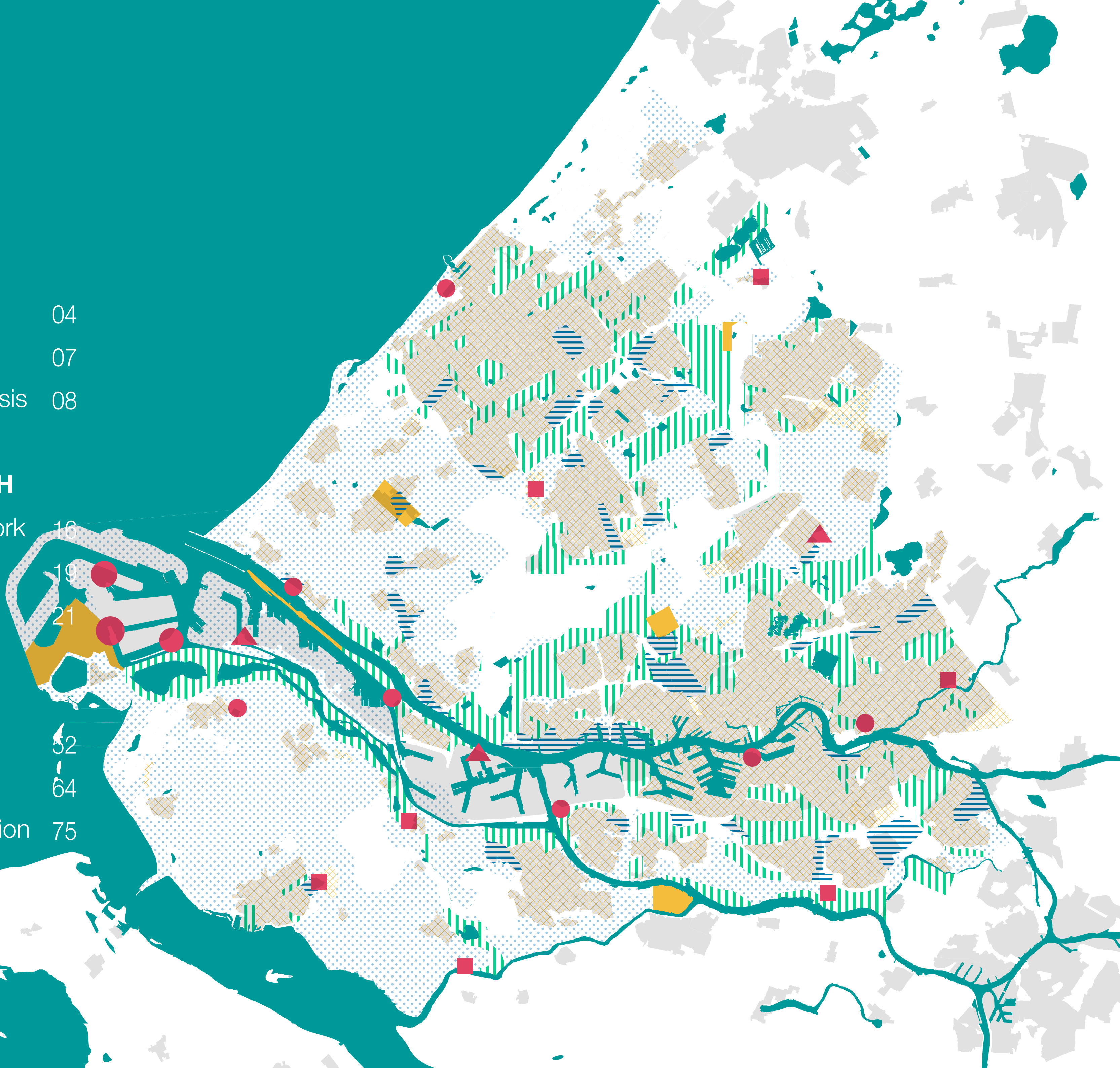
EMPOWER ENERGYSCAPE

INTEGRATING LANDSCAPE QUALITY INTO THE DESIGN OF ENERGY LANDSCAPE IN THE ROTTERDAM-THE HAGUE METROPOLITAN AREA

TIANYUE MA

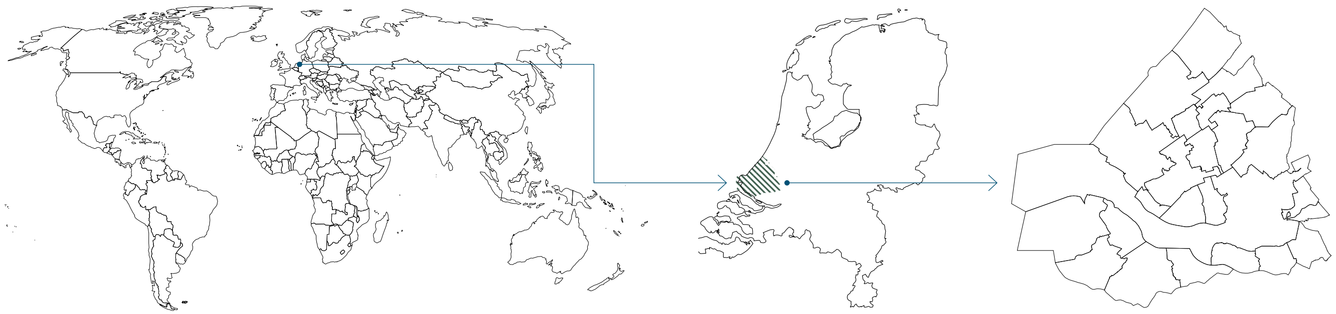
JULY, 2019

CONTENT



1 DEFINE THE PROBLEM

INTRODUCTION



World

Netherlands

MRDH region

Map 1. location of the MRDH region

What is MRDH?

Located in Randstad Area, founded in 2014
Encompassing the city of Rotterdam, The Hague and 21 municipalities
Largest European port and Dutch Greenport

Harbor industrial complex

Westland greenhouse area

Urban area

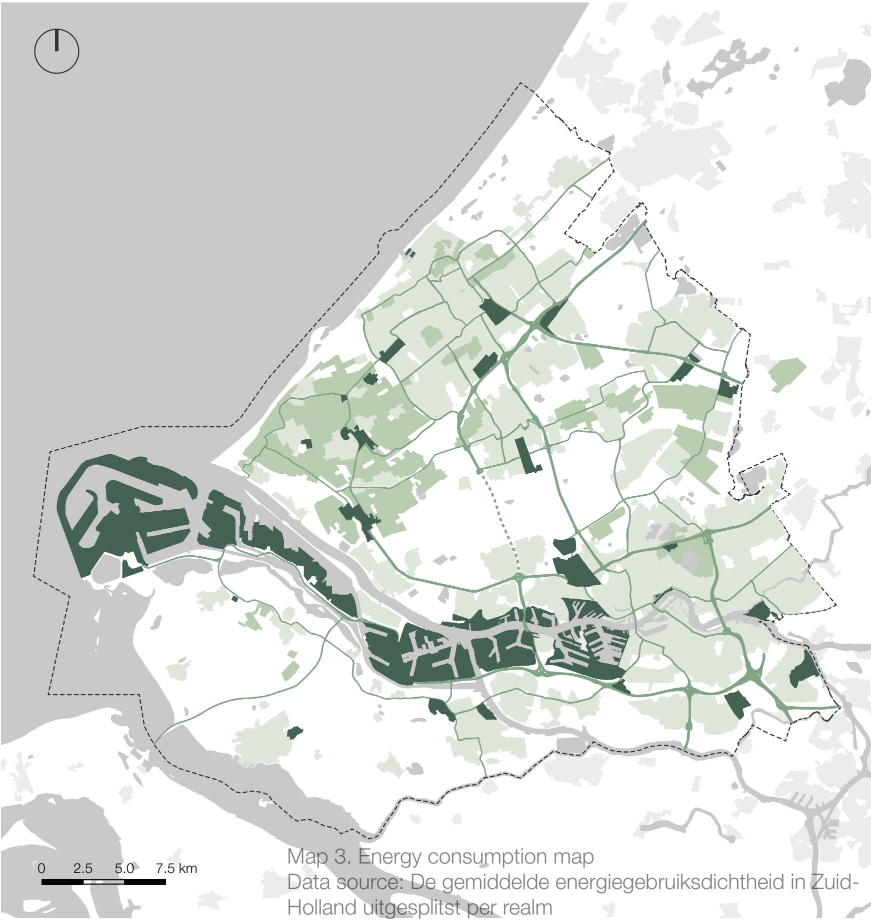
most energy consuming sectors

Source: public domain

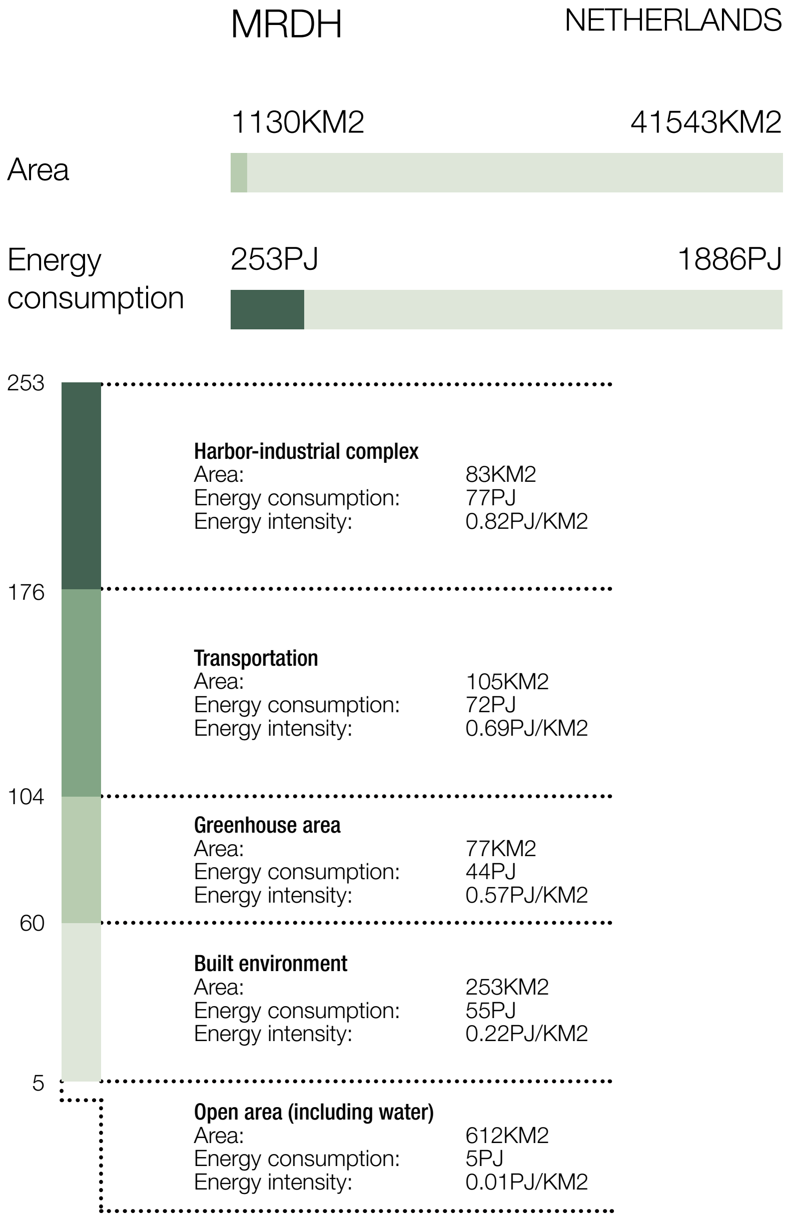
ENERGY CONSUMPTION

Only **2.7%** of national land area

With **13.4%** of domestic energy use



Map 3. Energy consumption map
Data source: De gemiddelde energiegebruiksdichtheid in Zuid-Holland uitgesplitst per realm



FOSSIL FUEL MARKET

Still **fossil fuel-dependent**

Oil and coal are mainly import

Natural gas from Groningen gas field

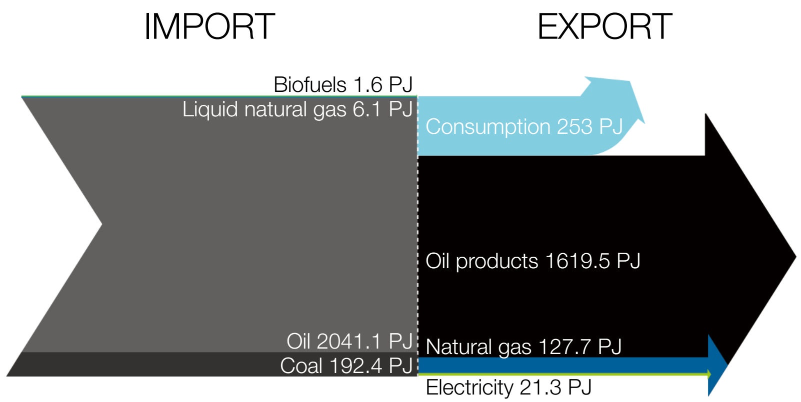


Figure 2. Import and export of energy in the Rotterdam harbour
Source: Quintel Energy Transition Model

- Producing gas field
- Undeveloped gas field
- Out of production gas field
- Producing oil field
- Undeveloped oil field
- Out of production oil field
- Import gas (6.1PJ)
- Import oil (2041.1PJ)
- Import coal (192.4PJ)
- Import biofuels (1.6PJ)

Map 2. Import and extraction of fossil fuel energy
Data source: www.nlog.nl/en/map-fields, drawn by author

GLOBAL WARMING

Significant rise of atmospheric CO2 after industrial revolution

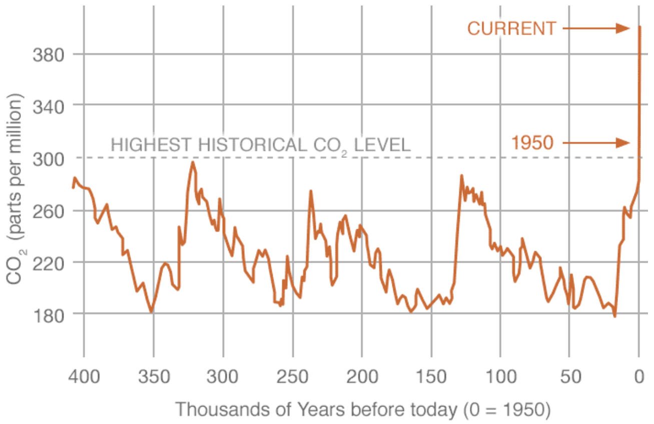


Figure 3. Atmospheric CO2 content
Source: NASA

GREENHOUSE EFFECT

Rise of 0.9°C in global surface temprature

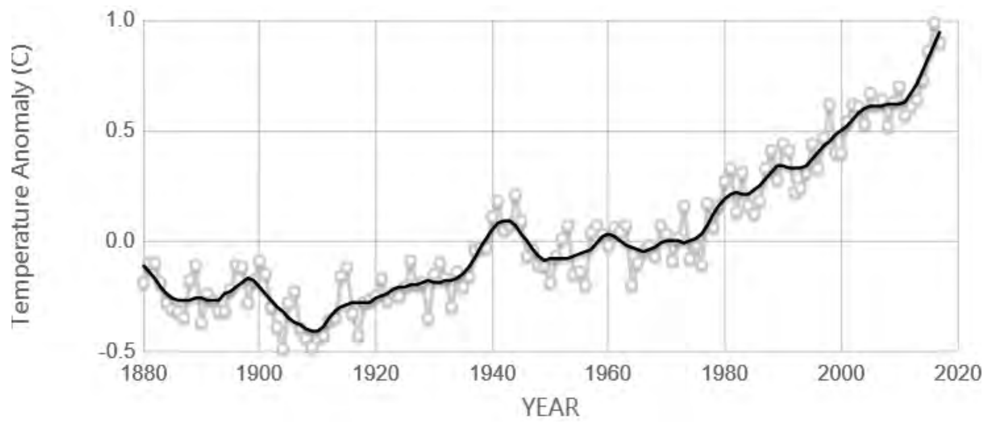
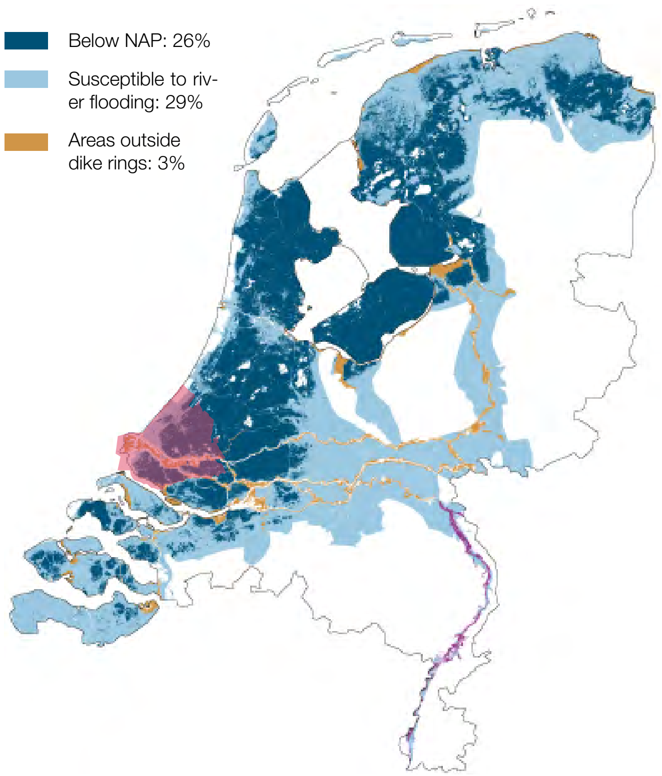


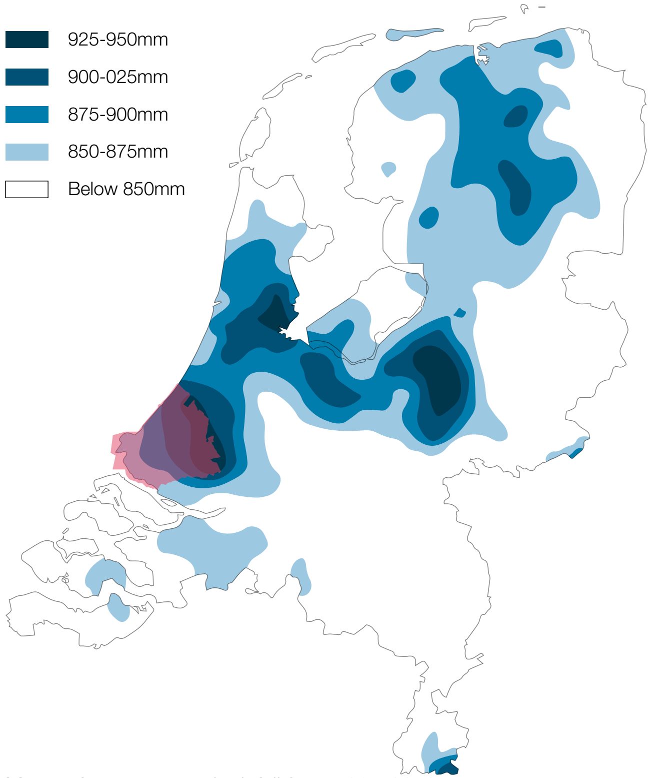
Figure 4. Global surface temperature (average)
Source: NASA/GISS

ENVIRONMENTAL THREATS IN MRDH



Map 4. Flood risks of the Netherlands.
Source: Netherlands environmental assessment agency, www.pbl.nl/en/dossiers/Climatechange/content/correction-wording-flood-risks

With most of the region lying below the sea level, the MRDH is under the great pressure of the **rising sea level**.



Map 5. Average annual rainfall from 1981-2010
Data source: www.elektro-rama.nl/weather/Klimaatatlas/Klimaatatlas-Neerslag.html, drawn by author

Climate change brings more extreme precipitation events which has caused the **flooding issue**.

Picture 7. Flooding

Picture 8. River discharge

FOSSIL FUEL DEPLETION

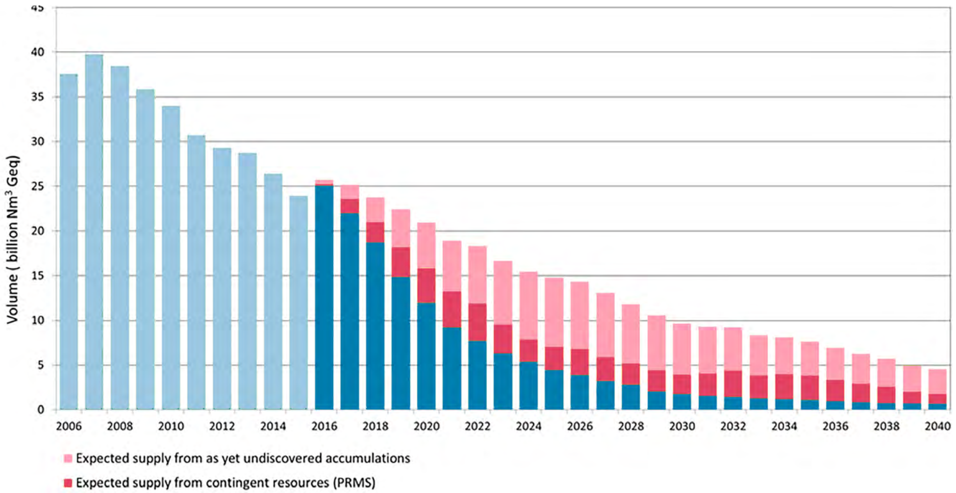


Figure 8. Expected trend in the supply of Dutch natural gas
Data source: www.nlog.nl/en/oil-and-gas-fields-overview

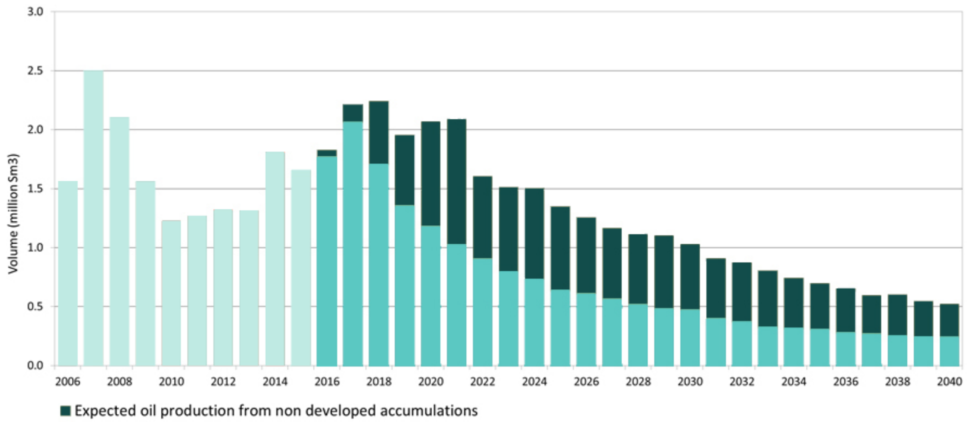


Figure 9. Expected trend in the supply of Dutch Oil
Data source: www.nlog.nl/en/oil-and-gas-fields-overview

IMPORT-DEPENDENT ENERGY

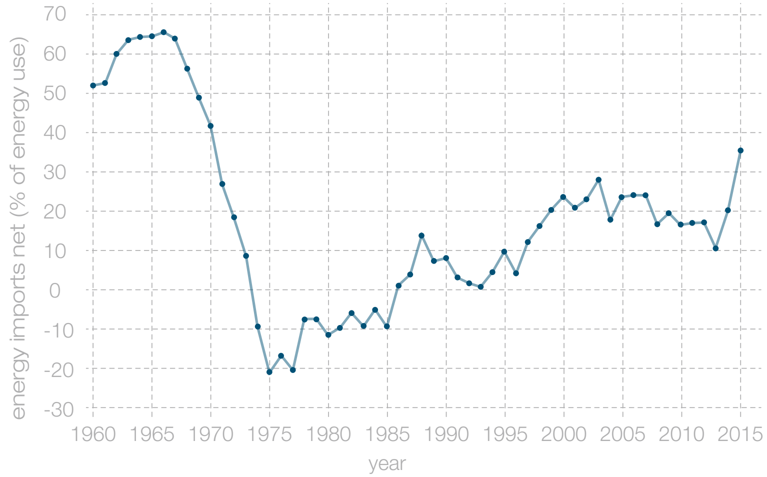


Figure 9. Energy dependence of the Netherlands
Data source: data.worldbank.org/indicator/EG.IMP.CONS.ZS?locations=NL

- The largest natural gas producer in Europe
- Significant depletion in the reserves and production of natural gas and oil in next 40 years

- The rising trend of import dependence since 2013 will keep going
- Energy security influenced by unstable geopolitics and changing political relations

Traditional energy landscape

↓ transition

Sustainable energy landscape

Little to no global warming emissions
Little to no pollution
Help stabilizing energy price
Labor intensive, creating more job opportunities


Picture 14 Traditional energy landscape


Picture X. Sustainable energy landscape

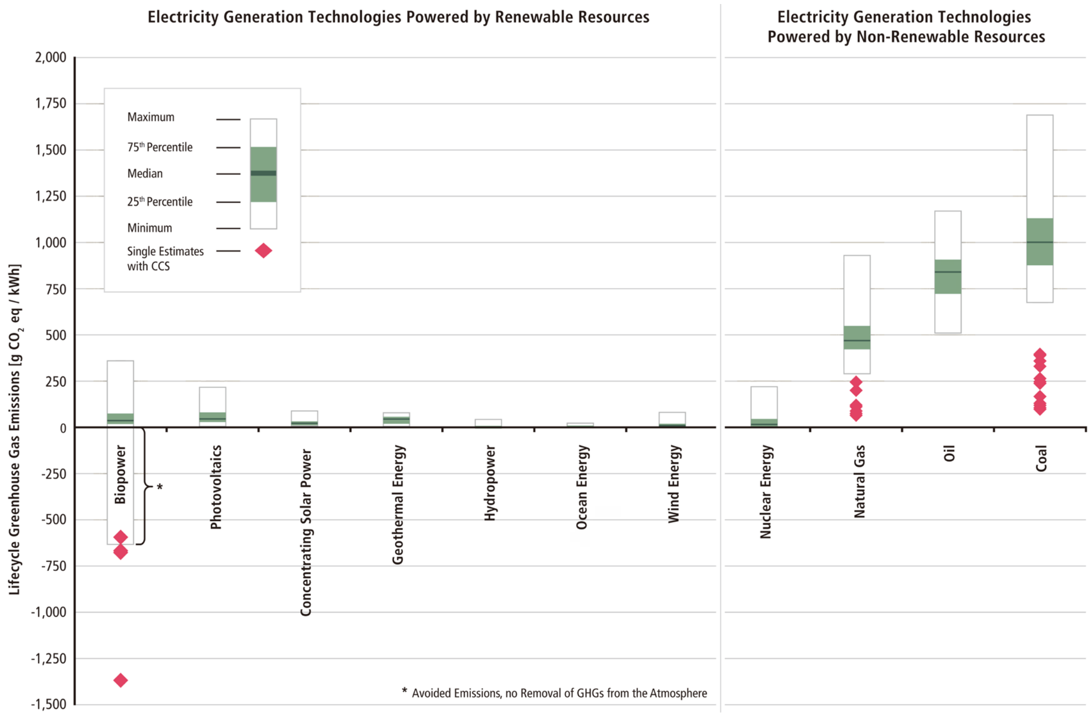


Figure 11. Different sources of energy produce different amounts of greenhouse gases.
Source: IPCC, 2011 Special Report on Renewable Energy Sources and Climate Change Mitigation (Chapter 9)

CURRENT APPROACH

≠

Picture 14 Paris Agreement aims at reducing greenhouse gas emissions

Picture 14 Public protests against renewable energy deployment

2016 RENEWABLE ENERGY PRODUCTION MRDH

Unit: PJ	ELECTRICITY	HEAT NETWORK	BIOGAS
WIND	1.44	—	—
SOLAR	0.42	—	—
BIOMASS	1.41	4.50	0.96
GEOTHERMAL	—	0.16	—
TOTAL	8.88 (2.7% of total energy consumption)		

Table 1. Current renewable energy production
Data source: klimaatmonitor.databank.nl/

· National goal: 14% renewable energy share by 2020 and **16% by 2023**

· Current approach: Only **6%** of the energy used in the Netherlands comes from renewable sources

· Current problem: **public resistance** against renewable energy because people are more aware and concerned about the quality of living environment.

By 2016, the total renewable energy production of the MRDH region is **8.88 PJ**, only **2.7%** of total energy consumption. The majority of the renewable energy technologies applied in the region are wind turbines and biomass digester.

PROBLEM STATEMENT

Practical gap:
Governmental aspiration
VS
Inhabitant aspiration

Landscape quality which valued by local inhabitants is missing in current energy transition

Solution:
creating an integrated energy landscape

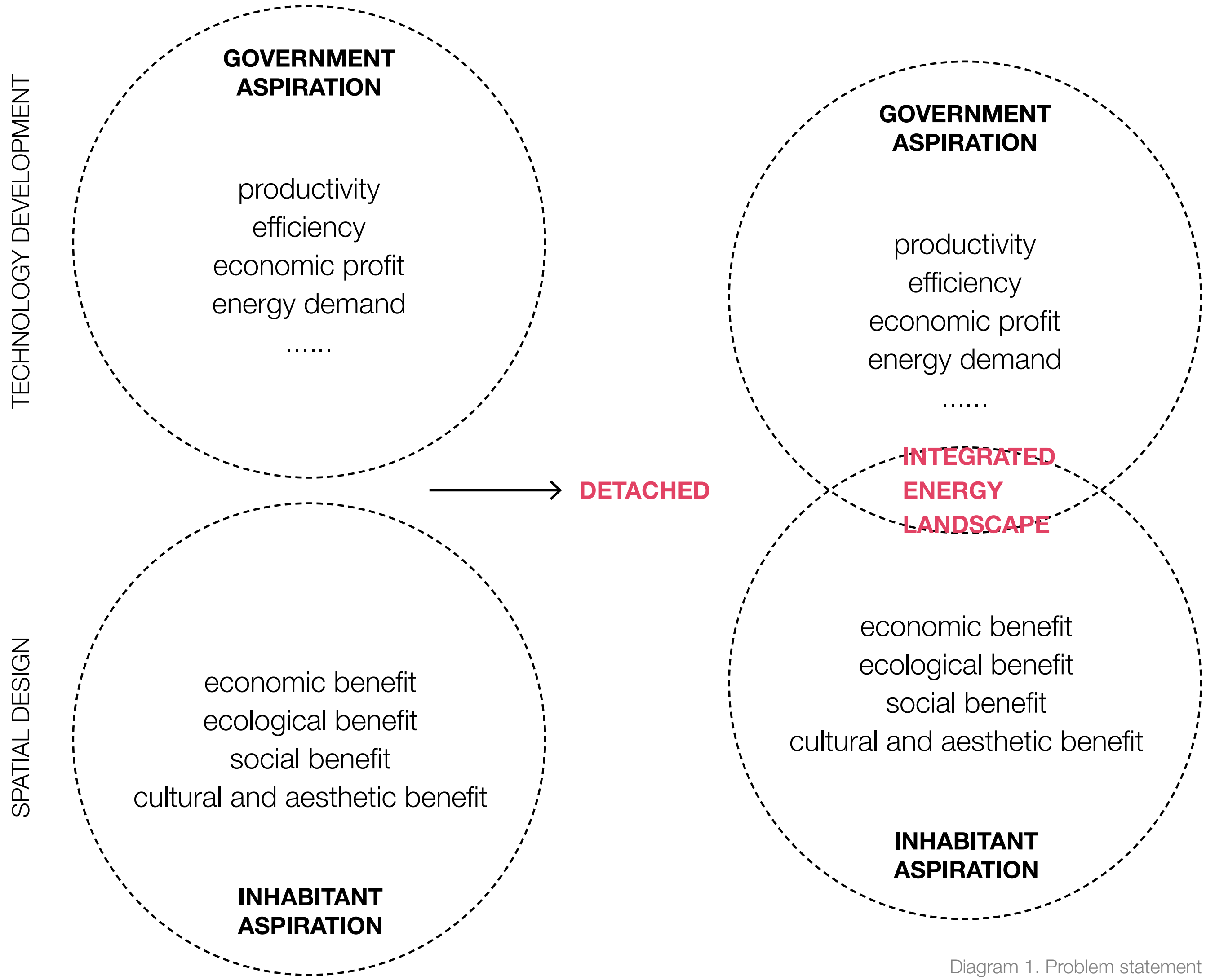


Diagram 1. Problem statement

RESEARCH AIM

The aim of the research is to facilitate the ongoing trend towards sustainable energy. By **integrating landscape quality** into the design of **energy landscape**, the public will be more concerned and supportive about sustainable energy transition, thus to contribute to creating a more **sustainable, livable and resilient MRDH**.

