Re-connect Green & Blue Highways of Nature Flows

A new urban landscape for renewable energy systems and biodiversity in Rotterdam

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MSc Architecture, Urbanism and Building Sciences:
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https://www.portofrotterdam.com/en/news-and-press-releases/port-of-rotterdam-authority-makes-greener-sea-going-shipping-more-accessible

Renewable Energy Landscape

Source: https://twitter.com/sarah_edo/status/1074006553215135744
https://www.dutchnews.nl/news/2021/05/bearded-vulture-on-rare-visit-to-netherlands-killed-by-wind-turbine-blades/

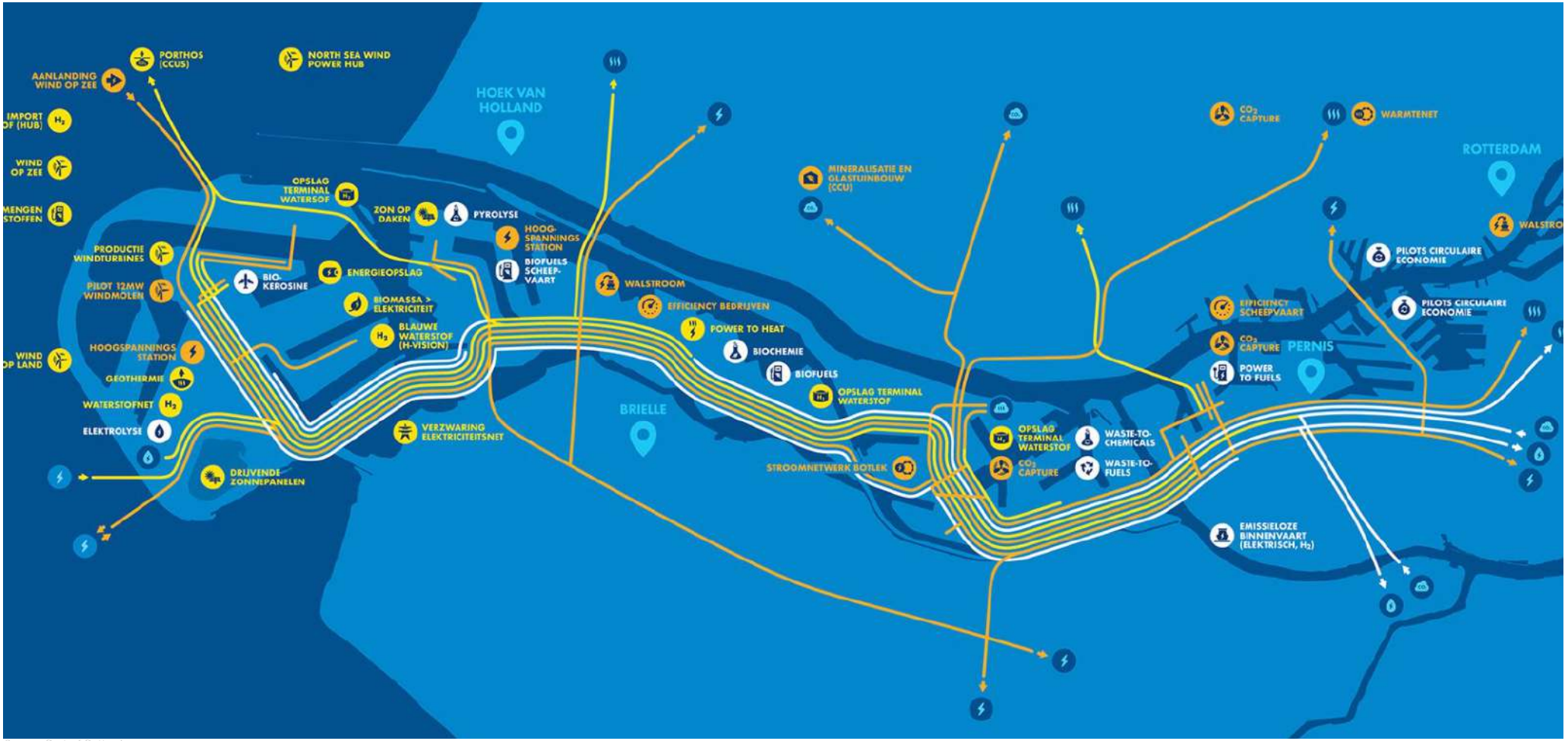
Bearded vulture on rare visit to Netherlands killed by wind turbine blades

Society May 27, 2021

Renewable energy landscape

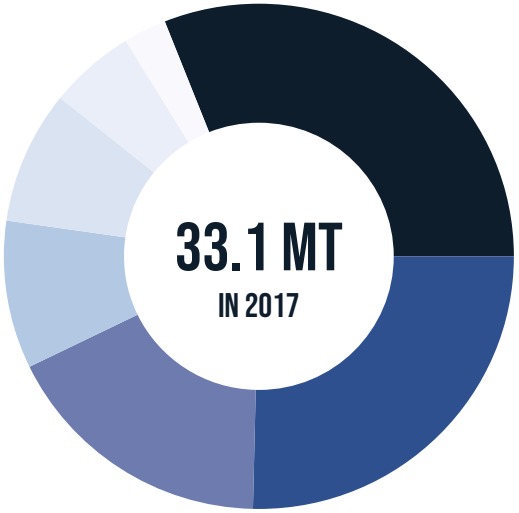
We all know renewable energy system is beneficial to human life. It provides power generation without greenhouse gas and enhances fuel diversification and lower risk of a fuel spill. However, in terms of biodiversity, what will it look like? Can we honestly say renewable energy improves ecosystem?

RDM: From fossil fuel to renewable energy!



Source: Port of Rotterdam

Fossil fuel-related industries



10.7 MT
Coal-powered plants

8.5 MT
Refineries

5.0 MT
Chemical companies

3.9 MT
Gas-powered plants

3.0 MT
Producers of industrial gases

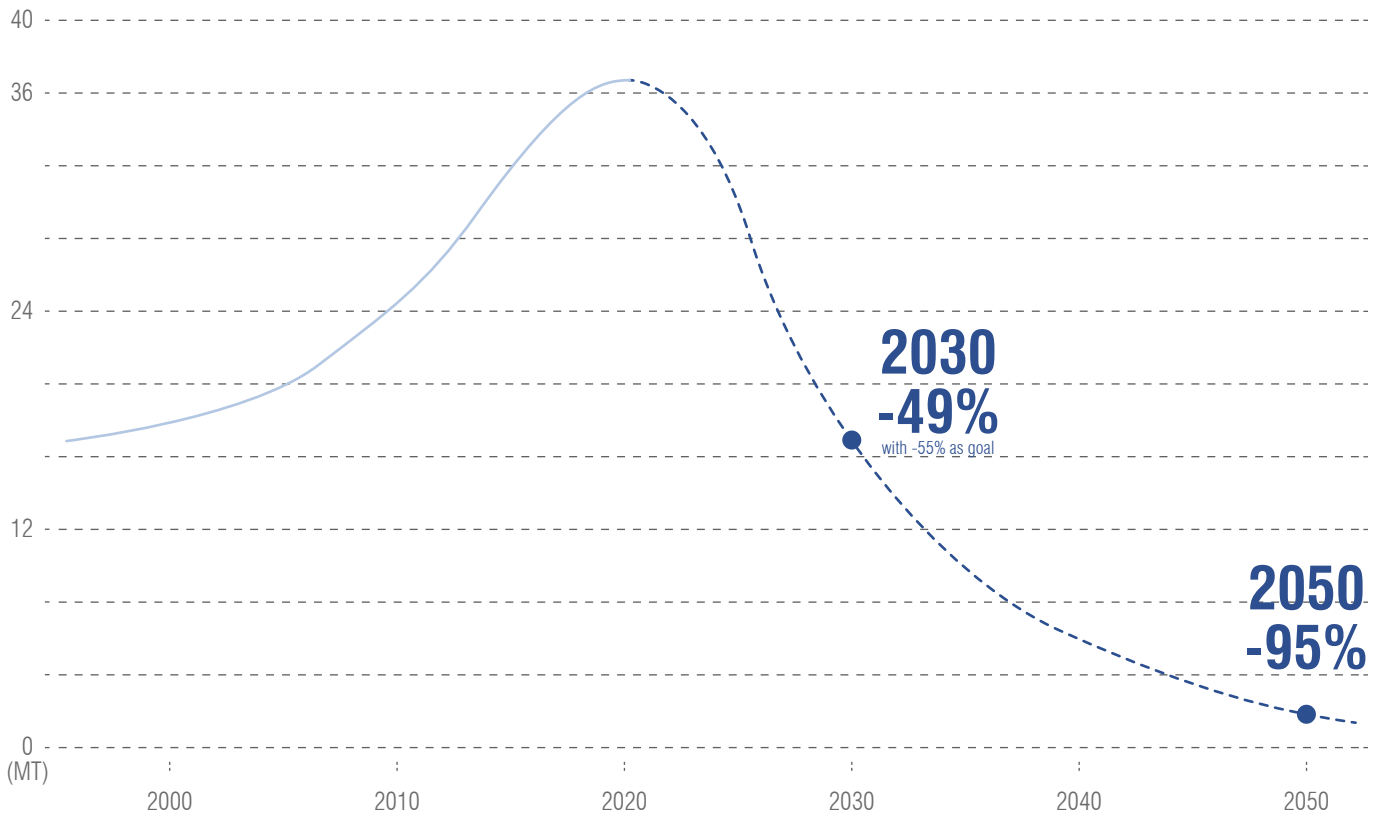
1.6 MT
Waste processing

0.4 MT
Other industries

Source: Port of Rotterdam (Modified by author)

Be an Energy Transition Leader!

RDM ambition by reducing CO2



Source: Port of Rotterdam (Modified by author)

Type of RE in RDM

Solar energy system

Wind energy system

Bioenergy system

Residual heat system

Source: Port of Rotterdam

Surrounding landscape around RE systems

Low vegetation gradient

A. Maasvlakte
only have mowed lawn

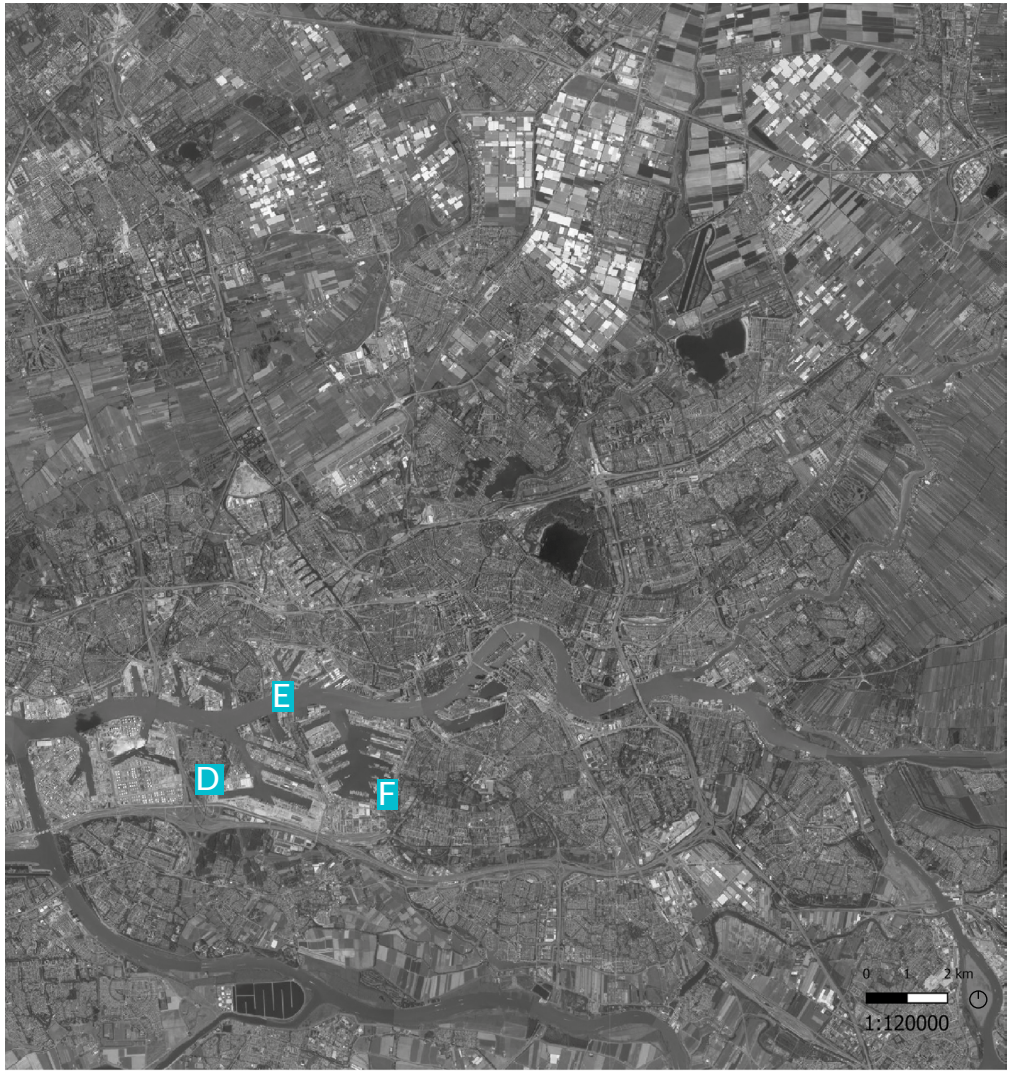
B. Europoort
a row of trees due to wind turbines

