem wherein humans and non-humans are both situated. Besides this transition pressuring spatial justice, because everyone, including non-humans in the ecosystem, should be accounted for, the energy transition is also a power that enables change of the current system. By redesigning something substantial, like an energy transition, you create opportunities to promote justice in an ecosystem.

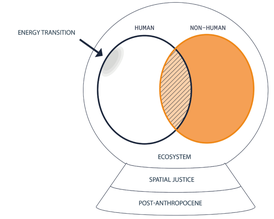


18. *Conceptual framework, shift*

Phase 3: The foundation

This phase adds a substantial theoretical foundation to the framework of spatial justice and the Post-Anthropocene. To create a worldwide system transition in which we uncenter humans and place them in ecosystems, we need a foundation of theories that support this worldview. The Post-Anthropocenic worldview as described in the theoretical framework builds a foundation for this system, as well as a foundation for this particular research.

Spatial justice operates as the critical bridge between ecosystem thinking and the Post-Anthropocenic worldview. While ecosystems emphasize the entanglement of human and non-human agents in shared environments, and the Post-Anthropocene calls for a radical reordering of human centrality, spatial justice ensures that these shifts are grounded in equitable spatial and social arrangements. (Fieuw et al., 2022; Haraway et al., 2016; Soja, 2009). It questions who benefits, who is harmed, and whose voices, human or non-human, are being acknowledged in spatial decisions. In this way, spatial justice enables a redistribution of power and recognition across species, geographies, and temporalities. It creates the ethical and physical space where ecological interdependence can be translated into practice, making it not just a theoretical ideal but a tangible framework for designing futures beyond human dominance. A framework for creating true justice.



19. *Conceptual framework, foundation Feathers & Fuel*

03. METHODOLOGY

CASE STUDY

Port of Rotterdam

The Port of Rotterdam is the largest seaport in Europe and one of the most important logistical and industrial hubs in the world. Located on the North Sea coast, it stretches over 40 kilometers and handles hundreds of millions of tons of cargo each year. It serves as a key gateway for goods entering and leaving Europe, with extensive connections by sea, rail, road, and inland waterways.

Economically, the port plays a crucial role in the Dutch economy. It supports hundreds of thousands of jobs, both directly in the port area and indirectly through logistics, trade, and industry. It is also a major contributor to the country's GDP and a central node in international trade networks. (Port of Rotterdam, n.d.-a).

In terms of energy, the Port of Rotterdam is a critical distribution and processing point. It hosts refineries, chemical plants, and energy terminals and has traditionally been a hub for the import and export of fossil fuels such as oil, coal, and natural gas. Now, as the Netherlands shifts toward renewable energy, the port is becoming a key site for the development and distribution of alternative energy sources like hydrogen and wind power, positioning itself as a front-runner in the energy transition. (Port of Rotterdam, n.d.-a; Porthos, 2023).

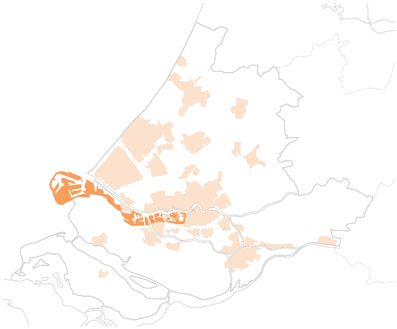
The Port of Rotterdam was an interesting case for this post-anthropogenic research design because the port is currently very human-focused. Redesigning the port for the seagull is challenging because the human interest in the port is high because of its high economic value. (Port of Rotterdam, n.d.-a). The port is a place where ecological, social, and economic interests collide, making it ideal for exploring sustainability challenges, like the challenge of a non-human-inclusive energy transition.

The seagull

The non-human community our spatial design is based around is the community of the Seagull in the Port of Rotterdam. The port of Rotterdam houses the largest population of herring and lesser black-backed gulls in the whole of Europe. (Port of Rotterdam, 2022). The Seagull thus has an important role in the ports' ecosystem, making it one of the most interesting non-human species to research in combination with a big transition in the port.

Besides this, the seagull is an interesting animal due to its remarkable adaptability, intelligence, and social behavior. Often found in coastal and urban environments, seagulls are opportunistic feeders known for their problem-solving skills, such as dropping shellfish from heights to crack them open or stealing food from unsuspecting humans. They are highly social birds that communicate through a variety of vocal calls and body language, often nesting in large, noisy colonies. (Dr. Biology, 2017). Seagulls also form strong pair bonds and exhibit cooperative parenting, sharing responsibilities between mates. (Joanna van der Leun). Their ability to thrive in both natural and human-made environments makes them a compelling species for studying human-nonhuman interactions, especially in dynamic and valuable spaces like cities and ports.

20. *Port of Rotterdam in The Netherlands (Google Earth Pro, 2025)* Scale 1 : 1300000



21. *Port of Rotterdam in the region (Google Earth Pro, 2025)* Scale 1 : 367500

22. *Port of Rotterdam (Google Earth Pro, 2025)* Scale 1 : 125000

Urban fabric

The port of Rotterdam

METHODS

Various approaches

This research is a case study focusing on the needs of seagulls, humans, and the energy transition in the Port of Rotterdam. The research we did was deductive, meaning that we, through taking proper steps, aimed to answer the research question. Because the research question can't be answered by solely relying on one method, we created three sub-questions as a base layer. We've researched these questions using a variety of methods, therefore using a mixed-methods research approach. Figure 23 (the chart with rq+methods) visualizes which methods we have used to answer all relevant sub-questions.

In the analysis, we explain and review all the gathered data from maps, interviews, and literature research. The mixed method approach, in which we have used a variety of data sources and methods, is a valid approach for this design-focused research. It makes use of triangulation by combining insights from literature with insights from spatial data and In-depth interviews with experts. By clearly explaining every step we take in the research process, we aim to improve the replicability of this research paper. This is important because, besides the port of Rotterdam, there are a lot of other spaces undergoing an energy transition and a lot of other non-human communities to implement in the transition plans of these places.

Our design, vision, and strategy are all based on the research we displayed in the analysis. In the discussion, we answered the main research question:

How can we create a strategy for the green energy transition in the Port of Rotterdam, considering non-human species, such as seagulls?

The answer we gave to this question has been based on our vision for the port of Rotterdam and the strategy to achieve this vision in the port. The timeline provides a schedule of how we built up this research through time, visualizing when we talked to certain experts, when we gathered data, and how we, throughout time, used it. (Figure 24).

Research question	Method	Data sources
What are the spatial needs of humans and seagulls?	1. Mapping spatial needs 2. In-depth interview on spatial needs seagull	• GIS Data • Joanna • Jan Putters
Which energy system is spatially and ethically just for humans and seagulls?	1. Literature research 2. Measuring spatial impact of energy sources 3. In-depth interviews with seagull expert and energy experts	• Scientific research on energy sources • Newspapers/media on energy sources • Energy reports • Google earth • Joanna, Lucas, Floris, Willem-Jan
How can the spatial needs of humans, seagulls, and a new energy system be combined in the port of Rotterdam?	1. Layering spatial needs of seagulls, humans and relevant energy sources 2. Mapping conflict zones 3. Creating a vision	• Spatial needs • Just energy mix for humans and seagulls

23. *Method framework Feathers & Fuel*

WEEK 1
Place selection: Port of Rotterdam
Literature research:
- Energy investigation on Port of Rotterdam
- Communities in and around the port

WEEK 2
Field trip to the port of Rotterdam
Literature research:
- Energy investigation on Port of Rotterdam
- Communities in and around the port

(GIS)Data gathering:
- Energy system in the port

In-depth interview with Julia
- Justice
- Post-Antropocene
- non-human

WEEK 3
Picking a community: Seagull
Literature research:
- Seagull needs
- Human needs
- Energy needs

(GIS)Data gathering:
- Seagull needs
- Human needs
- Energy needs

In-depth interview with Joanna
- Seagull needs and behaviour

WEEK 4
Layering maps
- Seagull needs
- Human needs
- Energy needs

Mapping conflicts in the port
Literature research:
- Just energy sources

WEEK 5
Literature research:
- Just energy sources

Creating a vision based on just energy sources and conflict map
Midterm presentation

WEEK 6
Literature research
- Stakeholders
- Policies

Mapping stakeholders and their interests

WEEK 7
Excursion to the Maasvlakte
- Presentation about energy and CCS in the Port of Rotterdam

Revise the vision using newly gained information
Schedule for the strategy done

WEEK 8
Zoom in to differen stategy projects
Create a storyline for the stategy
Literature research:
- Zoom into rangers for the final presentation

WEEK 9
Group reflection
Individual reflection
Finishing the paper
Final paper deadline
Final presentation

WEEK 10
Online exhibition
Peerreview

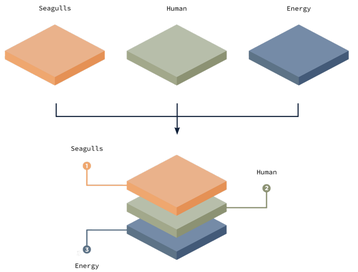
24. *Project timeline Feathers & Fuel*

1. Layering

A substantial part of the analysis is presenting spatial data on seagulls, humans, and energy systems in the port and the Netherlands. These maps will show the spatial needs of the three categories and, therefore, will also provide an answer to the sub-question: **What are the spatial needs of humans and seagulls?** The spatial needs of the seagull are shown in orange, the ones of humans in green, and the spatial needs of energy systems in blue.

Layering these maps on top of each other provides the answer to the sub-question: **How can the spatial needs of humans, seagulls, and a new energy system be combined in the Port of Rotterdam?**

This approach allows us to visualize and analyze how different needs intersect and potentially conflict, such as where energy infrastructure expansion might disrupt crucial nesting zones or where industrial areas could make space for green areas where seagulls thrive. Layering these maps enables a more inclusive and multi-species understanding of the transition, supporting decisions that consider both spatial justice for humans and non-human inhabitants like seagulls. It also provides a transparent and adaptable framework to guide iterative planning as conditions, data, and priorities evolve throughout the transition.



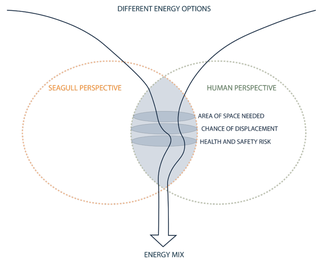
25. *Layering the seagull, human and energy*

2. Spatial justice discussion

We have created a framework to structure our process in finding the answer to the sub-question: **Which energy system is spatially and ethically just for humans and seagulls?** (Figure 27).
The figure implies that there are a lot of different options for energy production, from which there are multiple ones that are green. For our vision, we have created a mix of energy production systems. This mix is based on the perspectives of seagulls and humans. The great supply of options is, therefore, filtered through a system that keeps in mind seagulls' and humans' perspectives. The overlapping area in the center highlights shared concerns of humans and seagulls, through which the energy is tested to be just.

- **Area of space needed**: Both species require territory, whether for nesting or working/industrial activity.
- **Chance of displacement**: Energy infrastructure can push the communities out of their habitat or workspaces.
- **Health and safety risk**: Includes risks like pollution, noise, and safety hazards from new energy systems.

The energy mix that came out of this analysis provides a base for the design of the ports' vision and strategy.



26. *Energy mix filter framework*

3. Advisory board

All the experts we consulted will, on the next pages, be introduced as our advisory board. We have used experts to gain a deeper understanding of the Port of Rotterdam, the energy transition, and the behavior of seagulls. Specific information on these topics was often not available freely online or in libraries. These experts, therefore, allowed us to have in-depth conversations on the subjects necessary for our research.

Prior to publication, we asked for their permission to be acknowledged by name, to which they agreed. Their willingness to be cited reflects a shared commitment to the transparency and credibility of this research. By including their names, we aim to recognize their contributions while also reinforcing the collaborative and interdisciplinary nature of our approach to the energy transition in the Port of Rotterdam.

ADVISORY BOARD

Post-Anthropocene | *Julia Schasfoort*

Julia Schasfort is a graduate student from the TU Delft department of Urbanism. In her graduation she focuses on the non-human body of the River Muse. Through the practice of embodiment; cycling alongside the river, participating in river cleanups, interviewing actors stationed alongside the river and more actions, she is becoming an expert on the topic of designing with, and for a non-human. Knowing a lot about posthumanism theory, how to pragmatize it and more specific; right to nature, she is an important advisor and teacher. She has played a key role in the start of the project, educating the group about the key principles of posthumanism and spatial justice. She did so by explaining some basic concepts that are often used in posthuman/non-human theories and showing examples from projects that are built on this philosophy.

Seagulls | *Joanna van der Leun*

Joanna van der Leun is a former graduate from the TU Delft department of Industrial Design. Her graduation project was focused on the creation of nesting hubs for Black-Backed Gulls. The project became so successful that she is currently working together with the Dutch bird conservation institute to spread her design, allowing more nesting places for the gulls. Throughout these last years she became a huge seagull expert. As her research was focussed on the nesting of the bird. She has a lot of knowledge about the behaviour of the bird and the social relations between the birds. This knowledge has added a lot to the project adding a social approach to the spatial one. By sharing her knowledge, the group has gained a more extensive and deeper understanding of the seagull.

Seagulls & Port of Rotterdam | *Jan Putters & Lissethe Veenstra*

To gain insight into the perspective of the Port of Rotterdam on non-humans (specifically the seagull) an online interview was conducted with Jan Putters and Lissethe Veenstra.

Jan Putters has been working as a Senior Asset Manager Infrastructure at the Port of Rotterdam Authority for 18 years. He is responsible for the management and organization of the area, particularly the land within the port. His team manages public space, leasable land, and buffer zones. Jan has extensive knowledge of the flora and fauna in the Rotterdam port area and is very familiar with the seagull population.
Lissethe Veenstra has been working at the Port of Rotterdam for 1.5 years as a biologist/herpetologist and supports Jan Putters in his work with her knowledge about the flora and fauna.

The interview covered the following themes:
- Their views on the energy transition and wind farms
- The seagull in the port area:
    - Life cycle
    - Food sources
    - Environmental pressures
- Future plans for the Slufter

After the interview, they sent several documents outlining plans concerning the seagull in the Port of Rotterdam. These, along with a summary of the interview, can be found in the '*appendix*'.

Energy & port of Rotterdam | *Lucas de Graaf, Porthos*

To gain a better understanding of the developments taking place in the Port of Rotterdam regarding the energy transition, we participated in an excursion organized by 'AllEnergyDay'.

This excursion focused on the Porthos project, which involves capturing CO_2 directly at the source (refineries and factories in the Port of Rotterdam) and transporting it via pipelines to be stored under pressure beneath the North Sea in an empty gas field.

Lucas de Graaf, who works at Porthos, gave us a comprehensive presentation on how this complicated project works. He discussed the stakeholders involved, the project's vision, and how this vision was translated into a strategy, ultimately leading to the realization of the project by 2026.

As part of the excursion, we also visited the pipelines and the construction site of the future compression station. All in all, it was an insightful and engaging excursion, where we particularly gained valuable perspectives on the human side of the energy transition.

Energy & port of Rotterdam | *Friso Resink, Gasunie*

The Porthos Project is a collaborative initiative between the government-owned companies Gasunie, EBN, and the Port of Rotterdam.

During our visit, Friso Resink provided deeper insight into Gasunie's past and current activities. Gasunie, a Dutch state-owned enterprise established in 1963, is responsible for managing and maintaining the infrastructure for large-scale transport and storage of natural gas in both the Netherlands and northern Germany. It oversees a network of over 12,000 kilometers of pipelines, ensuring safe and efficient gas transmission.

Today, however, Gasunie is increasingly focused on driving the Netherlands' energy transition. In addition to its role in Porthos, the company is also involved in projects like WarmtelinQ, which transports waste heat to residential areas, and the development of a national hydrogen network. This session gave us clearer insight into what is practically achievable, and Friso helped explain and contextualize plans we had previously encountered during our own research.

Energy & port of Rotterdam | *Willem-Jan Plug, EBN*

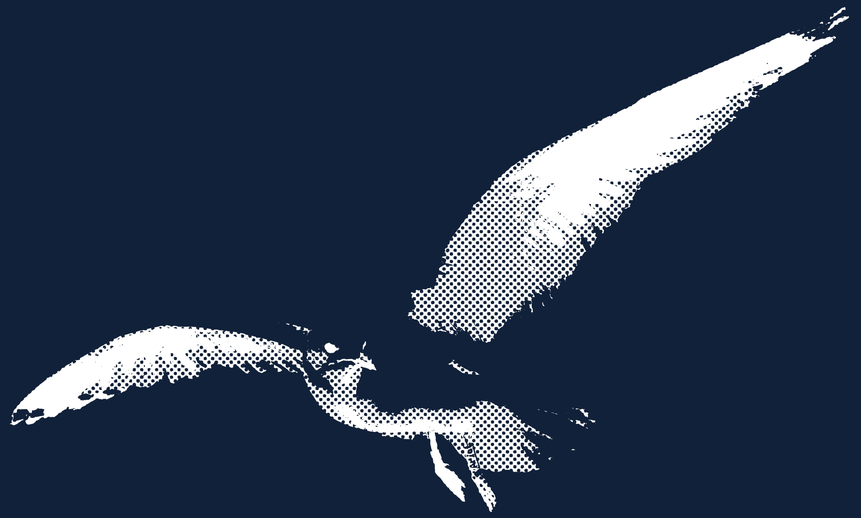
The last professional presenting at the excursion was Willem-Jan from EBN (Energie Beheer Nederland). Energie Beheer Nederland (EBN) is a Dutch state-owned energy company dedicated to ensuring a reliable, affordable, and sustainable energy supply. Established to invest in oil and gas projects, EBN now focuses on facilitating the energy transition through initiatives in sustainable gas systems, heat transitions, and responsible carbon storage. Because of this new focus on the energy transition the EBN is now hiring a lot of new employees.

When Willem-Jan talked about project Porthos he also mentioned how the oil/gas drilling platforms need to be transformed into pumping platforms. Due to these new platforms, it will be possible to fill up the empty gas fields with CO2.

How to recognise advise:

'**Joanna van der Leun** *has stated that seagulls have monogamous relationships*'

04.
ANALYSIS



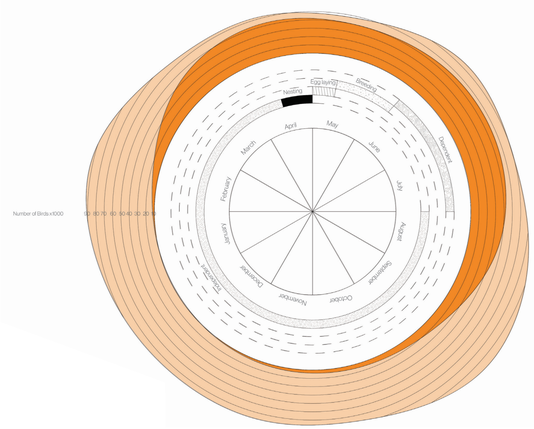
SEAGULL

The Seagull is the largest non-human population in the harbor. It is taken as an exemplary species to show the possible approaches while working with non-humans. The bird is using the land, sea, and air as its habitat. Seagulls, by humans often seen as annoying and always with too many, are a threatened species. Their numbers have been declining over the last years (Faunabeheerplan Vos Zuid-Holland, 2023). Therefore, the seagull needs nurturing and preservation.

This chapter will give an overview of the spatial elements and areas that are of importance for Seagull use. The chapter ends with a map in which all spatial analyses are overlapped, giving an idea of Seagull activity and needs in the port of Rotterdam.

04. ANALYSIS

LIFECYCLE



27. *Lifecycle Black-Backed Gull and Harring Gull ((Watervogels in Nederland 2021/2022, 2024)*

The diagram above represents the lifecycle of the Black-Backed Gull and the Herring Gull. Both species are considered as they are both living in the Rotterdam Port. The Black-Backed Gull is migratory and, therefore, its numbers decrease in the winter seasons. The Herring Gull isn't, keeping its number reasonably constant. The Gulls share their behavioral patterns in the spring and summer seasons. Beginning in April, the birds start building their nest. This takes approximately 3-4 weeks. When the nest is ready, the bird needs 1-2 weeks to lay 2-3 eggs. Breeding takes 3-4 weeks, whereafter the babies are still depending on their parents for 5-7 weeks (Hornman et al., 2022)

Black-Backed Gull | *migatory*

Harring Gull | *not migratory*

28. *Migration routes gulls, Europe (Bird Migration Atlas, 2025), (Bird Migration Atlas, 2025-b)*

Scale 1 : 16350000

Migration routes | *Europe*

The Lesser Black-Backed Gull, as you can see above, migrates through the whole of Europe and beyond. There are large gull colonies in the South of Scandinavia, especially Norway, crossing the Netherlands while migrating to the South of Spain, Portugal, and Morocco. The Gull colony in Finland mainly migrated to Palestine/Israel. If we zoom in on the birds migrating from the Netherlands, we see that most birds go to the north of France, the middle of Germany, and the south of England (Bird Migration Atlas, 2025).

Harring Gull

Black-Backed Gull

Migration in contact with the Netherlands

29. *Breeding spots, national (Sovon Vogelonderzoek Nederland, 2025), (Sovon Vogelonderzoek Nederland, 2025-b)*

Scale 1 : 1300000

Breeding spots | *National*

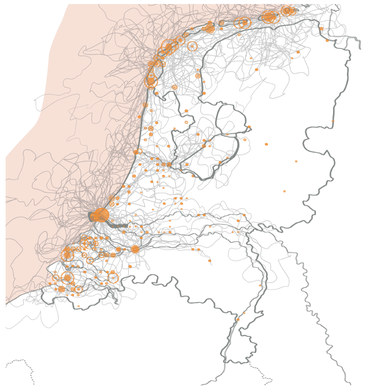
The biggest seagull colony in the Netherlands is situated in the harbor of Rotterdam. Another preferred habitat is the Wadden Islands, home to a high number of Herring Gulls. On the national scale, you can see that the birds have a huge preference for the coast, as most and biggest colonies are situated alongside the Dutch coastline. Nevertheless, some colonies settled more inland. They are smaller due to fewer of their primary food source, fish. Previously, there used to be a big colony close to Den Haag. The rise in the number of foxes forced the birds to leave, migrating primarily to the Rotterdam Port (Faunabeheerplan Vos Zuid-Holland, 2023)

Black-Backed Gull (2021-23)

- < 150
- 1 500
- 3 000
- 7 500
- 15 000

Herring Gull (2021-23)

- <20
- 200
- 400
- 1 000
- 2 000



30. *Flight paths, national (Tracking Movements Of Gulls - NIOZ, 2025)*

Scale 1 : 1300000

Flight paths | *National*

To grasp the flighscape of the gulls, we used seagull tracking data (Tracking Movements Of Gulls - NIOZ, 2025) and video art made of gull flight patterns (Fessenden, 2015) to create an impression of the landscape as interpreted by seagulls. Knowing that gulls have a flight range of 100km (Vogelbescherming Nederland, n.d.), the 100km zone covering the North Sea is part of their domain. This information will be referred to later in this report when speaking about energy choices.

Flying patterns

100 km radius

Black-Backed Gull (2021-23)

- < 150
- 1 500
- 3 000
- 7 500
- 15 000

Herring Gull (2021-23)

- <20
- 200
- 400
- 1 000
- 2 000

Orthographic lift

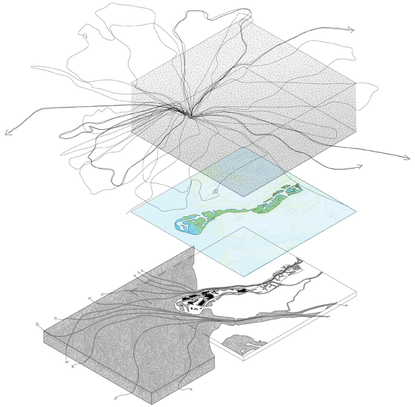
Although Seagull flight movements might seem random, research into orthographic lift and the gulls' flight patterns show that these smart animals fly according to thought-through routes. Arguing that human interpretation of their movement, being random and chaotic, is rather based on a knowledge gap than on truth.

To dive a bit into depth, orthographic lift is the phenomenon where air gets pushed upward by elements in the landscape. Often occurring examples of these elements are dykes, buildings or tree lines. This upward pressure slightly lifts everything that is hovering above. Seagulls use these lifts particularly when they are flying at low altitudes. (Sage et al. 2019). Researchers manage to identify this correlation when tracking flight patterns. "These gulls do not take the most direct route between their colony and flight destinations, but follow repeated routes, converging upon paths which follow landscape structures." (Sage et al. 2019). This is important while creating a vision and strategy for the seagull as "In highly anthropogenic landscapes which have been subject to much human alteration, even small changes to land cover alter the atmospheric resources available to volant species and by extension the energy landscape in which they move. Landscape structure directly impacts the strength and distribution of orthographic lift, which forms part of the energy landscape, and impacts landscape connectivity for soaring birds" (Sage et al. 2019). Important to note that this lift should be taken into account from the ground until 25m in height. When going higher than 25m, the orthographic lift is negligible, and the bird uses thermal convection.

Scale 1 : 125000

32. *Orthographic lift by landscape, map harbour of Rotterdam (Actueel Hoogtebestand Nederland, 2025)*

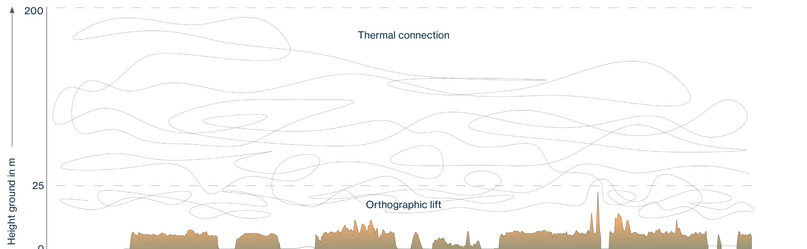
Landscape 0+ up to 25 m



31. *Flying patterns: air, land, water (Orthographic lift shapes flight routes of gulls in virtually flat landscapes, 2019)*

'Joanna van der Leun stated that currently some people have the full time job removing seagull nesting. As long as there is no bird breeding on the nest, this is allowed.'