CONCEPTUAL FRAMEWORK

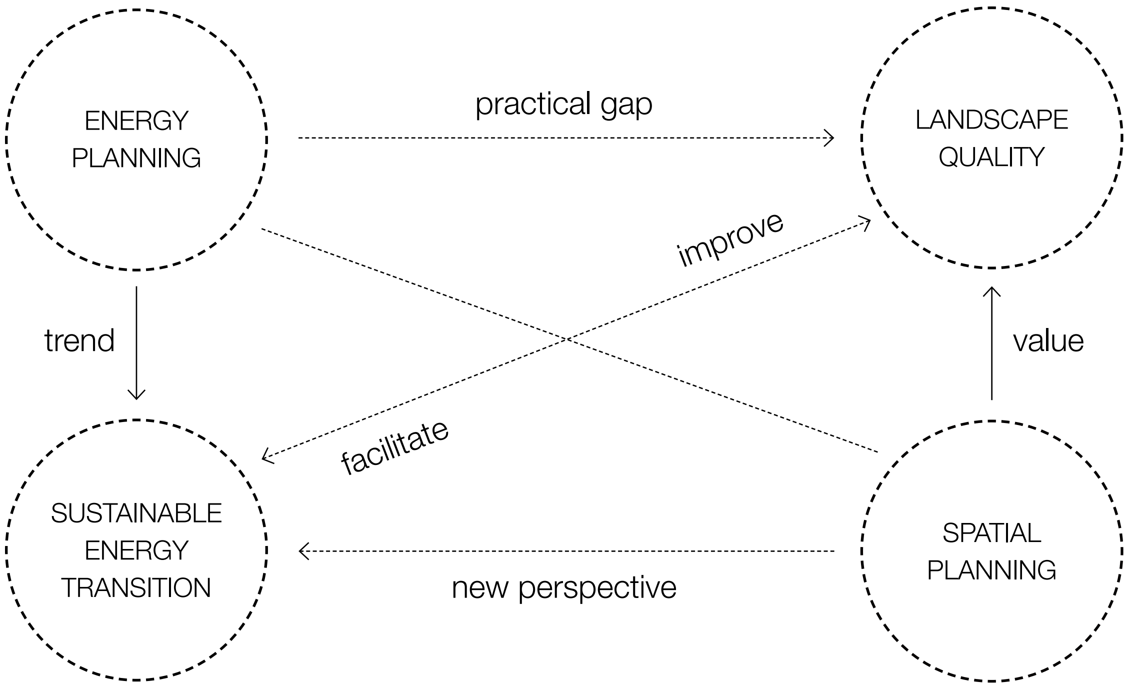


Diagram 3. Conceptual framework

RESEARCH QUESTION

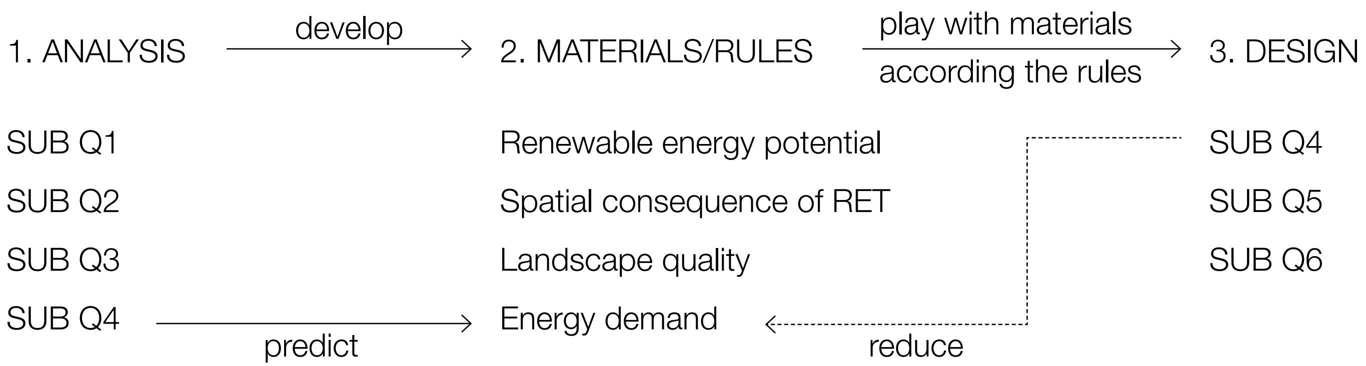
How to integrate landscape quality in the energy landscape which facilitates sustainable energy transition of the Metropolitan Area Rotterdam-The Hague (MRDH) through spatial planning and design?

Descriptive questions:

1. How to map the **potential of renewable energy** in the region?
2. What are the general **spatial implications** of renewable energy technologies?
3. What's the current condition of **landscape quality**?

Prescriptive questions:

4. How much **renewable energy production** is required in order to realize energy neutrality?
5. What are the expected **scenarios of landscape quality** for different urban realm?
6. How to integrate energy production and landscape quality in **spatial interventions**?



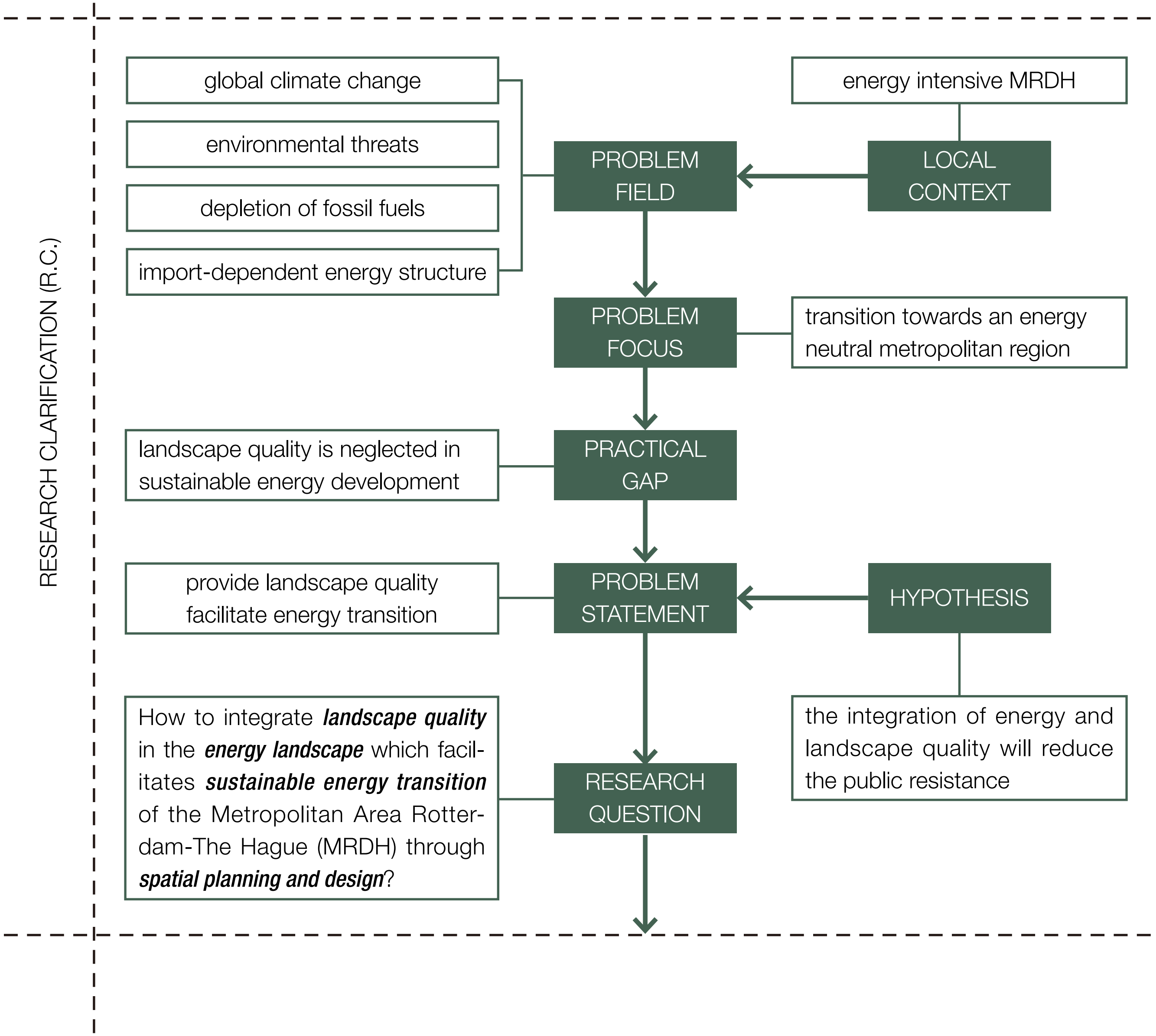
2 DESIGN THE RESEARCH

METHODOLOGY FRAMEWORK

Overall approach:
Four-stage methodology by Lucienne T. M. Blessing and Amaresh Chakrabarti

1. Research Clarification (R.C.)
2. Descriptive Study I (D.S.I)
3. Prescriptive Study (P.S.)
4. Descriptive Study II (D.S.II)

FOUR-STAGE METHODOLOGY

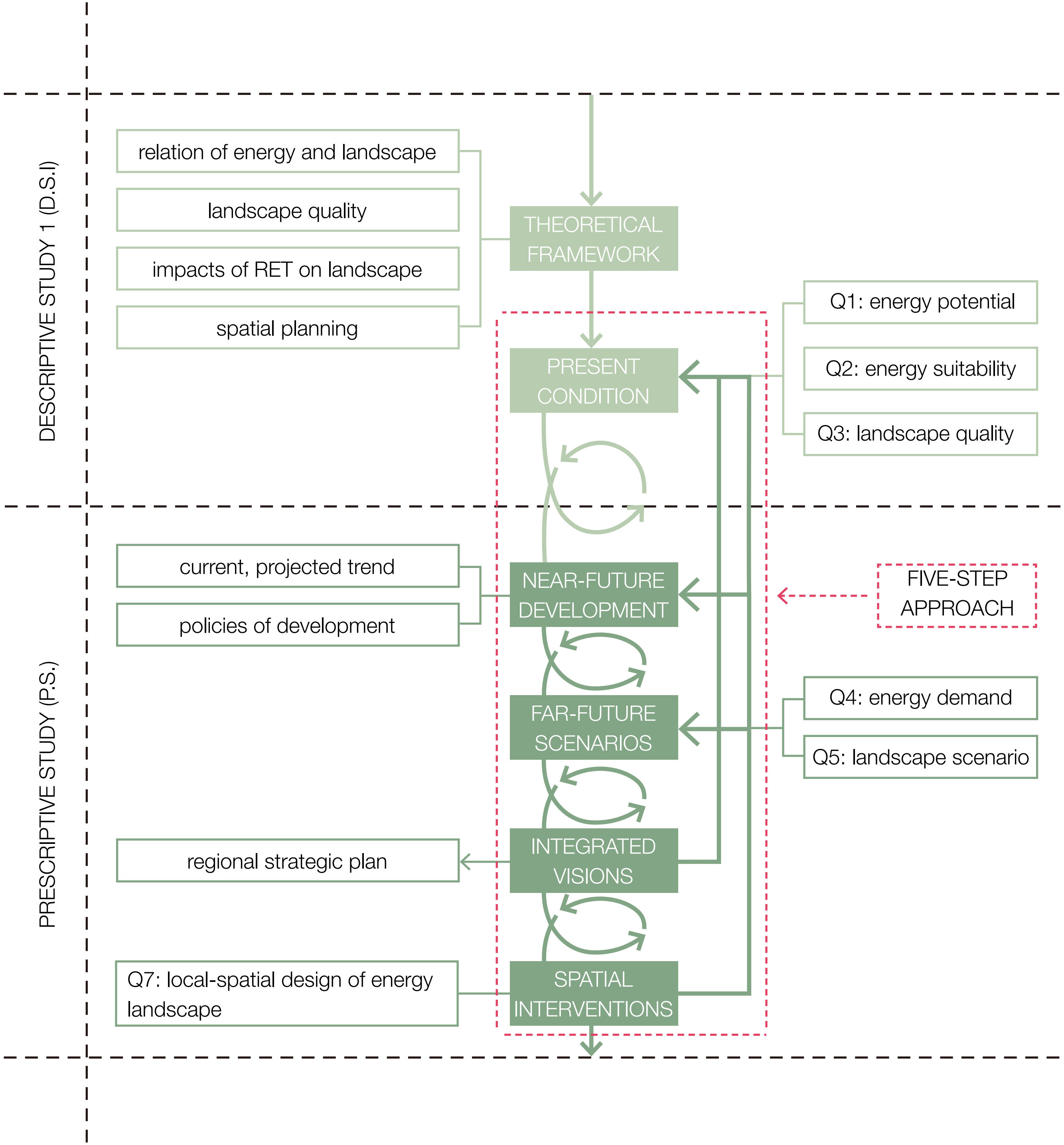


Within this research framework, the **five-step approach** is integrated in stage D.S.I and P.S to develop a long-term regional vision.

1. Analyzing present conditions
2. Mapping near-future developments
3. Illustrating possible far futures
4. Developing integrated visions
5. Identifying spatial interventions

This is an **iterative process** with evaluations reflections between and among different steps.

In this presentation, Q4 is addressed and answered before Q1 because then it's easier to transform potential into actual numbers of renewable energy technologies.



RESEARCH METHODS

· For descriptive questions, analytical methods such as **phenomenon diagnosis, data analysis and mapping** are used to give a better understanding of current condition

· For prescriptive questions, design methods such as **future prediction, visualization and generalization** are used to develop design proposals

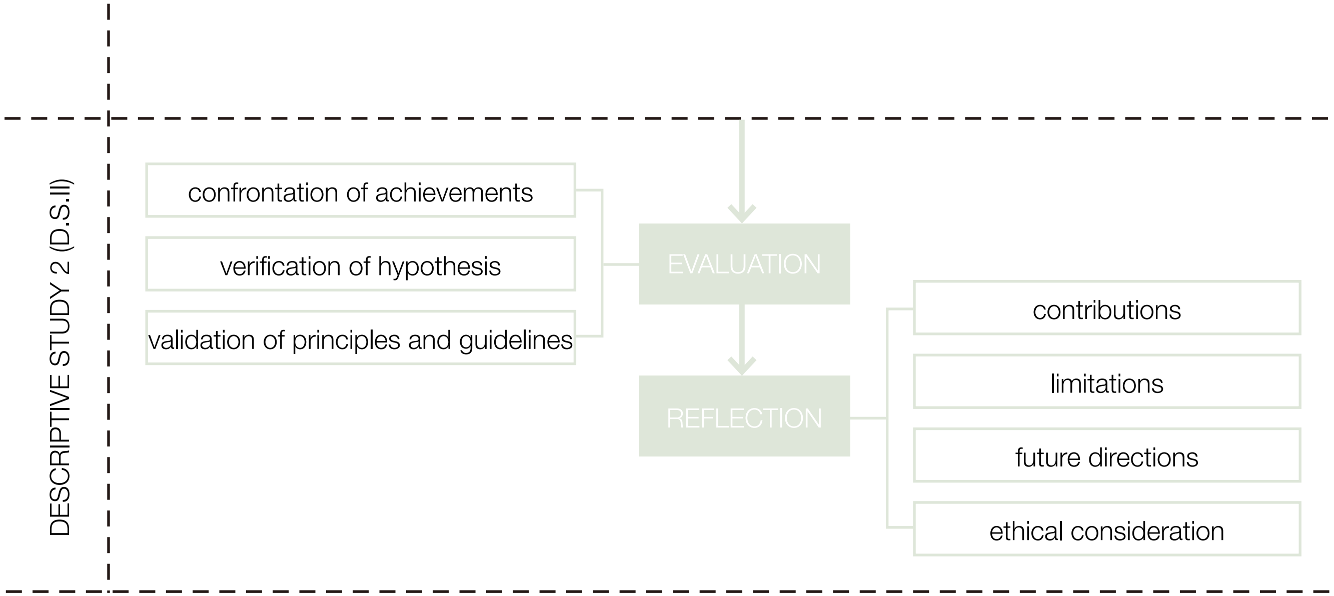


Diagram 4. Methodology framework

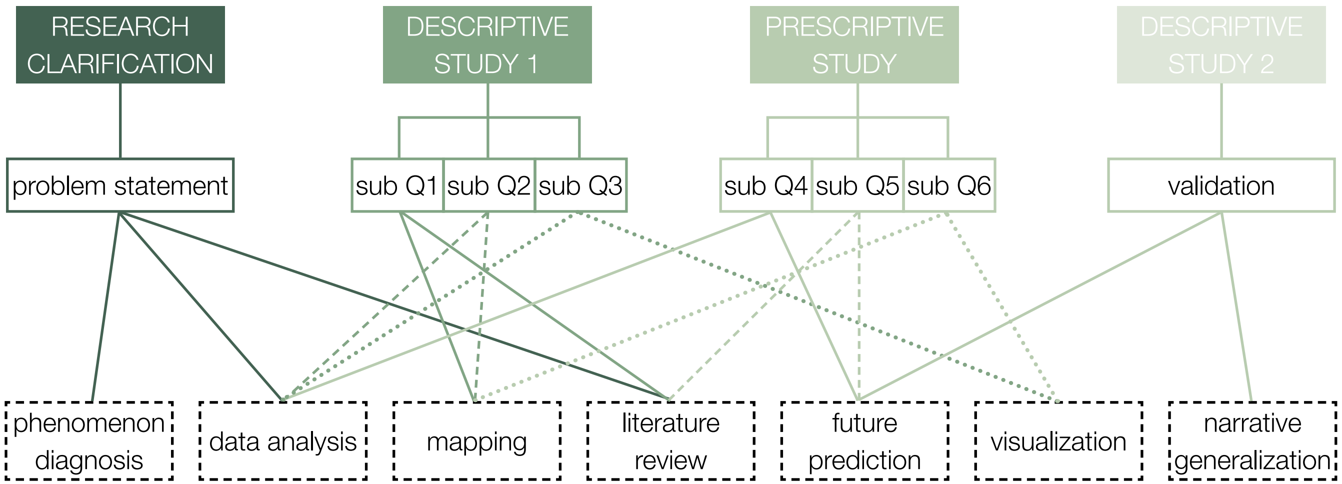


Diagram 5. Methods

Assessment matrix of landscape quality (Dauvellier and Luttik, 2003).

	Economic Quality	Ecological Quality	Cultural/aesthetic Quality	Social Quality
Use value	Land productivity Multi functionality Reuse of vacant space	Ecological corridor		Equity and fairness
Perception value	Fine-tuning function	Transparent air Clean water Acoustic wellness	Cultural diversity Historic awareness Aesthetic quality	Space identity Sense of belonging Sense of secure
Future value	Function adaptability	Biodiversity Resilience		Social coherence

ECONOMIC QUALITY

Farmland

Greenhouse

Recreational area

ECOLOGICAL QUALITY

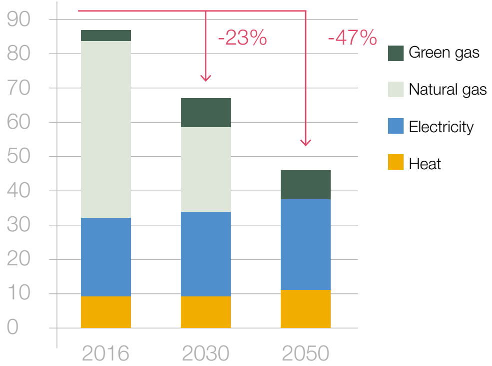
Nature preserve

Ecological corridor

Acoustic wellness

ENERGY DEMAND

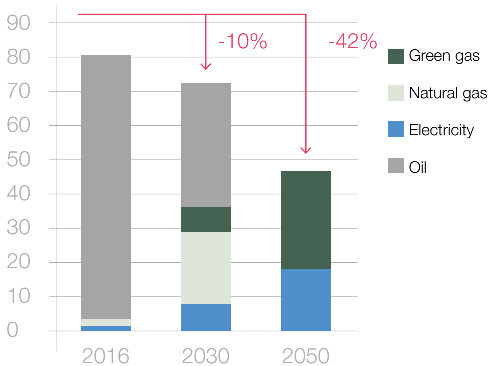
Final energy demand for built environment



2030	2050
+110%	+112%
-50%	-100%
+8%	+15%
-4%	+18%

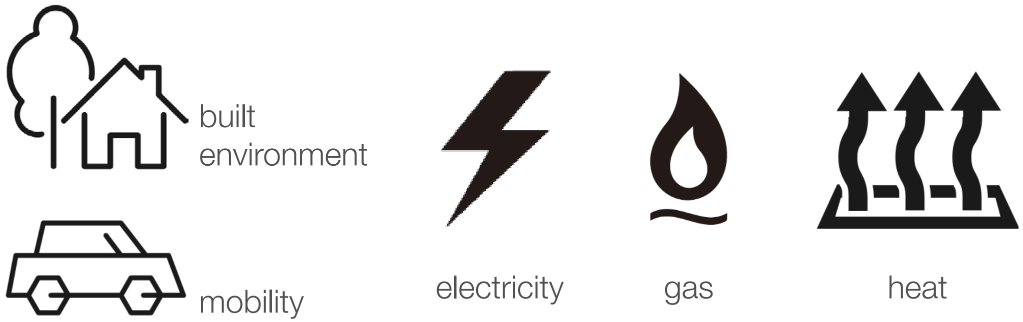
Figure X. Final energy demand for built environment
Data reference: Gasunie Survey 2050, (2018)

Final energy demand for mobility



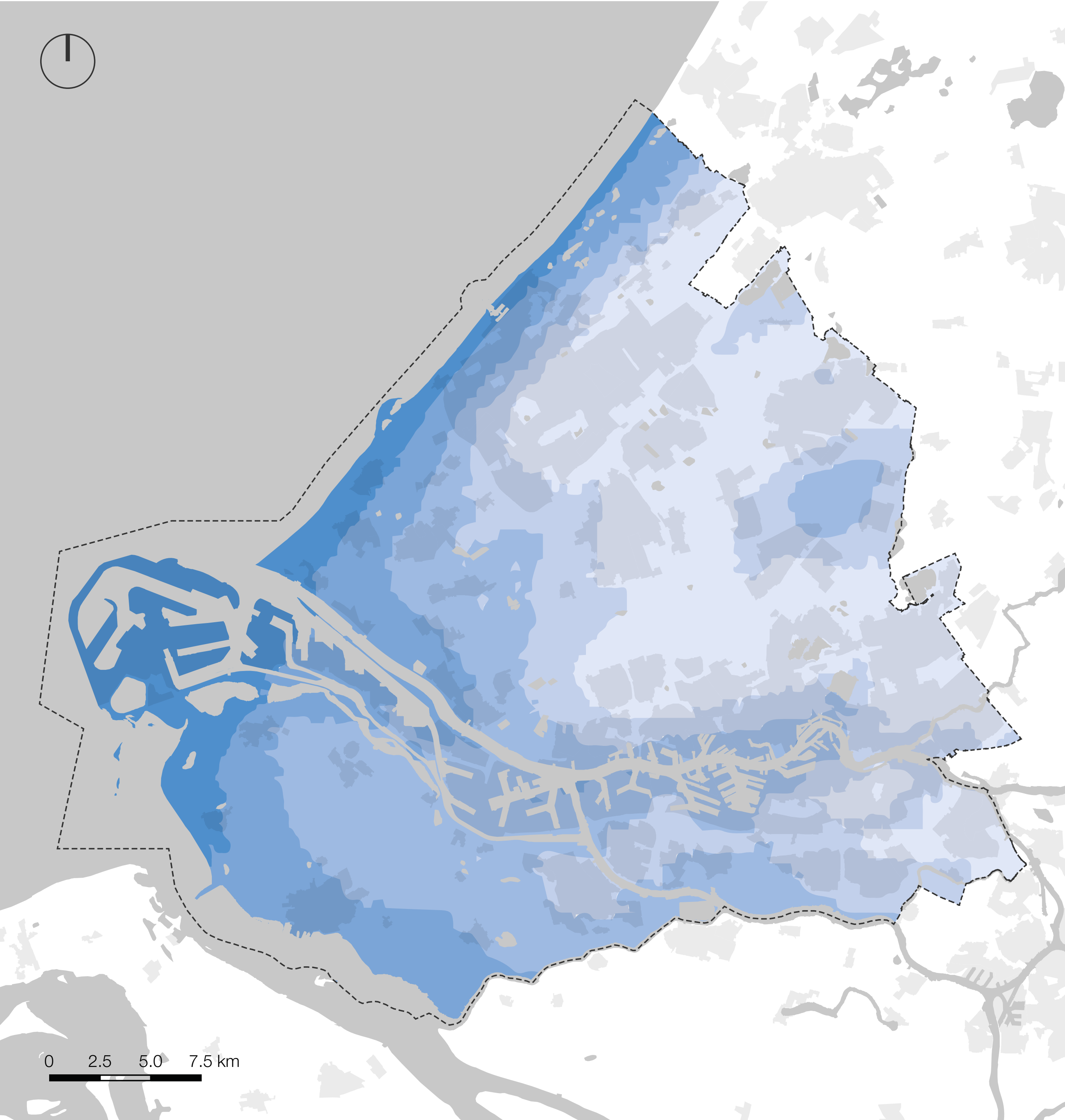
2030	2050
+500%	+2000%
+1000%	-100%
+450%	+1200%
-50%	-100%

Figure X. Final energy demand for built environment
Data reference: Gasunie Survey 2050, (2018)



Unit: PJ	2016		2030		2050	
	BUILT ENVIRON-MENT	MOBILITY	BUILT ENVIRON-MENT	MOBILITY	BUILT ENVIRON-MENT	MOBILITY
HEAT NETWORK	8.53	0	8.16 (-4%)	0	10.14 (+18%)	0
ELECTRICITY	20.24	0.94	21.95 (+8%)	5.21 (+450%)	23.20 (+15%)	12.28 (+1200%)
NATURAL GAS	44.34	1.32	21.81 (-50%)	14.41 (+1000%)	0 (-100%)	0 (-100%)
GREEN GAS	3.59	0	7.59 (+110%)	4.99 (+500%)	7.62 (+112%)	19.42 (+2000%)
OIL	0	52.41	0	26.20 (-50%)	0	0 (-100%)
TOTAL	77.28	54.67	59.51 (-20%)	49.20 (-10%)	40.96 (-45%)	31.71 (-42%)

Figure X. Energy demand prediction in the MRDH
Data reference: Gasunie Survey 2050, (2018)



WIND ENERGY

Good potential of wind energy

Wind power density depends on the height

	30 m (98 ft)		50 m (164 ft)	
Wind Power Class	Wind Power Density (W/m²)	Wind Speed m/s (mph)	Wind Power Density (W/m²)	Wind Speed m/s (mph)
1	≤160	≤5.1 (11.4)	≤200	≤5.6 (12.5)
2	≤240	≤5.9 (13.2)	≤300	≤6.4 (14.3)
3	≤320	≤6.5 (14.6)	≤400	≤7.0 (15.7)
4	≤400	≤7.0 (15.7)	≤500	≤7.5 (16.8)
5	≤480	≤7.4 (16.6)	≤600	≤8.0 (17.9)
6	≤640	≤8.2 (18.3)	≤800	≤8.8 (19.7)
7	≤1600	≤11.0 (24.7)	≤2000	≤11.9 (26.6)

Figure X. Classes of wind power density
Source: wind resource assessment handbook

Class	H=100m	H=50m
1	625 W/m²	400 W/m²
2	525 W/m²	325 W/m²
3	425 W/m²	275 W/m²
4	375 W/m²	225 W/m²
5	325 W/m²	175 W/m²