C. Botlek
mowed lawn with shrubs adjacent to industries

Source: Google maps

Surrounding landscape around RE systems

Low vegetation gradient & unpermeable pavement



D. Eemhaven

Linear green spaces alongside the road are adjacent to the river

F. Waalhaven

Linear green spaces alongside the road

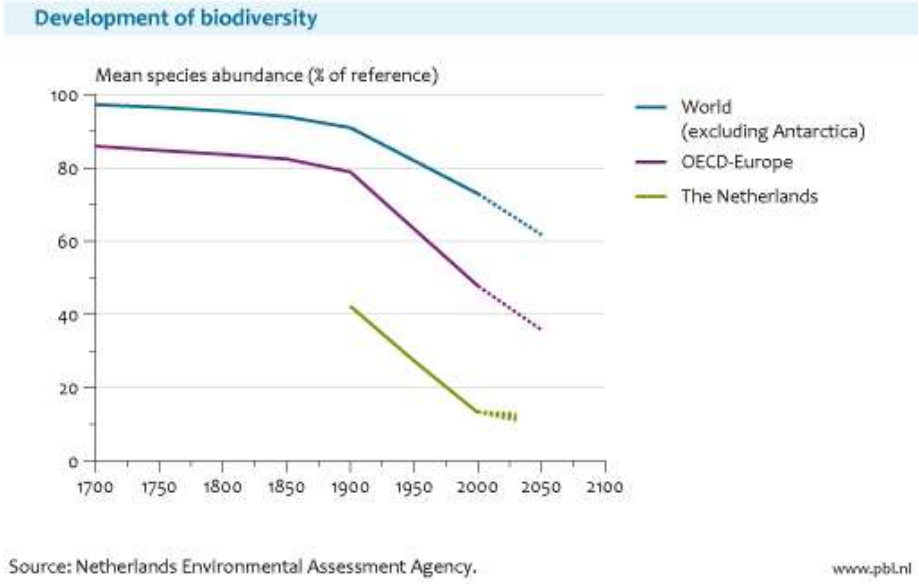
G. Waalhaven

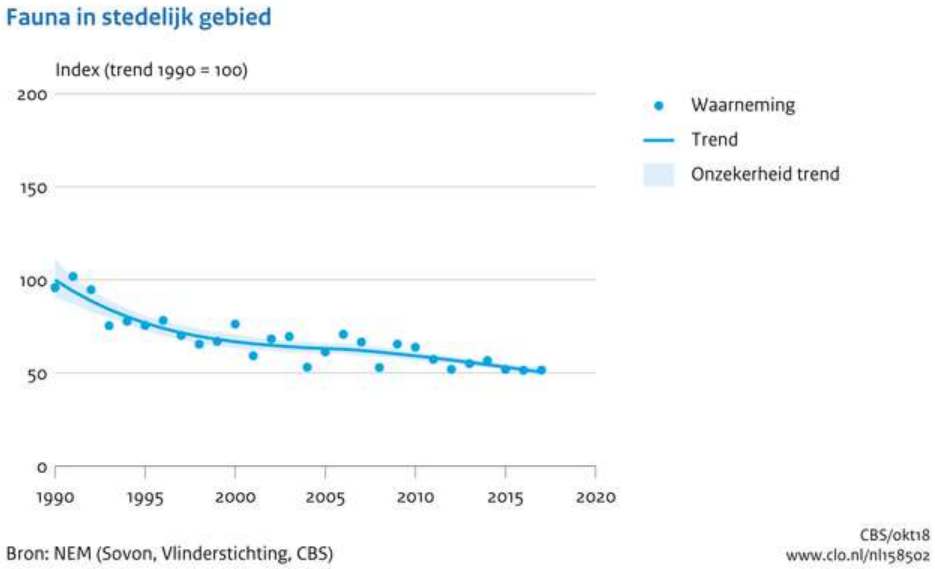
Impervious surface in industrial areas is harsh for biodiversity

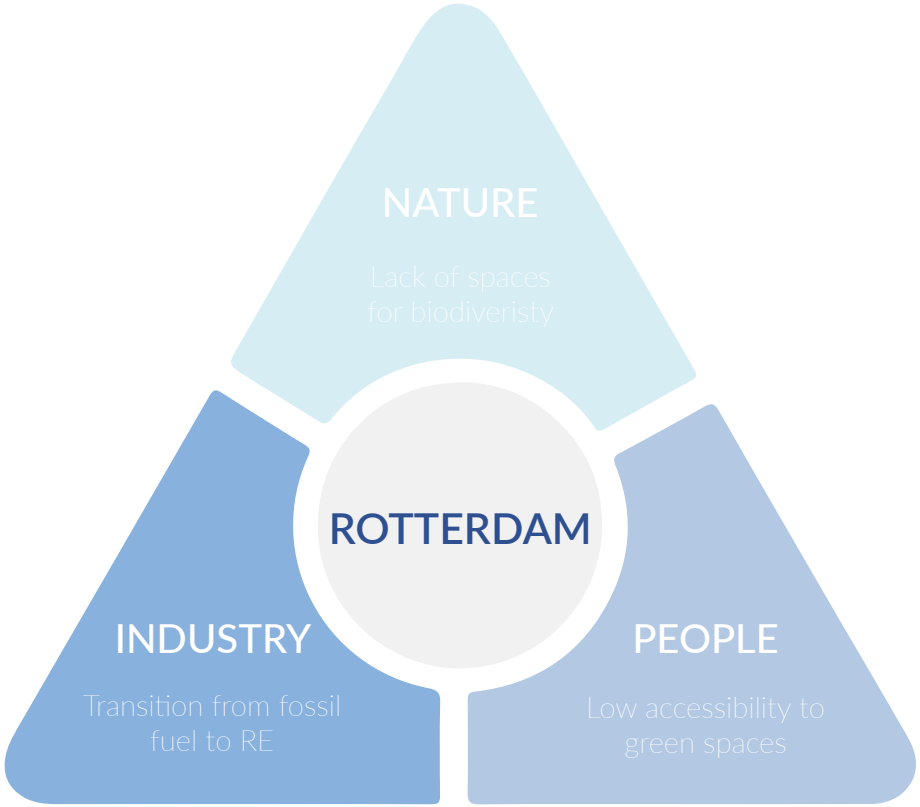
Source: Google maps

Biodiversity of NL

Harsh energy landscape can acclerate biodiversity loss







Problems of RE landscape in RDM

The current renewable energy landscape has fewer spaces for biodiversity. Also, as port industries are changing the energy production system, they will require more land and resources. It can affect the surrounding ecosystem and human life.

Research Quetstion

What is a possible **spatial framework** to create **a renewable energy landscape** which **improves urban biodiversity** and **provides ecosystem services** while **enhancing recreational values** for citizens?

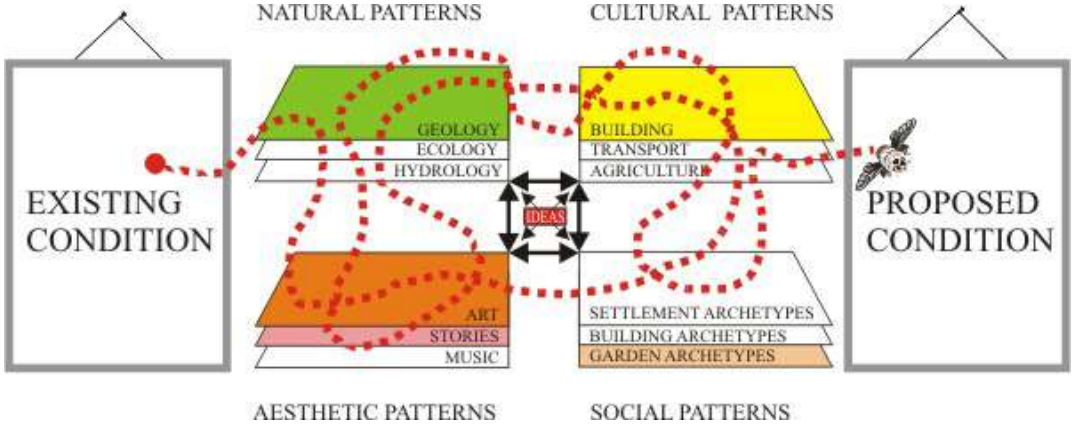
Sub-research questions

What is a possible **spatial framework** to create **a renewable energy landscape** which **improves urban biodiversity** and **provides ecosystem services** while **enhancing recreational values** for citizens?

1. What is RE landscape in terms of non-human species?
2. What spatial interventions are needed for different landscape typology?
3. How can REL which contains large-scale energy infrastructures can work with residential areas?
4. How industries & companies and RE landscape compromise together without any loss?
5. What position/ strategy should RE industries take into account during a planning stage (e.g. wind farm, solar park)?

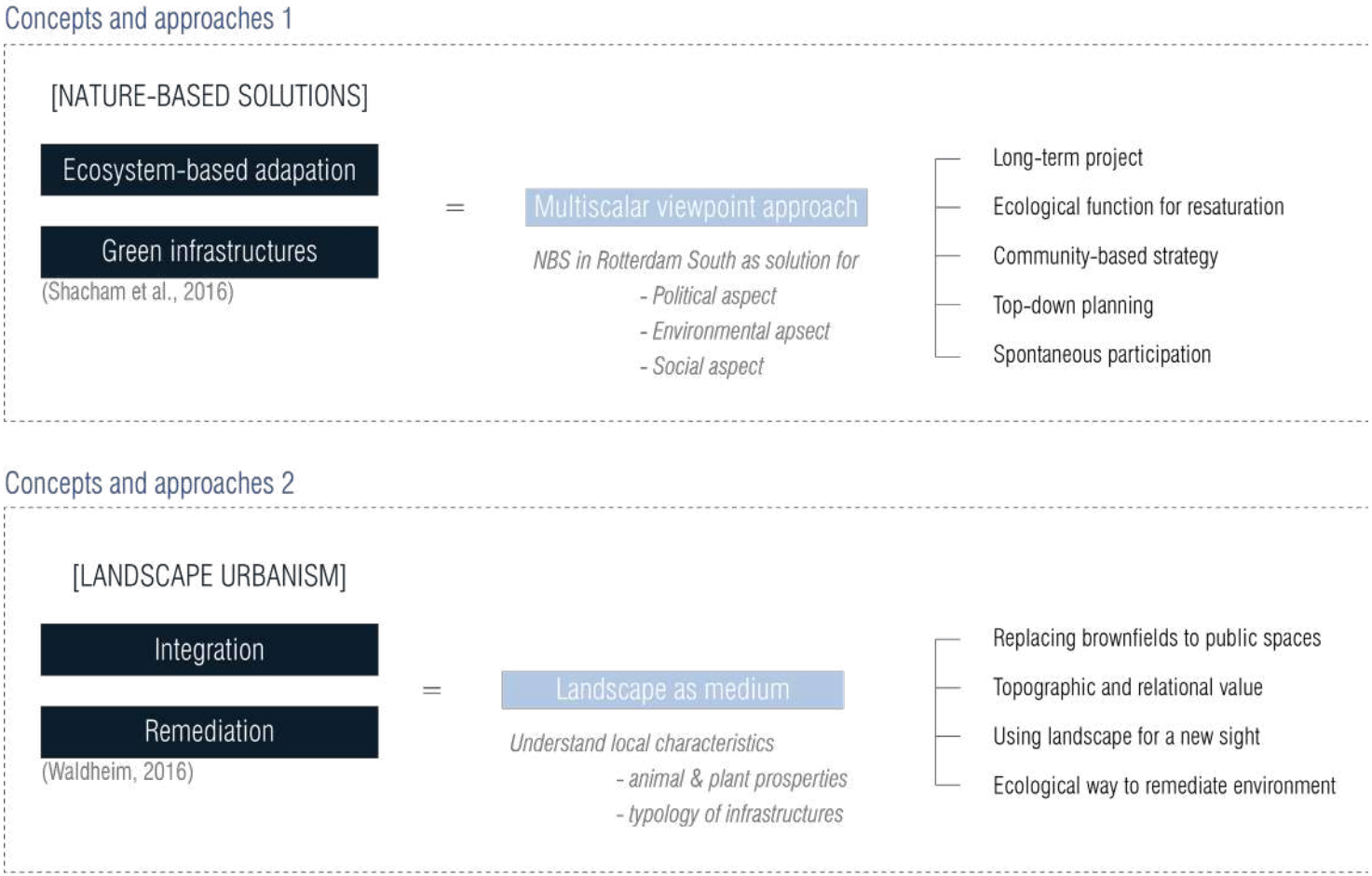
Theory

Nature-based Solutions and Landscape Urbanism



Approaches

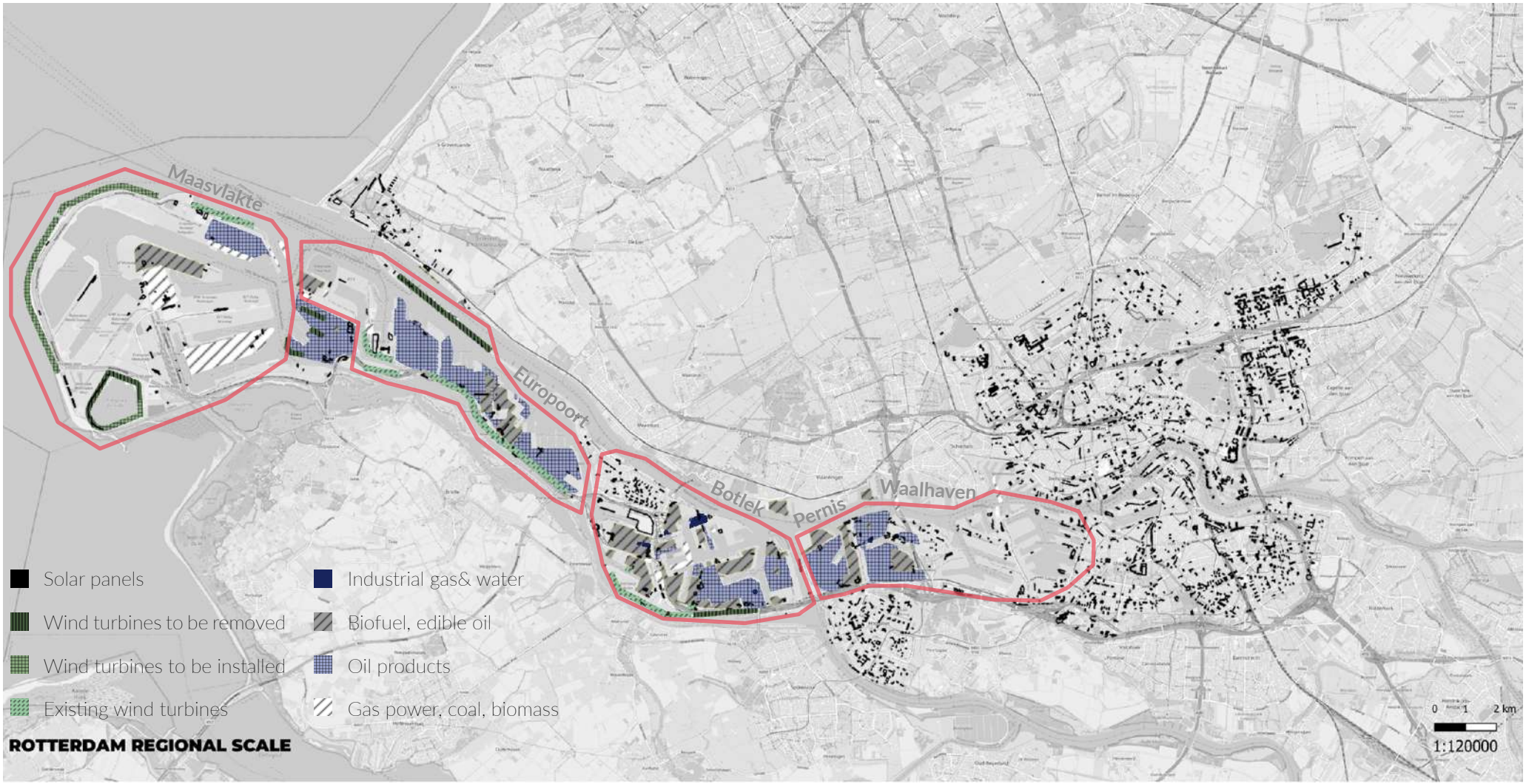
EbA, Green Infrastructures, Integration, and Remediation