'Joanna van der Leun stated that the location of the breeding spot of the seagulls is really important because it brings a couple back to each other every year'



33. *Orthographic lift, section harbour of Rotterdam (Google Earth Pro, 2025)*

34. *Breeding spots, Rotterdam (Faunabeheerplan Vos Zuid-Holland 2024-2031, 2023)*

Scale 1 : 125000

Breeding spots | *Regional*

The biggest seagull colony in the Netherlands is situated in the harbor of Rotterdam. Another preferred habitat is the Wadden Islands, home to a high number of Herring Gulls. On the national scale, you can see that the birds have a huge preference for the coast, as most and biggest colonies are situated alongside the Dutch coastline. Nevertheless, some colonies settled more inland. They are smaller due to fewer of their primary food source, fish. Previously, there used to be a big colony close to Den Haag. The rise in the number of foxes forced the birds to leave, migrating primarily to the Rotterdam Port (Faunabeheerplan Vos Zuid-Holland, 2023)

Breeding spots

35. *Food source, Rotterdam (Vogelbescherming Nederland. (z.d.). Kleine mantelmeeuw. Vogelbescherming), (Vogelbescherming Nederland. (z.d.-b). Zilvermeeuw) (Urban Metabolism Rotterdam,2014)*

Scale 1 : 125000

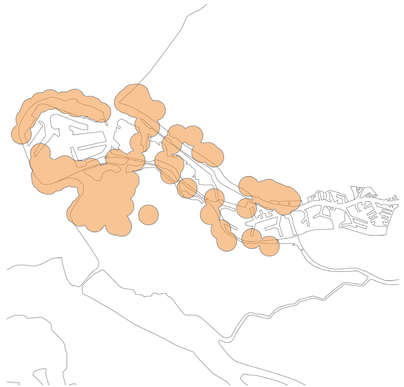
Food source | *Migrating fish*

The seagulls' main food source is fish. The Black-Backed Gull eats shellfish, small fish, bird eggs and chicks, rodents, and berries. The bird searches for food on foot but also flies after trawlers and pecks fish out of the surface water (Vogelbescherming Nederland, n.d.). The Herring Gull is an omnivore. They eat seafood, fish, and shellfish, but also like human food scraps: chips, bread, carrion, eggs, and chicks of other shorebirds. The Herring Gull searches for food in groups. Following phishing boats, they pick a meal from ploughed fields or visit rubbish dumps (Vogelbescherming Nederland, n.d.). The reduction of human waste is, therefore, also one of the reasons that Herring Gull numbers are declining (Arts and Janse, 2021). At the moment, the two most important food sources are the migrating fish populations (Frijters, 2014) and the agricultural lands surrounding the area.

Fish migration lines

Fish migration movement

Agriculture



36. *Predator, Rotterdam (Faunabeheerplan Vos Zuid-Holland 2024-2031, 2023)*

Scale 1 : 125000

Predator | *Fox*

The seagull has a few natural predators, but the one that is currently very threatening in the port area is the fox. Until the 1960s, the fox occurred exclusively in the east and center of the Netherlands. Since the 1970s, the fox expanded westward, resulting in a large population in the harbor (Faunabeheerplan Vos Zuid-Holland 2024-2031, 2023). "Foxes are real killers; they kill a large amount of prey, eating only a few of them"(Jan Putters). As the seagulls breed on the ground, an accessible place for the foxes, they become an easy target. To protect the gulls and other species, Port authorities are shooting foxes, reducing their numbers. By implementing fences, the authorities also try to create safe spaces for gulls to breed (Faunabeheerplan Vos Zuid-Holland, 2023).

Territory fox

> 'Jan Putters stated that Foxes are real killers; they kill a large amount of prey, eating only a few of them'

SEAGULL SPATIAL NEEDS

Summary of requirements

Overlapping the data, collected from the seagull, the following map is created as a summary of the previously discussed elements. It showcast the most important spatial aspects for the seagulls. These elements should be considered when comparing the needs of the seagulls with those of humans and of the energy transition.

Listing the following elements:
- Breeding spaces
- Fish migration
- Agriculture
- Predator territory (fox)
- Orthographic lift

Breeding spaces
The larges breeding spaces are situated on the Maasvlakte and at the Europoort. All breeding spaces host Black-Backed Gulls as well as Herring Gulls. The Black-Backed Gull is most occurent in all breeding spaces.

Fish migration
Fish species migrate from the river to the sea and the other way around ((Urban Metabolism Rotterdam, 2014). Therefore the estuary is the perfect hunting ground for fish eaters like the Seagull.

Archiculture
Mainly the Herring Gull profits from agriculture. The ploughed fields offer a source of worms, rich in nutrients.

Predator territory
The foxes are currently with such high numbers that they have been sighted all over the harbor (Faunabeheerplan Vos Zuid-Holland, 2023). The Fox's hunting ground depends on the availability of food. The radius in the map has been based on fox sightings and the approximate range of their territory; 300 hectares (Zoogdier vereniging,n.d.). We have chosen to use a slightly big range, to show the possible impact of the animal.Therefore, there are no free fox-zones at the moment with exception of some of the part of the Maasvlakte.

Orthographic lift
The Orthographic lift is based on a height map of Rotterdam (Actueel Hoogtebestand Nederland, n.d.) It is mainly found at the dyk surrounding the slufter, at the dunes and at the largest industrial complexes.

37. *Seagull spatial needs (Vogelbescherming Nederland. (z.d.-b)), (Actueel Hoogtebestand Nederland, 2025), (Urban Metabolism Rotterdam, 2014) (Faunabeheerplan Vos Zuid-Holland 2024-2031,2023), (Zoogdier vereniging,z.d.)*

Breeding places

Landscape 0+ up to 25 m

Fish migration movement

Agriculture

Territory fox

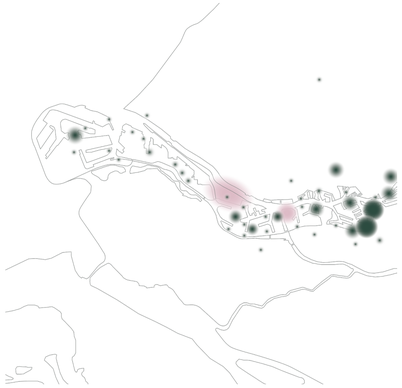
Scale 1 : 125000

HUMAN

We, human beings, are a species with specific spatial needs. Humans need certain spatial aspects to survive, like clean air and housing. Humans benefit from leisure activities and social well-being, which often demand space as well. Spaces often get designed in a way that they offer the most, or the most important, affordances for groups and people in power. However, current designs are made more inclusive, meaning that everyone should benefit equally from spatial designs and everyone should have the same affordances in space. (Clarkson & and Coleman, 2010). Humans tend to shape spaces in the way that humans most benefit from these spaces. But paradoxically, these processes often damage the space or the spaces around them, often resulting in even worse living conditions for the human species. (Stern & Kaufmann, 2014).

In this chapter, we show our spatial analysis of space used for human purposes and the spatial implications of this human-focused use. The chapter ends with a map in which all spatial analyses are overlapped, giving an idea of human activity and human needs in the port of Rotterdam.

ROUTINE



38. *Business density, Rotterdam (Urban Metabolism Rotterdam, 2014)* Scale 1 : 125000

Business density | *Regional*

Mapping humans in the port of Rotterdam is most efficient by looking at current business activity there. The port currently doesn't contain much residential space. Except for two small villages there, Pernis and Rozenburg, not many people live in the rest of the area. The human activity that happens in the port is mostly by people at work because the port has a total employee count of 385,000. (Port of Rotterdam, n.d.-a). In Figure 38, we have mapped the areas in which the most business activities take place. As becomes clear from the map, the main hotspot of businesses is concentrated in the eastside of the port, relatively close to the city of Rotterdam. The rest of the businesses, and thus human activities, are scattered quite evenly through the rest of the port area.

The businesses in the port are of massive importance for the Dutch economy, as the port of Rotterdam has an added value of 45.6 billion euros. This represents 6.2% of the GDP of the Netherlands. (Port of Rotterdam, n.d.-a). One of the most vital spatial needs of the port of Rotterdam from a human perspective is currently its business value. We will consider this in the vision for the future port.

- Low density (1-2)
- Medium density (3-5)
- High density (5+)
- Residential area

39. *Green structures, Rotterdam (ESRI, 2025)* Scale 1 : 125000

Green structures | *Regional*

Figure 39 shows a map of the green spaces in the port and its hinterlands. It shows farmland in the lightest shade of green, and recreational green areas and forests are highlighted by the darker shades. The largest area of the port lacks any form of human accessible green structures. Green spaces in urban and suburban regions prove to be of great importance for the well-being of humans, as these improve community bonds and individual health. (Arnberger & Eder, 2012; de Vries et al., 2003; Tzoulas et al., 2007). The absence of good quality and accessible green spaces thus forms a problem for the well-being of the people working in the port.

- Forest
- Recreational green
- Farm land

STRESSORS

40. *Soil pollution, Rotterdam (ESRI, 2025)* Scale 1 : 125000

Soil pollution | *Regional*

The soil in the harbor is polluted in different areas. As Figure 40 shows, there is little soil pollution in the east side of the port. The Slufter, a highly polluted lake in the east of the port also shows to have soil pollution. The darker area in the middle of the map shows the place where the oil industry of the port is situated currently. Oil giants like Shell and ExxonMobil own a lot of industries in that area. (Port of Rotterdam, 2021). Other industries don't pollute the soil in a significant way.

Even though human activities cause the polluted soil in the harbor, humans also suffer from this polluted soil. Humans might be exposed to health risks due to the ingestion of the pollutants residing in the soil. (Rodrigues & Römkens, 2018; Singh & Singh, 2020). Therefore, it's crucial to take the pollution of the soil into account when rearranging the polluted areas of the port of Rotterdam.

- Highly polluted
- Moderately polluted
- Low polluted
- Very low polluted
- Clean

41. *Air pollution, Rotterdam (ESRI, 2025)* Scale 1 : 125000

Air pollution | *Regional*

Besides the pollution of the soil, the industries in the port also pollute the air on a massive scale. Figure 41 shows the areas in the port with a large concentration of particulate matter in the air. Particulate matter is microscopic pieces of dust that enter the air as a byproduct of many industries. PM10 includes all particles smaller than 10 micrometers, and PM2.5 includes all particles smaller than 2.5 micrometers.

PM10, when inhaled by a human being, can penetrate the upper airways. PM2.5 can reach the deeper airways, and some really fine dust can penetrate the alveoli and be absorbed into the bloodstream. (Brook et al., 2010). A strong positive relationship between the amount of particulate matter and health issues in the corresponding area is present. (Sosa et al., 2017). Literature has shown that the number of casualties caused by the joint effects of air pollution is estimated to be up to 4.2 million yearly. (WHO, 2024).

- Particultate matter 2.5
- Particultate matter 10

42. *Heat stress, Rotterdam (ESRI, 2025)* Scale 1 : 125000

Heat stress | *Regional*

In this map (Figure 42), the perceived temperature has been used to map the areas where the temperature is being perceived as hot and where it is perceived as cold by human beings in the area. As becomes clear from the dark grey color of the port, the whole port is perceived as an area where the heat stress is extreme. During heat peaks, the heat in the port is mainly perceived between 46°C and 50°. An increase in temperature arises when there is a lack of greenery or water in an area. (Butters, 2018). The port of Rotterdam contains a lot of water but almost no green structures as shown before.
Heat is a natural hazard and can have immense impacts on the human body when exposed to it. Too much exposure to high temperatures can cause heat stroke, heat exhaustion, heat syncope, and heat cramps. (Kovats & Hajat, 2008). This is a significant problem in the port, as many workers perform physically demanding tasks in outdoor environments with limited shade and ventilation. (Port of Rotterdam, n.d.-a) The combination of high temperatures, heavy labor, and heat-absorbing surfaces, such as concrete and metal structures, can increase the risk of heat-related illnesses.

- 46-50 (extreme heat stress)
- 44-45 (extreme heat stress)
- 42-43 (extreme heat stress)
- 40-41 (extreme heat stress)
- 34-39
- Port of Rotterdam

NEW POSITIONS

Port Workers | 385.000

Container Worker	Shipping Worker	Mechanic	Construction Worker	Researcher	Management	Factory Worker
Terminal Operator	**Stevedore**	**Technical Maintenance**	**Built Environment**	**Innovation**	**Logistics & Operations**	**Port-based industries**
Tasks • (Un-)loading containers • Operating cranes or forklifts • Checking shipments	**Tasks** • Handling cargo • Securing ships • (Un-)loading vessels	**Tasks** • Repairing equipment • Preventive maintenance • Troubleshooting	**Tasks** • Building or repairing port infrastructure • Welding • Concrete work	**Tasks** • Conducting studies • Developing innovative port tech • Environmental monitoring	**Tasks** • Overseeing teams • Ensuring efficiency • Managing budgets and planning	**Tasks** • Operating machinery • Assembly • Monitoring production lines
Skills & Qualifications • Forklift or crane operation license • Basic logistics knowledge • Physical fitness and stamina • Safety awareness (VCA certificate required) • Strong Teamwork and communication skills • Willingness to work (night) shifts	**Skills & Qualifications** • Physical strength and endurance • Safety training and procedure knowledge (VCA certificate required) • Good hand-eye coordination • Ability to work in all weather conditions • Strong communication skills • Experience with ropes, winches, mooring equipment (for some roles)	**Skills & Qualifications** • MBO in Mechatronics, Mechanical/ Electrical Engineering • Diagnostic and repair skills • Knowledge of hydraulic/ pneumatic systems • Safety training and procedure knowledge (VCA certificate required) • Experience with marine or heavy industrial equipment is gladly seen • Problem-solving mindset	**Skills & Qualifications** • Construction experience or vocational training (Bouwkunde or MBO-level) • Ability to read technical drawings • Use of tools and machinery • VCA certification required • Physical fitness • Basic math and measurement skills	**Skills & Qualifications** • University degree in relevant field (e.g., logistics, engineering) • Analytical and critical thinking • Report writing and data analysis • Familiarity with simulation tools, GIS, or modeling software • Communication and presentation skills • Knowledge of port operations is gladly seen	**Skills & Qualifications** • University degree in Business, Logistics or Maritime Studies • Leadership and decision-making • Strategic thinking and planning • Strong communication skills and people management • Familiarity with port logistics and international trade • Project management skills (e.g., Lean Six Sigma)	**Skills & Qualifications** • Basic technical or vocational training (MBO level) • Machinery operation skills • Safety awareness (VCA; HACCP if food-related) • Teamwork and reliability • Quality control knowledge • Willingness to work shifts

HUMAN SPATIAL NEEDS

Summary of requirements

Overlapping the data collected from the human, the following map is created. As a summary of the previously discussed elements, it showcast the most important spatial aspects for humans. These elements should be considered when cmoparing the needs of humans with those of the seagulls and the energy transition.

Listing the following elements:
- Heat stress
- Polluted soil
- Residential areas
- Business density
- Air pollution
- Greenery

Heat stress
The whole port is analysed to have extreme heat stress. Perceived temperature can rise to 46 till 50 degrees. This heat stress is caused by the lack of green structures. Port workers suffer from the heat and possibly health issues that it is causing.

Polluted soil
The most polluted soil in the harbor is located at the Botlek and the Slufter. The Slufter is currently used for the dump of polluted river dredged sludge (after a few years the Slufter will be filled and it is planned to give the seagulls more space there - Jan Putters). The Botlek is home to polluting fossil fuel industries.

Residential areas
The port contains only two residential areas, the majority of space is used for industries. The residential areas are Rozenburg and Pernis. Currently the neighborhoods are oasis within the industrial structure. Separated from the industries by wide green buffer zones.

Business density
Major human activity in the port comes from the businesses. The total count of employees in the harbor is 385,000 (port of Rotterdam, n.d. -a). Most businesses are concentrated in the eastside of the port, close to the city of Rotterdam.

Air pollution
The air in the harbor contains large concentrations of particulate matter smaller than 10 micrometers and 2,5 micrometers. This air pollution is causing health issues infiltrating human airways and bloodstreams.

Greenery
Non-human vegetative species are almost non-existing within the harbor although their presence is of great importance for human wellbeing.

43. *Human spatial needs*

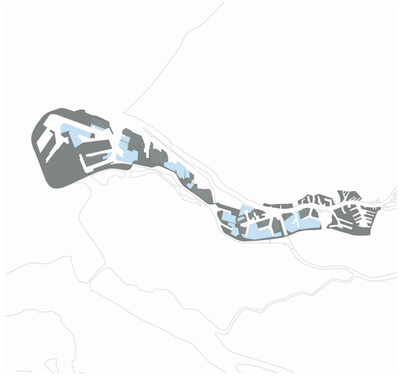
ENERGY

The Port of Rotterdam is responsible for approximately 14% of the total CO_2 emissions in the Netherlands (Wikipedia, 2024). This striking figure highlights the immense energy demands of the port and its surrounding areas. As such, understanding the national and regional strategies for energy transition is essential, especially in regions where heavy industry is concentrated.

However, current energy policies and visions tend to focus primarily on human-centered needs, often overlooking the perspective of non-human actors and ecosystems. To address this gap, this chapter also considers the concept of spatial justice in relation to energy sources, questioning who benefits, who bears the burden, and what environmental trade-offs are made.

From this perspective, we explore a new energy mix—one that not only meets human needs but also respects ecological systems. This reimagined approach forms the foundation for our proposed vision for the future energy landscape of the Port of Rotterdam.

44. *Industries, National (Wikipedia-bijdragers, 2024)* Scale 1 : 1300000



45. *Industries, Regional (Rotterdam Port Area, w.d.)* Scale 1 : 125000

Industries | *National*

Illustrated above is the distribution of the largest industry areas and cities with industries in the Netherlands. The industry is considered to be of medium size when compared to the largest industries in Europe. The most common industries in the Netherlands are food processing, chemicals, oil refining and the manufacture of electrical equipment (Wikipedia-bijdragers, 2024).
The geographical distribution of these industries is mainly concentrated around cities and bodies of water such as the North Sea and major rivers.

Fossil fuel industries | *Regional*

Currently a major part of the port is used for fossil fuel industries. The map above shows the sites that are currently in use for either fossil fuel storage; dry storage like coals and wet storage like oil, or fossil fuel processing; chemical industries and refineries (Port of Rotterdam, n.d.). We are aware that the chemical industries are not used for the fossil fuel industry only, nevertheless, they play a part in the chain and are therefore as a whole, visualized. The main sides claimed by the fossil industry are the Botlek; containing refineries, dry and wet storage and the Europoort mainly hosting dry and wet storage but also giving some space to refineries and chemical industries. Fossil fuel industries that are currently stationed in the harbor are among others, are world leaders; Shell and ExxonMobil.

Industry areas

Wet bulk

Dry bulk

Refineries/chemicals

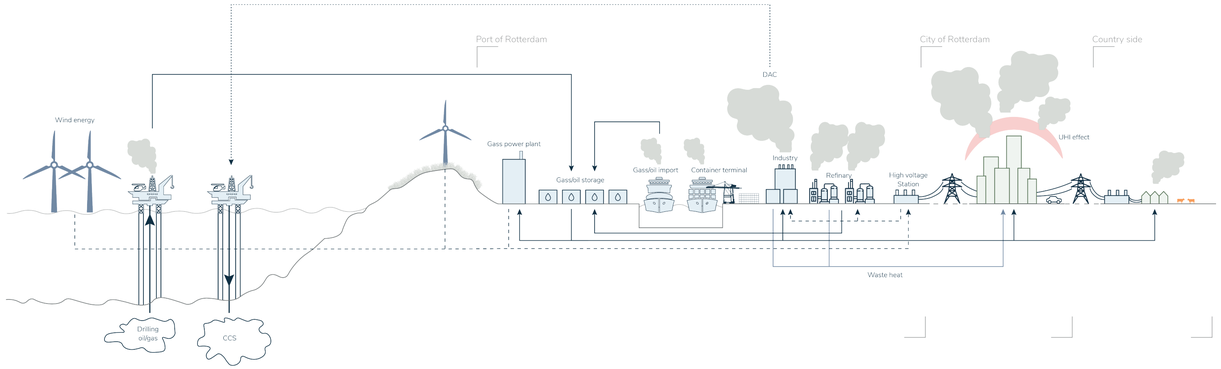
Industries through the landscape

The Port of Rotterdam plays a crucial role in the production and import of energy that is consequently consumed by industries and citizens of the Netherlands. Only a small part of this energy mix is non-emitting. Most of the harbor space currently consists of industries that rely on fossil fuels like coal, gas, and oil. The North Sea plays a significant role in the current energy mix because, besides the wind turbines at sea, the North Sea also provides drill platforms that extract gas out of the ground. Empty gas fields will, from 2026 onwards, be used to store CO2 emissions from companies in the port. (Porthos, 2023). However, this project will only be able to capture 10% of the port's emissions.

After the fossil fuels arrive in the harbor, they're stored there, used for industry, and broken down in refineries. In the end, the energy is consumed by different actors in and outside the port. For example, for the heating of buildings, chemical processes of industries, and as fuel for trucks, ships, and cars, importing and exporting various goods and people. Surrounding cities and villages benefit from this industry because the energy produced in the port provides residential heating and electricity.

This system is spatially unjust because the port and its companies emit a lot of CO2, which not every stakeholder benefits equally from. The industrial companies in the port financially benefit the most from this use of fossil fuels, while residents of nearby villages suffer from health issues caused by air pollution. Fossil fuels, thus, are a spatially unjust source of energy. When transitioning to a new energy mix, this spatial injustice should be tackled. We aim to distribute the harbors' public goods as equally as possible between different human communities, as well as non-humans. This implies that the space in the harbor should be available for human and non-human activities while providing a green energy source for the industries and citizens of the Netherlands.

As shown in the section, with the current port industry, the city of Rotterdam suffers from an Urban Heat Island effect. This means that due to the concretization of the city and its hinterlands, including the port of Rotterdam, the temperatures in the city have increased. By implementing more green space in the port and the city, this effect will decline. Besides offering potential living conditions for animal life, this green space also improves the living conditions for city residents by lowering urban heat stress. Implementing a new energy system could provide an opportunity to solve this problem. By producing energy more efficiently and in a smaller area than the current system does, freed-up space can be used to bring greenery back into the port.



46. *Current situation, Section*

Electricity

Waste heat

CO2

Oil/Gass

ENERGY 2050

PBL STATUS QUO

Global corporations scenario

The PBL is a Dutch government agency that conducts strategic policy analysis in the fields of environment, nature, and spatial planning. It provides independent advice to the Dutch government to support sustainable development.

In 2023, the PBL published the report Spatial Exploration 2023, which outlines four scenarios for how the Netherlands could evolve by 2050. These scenarios are:

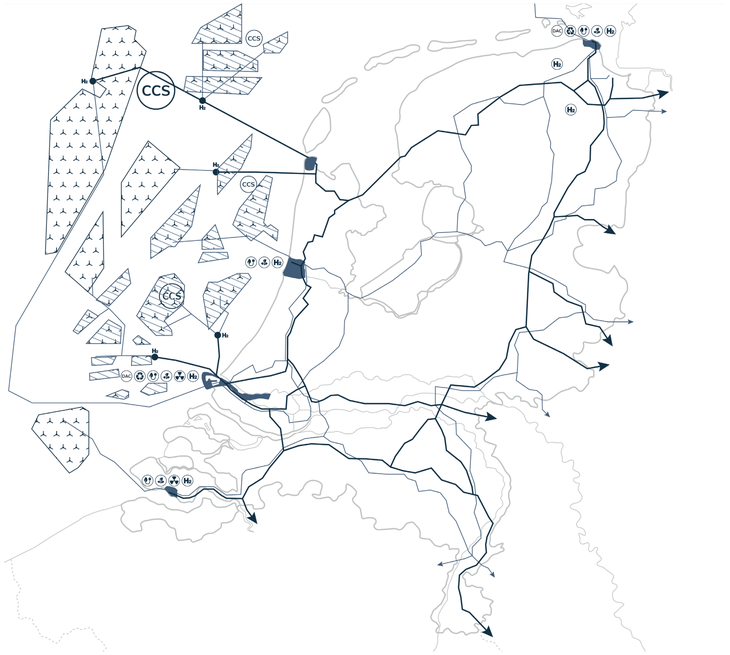
- Global corporations
- Fast World
- Green Land
- Regionally Rooted

From these four, we chose the most extreme scenario: Global Corporations, where humans dominate nature and significant inequality may emerge. This scenario is based on an individualistic society focused on global markets, technological progress, and economic growth.

The map on the right shows only the energy layer of the Global Corporation scenario. It highlights that the North Sea is heavily utilized for energy production, especially wind and solar energy. Additionally, a vast hydrogen network is established within the Netherlands, connecting major industrial areas and exporting hydrogen abroad.
For the main industrial coastal regions, PBL outlines several possible developments:

- Hydrogen: Used as a key energy carrier for industry and transport, with import terminals and infrastructure concentrated around ports like Rotterdam.
- Nuclear Energy: Considered for stable baseload power to support large-scale industry and reduce dependency on fossil fuels.
- Biomass: Applied for energy generation and as raw material for the chemical industry, though its use is dependent on sustainable sourcing.
- Recycling: Plays a larger role in reducing raw material use and lowering emissions, with industrial areas becoming circular hubs.
- CO_2 Storage: Large-scale capture and storage of CO_2 takes place under the North Sea and in onshore salt caverns, supporting climate neutrality goals.

This scenario prioritizes efficiency and economic growth, often at the expense of ecological considerations and social equity.