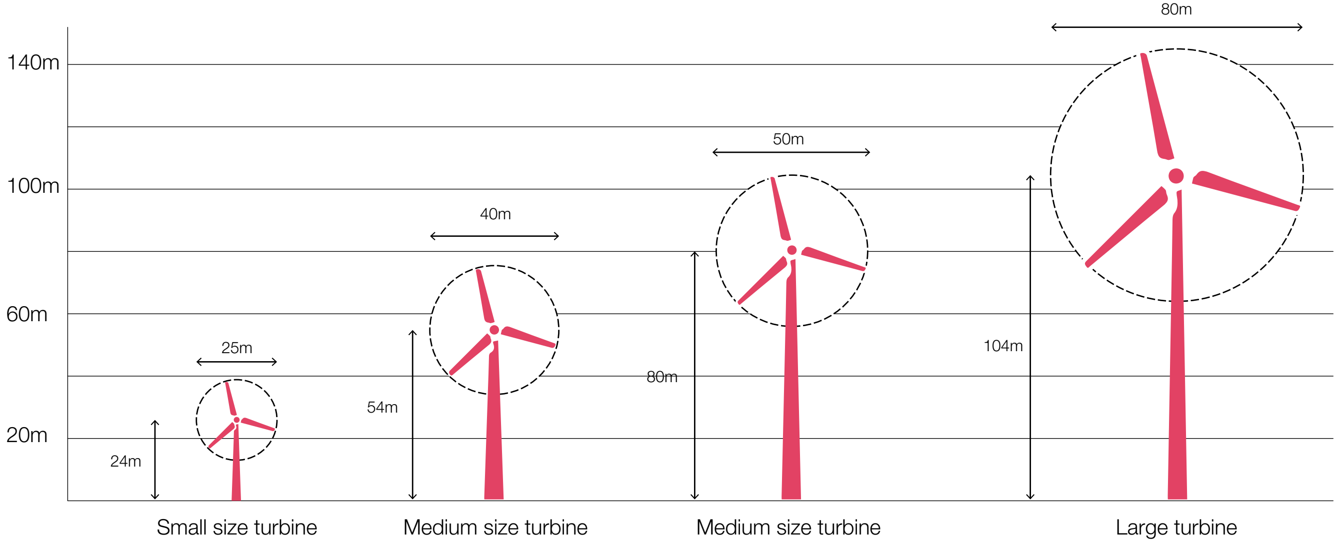
Map 2. Wind energy potential
Data source: global wind atlas

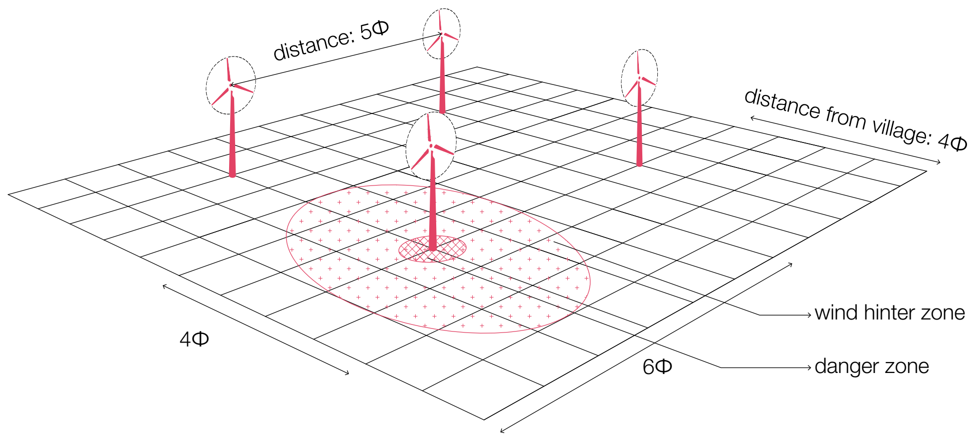
Rating power : 100KW
Mast height: 24m
Rotordiameter: 25m
Year: 1990

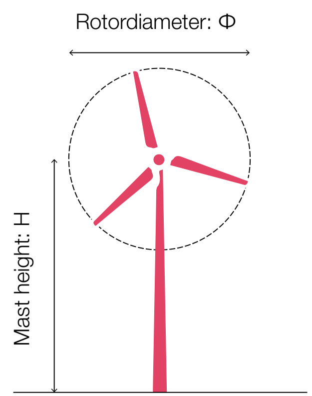
Rating power: 500KW
Mast height: 54m
Rotordiameter: 40m
Year: 1990

Rating power: 800KW
Mast height: 80m
Rotordiameter: 50m
Year: 1995

Rating power: 2000KW
Mast height: 104m
Rotordiameter: 80m
Year: 2000







EFFICIENCY

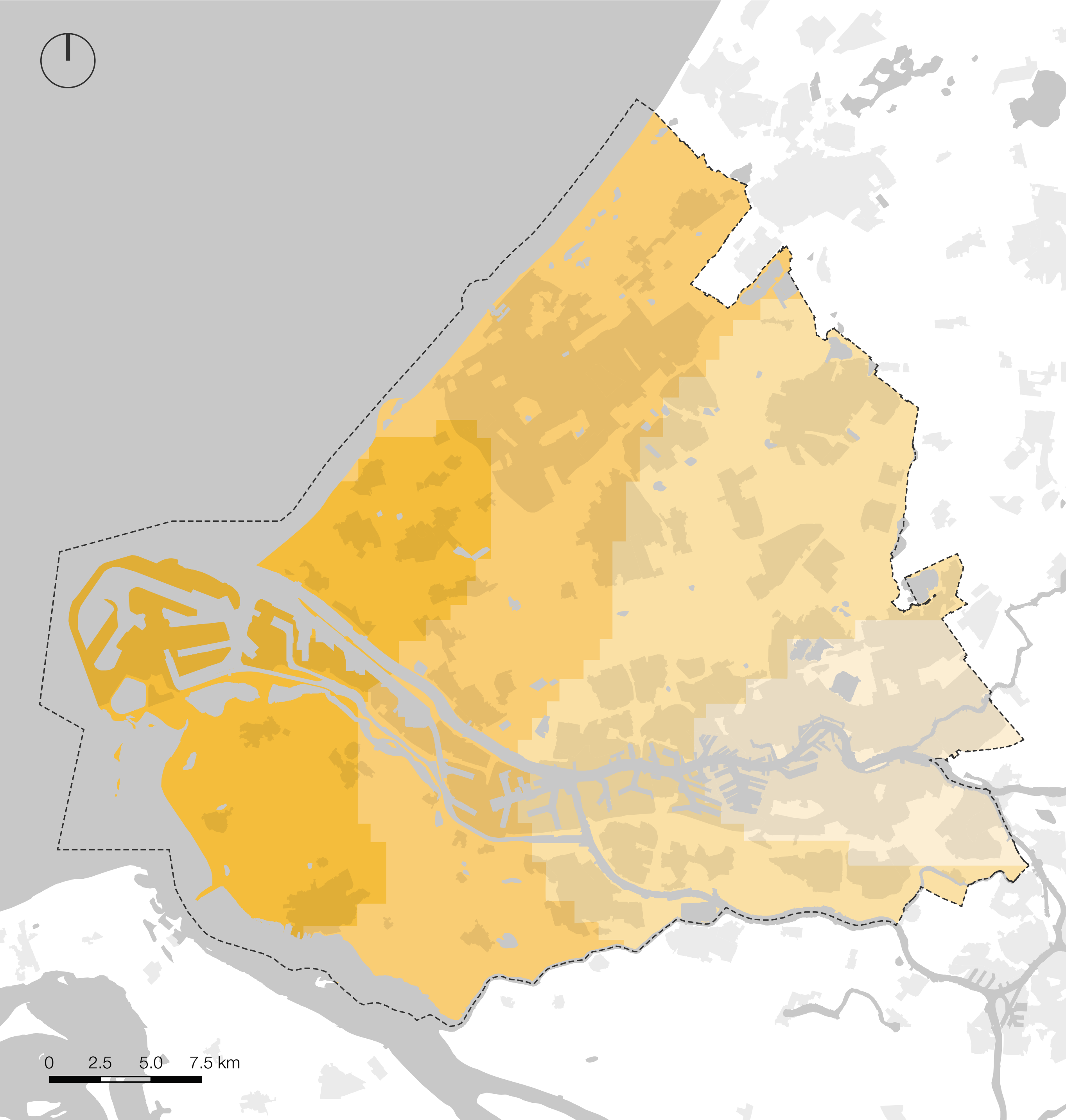
Generally, the average wind efficiency (η) of turbines is between 35-45%. In this project η= 40%.

Use the formula $P_{(actual)} = P_{(wind\ power\ density)} \times S_{(swept\ area)} \times \eta$ to have the table below.

	H=24m	H=54m	H=80m	H=104m
Class 1	39.3KW	201.1KW	392.72KW	1256.6KW
Class 2	31.9KW	163.4KW	329.84KW	1055.6KW
Class 3	27.0KW	138.2KW	267.04KW	854.5KW
Class 4	22.1KW	113.1KW	235.6KW	754.0KW
Class 5	17.2KW	88.0KW	204.24KW	653.5KW

Table X. Actual power of turbines in different wind power density
Source: wind resource assessment handbook

800KW wind turbine has the highest land use efficiency.



SOLAR ENERGY

Good potential of solar energy

The average global radiation per year ranges from 1025 kWh/m2 to 1100 kWh/m2

Orientation is essential

1100 kWh/m^2

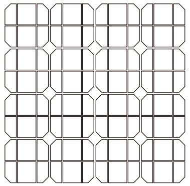
1075 kWh/m^2

1050 kWh/m^2

1025 kWh/m^2

Map 2. Average quantity of global radiation per year
Data source: solargis.com/maps-and-gis-data/overview/

PV panels



Standard dimensions of this kind of PV panel is 99 x 165 cm.

Yield: electricity
Efficiency: 15%~18%
Production: 90 kWh/m^2*year

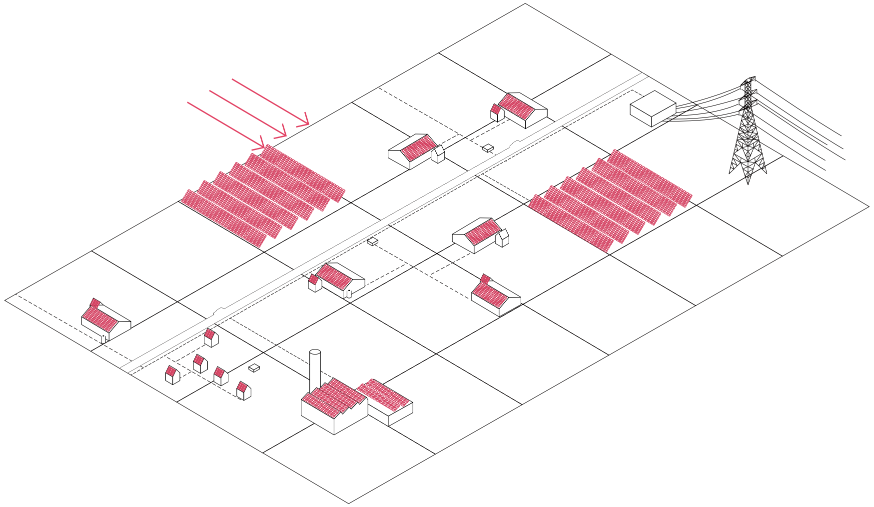
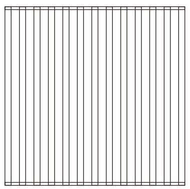


Diagram 2. Sspatial integration photovoltaic panels
Source: Energy landscape Flemish - POSAD

Solar thermal collector



A solar thermal collector collects heat by absorbing sunlight.

Yield: heat
Efficiency: 60%~80%
Production: 400 kWh/m^2*year

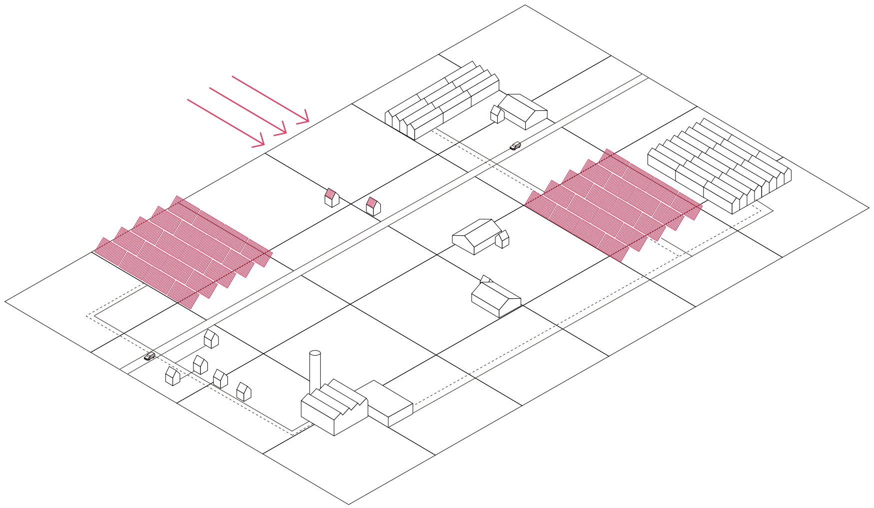
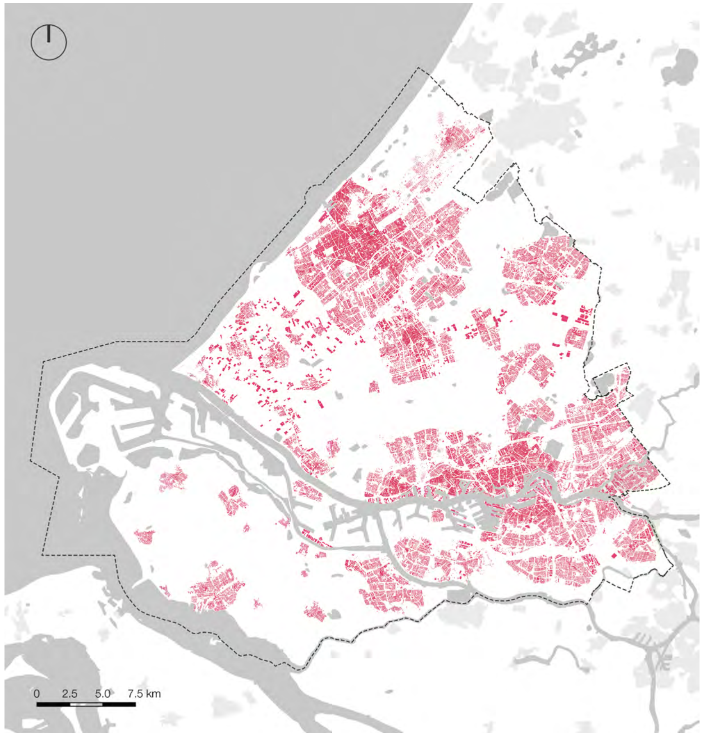


Diagram 2. Spatial integration solar collector
Source: Energy landscape Flemish - POSAD



Map X. Potential locations for solar panels
Data source: www.nationaleenergieatlas.nl/

Only **65%** of rooftop area is suitable for panel's installation (Sustainability Outlook, 2019).

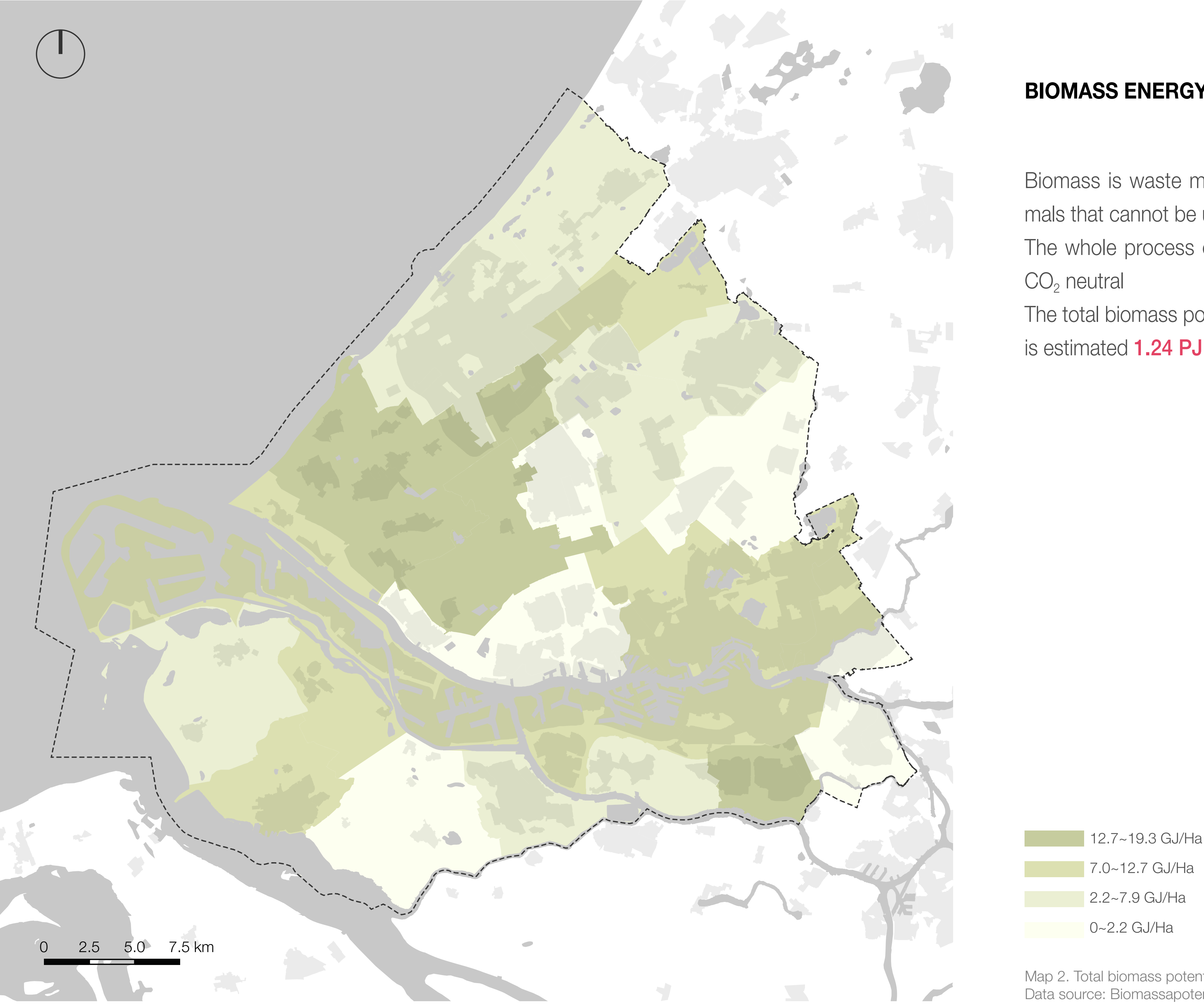
This means if all the potential rooftops are installed with PV panels, the annual production of electricity will be **20 PJ**.

BIOMASS ENERGY

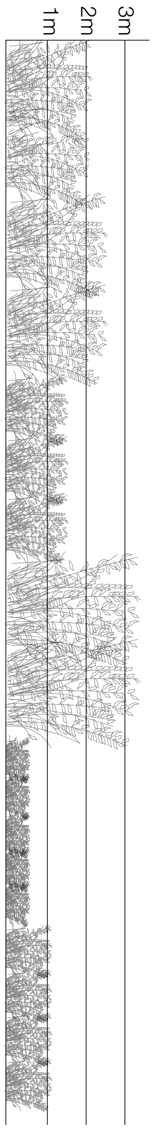
Biomass is waste material from plants or animals that cannot be used for food or feed

The whole process of biomass combustion is CO_2 neutral

The total biomass potential of the MRDH region is estimated **1.24 PJ**.



Map 2. Total biomass potential
Data source: Biomassapotentieel - Warmteatlas



	Annual yield (t/ha)	CH4 yield (m^3/ha)
Maize	9~30	3573~18540
Sweet sorghum	8~25	2360~9300
Elephant grass	8~25	1432~5450
Sunflower	6~8	929~3200
Canary grass	5~11	1700~4730
Alfalfa	7.5~16.5	2250~8250

Table X. Range of estimated crop and methane yields
Source: Biogas from Energy Crop Digestion

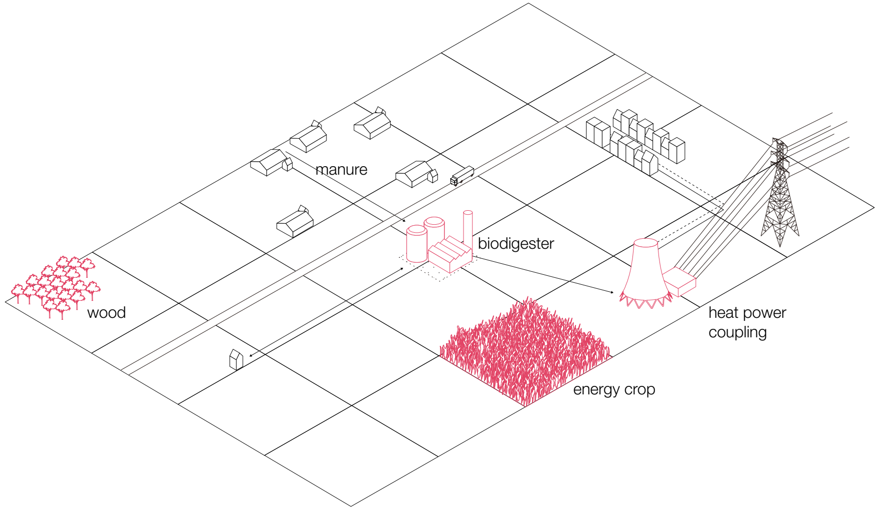
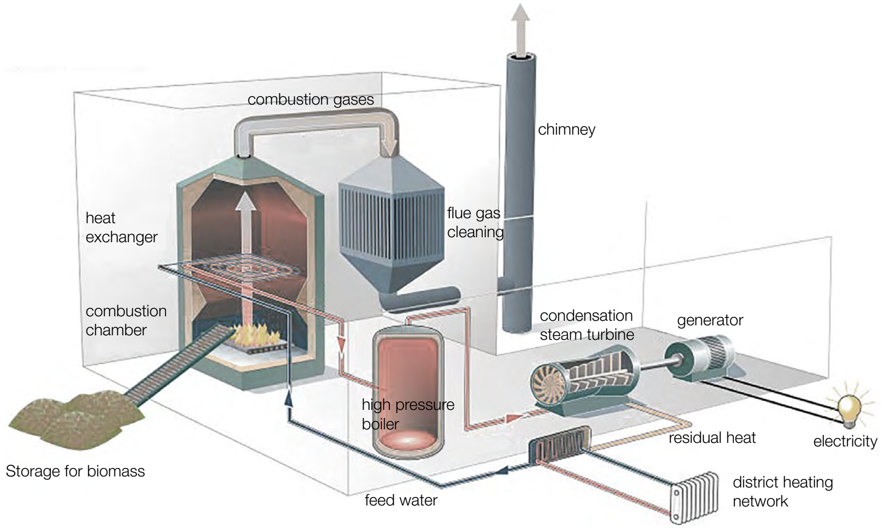
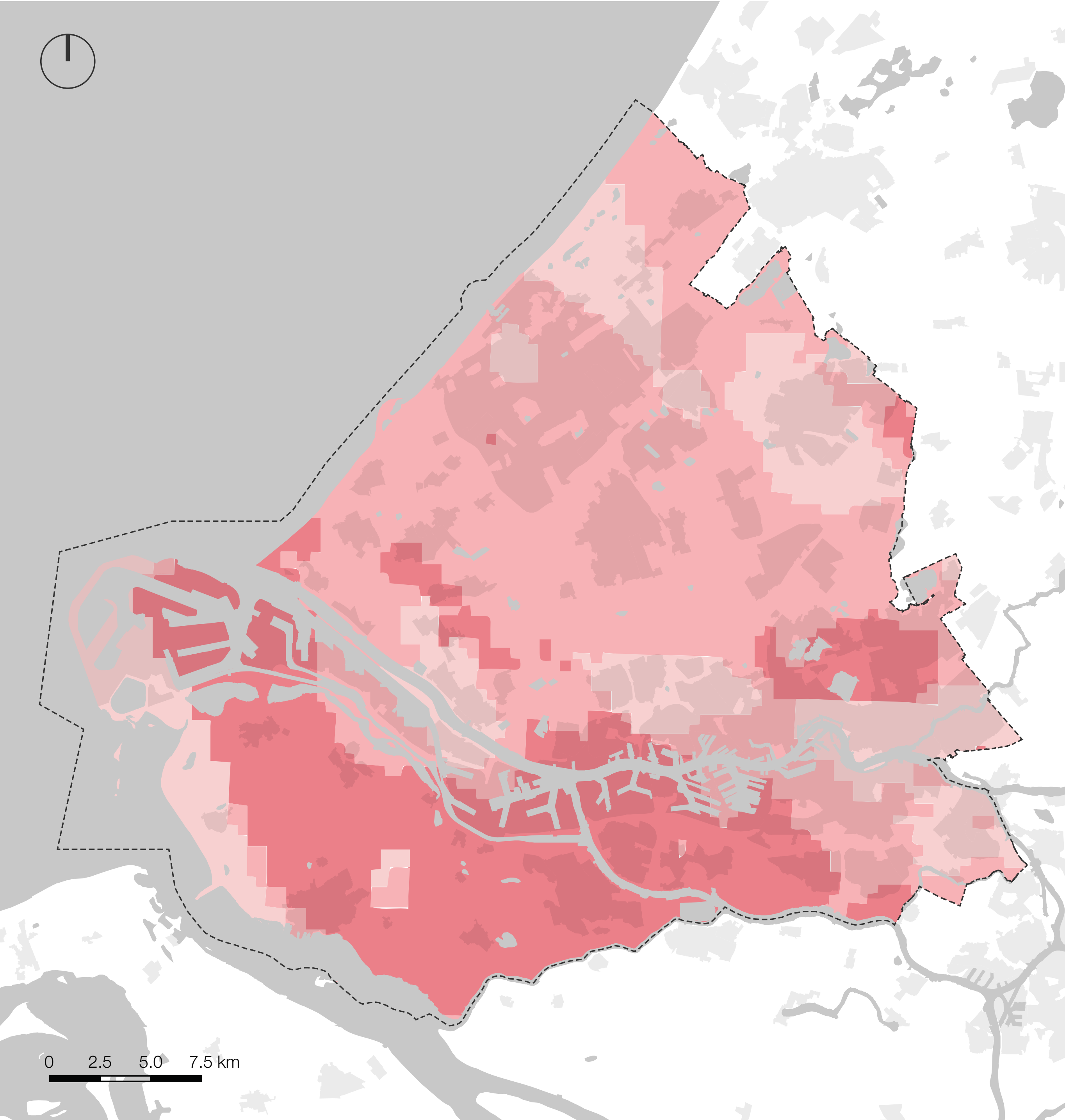


Diagram 2. Spatial integration biomass field and digester
Source: Energy landscape Flemish - POSAD



Picture X. Biomass power plant.
Source: Public domain



GEOTHERMAL ENERGY

Due to the limitation of geographical distribution of heat supply, the geothermal potential has been brought down to **26.8 PJ** in 2020.

50% chance of > 5MW

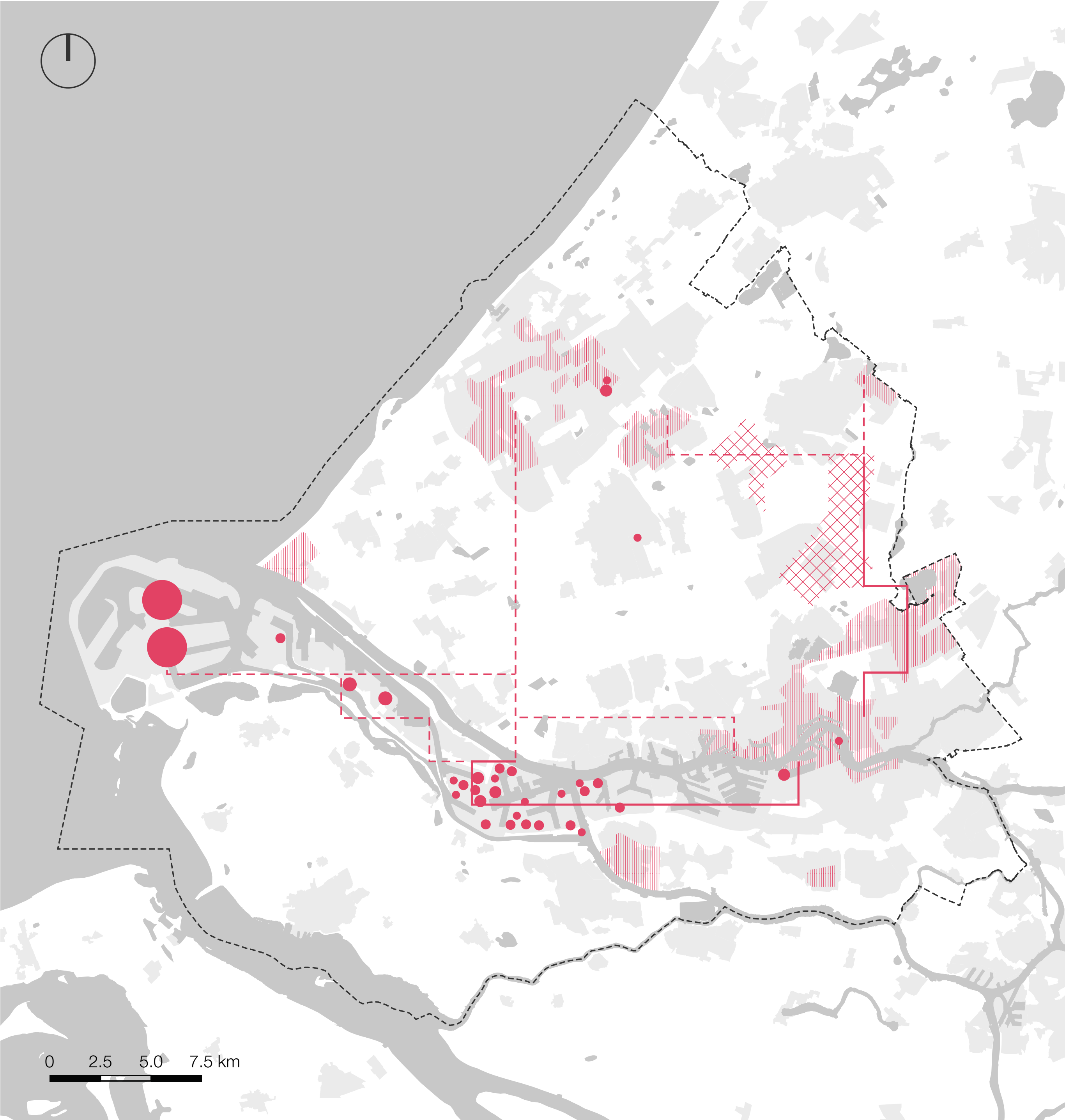
30%~50% chance of > 5MW

0~30% chance of > 5MW

Map 2. Geothermal potential
Data source: www.nationaleenergieatlas.nl

RESIDUAL HEAT

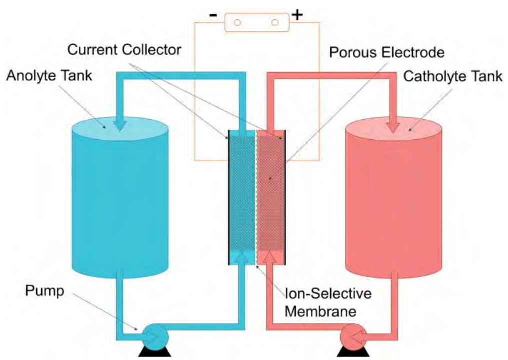
It's not renewable energy source but can be considered sustainable heat sources
In the form of hot water, total residual heat potential is **36.6 PJ**.

