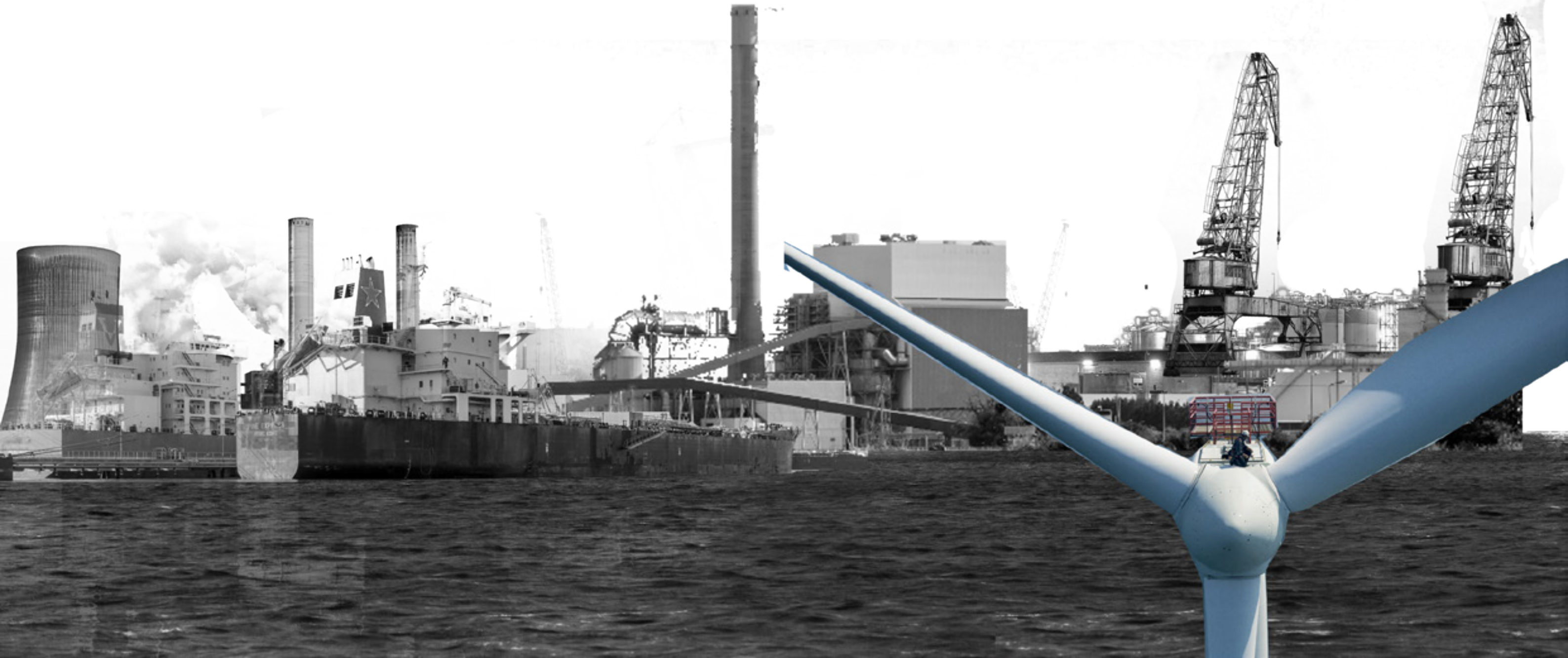
ILLUMINATING THE BLIND FIELD

landscape Infrastructure as intervention: Guideline for a sustainable energy landscape in dynamic urban territory

Yifan Zhang



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PREFACE

Climate change has been posing massive influence on our environment, especially for city areas. Therefore, a shift towards renewable energy is quite necessary nowadays. The installation of renewable energy will have a great impact on the landscape, occupying part of the physical environment of the city. However, cities are places where people live. The installation of the renewable energy infrastructure in urban territory means they will be more visible in everybody's living environment. People are connected and related to their living environment, and that is why renewable energy projects are often encountered with public resistance. Big challenges, therefore, exist to engage renewable energy infrastructure sustainably in the urban territory.

Fascinated by the challenges, I started this thesis. The concept of sustainable energy landscape and landscape infrastructure attract me, as it can provide me with a way to accommodate renewable energy infrastructures sustainably in the urban territory while offering multiple functions at the same time. The exploration of these concepts was, therefore, an exciting and inspiring process.

I would like to thank my two supervisors Stremke Sven and Paolo Picchi for their patient guiding during the whole thesis process. At the same time, I also want to thank my fellow students from the NRGlab who inspired me with their works and their remarkable advice to keep me moving forward. Finally, I want to thank my family and friends for their support.

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ABSTRACT

In the last decades, climate change has been exerting a great influence on the Earth, especially in urban regions. The extreme weather events triggered by climate change lead to a series of problems for city engineering. Furthermore, the majority of anthropogenic greenhouse gases contributing to climate change are emitted from cities. Thus, cities need to take responsibility during the transition towards sustainable energy, reducing their emissions and improving their living standards. This thesis aims to investigate how to achieve the transition towards sustainable energy and to install renewable energy infrastructure in urban territory.

The main research question of this thesis is: What is the potential of renewable energy infrastructure to be multifunctional during the transition towards sustainable energy in the Amsterdammerpolder area? It is addressed in three steps. Firstly, document analysis helps to understand the narrative of the desirable transition for the Amsterdammerpolder area as a city region. Secondly, the landscape types inside the Amsterdammerpolder area that are suitable for the installation of renewable energy infrastructure are identified. For each landscape type, a future is envisioned where their characteristics are conserved and redeveloped, while at the same time engaging in the installation of renewable energy infrastructure. Lastly, one landscape type is chosen and designed to achieve sustainable transition.

KEY WORDS:
renewable energy infrastructure, sustainable energy transition, multifunctionality, landscape types

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1.1 Problem context

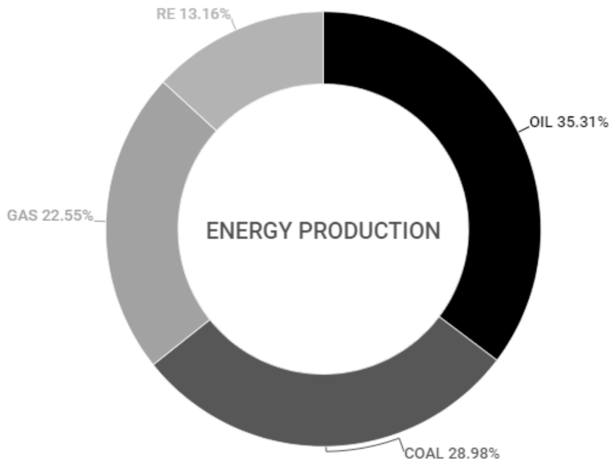
1.1.1 Climate change impacts and actions

In the last decades, the Earth has witnessed the impacts of climate change on both natural and human systems. The evidence of climate change is wide-ranging, and its consequences on the natural environment are particularly striking. For example, changes in precipitation events, combined with snow melting, affect the global hydrological systems and water resources availability across both spatial and temporal scales (IPCC, 2014). At the same time, the energy sector, including energy production, transportation, and consumption, is responsible for two-thirds of global greenhouse gas (GHG) emissions(Kammen & Sunter, 2016). Thus, as stated by the Intergovernmental Panel on Climate Change (IPCC), we need an urgent and large-scale shift towards renewable energy, so as to achieve GHG emission reduction and contribute to the achievement of the objectives of the Paris Climate agenda (IPCC, 2019).

1.1.2 Renewable energy in the densely populated city

I. City-integrated renewable energy

In the following decades, a quick expansion of urban regions is expected, such that by 2050, about 2.5 billion people will live and work in cities. As argued by Kammen, today cities are not adequately prepared to face the expected urban expansion in a sustainable way, specifically in relation to their energy systems (Kammen & Sunter, 2016). Becoming a low-carbon city is crucial to achieve urban sustainability. To achieve this objective, two main strategies are currently available and the first one is to reduce energy consumption level in the urban territory. The second strategy is to shift from fossil fuel to renewable energy sources (Kammen & Sunter, 2016). Currently, only around 13% of the energy production is from renewable energy(Figure 1). Cities consume around 75% of the energy produced in the world; the production of city-integrated renewable energy, located directly at the site of energy use, can thus contribute to achieve urban sustainability (Kammen & Sunter, 2016).