47. *Global Corporations scenario PBL, National (PBL, 2023)*

Scale 1 : 1300000

- Hydrogen electrolizer & storage
- Nuclear powerplant
- Import green electricity
- Biomass based industry
- Recycling factory
- CO2 storage from airfillers (DAC)
- CO2 storage (CCS)
- Hydrogen storage in salt cavern
- Windturbines at sea
- Solar fields at sea
- High voltage network
- Hydrogen network
- Port with industry

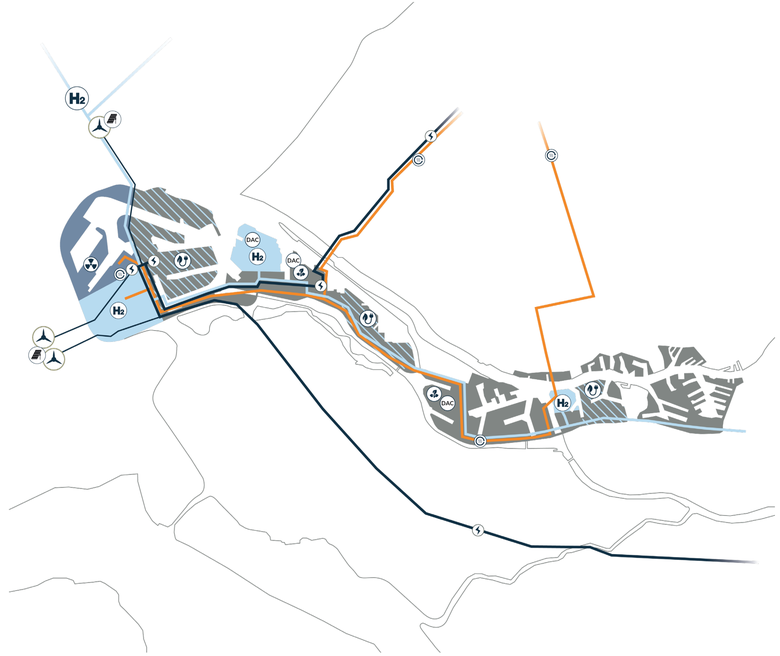
PBL | Regional

First of all, large amounts of electricity generated offshore in the North Sea are brought onshore at the Maasvlakte. The energy is supplemented by the constant output from a nearby nuclear power plant. In addition, a large hydrogen production facility is being constructed to absorb excess energy during periods of overproduction. The hydrogen is stored and then distributed via a national hydrogen network to serve heavy industry and other regions across the country.

Industrial processes, along with nuclear and hydrogen plants, generate substantial amounts of residual heat. Since not all of this heat can be used directly by industry, the surplus is repurposed via a pipe network to heat homes and greenhouses in areas such as Rotterdam, the Westland, and The Hague.

Although the industry still emits CO_2, these emissions are captured using Direct Air Capture (DAC) systems and stored underground through Carbon Capture and Storage (CCS) in former gas reservoirs beneath the North Sea.

Import Role
The Port of Rotterdam also plays a key role as a major import hub for green hydrogen and renewable electricity. From here, energy is distributed throughout the Netherlands and even across Europe, positioning the port as a central energy gateway for the region's transition to sustainability.



48. *Interpreted from Scenario PBL, Regional (PBL, 2023)*

Scale 1 : 125000

- Hydrogen area
- Nuclear area
- Import green electricity
- Nuclear energy plant
- Green electricity
- Hydrogen plant
- Solar power
- Wind power
- CO2 storage from airfilters (DAC)
- Residual heat
- Residual heat infrastructure
- Electricity infrastructure
- Hydrogen infrastructure

LAYERING

CONFLICTS & SYNERGIES

National result

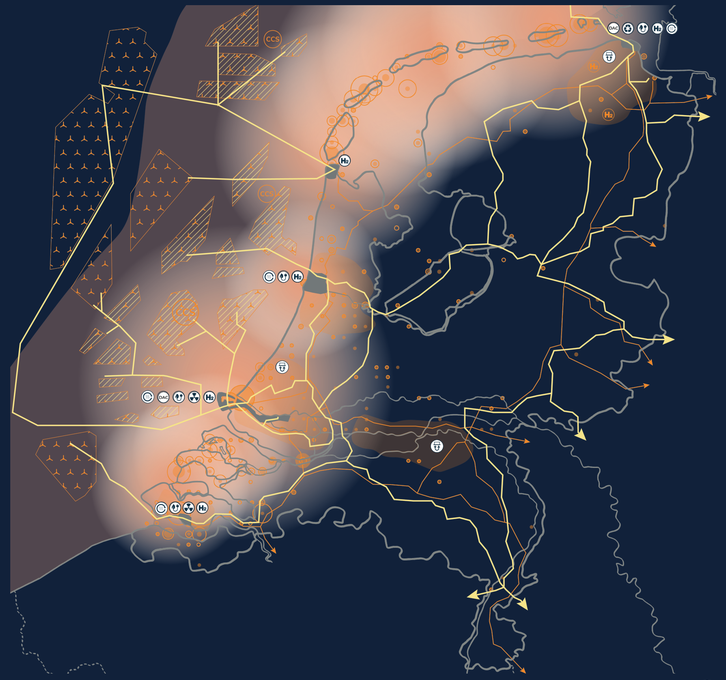
On the map (figure 49), two layers have been overlaid: the energy vision for 2050 and the national map of the seagull's habitat. At a national scale, the energy vision is based on the Global Corporation scenario developed by PBL. In addition, the map shows the nesting sites and flight areas of the seagull. This overlay reveals several conflicts as well as potential synergies.

Research has shown that wind turbines, while a renewable energy source, lead to significant bird mortality (Groot et al., 2022; Lowe, 2021). This presents a conflict with the flight zones of the seagull, as many planned offshore wind farms fall within a 100-kilometer radius of their key flight paths. As a result, there is a high risk of collisions, which could lead to a rapid decline in the seagull population.

Another conflict emerges in the Port of Rotterdam, which is identified at the national level as an important nesting site for seagulls. However, this area is also earmarked for several sustainable development projects. These initiatives could interfere with the seagull's habitat and breeding success.

On the other hand, a potential synergy arises from the establishment of wind and solar farms at sea. These areas often become restricted zones where commercial fishing is no longer permitted. This protection allows marine ecosystems to regenerate, indirectly benefiting the seagull by enriching its food supply.

Looking inland, the planned hydrogen network and the expansion of high-voltage power lines appear to have minimal impact on the seagull, as they do not intersect with key nesting or flight areas.



49. *Conflict & synergies map, National*

Scale 1 : 1300000

- Hydrogen electrolizer & storage
- Nuclear powerplant
- Import green electricity
- Biomass based industry
- Recycling factory
- CO2 storage from airfillers (DAC)
- CO2 storage (CCS)
- Hydrogen storage in salt cavern
- Residual heat
- Geothermal
- Windturbines at sea
- Solar fields at sea
- High voltage network
- Hydrogen network

Regional result

Zooming in on the Port of Rotterdam reveals several conflicts and synergies. This map (figure 50) was created by layering the spatial needs of humans, seagulls, and energy development. From this, several key analyses emerge:

Firstly, the nesting areas of seagulls often overlap with locations where new hydrogen production facilities are planned. This presents a potential conflict, as construction in these zones could displace large seagull colonies. Seagulls are known to be highly attached to their nesting grounds, and relocating them can disrupt their breeding behavior and population stability.

Secondly, the residents of Rozenburg and Pernis are surrounded by an extremely polluted environment. Both the soil and air quality in this area are heavily compromised, and the communities are relatively isolated from more urbanized areas. This raises serious concerns about livability and environmental justice.

Interestingly, directly next to Rozenburg is a major nesting site for seagulls. This proximity presents a unique opportunity: it suggests that humans and seagulls could potentially coexist within a shared ecosystem. If approached thoughtfully, this area holds significant potential to become a model for integrated urban-nature development.

By rethinking the spatial layout and development strategies in the port area, it may be possible to create a healthier environment for both humans and non-humans, supporting biodiversity while also addressing the social and environmental challenges faced by local residents.

50. *Conflict & synergies map, Regional*

Scale 1 : 250000

- Breeding place seagulls
- Fish migration

Air pollution

- Particulate matter P2.5
- Particulate matter P10
- Extreme heat stress

Business density

- Low density (1-2)
- Medium density (3-5)
- High density (5+)
- Moderate-highly polluted soil

Green

- Forest
- Recreational
- Farm land
- Hydrogen factory
- Nuclear zone
- Biomass power plant
- Windturbine energy
- Solar energy
- High voltage
- Hydrogen network
- Waste heat

ENERGY 2050

ENERGY CHOICES

Spatial justice

The project this paper is proposing gives a vision of the energy transition for the Port of Rotterdam. This port is an essential asset for providing energy to the rest of the Netherlands and is also a big energy consumer for the industries located in the port. (Vries, 2023). For this discussion, we first took an approach to getting a clear understanding of the Netherlands' whole energy mix, discussing the energy sources we are using in our vision.

Targets for 2050

The first aim was to create a vision that is CO2 neutral. The European Union and the Netherlands are aiming to become climate-neutral by 2050. (Rijksoverheid, 2021). In this process, the electricity production of the Netherlands should be scaled up massively. This demands a 3 to 5 times increase in green electricity production. (PBL, 2024). This does not take into account yet the high amount of green hydrogen production that would be needed to provide industries and transport with climate-neutral fuel, which would make the electricity demand even higher.

Current data about Dutch energy consumption tells that the Netherlands is using around 2600 PJ of energy per year. (CBS, 2024a). However, the question of whether this number is all-encompassing is a debated topic. An expert on the topic of energy consumption claims the numbers lack certain energy flows of, for example, companies producing and using their own energy, which makes those quantities harder to track for the Dutch government. His estimation is that the Netherlands is using around 3500 PJ each year. (Visser, 2022). In the last few years, we have seen a slight decline in energy consumption in the Netherlands. (CBS, 2024a). This led our estimation to a total energy consumption of 3000 PJ per year by 2050. The final vision of the port is based on this amount of energy consumption on the national scale.

Debating spatial justice

Besides taking into consideration the pollution the energy production emits, we want to take into account our non-human community, the seagull, as well as the humans living in the energy regions. Our final design is built on a spatial justice between the two species. We operationalized the spatial justice concept into three different discussion points per energy source: Area of space, chance of displacement, and health risk. In our approach, we created a question per category, through which we were able to give a score for each energy source to the different discussion points.

To operationalize the concept of 'space', we used the question: **What is the amount of space taken from the habitat of the species?**

For the concept 'chance of displacement', we used the question: **Do the species have to move to another area due to the energy production source?**

For the concept 'health risk', we used the question: **To what extent and with what severity are species likely to be harmed by the energy source?**

51. *Explanation diagram, ethical duscussion*

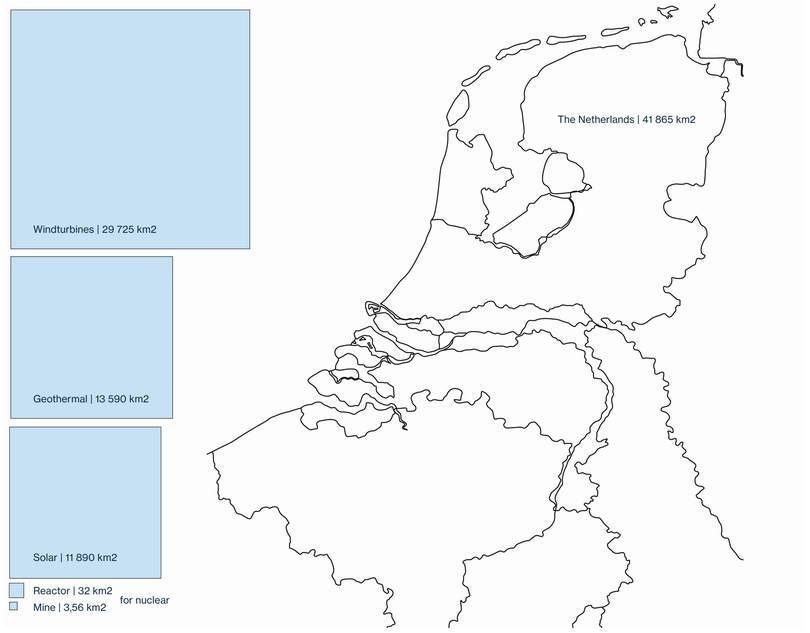
Necessary space

The map on the right shows the area that is needed per energy source, to provide the Netherlands with 3000PJ per year. It makes very clear that wind turbines take up the largest area, although nuclear power plants have a very high energy density, only taking up 32 km 2 to provide for the whole country.

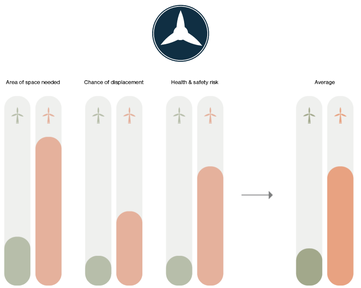
The map below shows the area needed for nuclear power (Traditional and SMR) when taking into account the already existing wind turbine parks and planned solar at sea, to provide for the whole country.

For the calculations, see Appendix 2. Calculations

52. *Energy in scale, Port of Rotterdam*



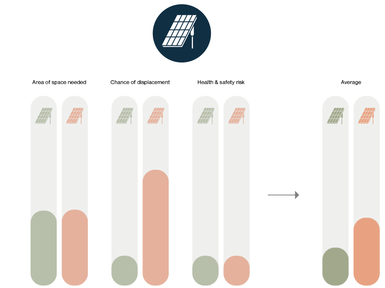
53. *Spatial needs energy sources when providing for The Netherlands*



54. *Spatial justice, off shore windturbines*

Off shore windturbines

The windturbine is a viable solution to provide green energy to the Netherlands, especially windmills in the North-sea could provide a solid source of green energy due to the favorable wind climate in the area. (Rijkswaterstaat, n.d.). To provide the whole country with green energy from windmills in the sea, we would need an area of around 12000 Km2. This calculation is based on the amount of energy the windmills could provide if they were spinning at their maximum capacity non-stop; in practice, their energy generation in the North Sea is 39% of their total capacity. (CBS, 2024b). The space needed would thus be even bigger. (Koch, 2020).
Although humans do use the North Sea for shipping, fishing, recreation, and sand extraction, the sea is not their direct habitat. (Rijkswaterstaat, n.d.). The seagull, on the other hand, uses the area of the North Sea to migrate to other places and countries, making the North Sea an important area in their lifecycle. We thus state that the amount of space taken from the seagulls' habitat is high, and the space taken from the humans' habitat is moderate. For seagulls, the chance of displacement by placing windmills in the North Sea is zero because the living area of a seagull is on land, and the windmills in the sea don't change the living patterns of the seagull. For humans, there is a chance of displacement because human activities, like fishing or sand extraction, in the North Sea could be blocked by the placement of a high quantity of windmills. (Rijkswaterstaat, n.d.). Lastly, the wind parks in the North Sea form a health risk for seagulls, because seagulls flying through the area might get hit by the rotors of the windmill, which can be fatal for the bird. (Lowe, 2021). The exact number of casualties of Dutch seagulls is not available, but one of the experts we spoke to (reference to Joanne) informed us that the actual number of seagulls killed by windmills might be a lot smaller than stories on the internet. We still conclude that the health risks of windmills for seagulls is relatively big in comparison with other sources of energy, so we have taken this into account in our final design by not building any new windmills.



55. *Spatial justice, solar panels*

Solar panels

Just like windmills, solar panels can produce green electricity for the Netherlands, harnessing the power of the sun. With a capacity factor of only 10%, the Netherlands would need an area of around 12000 Km2 to provide energy for the Netherlands. (Schrijver, 2020). And if you take into account that the sun is not shining the whole day long, but the peaks of solar energy production are far apart from the roughs, this system will also require a high capacity of electricity storage. Solar panels are a versatile energy production source that can be implemented in a lot of places. The Dutch government prefers solar panels on the roofs of buildings, where they don't take up ground space that could otherwise be used for other things. (CLO, 2024).

Seagulls don't lose much space by the placement of solar panels, as they don't mind sitting on solar panels and they often even use solar panels as a form of shelter during their breeding season. In cities, this forms quite a big problem because residents experience inconvenience due to the seagulls breeding on their roofs; that's why they are being deterred in cities for nesting under solar panels. (Pest UK, 2021). In rural and industrial areas, this problem is not that present, because the gulls form less of an inconvenience for people there. The displacement of seagulls in cities due to the implementation of solar panels is high because of those measures. Implementing solar panels at other places, like rural areas, industrial areas, and the North Sea, would not cause a displacement of seagull habitats. Solar panels don't form a health risk for humans or seagulls.

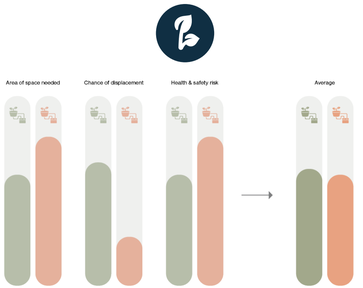
56. *Spatial justice, geothermal*

Geothermal

Geothermal energy is a way of generating energy using the heat of the earth. This source is thus also renewable and does not emit CO2. There are multiple sorts of geothermal energy; many Dutch households for example, own a heat pump, which pumps hot water out of the earth on the scale of one or a few houses. Another form of geothermal energy that is being used in the Netherlands is a geothermal energy station, which has deeper pumps, therefore retrieving more heat. One of these is situated in Den Haag and produces heat for around 4000 residences. (Allesoveraardwarmte.nl, 2021). These centrals could provide heating in densely populated areas. A drawback of the implementation of geothermal energy is that not every area in the Netherlands has the same potential for producing energy. To increase efficiency, some areas are more suitable for other sustainable energy sources. Besides certain areas being unsuitable for geothermal energy, the source offers a lot of potential for providing buildings with heat.

Geothermal energy is also space efficient in comparison with windmills and solar panels, a geothermal energy station takes up little space because a lot of the technical system is located vertically underground. The downside is that the efficiency of the geothermal centrals decreases when wells are located within a certain reach of each other. To guarantee optimal efficiency, two wells should be located at least 1000m apart from each other. (Daniilidis et al., 2021). Using geothermal energy knows no major risks for humans or seagulls, as it doesn't take a lot of space from human and non-human habitats, and it doesn't cause health risks for seagulls and humans. The reason our vision is only partly implementing geothermal energy is that it can't be used to obtain the high temperatures needed for a lot of industry. Furthermore, the geological conditions of the Dutch landscape are not well-suited for large-scale energy production through geothermal sources, limiting its application primarily to the heating of buildings.

Non-human Human

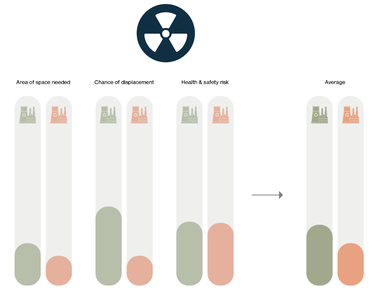


57. *Spatial justice, biomass*

Biomass

The burning of biomass, like wood and organic waste, is a carbon-neutral way to create energy in the form of heat and electricity. This process does emit CO2 into the air, but it does not chemically produce new CO2. The Netherlands uses biomass in its current energy mix by predominantly importing waste wood from other countries and burning it in the Netherlands. This process is often combined with energy production using coals. (Veen et al., 2023). The burning of biomass in the Netherlands doesn't form any risks for seagulls and their habitats. The seagulls don't experience any risks from the CO2 emissions into the air, and the energy centrals don't take away space from the seagulls' habitats.

The main disadvantage of using wood to create energy is that the wood has to be produced somewhere. Research has shown that there is too little sustainable wood production to use biomass as a sustainable energy source in the Netherlands. (Langeveld, 2020). To increase the use of biomass in the Netherlands we would thus need to import even more wood from other countries. This causes ecosystems in these countries to be demolished. Although the seagull doesn't suffer from this, it creates great spatial injustices in other parts of the world, which our vision strongly opposes.



58. *Spatial justice, nuclear*

Nuclear

The Netherlands currently owns one nuclear power plant, producing clean electricity for the country. An advantage of nuclear power plants is that they, in comparison to other green energy-producing mechanisms, take up a lot less space. Besides the little space a nuclear power plant takes up, nuclear fission doesn't emit any CO2 when producing energy. A byproduct of this form of energy production is that it produces radioactive waste. The Netherlands currently stores its nuclear waste in proximity to the reactor site. While future technological advancements may enable the recycling of highly radioactive waste for additional energy production, it is essential in the meantime to ensure the safe and secure storage of this material. (Kurniawan et al., 2022).

Nuclear scores well on the three questions on spatial justice for humans and non-humans. The reactors don't take up much space, and the mining of suitable elements for fission takes up less space than the space needed for biomass. The health risks of nuclear energy are minor for seagulls as well as humans living near the facilities. (Rowinski et al., 2015; Tangerman, 2013). Although the chance of an accident is small, many people still fear the implementation of nuclear energy on a large scale, so when designing a vision based partly on the use of nuclear energy, social acceptance of humans should be considered. Research shows that people differ greatly in their perceptions on the usage of nuclear power, but people with more knowledge about the subject usually also are more in favor of implementing it. (Cale & Kromer, 2015).

Nuclear energy production offers a lot of potential for our vision, and future research could improve systems even more. Small and medium Modular Reactors seem like a promising advancement, especially in a time in which the Netherlands is relatively politically unstable, because these reactors could be cheaper, safer, and easier to (re)move. (Rowinski et al., 2015). Besides that, Thorium also promises to be a new element that could be used for nuclear fission, this element is less depletable than the currently used Uranium. (Humphrey & Khandaker, 2018).

59. *Spatial justice, hydrogen*

Hydrogen

Besides having a strong electricity net, it's also important to replace current fossil fuels with something that can generate high temperatures, which are necessary for heavy industries and big transportation, such as freight ships and airplanes. Green hydrogen is a possible renewable and sustainable energy source to fill in this gap. The Port of Rotterdam currently aims to become the first hydrogen hub in the world, which will produce hydrogen on an international scale, transporting it through a hydrogen gas line network. (Port of Rotterdam, n.d.-b).

From the meeting with Friso Resink, we learned that for the hydrogen transport lines, underground gas pipes can be reused. This has no spatial or health impact on humans or seagulls. Electrolysers and water installations do require space. Because the hydrogen transition has not yet started, information on the exact space of the installation is not available yet. Electrolysers can be built in a variety of sizes, but the exact amount of space we would need to provide the Netherlands is a question that can only be answered by experts. (IEA, 2025). Because the only emission of hydrogen installations is oxygen, they do not form a health threat for humans or seagulls. Because there is still a knowledge gap on the effects of hydrogen installations on the displacement of bird species, we can't make a judgement on the displacement of seagulls.

> '*Friso Resink (Gasunie)* stated that *underground gas pipes can be reused for the hydrogen transport lines.*

Non-human Human

SPATIAL JUST ENERGY

60. *Spatial justice, CCS*

61. *Spatial justice, electricity grid extension*

Carbon capture and storage

To bridge gaps of industries with currently large CO2 outputs, this carbon must be captured and stored safely to transition smoothly. The Port of Rotterdam is currently working on the Porthos project, aiming to be operational in 2026. The aim of this project is to capture CO2 from several highly polluting industrial companies and store that CO2 in depleted gas fields in the North Sea. This is necessary when transitioning to hydrogen because it takes time to have a whole hydrogen installation up and running so that industries can transition from fossil fuels to hydrogen. During this transitioning period, it's just to capture carbon so it doesn't pollute the ecosystem. (Lucas de Graaf, Porthos).

Carbon capture and storage barely have a real spatial implication for humans and seagulls. CO2 must be transported from the emission place to the North Sea. This transport happens in underground pipelines. On its way, the CO2 needs to go through a compressor station and the cooling water pump station, which do take up some space. (Port of Rotterdam, 2025a). But in comparison with other port infrastructure, this does not take up a lot of space. (Lucas de Graaf, Porthos). The systems are indoor and underground and therefore don't cause displacement for seagulls, which are still able to sit on the roofs of the facility without causing trouble for the system. The system reduces CO2 emissions without any byproducts, making it non-hazardous and not problematic for human and seagull health.

Electricity grid extension

The expansion of the Dutch electricity grid is crucial as the Netherlands shifts towards a fully electrified and sustainable society. With national plans to reduce carbon emissions and move away from fossil fuels, electricity is becoming the central energy source for homes, industries, and mobility. This transition includes getting houses "off the gas" by replacing traditional gas heating with electric alternatives like heat pumps and induction cooktops. (Rijksoverheid, 2017). As a result, residential energy demand is shifting from gas to electricity, requiring a more robust and widespread grid.
Furthermore, electricity powers not just homes but also a growing share of the transport sector. Electric vehicles, e-bikes, and public transport systems all contribute to a cleaner urban environment, but they also increase the strain on the electricity grid. To meet these growing demands, the grid must be upgraded and expanded to deliver power reliably and efficiently across the country. (Voorhoeve, 2022). A strong electricity grid enables innovation, supports renewable energy sources with high production peaks, like solar and wind, and ensures that the Dutch energy transition can happen without blackouts or bottlenecks. In short, expanding the grid is foundational to the energy transition in the Netherlands.
The expansion of the electricity grid will have spatial implications. More high-voltage lines must be built to provide the whole country with green electricity. Seagulls don't lose habitat space because they can still use the space in a similar way when there are more power lines. (Joanna). They also have no chance of being displaced by the expansion of the net. For humans, the electricity installations do take up space. Humans make objections to the expansion of the electricity grid because citizens don't want to participate in the process of the creation of an expanded electricity net. This causes the procedures to build electricity installations to take a long time. (NOS, 2025). However, we couldn't find evidence that these installations also cause a chance of displacement for humans. To humans, these high voltage cables don't form a threat, because safety measures are taken into account to make all systems safe for humans. For seagulls, on the other hand, these cables can be fatal. More than 400 birds die from collisions with the, for birds barely visible, high voltage cables. (Dillen, 2019; Karatzia, 2024).

'Lucas de Graaf (Porthos) stated that during the transitioning period to green energy, CCS is just to capture carbon so it doesn't pollute the ecosystem.'

'Lucas de Graaf (Porthos) stated that in comparison with other port infrastructure, CCS does not take up a lot of space.'