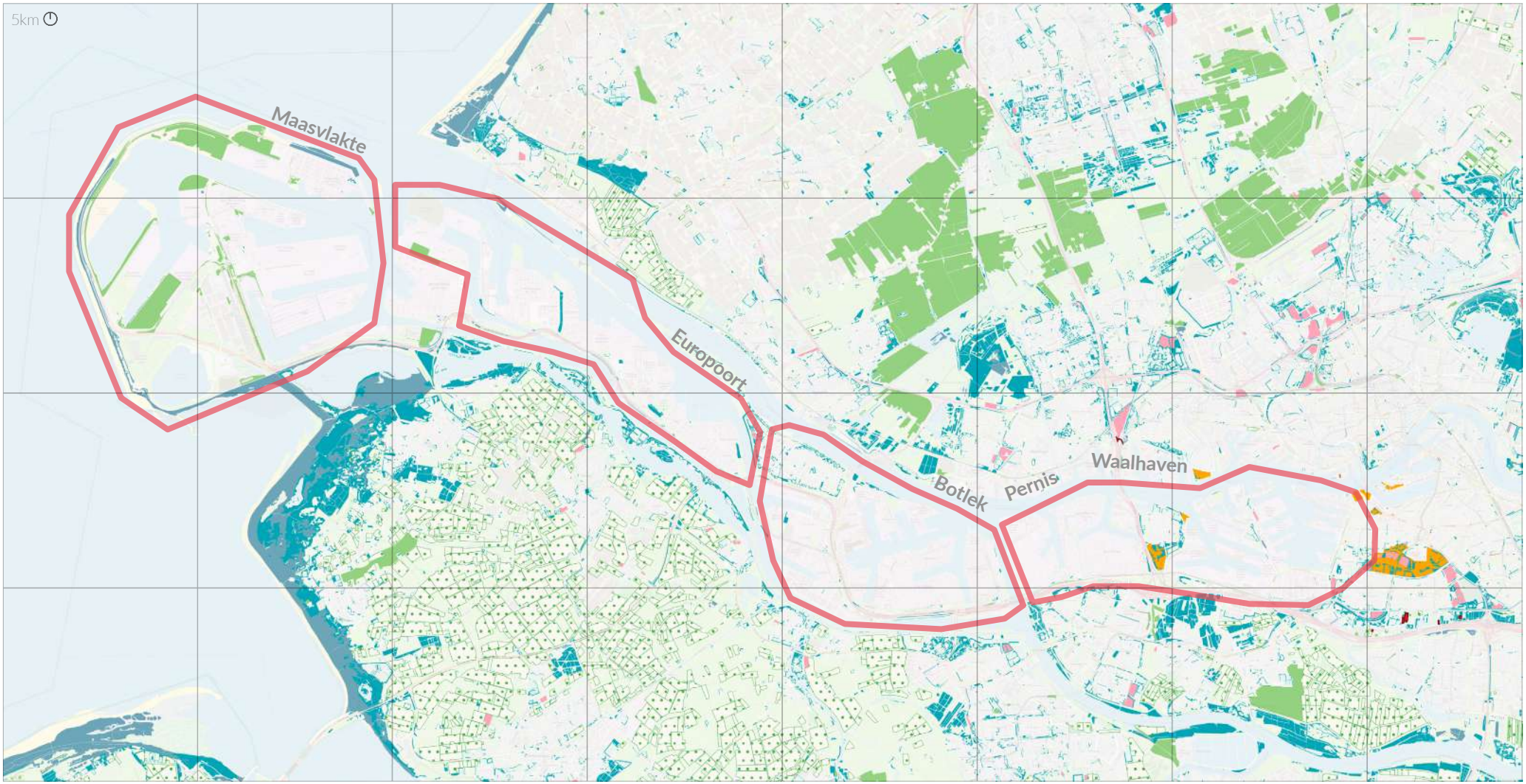
Source: Author

Location of RE in RDM

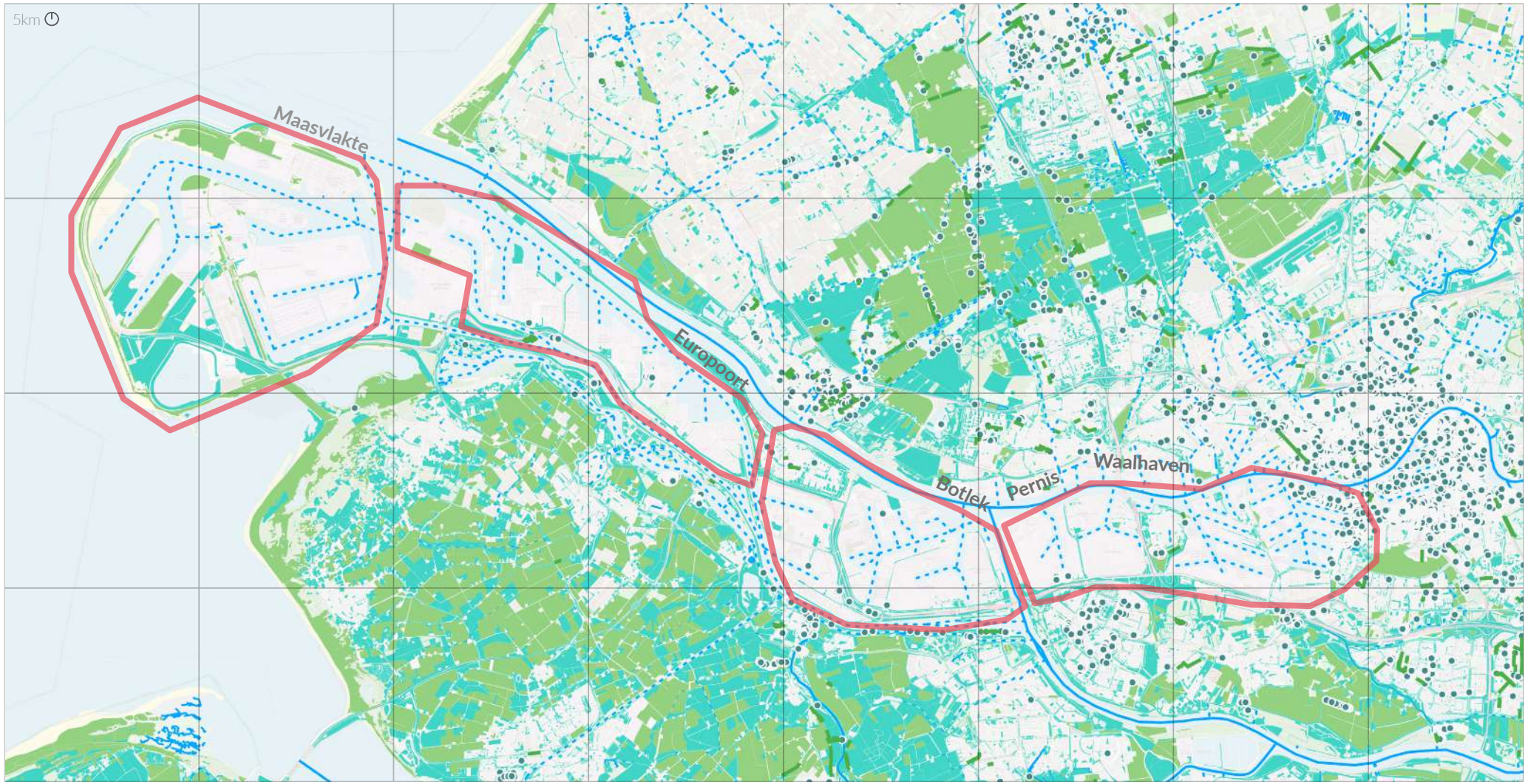
Different scale of RE industries



‘Official’ Green Areas around RE Infrastructures



Potential Green/Blue for RE Landscape



Potential Green/Blue for RE Landscape

Closeness to Residential Areas

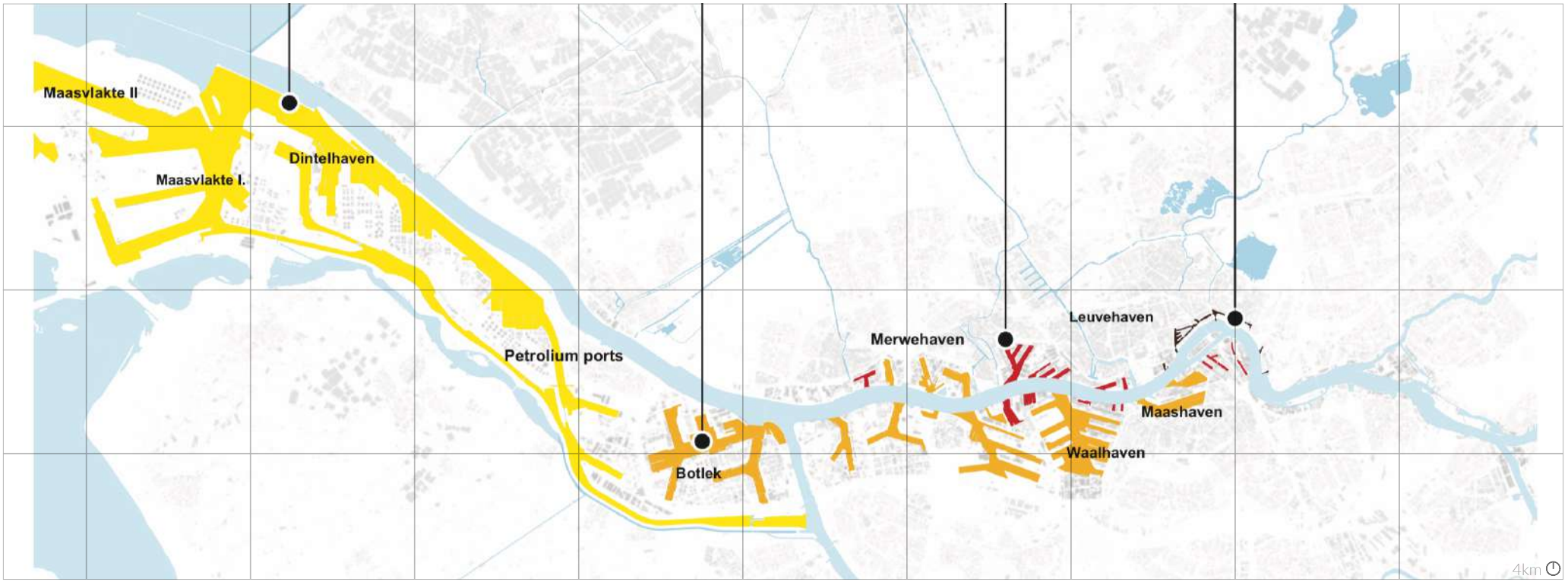
Year of build and mix of urban life

XL
Built in 19/20c
Less urban life

L
Built in 19/20 c

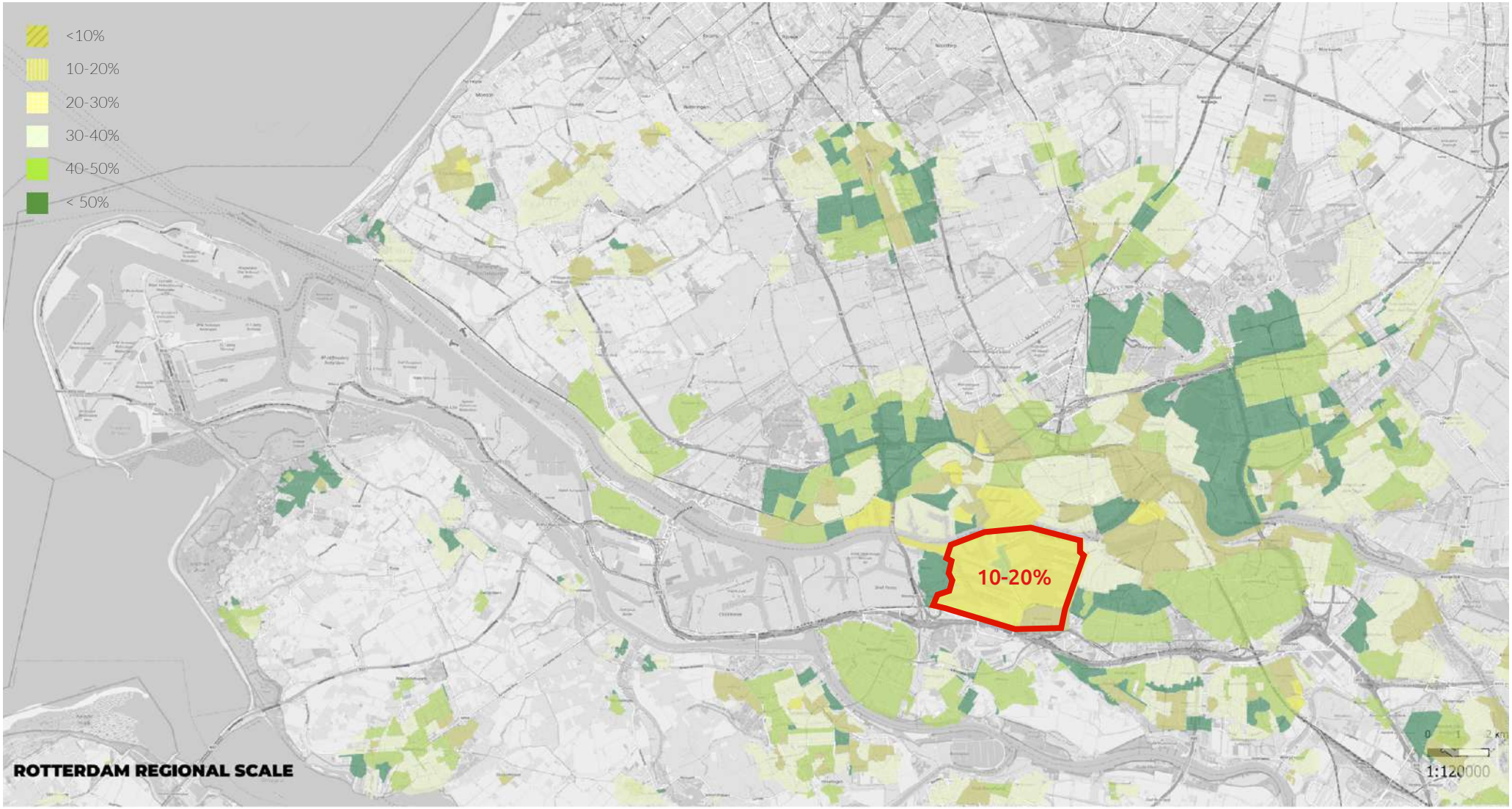
M
Built in 18/19c
Mix of urban life and industry

S
Built in 16/17c
Mix of urban life and port activity

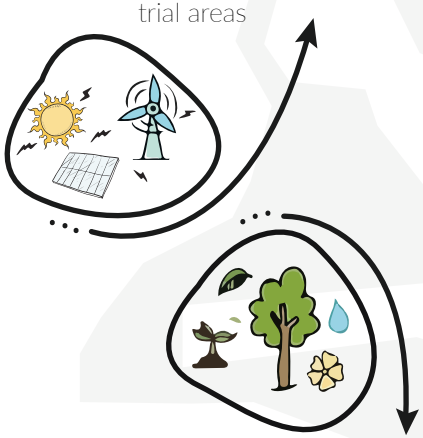


Landscape framework (2016) Strootman Landschapsarchitecten

Green Percentage

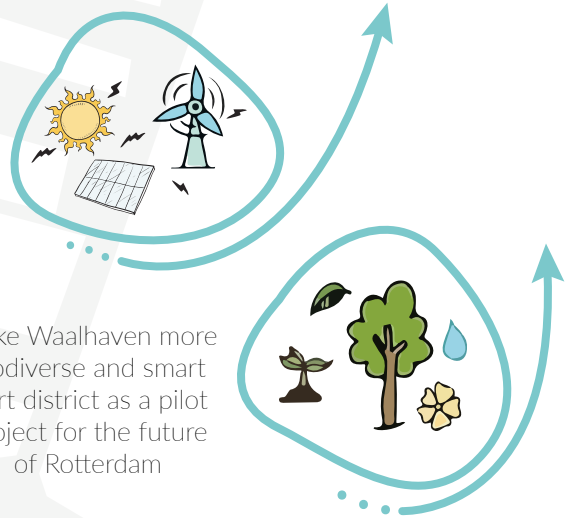


Waalhaven is in transitional stage of accepting renewable energy in residential & industrial areas