Energy Production
1. oil 35.31%
2. coal 28.98
3. gas 22.55%
4. re 13.15%

Figure 1: Total energy production in the world. Based on (IPCC,2012)

City-integrated renewable energy provides four main advantages:
"(i) it generates low- or zero-carbon emissions; (ii) it offsets capital-intensive investments for network upgrades; (iii) it entails local energy independence and network security; and (iv) it stimulates social capital and cohesion"

(Kammen & Sunter, 2016, p922)

II. Challenges of the sustainable energy transition in the dynamic urban territory

The ECLAS, the Europe council of landscape architecture schools, concludes the definition for landscape architecture- "Landscape architecture is the discipline concerned with mankind's conscious shaping of his external environment. It involves planning, design and management of the landscape to create, maintain, protect and enhance places so as to be both functional, beautiful and sustainable (in every sense of the word), and appropriate to diverse human and ecological needs."(ECLAS, n.d, "landscape architecture", para 1). As de Waal and Stremke mentioned that, Landscape architecture ought to take a role during the energy transition(de Waal & Stremke, 2014). Both of them is striving for sustainability. Furthermore, the changes brought by energy transition which exist in the physical landscape will affect the environment(de Waal & Stremke, 2014).

Apart from limited available spaces for the installation, in fact, there are conceptual and technical challenges:

(i)Conceptual challenges.

Conventional energy power plants are usually located in the suburbs, far away from people's lives, and the public easily gets used to this. On the contrary, city-integrated renewable energy power plants are close to the end users. Therefore, a strong resistance is often posed towards these developments by several groups, which find that their own comfort and living space is more important than that of others, and leading to phenomena such as the famous 'Not In My Backyard'(Figure 2). As argued by Pasqualetti and Stremke, people are resistant to changes to their living environment, and their expectation of landscape stability is like a full-fledged faith (Pasqualetti & Stremke, 2018).

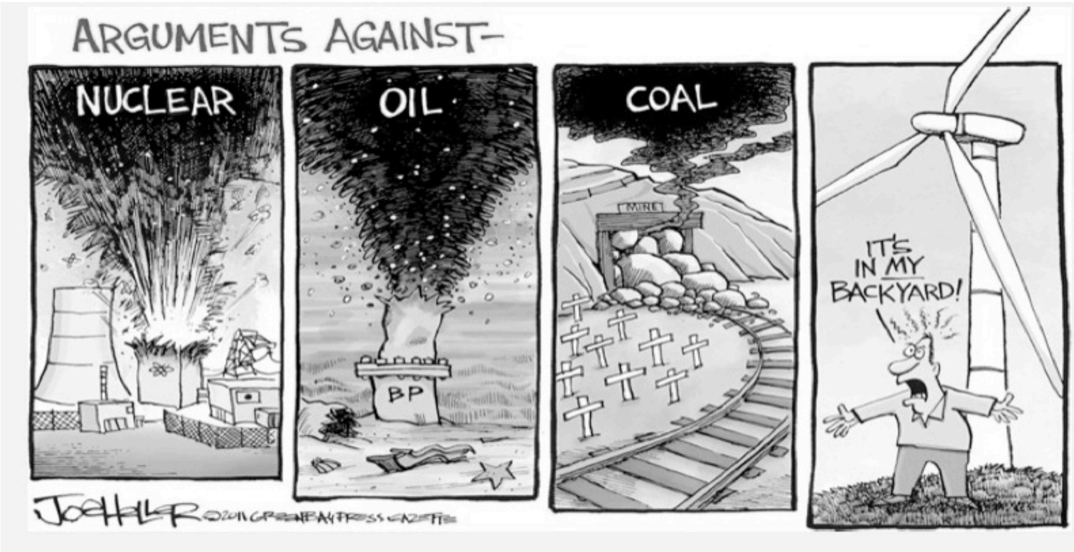


Figure 2: Not in my backyard, from Dunlop (2012)

(ii)Technical Challenges

Both the uncertainty and the variability in energy use across the urban territory induce technical challenges (Joss, 2015). These are different in terms of needs and available types of energy across different parts of the city. For example, it is true that industrial areas consume more energy than residential districts; however, this also means that there is more potential for district heating to balance the relationship between energy production and consumption (Kammen & Sunter, 2016).

Furthermore, the average households' carbon footprint differ across residential districts according to income, households' size, and other factors(Figure 3) (Voskamp et al., 2020). In other words, the state of the electrical grid, the location of renewable infrastructure, and socioeconomic conditions play an essential role in determining the available space of urban renewable energy (Kammen & Sunter, 2016).

Elements	**Needs**	**Facilitators/constraints**			**Drivers**
		Consumer characteristics	**Resource characteristics**	**Urban landscape characteristics**	
Categories of factors	Individual survival	Personal	Quality	Spatial	Demographic
	Individual aspirations	Psychological	Price	Infrastructural	Economic
	Satisfaction	Social context	Availability		Political
	Social	Cultural context			Cultural
	Practical	Decision making			Technological
	Political				Geographical

Figure 3: Categorization of factors affecting resource consumption in relation to the elements needs, facilitators/constraints and drivers, from Voslamp et al.(2020, p3).

1.2 Problem statement

The global scale of climate change demands a transition towards renewable energy sources in densely populated urban areas. By seizing part of the physical environment of a city, the renewable energy infrastructure will inevitably influence the landscape of the urban territory. As highlighted by Sijmons, energy use has always had a direct relationship with the landscape; in fact, energy production and consumption have structured our landscape through history (Sijmons, 2014). The changes brought by renewable energy infrastructure to the city landscape will inevitably raise controversy (Selman, 2010). It is therefore important to reflect on the way to deal with the current urban landscape while engaging in renewable energy infrastructure installation.

On the other hand, abandoned land that emerged during urban expansion, such as post-industrial areas, can provide the space required for the installation of renewable energy infrastructure (Kammen & Sunter, 2016). However, the facilities formed by post-industrial activities will soon become obsolete. Therefore, it is also essential to think about how to deal with those facilities while developing renewable energy infrastructure.

1.3 Knowledge gap

This thesis advances the body of knowledge on sustainable energy transition, with a particular focus on renewable infrastructures within landscape systems. Although several scholars studied the topic of sustainable energy landscape, little has been written about renewable energy infrastructure, and there is no widely applicable approach for the design of renewable energy infrastructure. Furthermore, if we focus on the relationship of this type of infrastructure with both the regeneration of abandoned spaces and the energy landscape, even less attention has been paid in the literature on the redevelopment of abandoned land through the energy landscape, an aspect that therefore deserves further research.

1.4 Conceptual framework

Landscape infrastructure approach

The traditional engineer infrastructures constructed with 'singular objective' often lead to the interruption of landscape and the decrease of cultural and natural values (Nijhuis, 2015). In order to deal with this problem, one concept called *landscape infrastructure* is defined by YING-YU HUNG. In this idea, the landscape takes the role of structure through which can help to develop and concatenate the solutions for the construction of infrastructure systems that can solve many urgent issues perplexing many cities in the world, including global warming (Hung, 2013). Meanwhile, the infrastructure itself can become part of the landscape system, which can be capable of increasing various values like ecology value and entertainment value (Hung, 2013).

Synchronicity landscape

Infrastructure needs to become part of the landscape system so as to increase its overall value, including the ecology value. Kristen developed the method of *synchronicity landscape*, through which an installed infrastructure program can be integrated into the 'old' landscape so that they can exist and be beneficial to each other simultaneously (Kristen et al., 2004).

The conventional landscape analysis, including history analysis, ecology analysis, energy analysis, and infrastructure analysis, can help to determine two landscape qualities: "the containment and openness", and "the textural and sensuous qualities" (Kristen et al., 2004, p310), which concern the shape of the 'old 'landscape and how the new design program would interact with it (Kristen et al., 2004). This process includes the development of landscape type maps and representational tools. As Kristen, Julian, and Chris highlighted, "these landscape types effectively became the 'landscape character units of old'" (Kristen et al., 2004, p310). Representational tools such as analytical drawings based on-site photos, can illustrate the spatial characteristics of the space of each different landscape type (Kristen et al., 2004). Furthermore, these authors argue that basing on these analytical drawings "landscape architects can derive a 'logic' for development that synchronizes new programs with the way the site worked" (Kristen et al., 2004, p310).

1.5 Case study area: Amsterdammerpolder Area

A case study area is chosen to test the findings from previous research. Amsterdam is a densely populated city of the Netherlands and is an ideal background to perform these tests. More into detail, abandoned spaces, which emerged during urban expansion, are the perfect focus of this thesis, as sufficient space should be guaranteed to the installation of renewable energy infrastructure in urban territory. At the same time, considering the need to transport the renewable energy produced, installation sites should have acceptable traffic conditions, and also be close to the electricity grid. Based upon these conditions, the Amsterdammerpolder, a part of the Port of Amsterdam, was chosen as the testing ground of current theories and knowledge, also providing a holistic input for the design process.