'Joanna van der Leun stated that seagulls don't lose habitat space because they can still use the space in a similar way when there are more power lines'

Non-human

Human

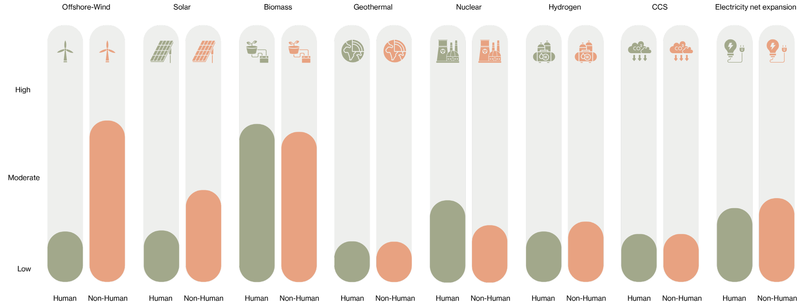
Conclusion spatial just energy

In our vision for 2050, the Netherlands will rely on a stable annual energy production of 3000 PJ, with a strong emphasis on renewable energy. The projected national energy mix includes 74.5% solar (2235.1 PJ), 8.23% wind (246.9 PJ), and 17.27% nuclear (518 PJ). This mix reflects a decisive move toward electrification, with solar energy taking a dominant role. The Port of Rotterdam will have a production of 1200 PJ in our 2050 vision. Rotterdam will produce 5.88% (70.5 PJ) with windmills, mainly located in the North Sea. 50.96% (611.5 PJ) of Rotterdam's energy production will come from solar panels on the roofs of industry buildings and solar parks on the North Sea. Nuclear production will have a stake of 43.17% (518.0 PJ) in the port, meaning that all nuclear energy of the Netherlands will be generated in the Port of Rotterdam.

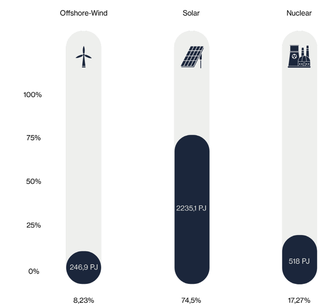
Such a solar-heavy mix brings both opportunities and challenges. Solar energy production is highly variable and peaks during the day, which can lead to grid instability if not properly managed. To accommodate this, our vision includes significant upgrades to the Dutch electricity grid. A stronger grid will allow for better distribution of electricity, reduce the risk of overload, and support the integration of decentralized energy sources like rooftop solar panels. The vision will also take into account carbon capture and storage in the first phases of the Port of Rotterdam, but these projects will be phased out when the port is fully transitioned to electricity and hydrogen-based energy sources, as these don't emit CO2.

In addition, part of the generated electricity will be converted into hydrogen, which requires an advanced hydrogen distribution infrastructure. The Port of Rotterdam will serve as the central energy hub in this system. It will not only facilitate the conversion from electricity to hydrogen but also ensure efficient transport, storage, and distribution of both energy carriers. This strategic role positions the port as a critical link in the Netherlands' sustainable energy future.

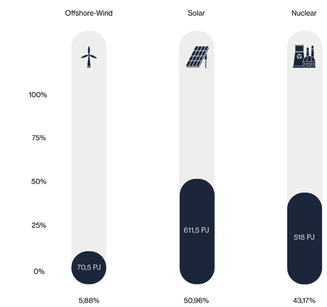
This energy mix is beneficial for seagulls and humans because it's based on the spatial justice of these two species. This mix is thus an opportunity for the Port of Rotterdam to transition to a sustainable energy system justly. Our vision also enhances these energy sources in a way that seagulls profit from the spatial implications of the energy sources. Solar panels on the sea could, for example, be combined with on-sea breeding spaces, and nuclear power plants can free up space where greenery can be planted to improve the quality of life of seagulls and humans.



62. *Spatial justice, summary*



63. *Energy choices for The Netherlands*



64. *Energy choices for Rotterdam*

05. VISION

05. VISION

TOWARDS 2050

With our vision entitled “Feathers & Fuel – Merging Perspectives”, we aim to challenge and expand current narratives within the discourse of sustainable development by proposing a more inclusive and balanced relationship between human and non-human actors. Our project emphasizes the importance of landscapes not merely being functional or aesthetic, but ethically and ecologically responsive. The accompanying collage visually articulates this vision, representing a scenario in which sustainable energy infrastructure is harmonized with the needs and rights of all living beings.

In this speculative future, the boundary between land and sea dissolves in an almost playful yet deliberate manner, resulting in a continuous and interconnected terrain. This designed environment goes beyond anthropocentric utility; it embraces a multispecies perspective, where space is consciously shared, negotiated, and cohabited. The landscape is carefully curated to provide meaningful habitat for non-human communities – in particular, for seagulls, whose presence becomes an indicator of ecological vitality. Vegetated corridors thread through the terrain, creating high-quality nesting, breeding, and resting zones that are seamlessly woven into the broader green infrastructure.

At sea, the design further reflects this ethic of care and balance. The placement and quantity of offshore wind turbines have been reconsidered to reduce spatial disruption for avian and marine life. Compared to the projections in the PBL scenario, the number of turbines is significantly minimized to lessen ecological impact while maintaining energy efficiency. Simultaneously, solar parks are not treated as isolated energy sites, but as dynamic ecological spaces. These installations incorporate vegetated elements – such as pollinator-friendly plants and grasses – to foster biodiversity and provide microhabitats for insects, birds, and small mammals.

Beneath the solar panels, artificial reefs will be constructed, designed to stimulate the regeneration of local fish populations. These reefs do not serve an ornamental function; rather, they play a crucial ecological role in enhancing biodiversity, stabilizing underwater ecosystems, and supplying a reliable food source for coastal bird species, especially seagulls. This multilayered approach demonstrates our commitment to designing energy infrastructures that are regenerative, rather than extractive, supporting both energy needs and spatial justice.

Finally, the presence of an elevated boardwalk on land and a kite surfer traversing the coastal waters serve as powerful symbolic gestures. These figures underscore the interconnectedness of the three foundational elements of our project: human, non-human, and energy. They emphasize the importance of continuous interaction, exchange, and coexistence between species and systems. Rather than isolating nature from culture or separating ecological considerations from technological advancement, our vision insists on their mutual entanglement.

Through this proposal, “Feathers & Fuel – Merging Perspectives” advocates for a reimagining of future energy landscapes – ones in which care, cooperation, and coexistence are not merely aspirations but foundational design principles.

65. *Feathers & Fuel*

FEATHERS & FUEL

Spatial vision

Our vision for the regional port scale is grounded in several fundamental pillars.

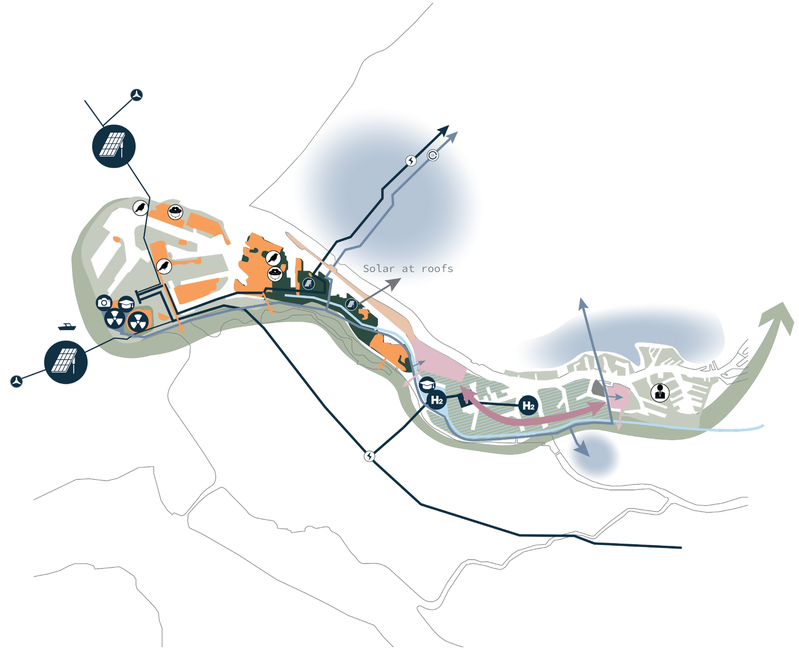
The connection between the two adjacent urban districts within the port area is reimagined through the establishment of an ecological wild park. In this process, the currently situated oil processing facilities are gradually dismantled, and the contaminated land undergoes a step-by-step remediation. This transformation not only expands the existing human-centered connectivity but also includes the needs of non-human species. Once the soil has been fully cleansed and restored, a third foundational element—the energy dimension—can be introduced by integrating hydrogen storage tanks across the site in an ecologically responsible manner.

Furthermore, the connecting passage physically reconnects the currently isolated port zone with the city center and also relinks fragmented sections of the harbor area in a manner that is considerate of non-human life. The result is a coherent spatial framework that prioritizes inclusivity and ecological harmony. This green corridor culminates in a panoramic viewpoint, a space designed to celebrate the entangled relationships between humans, non-humans, and the energy landscape. From this elevated perspective, visitors can observe the nesting grounds of seagulls in the northern port zone, as well as offshore renewable energy infrastructures —emphasizing the multilayered interconnections of species and systems within the transition.

The seagulls' nesting sites are comprehensively protected across the territory. In specific areas—such as the site of the proposed nuclear power plant near the Maasvlakte or in proximity to Rozenburg—points of interaction between seagulls, humans, and energy infrastructure may occur. However, these interactions are carefully regulated and allowed only to the extent that they are deemed non-disruptive from an avian ecological perspective, particularly during the sensitive breeding season.

In these zones, wild rangers and bird-watching platforms are strategically deployed to encourage inter-species engagement and awareness, fostering a deeper understanding and appreciation of the multispecies dynamics at play within the energy landscape.

Finally, the eastern section of the port area is designated primarily for commercial and industrial activities. This planning decision reflects a commitment to maintaining the human perspective, especially considering the site's proximity to the urban core, ensuring that economic and social functions remain integrated within the broader vision of ecological transition.



66. *Vision, Feathers & Fuel*

Scale 1 : 125000

- Wild park - Purification and H2
- Breeding areas - Rewilding
- Neighbourhoods
- Distribution, Cargo
- Industry
- Green corridor
- Nuclear energy
- Hydrogen
- Solar power
- Wind power
- Electricity
- Residual heat
- Businesses
- Bird watching
- Rangers
- Education center
- Tourist center
- Hydrogen infrastructure
- Electricity infrastructure
- Residual heat infrastucture
- Heated urban areas

Feathers & Fuel | Connections

In our vision for the future, the Port of Rotterdam continues to play a vital role in energy production. However, this role has undergone a significant transformation compared to the current energy landscape. The most striking difference is the complete elimination of fossil fuels from the energy mix. Instead, the port is now fully powered by sustainable and carbon-free energy sources, positioning it as a global leader in clean industrial energy.

Three primary sources are responsible for the energy production in the Port of Rotterdam:

1. Offshore wind farms (These remain a small part of the energy system, similar to the current situation.)
2. Offshore solar panels (These account for 50% of the energy generation, making solar energy a dominant force in the port's supply.)
3. Nuclear power plants (These provide 43% of the port's energy, ensuring a stable and continuous supply of electricity.)

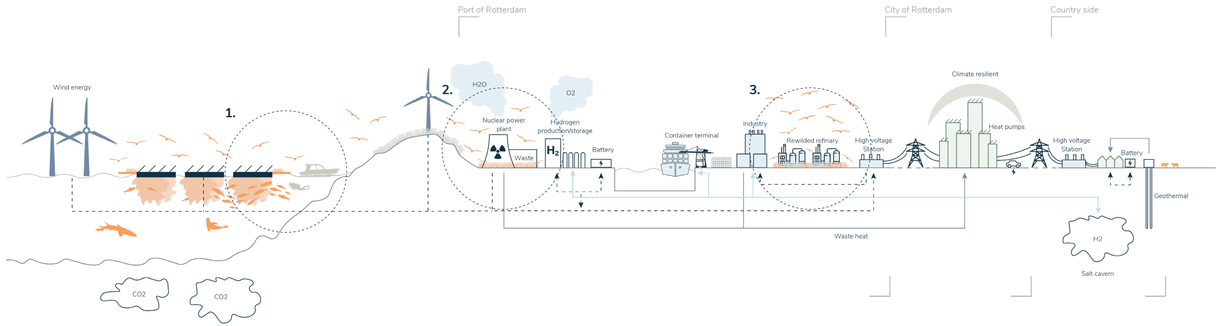
The backbone of this new energy landscape is electricity, which has become the main energy carrier throughout the port. To guarantee a reliable and constant energy supply, nuclear power plays a key role due to its ability to deliver large amounts of electricity steadily. In contrast, solar energy, while abundant and clean, is subject to fluctuations depending on weather and time of day.

To balance these fluctuations, two systems are in place: batteries and a hydrogen plant that uses electrolysis. During periods of surplus solar energy, such as on sunny summer days, electricity is stored either in batteries or converted into hydrogen. These energy reserves are then used during times of low solar production, such as nighttime or during cloudy winter months.

The hydrogen plant is connected to a national hydrogen network, linking it to major industrial regions across the Netherlands. Additionally, this network is connected to underground salt caverns in the north of the country, which serve as large-scale, secure hydrogen storage facilities. This strategic infrastructure ensures energy security year-round.

Moreover, the heavy industry in the Port of Rotterdam has transitioned from fossil fuels to hydrogen-based operations. These industrial processes produce significant residual heat, as do the nuclear power plants and the hydrogen facility. This excess heat is captured and distributed via a district heating network to nearby urban areas such as Rotterdam, The Hague, and Westland, where it is used to heat homes and greenhouses.

Most importantly, this entire system operates without emitting CO2, allowing nature to recover and coexist with human activity and energy production. The Port of Rotterdam has become not only a hub of clean energy, but also a model for sustainable living and environmental harmony.



67. *Scenario vision, Section*

- Electricity
- Hydrogen
- Waste heat

FEATHERS & FUEL *EXTRUDED*

Breeding places

68. *Breeding places* Scale 1 : 125000

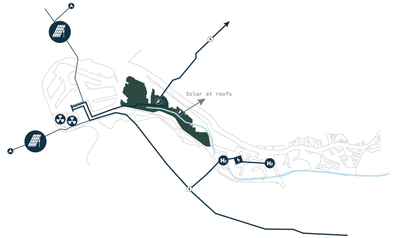
The analysis of the seagull has shown that there are several large breeding areas in the western part of the Port of Rotterdam. We aim to protect and preserve all the current breeding sites, as they are vital for the seagull's survival. In addition, we are also creating new breeding sites in several locations.

Businesses and industries

69. *Businesses and industries* Scale 1 : 125000

The Port of Rotterdam will retain much of its activity, such as container terminals (light green). However, heavy industry will transition to hydrogen, becoming climate neutral (dark green). In addition, the oil refineries will close, and these areas will undergo rewilding (striped green), making space for nature to return and supporting ecological restoration.

Energy network



70. *Energy network* Scale 1 : 125000

The new energy mix shows that most energy comes from offshore solar power. This is complemented by nuclear energy, ensuring a constant supply. To handle fluctuations, we use a hydrogen plant and batteries. The hydrogen plant not only balances the grid but also supplies hydrogen to the heavy industry in the port.

Waste heat

71. *Waste heat* Scale 1 : 125000

Producing hydrogen and nuclear energy generates a lot of residual heat. This heat is transferred to water and transported through a large pipeline network to Rotterdam and The Hague, where it is used to heat homes. Greenhouses in the Westland region can also benefit from this sustainable source of heat.

Co-existing neighbourhoods

72. *Co-existing neighbourhoods* Scale 1 : 125000

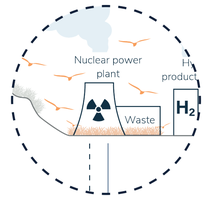
Rozenburg and Pernis are currently two neighborhood islands located in the middle of the Port of Rotterdam. By creating a connection between them, we aim to improve accessibility and foster stronger cohesion between the two areas. This link will help the communities grow closer and feel more integrated within the larger harbor environment.

Connecting passage

73. *Connecting passage* Scale 1 : 125000

To connect all these interventions, a connecting passage has been chosen. This passage links nature, energy, and mobility (people), creating an integrated system. It serves as a unifying element, allowing different functions to interact smoothly with each other.

FEATHERS & FUEL *ZOOM*



1. Solar at sea

After determining the energy mix in the vision, the next step was to explore how this could be spatially implemented. The main energy source is offshore solar power, but careful planning is required for its integration into the North Sea. Covering large areas with solar panels affects the seascape and must consider ecological and spatial dynamics.

One advantage of these solar zones is that they restrict access for fishing, allowing marine ecosystems to flourish. This creates opportunities for both underwater life and birds to thrive in protected environments. To support this, artificial reefs will be placed beneath the solar panels, providing shelter for marine species. At the edges, vegetation and bird resting areas will be added to support biodiversity above water.

This strategy not only focuses on clean energy production but also enhances ecological value. After 2050, when a balance between nature and technology is expected to be achieved, these areas could also serve as eco-tourism destinations. Activities like diving could allow people to experience the renewed marine life up close.

By integrating energy, nature, and people, this approach aims to create a resilient and multifunctional ecosystem that serves both environmental and societal goals.

2. Nuclear power plant

In addition to solar energy, nuclear energy plays a key role in the vision. It offers a constant and reliable energy supply, balancing the fluctuating production of solar power. The nuclear power plants are planned at the edge of the Maasvlakte, positioned as far away as possible from residential areas. However, nature does not mind this distance. In fact, it may benefit.

Currently, the design of nuclear facilities is often disconnected from the surrounding environment. In this vision, we aim to change that by integrating nature into the design of the plants. This creates a unique opportunity to support local wildlife, especially seagulls. Nuclear sites are usually surrounded by fences for safety, which also keep out predators like foxes. This makes the area an ideal and protected breeding ground for seagulls.

By allowing nature to become part of the nuclear landscape, we create a new kind of balance between energy production and ecological value. This vision rethinks the relationship between industry and the environment, showing that even high-tech infrastructure like nuclear plants can coexist with and support natural ecosystems.

3. Rewilded refinery

As the transition from fossil fuels to renewable energy progresses, oil and gas refineries in the port are becoming outdated. These industrial sites occupy large areas in the Port of Rotterdam, but their disappearance opens up new opportunities for spatial and ecological transformation. In this vision, these former refinery zones will undergo rewilding, allowing nature to return and begin the process of soil purification and ecological recovery.

Rewilding these spaces not only supports environmental restoration but also creates new value for humans. As the land heals, it can be repurposed for recreational use, offering residents and visitors a place to connect with nature. Walking paths, space for events, and nature parks will allow humans to explore these areas, while the ruins of the fossil fuel era remain visible as silent monuments of a past energy age.

KEY PRINCIPLES

1. Co-existing

74. *Co-existing*

The state or fact of living or existing at the same time or in the same place (Oxford dictionary, 2025). In the context of the report this applies to non-humans, humans and energy implementations.

Seagull

For seagulls, co-existence means no disruption to their natural habitat. With designated breeding areas and protection from predators like foxes, they can nest peacefully. A reduction in industrial noise and pollution makes the port more suitable for their survival.

Human

Humans coexist harmoniously with seagulls, enjoying nature without interference. Public spaces are designed to be shared, allowing for recreation while respecting wildlife. Education and awareness initiatives help residents understand how to live alongside the birds without disturbance.

Energy

Energy production is integrated with the seagull's habitat. The powerplants are designed to minimize ecological disruption, providing clean energy while supporting biodiversity. This harmonious approach ensures that both nature and human energy needs are met.

Stakeholders

- Environmental NGO's
- Energy providers
- Residents
- Ecologist
- Non-humans

2. Rewilding

75. *Rewilding*

Rewilding refers to the process where non-human life gradually reclaims areas once dominated by human activity. This transition allows for the expansion and creation of new natural habitats, offering space for ecosystems to regenerate and biodiversity to thrive.

Seagull

Rewilding offers increased space for seagulls to nest and breed. Their territorial range expands, creating new breeding grounds and supporting larger, healthier colonies. This improved habitat availability is essential for stabilizing seagull populations in and around the port area.

Human

Rewilding also benefits humans by making previously inaccessible or polluted areas, such as old oil refineries with heavily contaminated soil, available once again for public use. These areas can be transformed into green, recreational spaces, reconnecting people with nature and improving overall well-being.

Energy

As a result of rewilding, fossil fuel infrastructure gradually disappears from the Port of Rotterdam. However, the industrial history remains visible in the landscape, preserving the cultural identity of the area while shifting toward a more sustainable future.

Stakeholders

- Non-humans
- Park rangers/ecologists
- Festivals
- Hikers
- Local communities
- Tourism sector
- Port of Rotterdam

3. Connecting

76. *Connecting*

It is essential to establish a strong network between non-humans, humans, and energy producers and users. To achieve this, a connecting passage has been proposed. This is an integrated spatial and ecological corridor that brings together nature, people, and energy infrastructure in the Port of Rotterdam and beyond.

Seagull

A continuous green structure will connect key nesting areas for seagulls throughout the Rotterdam port. This not only strengthens local biodiversity but also links the breeding grounds to a broader ecological network across the Dutch/Belgian Delta. It forms part of a European migratory and habitat corridor critical for the seagulls.

Human

Within the port, residential neighborhoods and work areas should be connected to avoid becoming isolated "islands." The connecting passage allows for seamless access between different urban zones and opens up the port for diverse recreational uses, such as walking, cycling, and educational trails, fostering a stronger human-nature relationship. In addition, a connection is created with the city of Rotterdam.

Energy

The connecting passage also provides a physical and infrastructural link to the national electricity and hydrogen networks. It strengthens connections between industrial zones, cities, and renewable energy hubs, supporting the transition to a cleaner, decentralized energy system.

Stakeholders

- Rijkswaterstaat
- Energy network operators
- Local residents and workers
- Ecologists
- Recreational organisations
- Municipality of Rotterdam

4. Greenifying

77. *Greenifying*

Humans actively plant vegetation to increase green spaces in an area. This process, known as greenifying, helps restore biodiversity, improve air quality, and create more sustainable urban environments. It also enhances the quality of life for both humans and non-human.

Seagull

Rewilding and greenifying efforts provide more space for seagulls to nest. By expanding their territorial range, more breeding grounds become available, helping to support a larger and healthier population of seagulls in the Port of Rotterdam. This increased space is essential for species preservation.

Human

For humans, rewilding and greenifying transform polluted industrial areas, such as old refineries, into accessible, recreational spaces. This revitalization reduces contamination, increases green areas, and improves overall quality of life. It also lowers the "felt" temperature in urban environments, making the area more comfortable for residents and workers.

Energy

Sustainable energy production sites, like nuclear or hydrogen plants, are greenified by integrating green spaces in and around their facilities. This does not affect energy output but improves the aesthetic value of the landscape and enhances biodiversity. These spaces also provide natural cooling benefits.

Stakeholders

- Port of Rotterdam
- Environmental NGO's
- Energy providers
- Local residents
- Workers
- Non-humans
- Ecologists

5. Appealing

78. *Appealing*

For the future development of the Port of Rotterdam, it is crucial that the area becomes an appealing place (for both people and non-human) to stay, visit, or invest in. By increasing its attractiveness, the public is more likely to support and engage with this new vision and strategy.

Seagull

To make the area appealing for seagulls, nesting grounds must remain undisturbed during the breeding season. A consistent supply of food is essential to sustain and grow the population. Furthermore, the environment must be designed to deter predators like foxes, allowing seagulls to live and breed peacefully in a secure habitat.

Human

The Port of Rotterdam transforms into a more accessible and inviting public space. With areas for recreation, sports, festivals, and moments of rest, the port becomes a dynamic destination. Extensive greenery brings cooling effects, biodiversity, and visual comfort. This will attract residents, workers, and visitors to stay and engage with the space.

Energy

The shift to renewable energy sources becomes more appealing for two reasons. First, it helps combat climate change and reduces harmful CO_2 emissions, which positively impacts public health. Second, it increases national energy independence, reducing reliance on foreign energy imports and contributing to a more secure future.

Stakeholders

- Environmental NGO's
- Festival & event organizers
- Energy transition companies
- Non-humans
- Ecologists
- Tourism institutions

6. Evolving

79. *Evolving*

In the final phase toward creating a balanced ecosystem where non-humans, humans, and energy production co-exist, it is essential that the vision continues to evolve over time. The future will inevitably bring new challenges, but the strategy must remain adaptive and resilient in response to changing conditions.

Seagull

The voice of the seagull must not be forgotten in this evolving landscape. A healthy, stable population must be maintained, with consistent access to food, secure and undisturbed breeding grounds, and controlled management of natural threats like predators. Their role within the ecosystem must be continually reassessed and protected.

Human

For people, evolving means creating a long-term, healthy environment in which to live, work, and relax. The development of the port must continue to support mental and physical well-being, while remaining flexible enough to respond to demographic shifts, climate change, and social trends.

Energy

The energy sector must remain dynamic and responsive. As demand rises, the system should scale sustainably. During periods of surplus, production must be adjusted to avoid waste and environmental pressure. Innovations in green energy, circular systems, and smart infrastructure will guide this flexible evolution.

Stakeholders

- Academic & research institutions
- Port of Rotterdam
- Technology & data companies
- Public heath institutions
- Non-humans
- Ecologists

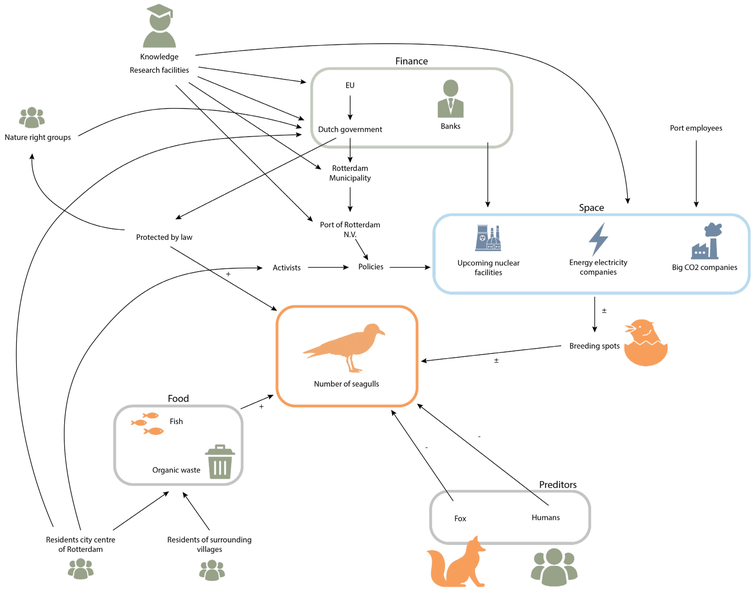
06. STRATEGY

06. STRATEGY

STAKEHOLDER *RELATIONS*

Introduction

To determine the strategy, research was first conducted into the stakeholders involved in the vision. The focus was on understanding the factors that influence the population of seagulls in the Port of Rotterdam. Key actors and parties were identified across three main areas: humans, non-humans, and energy. This analysis helped define the roles of various stakeholders, such as local communities, nature right groups, industries, and energy producers. Additionally, considerations were made regarding financing, available space, predators, and food sources. Ultimately, the strategy is designed to ensure the health of the seagull population while fostering a harmonious coexistence between humans, nature, and energy in the port area.