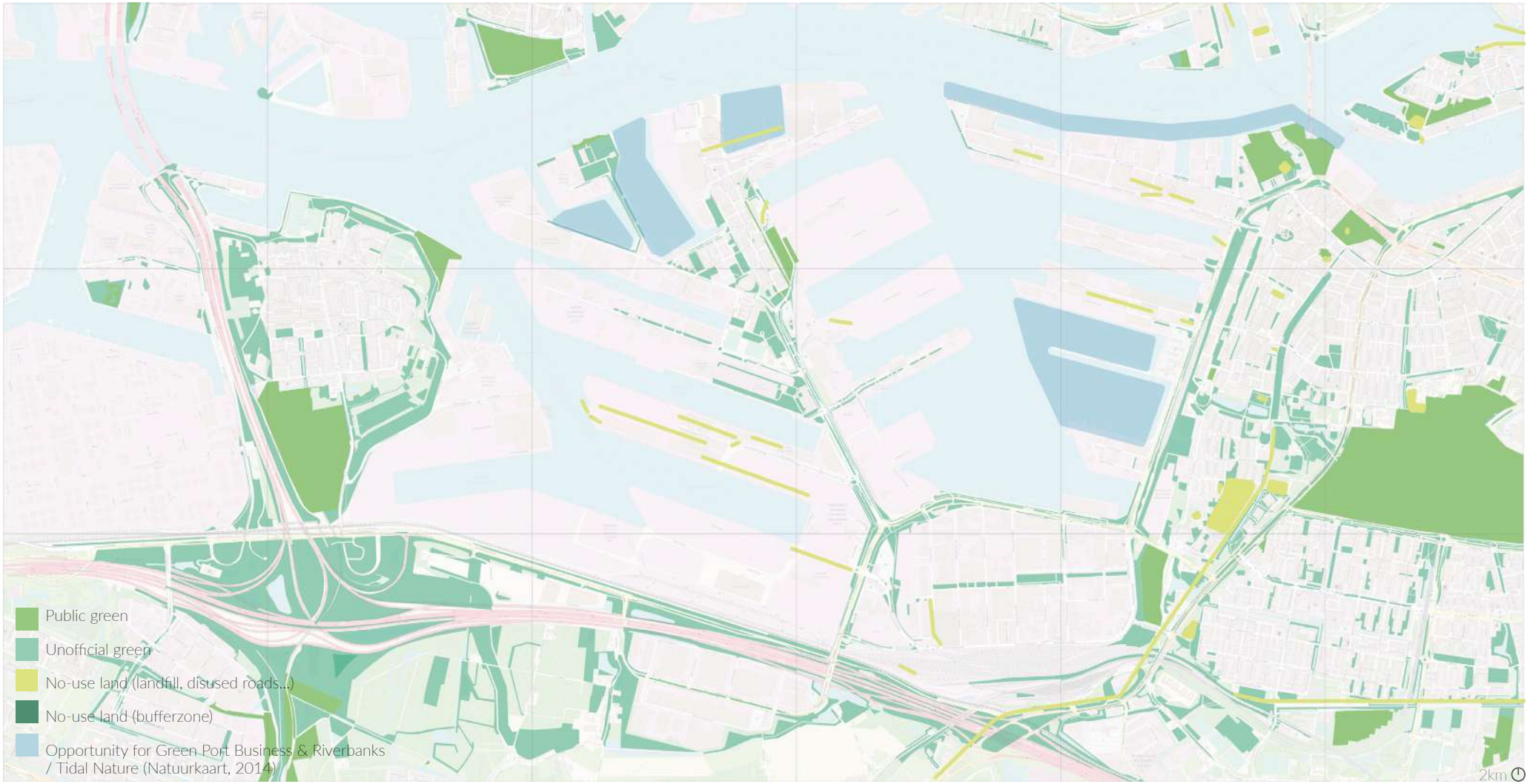


Lack of landscape for biodiversity

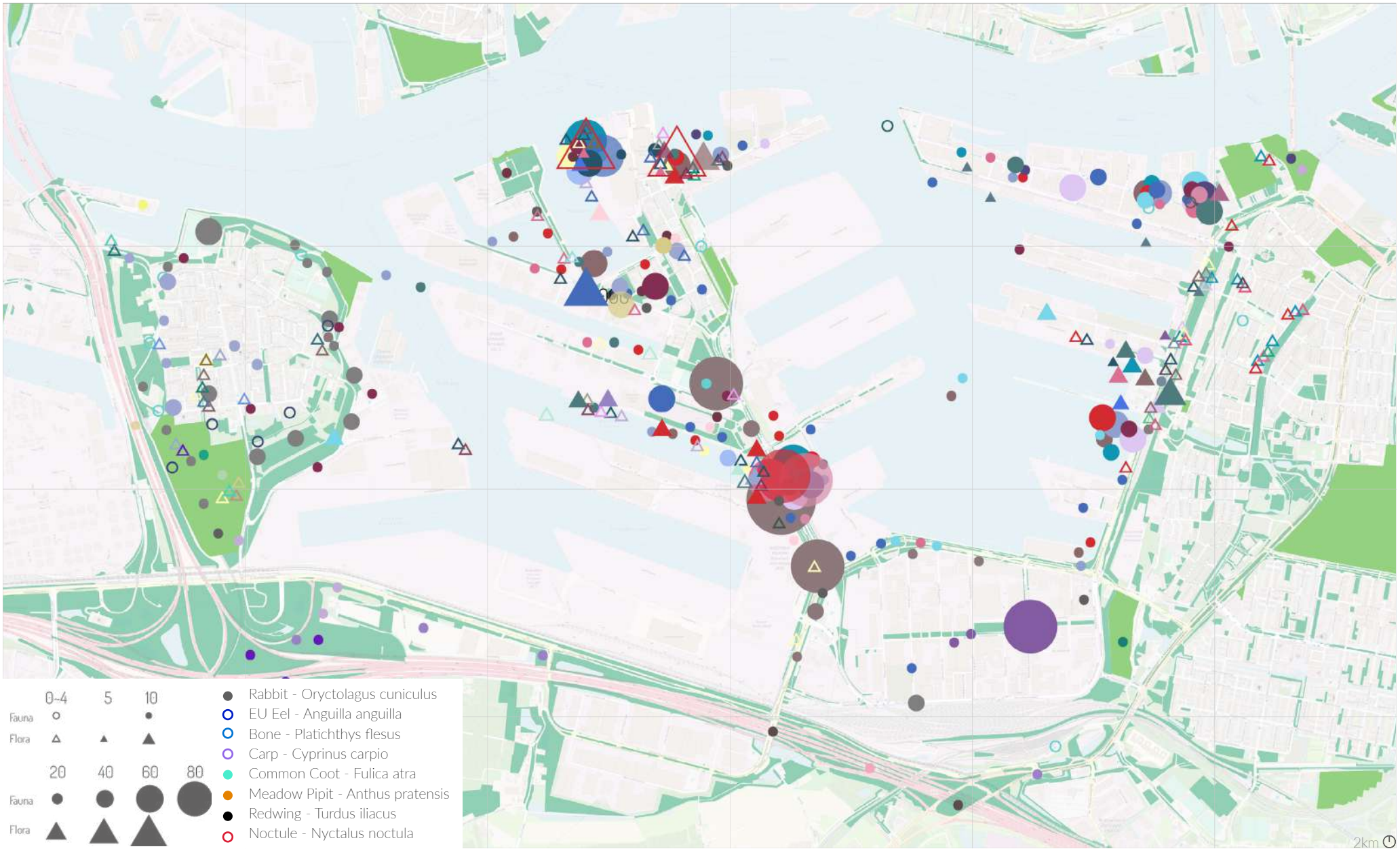
Make Waalhaven more biodiverse and smart port district as a pilot project for the future of Rotterdam



Current Green Areas of Waalhaven

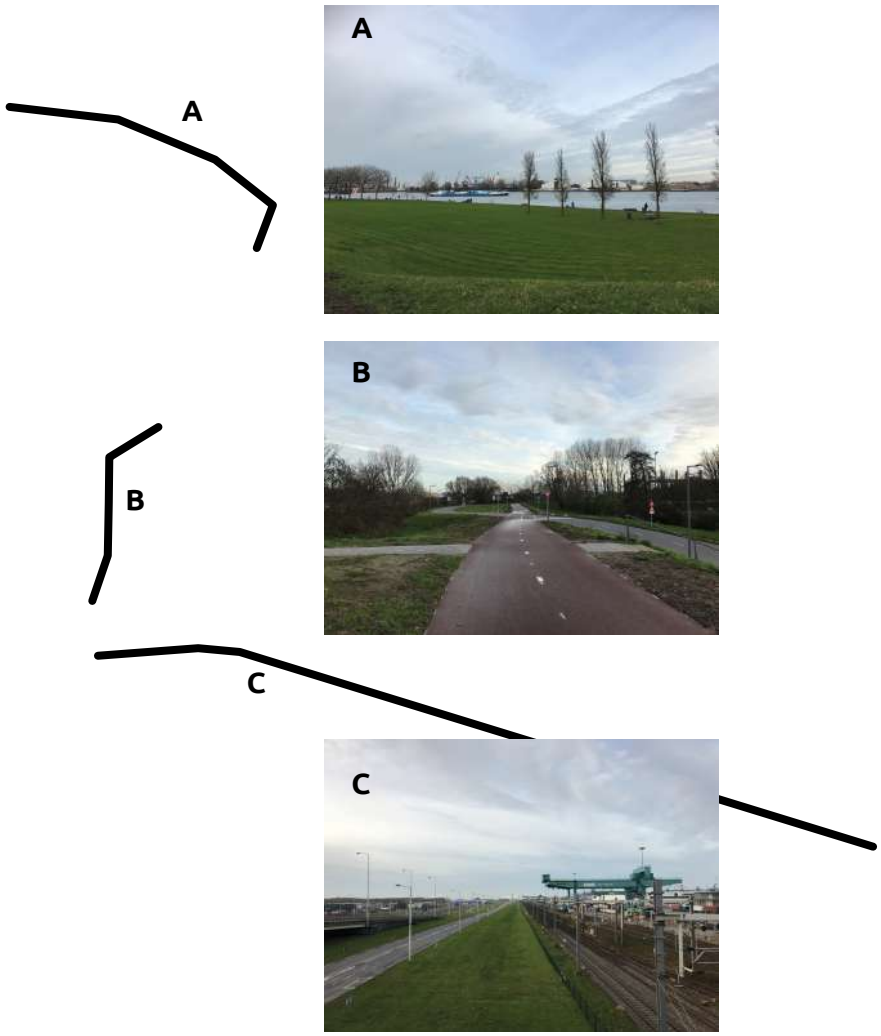


Flora and Fauna of Green Areas



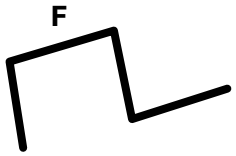
Habitats of Flora & Fauna

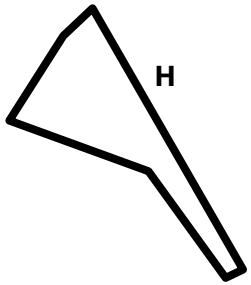
Linear green buffer zone: Low natural vegetation gradient



Habitats of Flora & Fauna

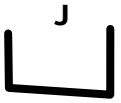
Heijplaat: Unpermeable pavement, Low natural vegetation gradient



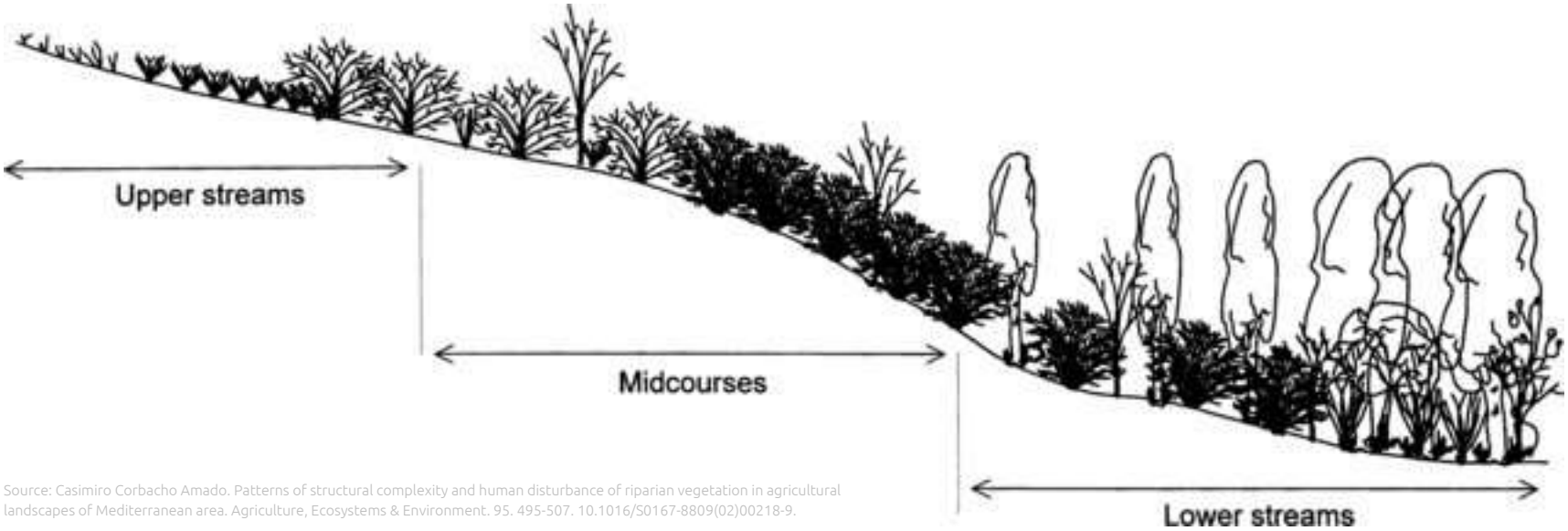


Habitats of Flora & Fauna

Industrial area: Unpermeable pavement, Low natural vegetation gradient



Natural Vegetation Gradient



Source: Casimiro Corbacho Amado. Patterns of structural complexity and human disturbance of riparian vegetation in agricultural landscapes of Mediterranean area. Agriculture, Ecosystems & Environment. 95. 495-507. 10.1016/S0167-8809(02)00218-9.

Why is natural vegetation important?

- controls erosion through protecting soils and riverbanks
- reduces land degradation and salinity
- improves water quality and availability
- provides habitat for a wealth of unique biodiversity including threatened species.