The Amsterdammerpolder is located in the western part of Amsterdam (Figure 4), close to the A10 highway ring. It was constructed around 150 years ago to serve as agricultural land. With the passage of time, several business parks have been built in this area, which gradually transformed it into industrial land. Nowadays, several vital industries are located in this area. One of these industries deals with tanks storage; its hundreds of huge tanks, containing gasoil and other fossil fuels for cargo ships, occupy almost half of the land. The Central Hemweg coal-fired energy plant is also located here, although most of its activities have been closed at the end of 2019 to reduce CO2 emissions(Vattenfall Press Office, 2019).

Nowadays, the Port of Amsterdam has a great ambition to develop renewable energy in the whole harbour, including the Amsterdammerpolder area, which implies the installation of renewable energy infrastructure (Port of Amsterdam, 2017).

Furthermore, on the eastern side of the case study area, the city council of Amsterdam has planned to develop a new urban region, called Port City, where around 70,000 family units are expected to live and work. This implies that there will be a growing demand for energy and public spaces in the future (Port of Amsterdam, 2017).

Figure 4: Site location Ammsterdammerpolder area

1.6 Research question

Main Research Question

What is the potential of renewable energy infrastructure to be multifunctional during the transition towards sustainable energy in the Amsterdammerpolder area?

Sub research question

I. What kind of functions should the Amsterdammerpolder area have during the transition towards sustainable energy?

II. Which types of landscape in the Amsterdammerpolder area are suitable for the renewable energy infrastructure, and how?

1) Which are these landscape types?
2) How can renewable energy infrastructure be implemented in these l landscape types?

Design Question

How can this transition be realized incorporating the recycling of the previous post-industrial landscape of OBA coal field?

1.7 Research relevance

This thesis can be a starting point for further discussion about the installation of renewable energy infrastructure in urban territory. It can provide landscape architects and spatial designers in general with a new way to think about energy landscape. Furthermore, it can also suggest an alternative way to regenerate abandoned land through energy landscape in urban territory.

2

THEORETICAL FRAMEWORK

In order to unfold the potential for renewable energy infrastructure during the transition towards sustainable energy, a basic knowledge of the topics related to renewable energy and sustainable energy landscape must be gained. Meanwhile, the concept of landscape infrastructure is also explored as the major focus of this thesis is about renewable energy infrastructure. Much of the previous research on the concept of landscape infrastructure can help to identify the contribution which infrastructure can do to the city and the landscape(Kathy, 2004). Basing on this concept, the design for renewable energy infrastructure will, therefore, provide more functions rather than only producing energy.

2.1 Energy transition and sustainable energy landscape

Nowadays, a transition to sustainable energy is pushed by Climate change (Stremke et al., 2012). One study by Hepbasli described the definition of sustainable energy - "cost-efficient, reliable, and environmentally friendly energy systems that effectively utilize local resources and networks" (Hepbasli, 2008, p. 598). Meanwhile, in order to fulfil the sustainable energy transition, one assignment is to replace fossil fuels with renewable energy (Lysen, 1996). However, the installation of renewable energy occupies space and contributes to changes in the landscape environment (Pasqualetti & Stremke, 2018). This view is supported by Sijmons, who refers that energy provision influences the landscape (Sijmons, 2014) and for renewable energy as well. Renewable energy infrastructure may contribute to a disruption to the landscape, which is unsustainable (de Waal & Stremke, 2014). On the other hand, the installation of renewable energy infrastructure ought to contribute to sustainability during the transition towards sustainable energy.

A series of studies have explored the definition of sustainability, and the definition from the American Society of Landscape Architects (ASLA) is the most commonly used in landscape architecture, "Sustainable landscapes are responsive to the environment, regenerative, and can actively contribute to the development of healthy communities. Sustainable landscapes sequester carbon, clean the air and water, increase energy efficiency, restore habitats, and create value through significant economic, social and, environmental benefits."(Haiman, 2017," WHAT IS SUSTAINABLE LANDSCAPE DESIGN?", para 2)

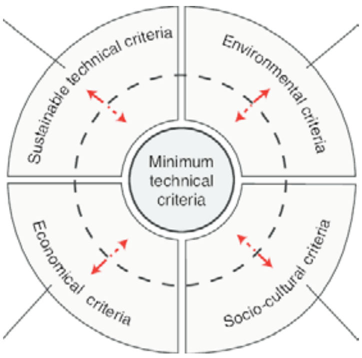


Figure 5: Illustration of the conceptual framework for sustainable energy landscapes, from Stremke(2015)

Furthermore, one comprehensive conceptual framework for the *sustainable energy landscape* is conducted by Stremke(Figure 5), consisting of four dimensions: "sustainable technical, environmental, sociocultural, and economical criteria" (Stremke, 2015, P6). Additionally, some minimum technical criteria which are always needed and therefore are located in the centre of the circle diagram(Stremke, 2015). Most of the components of this framework are quite similar to the definition of sustainability from the ASLA, economic, social and environmental criteria. Some additional criteria are more specific for the sustainable energy landscape.

At the same time, the transition towards sustainable energy will change the landscape. As Pasqualetti refers that, the renewable energy infrastructure, like wind turbines, solar panels, and geothermal energy facilities, all have significant impacts on the landscape environment because of their typical features. One of the assignments to accomplish the sustainable transition is to understand the public response to the changes which renewable energy infrastructures pose to the landscape (Pasqualetti & Stremke, 2018). Selman mentions that if people understand the importance of sustainable development, they will become more acceptable for the need of these landscape changes, 'the hard but intelligent choice' (Selman, 2010).

2.2 The concept of Landscape infrastructure

2.2.1 definition of landscape infrastructure

Infrastructure is usually defined as "the basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons"(Hung, 2013, p16). Considering its scale and omnipresence, infrastructure has been a crucial element of the urban landscape(Strang, 1996). On the other hand, the traditional engineer infrastructures constructed with 'singular objective' often lead to the interruption of landscape and the decrease of cultural and natural values (Figure 6). Nowadays, there is an increasing trend in the numbers of people who are aware of the necessity to find more harmonious solutions to tackle with infrastructures in the region of landscape architecture (Nijhuis, 2015).

Figure 6: A channelized waterway isolated from the rest of the urban context by chain link fences, from Hung(2013, p16)

Before innovative solutions, it is crucial to understand the characteristics of the current traditional infrastructural system. There are several defining features for the conventional infrastructural system. Firstly, being shielded from people's view, the design of the infrastructural system is usually constructed to be isolated, detached from the overall urban territory. Meanwhile, people typically think that the coordination of the infrastructure and its surrounding context result in collision and incompatibility. Secondly, in order to maximize the efficiency of the infrastructure, high focus is placed on one single purpose for one given time, failing to provide a consistent level of efficiency with time goes on (Hung, 2013) A case in point was the Carrizo Solar Power Plant in California, exploited as the solar power industry from 1982 to 1994, and used to be one of the largest photovoltaic arrays in the world. Failing to compete with the fossil-fuel-based energy industry because the price of the oil did not increase as prophecy, the factory demolished this 177-acre power plant in the 1990s(CLUI, 1999). In summary, operating in the background, the public knows the existence of these infrastructures, but people prefer to forget about them.

On the other hand, the landscape is defined as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (Council of Europe, 2000, p2). A series of recent studies have indicated that: "once married with landscape architecture, infrastructure can be more meaningfully integrated into territories, reducing marginalization and segregation and stimulating new forms of interaction. It can truly become landscape" (Shannon & Smets, 2010, p9).

However, as Hung mentioned, before the synthesis of the infrastructure system into the landscape framework, the old system needed to be redefined within a new series of paradigms. Firstly, the infrastructure today needs to be more successional, adaptive and flexible to the changing world. Secondly, instead of being conceived as the traditional infrastructure system, a centralized and monofunctional one, the new system ought to be designed more decentralized and multifunctional. It is also expected to provide habitat and open-space entertainment (Hung, 2013).

2.2.2 Attributes of landscape infrastructure

"In order to be decentralized, multifunctional, and successive, there are few attributes landscape infrastructure need to compromise about its form, function and time during the design phase"(Hung, 2013, p17). A landscape infrastructure project probably contains the attributes listed below (Hung, 2013).

I. Performance

"As a nonisolated system, landscape infrastructure has the ability to adhere to a set of requirements and achieve measurable results"(Hung, 2013, p17).
Instead of undervaluing the profits of landscape, the adoption towards the infrastructure system can perform as part of the urban ecosystem and achieve more value. For example, the ecology corridor can grow and develop under the vacant space under the solar panels (Hung, 2013).