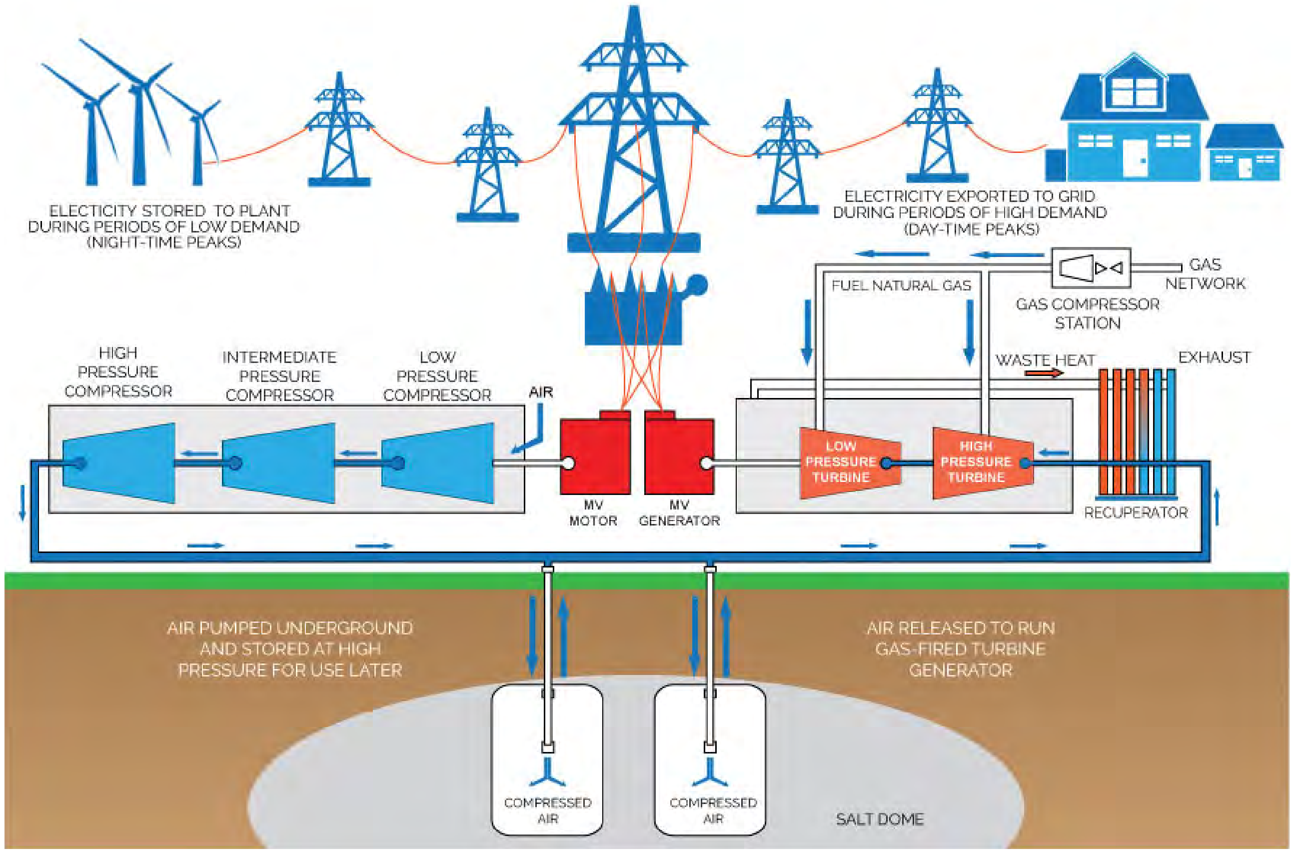


Map X. Available residual heat potential
Data source: Ruimte & Energie - Zuid-Holland

ENERGY STORAGE

Solid State Batteries
Flow Batteries
Flywheels
Compressed Air Energy Storage
Thermal
Pumped Hydro-Power





CONCLUSION

This table shows the conclusion of the demand of renewable energy technologies to satisfy the energy demand.

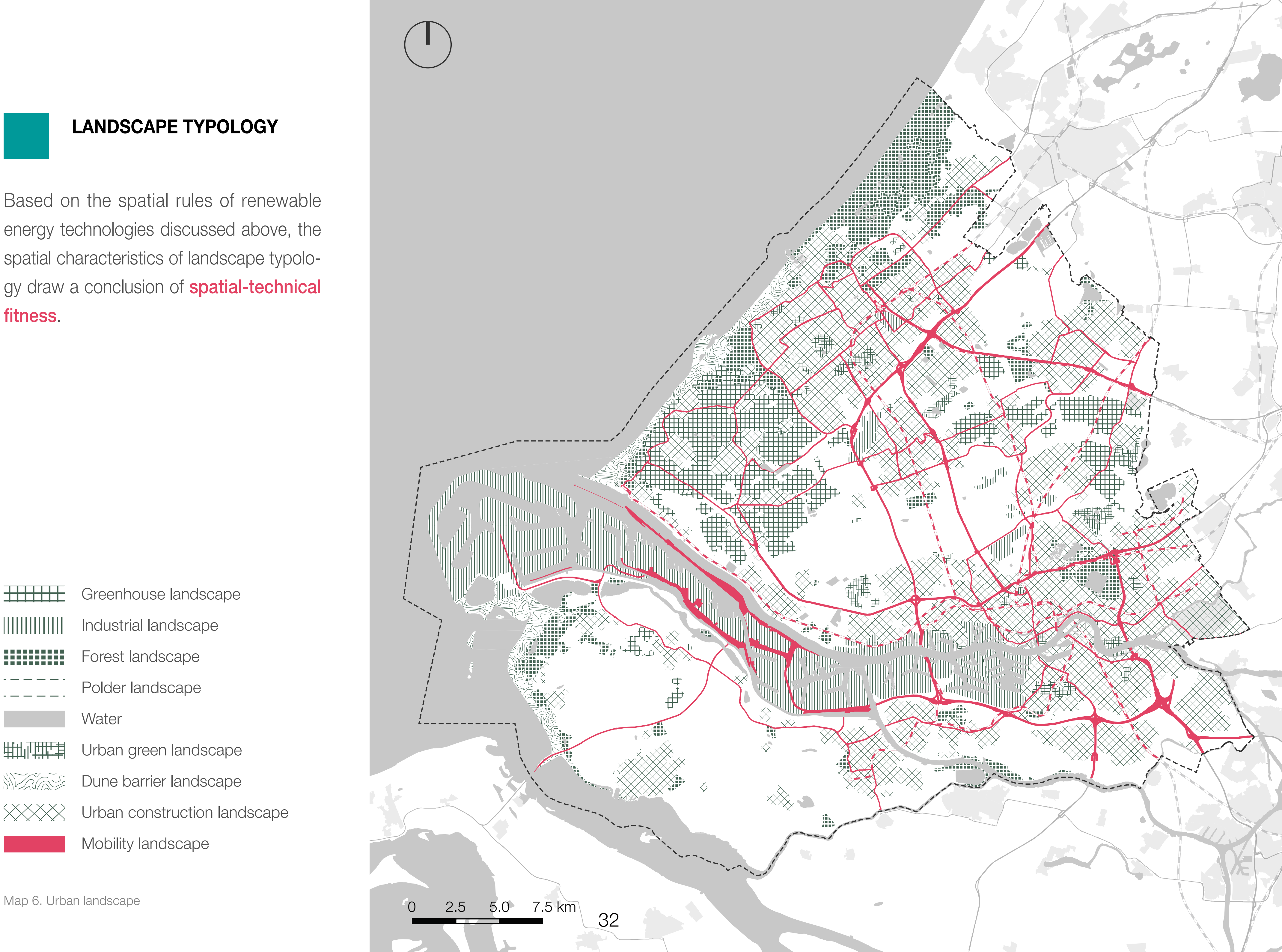
But can all of them be deployed in the region?

The deployment of renewable energy technologies is limited by **landscape typologies** and **landscape quality** that needs to be preserved.

Energy type	Year	Energy source	Number	Area (ha)
Electricity	2030	Wind	2871	17943.89
		Solar		8383.39
	2050	Wind	3751	23440.7
		Solar		10951.49
Heat	2030	Solar		566.71
	2050			704.22
Biogas	2030	Maize	min	17856.13
	2050		max	92653.97
	2030	Sweet sorghum	min	35597.06
	2050		max	76513.87
	2030	Alfalfa	min	40127.59
	2050		max	86251.99

LANDSCAPE TYPOLOGY

Based on the spatial rules of renewable energy technologies discussed above, the spatial characteristics of landscape typology draw a conclusion of **spatial-technical fitness**.

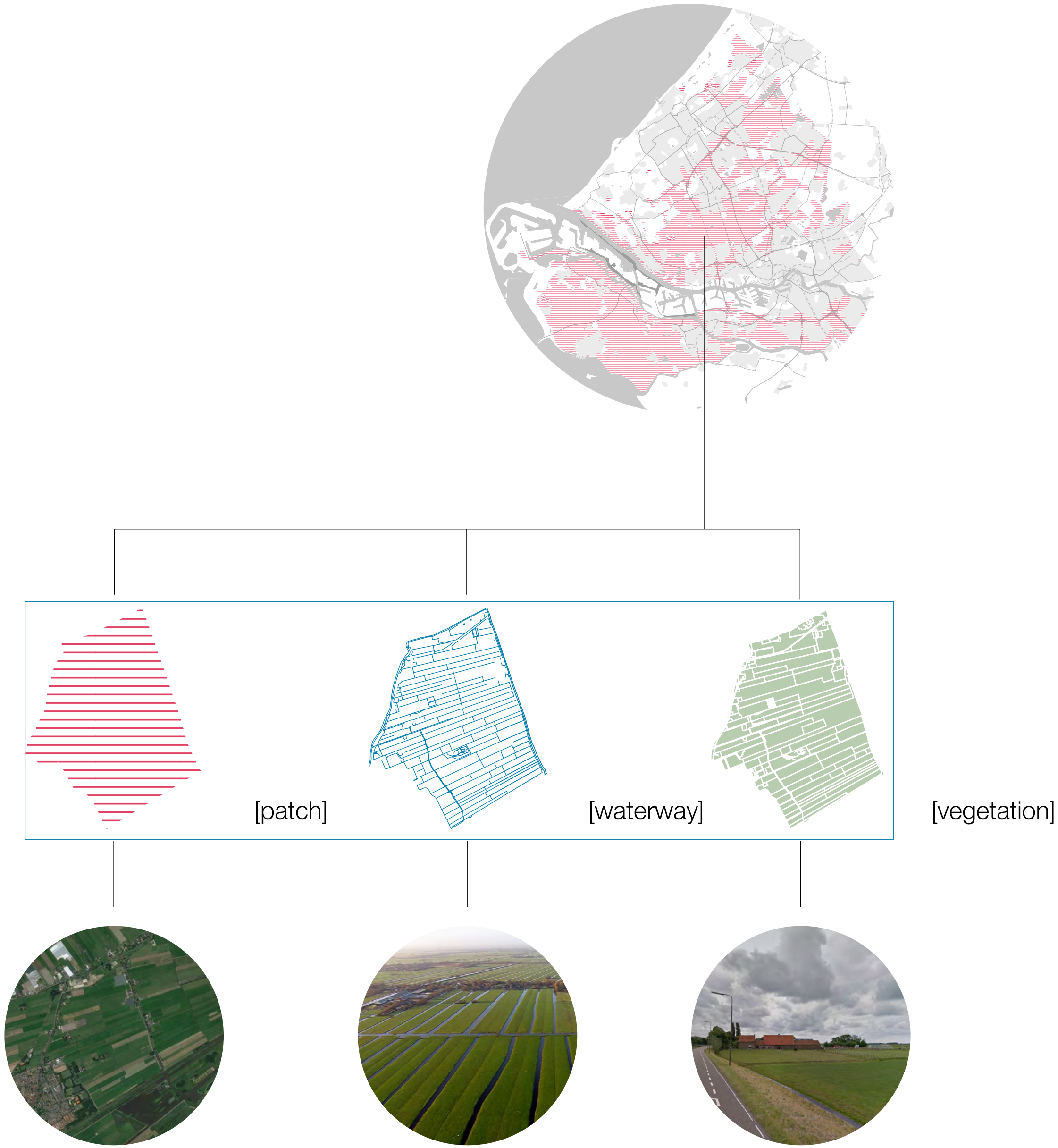


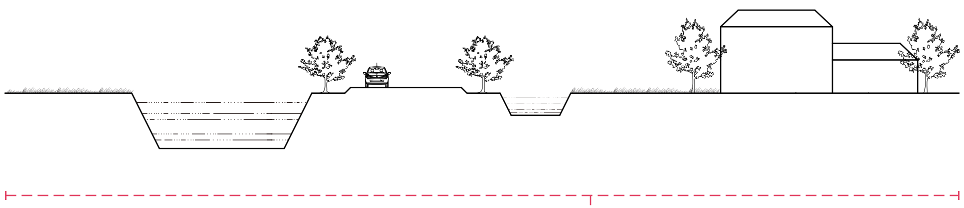
Map 6. Urban landscape

POLDER LANDSCAPE

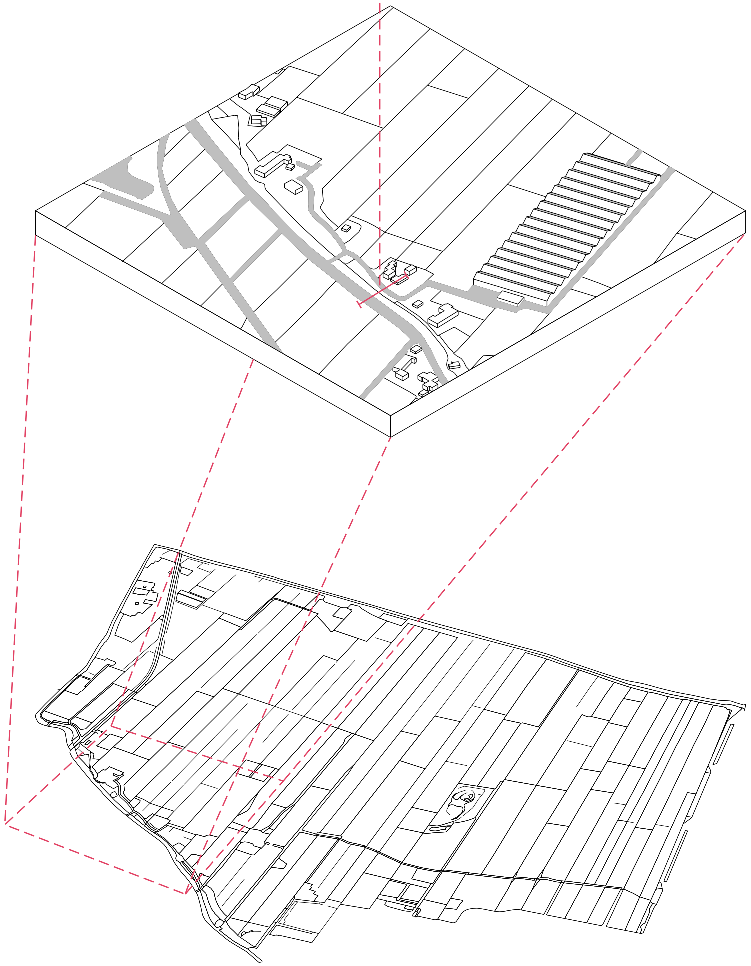
Low-lying tract of land enclosed by dikes that form an artificial hydrological entity.

Most of the polder landscape in the MRDH is agricultural area or has recreational function.



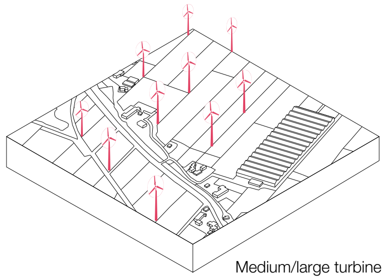


Polder land-
scape

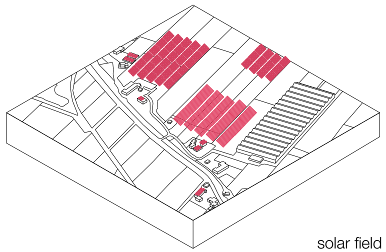


zoom-in area

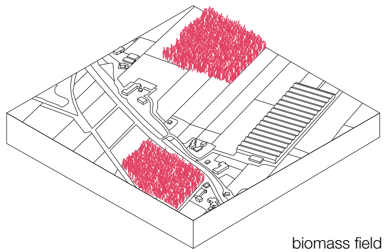
wind turbine



solar panel



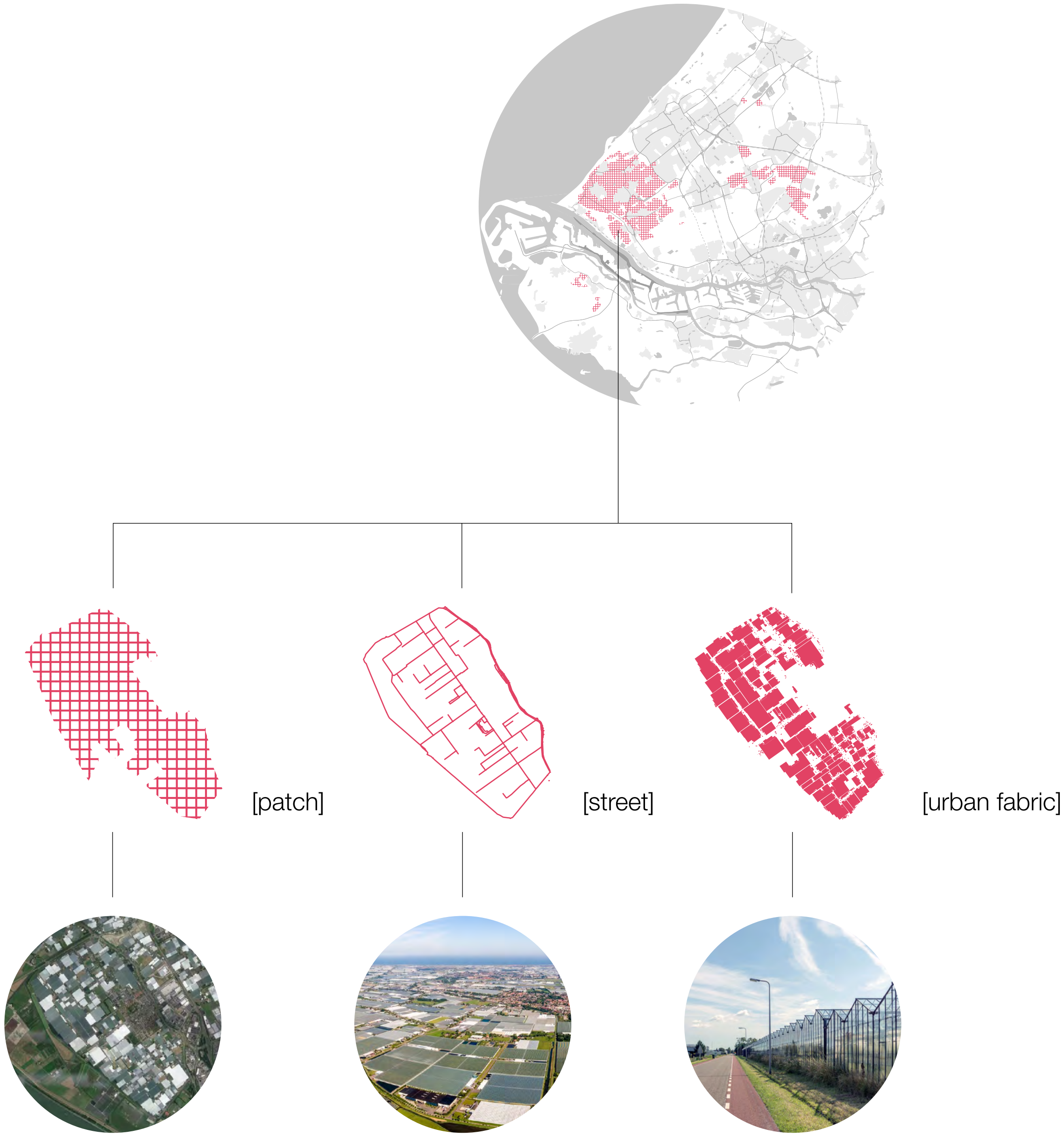
biomass field
and digester

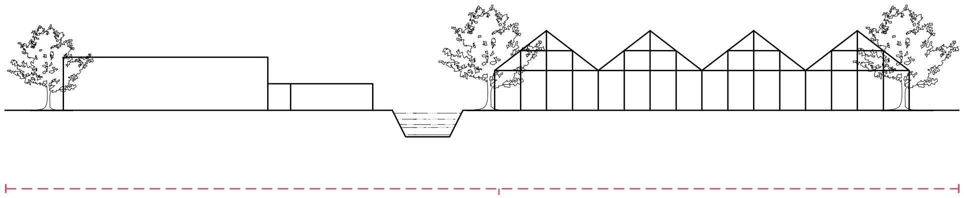


geothermal system

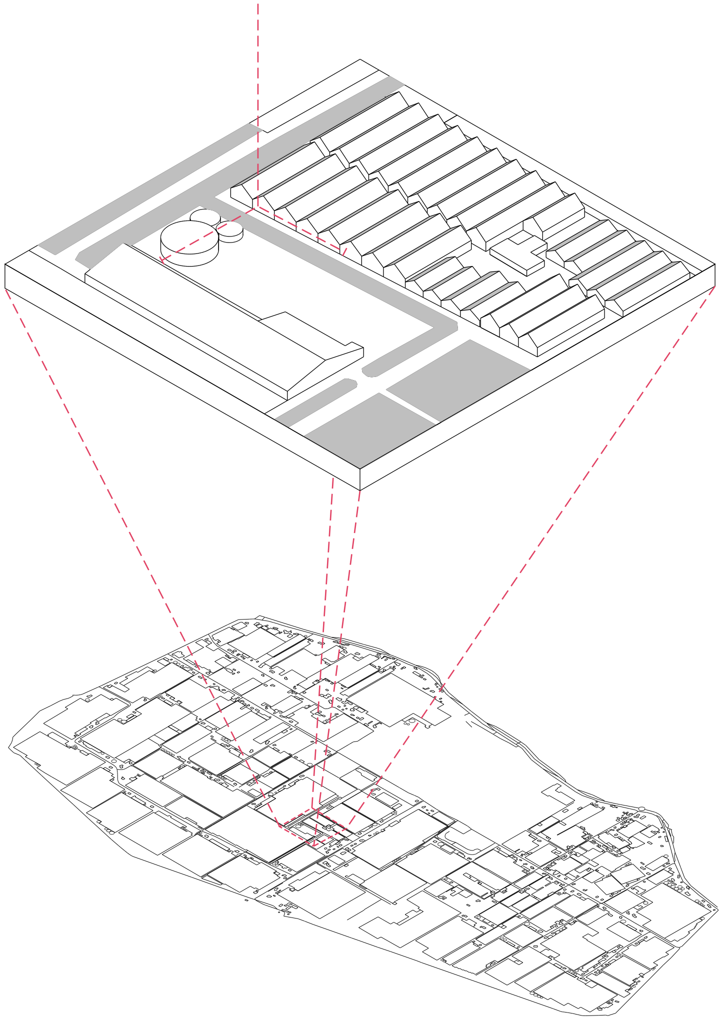
GREENHOUSE LANDSCAPE

The MRDH accommodates the majority of the extensive and energy intensive Dutch greenhouse sector, as known as 'The Greenport', located in the southwest of the region.

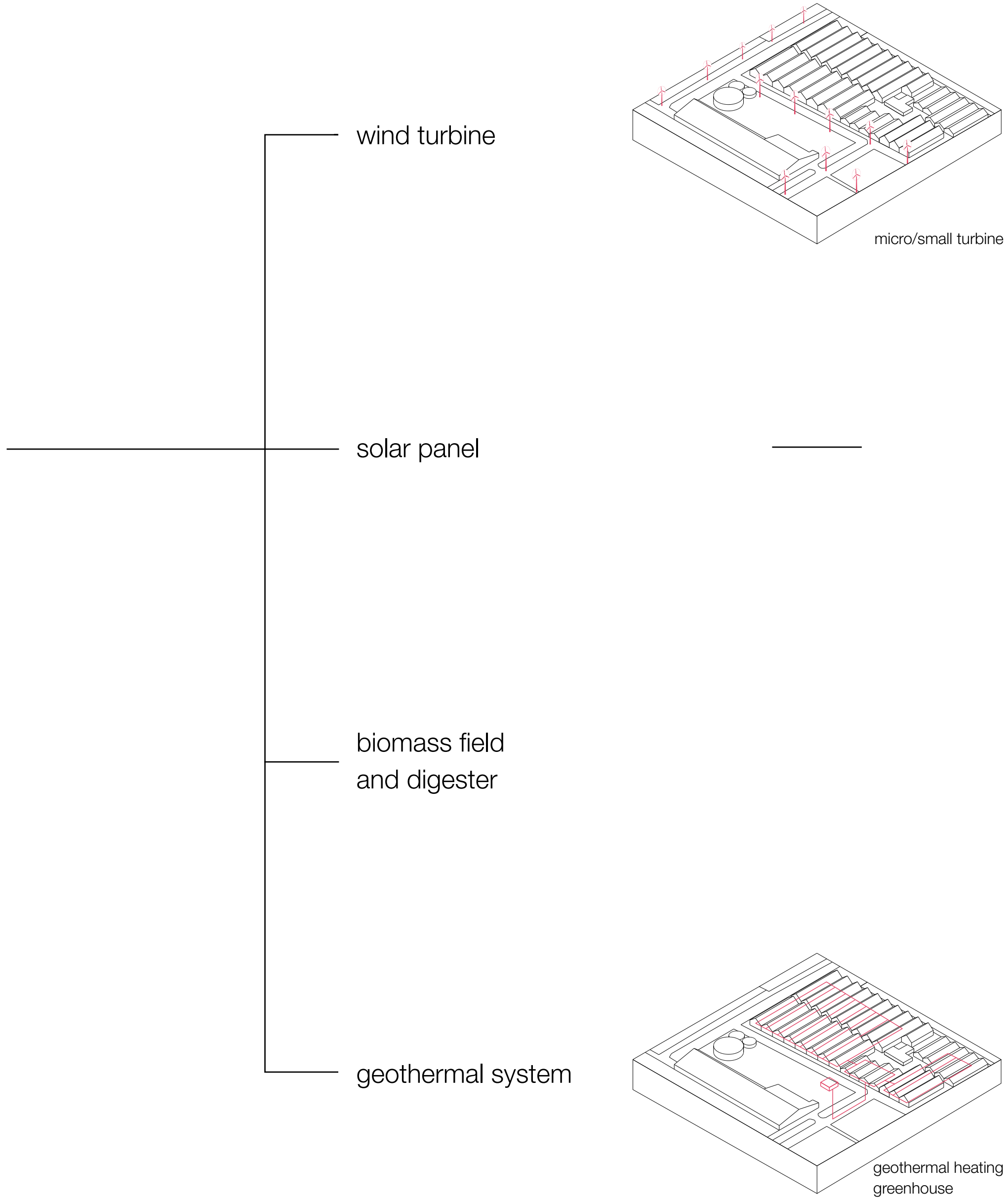




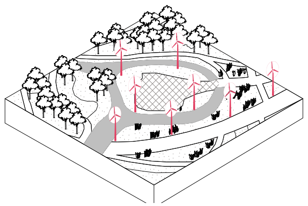
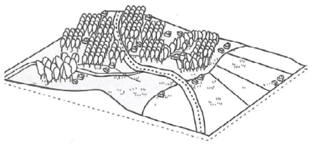
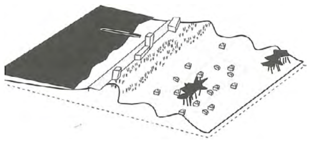
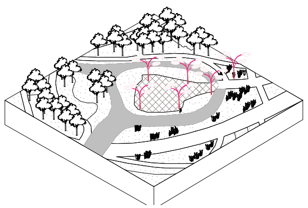
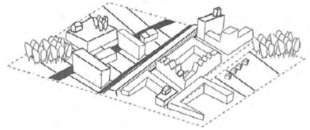
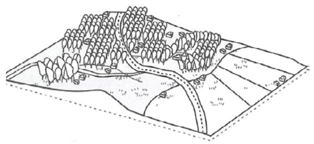
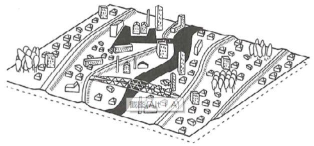
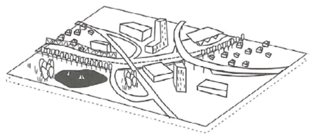
peak meadow
landscape with
Dutch polder

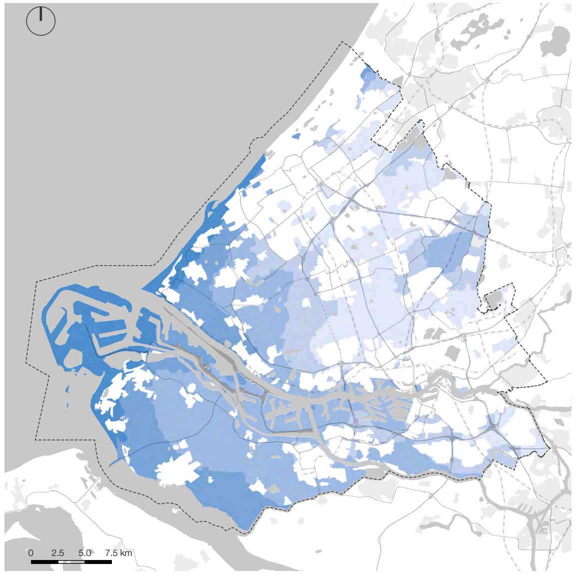


zoom-in area



SPATIAL FITNESS OF RET

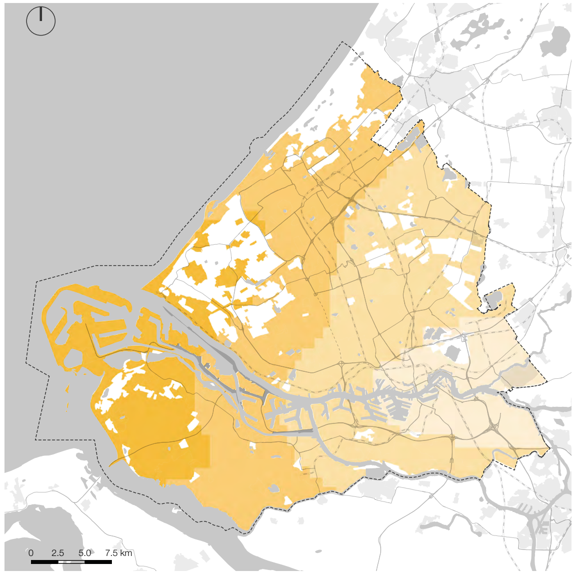
Landscape		wind	solar	biomass field	geothermal
Polder landscape		○	○	○	—
Forest landscape		—	—	○	—
Barrier dune landscape		○	○	○	—
Greenhouse landscape		○	—	—	○
Urban construction landscape		—	○	—	○
Urban green landscape		○	○	○	—
Industrial landscape		○	○	—	○
Mobility landscape		○	○	—	—