Fauna from IUCN Red List

NT : Near Threatened
CE : Critically Endangered
LC : Least Concern
VU : Vulnerable
*European scale

Source: IUCN

NT

Rabbit - Oryctolagus cuniculus

CE

EU Eel - Anguilla anguilla

LC

Bone - Platichthys flesus

VU

Carp - Cyprinus carpio

NT

Common Coot - Fulica atra

NT

Meadow Pipit - Anthus pratensis

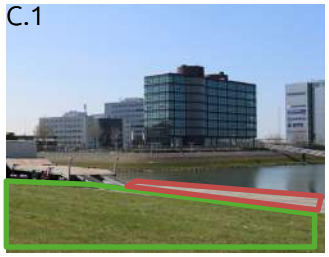
NT

Redwing - Turdus iliacus

LC

Noctule - Nyctalus noctula

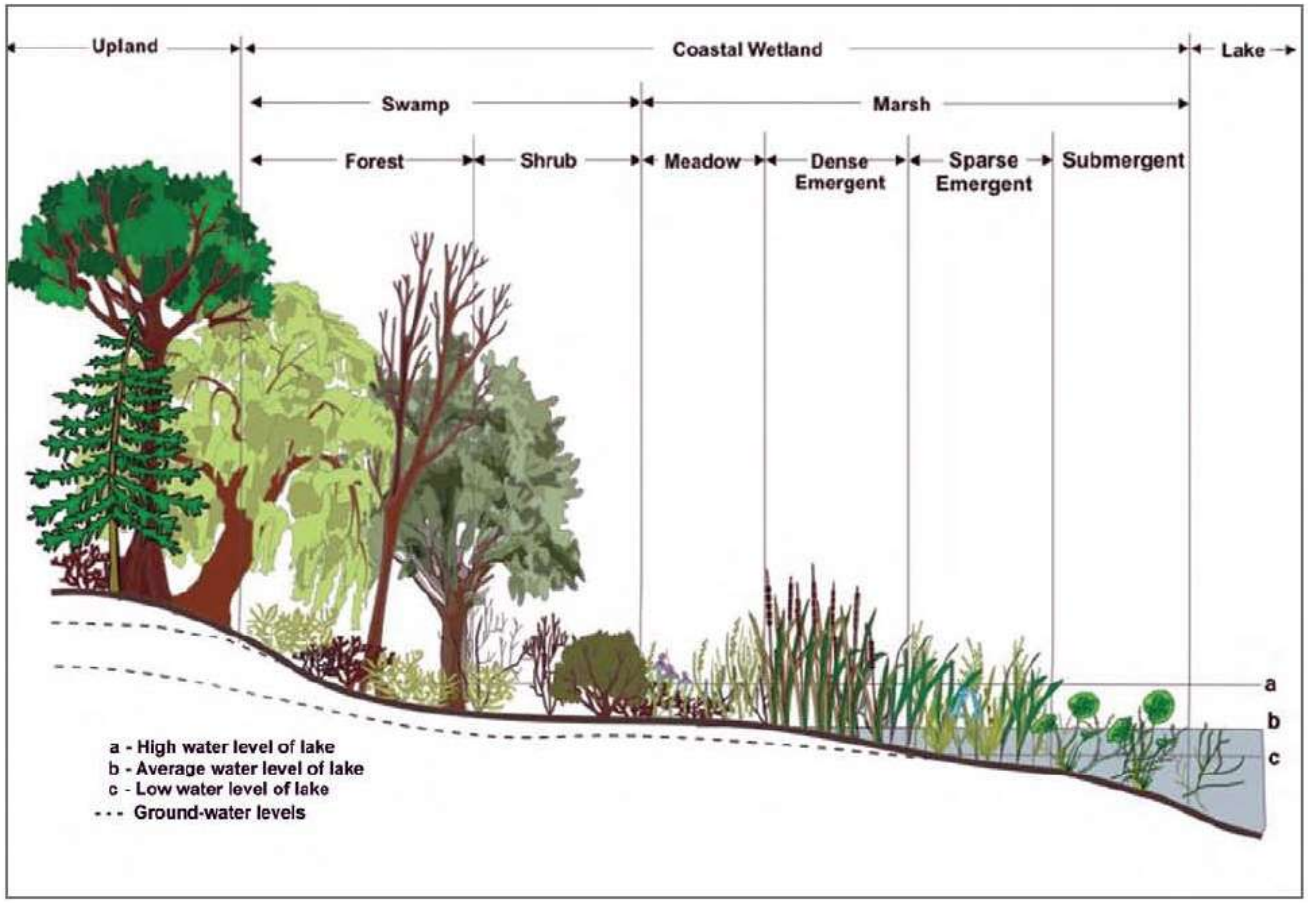
Habitats of Selected Species



- Rabbit - Oryctolagus cuniculus
- EU Eel - Anguilla anguilla
- Bone - Platichthys flesus
- Carp - Cyprinus carpio
- Common Coot - Fulica atra
- Meadow Pipit - Anthus pratensis
- Redwing - Turdus iliacus
- Noctule - Nyctalus noctula

Improve Natural Vegetation Gradient

Proposal for BD

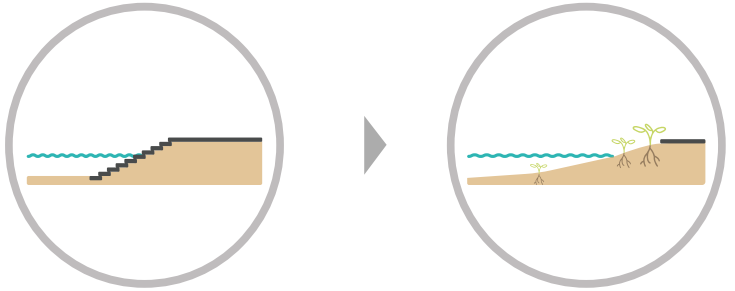


Source: Douglas A. Wilcox, Todd A. Thompson, Robert K. Booth, and J.R. Nicholas - USGS Document, Circular 1311, Lake-Level Variability and Water Availability in the Great Lakes

Characteristics of Riverbanks

Proposal for BD

Landscape framework (2016) Strootman Landschapsarchitecten



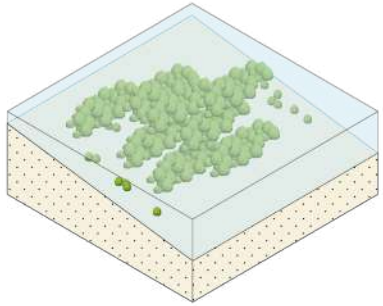
Riverside 33km

- Construction of harbours and industrial areas
- 70% of riverbanks are paved with stone embankments and quays
- Ground level: 4 meters above sea level due to accretion
- Urbanized (elevated) banks

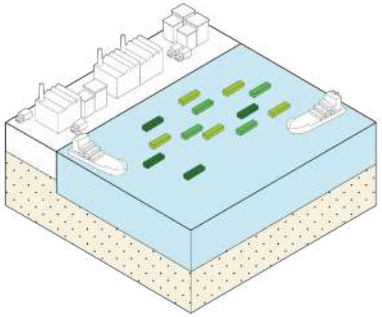
Spatial Interventions

Proposal for BD

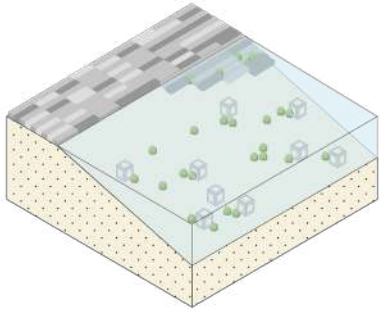
Bioswale



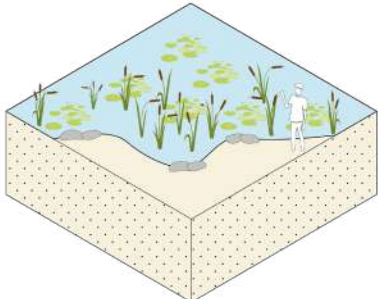
Water Plant



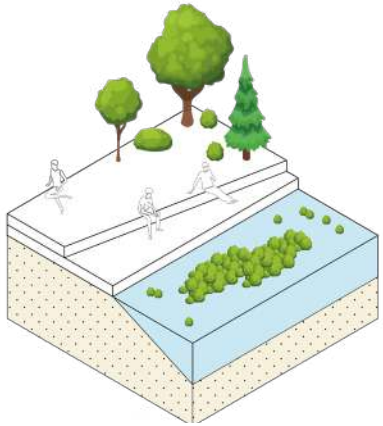
Hanging/ floating structure



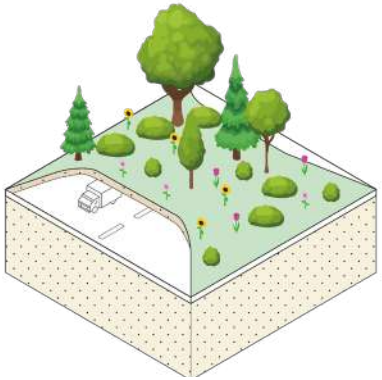
Rich revetments



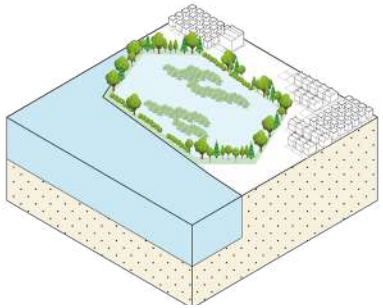
Helophyte pond



Urban promenade



Eco-corridor



Inland buffer zones

Potential Renewable Energy

Exploring Potential RE

Solar energy & wind energy on buildings
Solar energy of parking lots

Bioenergy with water plant
Bioenergy with land plant

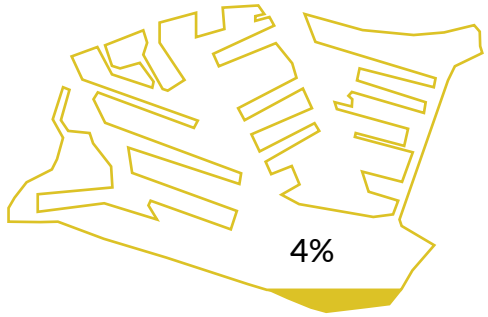
Exploring Potential RE

Bioenergy with land plant

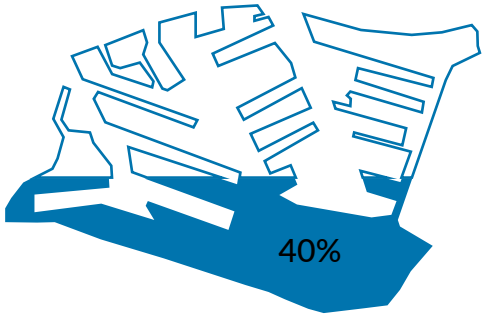
Bioenergy with land plant
Solar energy on roads

How much surface does Waalhaven need?

To meet energy consumption



Sun 5,355,000W

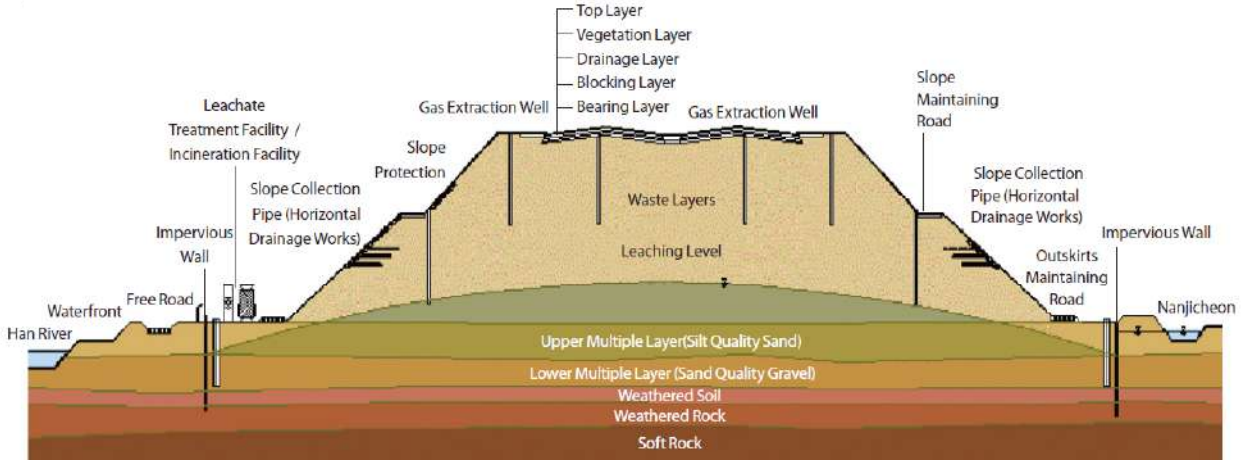


Wind 468,000W

Bioplant 6,029W

Nanji Haneull Park, Seoul, South Korea

Case study



Source: seoulsolution.kr

Water	■
Heat	■■■
Energy	■■■
Biodiversity	■■■■
Social and economic importance	■■■■
Multifunctional space usage	■■
Costs	■■

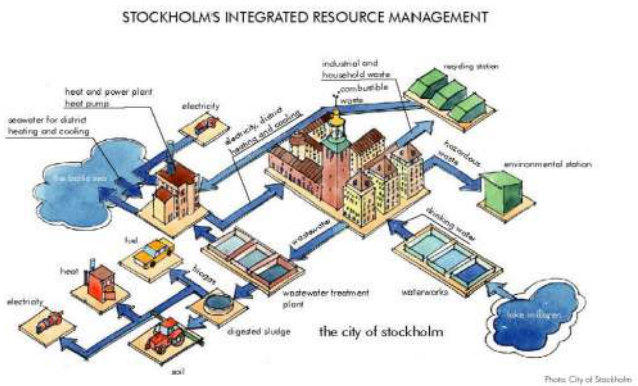
- Use heat and gas(Methane) from the landfill for district heating through gas extraction wells
- Install impervious wall to protect the soil from leachate
- Purify polluted water and discharge the water into Han River

Hammarby Sjöstad, Stockholm, Sweden

Case study

Dagvatten canal © André Vaxelaire

Source: Fabege



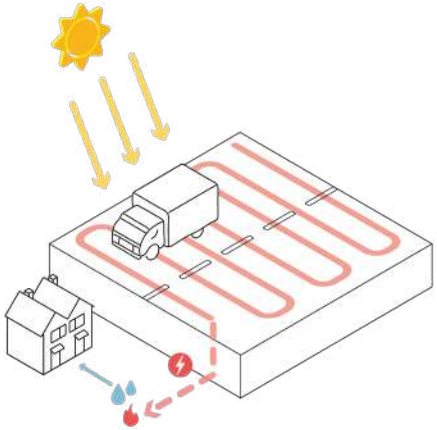
Source: Hammarby Sjöstad 2.0

Water	■■■
Heat	■
Air quality	■
Energy	■■■
Biodiversity	■■
Social and economic importance	■■■
Costs	■■

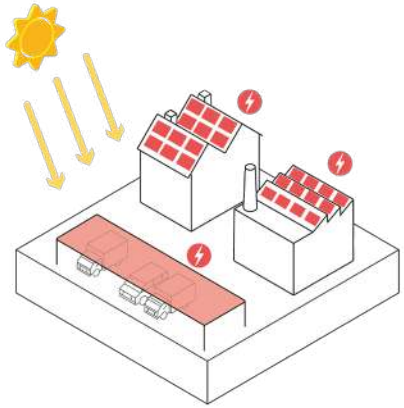
- Extract the heat from the purified wastewater. (Remaining cold water is used for cooling industries and commercials)
- Send the sludge (from the water treatment process) to farmland and forestry as a fertilizer.
- Use biogas from the sludge for fuel and district heating