II.Aggregate

"Landscape infrastructure is often seen as piecemeal objects. When consolidated, the collective whole has the ability to remediate and sometimes even reverse negative impact" (Hung, 2013, p18).

The new landscape infrastructure system can help to remediate and revitalize the terrain-zone area in the urban territory. One case in point is the method called Phyto which can both produce energy and absorb the toxicity from the contaminated soil (Hung, 2013).

III. Network

"Infrastructure is a connective tissue that brings together disparate elements, instilling cohesion and purpose. The sheer scale and vast resources spent on network infrastructure present tremendous opportunities to leverage unrealized potential in the urban environment" (Hung, 2013, p18).

One incredibly crucial role of the landscape infrastructure is to structure and to organize. For example, the road infrastructure can bring the scattered block together (Hung, 2013).

IV. Increment

"The incremental nature of infrastructural projects bears directly on a city's ability to sustain growth through a measured period of time" (Hung, 2013, p18).
Being put into full operation over several decades, most of the infrastructure projects can be realized to grow with the development of the surrounding region and even bring benefits to the local area from various perspectives (Hung, 2013).

2.2.3 Dealing with landscape infrastructure and precedents

In order to realize these attributes for landscape infrastructure projects, one framework is conducted by Kathy Poole. Kathy Poole developed a 'six-and-a-half-degrees' design method framework, one non-hierarchical, descriptive manner, in what to produce design strategies through which landscape designers can design 'infrastructurally' and meet the attributes of the landscape infrastructure project mentioned above. There are five design methods which are relevant for renewable energy infrastructure

The first three 'degrees' methods attempt to focus on the role of which the landscape can take within the municipal utilities, the infrastructure system (Kathy, 2004).

The first degree is to beautifully coexist with the municipal infrastructure. In this degree, the dominant matter is to provide function service, for renewable energy to produce energy. Basing on this premise, what landscape designers can do is to add content to these infrastructure projects and make them more beautiful and sometimes accessible for the public. One case in point is the Parc de La Trintat in Barcelona (Figure 7,8) which increases the accessibility to the infrastructure for the people. The designers conduct a dialogue between the infrastructure and the landscape which make part of the system can serve as a park for the public (Kathy, 2004).

The second degree is to integrate aesthetics and utility. Different from the first degree, the content of utility and landscape are so integrated that you cannot separate them. A new 'vocabulary' is developed through the use of engineer materials, the plants and so on. The Portland Water Pollution Control Laboratory (Figure 9) designed by Murase Associates, constructed a model integrating both infrastructure functions and landscape expression. These facilities look like the 'sculpture' in a landscape field. The cleaning engineer network is hidden under or even become part of the stones along the creek and the grasses, which can help to settle down the sands, the polluted parcels (Kathy, 2004).

Figure 7: Parc de La Trintat pool, from Ajuntament de Barcelona(2020)

Figure 8: Parc de La Trintat pool, from Ajuntament de Barcelona(2020)

The third degree is to employ the appearance of the infrastructure. Unlike the degree one and two, the main focus of this method is to try to employ the form and materials from the infrastructure to show the industry aesthetic rather than to satisfy any real engineering function. These projects usually try to regenerate abandoned infrastructure and help people understand how previous infrastructure functions for the city. For example, the Bamboo Garden at Parc de la Villette (Figure 10), employs the old pipe network as its fundamental element. New planting and paving design are introduced to the site to regenerate this abandoned space. The design keeps the 'overlapping' characteristic of the original pipe infrastructure space and allows people to visit (Kathy, 2004).

The next two degrees are about how the infrastructure can do as one member of the landscape system. The first one is to recover history memories. The history of the site, like some historical traces, can help to structure the form, the organization of the infrastructure system. For example, being a crucial element of Dutch landscape history, the old polder line being diminished with the development of the city can form the spatial arrangement for wind turbines. The last degree is to provide entertainment, ecology and some other functions. The operation of infrastructure should not be limited to mere engineering utilities, and they have the potential to solve other urban problems, to push urban development and to make the urban dynamic (Kathy, 2004).

Figure 9: Portland water pollution control lab, from Mayer-Reed(n. d.)

Figure 10: Bamboo garden at Parc de la Villette, from Clausen (2009)

2.3 Uncertainty

The last theory is about designing with uncertainty. Our project is to focus on sustainable energy transition in the urban territory, which means that uncertainties need to be taken into account. The climate change, the economic development, the demographic increase, and the urban expansions will bring something may not expect at the starting point (Chris Gray, 2011). As Henri Lefebvre mentioned, during the development of the city, we will experience a 'blind field' which means we cannot expect what we will experience in this phase (Lefebvre, 2014). Michel Desvigne also refers that a rigid plan which will lead to definite false should be replaced by a controlled and managed vision which is adaptive to the changing environment (Tiberghien, Desvigne & Corner, 2009). For this reason, we need to develop design and design-methods which are capable of tackling these uncertainties. Preparation for the long-term future should be considered during our design for short and middle-term problems (Chris Gray, 2011).

2.4 Conclusion

During the transition towards sustainable energy, it is crucial to design and construct renewable energy infrastructure in a sustainable way. Meanwhile, the landscape infrastructure approach can help to fulfil this goal. Being decentralized, multifunctional, and successive, the renewable energy infrastructure can promote the sustainable energy transition.

Uncertainty is another focus during the sustainable transition. During the development of the urban region, designers always ought to pay attention to these unexpected influences. Renewable energy infrastructure can be designed through the landscape infrastructure approach to structure and guide both short-term and long-term development.

.

3

METHODOLOGY FRAMEWORK

Multiple methods were employed to answer the main research question of this thesis: What is the potential of renewable energy infrastructure to be multifunctional during the transition towards sustainable energy in the Amsterdammerpolder area? These methods were linked to corresponding research sub-questions at large, medium, and small scale, as explained in the following sub-sections.

3.1 large scale

The first research sub-question 'What kind of functions should the Amsterdammerpolder area have during the transition towards sustainable energy' focuses on the larger scale of the Amsterdam port area. Its aim is to analyze the transition process that can fit the programmed or desirable future. As stated by Michel Desvigne, only working with the project material itself can ensure the success of a transition (Tiberghien, Desvigne & Corner, 2009). Accordingly, the method of document analysis is employed to determine the project material, as well as the current visions for this area by different stakeholders, to assess the desirable future.

3.1.1 Document analysis

Document analysis is an important tool to understand the information available about a specific topic. Through the exploitation, analysis, and coding of documents, researchers can make the information more readable and adaptive to their projects (Bowen, 2009). Three main types of documents are usually analyzed. The first one is public records, i.e., the official and valid records of an organization's activities, such as for example a policy manual. The second type is personal documents; for example, an increasing number of researchers are making use of the information collected from people's posts in social networks such as Facebook, Twitter, and Instagram. The third type is physical evidence, which includes posters, flyers, and handbooks (O'Leary, 2017).

Usually, more than one resource from different sources is investigated to ascertain their validation and credibility (Bowen, 2009). Bowen argues that several arguments can support researchers in choosing this important social research method. Firstly, its efficiency and effectiveness can help researchers to analyze abundant and messy documents of various forms (Bowen, 2009). Furthermore, the method of document analysis encourages researchers to collect information from other researchers, thereby allowing time saving. Finally, after the coding, documents can be easier to read and review in the future (Bowen, 2009).

Bowen provides a framework to perform document analysis, which includes the preparation process and the ongoing process. Two key points must be remembered during the research process (Bowen, 2009). The first one is to be careful with the subjectivity of the author, which may bring biases to the research (Bowen, 2009). The second point is the latent content of the documents, i.e., the style, agenda, tone, or hiding opinions of the documents (O'Leary, 2017).

In this thesis, the documents related to three perspectives are analyzed: the Amsterdam port, the Vattenfall energy company, and the Council of Amsterdam. The Amsterdam port has a strong ambition to promote the transition towards sustainable energy. In parallel, the Vattenfall energy company also has plans for the future progress of the site of the Hemweg energy plant. The last source of documents is the Port City plan, issued by the council of Amsterdam. In the course of the centuries, the Amsterdam harbour gradually migrated from the city centre towards the western areas, where new urban development is now gradually taking place. The Port City plan will be implemented in the next three decades to promote the further regeneration of the abandoned harbour area, contributing to the sustainable transition of the site.

The large-scale analysis allows to appreciate the functions the site should take according to the desired future, or the expected vision of, and around, the site. This comprehensive understanding of the progress relates to different aspects, such as traffic, energy, ecology, and demography, building a comprehensive narrative of the potential of this gradually abandoned spot. This narrative is linked to the timeline, showing information from various sources at the same time, so as to make it clearer and more visible. Based on these project materials, the transition can be more adaptive to the future and to uncertainty.