80. *Stakeholder relations*

Non-human stakeholder

Human stakeholder

Energy stakeholder

STAKEHOLDER *POLICIES*

Policy designers

In the complex network of stakeholder relationships, a clear hierarchy emerges in which institutions influence each other through the creation and implementation of policies. These stakeholders, ranging from government agencies to private companies, play a crucial role in shaping spatial development, particularly in areas affected by the expansion of nuclear facilities, energy and electricity companies, and other major carbon emitters. Such spatial decisions have direct consequences for ecological systems, including the displacement or preservation of breeding grounds for species such as seagulls, as well as the availability of space for other non-human life. It is important to note that policy directions are not formed in isolation. Activist movements exert pressure that can redirect institutional priorities, while research and knowledge-producing institutions contribute by informing evidence-based policy-making. This dynamic interplay highlights how policy is both a product of institutional hierarchies and a response to broader social and environmental inputs.
The scheme on the right shows the policy makers and their recent policies related to the project's vision in hierarchical order.

	Policy	Main vision of the policy	In line with the vision?	Conflicts	Opportunities
Europe	European Green Deal (2021)	• Climate neutral Europe in 2050. • Economic growth decoupled from resource use. • No person and no place left behind. • Clean and efficient energy transition. • Protecting biodiversity and ecosystems.	YES		
	Nature restoration law (2023)	• Restoring every ecosystem on land and sea by 2050. • Mainly focusing on Natura 2000 areas for now. • Maintaining areas which are in good state right now.	YES		
	Just Transition Fund (2021)	• Support social-economic challenges created by the energy transition. • For humans. • No funding nuclear energy	NO	NO: Funding human oriented energy transition.	
The Netherlands	Netherlands Nature Positive (2019)	• Not just recovering nature areas, but recovering nature. everywhere in the Netherlands. • Inspire the rest of the world. • Connecting nature policy to other sectors.	YES		
	National growth fund (revised in 2024)	• Financing human knowledge development. • Research into hydrogen. • Improving the Dutch economy.	YES / NO	NO: Really growth oriented, is conflicting with our vision	
	National Plan Energy Systems(2021)	• Producing a lot of electricity. • Implementing Hydrogen. • Using energy more efficiently.	YES		
	Omgevingswet (2024)	• Combining nature, economy, health, energy etc. in final design. • Focus on participation. • Decentralizing decision- making. • Improve quality of the living environment.	YES / NO	NO: The vision leaves space to sacrifice nature for the creation of new energy sources.	YES: Participation opens the door for non-human advocates to speak and contribute to designs.
Regional	Fauna Management fox, Southern of Holland (2024-2031)	• Prevent or limit predation to protect of vulnerable species including ground-breeding birds. • Sustainable management of wildlife populations: sustainable management. • Control of damage-causing animals by land users: control by land users.	YES		YES: Want to prevent any harm to flora and fauna, and of the conservation of the natural habitats YES: Is for the human and health as well as for the non-human
	Nature management plan 2025 (2024) South-Holland	• Protecting animals and plants. • Catalogue for all blue and green services. • Building and defining of index. • Subsidies and management impulses.	YES		
Port	Nature vision (2022)	• Economic progress can't be in the expense of nature. • Facilitate non-human migration. • Include nature in development.	YES		
	Publiek kader Havenbedrijf Rotterdam	• Continuity of the harbor facilities. • Efficient market relations. • Safety in the port. • Sustainable use of space.	NO	NO: Focusses on the retention of market relations and economical prosperity that are harmfull to non-humans.	

81. *Stakeholder policies*

In line with Feathers & Fuel vision

Not in line with Feathers & Fuel vision

STAKEHOLDER *INTEREST*

Alignment with vision

After observing all the stakeholders, this table analyzes how each stakeholder aligns with our vision. It considers their interests, problems, attitude, power, and the resources they have. This analysis is then incorporated into the report to better understand the dynamics between the stakeholders and how they influence or support the vision.
The three most important stakeholders are the Seagulls (our community for the project), big CO2 companies (with a lot of power and land) and the residents of the surrounding villages. In the following pages the different relations will be explained via a power interest diagram.

Stakeholders	Interests	Problem	Attitude	Power	Resources
Seagull	Breeding Feeding Habitat	Lack of space/food/ being considerd Preditors	Positive	No power	Protective policies Their being
Port authority	Sustainable future Economical prosperity Optimized space use	Restricted by rules that protect seagulls Not profitable & energy	Positive / Negative	Blocking power	Finance Knowledge Human power
Big CO2 Companies	Keep their position in Port (spatialy and financially)	Threat to power position Money for the energy transition	Negative	Blocking power	Own a lot of space Greenwashing Finance
Residents city center Rotterdam	Job opportunities Save place to live Recreation	Health issues Energy costs Lack of recreation	Fencesitters	Production / Blocking	Human power Mobilise or influence others
Residents surrounding villages	Job opportunities Save place to live No nuisance	Not feeling heard Health issues Energy costs	Positive	No power	Human power Mobilise or influence others
Port workers	Job continuity Healthy work environment	Change to lose job To change the field of work	Negative	Blocking power	Human power Knowledge
Non humans	Habitat Balanced life cycle Consideration	Lack of human justice and perspective Threatened	Positive	No power	Protective policies Their being
Municipality of Rotterdam	Good and healthy living space with economical prosperity	High investments Job loss Various interests	Positive / Negative	Production / Blocking	Finance Knowledge Political power
EU	International trade CO2 neutral in 2050 Economical prosperity	Neglections climate policies Political instability	Positive	Production / Blocking	Mobilise others Knowledge Political power
Dutch government	Good & healthy living environment Economical prosperity	High investments Long term planning Lack of space	Positive / Negative	Production / Blocking	Mobilise others Knowledge Political power
Banks	Profit/revenue Economical prosperity	Uncertain outcome Low revenues Losing big customers	Positive / Negative	Production / Blocking	Finance
Research facilities	International collab Innovation Gaining knowledge	Budget cuts Political instability Disbelieve	Positive	Production power	Mobilise others Knowledge
Renewable energy companies	Funding Reputation Innovation	Public opinion Political instability High investments	Positive	Production power	Knowlegde
Activist groups	Change policies/laws Create awareness among public	Passive society Contradicting opinions Companies with power	Positive / Negative	Blocking power	Mobilise others Knowledge Voting power
Fox	Breeding Feeding Habitat	Lack of space/food and being considerd	Positive / Negative	No power	Ability to hunt Their being
Electricity companies	Innovation Capacity Profitable	Political instability Limited technology High investments	Positive	Production power	Mobilise others Knowledge Finance
Fish	Breeding Migrating Habitat	Fish industry Polluted waters Lack of protection	Positive / Negative	No power	Protective policies Their being
Nature right groups	Protecting habitat Sustainable future	Lack of non-human perspective Lack of protectiveness	Positive	Production power	Protective policies Political influence

82. *Stakeholder interests*

Positive power

Negative power

No power

STAKEHOLDER *POWER & INTEREST*

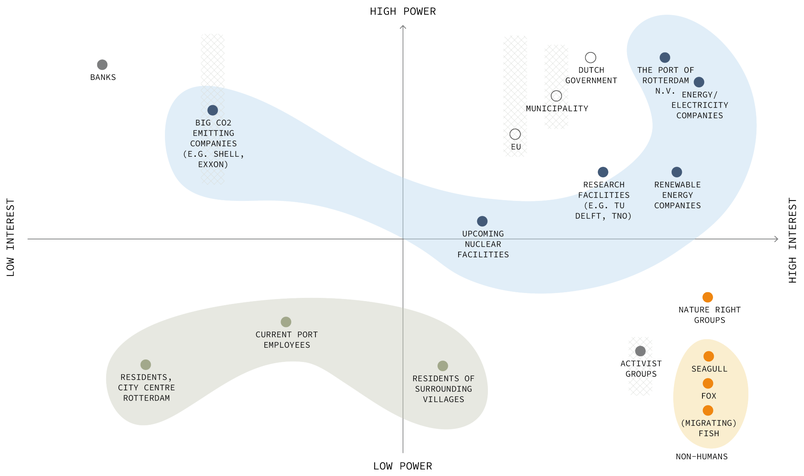
Scenario 2050 *PBL*

As demonstrated in the figure, the non-humans are of great interest, but have very little power. This is due to the current system of justice, in which they have almost no voice. The seagull is placed the highest in the hierarchy due to its protection during the breeding season, as previously discussed in Chapter 04, Analysis, Seagull.

In contrast, the human subjects of this study, including residents of the city, surrounding villages and current port employees, exhibited a comparatively low level of interest and limited power within the context of the PBL scenario. Conversely, the residents of the villages have expressed a keen interest, as the scenario will generate new employment opportunities. Among the employees, the most significant power is held by those with the capacity to initiate strike action and shake up the companies.

The most powerful sector in this possible future is that of the energy stakeholders. A notable shift in interest levels is evident, with the Port of Rotterdam, energy and electricity companies, renewable energy companies, and research facilities exhibiting a high level of interest. In contrast, large CO2-emitting companies demonstrate a low level of interest. The high-interest companies are of particular significance as they possess valuable assets, including land, businesses, infrastructure, and new innovations. In contrast, the low-interest companies will gradually become obsolete within the new system.

The influence of governments within this system is subject to variation, contingent on the particulars of the subject matter. For instance, the EU adopts a top-down approach through legislation in certain contexts, while in others, it permits national governments to exercise discretion. The municipality's authority is subject to the legislation of the government, yet there are instances where it is permitted to exercise independent decision-making.



83. *Stakeholder interests for scenario 2050 PBL*

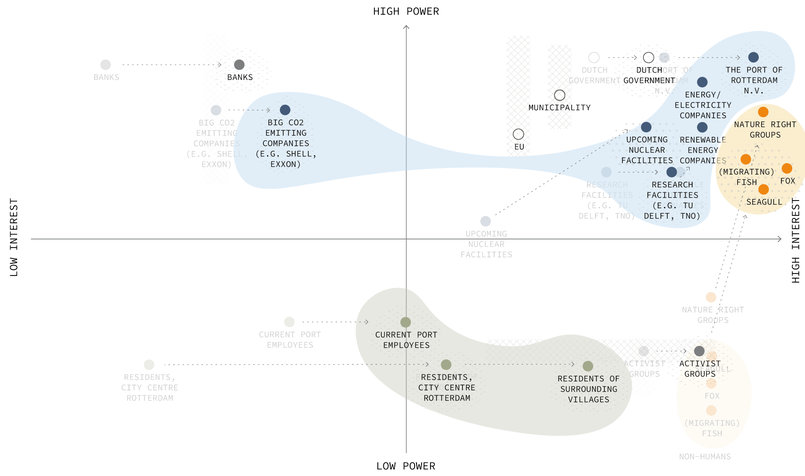
Legislation
Energy stakeholder
Human stakeholder
Non-human stakeholder
Other
Relational area
Scalebar of interest/power

Scenario 2050 *Feathers & Fuel*

In the 2050 scenario of Feathers & Fuel, there has been an increase in the interest and power of non-humans. Their environment and habitat will be enhanced, and they will have a voice and rights in this scenario. Nature rights activists have also gained more power and interest in this new scenario.

The human subjects of this study have also increased in interest. Their work and life environment is projected to become healthier, and there will be substitutions for their previous jobs within the new ranger programme. They will have the opportunity to undergo retraining for roles that demand specific skills, which are closely related to their previous positions (see Chapter 04, Analysis, Human, Employment).

The energy sector is identified as the most powerful sector in this vision. It is evident that the nuclear industry is set to gain power and interest, as it has the necessary knowledge and skills to make the transition to nuclear energy possible. The port of Rotterdam will also increase its interest, although it will have to make large investments. However, it is projected that they will generate more energy for the nation than in the PBL scenario, thereby creating an export product that will benefit the Dutch economy and creating an export product for when production reaches the 300 PJ mark. It is evident that the energy sector will continue to dominate the economic landscape. The Port of Rotterdam will still be the first port to have an human and non-human integrative port and to achieve extreme green energy targets.



84. *Stakeholder interests for scenario 2050 Feathers & Fuel*

Legislation
Energy stakeholder
Human stakeholder
Non-human stakeholder
Other
Relational area
Increase interest and power
Interest interest
Moving direction
Scalebar of interest/power

PHASING

SOCIAL INDICATORS

Phasing strategy

In this chapter the phasing of the strategy is explained. First of all the external conditions are explained. These conditions are predicted societal changes that influence the phasing. Secondly a linear timeline elaborates on the building activities. Separated in human, nonhuman and energy it shows which activity is related to which aspect. The timeline also contains policies, implemented to achieve the vision. Lastly each phase is separately interpreted showcasing the most important changes occurring in that phase.

Phase 1: Showcasts the construction of new spatial elements and perspectives and the deconstruction of old ones.

Phase 2: Uses the constructions from phase1 to transition from old, into new habits

Phase 3: Visualizes the implemented aspects being harmonized.

External conditions

This timeline shaped in a X curve shows the predicted external conditions that influence our strategy and are the result of our strategy. The diagram is divided in three consecutive phases; Construction, Shift and Balance (for further explanation see the following page). Within these phases there are several happenings influencing the strategy; Protest, Politics, Justice, Climate and War. Some external conditions are linked, meaning that they are responding to each other or the consequence of one and other.

Protest

Societal dissatisfaction and uproar influences political policy. Boycotts can also influence markets and political budgets. The recurring climate protest demands political consideration. Protests are the start of change. For example the protest and activism against fossil fuels have started the reduction of the fossil fuel industry by cutting their funding and use.

Politics

Political structures are determining how societal dissatisfaction, climate disasters, results of court cases are translated to policy, influencing everyday society. Therefore the political climate is very dominant in the stimulating or stopping practical implementations. Also the stability of a political ideology (currently democracy) is very influential. Currently the instability of the democratic system stops a lot of progress concerning climate as we have seen with the withdrawal of USA from the Green Deal. Also other shifts in ideology influence everyday life. The rise of conservatism results in injustice towards minorities and non-humans. Lastly the shift towards anarchocapitalism centralizes power making politics more unequal.

Justice

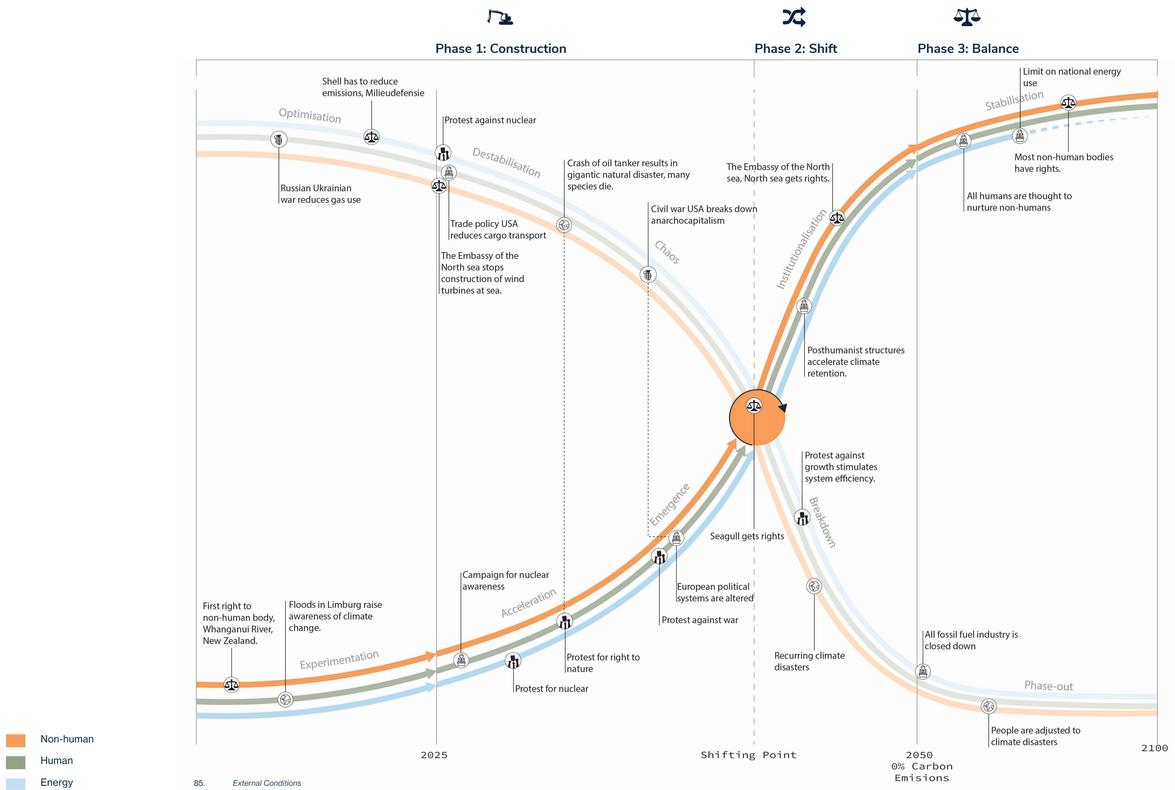
The court cases give power to those (action groups) trying to alter companies/ human behavior by enforcing different values by law. On the one hand, law can be used to reduce current negative impact. On the other hand, it can be used to create a positive impact, stimulating equality between humans and non-humans. We have seen the example of the negative impact in the case against Shell. Influencing their production capacities, reducing their emissions. An example of the positive impact is the case giving right to the Whanganui River in New Zealand. Our justice system is a strong tool for altering behaviour patterns and can therefore be very influential in the future.

Climate

Climate disasters showcase the urgency of climate change implying behavioural change. During the last years climate disasters have been more substantial and frequent. The implication of climate change have been exposed by researchers (IPCC), predicting social instability due to lack of resources, climate wars, etc. Therefore these disasters are capable of evoking drastic societal change whenever they occur. There are numerous examples of disaster such as the floods in limburg, floods in valencia, forest fires in LA...

War

As we have seen, the Russian-Ukrainian war has been very influential, stimulating the energy transition. The reduction of gas export to European countries gave them no other option than becoming more self-sufficient. Wars disrupting societies are in all ways very influential for the progress during and after the war. The need for advanced arms spikes innovation.



85. *External Conditions*

TRANSLATING TO THE PORT OF ROTTERDAM

Spatial applications timeline

The linear timeline gives an overview of the main spatial implementations and policies shaping the vision and strategy. The timeline is divided in the three aspects;human, non-human and energy, to clarify which implementation is influencing which aspect. The policies, sometimes aiming for reduction, are mainly focussed on the stimulation of newly introduced elements.

Looking at the Humans, the timeline focuses on the Energy workers, the human group that will have to transition the moste. Next to this Construction workers are of great importance as they are reshaping current energy systems. New are the Rangers, working towards the post-anthropocene, they are the pioneers that start nurturing non-humans. Ecologists nowadays being the advocates of the non-humans are undervalued and get an important position. After a while, tourism and recreation can start to take place as the harbor has become more of a natural park. Bringing together human and non-human, the Co-living area is introduced. To allow for green structures to expand and roadnetworks to decrease, mobility structures are made more public and automated.

The Non-Humans currently being eradicated first need to be stabilized. The Seagull, the main example, needs 25 years (one lifetime) to stabilize thereafter they can start expanding. Marine species are stimulated by the construction of artificial reefs. Vegetative species are expanding; rewilding the old industrial sites and implementing them in the Connecting Passage and Co-living area. The fox can no longer be shot down, instead their habitat will be limited by the use of fencing. Other non-humans are rising as human behavior changes and the right for nature expands.

Energy systems are completely reshaped. Starting with the fossil fuel industry that has to be closed down by 2050. Taken over hydrogen, the build of hydrogen infrastructure; production, storage and pipelines is started directly. Together with the build of a Nuclear powerplant and waste storage. As soon as the plant is finished, big parts of the fossil fuel industry close down, allowing the rewilding project to start. The construction of solar at sea is started, parallel with the implementations of the reefs, creating new marine habitats. The construction of wind turbines is directly shutdown making sure not to demolish more habitats or kill birds. Expansion of the electricity grid proceeds, being finished in 2036 and batteries get implemented to capture residual power.

Phase 1: Construction

The construction phase transforms fossil fuel sites into energy transition spaces, integrating human, non-human and energy needs, while moving towards a post-anthropocene perspective.

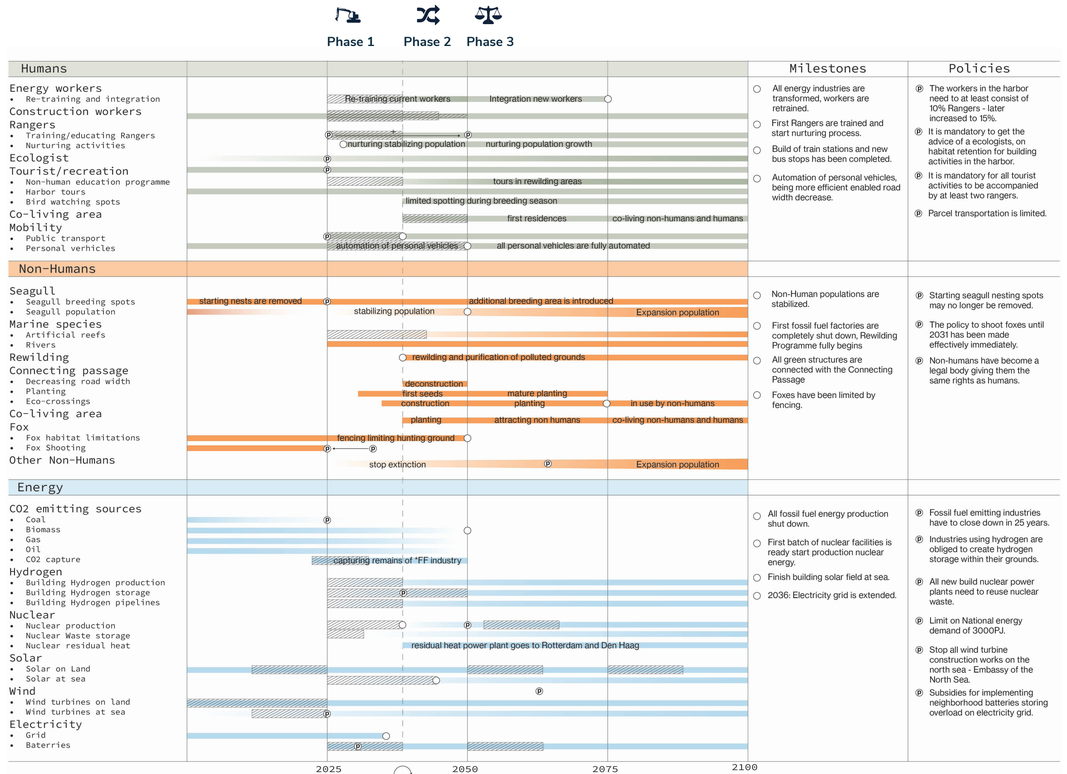
Phase 2: Shift

In the shift phase, fossil fuels are replaced by nuclear and solar energy, while ranger care and the connecting passage support non-human life and a post-anthropocene shift.

Phase 3: Balance

In the balance phase, human, non-human, and energy systems coexist equally, supported by legal recognition of non-humans and a shift toward post-human perspective.

- Shifting point
- Policy
- Milestone
- Building facility
- Human activity
- Human activity - increasing
- Human activity - decreasing
- Non-Human activity
- Non-Human activity - increasing
- Non-Human activity - decreasing
- Energy activity
- Energy activity - increasing
- Energy activity - decreasing



86. *Stakeholder interests*

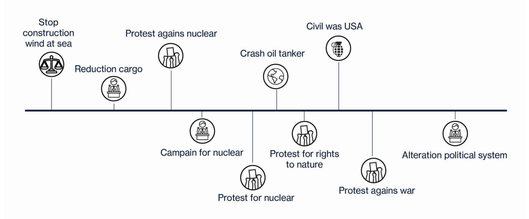
CONSTRUCTION

Phase 1

During the construction phase, the foundation necessary to shift is being built. Many old structures are reshaped or deconstructed to create space for new structures. These structures are hosting human, non-human and energy elements that are required for the energy transition, while considering non-humans. The old structures that are transformed are mainly fossil fuel industrial and storage sides. Simultaneously the Anthropocenic perspective gets deconstructed and reshaped into an Post-Anthropocenic one.Examples of the structures adding to this are; the rangers training center, the non-human education center, the artificial reefs and the solar, hydrogen and nuclear infrastructure.

87. *Phase 1: Construction*

External conditions



88. *External conditions: Phase 1*

Spatial applications during construction

Humans

Main Steps

1. Building facility to re-training current energy workers
2. Building facility to train and educating Rangers
3. Nurturing stabilizing population
4. Building facility for non-human education program.
5. Expanding public transport network
6. Start automation personal vehicles

Main Policies

1. It is mandatory to get the advice of a ecologists, on habitat retention for building activities in the harbor.
2. The workers in the harbor need to at least consist of 10% Rangers.

Non-Humans

Main Steps

1. Stabilizing population
2. Instalation artificial reefs
3. Start Green Corridor
4. Stop Extiction

Main Policies

1. Starting seagull nesting spots may no longer be removed.
2. The policy to shoot foxes until 2031 has been made effectively immediately.