Spatial Intervention

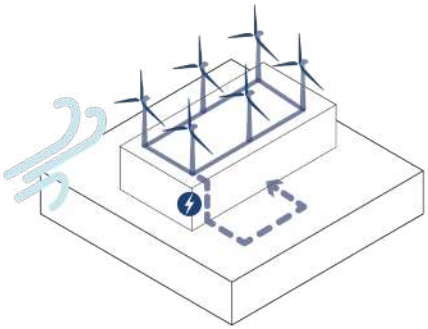
Proposal for RE



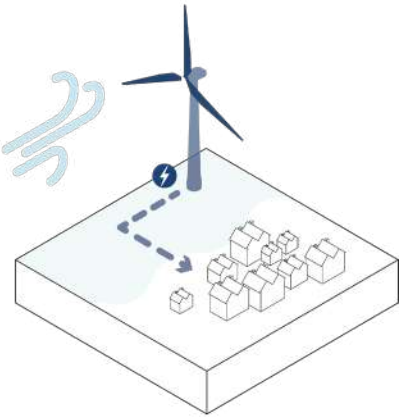
Asphalt heat collectors beneath road



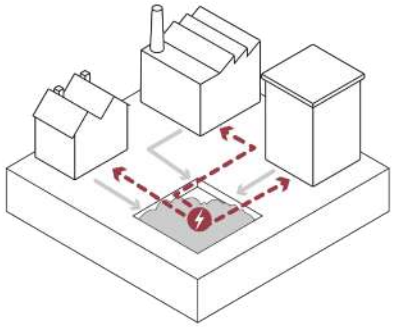
PV panels



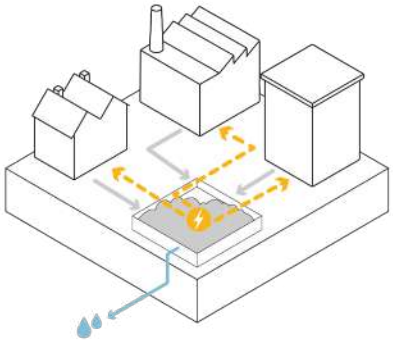
Small scale wind turbines



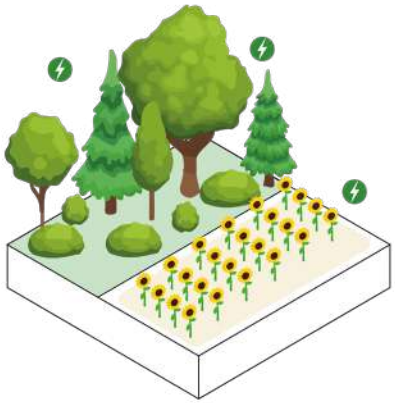
Large scale wind turbines



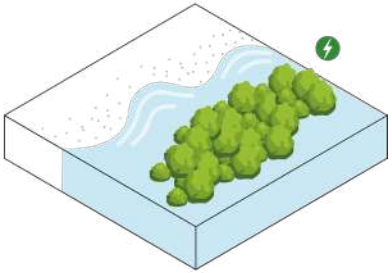
Heat from local waste



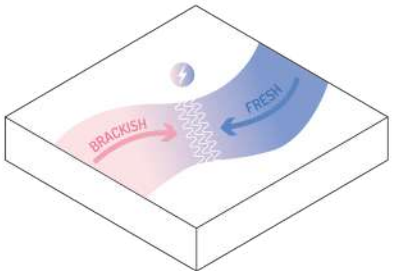
Heat/gas from wastewater treatment



Bioplant landscape



Algae farm

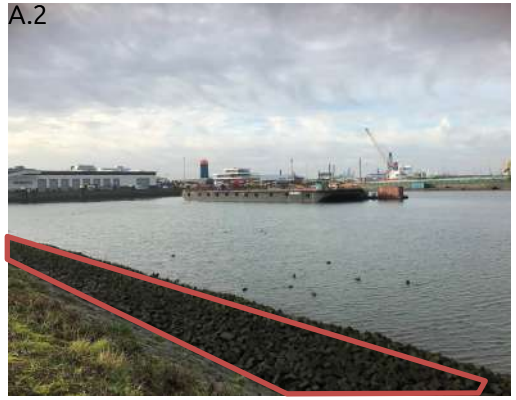


Blue energy: Membrane of brackish & fresh water

Target Areas

Locations of Spatial Interventions

- Rabbit - Oryctolagus cuniculus
- EU Eel - Anguilla anguilla
- Bone - Platichthys flesus
- Carp - Cyprinus carpio
- Common Coot - Fulica atra
- Meadow Pipit - Anthus pratensis
- Redwing - Turdus iliacus
- Noctule - Nyctalus noctula



Waalhaven Vision (before)

Waalhaven Vision (after)

Proposed masterplan

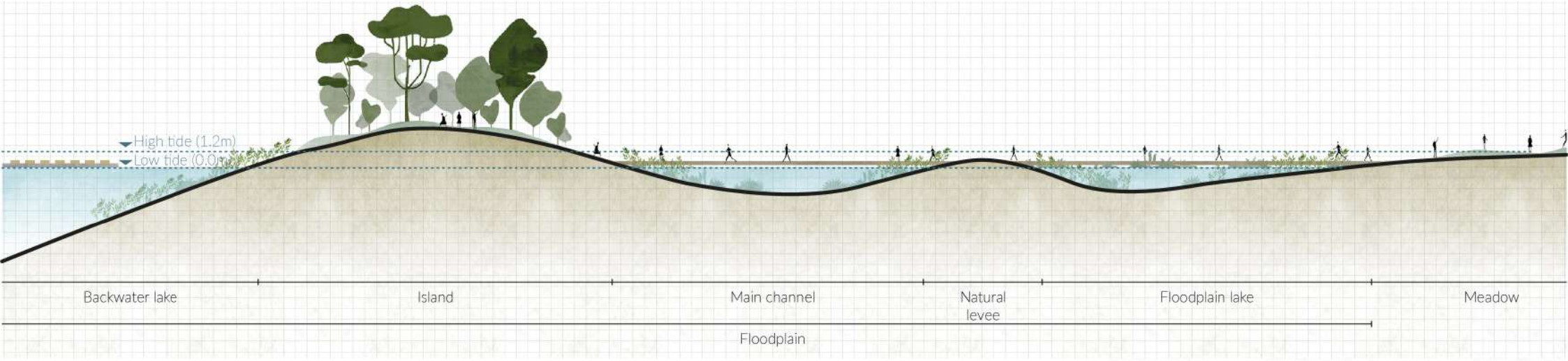
Proposed Masterplan

Design Area

Proposed Masterplan

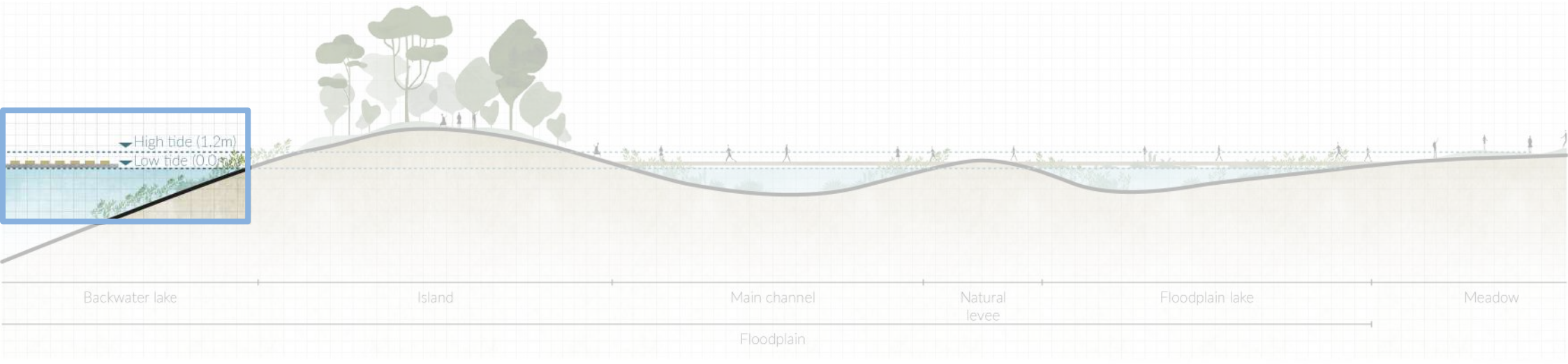
Integration of RE & BD

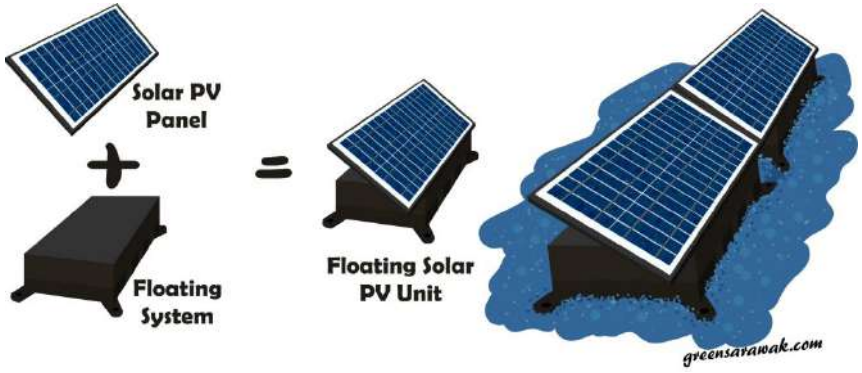
Wetland Elaboration



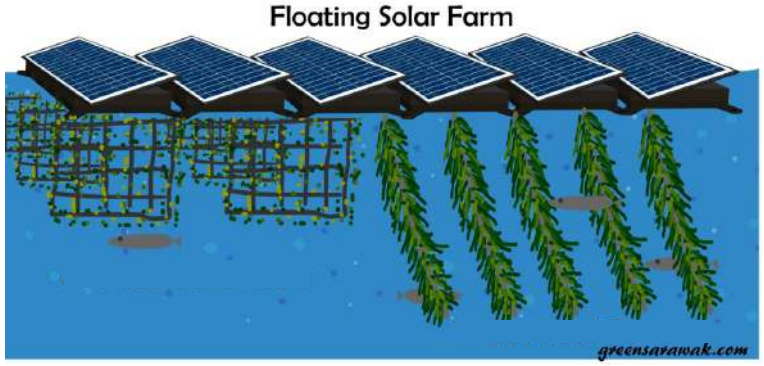
Solar Farm as a BD Farm

Design Elaboration

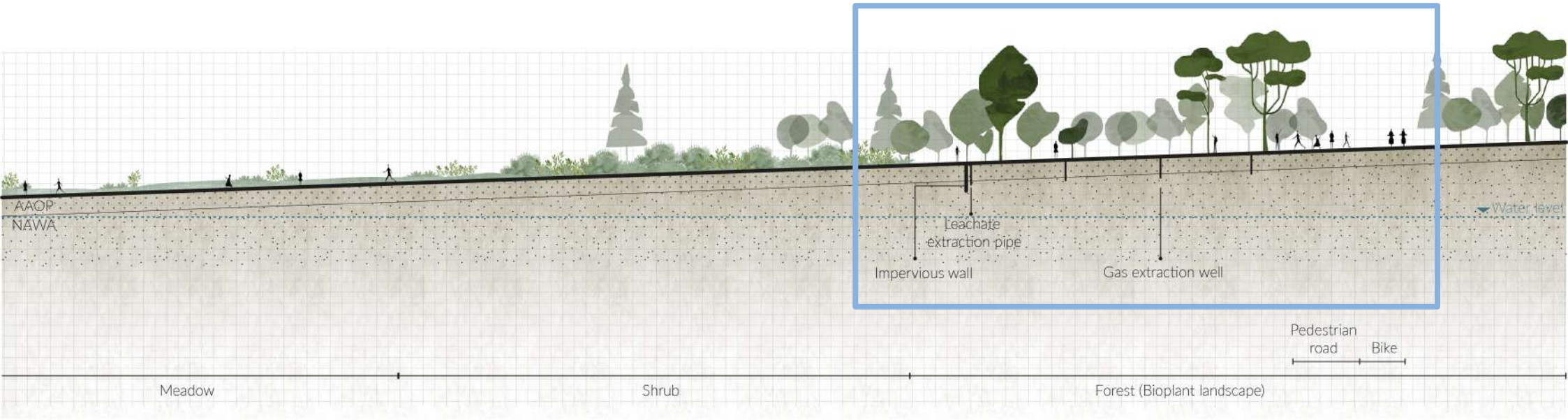




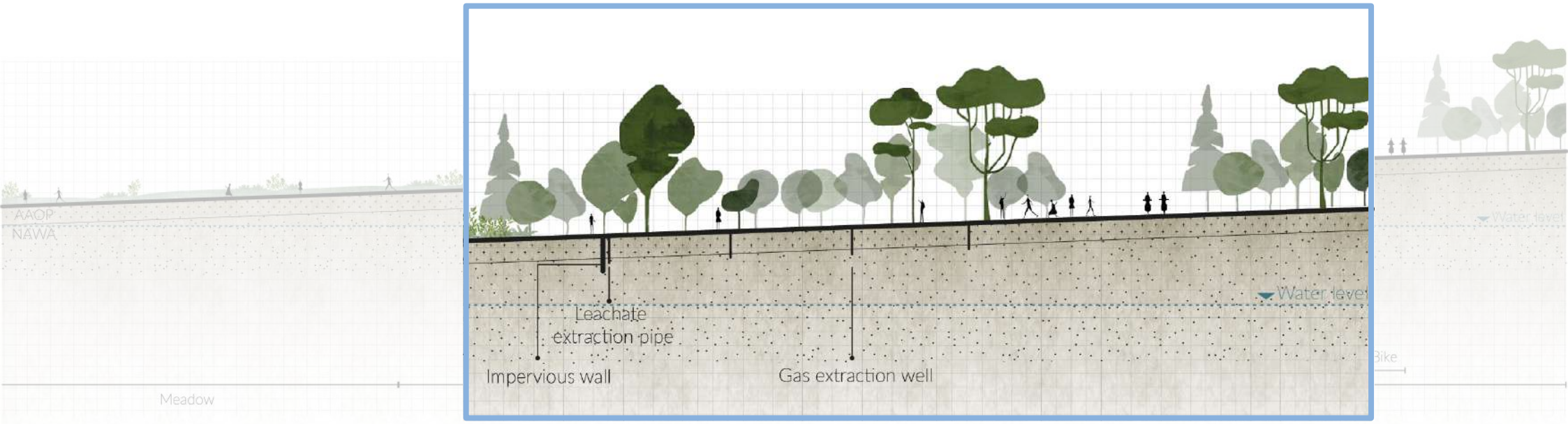
Source: Green Sarawak



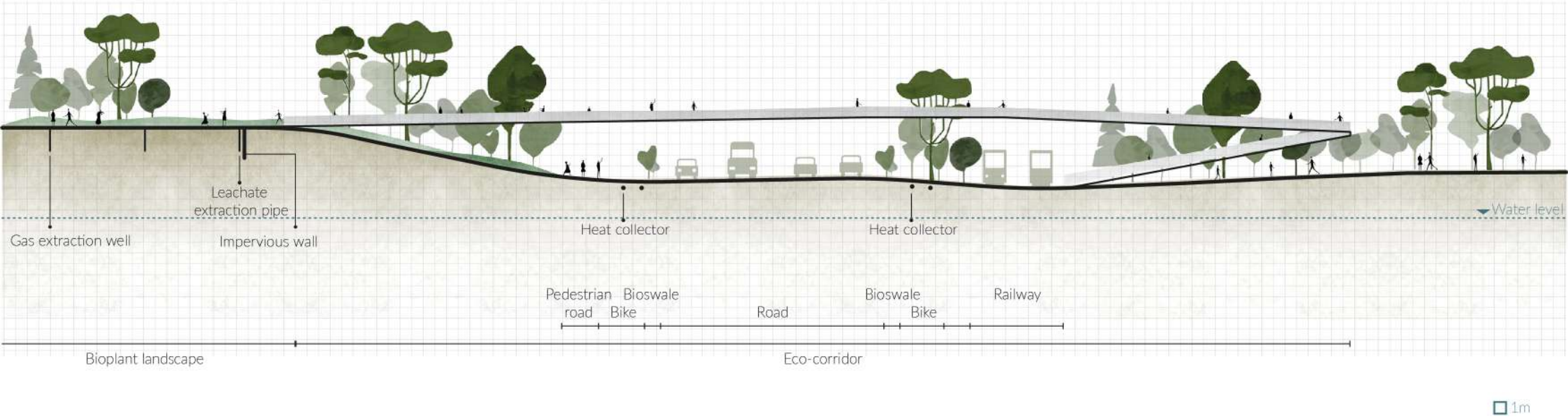
Wetland ~ Bio plant Landscape Elaboration