3.2 Medium scale

The second research sub-question 'Which types of landscape in the Amsterdammerpolder area are suitable for the renewable energy infrastructure, and how' aims to identify the suitable spaces for the installation of renewable energy infrastructure, and how to facilitate this process. To this purpose, the synchronicity landscape approach developed by Kristen, Julian, and Chris is employed.

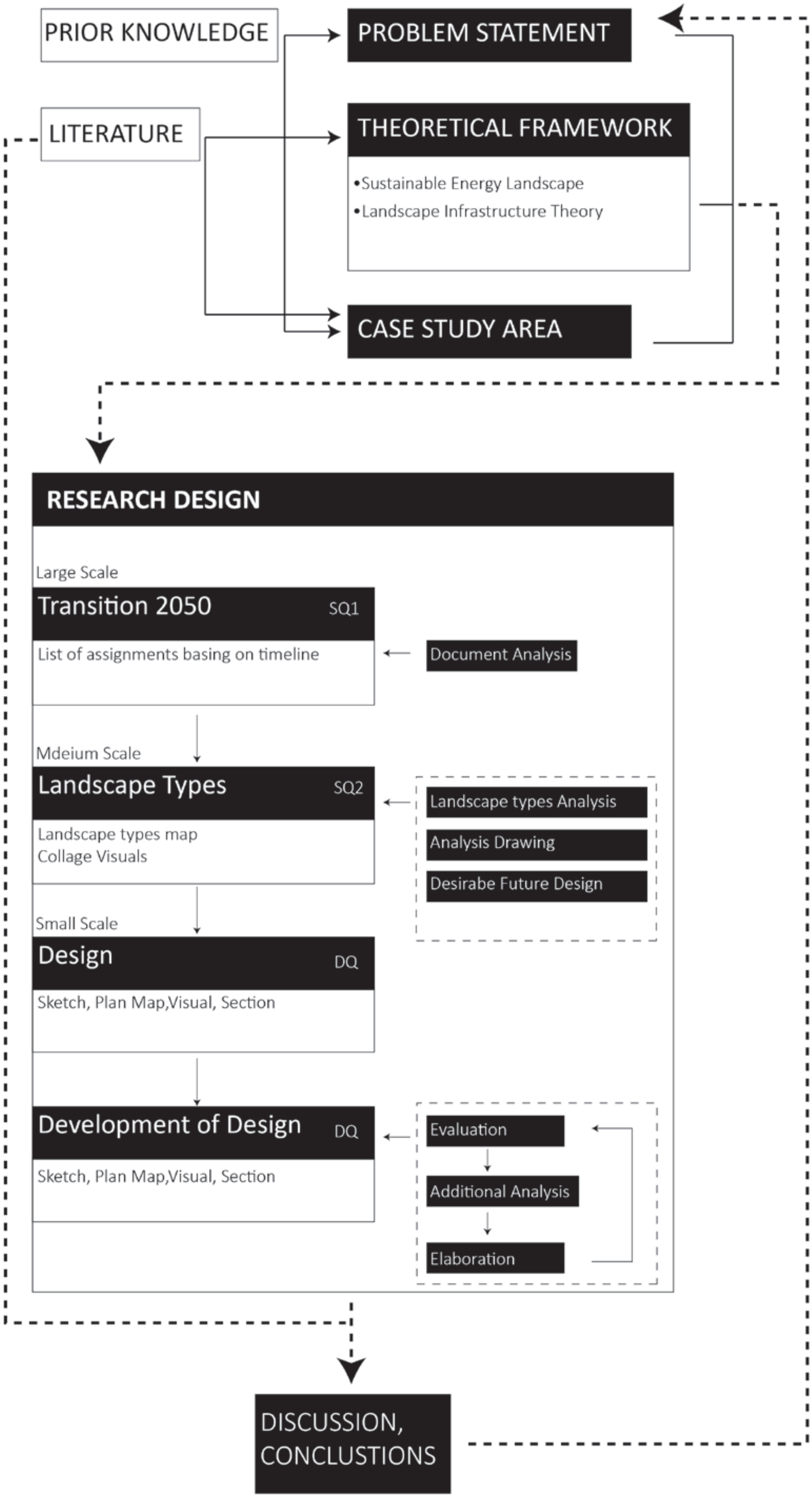
Following this approach, the second research sub-question is articulated into two parts. The first part (sub-question 2.1) is 'Which are these landscape types', while the second part (sub-question 2.2) is 'How can renewable energy infrastructure be implemented in these landscape types'.

Landscape types maps and analytical drawings are necessary to answer sub-question 2.1. In order to obtain this map, a normal or conventional analysis for landscape design, including history analysis, ecology analysis, energy analysis, soil analysis, and infrastructural analysis is conducted first. Then, these analytical layers are combined to produce the information required to measure the landscape qualities, i.e., "the sense of containment and openness" and "the textural and sensuous qualities" (Kristen et al., 2004, p310) of the site's existing materiality, which can produce the landscape types map and the related analytical drawings. To answer sub-question 2.2, based on the analytical drawings previously obtained and the results of the first research sub-question, a desirable future is visualized through collages and drawings for each landscape type.

3.3 Small scale

The design question focus on an even smaller scale, one landscape type. The results from the previous phase is used as a base for research through the design process in order to answer the design question 'How can this transition be realized incorporating the recycling of the previous post-industrial landscape of OBA coal field'. For this phase, one key concept is to fulfill the sustainable transition step by step. Other important ideas include the remediating of the soil, adding positive attributes to and taking advantage of the project materials. The last crucial point is to make use of the definition of sustainable energy landscape explained before to evaluate and elaborate on the design. After this design process, the results on this scale level can be used to answer the main research question.

Figure 10: Research Methdology



4

LARGE SCALE

In this chapter, the method document analysis is employed to know the function that the Amsterdammerpolder area should serve during the transition towards sustainable energy.
The document analyses can be split up into three sectors, one for Port of Amsterdam, one for Port-city, and the last for the Hemweg Vattenfall energy plant. All of them are highly related to the case study area. After all these three analysis sectors, the conclusion consisted of the assignments which the Amsterdammerpolder area should take during the transition towards sustainable energy is formulated in the last sector. These assignments are categorized according to the timeline.

4.1 Port of Amsterdam

The case study area is part of the Port of Amsterdam that is why it is crucial to figure out the assignments from the Port of Amsterdam.

4.1.1 Energy footprint and vision

Being one of Europe's largest energy-related harbours, coal and oil occupy 77% of storage and transport industrial activities in the port of Amsterdam. On the other hand, being a sustainable port has become more and more necessary in case of the Paris climate agreement (Port of Amsterdam, 2017). With this intention, Port of Amsterdam is seeking to expand and enrich their renewable energy sources. On the contrary, declines will be seen in coal-related industries over time, especially the use of coal to generate electricity (Port of Amsterdam, 2017).

Port of Amsterdam tries to promote sustainable growth and become one of the most sustainable ports in Europe by 2030. Rather than terminate the fossil-fuel industry totally, the plan of the port attempts to adjust the proportion of fossil fuel and non-fossil fuel. In other words, more and more efforts will be contributed to the development of renewable energy infrastructure and replace fossil-fuel related industry (Port of Amsterdam, 2017).

Port of Amsterdam wants to see remarkable progress in the production and storage of solar and wind power in the following years (Figure 11). 100.000 m^2 of solar panels and wind turbines which are capable of producing 100 MW are expected to be installed at the port (Port of Amsterdam, 2017). According to the port, fossil fuel energy is quite crucial for the operation that is why they don't want to close them. However, to reduce co2 emission, Port of Amsterdam reached the agreement with the municipality to stop all coal-related industries by 2030 to accelerate the sustainable transition, making room for new sustainable activities and innovations (Darby, 2020).

4.1.2 Environmental footprint

Located in the densely populated Metropolitan Area, being a sustainable port is far more about developing renewable energy. Firstly, the port seeks to control its noise space to reduce the noise effects for the surrounding area. Agreement

Figure 11: Energy transition, from Port of Amsterdam(2017, p6)

called 'Noise Allowance' has been conducted with the help from the municipality to reduce the noise nuisance for the possible place. Invests are applied to the innovation to decrease the noise level. At the same time, as the port is surrounded by Natura 2000 areas, such as the North Sea Coastal Zone and the Oostvaarderplassen, the port tries to help to protect these nature reserves (Figure 12). The coexisted method between industrial works and nature are constantly discovered. One case in that point is the construction of the new sea lock, serving to keep the environment for fish. Furthermore, More actions about reducing and reusing the waste is conducted with time going on for the sustainable vision (Port of Amsterdam, 2017).