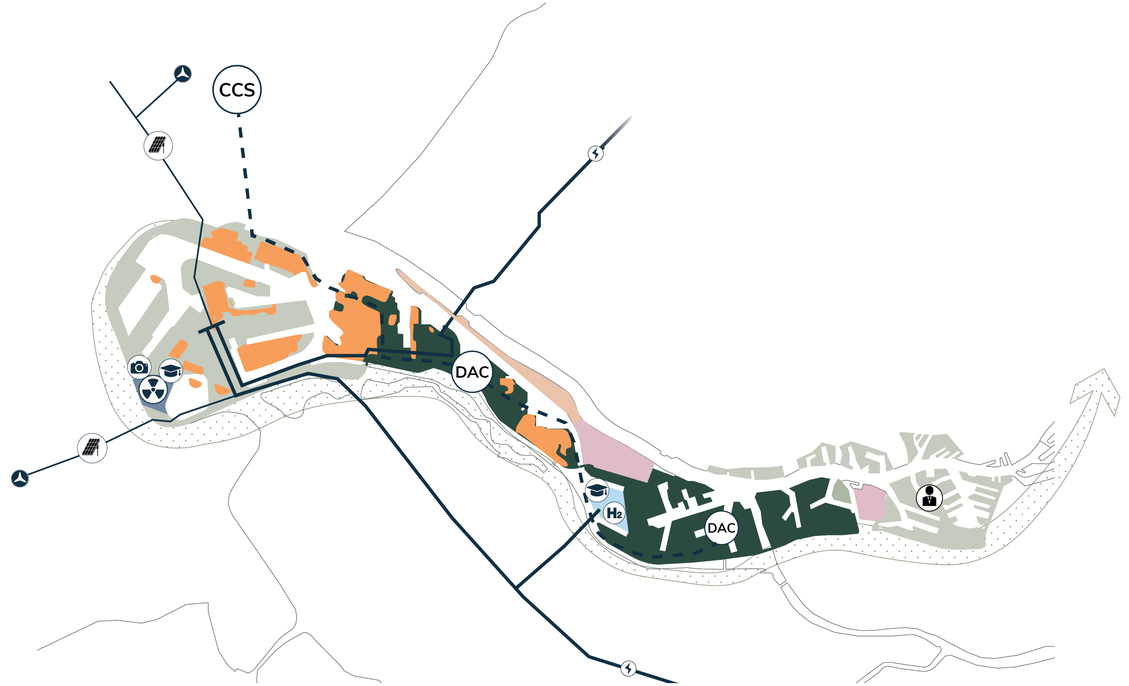
Energy

Main Steps

1. Start shut down FF industries
2. Build hydrogen production,storage and pipelines
3. Build nuclear production and waste
4. Start solar pannels at sea
5. Stop wind turbines at sea
6. Electricity grid is extended

Main Policies

1. Fossil fuel emitting industries have to close down in 25 years.
2. Stop all wind turbine construction works on the north sea - Embassy of the North Sea.
3. Subsidies for implementing neighborhood batteries storing overload on electricity grid.



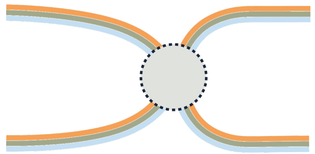
89. *Phase 1: Construction*

Scale 1 : 125000

- Wild park - Purification and H2
- Breeding areas - Rewilding
- Neighbourhoods
- Distribution, Cargo
- Industry
- Green corridor
- Nuclear energy, building
- Hydrogen, building
- Solar power, building
- Wind power, finished
- Electricity
- Electricity infrastructure
- Businesses
- Bird watching
- Education center, building
- Tourist center, building

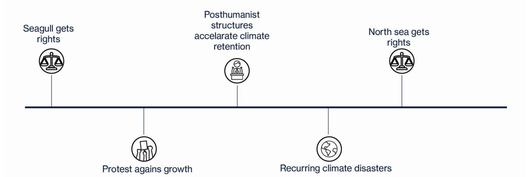
Phase 2

During the Shifting phase, traditional elements get replaced by new elements. Big parts of the fossil fuel industrial sides are closed down. Their energy production is taken over by the newly built nuclear power plant and the solar panels at sea. Anthropocenic perspectives are deconstructed as rangers and their nurturing activities have become a normality. Non-human populations are almost stabilized and vegetational species are expanded by the growth of the Connecting Passage.



90. *Phase 2: Shift*

External conditions



91. *External conditions: Phase 2*

Spatial applications during the shift

Humans

Main Steps

1. Re-training current energy workers
2. Training and educating Rangers
3. Nurturing stabilizing population
4. Start non-human education program for tourist
5. Limited birdwatching allowed
6. Building of Co-living area
7. All personal vehicles are automated

Main Policies

1. It is mandatory to get the advice of a ecologists, on habitat retention for building activities in the harbor.
2. The workers in the harbor need to at least consist of 15% Rangers.

Non-Humans

Main Steps

1. Population gets stabilized
2. Instalation artificial reefs
3. Start Rewilding
4. Build Green Corridor
5. Finish fox habitat limitations
6. Start planting in Co-living area
7. Stop Extiction

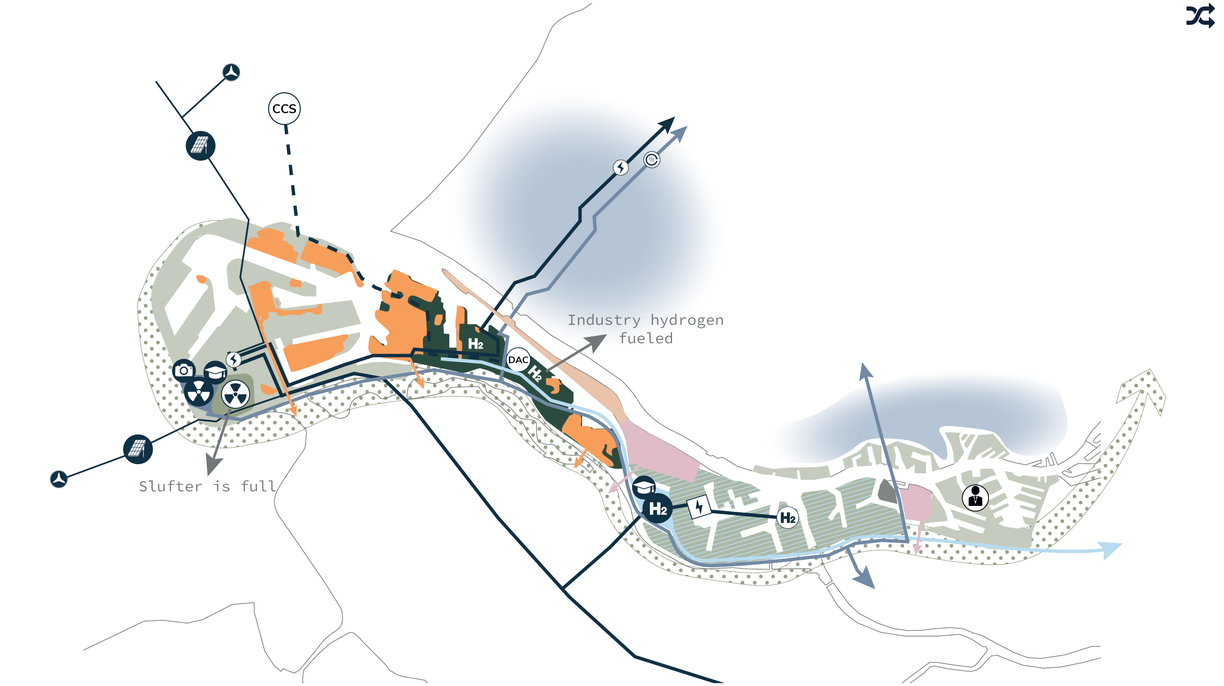
Energy

Main Steps

1. FF industries shut down
2. Start hydrogen production and transportation
3. Residual heat nuclear plant goes to cities
4. Completion construction solar pannels at sea

Main Policies

1. Industries using hydrogen are obliged to create hydrogen storage within their grounds.
2. All new build nuclear power plants need to reuse nuclear waste.

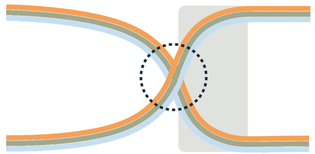


92. *Phase 2: Shift*

BALANCE

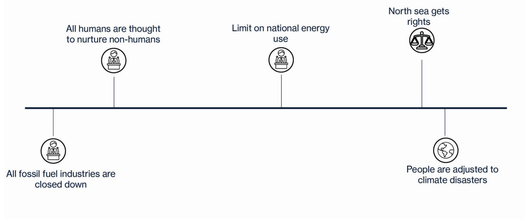
Phase 3

During the Balance phase, all aspects have been implemented and are harmonized. The three considered aspects; non-human, human and energy all have equal affordance scapes. This is made possible by the spatial implementations that focus on all three elements and by social changes. External conditions such as climate disasters, protest and war have led to the acknowledgement of non-humans. Recognizing the interdependence of human and non-humans, and the value of non-humans, they are included into the human justice system by becoming a legal body. Additionally humans are educated on how to nurture non-humans, working towards a post-human era.



93. *Phase 3: Balance*

External conditions



94. *External conditions: Phase 3*

Spatial applications in balance

Humans

Main Steps

1. Integration new energy workers
2. Nurturing population growth
3. Start tours in rewilding areas,tourist
4. First recidences of Co-living area

Non-Humans

Main Steps

1. Additional breeding areas are introduced for seagulls
2. Start expansion of seagull population
3. First coral shaping on artificial reefs
4. All green structures are connected to the Green Corridor
5. Planting in Co-living area is mature

Main Policies

1. Non-humans have become a legal body giving them the same rights as humans.

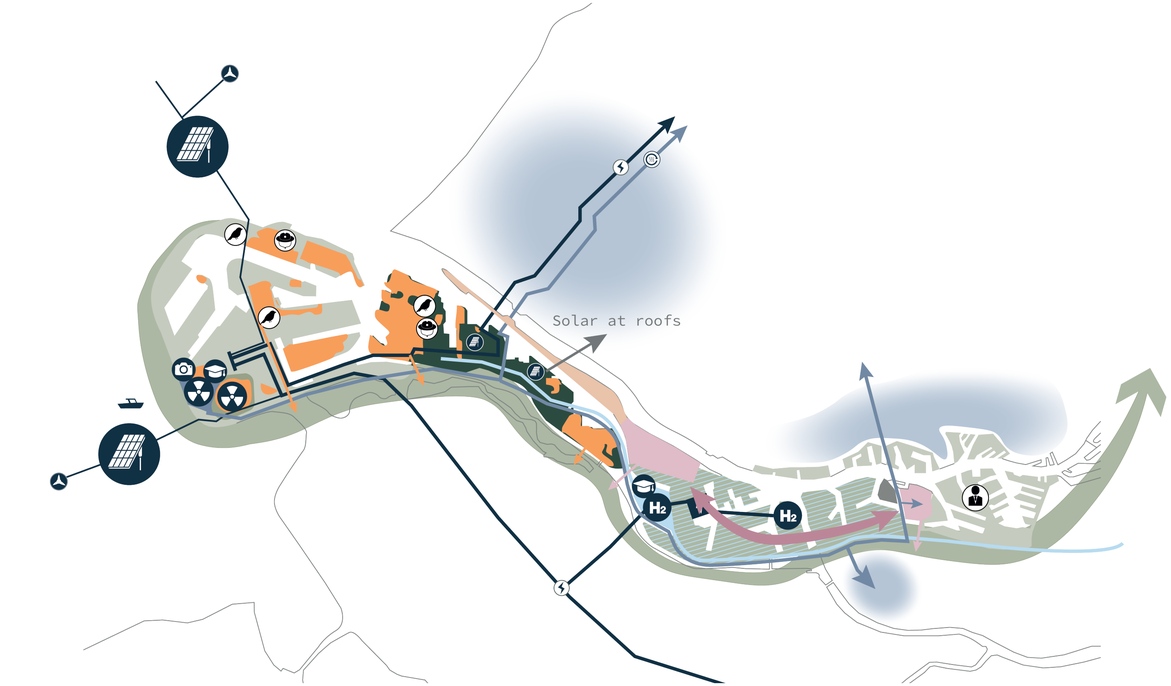
Energy

Main Steps

1. Completion build SMR
2. New batch solar on land
3. New batch batteries

Main Policies

1. Limit on National energy demand of 3000PJ.



95. *Phase 3: Balance*

Scale 1 : 125000

- Wild park - Purification and H2
- Breeding areas - Rewilding
- Neighbourhoods
- Distribution, Cargo
- Industry
- Green corridor
- Nuclear energy
- Hydrogen
- Solar power
- Wind power
- Electricity
- Residual heat
- Businesses
- Bird watching
- Rangers
- Education center
- Tourist center
- Hydrogen infrastructure
- Electricity infrastructure
- Residual heat infrastucture
- Heated urban areas

THE PORT

KEY LOCATIONS

Introduction

In order to provide a more thorough exposition of the fundamental principles, three key locations have been identified in which these principles can be applied in greater detail. In the following page, the co-existence of humans, non-humans and the energy transition is outlined for each of these locations. Each key location is then discussed individually, focusing on the specific principles relevant to that area.

For each location, the relevant key principles are highlighted, providing the context for their implementation. The the external conditions that influence the site are shown, which influence the spatial applications over time. This approach assists in understanding how the site will evolve and what factors need to be considered during development.

The next step is to visualise the phasing process using axonometric drawings to illustrate how the site will develop in the three phases. Finally, the stakeholders for this key location and the trade-offs and opportunities will be highlighted.

It concludes with a collage showing a vision of how each key location will look in the future, providing a glimpse of the transformed spaces where people, nature and energy systems will coexist harmoniously.

96. *Key locations*

- Wild park - Purification and H2
- Breeding areas - Rewilding
- Neighbourhoods
- Distribution, Cargo
- Industry
- Green corridor
- Nuclear energy
- Hydrogen
- Solar power
- Wind power
- Heated urban areas
- Electricity
- Residual heat
- Businesses
- Bird watching
- Rangers
- Scale 1 : 125000
- Education center
- Tourist center
- Hydrogen infrastructure
- Electricity infrastructure
- Residual heat infrastucture

EXPRESSIONS OF CO-EXISTENCE

Key location 1: Solar at sea

Non-humans, humans and energy use the same space.

Design according to this principle demonstrates that non-humans, humans and energy can coexist in the same space without restricting each other's affordances.

For example, the artificial reefs with solar panels. This zoom shows how solar panels can be used at sea to provide energy, while providing shelter for fish and other non-humans (as a no-fishing zone). The habitat created benefits the proliferation of marine species and later allows for human recreation.

Key location 2: Nuclear power plant

There is no interference between non-humans and humans as they both use their own space. However, they are connected by energy structures.

Design according to this principle shows that non-human and human space are separate, each having its own affordance scape, but that they share parts of their scape with energy.

For example, the nature reserve with nuclear power station on the Maasvlakte. This zoom shows how the currently heavily polluted land is being transformed into a nuclear production site and nature reserve. Humans will be restricted to the nuclear construction side to allow fragile non-human ecosystems to develop. Non-humans can use the nuclear construction side as they aren't restricted. Seagulls are even encouraged to nest on the side by the introduction of nesting sites.

Key location 3: Co-living area

Non-humans, humans and energy use the same space. However, their dominance in the use of the space is different.

Designing according to this principle shows that certain spaces are more dedicated to one of the aspects (non-humans, humans and energy). The dominance of one of the groups can vary according to the season or time period.

For example, in the co-living area. This zoom shows three different areas, the Rosenburg neighbourhood, the current oil depot and the current refineries. In the strategy, these three places develop separately, but are still intertwined.

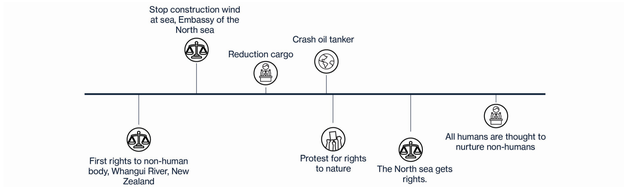
1. The current oil depot is initially dominated by energy, is rewilded after the fossil fuel industry closes (non-humans become dominant), and finally provides a place for humans to engage in seasonal activities (non-humans and humans share dominance).
2. The Rosenburg neighbourhood will remain primarily human-oriented throughout time. However, human behaviour in the neighbourhood will evolve due to the non-human education programme and the rise of the Rangers.
3. The current refineries will be rewilded after the industry closes, turned into a residential area and hydrogen storage facility. All claiming their own space within the boundaries of the co-living neighbourhood.

KEY LOCATION 1: SOLAR AT SEA

Key principles

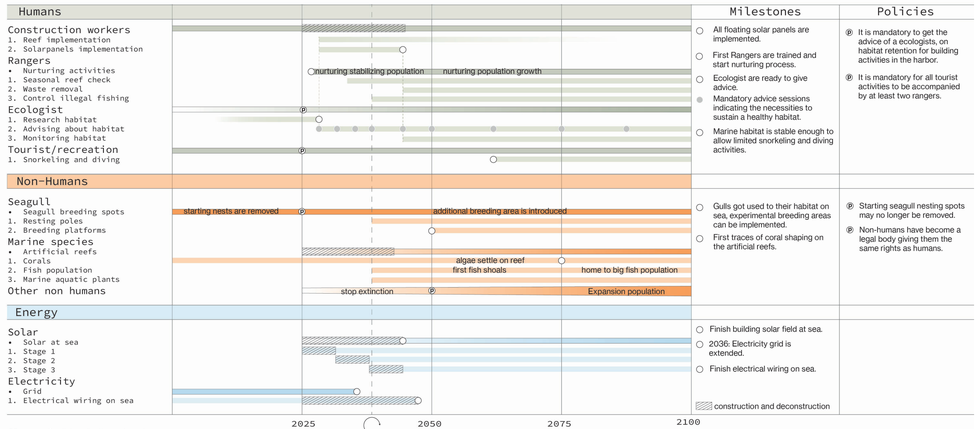
- Shifting point
- Policy
- Milestone
- Building facility
- Human activity
- Human activity - increasing
- Human activity - decreasing
- Non-Human activity
- Non-Human activity - increasing
- Non-Human activity - decreasing
- Energy activity
- Energy activity - increasing
- Energy activity - decreasing

External conditions



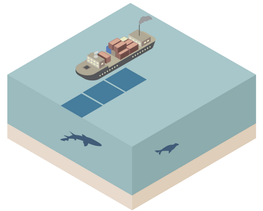
97. *External conditions, phase 1*

Spatial applications over time



99. *Spatial applications, phase 1*

Construction



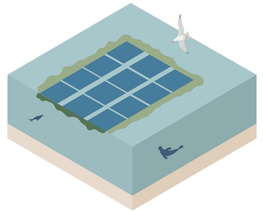
100. *Solar at sea during construction*

In the first phase, the installation of the first offshore solar fields begins. During this stage, it becomes clear that the fishing industry has significantly depleted the North Sea, resulting in a noticeable lack of marine life.

Construction of the solar field: The first solar fields being constructed

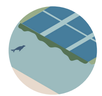
Empty sea with little fish: The fish industry fished quite a lot which resulted in a noticeable lack of marine life.

Shift



101. *Solar at sea during the shift*

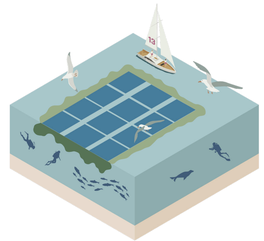
The installation of the offshore solar fields, combined with artificial reefs and vegetation around the panels, has now been completed. All solar panels are fully operational, supplying energy to the mainland, and occupy a large portion of the North Sea. As a result, fishing is no longer allowed in these areas, transforming them into protected zones for non-human species. This shift has created a safe environment for marine life to settle and thrive.



Artificial reef with the corresponding surface for real coral to grow on.

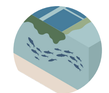
Vegetation on the edge of the solar fields for seagulls to rest and breed.

Balance



102. *Solar at sea balanced*

The artificial reefs have been expanded with real coral, providing a home for a wide variety of fish. In addition, seagulls now use the plants around the solar panels as resting and breeding grounds. Sustainable tourism has also emerged, with guided snorkeling tours offering visitors the chance to explore the vibrant marine life. A harmonious balance has been achieved between energy production, non-human protection and human recreation.



Artificial reef expanded with a lively ecosystem with a lot of fish.

Ideal location for eco-tourism and leasure boating.

KEY LOCATION 1: SOLAR AT SEA

Trade-offs

Impact on Existing Industries
Implementing offshore solar energy on a large scale may adversely affect traditional industries such as fishing and oil refining, leading to potential job losses. The fishing industry will face reduced access to fishing grounds due to the space occupied by solar panels, impacting livelihoods. Similarly, as the transition to renewable energy progresses, employment in the oil and gas sectors may decline. However, this shift also presents opportunities for workforce retraining and employment in the renewable energy sector.

Space Utilization in the North Sea
The installation of extensive solar panel arrays requires significant space in the North Sea, potentially leading to conflicts over maritime area usage. Careful spatial planning and stakeholder engagement are essential to balance energy production needs with other maritime activities.

Tourism and Ecosystem Disturbance
Introducing artificial reefs beneath solar panels can attract marine life, creating opportunities for eco-tourism activities like diving. However, increased human activity in these areas could disturb newly established ecosystems. Implementing strict regulations and guided tours can mitigate negative impacts, ensuring that tourism supports rather than harms environmental restoration efforts.

Opportunities

Marine Ecosystem Restoration
By restricting fishing activities in areas designated for solar panels and artificial reefs, marine ecosystems have the chance to recover from decades of overfishing. Studies have shown that overfishing has significantly depleted fish populations in the North Sea, with species like herring experiencing a 97% biomass decline from the 1950s to the 1980s (Dickey-Collas et al., 2010). Establishing protected zones can facilitate the resurgence of marine life and enhance biodiversity.

Renewable Energy Independence
Investing in offshore solar energy reduces reliance on fossil fuels and foreign energy sources, contributing to energy security and decreasing carbon emissions. This transition supports climate change mitigation efforts and aligns with global sustainability goals.

Eco-Tourism and Public Awareness
Artificial reefs can serve as attractions for eco-tourism, promoting environmental awareness and education. For example, the Cancún Underwater Museum in Mexico features over 500 life-sized sculptures designed to foster coral growth, drawing tourists and highlighting marine conservation (Taylor, 2009). Such initiatives can generate economic benefits for local communities while emphasizing the importance of preserving marine ecosystems.

Scalability and Global Impact
If successful, the integration of offshore solar panels with artificial reefs can be replicated in other regions, amplifying positive environmental and economic impacts worldwide. This model offers a sustainable approach to energy production and marine conservation that can be adapted to various coastal environments.

Conclusion

While the deployment of offshore solar panels combined with artificial reefs presents certain trade-offs, particularly concerning existing industries and space usage, the potential benefits for marine ecosystem restoration, renewable energy advancement, eco-tourism, and global sustainability are substantial. Strategic planning and stakeholder collaboration are crucial to maximize these opportunities.

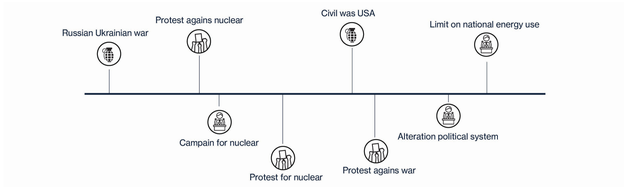
103. *Solar at sea balanced, collage (Baselayer: (OpenAI, 2025))*

KEY LOCATION 2: NUCLEAR POWER PLANT

Key principles

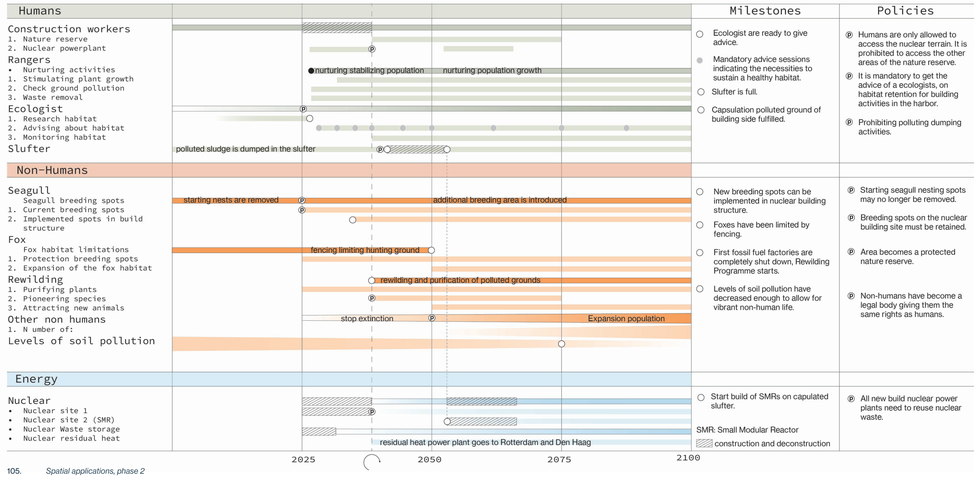
- Shifting point
- Policy
- Milestone
- Building facility
- Human activity
- Human activity - increasing
- Human activity - decreasing
- Non-Human activity
- Non-Human activity - increasing
- Non-Human activity - decreasing
- Energy activity
- Energy activity - increasing
- Energy activity - decreasing

External conditions



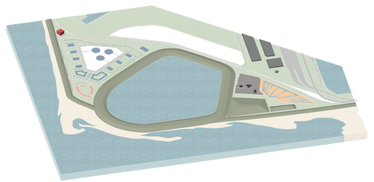
104. *External conditions, phase 3*

Spatial applications over time



105. *Spatial applications, phase 2*

Construction



106. *Nuclear during construction*

In the first phase, a traditional nuclear power plant with 7 reactors will be constructed, along with an expansion of the electricity grid. In addition, a large research institute will be built next to the power plant. To the north of the Slufter, an area will be transformed into a nature reserve to begin the restoration process.

Nuclear power plant construction: This nuclear power plant will be built with the current technology and will have three big chimneys.