Spatial fitness of wind turbine

1. polder landscape
2. barrier dune landscape
3. greenhouse landscape
4. urban green landscape
5. industrial landscape
6. mobility landscape

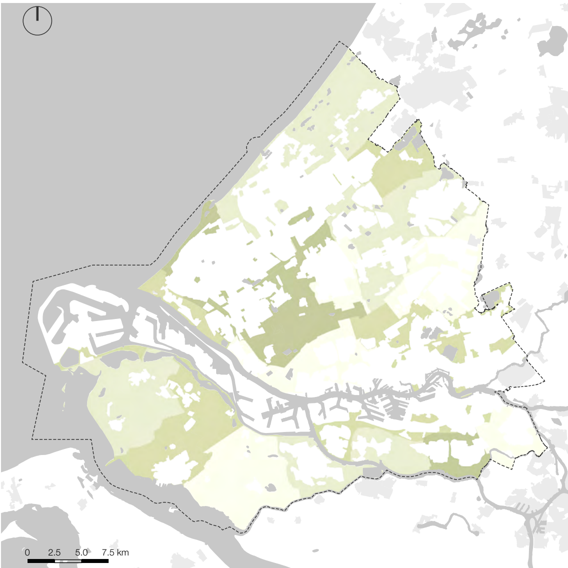
	Class	H=100m	H=50m
	1	625 W/m^2	400 W/m^2
	2	525 W/m^2	325 W/m^2
	3	425 W/m^2	275 W/m^2
	4	375 W/m^2	225 W/m^2
	5	325 W/m^2	175 W/m^2



Spatial fitness of solar panel

1. polder landscape
2. barrier dune landscape
3. urban construction landscape
4. urban green landscape
5. industrial landscape
6. mobility landscape

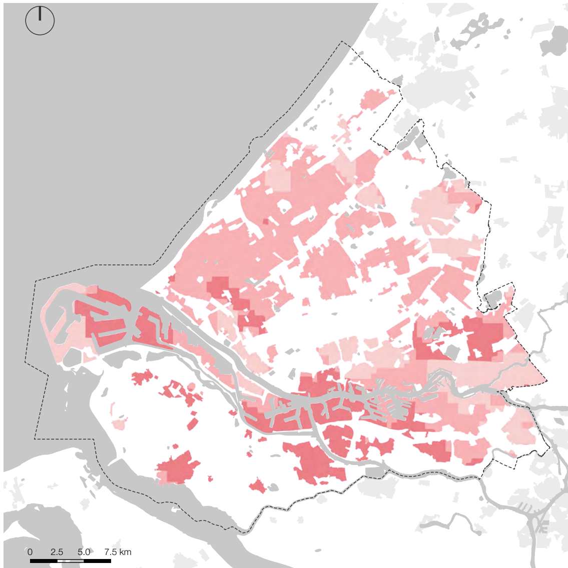
1100 kWh/m^2
1075 kWh/m^2
1050 kWh/m^2
1025 kWh/m^2



Spatial fitness of biomass field

1. polder landscape
2. forest landscape
3. urban green landscape

12.7~19.3 GJ/Ha
7.0~12.7 GJ/Ha
2.2~7.9 GJ/Ha
0~2.2 GJ/Ha



Spatial fitness of geothermal technique

1. greenhouse landscape
2. urban construction landscape
3. industrial landscape

50% chance of > 5MW
30%~50% chance of > 5MW
0~30% chance of > 5MW

LANDSCAPE QUALITY INFLUENCED BY RET

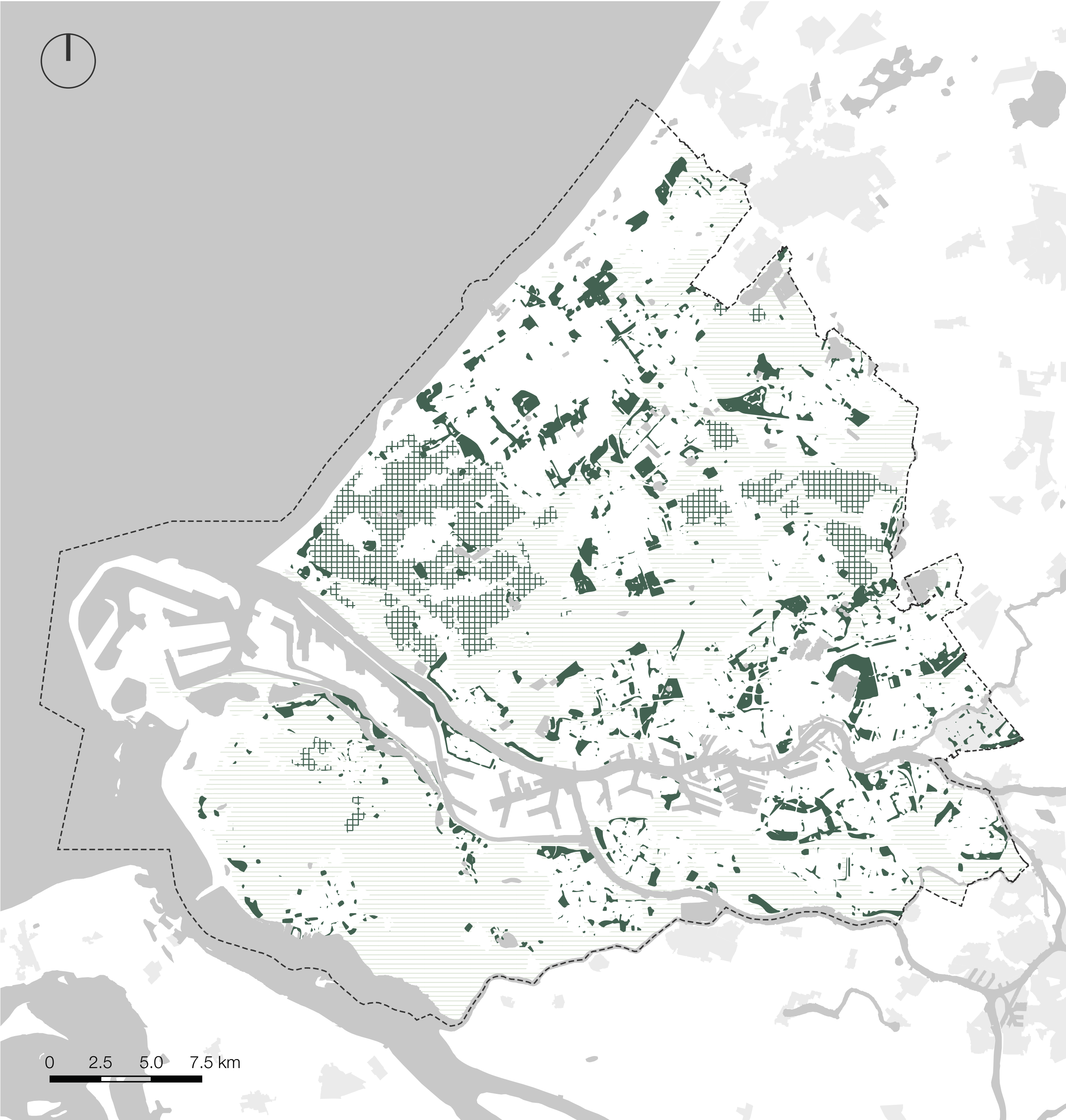
Landscape quality influenced by renewable energy technologies. (green-positive impact; red-negative impact)

	Economic Quality	Ecological Quality	Cultural/aesthetic Quality
Use value	Land productivity (biomass cultivation, PV field) Multi functionality (combine with existing infrastructure) Reuse of vacant space (brownfield, abandoned space)	Ecological corridor (no construction)	
Perception value	Fine-tuning function (energy parks)	Transparent air (biodigester) Acoustic wellness (wind turbine, PV panel along traffic lines)	Aesthetic quality (depending on location and style)
Future value		Biodiversity (wind turbine, PV field)	

ECONOMIC QUALITY

Goods and services provided by landscape which can bring economic values.

Agricultural landscape
Greenhouse landscape
Recreational landscape



Map X. Land use map
Data source: www.cbsinuwbuurt.nl

PRESENT CONDITION OF ECONOMIC LANDSCAPE

Farmland

Greenhouse

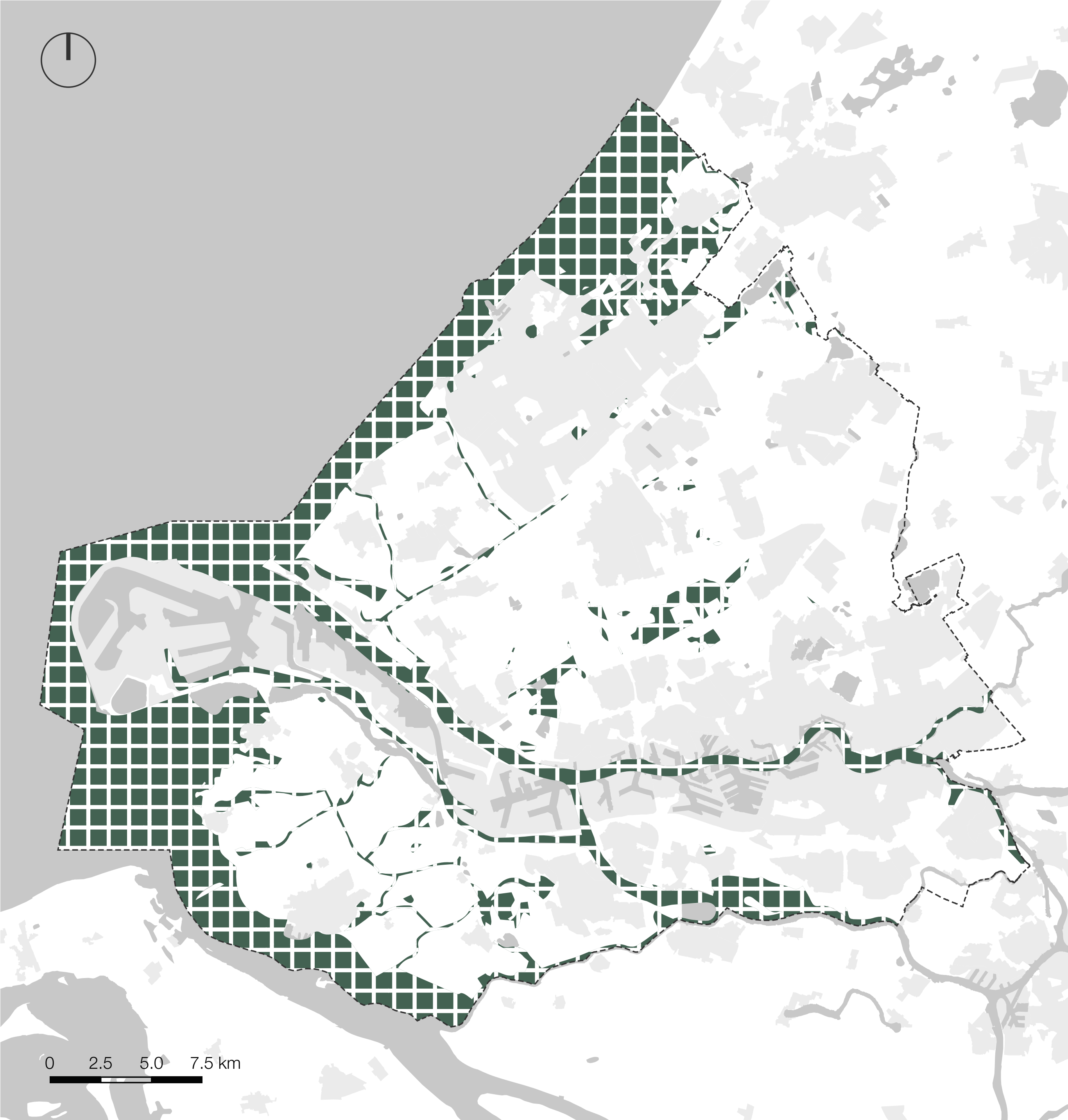
Golf club

HOW TO ADD ECONOMIC VALUE?

Multi functionality
(wind turbines alone dune)

Reuse of vacant space
(from brownfield to solar field)

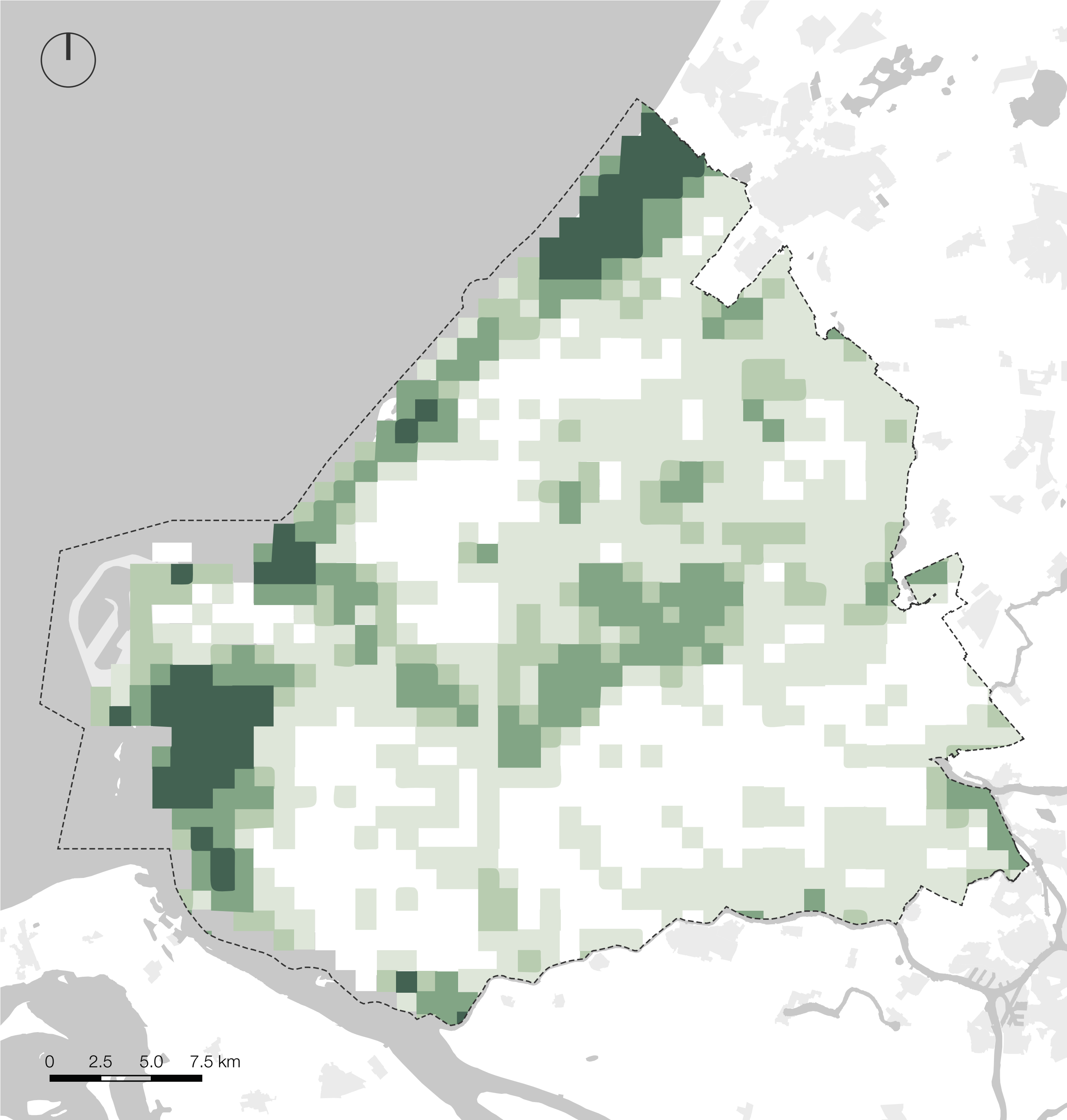
Fine-tuning function
(energy park)



ECOLOGICAL CORRIDOR

In the MRDH region, the ecological corridor is mostly located along the coast and Meuse river, with small branches extending into hinter-land.

Map X. Ecological corridor
Data source: www.atlasleefomgeving.nl/kaarten



REDLIST SPECIES DENSITY

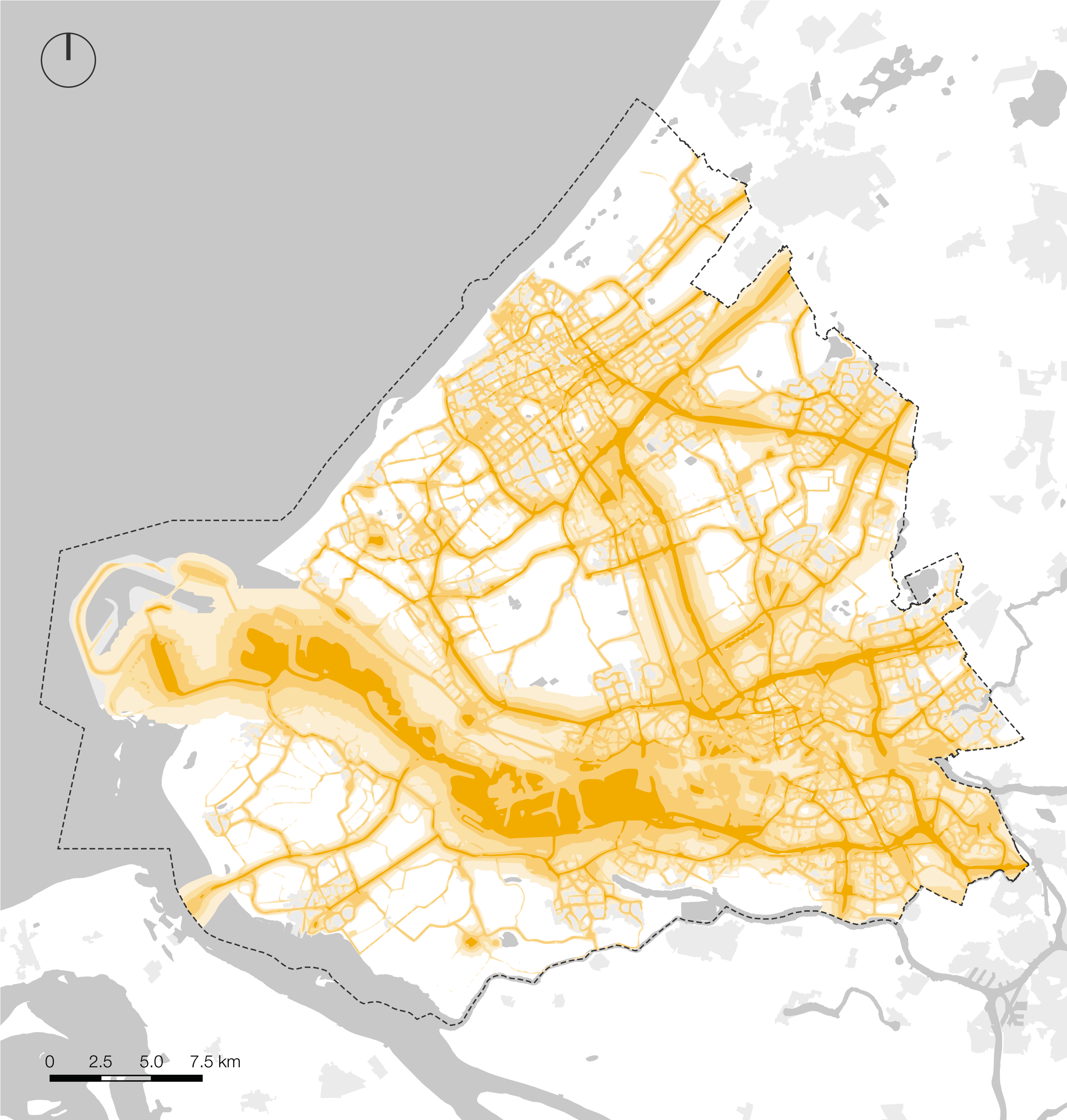
In those areas, the deployment of wind turbines, large PV fields and the cultivation of energy crops need to be limited or even forbidden.

>61/km²
51-61/km²
41-51/km²
31-41/km²
<31/km²

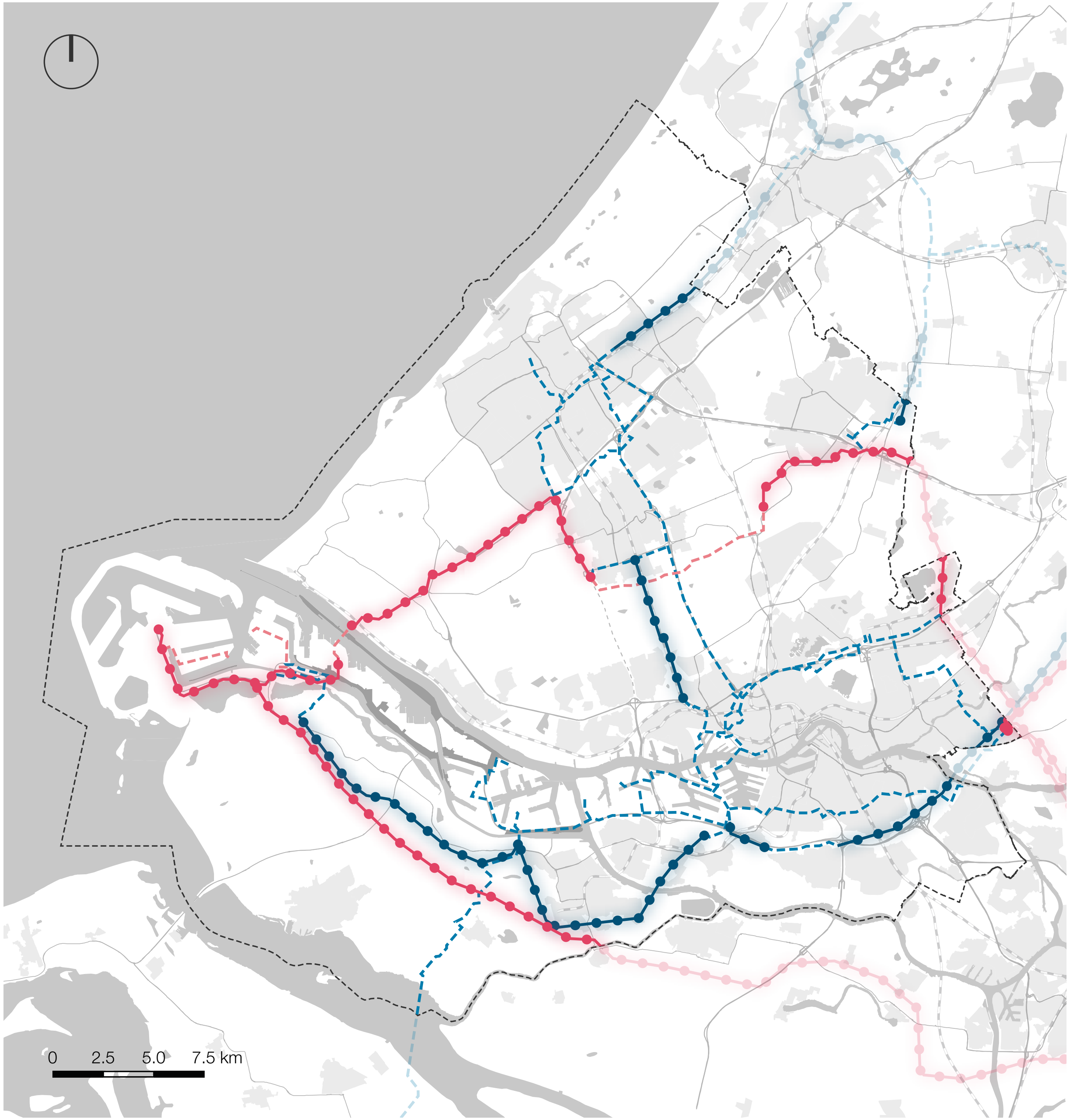
Map 2. Redlist species density
Data source: www.atlasleefomgeving.nl/kaarten

NOISE LEVEL

Wind turbines along busy roads
PV panels as sound barriers



Map X. Noise level
Data source: www.atlasleefomgeving.nl/kaarten



HIGH VOLTAGE BUFFER ZONE

Abandoned?

Or become ecological corridor!

363-420 kV line
146-170 kV line
363-420 kV cable (underground)
363-420 kV cable (underground)
Hight voltage mast

Map X. High voltage line
Data source: webkaart.hoogspanningsnet.com/

PRESENT CONDITION OF ECOLOGICAL LANDSCAPE

Nature preserve

Bird watching area

Railway

HOW TO PRESERVE ECOLOGICAL VALUE?

Eco-energy park

Reuse of buffer-zone

Sound barrier

AESTHETIC QUALITY

Five models → Psychophysical Model
Visualands Framework

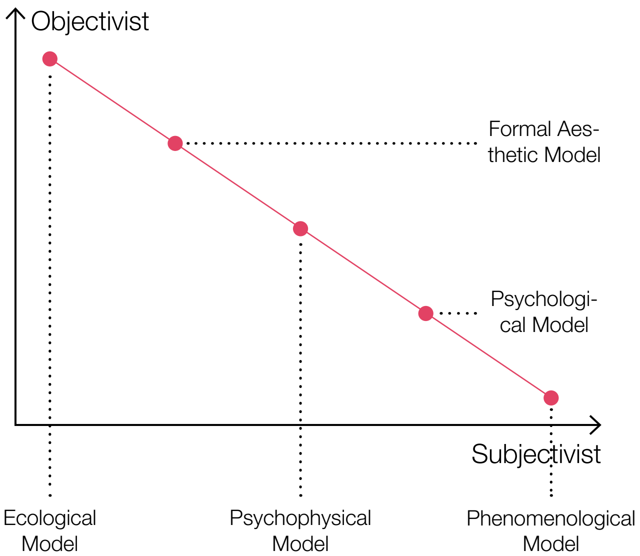
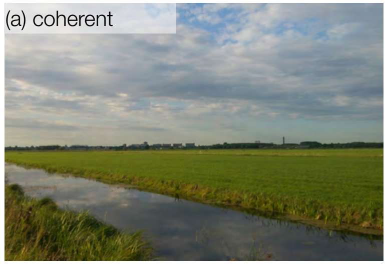


Figure X: Five models studying aesthetic
Source: Daniel and Vining, 1983.

naturalness

stewardship

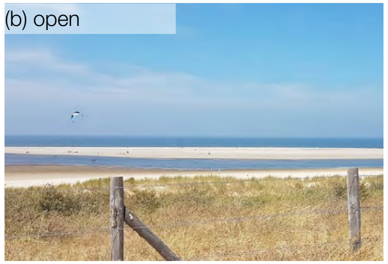


coherence

historicity

visual scale


(a) intimate


(b) open

imageability


(a) memorial


(b) boring

ephemera


(a) summer


(b) winter

complexity


(a) complex


(b) homogeneity

HOW TO PRESENT AESTHETIC QUALITY OF RENEWABLE ENERGY TECHNOLOGIES?

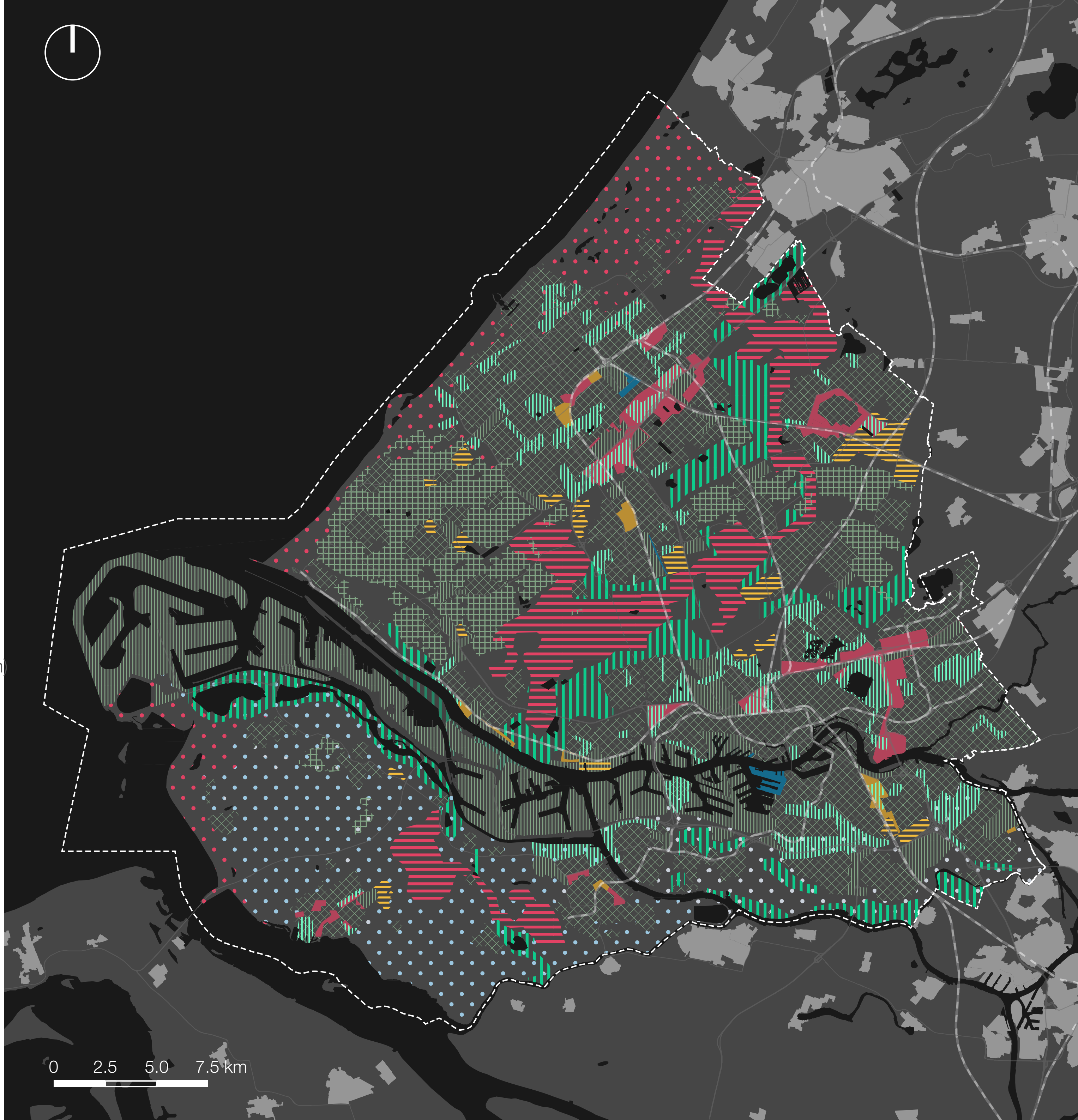
Wind kite

Solar flag

Wind flag

3 DESIGN THE FUTURE

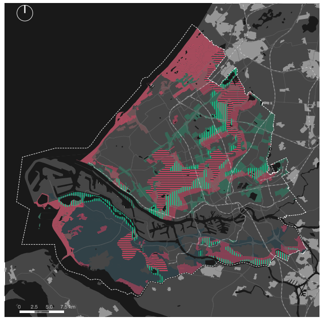
REGIONAL SCENARIO

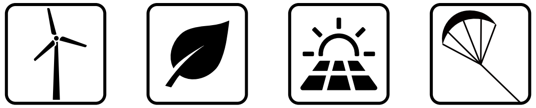


- River delta landscape
- Coastal landscape
- Meadow bird preservation (no construction)
- Recreational area
- Existing roof landscape
- Urban green
- Future-proof neighborhoods investment
- Develop nodes
- Focuses on transformation areas
- Industrial and business area
- Hard planned business park
- Greenhouse area

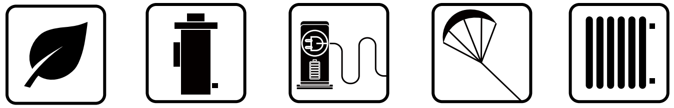
Map 6. Urban landscape of the MRDH 2050

For different realms, due to their specific and unique characteristics, sustainable energy solutions also differ from one place to the other. Finally a regional energy vision is drawn from the collection of solutions.