Wetland ~ Bio plant Landscape Elaboration

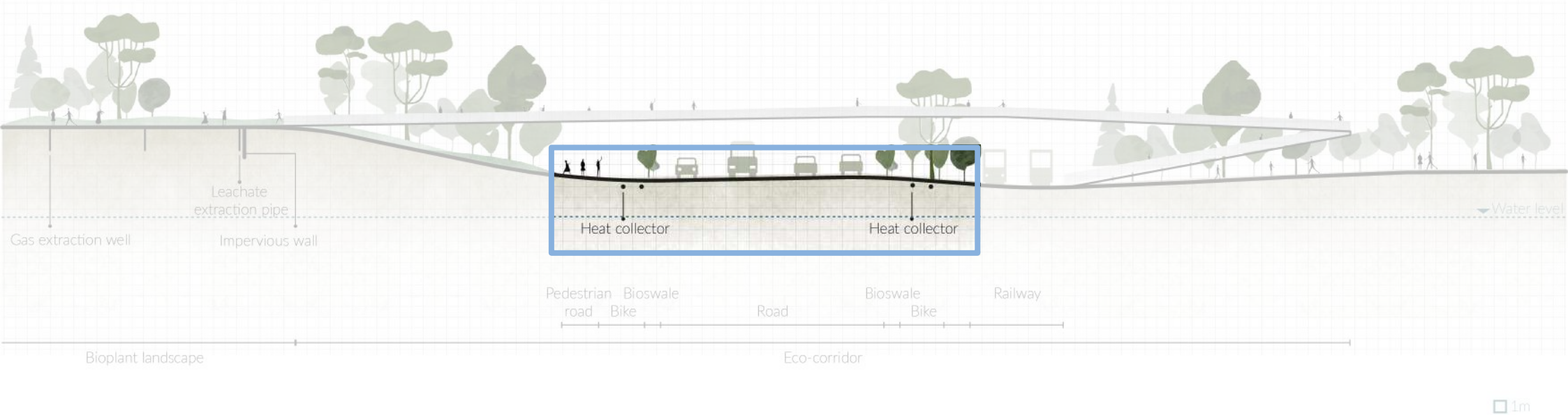


Bio plant Landscape ~ Eco-bridge Elaboration

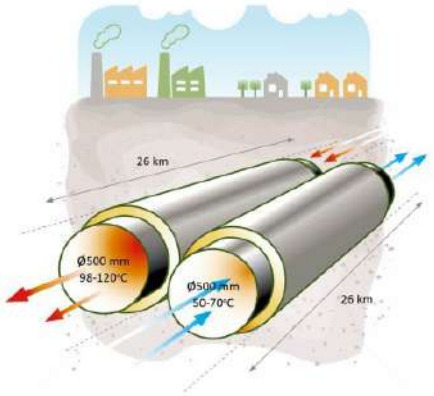


From Heat Collector to Heat Network

Design Elaboration

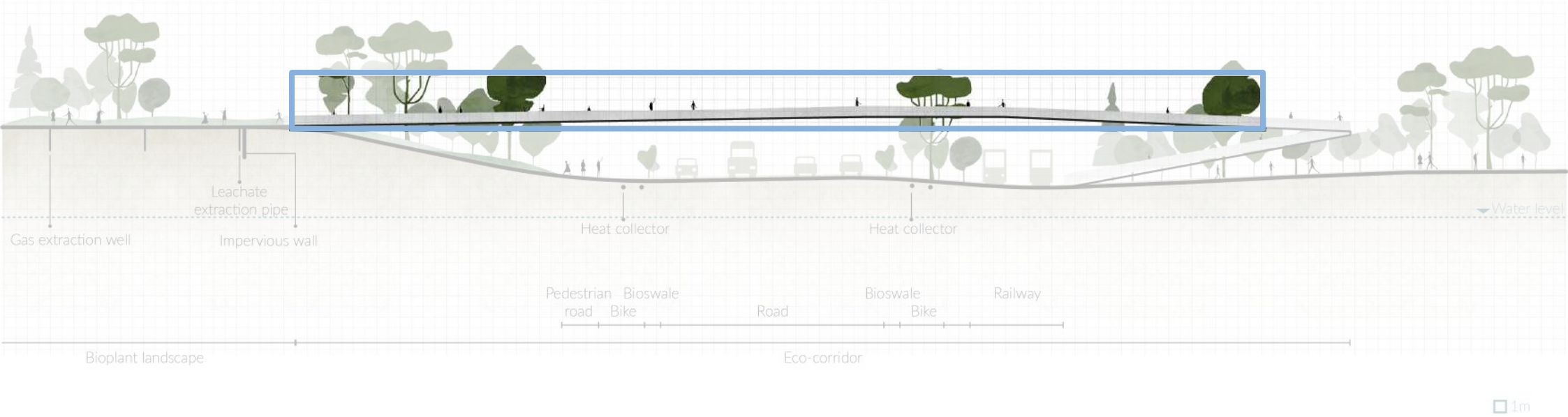


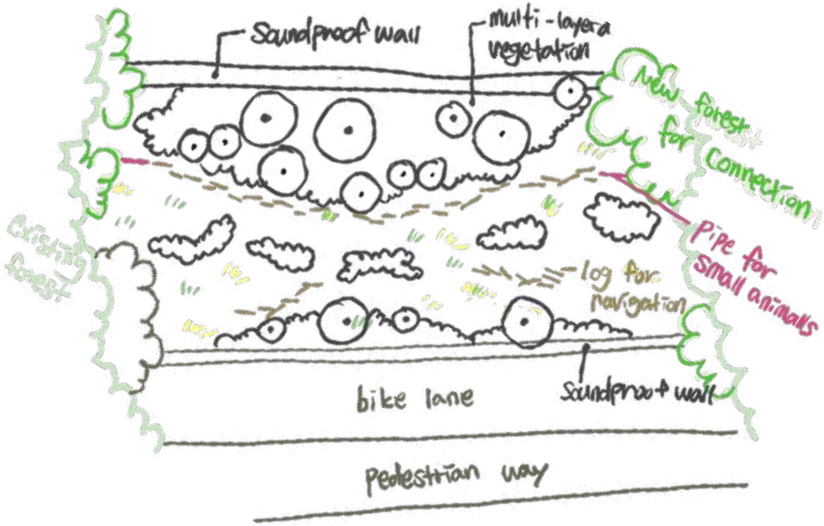
Source: Warmtebedrijf Rotterdam

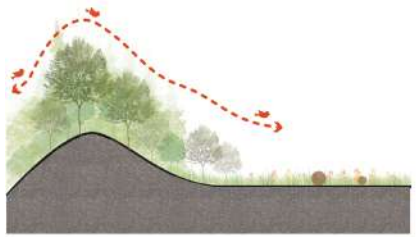


Details of Eco-bridge

Design Elaboration

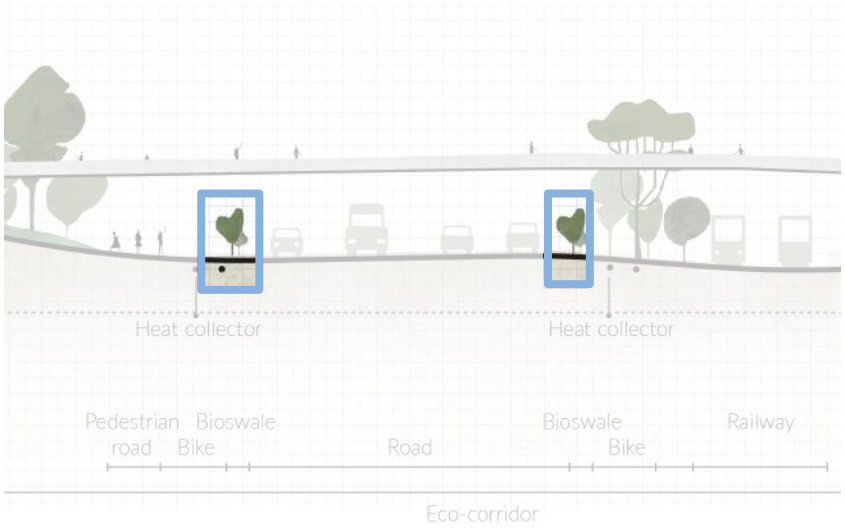




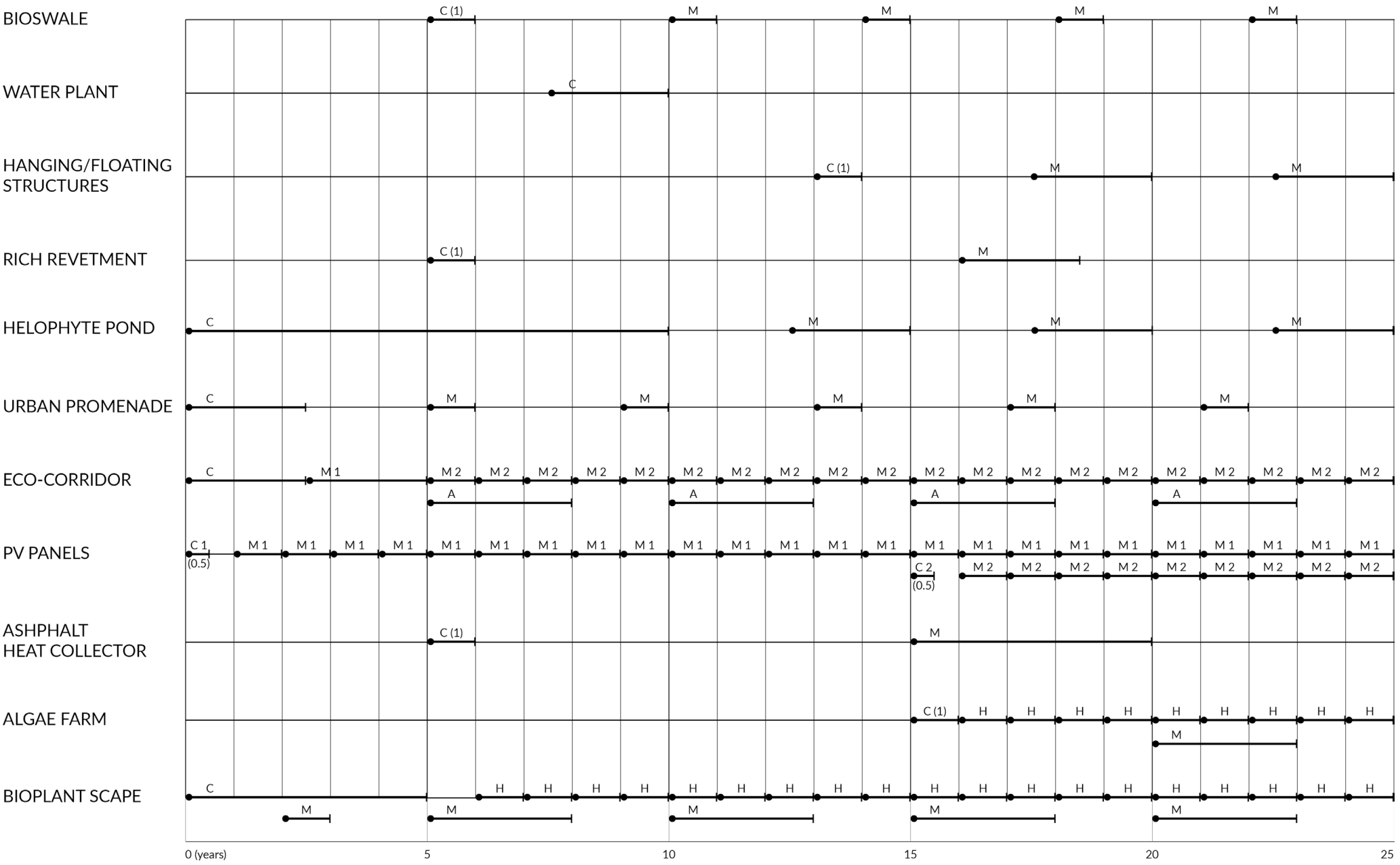


Details of Bioswale

Design Elaboration



Timeframe of Interventions



Design Proposal by 5 Years

Design Proposal by 15 Years

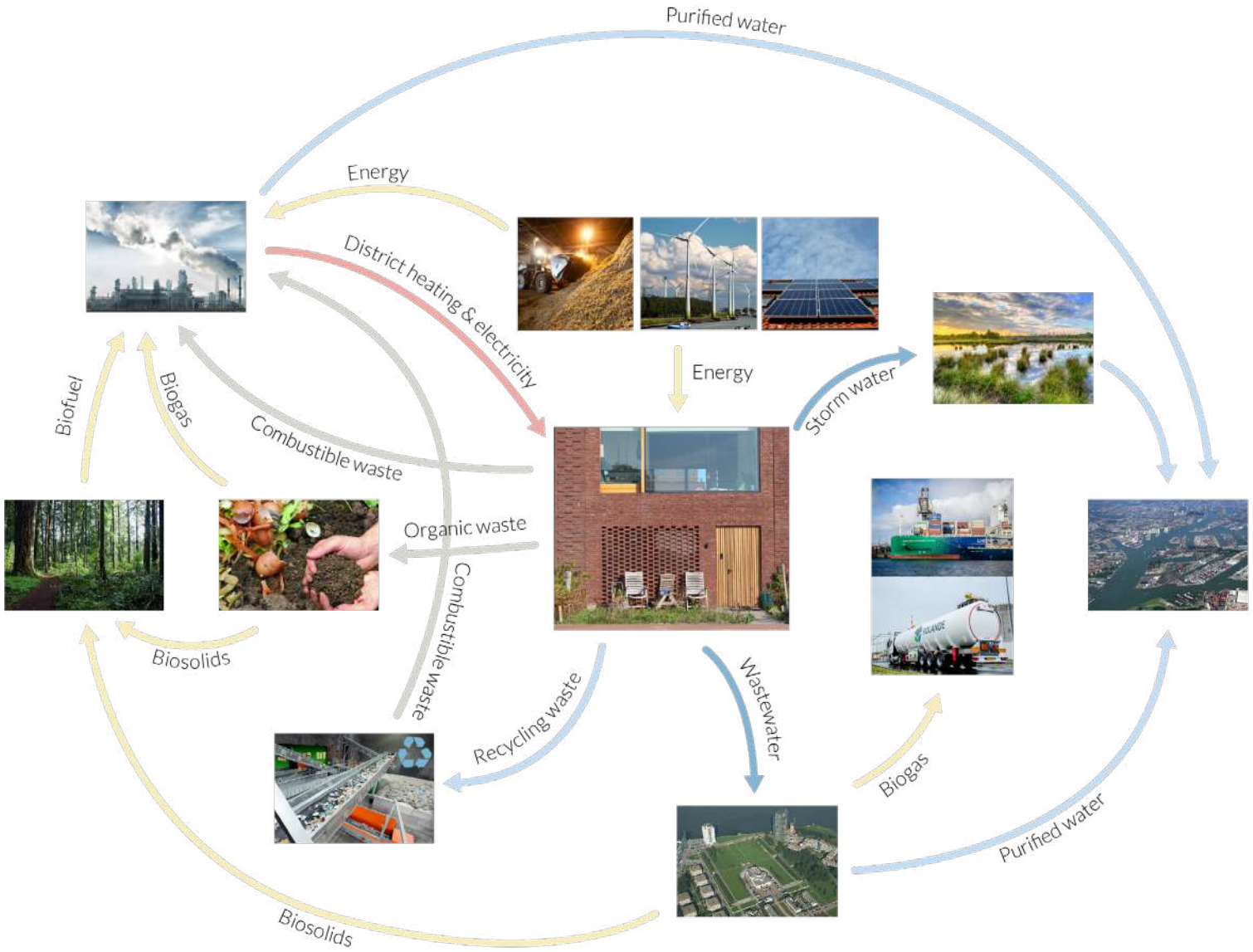
Design Proposal by 25 Years

Eco-bridge

Wetland (Island) & Solar Farm

Bioplant Landscape

Circularity of the Design Site



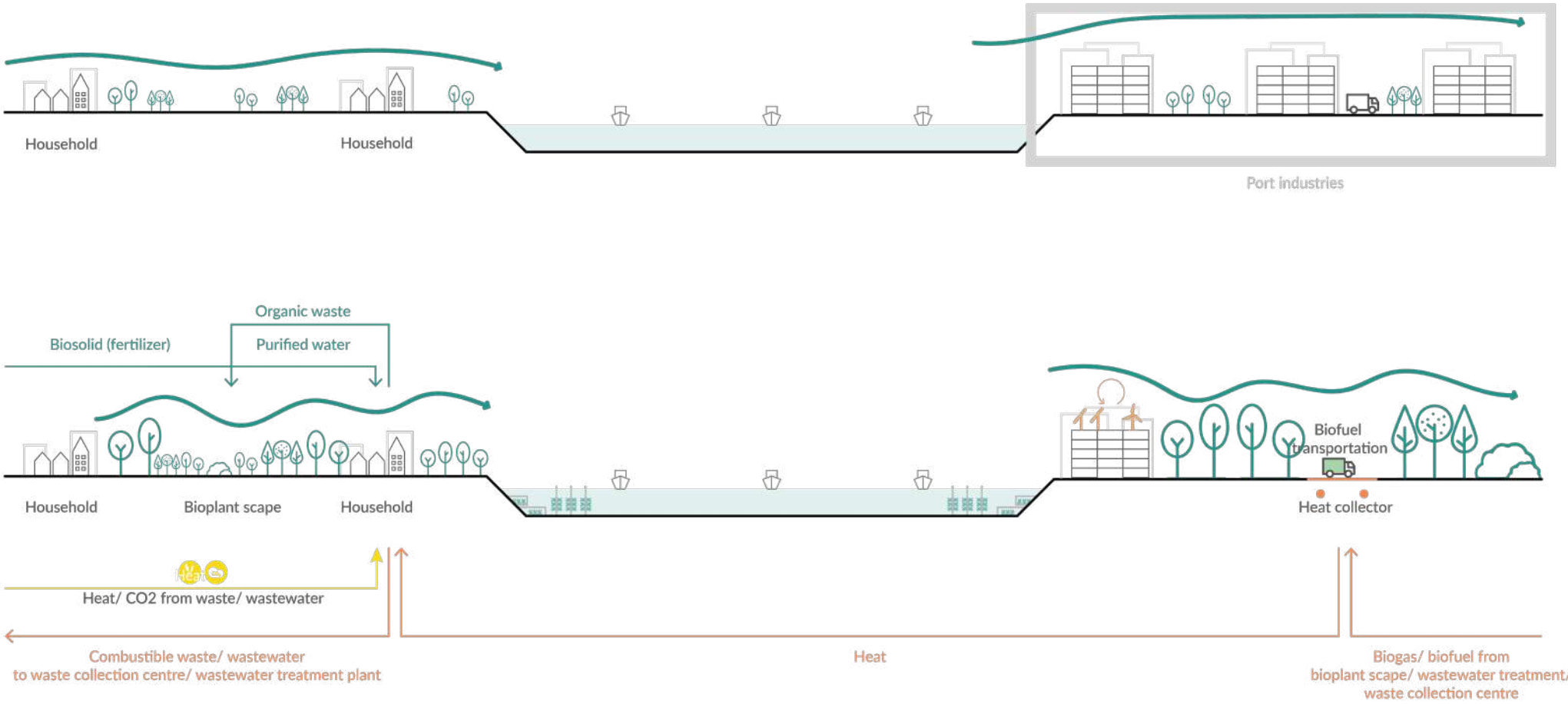
Adaptability of Spatial Interventions

Comparison Framework

INT. / ACC.	Heat collector	PV panels	Wind turbines (S)	Wind turbines (L)	Heat from local waste	Heat/gas from wastewater	Bioplant scape	Algae farm	Blue energy
High	○	○	△	✕	○	○	△	△	✕
Medium	○	○	△	△	○	○	○	△	✕
Low	○	○	○	○	△	△	○	○	△
	Bioswale	Water plants	Hanging/floating structures	Rich revetment	Helophyte pond	Urban promenade	Eco-bridge	Inland buffer zones	
High	○	○	○	○	△	○	△	✕	