Research institute: This research institute will be built to educate people about nuclear energy, but also has a ranger course.

Slufter is a depot in the Port of Rotterdam designed for the storage of contaminated dredged sludge.

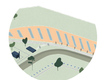
Shift

107. *Nuclear during the shift*

The first nuclear power plant, research institute, and the expansion of the electricity network have been completed. The area around the power plant is now fully integrated with nature, creating a harmonious environment for seagulls. The Slufter is completely filled with sludge, and work begins on the construction of 70 Small Modular Reactors (SMRs) in this newly transformed area. The first trees are planted to start the process of ecological restoration.

Nuclear power plant construction is finished and becomes the ideal habitat for seagulls with a protected zone around the chimneys.

Slufter is full and the construction of the SMR's begins.



(Orange zone above Slufter) Breeding zone for birds if finished.

Balance

108. *Nuclear balanced*

The SMRs are fully constructed and blend seamlessly into the newly vegetated environment of the Slufter. This integration neutralizes the contaminated sludge, improving the overall environmental quality. These changes create new breeding areas for seagulls, offering them safe habitats to settle and thrive. At the same time, a significant amount of energy continues to be produced in a stable, sustainable way. This leads to a balanced relationship between non-human life and the energy transition.

SMR's are fully integrated in the landscape and the area is completely greenified, where the vegetation cleans the soil and improves the environmental quality.

KEY LOCATION 2: NUCLEAR POWER PLANT

Trade-offs

Public resistance
In addition to solar power, nuclear energy plays a vital role in the envisioned energy mix. However, the construction of a traditional nuclear power plant often triggers significant public resistance. This is largely due to historical events, such as the disasters in Chernobyl and Fukushima, which have left lasting impressions on public perception and trust in nuclear safety (World Nuclear Association, 2023).

High investments
Another major drawback is the enormous upfront investment and long construction timeline. Building a nuclear plant can take over a decade before becoming operational, making it crucial to gain public and political support early in the process to avoid delays and increased costs.

Nuclear waste
Once operational, nuclear waste management becomes a critical issue. Although the waste occupies relatively little space, it must be securely stored for thousands of years. Deep geological repositories are the most commonly proposed solution, but they are expensive and politically sensitive (International Atomic Energy Agency, 2021).

High risk target
Additionally, nuclear facilities are considered high-risk targets in times of conflict or sabotage. While they are designed to withstand disasters, including the impact of a crashing aircraft, having nearby air defense systems is a logical precaution in today's geopolitical climate.

Opportunities

Efficient constant independent energy production
One of the key advantages of nuclear energy is land efficiency. A single plant produces vast amounts of energy on a small footprint, unlike solar farms which require extensive space. Moreover, nuclear energy provides consistent baseload power without the intermittency issues associated with solar and wind. This also contributes to energy independence, reducing reliance on foreign energy imports and increasing national resilience against political pressure from other countries.

Major research institute
The project also includes the creation of a major research institute adjacent to the nuclear facility. This has the potential to attract international scientists and engineers, turning the area into a hub for technological innovation, education, and knowledge-sharing in the field of clean energy.

Ecological restoration
Beyond energy production, the ecological restoration of the Slufter plays a crucial role. The area, heavily contaminated with toxic sludge, will be cleaned and revitalized through natural processes like phytoremediation and soil capping. This approach has been used successfully in other polluted sites across Europe (European Environment Agency, 2022).

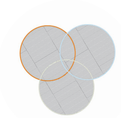
Co-existence
Lastly, this vision shows how nature and technology can coexist. The integration of seagull breeding areas within and around the nuclear site provides an example of how biodiversity and heavy infrastructure can share space, creating a balanced, resilient environment for both humans and non-humans.

Conclusion

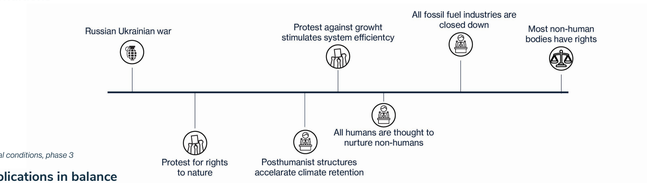
In conclusion, while the Port of Rotterdam's energy transition offers significant opportunities, it also involves critical trade-offs. Public resistance to nuclear energy, high upfront investments, and the challenges of nuclear waste management are notable hurdles that need careful consideration. However, nuclear power's ability to provide consistent, land-efficient energy alongside solar and wind helps ensure a reliable energy production. Additionally, the creation of a research institute next to the nuclear facility could foster technological innovation and attract global talent. Finally, the ecological restoration of the Slufter region exemplifies how technology and nature can coexist, offering a balanced approach to sustainability.

109. *Nuclear balanced, collage (Baselayer: (OpenAI, 2025))*

KEY LOCATION 3: CO-LIVING



External conditions

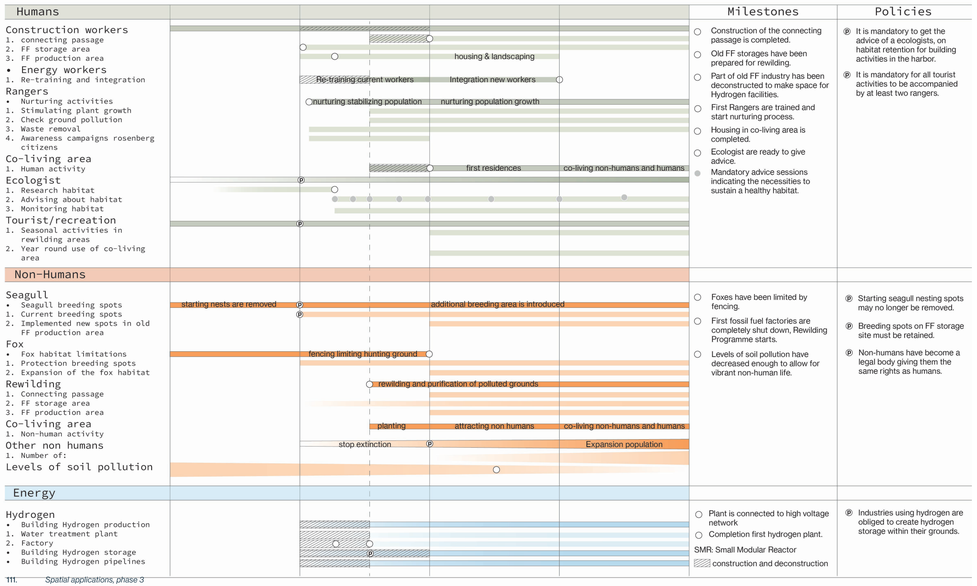


110. *External conditions, phase 3*

Key principles

- Shifting point
- Policy
- Milestone
- Building facility
- Human activity
- Human activity - increasing
- Human activity - decreasing
- Non-Human activity
- Non-Human activity - increasing
- Non-Human activity - decreasing
- Energy activity
- Energy activity - increasing
- Energy activity - decreasing

Spatial applications in balance



111. *Spatial applications, phase 3*

Construction

112. *Co-living during construction*

The large oil storage tanks, which have long been used as breeding grounds for seagulls, are becoming obsolete. This marks the beginning of a major rewilding process. At the same time, part of the Botlek industrial area is being transformed into the largest hydrogen electrolysis plant in the Netherlands. This includes integrated water filtration systems and an upgraded electricity grid next to the facility. Additionally, a hydrogen storage site is established, along with a major education center aimed at retraining workers and educating the public about hydrogen and clean energy.

Oil tanks protected habitat of the seagull will be left alone.

The hydrogen plant also includes a water purification area to convert salt water into fresh water. Additionally, the high-voltage electricity grid is being expanded to connect to the plant.

Shift

113. *Co-living during the shift*

The oil tanks are progressively rewilding, leading to improving soil quality and the gradual return of safe human activity in the area. Meanwhile, the hydrogen factory is fully constructed with all supporting components in place. The first wave of workers has already been successfully retrained from the oil and gas sector into hydrogen-related jobs. Construction of the “connecting passage” has also begun, creating a link between people, non-humans, and energy infrastructure.

Oil tanks slowly rewilding and cleaning the polluted soil.

The hydrogen plant is realised and is producing and storing hydrogen.

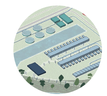
A major research and education institute has opened next to the factory. Workers from the fossil fuel industry can transition here into the renewable energy sector.

Balance

114. *Co-living balanced*

Eventually, the former oil tank area has been fully rewilded and is safe for recreational use, even becoming a space for community events such as festivals. This creates a stronger connection with the nearby town of Rozenburg. At the same time, the hydrogen factory is operating at full capacity, and the surrounding area continues to greenify, forming a balanced environment where energy production, biodiversity (non-humans), and human life coexist sustainably.

The oil tanks are fully rewilded and the soil is cleaned so the human activities will increase in the area, where nature and humans will live in co-excistance.



The area of the hydrogen plant is greenifying and slowly cleaning the polluted soil.

The connecting passage is finished so humans, non-humans and energy can go through this corridor.

KEY LOCATION 3: CO-LIVING

Trade-offs

Loss of industrial jobs
Transitioning from oil and gas to hydrogen production may lead to short-term job displacement. While retraining programs are planned, not all workers may transition smoothly, especially those with specialized skills or nearing retirement.

High investments
Establishing a hydrogen electrolysis plant, integrating water filtration systems, and upgrading the electricity grid require substantial financial investments. These costs could strain public budgets or necessitate significant private sector involvement. In addition, it could take 10 years to realize.

Hydrogen storage safety
Hydrogen is highly flammable and requires high-pressure storage, posing safety risks. Proper containment and safety protocols are essential to mitigate potential hazards. This makes the storage facility of hydrogen, like the nuclear power plant, a high-risk target. Therefore, robust safety and defense mechanisms are essential to keep the inhabitants of Rozenburg safe.

Opportunities

Job creation
The development of the hydrogen plant and associated infrastructure is projected to create numerous jobs in the renewable energy sector. The establishment of an education center further supports long-term workforce development and skill enhancement.

Environmental restoration
Rewilding the areas previously occupied by oil tanks can lead to improved soil health, enhanced biodiversity, and the creation of green spaces for public use, contributing to overall ecosystem resilience.

Integrated infrastructure
The construction of the “connecting passage” symbolizes and facilitates the integration of energy infrastructure with human and ecological systems, promoting a holistic approach to sustainable development.

Ideal energy carrier
Hydrogen is an ideal energy carrier to capture excess solar power during peak production moments and store it for later use. This allows for a stable and flexible energy supply, even when the sun isn’t shining. Moreover, hydrogen is especially suited for powering heavy industries, offering a clean alternative to fossil fuels.

Conclusion

In conclusion, while the transition to hydrogen production presents challenges like job displacement and high investments, it offers significant opportunities. The development of the hydrogen plant will create new jobs and support workforce development. Environmental benefits include rewilding industrial sites, improving biodiversity, and creating green spaces. Hydrogen also provides a stable, flexible energy supply and a clean alternative for heavy industries. Finally, the integrated infrastructure promotes a holistic approach to sustainable energy and development, ensuring a resilient future.

115. *Co-living balanced, collage (Baselayer: (OpenAI, 2025))*

NATIONAL

STRATEGY EXPANSION

Introduction

In this chapter, the influence, on National scale, from the harbor vision and strategy, is discussed. By producing all the needed energy for the Netherlands (3000PJ) within the Port of Rotterdam, all across the country energy industries can be closed down. These old industrial sites, using the same strategy, can become an co-living area, but above all an extension of non-human habitats.

Space for species

According to the species diversity map, all defined industrial areas are within/ bordering a high species diversity zone (with the exception of Region Eindhoven & Helmond, Breda & Tilburg and Eemshaven). Meaning that these areas have a great potential for becoming extended or new species habitats (Nationale Databank Flora en Fauna, 2017). To define the national non-human potential we looked into four types of non-humans; vegetation species, fish, mammals and birds. For every type, the three species that are currently most present in the appointed industrial area, are listed (Atlas Leefomgeving, 2025). These species, as they are already more dominant, will be the first to expand their habitats. This doesn't exclude the chances of other (or more) species thriving when applying this strategy.

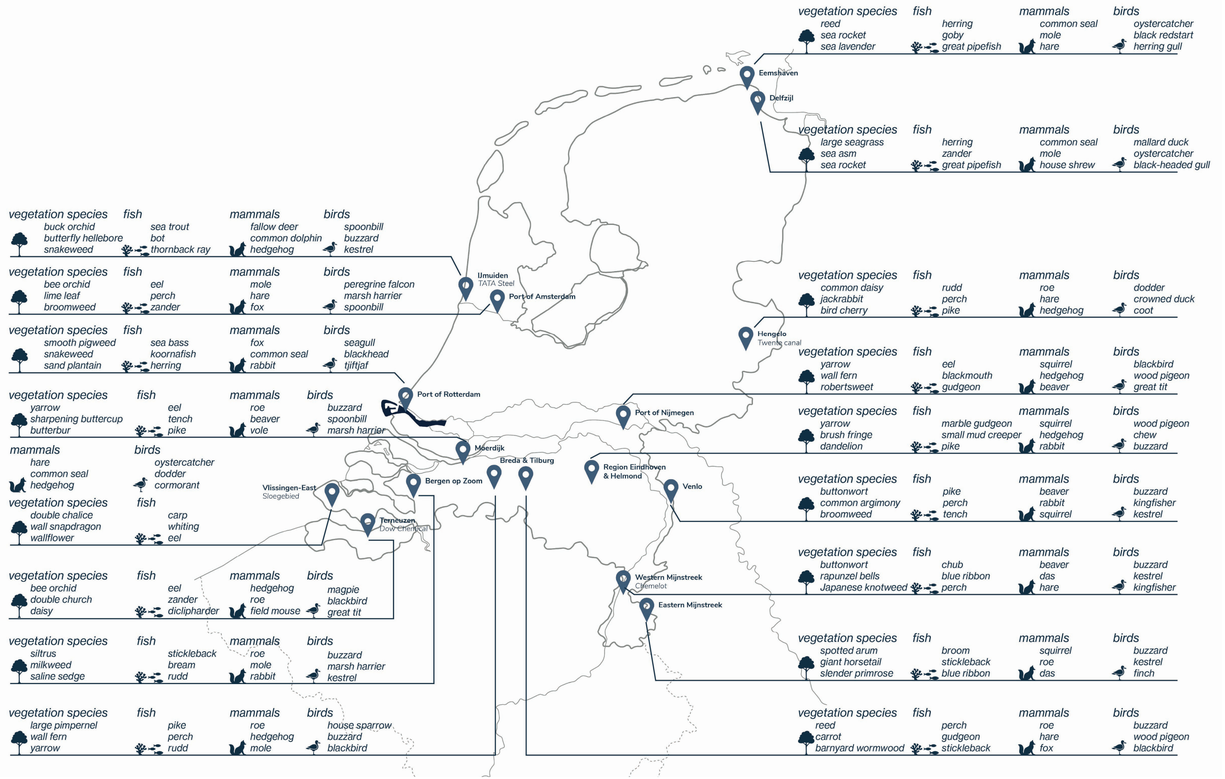
Vegetation species

Fish

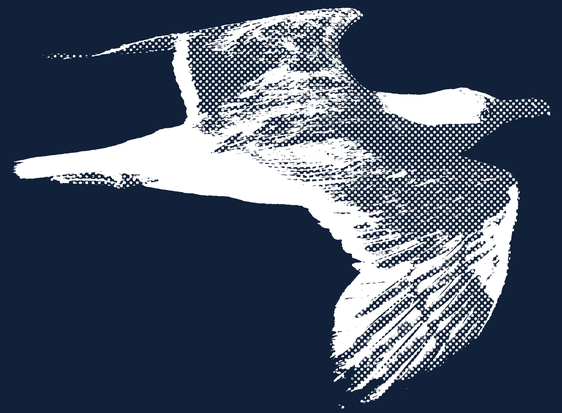
Mammals

Birds

116. *Space for species, National*



07.
DISCUSSION & REFLECTION



DISCUSSION

This research aimed to gain an improved understanding of how post-anthropogenic urban design can contribute to the creation of a more sustainable and ecologically just energy transition in the port of Rotterdam. We found out that using a framework that puts humans in the same ecosystem as a non-human species, in our case, the seagull, gave a lot of design insights where humans and that species both profit from. Rewilding port areas, for example, is a practice that is helpful to keep the ports' ecosystems healthy while also providing cleaner air, more public space, and recreational opportunities for humans. This report covered all sub-questions through extensive analysis of theoretical and spatial data. In this discussion, we reflect on these and describe how to answer the main research question using the information gathered throughout the analysis.

What are the spatial needs of humans and seagulls?

Humans are a species consisting of a lot of different communities, which all require different spatial needs. This report took some basic needs for humans in general, like clean air and soil, energy for residencies and industries, job opportunities, and urban green space for leisure activities. Some of these needs could be seriously improved in the port area to create a healthier living environment for humans, in which all these human needs are spatially connected.

Seagulls have different needs, which are often hard to map because we can't talk to seagulls to ask them what they need in certain areas. By reading literature on seagulls and talking with experts, we have gained a greater understanding of the lifecycle of the animal. With this improved understanding, we were able to map the spatial needs of seagulls. Our meeting with Joanna van der Leun gave us critical insights into the main food sources of seagulls, how they use space to hunt for food, their use of space to breed, and the spatial implication of the bird resting in human-built areas.

Which energy system is spatially and ethically just for humans and seagulls?

Spatially and ethically just energy systems for humans and seagulls are Nuclear energy, Solar energy, Geothermal energy, and Hydrogen. Based on this interpretation of just energy systems, we have created a vision with an energy mix that mainly relies on solar, nuclear, and hydrogen energy because these sources are all suitable options in the current port landscape.

How can the spatial needs of humans, seagulls, and a new energy system be combined in the Port of Rotterdam?

Through combining the spatial needs of humans and seagulls with a new energy system in the port of Rotterdam, we have created a spatial vision for 2050. In this vision, we have created areas in which seagulls can thrive, and humans play a crucial role in nurturing these areas, providing new jobs. The spatial changes also create possibilities for green tourism in the port, aiming to create a co-existence between humans and non-humans. This makes the new port useful for the spatial needs of humans and seagulls while providing a sustainable energy source for the Netherlands. This improves the quality of life and, therefore, the sustainability of the port.

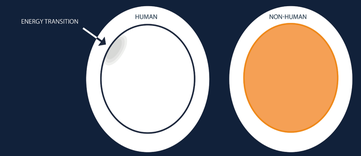
At this point, we return to the main research question:

How can we create a strategy for the green energy transition in the Port of Rotterdam, considering non-human species, such as seagulls?

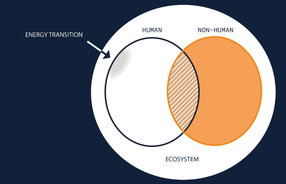
Our research has shown that the current energy transition in the port tends to prioritize human-centered technological advancement, often overlooking the entanglement of ecological systems and the needs of non-human species. The seagull, as an overlooked inhabitant of the port ecosystem, reveals the urgency of designing energy infrastructures that do not merely minimize harm but actively sustain multispecies cohabitation. Through this lens, the energy transition must be repositioned not just as a technical or economic challenge but as an ecological transformation embedded within a larger, interdependent system.

Shaped by our conceptual framework, we understand the port not as a neutral site of production and logistics but as a layered socio-ecological landscape where human and non-human actors interact and interrelate within shared spaces. Designing within this framework calls for a commitment to ecosystem-based thinking, where spatial interventions are evaluated not only for their efficiency but for their ecological consequences. This shift requires us to move beyond anthropocentric planning logic and towards a spatial practice rooted in justice, one that acknowledges all impacts of spatial transformation on all human and non-human entities.

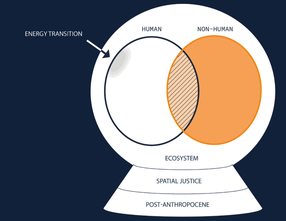
Ultimately, by embedding the energy transition within broader ecological and ethical considerations, we contribute to a vision of the post-Anthropocene. We aim to direct this research into a future in which human agency is decentered and multispecies co-existing, co-shaping, and flourishing becomes a core design principle. This reorientation opens up new possibilities for inclusive, evolving, and just energy landscapes in the port and beyond.



117. *Conceptual framework Anthropocene*



118. *Conceptual framework shift*



119. *Conceptual framework Feathers & Fuel*

GROUP REFLECTION

Reflection on Sustainable Development Goals

A comprehensive review of our project is essential to evaluate its impact and how effectively it meets its objectives. One useful framework for assessing our design proposal is the Sustainable Development Goals (SDGs), which emphasize the need for global collaboration. The graphic on the right illustrates our estimation of how well the project's outcomes align with the 17 goals. In the following, we highlight the most significant results.

When looking at the SDGs it quickly distinguishes that they are currently only human-focused (Figure 117). To combat that, we assessed them also from a non-human perspective, where it becomes visible that nearly one third of the categories cannot be transferred to non-human species (Figure 118). Thus, it is strongly advised to critically look at them when dealing with non-human communities.

Our commitment to spatial justice for both humans and non-humans reflects the principles of SDG 3 (Good Health and Well-being). By evaluating the project's effects on vulnerable groups, we aim to support the goal of leaving no one behind, as emphasized in SDG 10 (Reduced Inequalities). In addition, many of our initiatives actively contribute to SDG 11 (Sustainable Cities and Communities).

Considering the project's contribution to environmental sustainability—which we aim to achieve through various approaches—highlights the pressing need to combat climate change and preserve biodiversity, as emphasized in SDG 13 (Climate Action) and SDG 15 (Life on Land). As such, these core elements of our design proposal are intentionally balanced to address both human and non-human perspectives equally.

Promoting a more circular economy significantly supports SDG 12 (Responsible Consumption and Production). In combination with the integration of selected climate-neutral energy sources for sustainable energy generation, the project also aligns with SDG 7 (Affordable and Clean Energy). However, these approaches are primarily framed from a human-centered perspective, often overlooking the needs and roles of non-human entities.

On the other hand, there are also categories that are ranked higher for non-humans than for humans, such as SDG 2 (Zero Hunger) or SDG 14 (Life Below Water). Particularly interesting here are SDG 16 (Peace, Justice, and Strong Institutions) and SDG 17 (Partnerships for the Goals). By giving rights to nature and starting a new wave, or even a revolution, these two principles are closely connected to our topic of non-humans.

In summary, aligning our project with the Sustainable Development Goals allows us to contribute to the global push for sustainable development and collective responsibility. However, this initial assessment also reveals areas that require further attention. As we move forward with implementing our strategy, it remains essential to ensure an equal consideration of the human and the non-human perspectives and therefore, also formulate new goals that refer to both.

Reflection on scientific relevance

Scientifically speaking, it clearly distinguishes that science and research about non-human activities are very limited. Due to the massive knowledge gap, we are facing a whole undiscovered research field ahead of us – a field where we as humans can learn a lot from.

This project therefore seeks to address the inequality between human and non-human species. It should resemble an example of how it is possible to also consider more-than-human entities and still achieve human-set goals. In this regard, it adds to the scientific body of knowledge by offering a thought experiment on how this combination of different interests is possible.

Through the project, the human and the non-human species are set into the same framework and are being treated the same way, by giving rights to nature. This way of designing sheds light on what current practices are missing out.

Given the unpredictability of future developments, our work involves navigating a significant degree of uncertainty. While the project is grounded in a well-developed theoretical framework, its practical application remains an open question. This initiative offers a valuable opportunity to bridge that gap by presenting a model for designing in collaboration with non-human communities. As our project represents one of the first experiments in our work field, we are hoping to encourage others to do the same and start thinking out of the box.

Reflection on societal and ethical relevance

Regarding the societal and ethical system and how society perceives it nowadays, it is noticeable that we are currently missing a major part of it. Through this exemplary project, we are attempting to showcase another way of comprehending the topic and thus being highly ethically relevant. Therefore, this project marks the start of a larger transformation.

Justice lies at the heart of our vision, driving us toward a fairer and more equitable world for all. But is that really the case nowadays? Who are we taking into account when stating all? These questions represent the main pillars of our project and its framework.

A post-Anthropocene view is needed to live and design in an ethical way. However, achieving this vision requires more than just words – it demands a fundamental shift in how we make choices and think about us, humans, as a superior species. As urban designers of the future, it is our role to reflect on our systematic way of thinking.

Our project aims to steer these transitions in a new direction. By raising awareness about overlooked non-human communities, we can drive systematic change that also tackles underlying social injustices. Together, we can forge a path towards a more sustainable, equal, and just future where everyone and everything can thrive. Ultimately, to inspire more people and support this shift, we are also sending our final report to the Port of Rotterdam, showing a different way of planning.

120. *SDG's Feathers & Fuel, human perspective*

121. *SDG's Feathers & Fuel, non-human perspective*

Human

- Moderate
- High
- Very high

Non-human

- Not existing
- Moderate
- High
- Very high

Reflection on ethical issues

By working on behalf of a non-human needs it is not possible to make use of traditional methods and principles to perceive the interpretation of the community itself and their needs. Therefore, the amount of comprehension we can achieve is limited to the fact that we are humans. Although we cannot represent seagulls completely, we can express it as well as possible by talking about it with experts and doing research in this field.

As we had to work in combination with a human-focused view for this course, we used maps and methods practiced in university. But when designing for a non-human community, these practices are not always the right choice. To truly fulfill the needs of the picked transition community, a different rubric and set up of the program are needed. In addition, due to our composition of the group, we lack different qualifications and perspectives. Since we are all highly educated and have the same Western background, we have a limited understanding of humans and non-humans.

Furthermore, it is also important to note that by picking the seagull as an example, we pushed away other species – knowing that this should not be the way we, as post-anthropogenic urban designers, are planning regions. But even though we chose the seagull as our transition community, many other non-human species also profit from our design proposal, such as marine life.

Consequently, with this project we seek to show that it is possible to not only design for a non-human community but also to combine their spatial needs with the ones for humans to result in a balanced vision.

However, since the course is only supposed to take nine weeks, we only scratched the surface of issues of spatial justice and post-Anthropocene designs. While acknowledging the complexity of understanding the whole system, we remain committed to advocating for strategies that strive towards this overachieving goal.