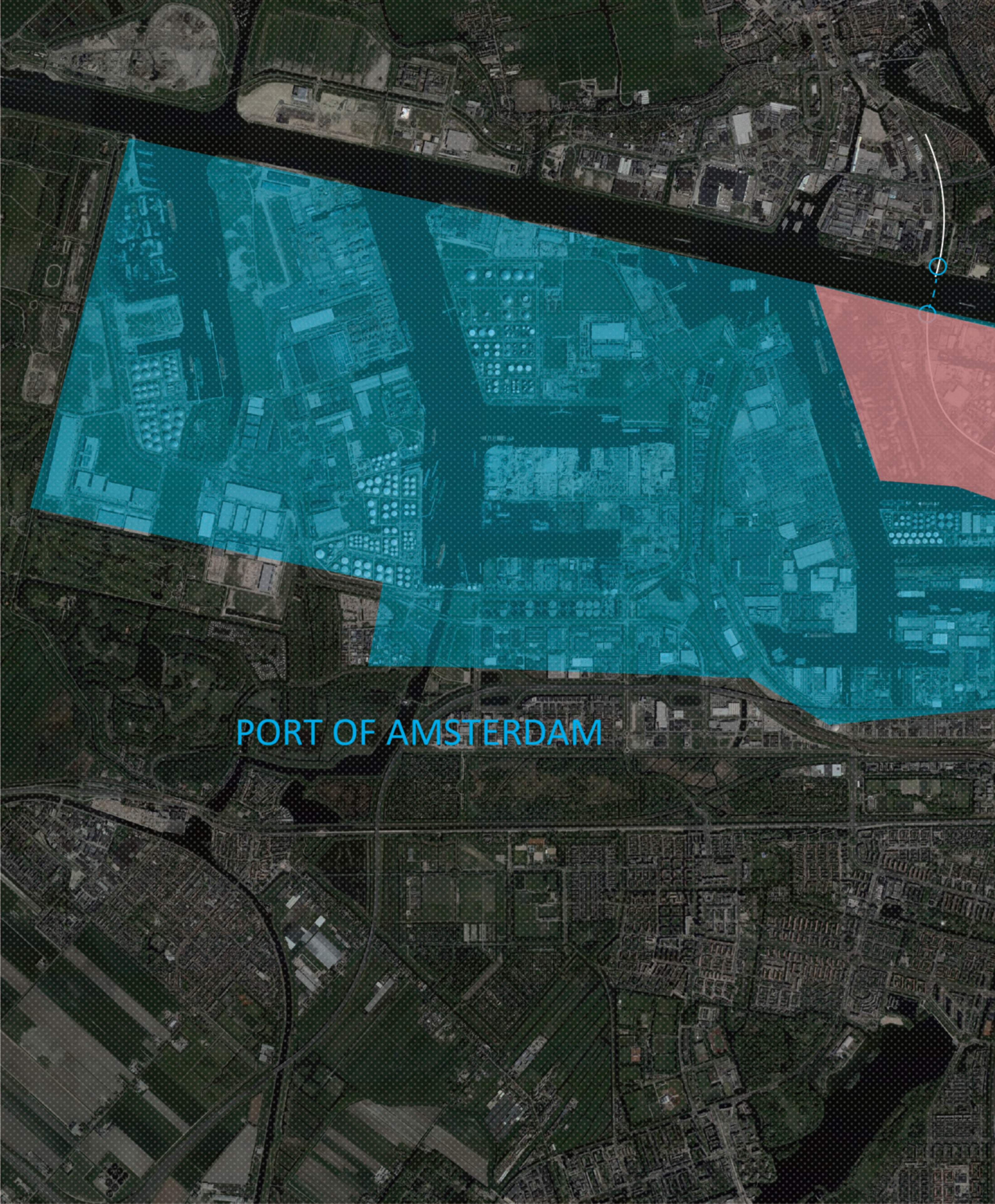
Figure 12: Environmental footprint, from Port of Amsterdam(2017, p16)

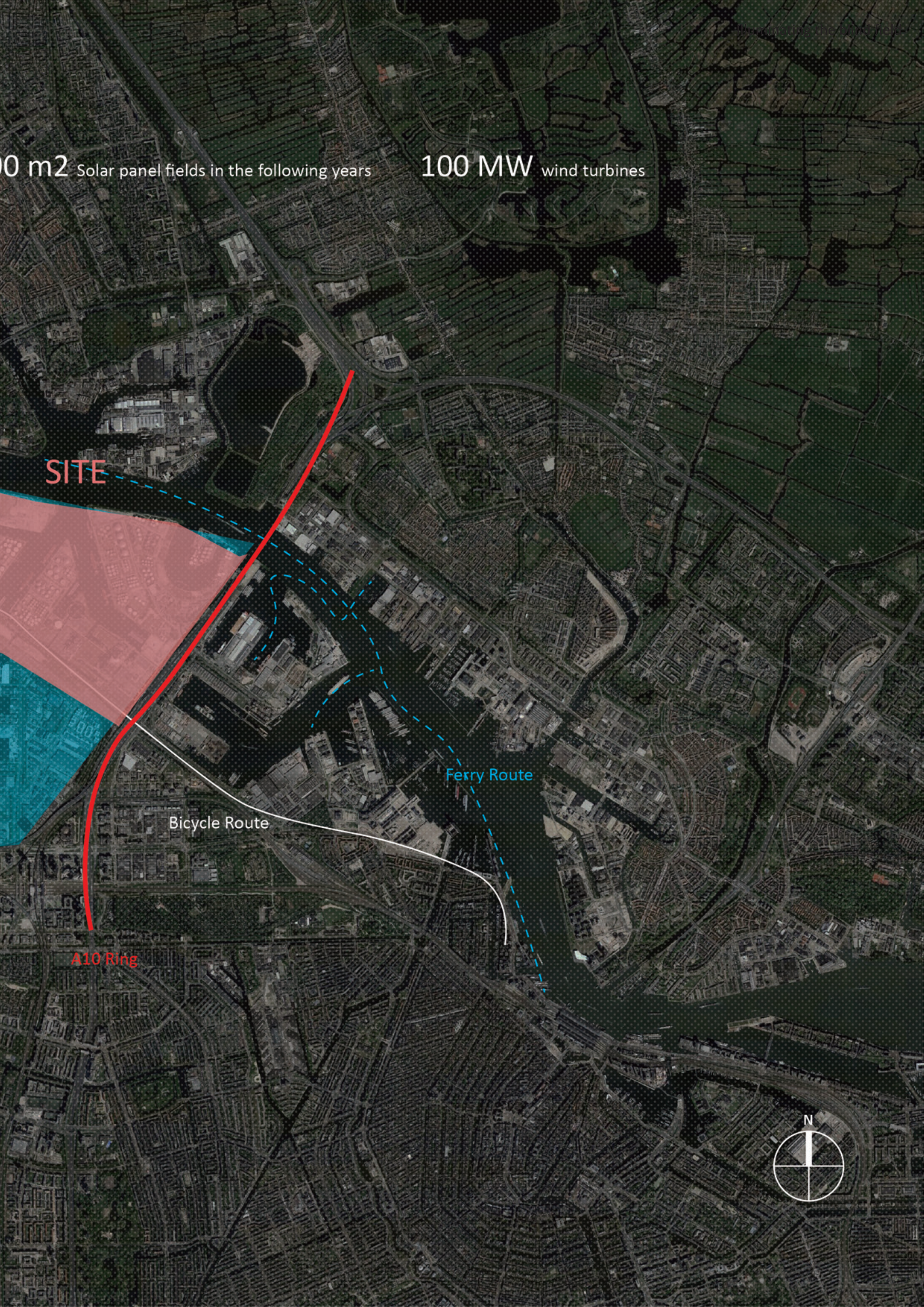
PORT OF AMSTERDAM

77% of storage and transport is for Coal and oil currently

0 for coal-related industry in 2030

100,00




00 m2 Solar panel fields in the following years
100 MW wind turbines
SITE
Ferry Route
Bicycle Route
A10 Ring
N

4.2 Port city

Dealing with the problems brought by urban expansion, one plan called port-city has been conducted by the municipality of Amsterdam. Being almost the same size as the city centre of Amsterdam, more than 150000 people are envisioned to live and work in this new region. At the same time, unlike the previous plan, this vision needs decades to finish and keeps adaptive to new changes and assignments during the period. Three time-spots are planned to separate all the tasks (2018,2029,2040). With the abandonment of the current harbour services, more living and working plans will be constructed (Gemeente Amsterdam, 2017).