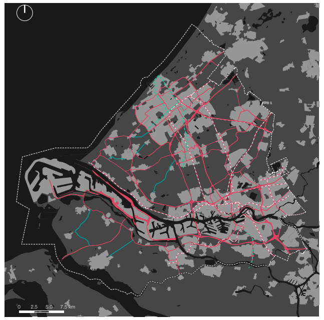


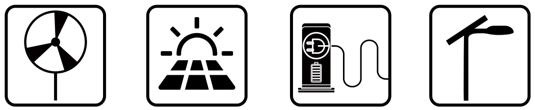


wind turbine | energy crop | PV field | wind kite

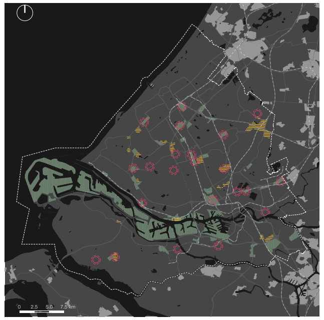


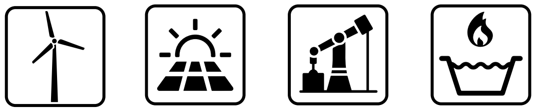
energy crop | heat pump | electric car charging point | wind kite | district heating



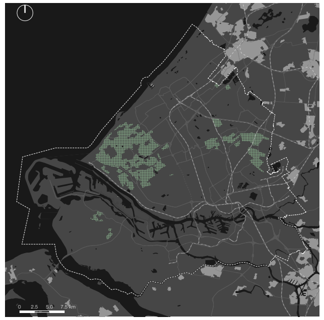


mini wind turbine | PV field | electric car charging point | self-sufficient street light



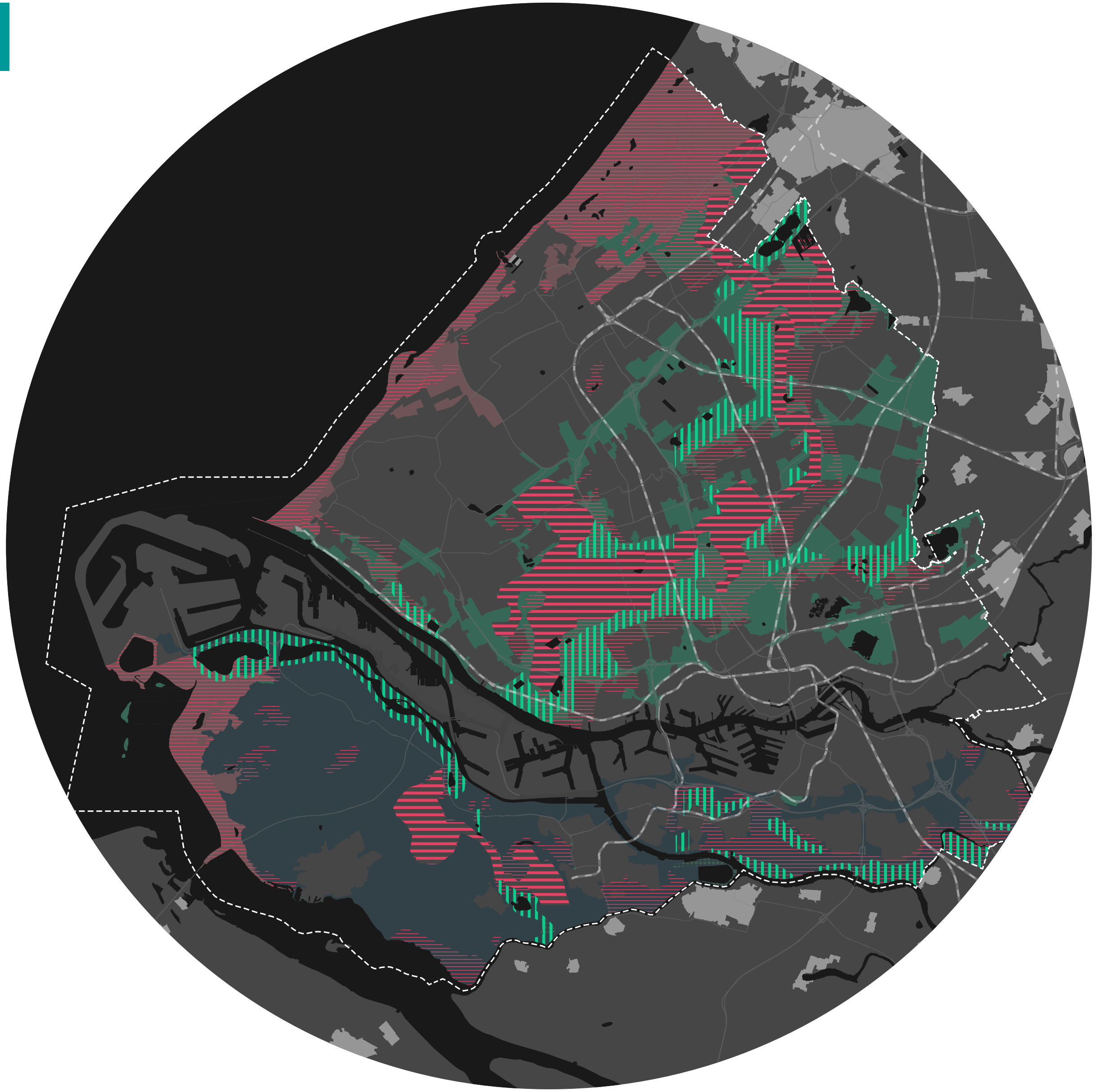


wind turbine | PV field | geothermal well | industrial residual heat



wind turbine | biodigester | geothermal well

OPEN REALM SCENARIO



Food production

Relaxation and tourism site

Peat landscape

River delta landscape

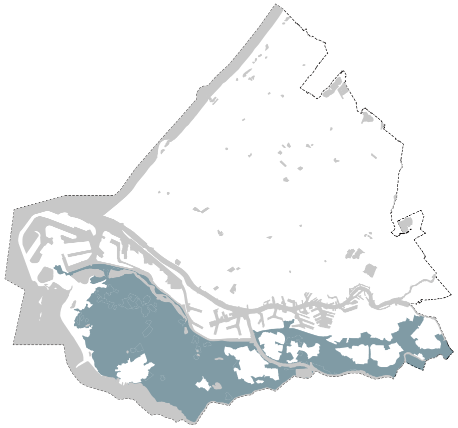
Coastal landscape

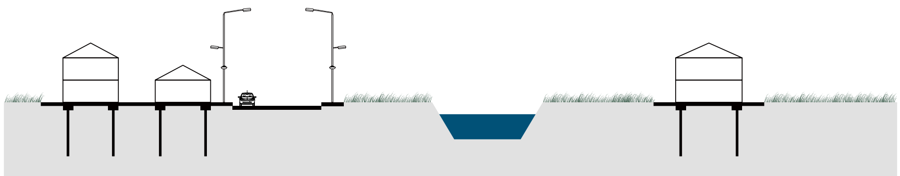
Protection Category (limited construction)

Meadow bird preservation (no construction)

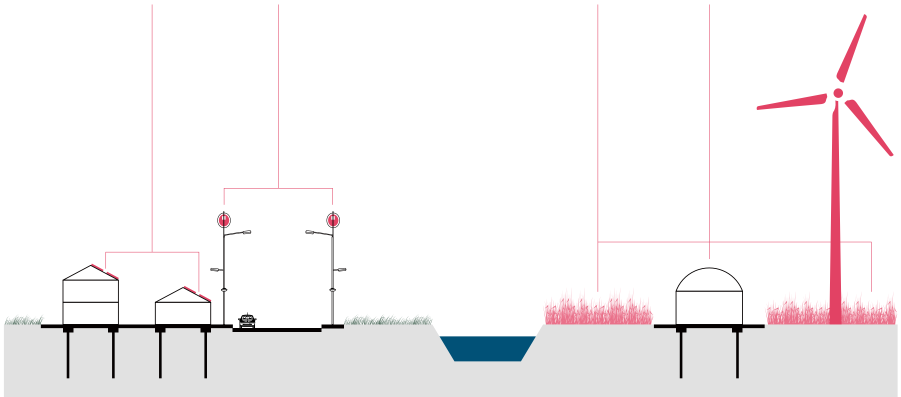
Recreational area

RIVER DELTA LANDSCAPE





Present

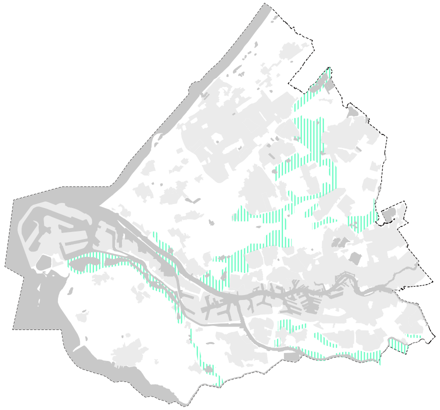


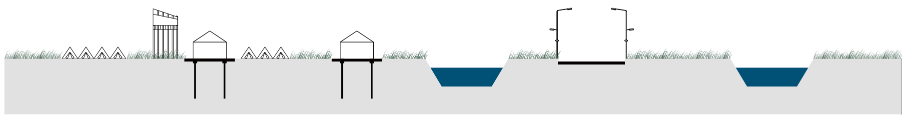
2030

SMART FARM (PRESENT)

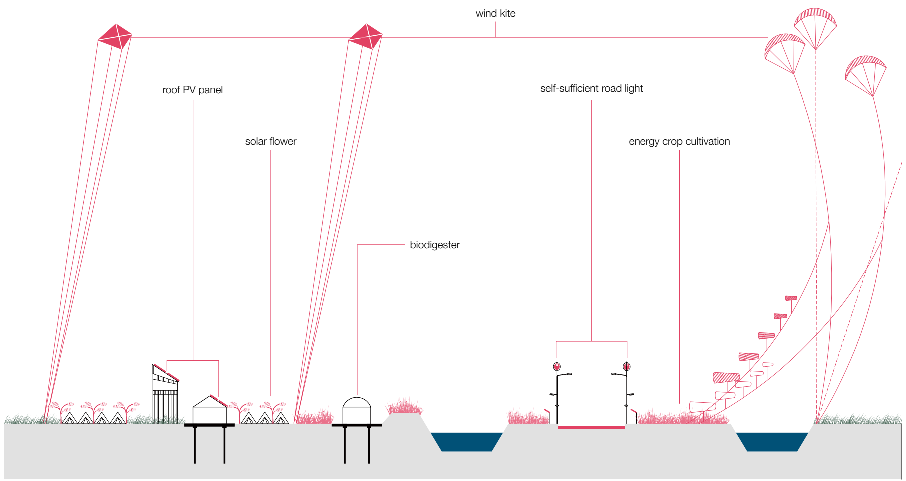
SMART FARM (2030)

RECREATIONAL LANDSCAPE





Present

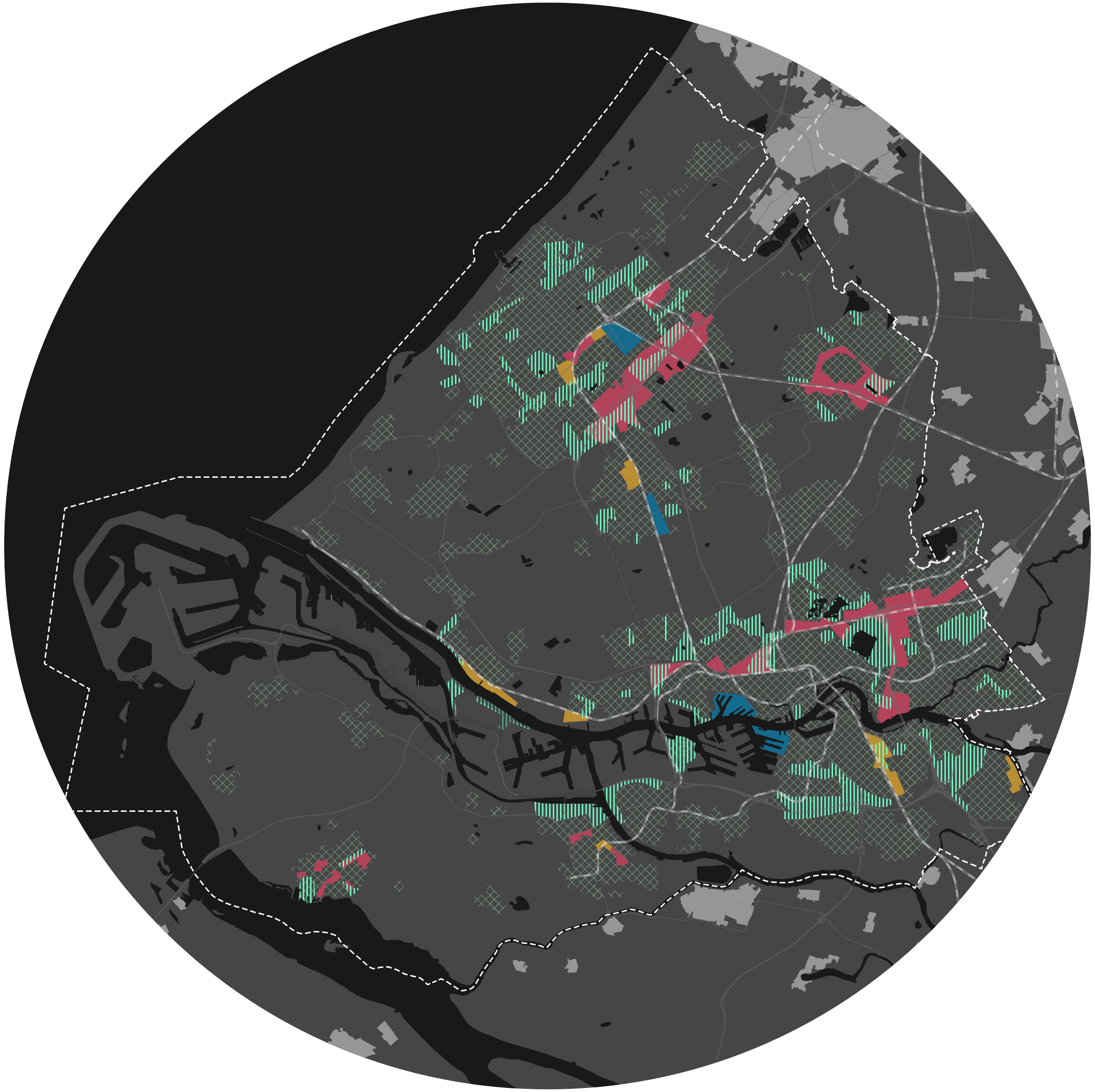


2030

Campsite (present)

Campsite (2030)

URBAN REALM SCENARIOS



Housing

Urban park

Existing roof landscape

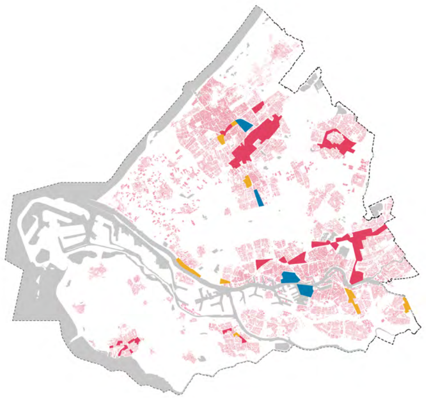
Urban green

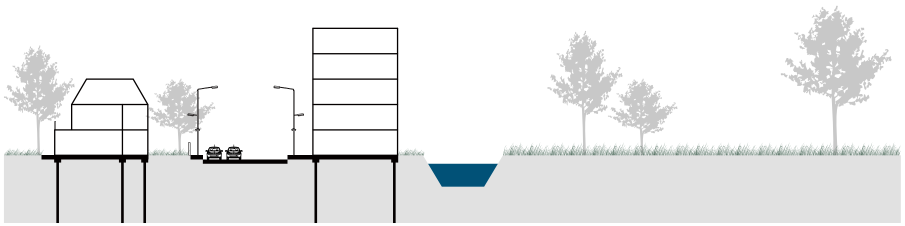
Future-proof neighborhoods investment

Develop nodes

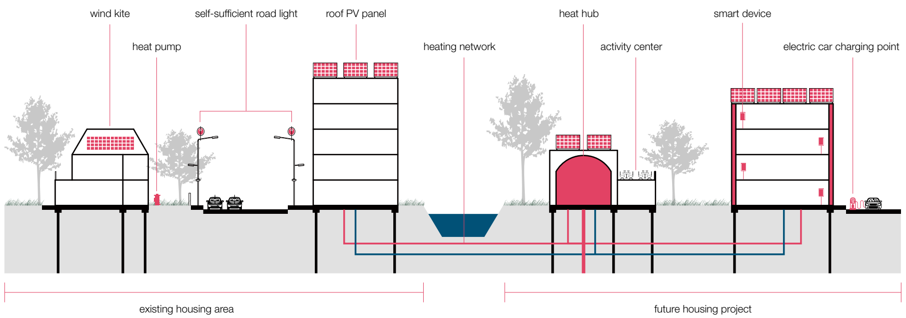
Focuses on transformation areas

HOUSING AREA



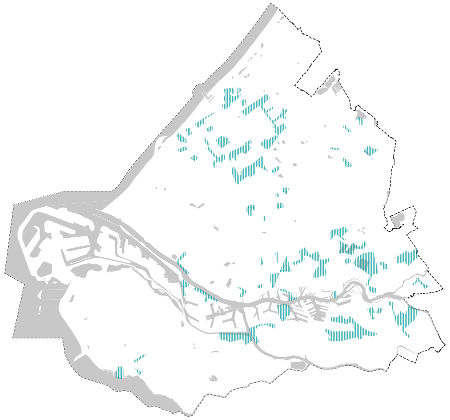


Present

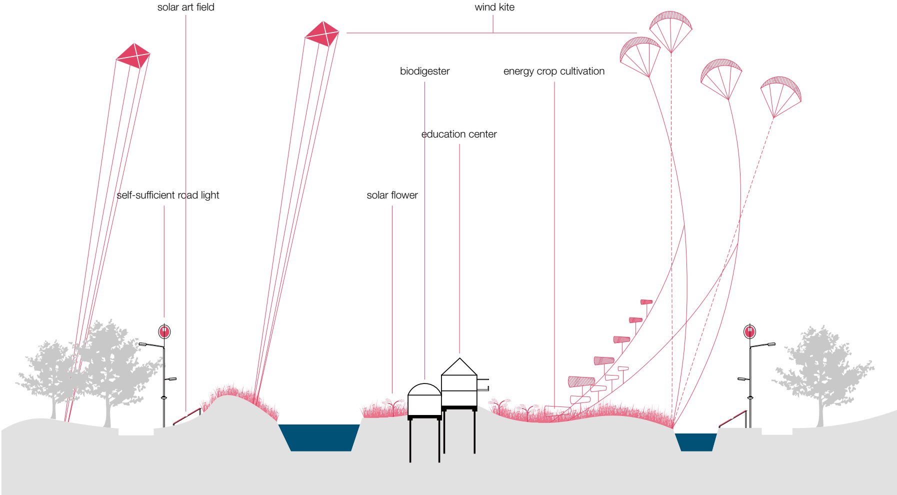


2030

ENERGY PARK



Present

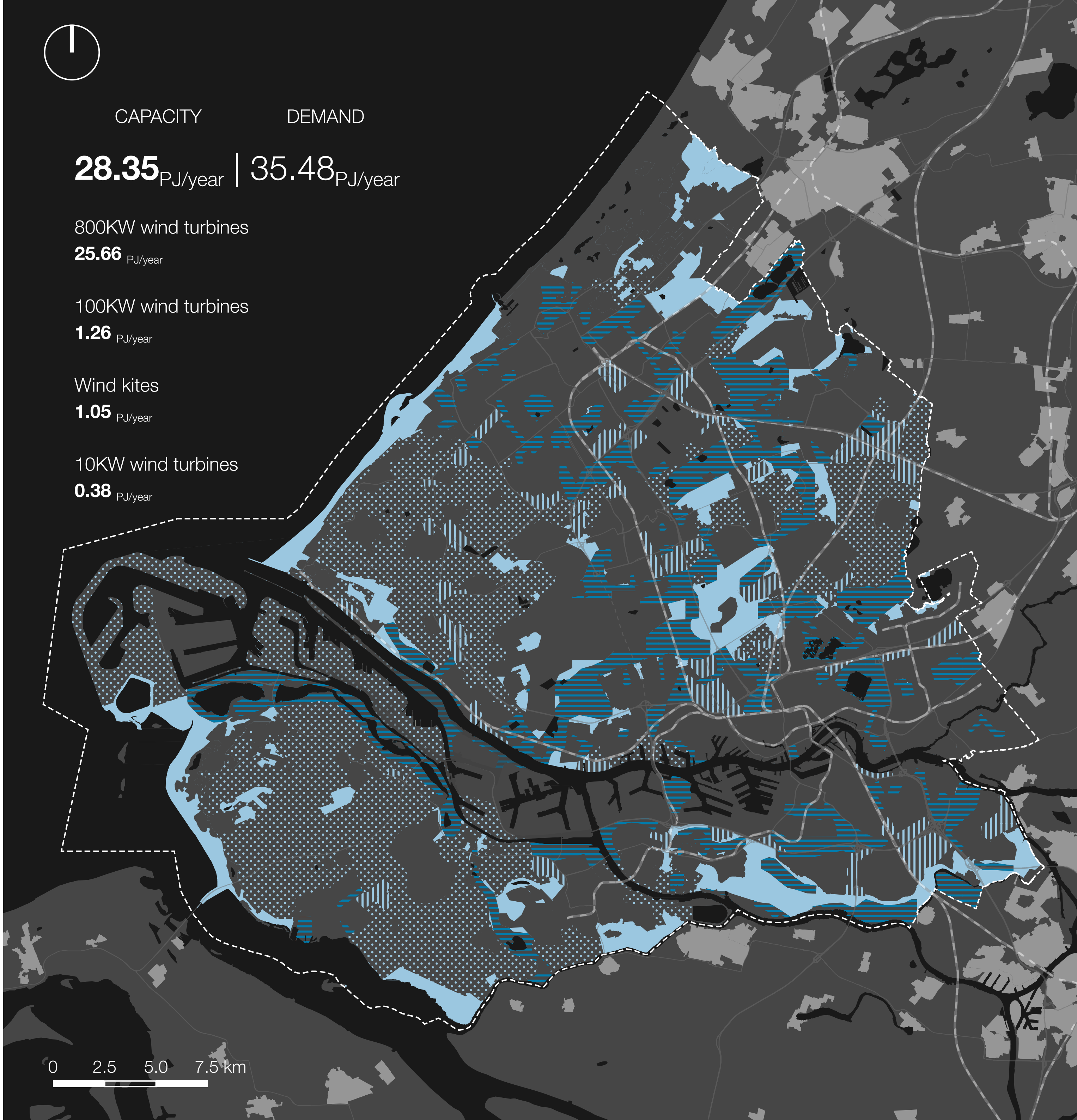


2030

Park (present)

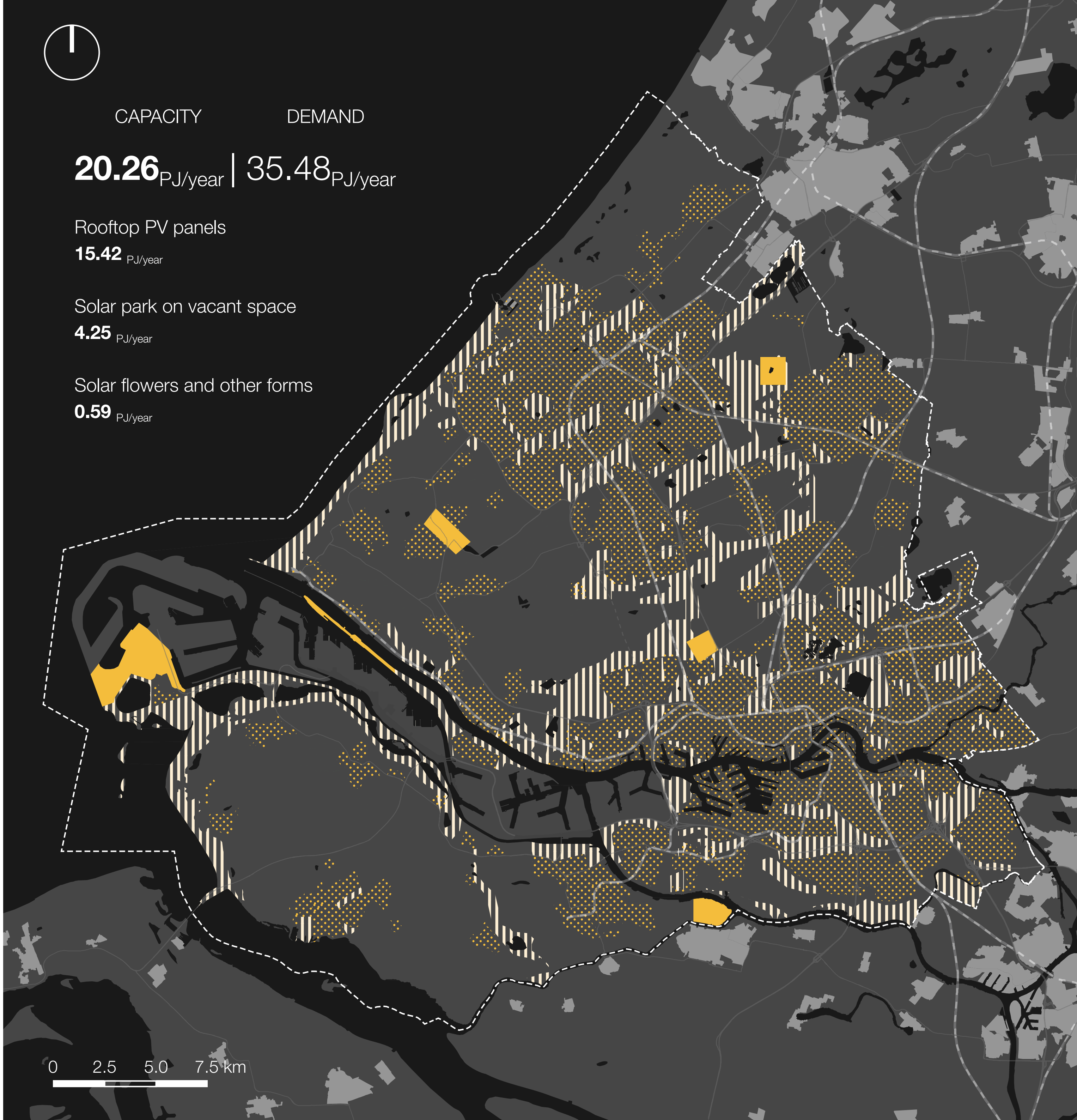
Energy Eco Park (2030)