Moreover, there is also a determined area of experimentation with this project. Due to the time restrictions, we needed to find data about seagulls from other researchers, but if we had more time, it would have also been interesting to do original research by ourselves with, for example, counting bird nests. Thus, we hope to encourage future projects to dive deeper into this field of work.

Reflection on public goods

The definition of Stanford Encyclopedia of Philosophy describes public goods as major backbones of a "smooth functioning of society—economically, politically, and culturally". ((Public Goods (Stanford Encyclopedia Of Philosophy), 2021)) Public goods are spatial elements that are freely accessible to all and do not lose value when used (Roberto Rocco, 2025) "such as national defense, infrastructure, education, security, and fire and environmental protection" (Public Goods (Stanford Encyclopedia Of Philosophy), 2021). As already mentioned, it is also noticeable here that the definition only takes the human perspective into account. Since the public does not only consist of the human species but also the non-humans, it is urgently needed to redefine this explanation and the way we comprehend it.

As we learned in the Methodology lecture, a high-valued place for humans is always characterized by a huge amount of public goods being around. But does this also apply to non-humans? Not per se. Thus, we, as a society, are asked to question the traditional public goods we are creating and to also consider the more-than-human aspects to design for a balanced future.

In our regional design proposal, we incorporated several public goods - traditional ones and new ones - in order to shift towards a new perspective. In the following, we shortly state some of those to offer a deeper understanding of the topic.

When thinking, for example, of environmental factors, it is noticeable that in the long-standing definition it mostly only means to create special ecological areas for human benefits. How our group started to comprehend this now is more to extend this definition by also considering the non-humans through giving them space to flourish (environmental restoration). Beyond that, through rewilding and greenifying dedicated areas, indirect health benefits as well as purified soil are achieved.

Furthermore, in our vision, a huge amount of private ground is being converted into public spaces and, above all, greenified to create an appealing scenery where all entities (human, non-human, and energy) can coexist with each other.

Moreover, by connecting not only the two neighborhoods inside the Port of Rotterdam with each other but also connecting the port itself to the city center, new infrastructure for humans and non-humans is being developed. As a result, the design proposal attempts to create (more-than-) public space by giving private companies less space.

As it is visible in our key principles of coexisting, connecting, evolving, rewilding, greenifying, and appealing, we are always taking into consideration both – the human and the more-than-human view. Ultimately, by designing the public goods named above, we are showing a new perspective and a possible shift in thinking about the public, society, and the way we perceive space. Through nurturing non-humans for a post-human future, a sustainable mindset will be built.

Possibilities for further research

In this project, we have attempted to address the topic as best as possible in the sake of the time given. However, due to the limitations named above, when looking at such big and innovative topics, it is indisputable that there are more possible research questions and ways to perceive this topic.

Further research, building upon this project, could include the identification of relations between the species of the seagull and other non-human communities.

How is it possible to design for multiple species without neglecting others?

Beyond that, it could also be fascinating to focus in more depth on the lifecycle of the seagull and design not location-based in the Port of Rotterdam but more in relation to the lifecycle.

Moreover, since the time perception of humans and non-humans is completely different, every month has a different routine, and even years can look completely different from species to species. Therefore, it would be thrilling to also dive deeper into these topics to fully understand the observed non-human community.

We hope that our project can be a pilot project for further research. By encouraging others to think out of the box and rethink set standards, principles, and paradigms, we are looking forward to seeing more projects like this in the field of urban design to create a balanced and sustainable future – for everyone and everything.

INDIVIDUAL REFLECTION

Jonne van Bunningen

In the following text I will reflect on the group process that created this project. Personally, this project working with posthumanism using a non-human perspective, is the second experiment, in a range of (hopefully) many still to follow, searching for posthumanist design approaches. As the first experiment (Q2) was individual, the collaborative aspect of this project has taught me a lot.

Looking back to the start of this process I'm amazed by the steps we took as a group. As the project is based on theories that are considered rather niche, neglecting dominant worldviews, I didn't expect a whole group to be interested, or to be willing/able to work with these concepts. Especially because the project started with a hype for non-humans, without everybody sharing the theoretical background knowledge feeding the urgence for that hype. Nevertheless, I feel honored that in the beginning of the project, I was given the chance to elaborate on the topic of posthumanism, post-Anthropocene and related concepts, to together with the group, lay the foundations of our criticism and aspirations within our theoretical and methodological framework.

To dive into the regional design, the design process in the beginning took up more time. Setting the baselines (narratives) for the posthumanism mindset required long in-depth group discussions. However, to create a posthuman future certain implementations are already demanded; decentralizing humans, equality for non-humans etc. Being clear guidelines for creating our vision. The vision became the confluence of all the aspirations created by the discussions. After having created a vision, we used it as our guideline to create the strategy. We have worked backwards to create the strategy that would lead to this vision (as was taught in the SDS lectures).

The most steering aspect in the creation of our vision was our understanding of the needs of the selected community. However, although understanding of the community and its relationship to other communities is essential for creating a successful strategy (you want to create their, and the stakeholders, aspiration) we can't communicate with non-humans. Nevertheless, as we are designing for transitions, we need to be able to design for transitioning communities (or the transition of the definition of communities). Therefore we need to acknowledge that our understanding of non-humans will always be a reflection of our own human interpretation. This reflection can be more or less accurate depending on the amount of knowledge you can gather on the species. As a group, by calling in advisors (I happened to know Julia and Joanna), we expanded our knowledge. Also knowing that academic knowledge in itself is limited.

To conclude, the collaboration with my group showed me that individuals without background knowledge about posthumanist theory can easily be though how to work with this theory* Collaboratively we became more radical than I could have been individually. The group also kept each other sharp, advocating for the narratives, as it was easy to fall back into dominant ideas. Experiencing this has given me a lot of hope for the possibilities of sharing this world view more widely with others. Still carefully to counter misconceptions, it is slowly becoming a philosophy that can exist beyond a niche and might one day even become common knowledge. I hope to add to this process by continuing to experiment with posthumanist urban design. It would be very interesting to, in the following experiment, step away from conventional urban methodologies and dive into other pedagogies.

*Hereby I have to exclude the nuances of the posthuman theory and related concepts, as due to time limitations and the boundaries of academic education, it isn't possible to encapsulate them. Also the current knowledge gaps concerning non-human actors etc. demand for a more extensive research period.

Jisk de Vries

With an urban planning background and now studying MSc MADE, I was really interested in bringing my theoretical skills to practice. In the past, I have learned a lot about planning principles, stakeholders, spatial policies, etc., while never truly designing spaces. This urbanism course sparked my interest because I believed that, together with a team of design experts, I would finally have the opportunity to contribute to a meaningful and future-oriented design for a place undergoing the energy transition.

The port of Rotterdam was an interesting place to investigate at first, and design and strategize for after that. It's a crucial element in the Dutch energy transition, behaving as a hub for several energy sources. The seagull is a highly overseen community there. Not just because the Port of Rotterdam has the biggest seagull population in Europe (Port of Rotterdam, 2022) but because the seagull is a species that travels great distances throughout its life cycle, covering space on land, above water, and in the air, and it has different needs depending on the season. This makes the bird, in my opinion, a perfect case study for this research and design course.

During my academic and professional development in the field of urban planning and this course, I have come to understand that regional planning has an integral nature. It's a multilayer approach in which spatial design, policy, and governance come together and shape a design vision of a region. Regional design doesn't solely operate on a spatial scale, but it also operates through time. The strategy for the port of Rotterdam offers insights into the different key projects, policies, and social events that have cascading effects on other events and spatial implications. For me, as a professional, this opens up the insight that planning and designing small spatial interventions could have an enormous impact on the overall spatial design of a region. I recognize the energy transition as an enabler of spatial evolution that has a far wider perspective than only creating a new energy infrastructure. It can enable spatial change in cities and, using solid policies, can improve communities' well-being.

Usually, when researching human communities, I think it's feasible to truly understand a community. There exist many strategies to put yourself, as a researcher, in a community by observations or in-depth interviews with community members. (Seale, 2012). Our non-human approach made it challenging to truly understand the needs and wants of the community we designed for. By conducting interviews with experts and doing literature research on seagulls, we could only partly grasp their spatial needs. The theoretical framework and the Post-Anthropocene foundation, however, gave us a good basis for understanding human-seagull relationships in an ethical and just way. These insights, although limited due to restraints in time and resources, gave a solid foundation to build upon when creating a vision and a strategy for the port of Rotterdam. Engaging in this allowed me to explore this multidimensional and ever-evolving role of regional design. What we do is not just reshaping spaces; we reimagine relationships between energy infrastructure and ecology, between human and non-human actors, and between today's choices and tomorrow's outcomes.

Derk Hermans

Reflection on our theme and myself as an urbanist

From a young age, I became familiar with the Port of Rotterdam, often cycling through it and learning about its significance as a symbol of Dutch pride and prosperity. When we took a field trip by car through the port, it felt like returning home. I already had certain communities in mind for our project, such as the workers in the port or residents of Rozenburg and Pernis.

What I always appreciate about group projects is how people bring in different perspectives. In today's world (especially on social media) there is often a strong focus on defending one's own values and beliefs. However, I find it enriching to be open to other viewpoints. While I viewed the port with pride, one of my group members saw something different: the lack of consideration for non-human actors in the design and function of the area.

This perspective led me to agree on choosing a non-human community for our project. It challenged my view of the Port of Rotterdam and pushed me to see it in a new light. Looking back, I've become more aware of the importance of designing inclusive environments where humans and non-humans coexist. A perfect example of this harmony is Nara, Japan, where people and wild deer live together in balance and can use the same public space. I hope our cities can move toward that vision.

Reflection on my learning process and personal skills

During this period, I found the schedule to be clear, and the lectures complemented each other well across the different courses. The workshops we followed throughout the weeks were well-aligned with the phases we were in at the time. One of the key insights I gained was understanding the importance of a conceptual framework. Initially, I didn't fully grasp what we were doing as a group, but after receiving a lecture and discussing the conceptual framework further during studio guidance, it became clear. It actually formed the foundation of how we approached our project.

Personally, I tend to take a hands-on approach. I like to get to work quickly and make progress. However, the lectures and studio sessions helped me realize the value of first reflecting on how I want to approach a project and what I want to highlight within it. This approach is something I will definitely carry with me into my master thesis.

I particularly enjoyed the GIS workshops. They allowed us to find valuable data on the seagull. The workshop in week 7 was perfectly timed, as we were just beginning to shape our strategy. I gained a much clearer understanding of what a spatial strategy entails. I also hadn't expected stakeholder analysis to be so essential, it really helped reveal relationships and identify who we needed to convince.

I especially enjoyed translating our strategy spatially. It allowed me to apply my personal skills in creating visualizations like axonometric drawings and renders. Crafting a clear narrative and knowing what you want to show was essential to convincing our audience.

All in all, I believe we created an inspiring project. I hope this will be an eye-opener for urbanists and policymakers to consider new perspectives. At least I know I certainly will in my future work.

Anouck van 't Schip

Our community started with truckers, but soon took an unexpected turn - towards a feathered friend (and often enemy): the seagull. Sharing our project with other students elicited interesting reactions. When I mentioned that we were designing from a non-human perspective, the common response was: *"Oh no! You're from that seagull group?!"* - followed by laughter. It was in those moments that I realised how different and perhaps radical our approach was.

A shift in perspective

Compared to earlier projects, regional design demanded a far more layered and interconnected mindset. Working in the port of Rotterdam – through the lens of the seagull – challenged me to design not just for people, but with and for more-than-human actors. This new way of thinking disrupted my previous understanding of design. While we were intrigued by the post-Anthropocene philosophy, we were far from fluent in it. The insights from Jonne and Julia helped, but we needed time to settle in. The first weeks were slow as we navigated unfamiliar territory.
Designing from a non-human perspective expanded the range of factors we had to consider: energy flows, ecological systems, and speculative futures all had to fit within a coherent design framework. We soon realised that the seagull wasn't a mascot, but a vehicle to explore a post-anthropocentric worldview – where coexistence, not dominance, shapes design.

The role of vision

Our vision became a defining moment in the project. Before the midterm, we were stuck in fragments, often debating ideas in isolation. As the deadline neared, we began weaving those fragments into a cohesive story. Our vision became both anchor and compass – an imagined future that guided our process. We broke it down into scenarios and spatial interventions across a timeline, allowing us to strategise long-term change while keeping interventions grounded and specific. Still, this clarity brought new debates and pushed us to constantly reassess our logic.

Imagination as method

We argued that non-human life should be part of a justice-oriented spatial approach – not merely for nature's sake. The key question wasn't if we should transition, but how to make it compelling and tangible. That's where imagination became essential. Our presentation, "Lesson 1: Introduction to Becoming a Ranger in the Port of Rotterdam, Class of 2040," aimed to visualise a future that was both radical and relatable. At times, I lost sight of the human perspective while immersed in non-human systems. But this tension helped us create a more inclusive and balanced narrative.

Understanding transitioning communities

Regional design, in this context, became a form of storytelling and translation. Engaging with transition communities is vital – not just because they face change, but because we can help shape what that change looks like. Understanding community desires, especially across species, is complex. We relied on expert knowledge and existing research to gain insight. This layered, indirect approach wasn't perfect, but it offered a multi-scalar understanding within the limits of the course and the current methodology system.

Conclusion

Designing with non-human actors in mind taught me to see space differently, act more imaginatively, and reflect more ethically. Regional design, I've learned, is not just about shaping land, but about shaping the stories we tell about who belongs in it.

INDIVIDUAL REFLECTION

Linda Peled

Reflection on group dynamics
I felt very comfortable right from the start of the group work and would describe it as extremely pleasant in retrospect. Even though we had difficulties agreeing on a topic at the beginning due to a change in the group constellation, we were able to overcome these initial difficulties through constructive discussions and then start producing the actual content.
At the start of the group work process, our focus was on understanding our team dynamics and establishing an effective workflow. Before long, we developed a smooth and balanced rhythm, with each member contributing equally. This collaborative dynamic remained consistent throughout the whole project. When individual working styles occasionally differed, the rest of the group adapted effortlessly to maintain a steady and productive flow.
The fact that most of the group members were working in the field of post-Anthropocene urban planning for the first time made the way we worked together very interesting, as everyone was able to contribute their own personal touch, ideas, and opinions.

Reflection on the course approach and personal growth
At the beginning of the project, I was not only somewhat critical of the large scale but also of the intensive consideration of the topic of energy, as I had hardly had any contact with these topics before and felt somewhat lost. However, it was precisely these topics that I found extremely interesting during the project, especially due to our completely different approach to the project.
Even if there were some challenges associated with the changed comprehension approach, I would definitely consider pursuing the topic of non-humans in future projects and doing further research in this field. During the project, I always found myself falling back into the thought patterns and principles that have been established over the years and automatically assuming the purely human perspective, which should not, however, be pre-set. This also played a key role in leading me to rethink my firmly anchored mindsets of ecological designs. Before this project, I usually considered myself to be interested in ecology, but it was only through this project that I realized how limited my views were before. I was right that my interest still lies in more ecological designs, but I have fundamentally changed my way of understanding and evaluating them.

Reflection on the role of the vision and how it has influenced our development strategy
As we have chosen a fundamentally different approach, it was particularly important to elaborate on the resulting vision with strong arguments so that it is not only purely feasible in the next step but also easily practicable and appealing to people to be successful in the long term. When designing the strategy, it was therefore particularly important not only to design for our chosen community but also to constantly reflect on the human impact. The fine line between focusing on a non-human community and strengthening their assumed needs while at the same time developing a balanced vision that also attracts humans was consequently not always easy to manage.

Reflection on whether we should design for transition communities
It is undeniable that it is good to design for transition communities. Due to the constant development of technology and new innovations - even beyond the energy transition - the whole of humanity (and, of course, the more-than-humanity as well) is facing an enormous challenge. The continuously changing settings and spatial needs of communities are just the tip of the iceberg. It is therefore of particular importance to address precisely those transition communities that are excessively affected by this ongoing change - in a positive or negative sense - and to give them a voice.
However, one should never lose sight of the big picture. By concentrating on one specific community, it can quickly happen that other equally important communities are negatively affected. With regional design, it is especially important to always remember that we are planning for an enormous amount of space and will accordingly encounter hundreds or even thousands of communities and influence their habitats. For that reason, design decisions should be made very carefully and on a strong basis. Does what appear at first glance to be an improvement in the situation lead to an enhancement? Who has the right to judge this?
To refer to the methodology lectures here, it is important to determine at the beginning of the design which evaluation system will be used to make these decisions. Should most individuals benefit from the changes (Utilitarianism), or perhaps a currently disadvantaged and subordinate group (Economic Egalitarianism) (Roberto Rocco, 2025)?

Reflection on the needs of transition communities in a regional design process
These certain communities should be involved in the decision-making process, but how is that possible?
Especially with the transition community chosen by our group - the seagulls - it is not easy to understand their hopes and dreams and thus to take them into account. In this way, it is of particular importance to - adapted to the specific transition community - find ways and means to give it a voice and then derive the outcomes into spatial principles in the next step.
In addition, also in regional design multi-scalarity should be permanently present to maintain constant contact with the humans and non-humans during the design process and beyond that, integrate them equally into the process.

Conclusion
In conclusion, I experienced the regional design group project to be a highly positive and enjoyable experience. It allowed me to learn from my peers, strengthen my design abilities, and grow more confident in the value of the skills I already bring to the table.

122. *Collage (OpenAI, 2025)*

123. *Collage (OpenAI, 2025)*

MORE SCENERY

Nothing but
Land cleared up
Shaped ideas of beauty
For a few hundred years

Till the land turned
Its gaze on us
The trees began to speak
Like before

And those huts in the distance
Straw as Van Gogh
Began to walk towards us
Bellowing a strange howl

As the air too changed
And the old pastels would no longer do
It would be now two-way or nothing
A strange reckoning

Our daily life, our museums
Our view of what works
That eureka moment, even that long lost
Trace of a smile.

A poem by
Goswami, A., (2021)

08
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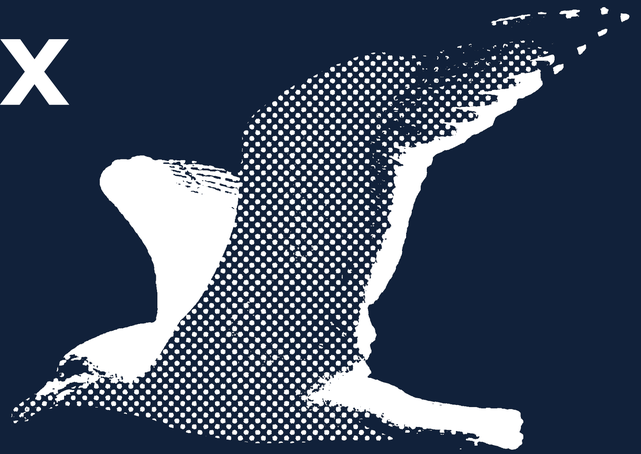
APPENDIX



APPENDIX

1. THE PORT OF ROTTERDAM

Interview summary Jan Putters and Lissethe Veenstra

The following is a summary of the interview with Jan Putters, Senior Asset Manager Infrastructure at the Port of Rotterdam, conducted as part of our research on the energy transition in the Port of Rotterdam and its impact on non-human stakeholders, specifically seagulls. Additionally, Lissethe Veenstra was present in the online meeting to provide further clarification on biodiversity within the Port of Rotterdam. She is a biologist/herpetologist and an Asset Manager for infrastructure at the Port of Rotterdam.

Key questions and findings

1. Permission for Recording: Jan Putters granted permission to record the conversation for transcription and use in the final report, which will be published on the TU Delft repository. The transcript will be sent to him for review and any corrections.

2. Introduction to the Project: The project aims to explore the energy transition in the Port of Rotterdam for 2050, with a particular focus on the non-human stakeholders, specifically seagulls. The project seeks to integrate the perspective of seagulls into the strategy for the energy transition, ensuring that both humans and non-humans can coexist in a healthy ecosystem.

3. Role and Background of Jan Putters: Jan Putters works as Senior Asset Manager Infrastructure at the Port of Rotterdam. He has been in this position for 18 years and is responsible for managing the land, both above and below ground, in the port area. His tasks include overseeing the management of public spaces, leasable land, and buffer zones.

4. Views on the Energy Transition: Jan sees the Port of Rotterdam's energy transition as part of the larger goal for the Netherlands to become climate-neutral by 2050. The Port is already taking steps towards this transition, including switching to electric vehicles for contractors and exploring circular initiatives. Projects like Porthos, Warmteling, and hydrogen networks are part of this transition.

5. Impact of Wind Farms on Seagulls: Jan expressed that the impact of wind farms on seagull populations is a topic of debate. Many ecologists believe the effect is minimal. The largest colony of seagulls in Europe exists in the Port of Rotterdam, and while wind farms are necessary for energy production, Jan doesn't foresee a major issue with seagulls being affected.

6. The Seagull in the Port: The interview focused on seagulls, particularly the silver gull and lesser black-backed gull, which are common in the port area. Jan and Lisette monitor the breeding process of these birds, with around 500 adults being tagged each year. The data shows that the birds migrate to southern Europe but return after 2-3 years to breed.

7. Seagull's Food Sources: The seagulls primarily rely on food from the port area, although recent regulatory changes have reduced available food sources. Additionally, the arrival of foxes in the area has led to a decline in the seagull population. Jan and Lisette are working to mitigate this through initiatives like tagging the birds and providing alternative breeding spaces.

8. The Fox as a Threat to Seagulls: Jan explained that the fox has become a new threat to seagulls in the port area, preying on their eggs and chicks. While the Port of Rotterdam is not actively combating the fox population, measures are being considered to protect seagull nests, such as installing fencing.

9. The Slufter as a New Location for Seagulls: The Slufter, a large artificial lake where polluted silt is deposited, may become a new site for seagull colonies in the future. The water quality has improved significantly, and it could offer a safe and undisturbed environment for seagulls to breed.

Key documents

Jan Putters en Lissethe Veenstra
Afdeling Assetmanagement Infrastructuur

124. *Status of gulls approach HbR (Putters, 2024)*

Structural vision (in progress)

125. *Structural vision in progress, Port of Rotterdam (Putters, 2025)*

Monitoring meeuwen 2024

Ringen en afkeuren, monitoren broedparen, broedsucces en monitoren U- en L-lokkiken

Projectnummer 231604

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deltamilieu

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126. *Monitoring gulls 2024 (Buijs, 2025)*

2. CALCULATIONS

Energy calculations

Most energy sources have their energy production capability stated in MegaWatt (MW), while national energy consumption data addresses consumption in PetaJoule per Year (PJ/Y).

1 MW = 1 Megawatt = 1.000.000 Watts (W)

To show how 1 megawatt (MW) translates to 0.03154 petajoules (PJ) per year, we will explain the unit conversion step by step:

1 MW = 1 megawatt = **1,000,000 watts (W)**

1 W = 1 joule/second (J/s)
So, **1 MW = 1,000,000 J/s**

We want to calculate the total energy in joules generated in one year:

1 MW = 1,000,000 J/s × number of seconds in a year

Seconds per year = 365 days × 24 hours × 60 minutes × 60 seconds = 31,536,000 seconds/year

1,000,000 J/s × 31,536,000 s = 31,536,000,000,000 J/year = 3.1536 × 10^{13} J/year

1 PJ = 10^{15} joules

This gives the final result:

$$\frac{3.1536 \times 10^{13} J}{10^{15}} = 0.031536 \text{ PJ/year}$$

Based on the aim of producing 3000 PJ of energy per year in our vision, we converted this number to MW.

$$\text{Energy production} = \frac{3000\ PJ\ per\ year \times 1\ MW}{0.03154\ PJ\ per\ year} = 95117 \text{ MW}$$

Based on the aim of producing 3000 PJ of energy per year in our vision, we converted this number to MW.

Windmills

Average windmill parks on sea produce up to 8MW per KM2. (Koch, 2020).
Windmills in the sea have an average production capacity of 40%. (CBS, 2024b).

$$\text{Space (100\% capacity)} = \frac{9511 MW}{8 MW\ per\ KM2} = 11890 \text{ km2}$$

$$\text{Space (40\% capacity)} = \frac{11890\ km2}{40\%} = 29725 \text{ km2}$$

Solar

Solar parks produce up to 80 MW per KM2. (Schrijver, 2020).
Solar parks have an avarage capacity of 10%. (Schrijver, 2020).

$$\text{Space (100\% capacity)} = \frac{95117\ MW}{80 MW\ per\ km2} = 1189 \text{ km2}$$

$$\text{Space (40\% capacity)} = \frac{1189\ km2}{10\%} = 11890 \text{ km2}$$

Nuclear

Nuclear power plants produce up to 3000 MW per KM2. (Rooker, 2021)
Nuclear power plants produce with a capacity of 100%. (Rooker, 2021).

$$\text{Space (100\% capacity)} = \frac{95117 MW}{3000 MW\ per\ km2} = 32 \text{ km2}$$

Geothermal

Geothermal installations in the Netherlands produce 7MW per installation. (Allesoveraardwarmte.nl, 2021).

We estimate that a space of 1Km2 per installation is necessary to optimally use the heat in underground heat sources. (Daniilidis et al., 2021).

Geothermal installations produce with a capacity of 100%. (Allesoveraardwarmte.nl, 2021).

$$\text{Space (100\% capacity)} = \frac{95117 MW}{7\ MW\ per\ km2} = 13590 \text{ km2}$$

3. INTERMEDIATE PRESENTATION

The dark side of the status quo

The figure shows the dark side of the current energy transition. Here, the future seems bright, but this does not turn out to be just and sustainable.

127. *The dark side of the status quo*

4. FINAL PRESENTATION

How to become a Ranger, class of 2040

To translate the implementation of Feathers & Fuel into society, we decided to focus on the human perspective in the final presentation. To do this, we travel to the year 2039, where the class of 2040, the future Rangers, will be given an introductory presentation. 2040 is the year of the shift in the Feathers & Fuel vision. In this first class the group is told about the ranger programme; what the different ranger roles are, what the training modules are and what qualifications they will need to start in each function.

128. *I want you (Open AI, 2025)*