The location of the port-city is just along the case study area, isolated by the A10 highway (Figure 13). The new inhabitants who will live and work in this region are expected to be the main visitors for the project in the case study area.

We can see a historically logical line behind the vision of Port city. During the history of Amsterdam harbour, its location which was first constructed in the city centre is gradually transferred to the west of the city, leaving vacant space for urban expansion. With time goes on, new living and working spaces are built on this series of 'abandoned' regions. Port city has the ambition to remodel one new, gradually 'abandoned' region and make it become an attractive area in the coming decades (Gemeente Amsterdam, 2017).

Figure 13: Location of Port city, from Gemeente Amsterdam(2017, p20)

4.2.1 Accessibility

In order to reach the ambition to be sustainable and attractive in the future, one human-friendly and future-oriented traffic system is envisioned in the port city. Firstly, walking and biking will be the main transport approaches inside this region. A well-connected bicycle and pedestrian road system will be formulated for the residents, workers, and visitors. Meanwhile, streets are expected to be more friendly for the public, for example, children can play on the road. Some play facilities can be installed along the road. Furthermore, for the sake of higher connection and usage for the bike system, three new ferry connections are proposed to be built in the future, enabling cyclists to travel between the northern and southern part of Port city more quickly and easily. At the same time, the attractiveness of the bicycle road will also be improved to make the residents prefer biking rather than driving (Gemeente Amsterdam, 2017).

In addition, it is also necessary to keep the port city well reached by other parts of Amsterdam, especially for the people who come to work here. Some new public transport hubs are scheduled to be built to guarantee accessibility. One case in this point is to have a metro or an equivalent High-Quality Public Transport (HOV) system for Port-City. Various options will be provided to the people in the coming years. Finally, limitations will be applied to the car traffic system; for example, parking options will be more minimized in the future (Gemeente Amsterdam, 2017).

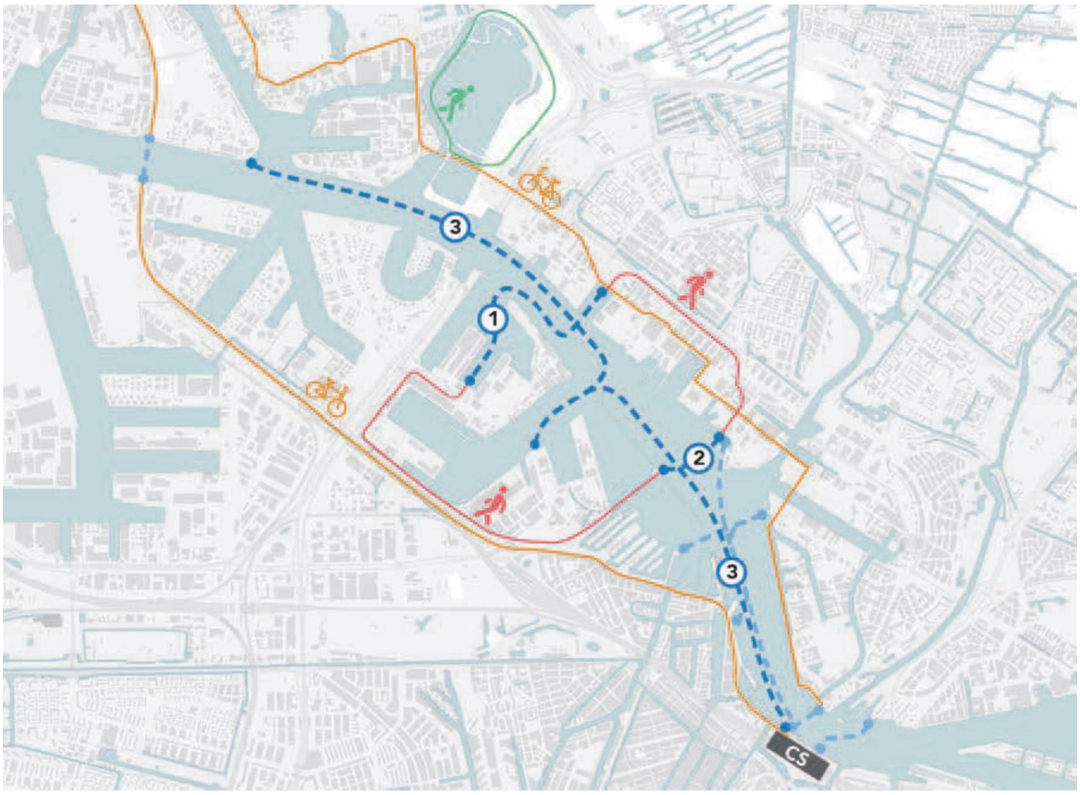


Figure 14 Overview map about Port-City that created by addition of new ferry connections and other routes, from Gemeente Amsterdam(2017, p50)

4.2.2 Sustainability

Reducing co2 emission is another challenge but also an opportunity for Port city to become more sustainable in the following decades (Gemeente Amsterdam, 2017). As the port city is expected to be a new highly-dense city region, not much space can be exploited for the production of renewable energy. In this case, using energy more efficiently will be the foremost choice, for example, making use of 'district heating' can balance between the cooling and heating supply system (Gemeente Amsterdam, 2017).

4.2.3 Greenspace

Developing a comprehensive green system is also crucial for being a sustainable region, suiting the needs and desires for its inhabitants (Figure 15). This system will consist of two large city parks, several neighbourhood parks, some green lots and some private gardens, thus creating enough relaxed space for people and a connected corridor for urban ecology. One large city park is Westerpark which has served for a series of outdoor activities and make the park very popular in Amsterdam. Another one is the Noorder-IJplas conquering large water spaces inside the park. Both of the parks function as the bond between the surrounding neighbourhood and plays an essential role in Port city (Gemeente Amsterdam, 2017).

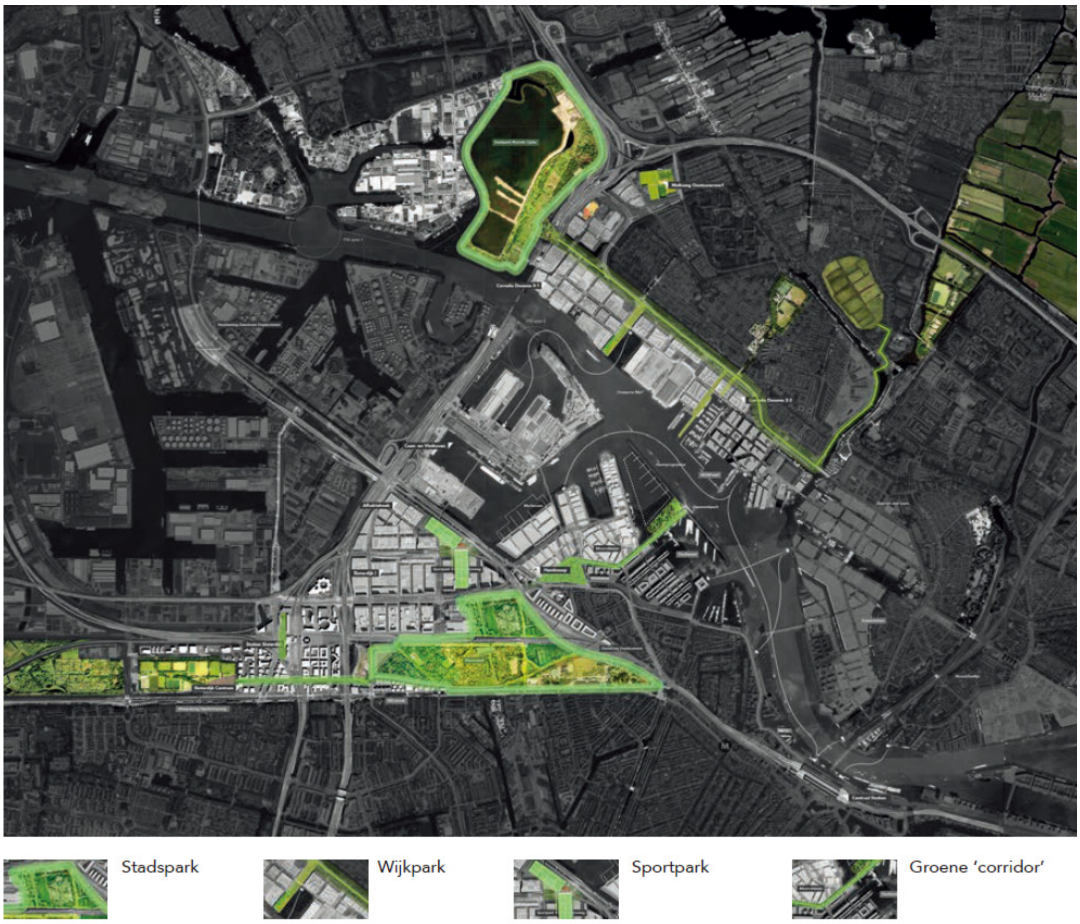


Figure 15: Overview map of green space in Port city, from from Gemeente Amsterdam(2017, p64)

Not as big as the two city parks, the neighbourhood park will provide green space for local residents in each sub-area. At the same time, as part of the continuation of the ecological corridor, these parks will evolve in a timely manner, being adaptive to the changing nature and human environment. Meanwhile, some green lots will occupy the interval space between larger green patterns and are available for the public. Finally, the public can have their own facade gardens, roof gardens or other options to make their building and house become more climate-adaptive, more sustainable and also have a green appearance (Gemeente Amsterdam, 2017).