WIND ENERGY VISION 2050



800KW wind turbines
100KW wind turbines
Wind kites
10KW rooftop wind turbines

SOLAR ENERGY VISION 2050

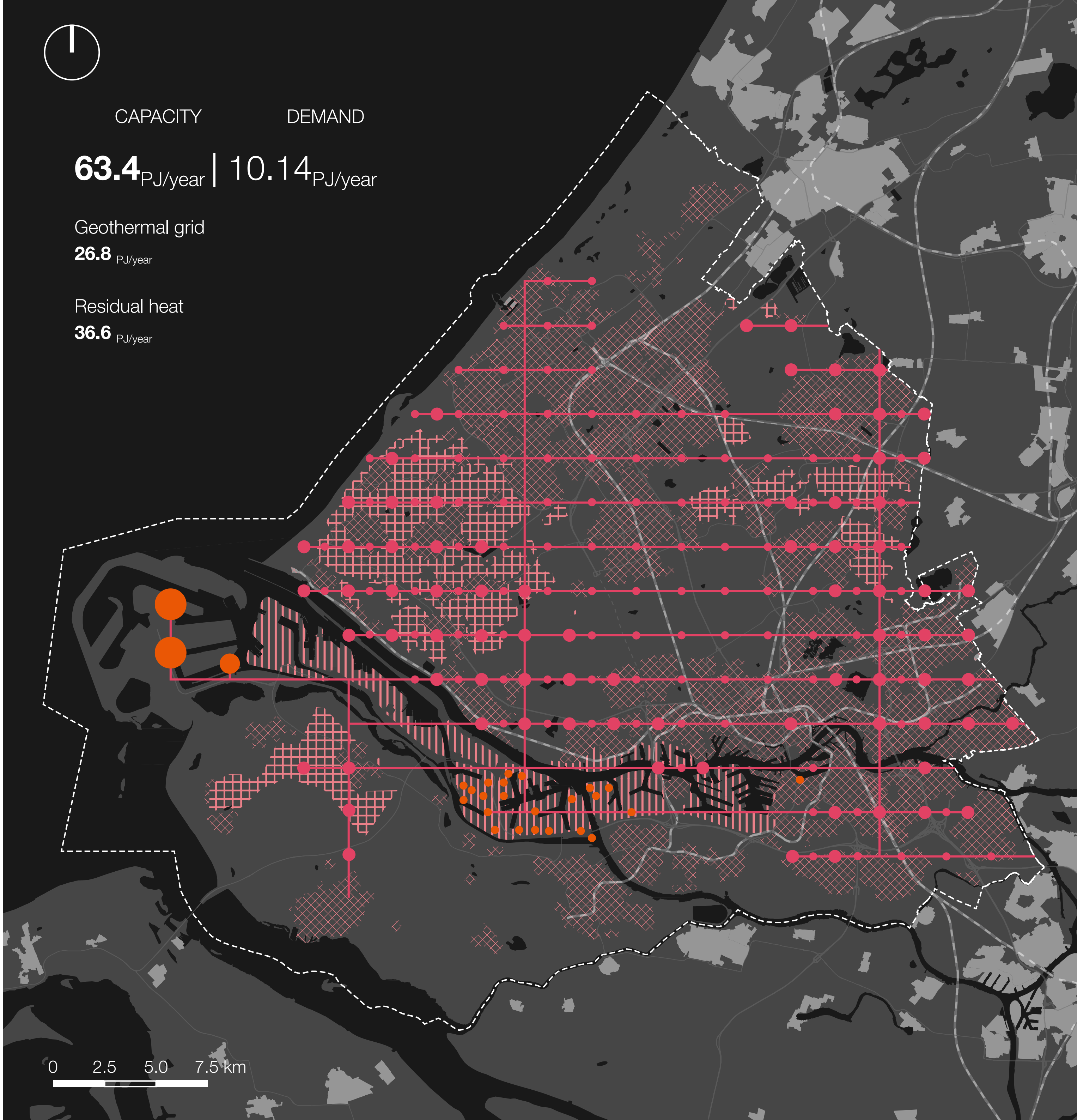


- Rooftop PV panels
- Solar flowers and other forms
- Solar park on vacant space

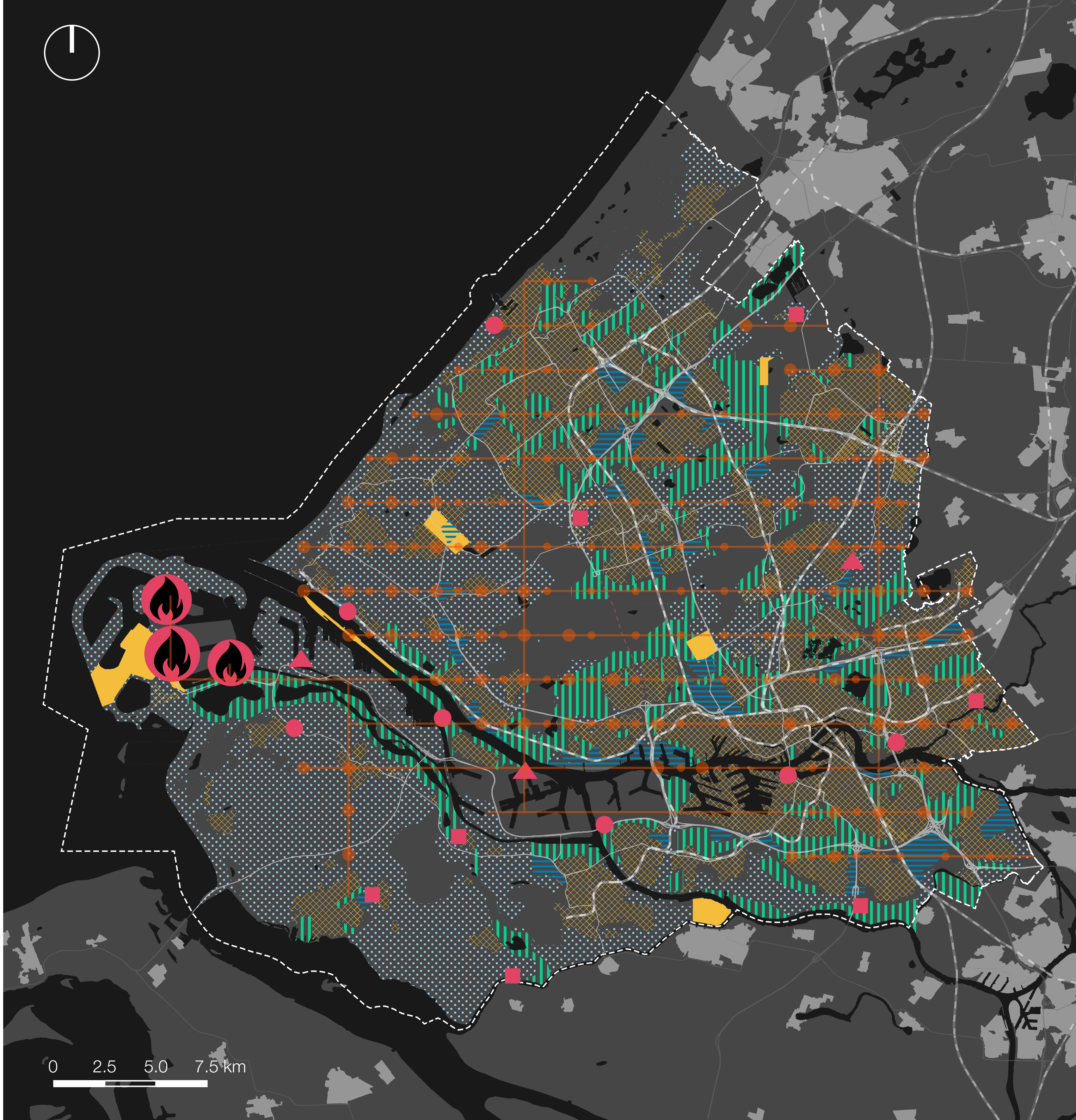
BIOMASS ENERGY VISION 2050

- Manual and food waste
- Residual vegetation
- Energy crops
- Biomass energy power plant
- RWZI with biogas production
- RWZI/AWZI with digester
- GFT composting installation

DISTRICT HEATING 2050

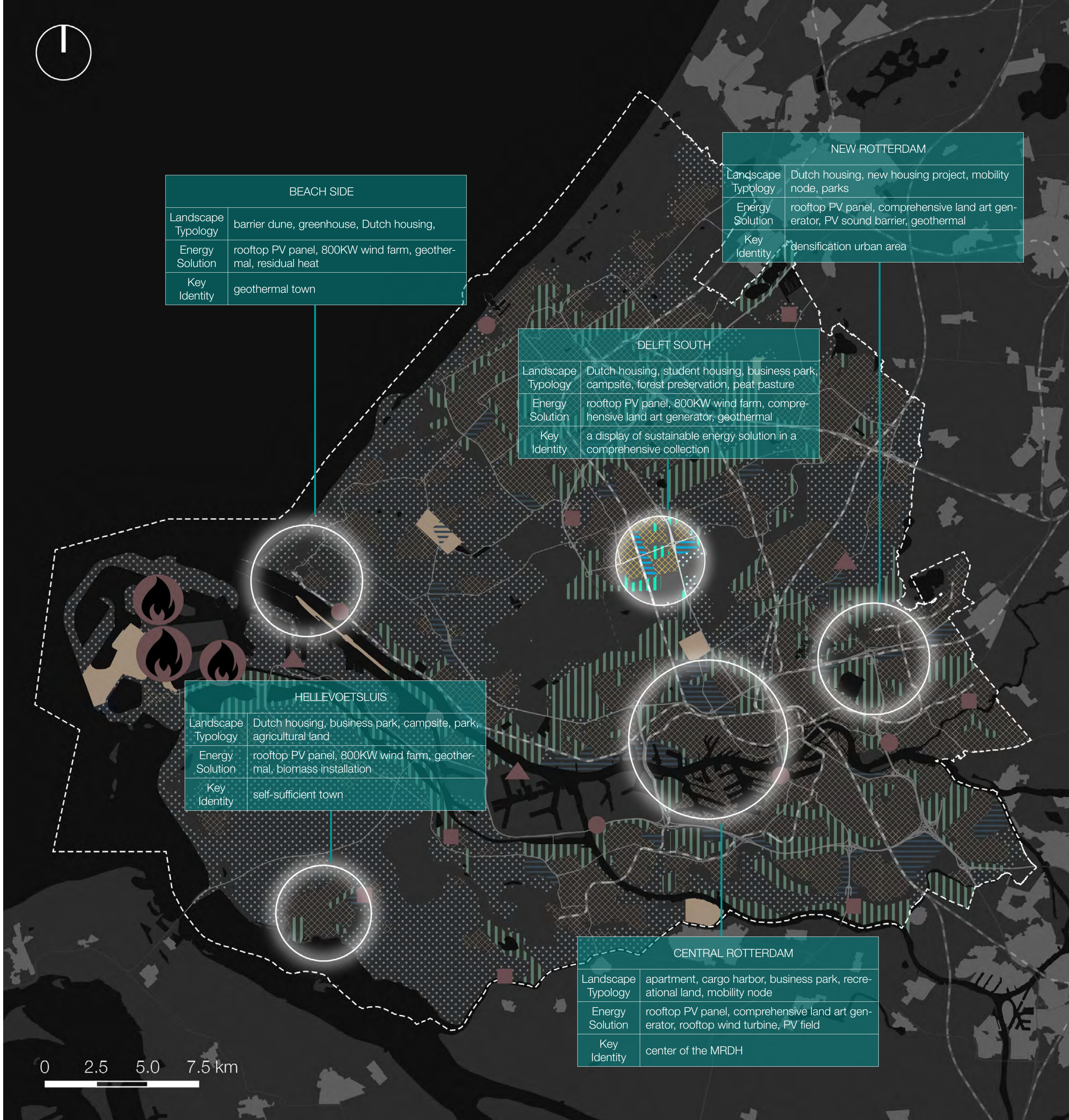


STRATEGIC MAP



Wind turbine area
Roof PV panel area
PV field area
Biomass installations
Comprehensive energy generation area
Energy generation in business area

KEY PROJECT



BEACH SIDE	
Landscape Typology	barrier dune, greenhouse, Dutch housing,
Energy Solution	rooftop PV panel, 800KW wind farm, geothermal, residual heat
Key Identity	geothermal town

NEW ROTTERDAM	
Landscape Typology	Dutch housing, new housing project, mobility node, parks
Energy Solution	rooftop PV panel, comprehensive land art generator, PV sound barrier, geothermal
Key Identity	densification urban area

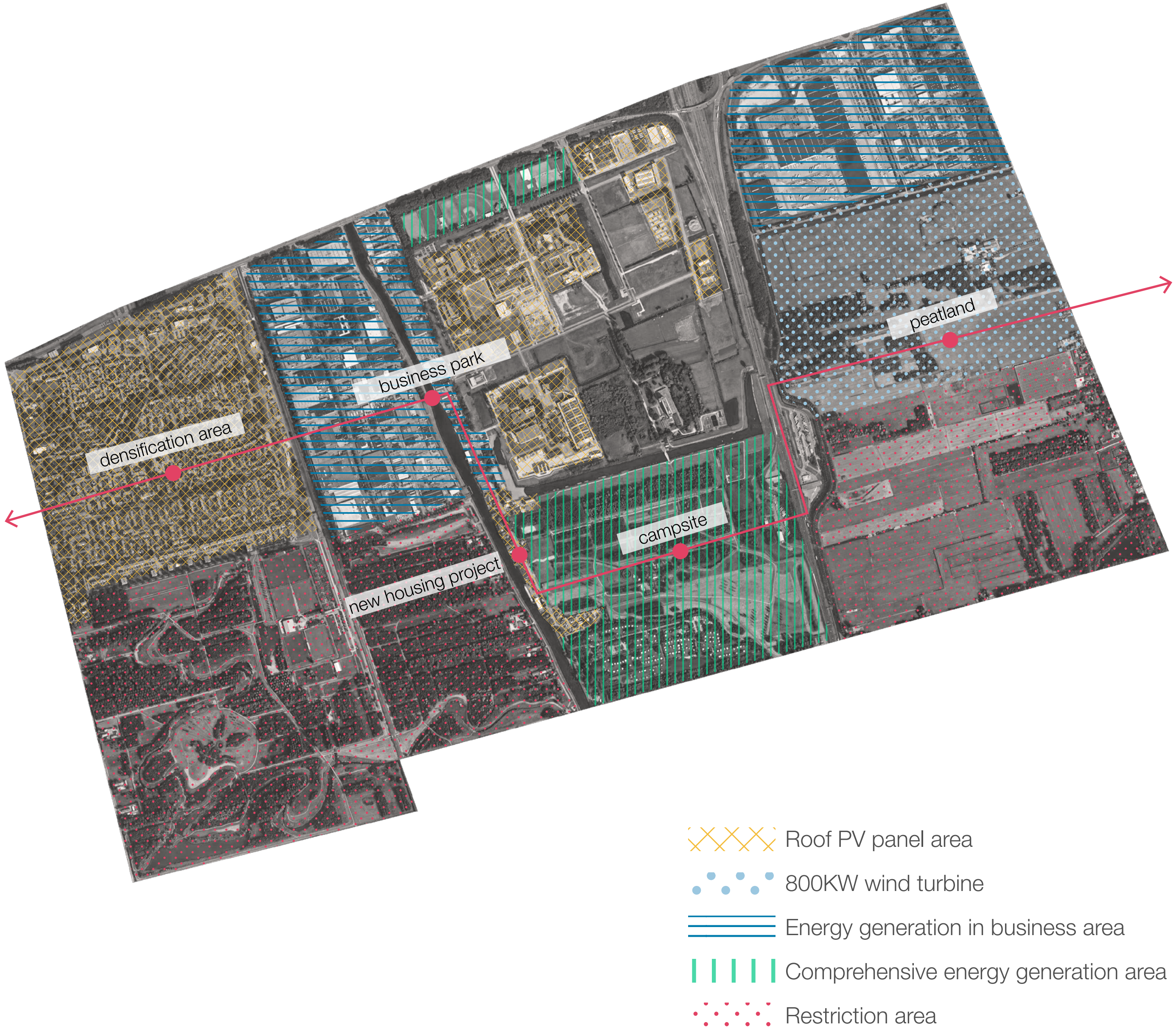
DELFT SOUTH	
Landscape Typology	Dutch housing, student housing, business park, campsite, forest preservation, peat pasture
Energy Solution	rooftop PV panel, 800KW wind farm, comprehensive land art generator, geothermal
Key Identity	a display of sustainable energy solution in a comprehensive collection

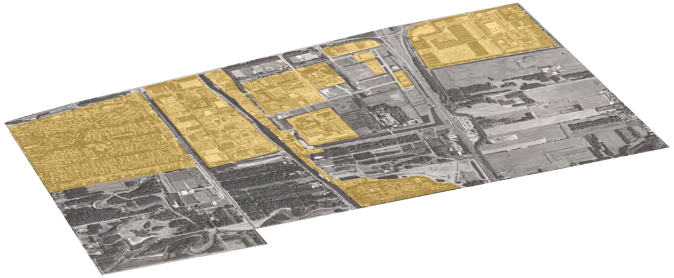
HELLEVOETSLUIS	
Landscape Typology	Dutch housing, business park, campsite, park, agricultural land
Energy Solution	rooftop PV panel, 800KW wind farm, geothermal, biomass installation
Key Identity	self-sufficient town

CENTRAL ROTTERDAM	
Landscape Typology	apartment, cargo harbor, business park, recreational land, mobility node
Energy Solution	rooftop PV panel, comprehensive land art generator, rooftop wind turbine, PV field
Key Identity	center of the MRDH

DELFT SOUTH

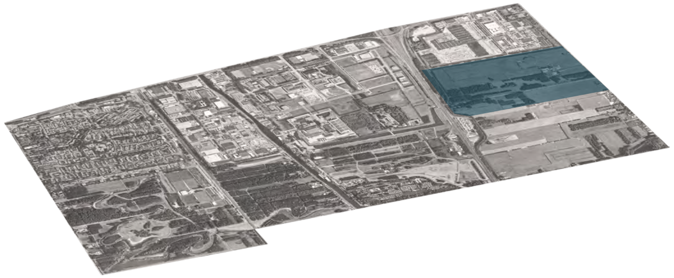
Dutch neighborhoods
Student housing projects
University buildings
Business parks
Peak land pastures
Forest preservation
Campsite





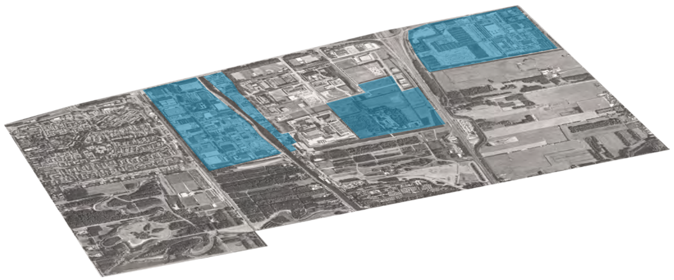
SOLAR

$40m^2$ PV panel/household
Housing: 15.57 GWh
Business: 7.66 GWh



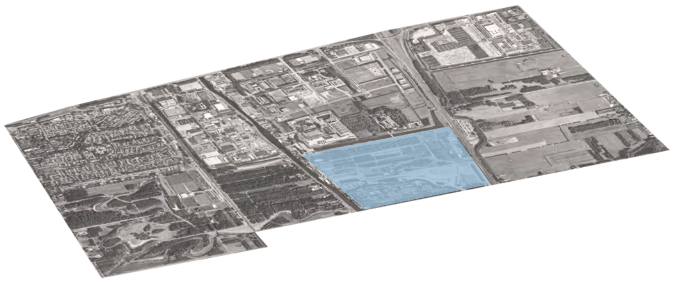
800KW TURBINE

Average power density:
0.23 GWh/ha
Electricity production:
16.10 GWh



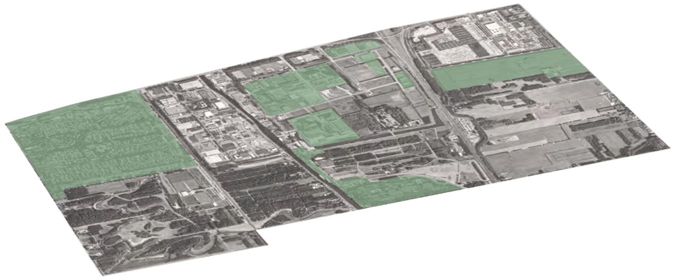
10KW TURBINE

Average yield per turbine
at 30m: 5 MWh
Electricity production:
2.65 GWh



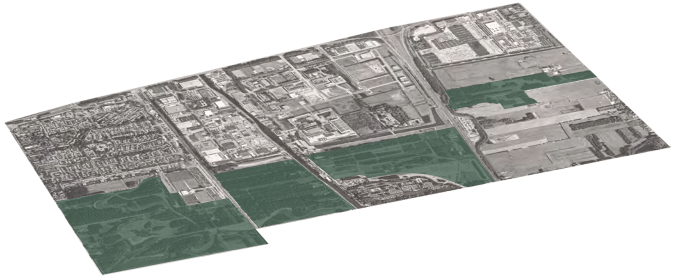
WIND KITE

Average power density:
0.025 GWh/ha
Electricity production:
1.80 GWh



WASTE

Per household: 0.57 ton
(326 KWh)
Electricity production:
1.06 GWh

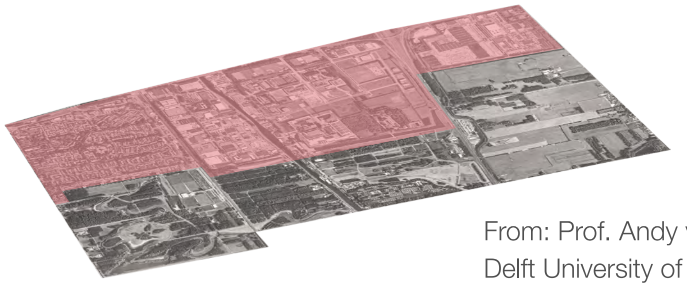


BIOMASS INCINERATIO

From maintenance of parks:
4.7 MWh/ha
gardens: 18.9 MWh/ha
Energy production:
2.78 GWh

WASTE HEAT

0 GWH



GEOTHERMAL

28.65 GWH

From: Prof. Andy van den Dobbelsteen ,
Delft University of Technology

Energy demand per 3000 dwellings:

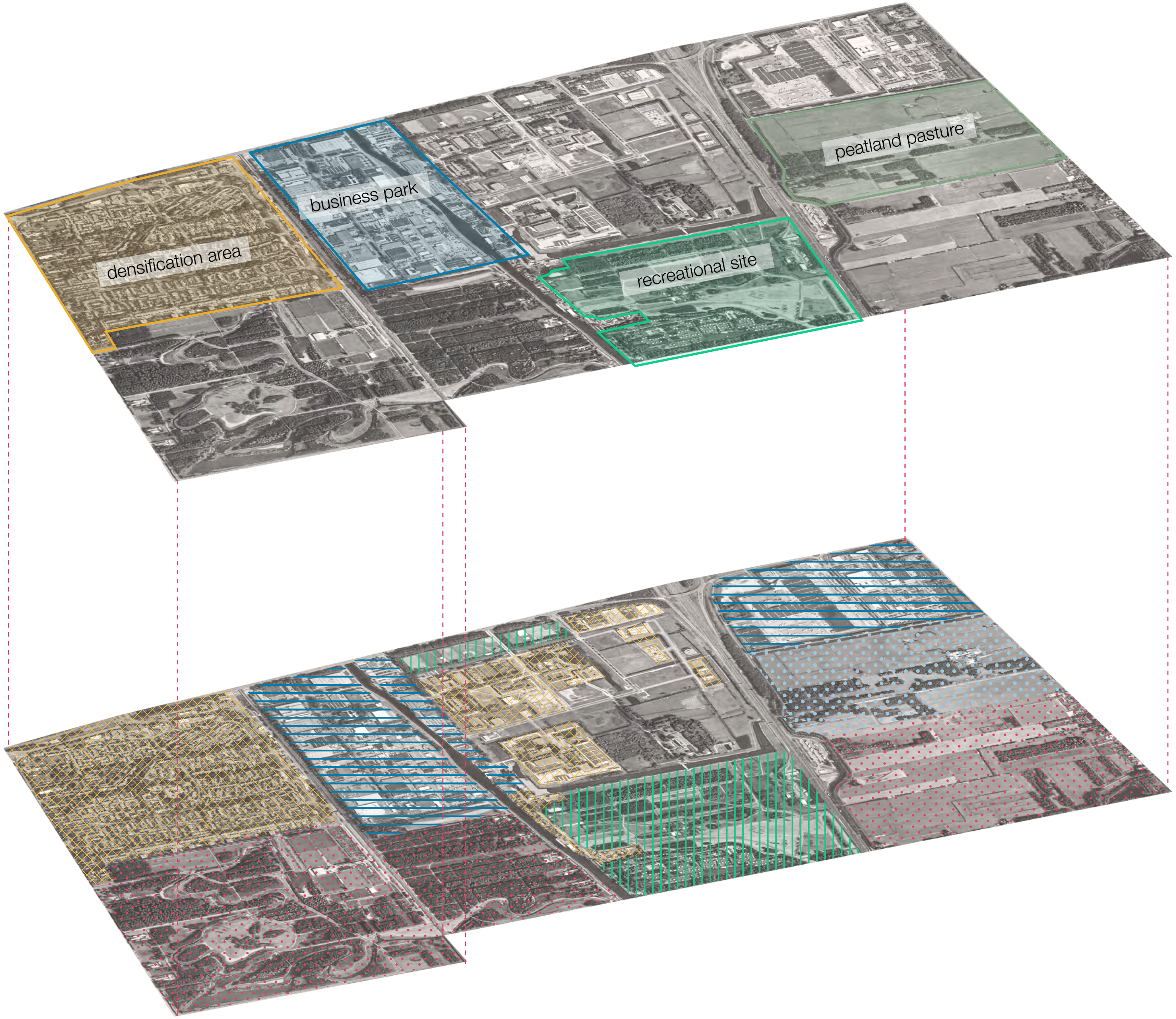
Elektricity: 10,5 $GWh_{(e)}$

Heating: 26,5 $GWh_{(th)}$ (aeq)

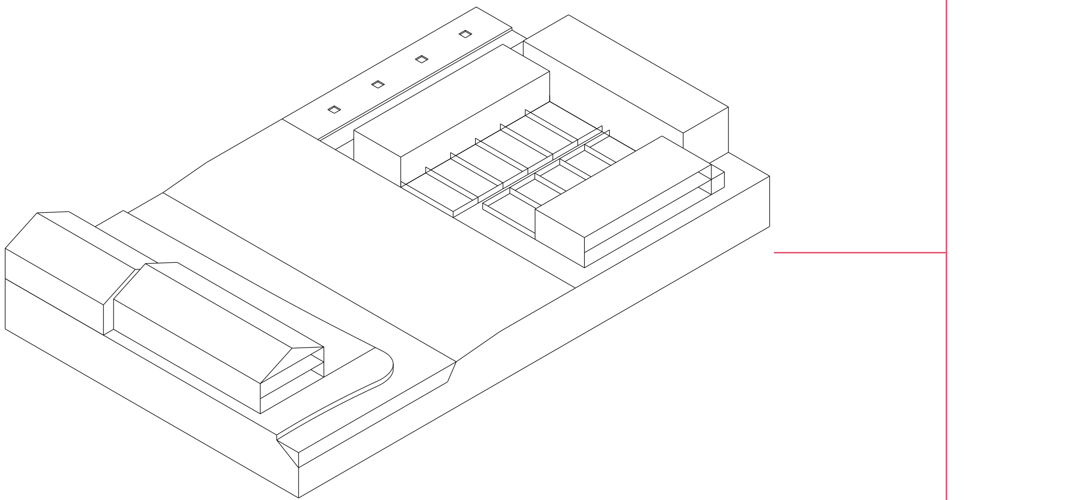
From: Prof. Andy van den Dobbelsteen ,
Delft University of Technology

INFORMATION		
Area (ha)	825	
Households	3243	
Energy demand (GWh)	Electricity	34.05
	Heat	28.65
Energy production capability (GWh)	Electricity	43.78
	Heat	>28.65
	Biogas	3.84

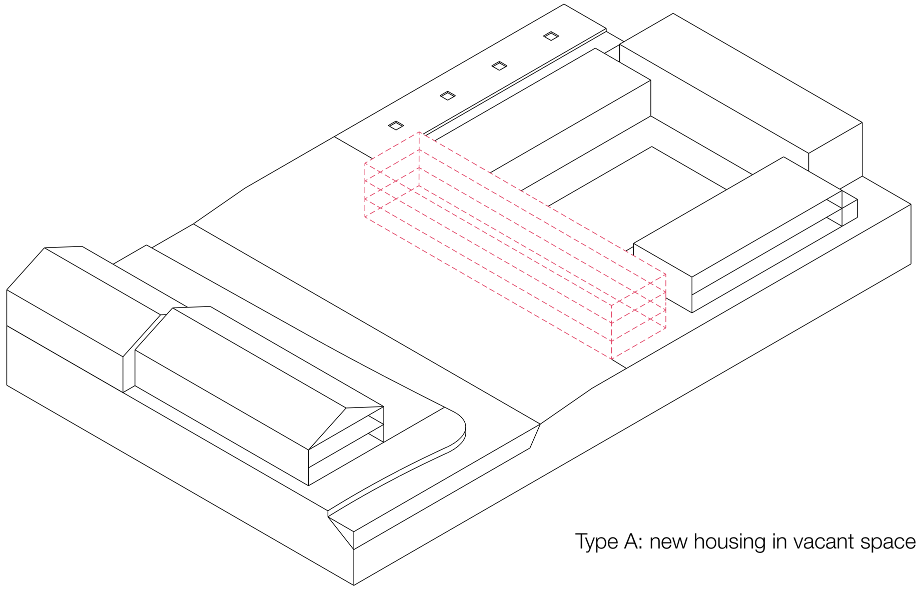
Table X. Basic information of Delft South
Data source: www.cbsinuwbuurt.nl/