Medium	○	○	○	○	△	△	△	✕	
Low	○	○	○	○	○	✕	△	△	

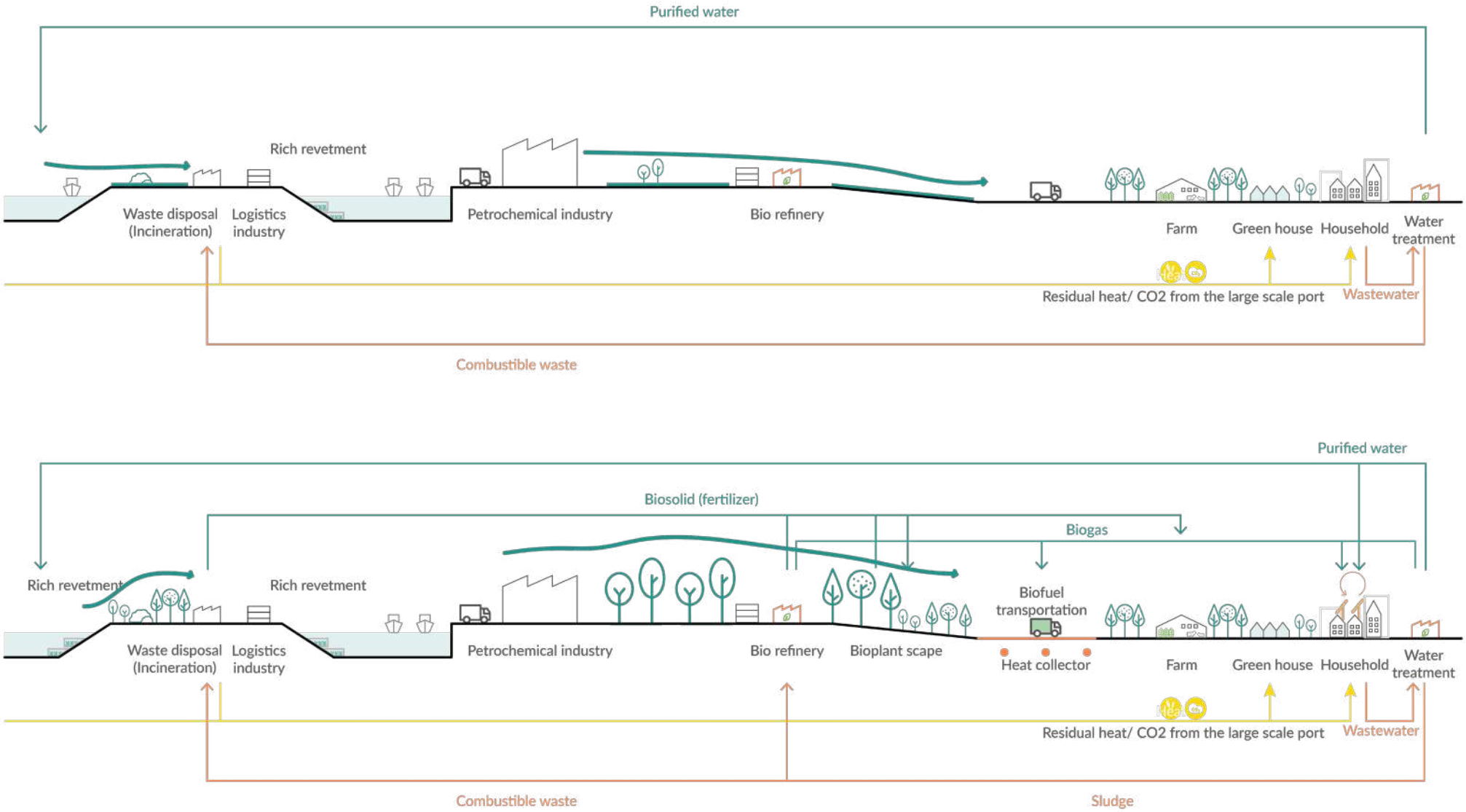
Circularity of RE & BD in High Accessibility Port

Comparison Framework



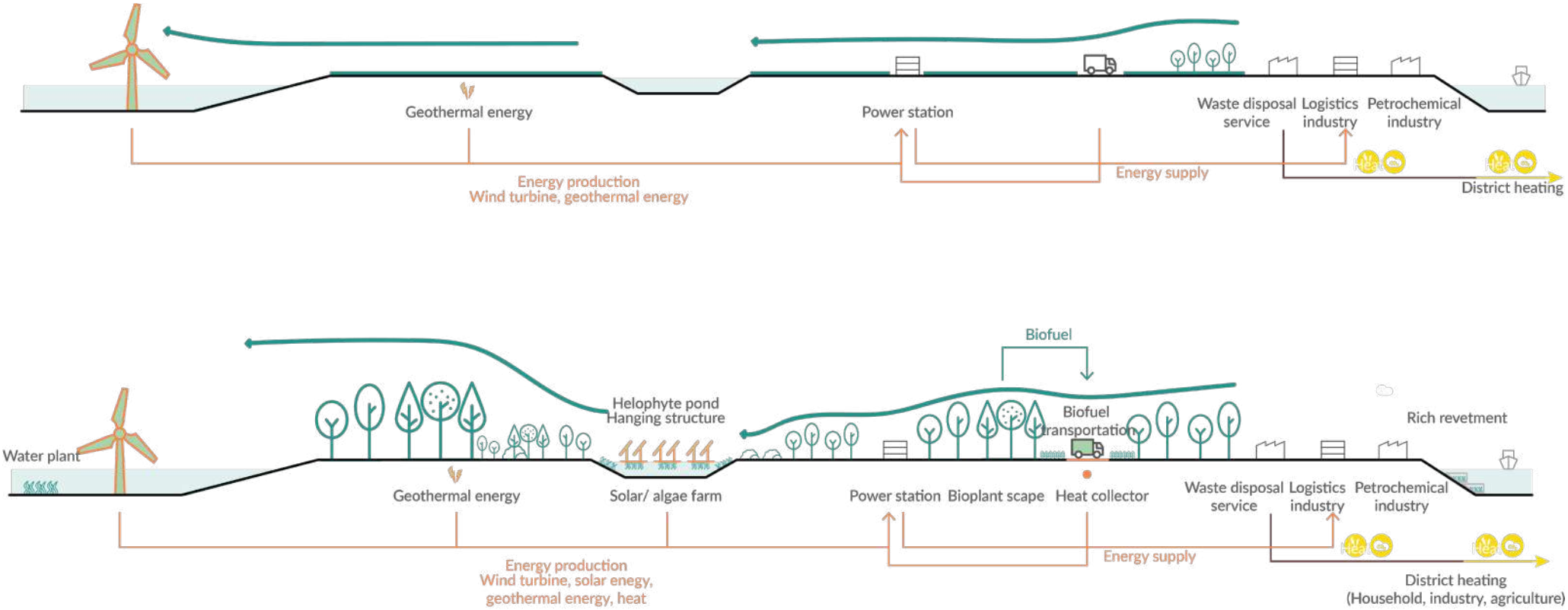
Circularity of RE & BD in Medium Accessibility Port

Comparison Framework



Circularity of RE & BD in Low Accessibility Port

Comparison Framework



What is a possible **spatial framework** to create **a renewable energy landscape** which **improves urban biodiversity** and **provides ecosystem services** while **enhancing recreational values** for citizens?

1. What is RE landscape in terms of non-human species?

2. What spatial interventions are needed for different landscape typology?

3. How can REL which contains large-scale energy infrastructures can work with residential areas?

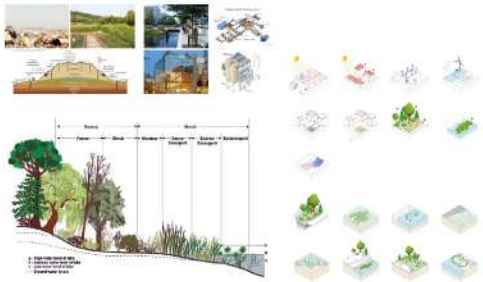
4. How industries & companies and RE landscape compromise together without any loss?

5. What position/ strategy should RE industries take into account during a planning stage (e.g. wind farm, solar park)?

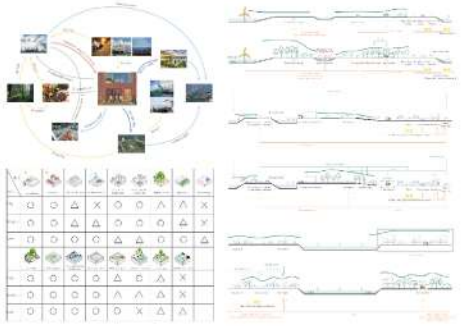
Project Re-cap

1. Definition & Framework

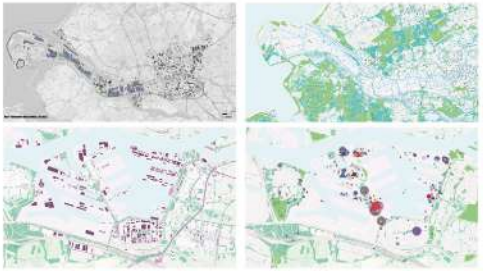
3. Analysis (Spatial Strategy)



5. Evaluation



2. Analysis (Understanding RE & BD)



4. Design

Thank you!