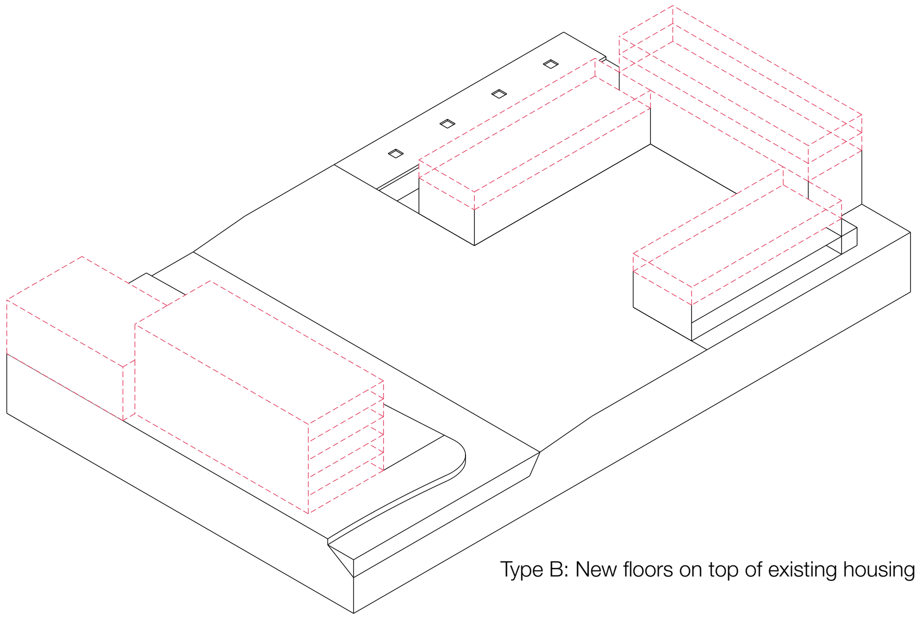
DENSIFICATION AREA



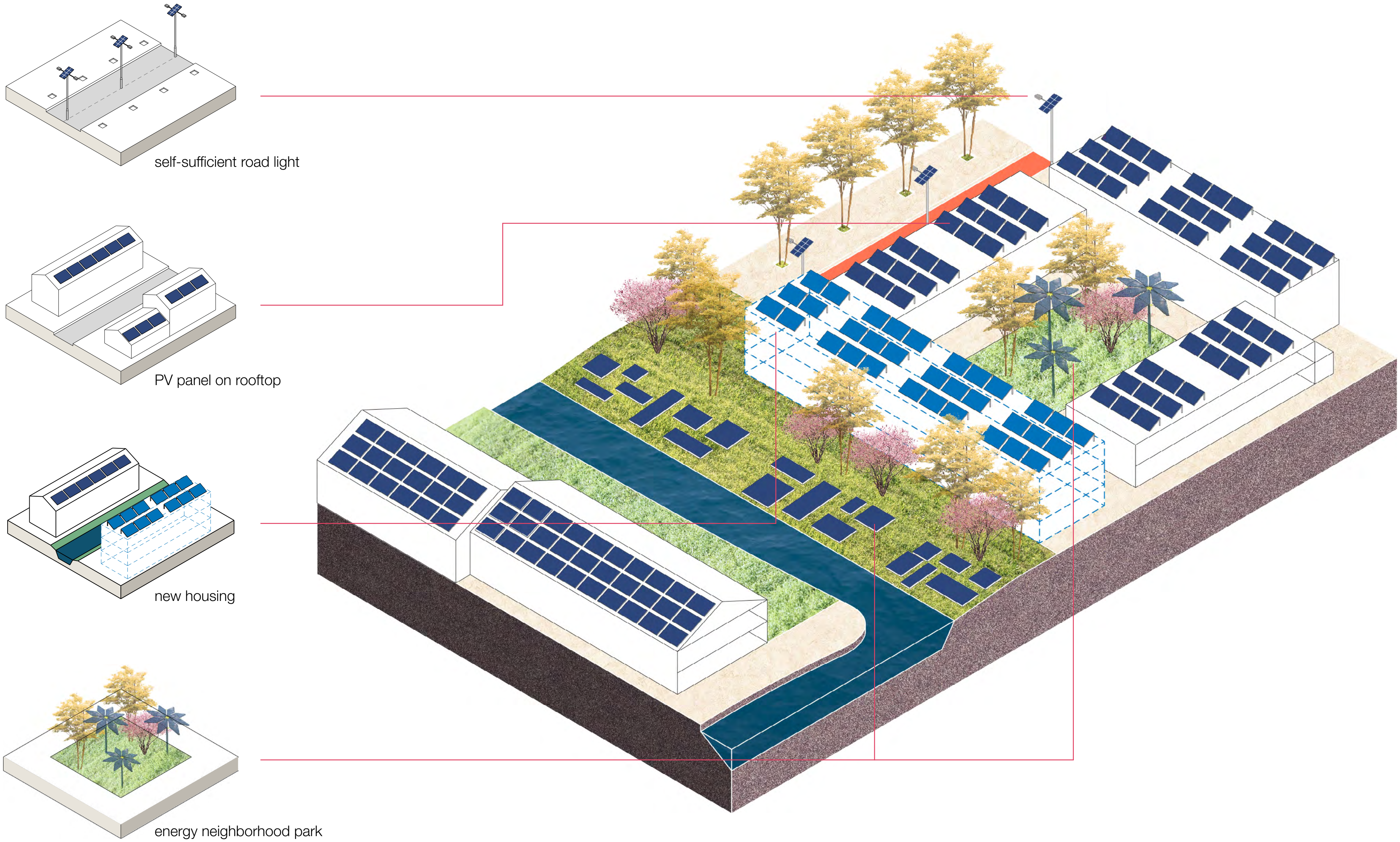
Current condition

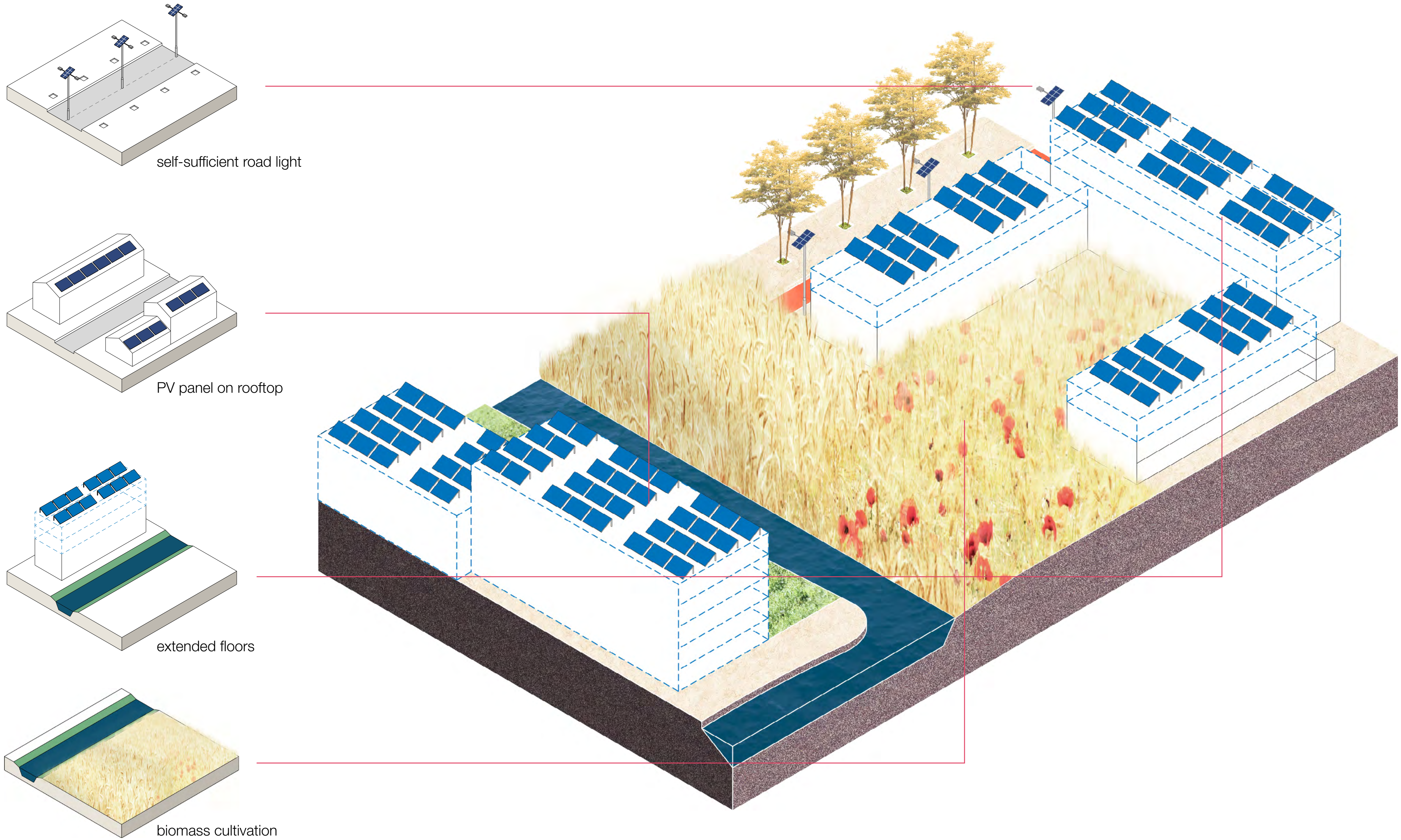


Type A: new housing in vacant space

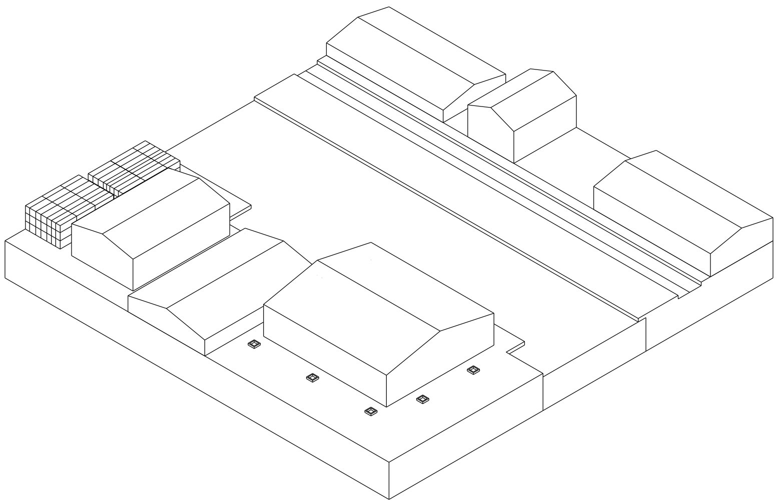


Type B: New floors on top of existing housing

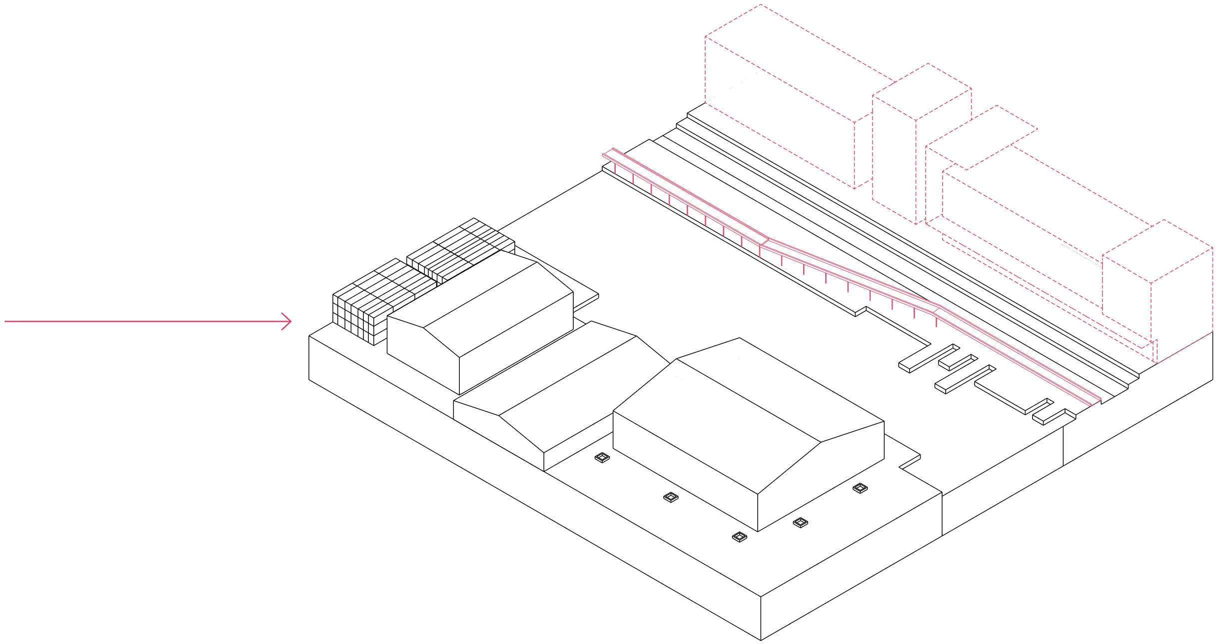

self-sufficient road light
PV panel on rooftop
new housing
energy neighborhood park


self-sufficient road light
PV panel on rooftop
extended floors
biomass cultivation

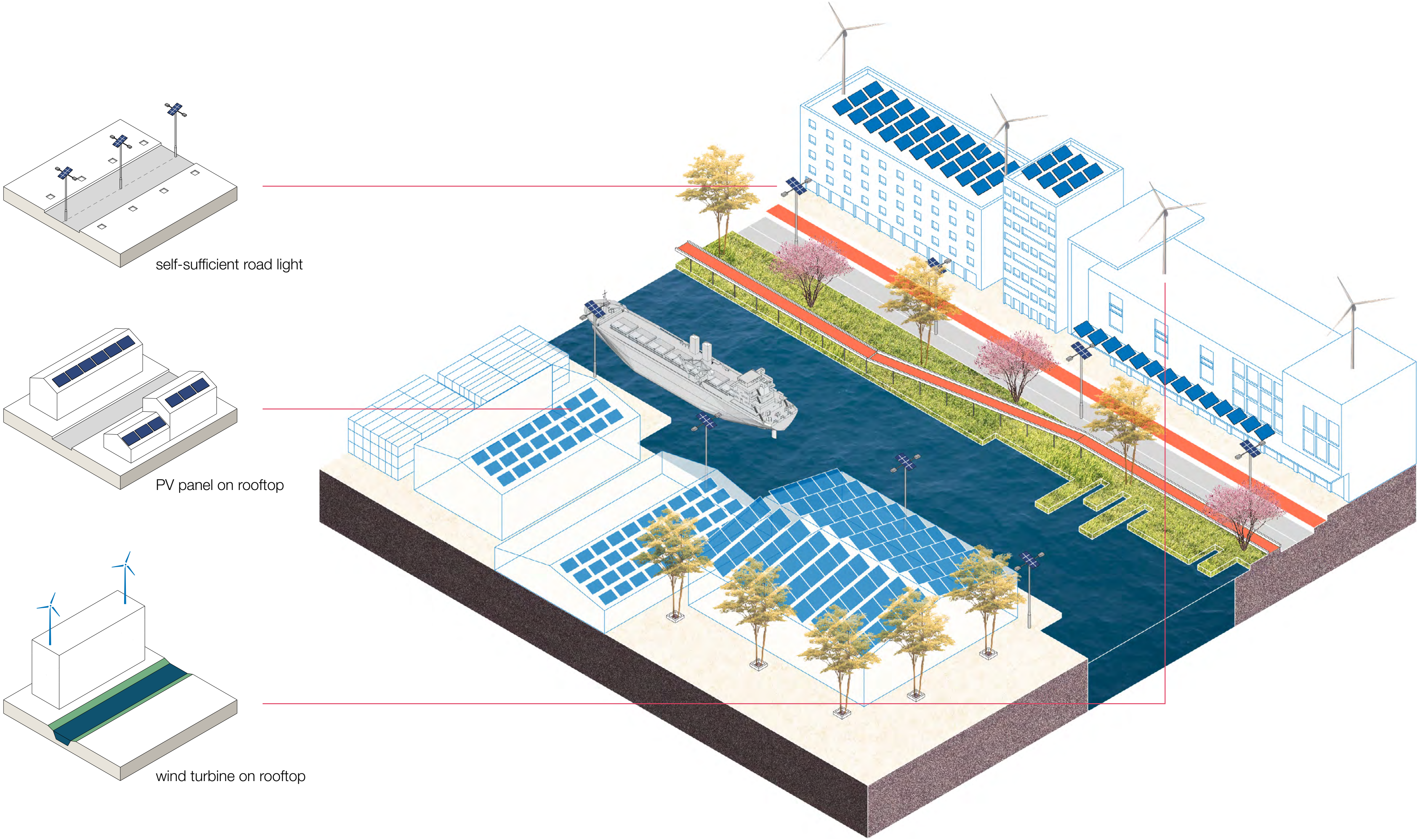
BUSINESS AREA



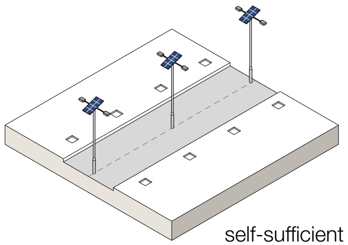
Current condition



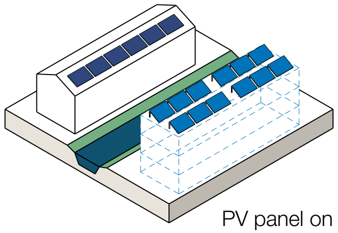
Business park transformation


self-sufficient road light
PV panel on rooftop
wind turbine on rooftop

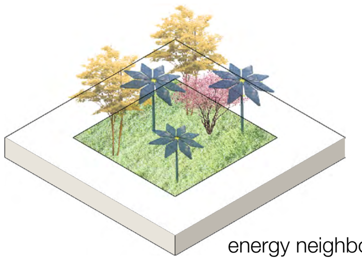
NEW HOUSING PROJECT



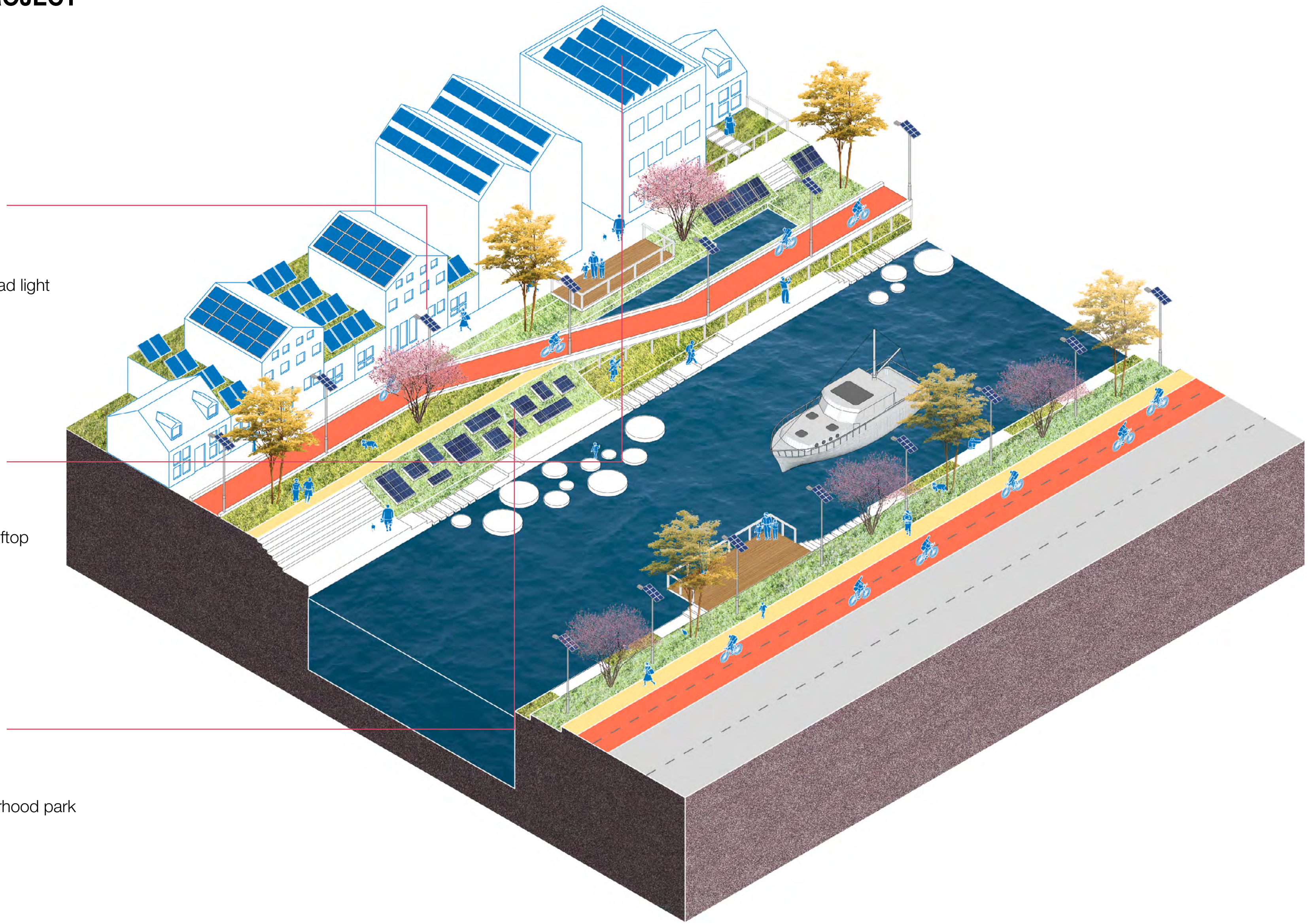
self-sufficient road light

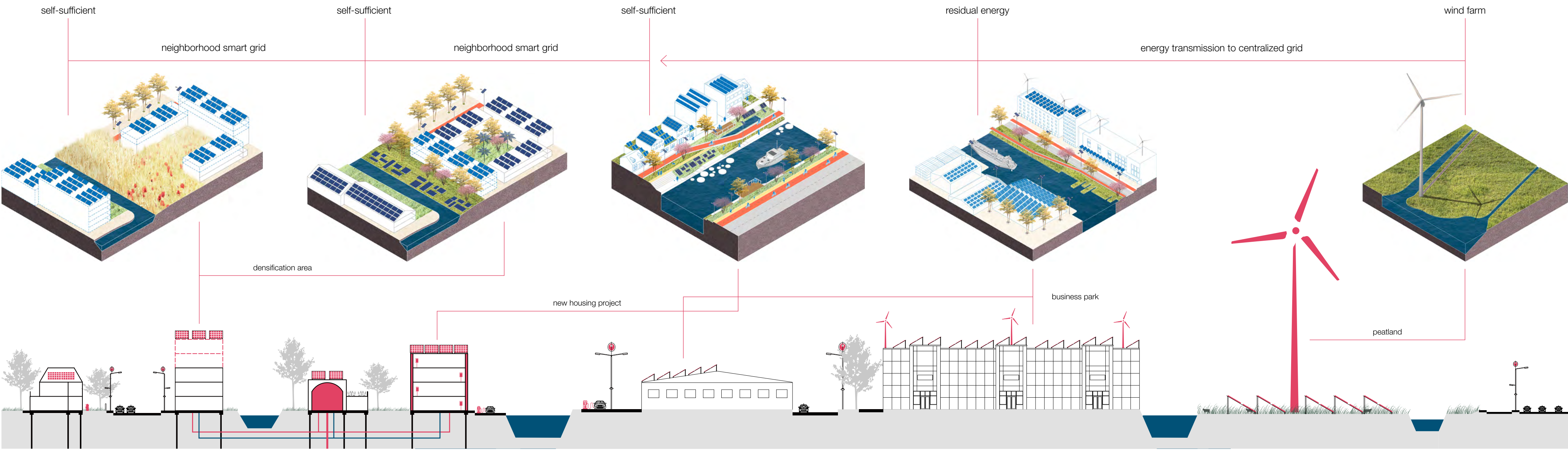


PV panel on rooftop

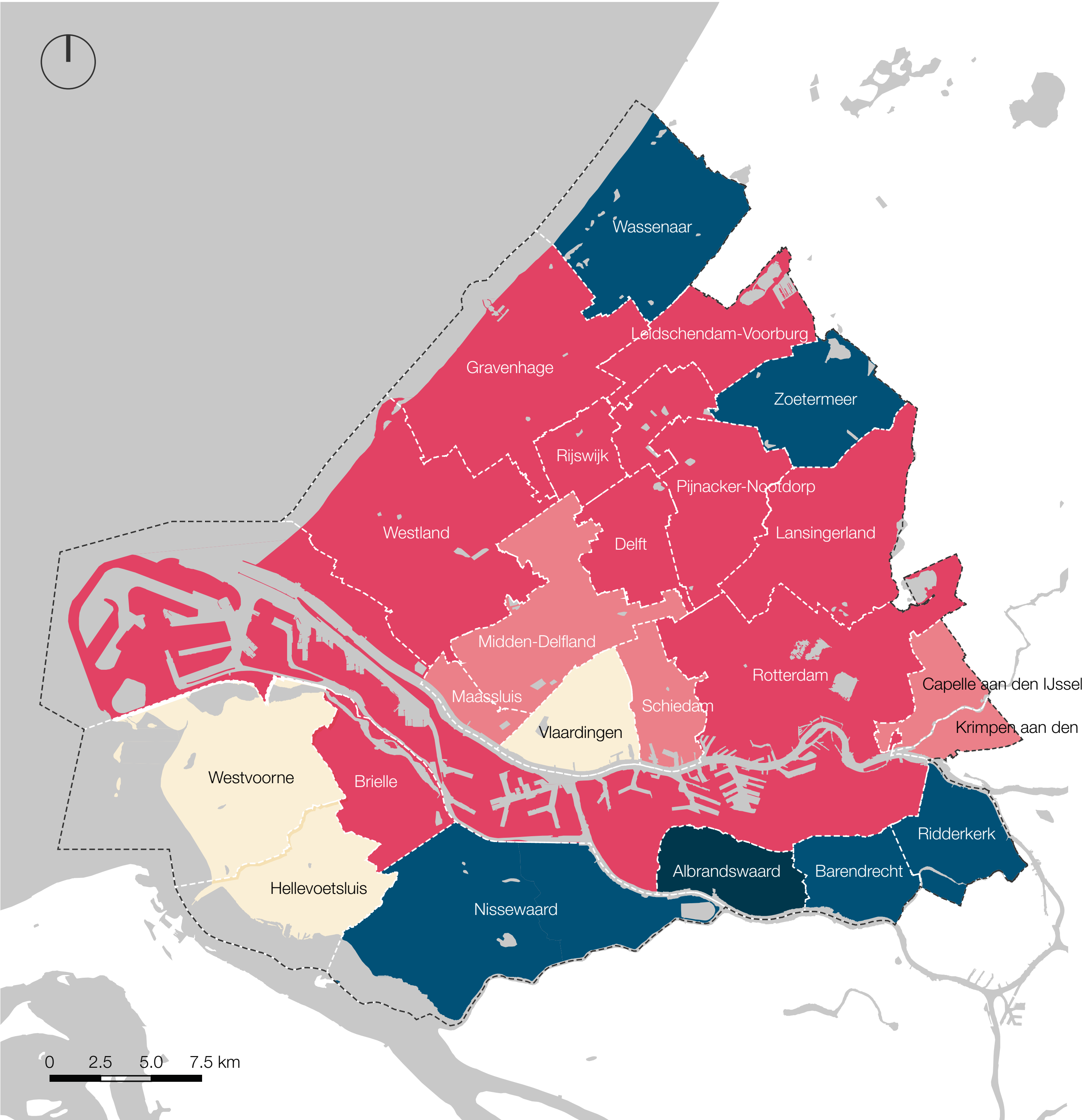


energy neighborhood park





self-sufficient
self-sufficient
self-sufficient
residual energy
wind farm
neighborhood smart grid
neighborhood smart grid
energy transmission to centralized grid
densification area
new housing project
business park
peatland



EVALUATION

The evaluation of energy production and consumption

The evaluation of landscape quality from different actors

- Huge decrease (-15% ~ -10%)
- Decrease (-10% ~ -2.5%)
- Reasonable stable (-2.5% ~ 2.5%)
- Increase (2.5% ~ 10%)
- Huge increase (10% ~ 15%)

Population change
Data source: www.pbl.nl/themasites/regionale-bevolkingsprognose/bevolkingsprognoses-2015-2040 bevolking

YEAR		POPULATION	ENERGY CONSUMPTION	ENERGY USAGE PER PERSON	ENERGY PRODUCTION CAPACITY	MAXIMUM ENERGY USAGE PER PERSON
2015		2,335,200	131.95 PJ	56.50 GJ		
2050	MILD	+ 144,800 2,480,000	72.67 PJ	29.30 GJ	113.72 PJ	45.85 GJ
	EXTREME	+ 264,800 2,600,000		27.95 GJ		43.73 GJ
MAXIMUM POPULATION		+ 1,733,500 4,068,700				

Table 16. The relation between population, energy production and personal usage

Image 88. AGRICULTURAL LAND BEFORE

Image 89. AGRICULTURAL LAND 2030

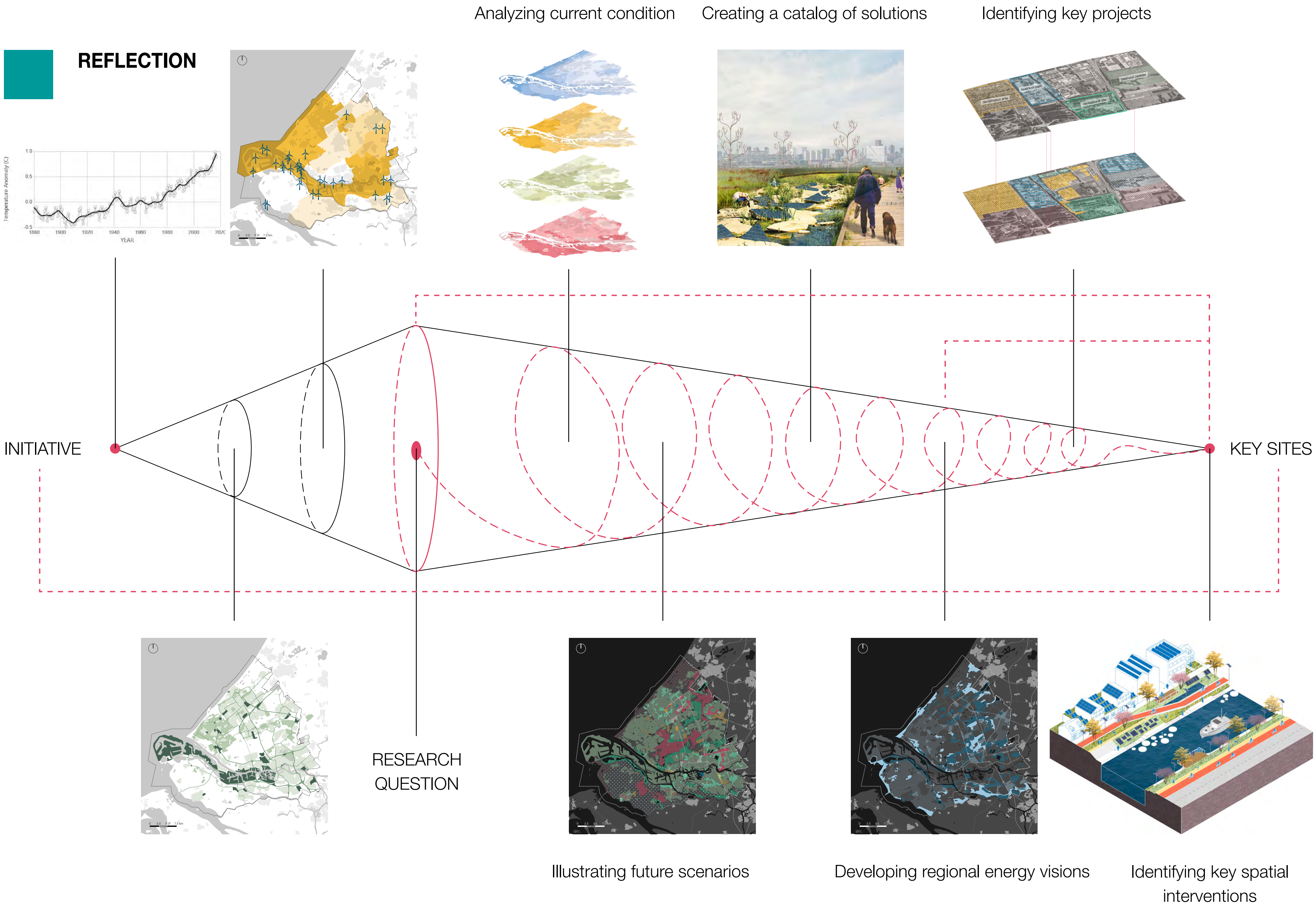
ACTORS	ADDED VALUE	DECREASED VALUE
farmer	selling energy crops wind electricity biogas	agricultural profit noise visual disturbance
municipality	wind electricity biogas	investment

Image 92. PARK BEFORE

Image 93. ECO-ENERGY PARK 2050

ACTORS	ADDED VALUE	DECREASED VALUE
visitor	visual beauty public space	
environmentalist		ecological value
municipality	attractiveness	investment

REFLECTION


Analyzing current condition
Creating a catalog of solutions
Identifying key projects
INITIATIVE
KEY SITES
RESEARCH QUESTION
Illustrating future scenarios
Developing regional energy visions
Identifying key spatial interventions

THANK YOU
DANK JE