4.2.4 Conclusion

Achieving the ambitions for Port city will take several decades. As stated in the Transformation Strategy 2013, the progress is phased according to the urban expansion and the economic requirement. For example, Port city tries to be 'careful' with housing development based on the needs of the market and land use. Before 2029, no new living neighbourhoods will be implemented except what has been started in Houthavens and the NDSM harbour. However, an average of 2000 homes will be built annually after that time. The image of the port city will be attractive and impressive; especially it is one of the large areas within Ring A10 which still have potential to develop for urban expansion, adaptive to new insights, wishes and ambitions during the ride continuously. As the municipal report depicted, they hope this new urban region can provide multifunctional space for residents, workers, and visitors where they can go to the gym, walk the dog, get a sandwich or drink a cup of coffee, and have fun in a green space with their children. All those facilities will be around the corner and serve the gradually-growed population (Gemeente Amsterdam, 2017).

PORT CITY PLAN

Figure 16: Phased plan, based on Gemeente Amsterdam(2017)

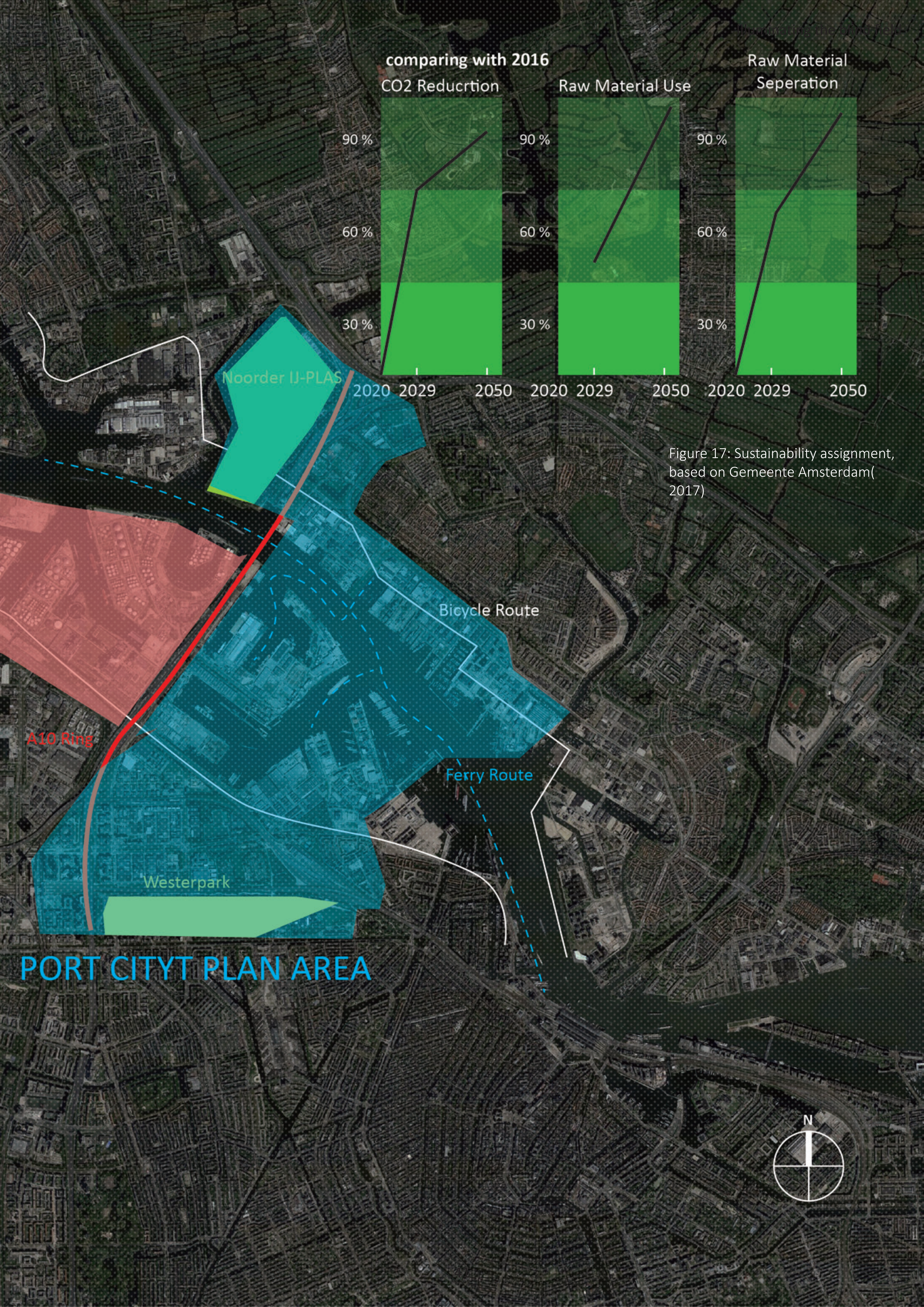


Figure 17: Sustainability assignment, based on Gemeente Amsterdam(2017)

HEMWEG VATTENFALL ENERGY PLAN

Fossil Free Eletricity

Fossil Free Heat

Energy Storag

4.3 Hemweg Vattenfall energy plant

Hemweg energy plant is a crucial element of the case study area. As the symbol of Amsterdam since the middle of the last century, the coal power plant of Hemweg has been closed since the end of 2019. In order to terminate the coal production in the Netherlands to reduce co2 emission, the legislation from the Dutch municipality promotes this closure.

Hemweg is owned by Vattenfall energy company and started for operation in 1959. For now, only Hemweg 9, a brand new gas-fired plant which was constructed in 2012, is still taken in operation and all coal power industries are closed after 67 years of production.

On the other hand, the closure of the coal power infrastructure provides the chance for the transition towards renewable energy. The Vattenfall-site on Hemweg is envisioned as a fossil-free hub for electricity and heat in the future. From production, as well as transit and temporary storage of renewable energy, the new Hemweg will serve as a crucial role in the energy-consumed system in the future, especially the rapid urban development in the surrounding region-the port city. At the same time, the production of alternative fuels such as green hydrogen and synthetic kerosene will also be developed here for the port of Amsterdam and the Amsterdam metropolitan region (Vattenfall Press Office, 2019).

4.4 Conclusion

The peripheral environment inevitably influences the sustainable energy transition in the Amsterdammpolder area. The energy agendas from the Port of Amsterdam, the Port-city, and the Hemweg Vattenfall, together with other strategies like green development, ecology promotion, city structure bring a series of assignments to the Amsterdammerpolder area. Several time slots are picked based on the analysis to fulfil the sustainable energy transition. Understanding the assignments also helps to make the future for the Amsterdampolder area more adaptive to the dynamic urban environment. As Michel Desivigne described, a controlled and managed vision can produce an adaptive design which embraces the changing environment, providing a more active, flexible transition (Tiberghien, Desvigne & Corner, 2009).

Amsterdammerpolder Area

	2020-2029	2030-2040
Energy Function	• Solar panel 100000m ˆ2 to the end of 2021 • CO2 reduction, 5%, compared to 2016	• Generation and storage cap MW in the port area • Coal free in port area 2030 • CO2 reduction, 20%, compa • Raw materials: 50% re-use
Other Function		
Performance	• Green/ecological corridor for connection	• Intact green/ecological cor • Incrased green spaces need • Green quay distinctive from
Network		• Create fine foot and bicycle • Improve foot and bicycle ne • Unbundle and optimize the emission-free zone • Parking hubs in the vicinity
Increment	• Regeneration of the existing industrial land	• Regeneration of the existin

2041-2050

pacity of renewable energy to 100

ared to 2016
in public spaces and buildings

ridor for connection
ds for new local residents
n the industrial ones

e networks
etworks for ferry
e current car network and build

of the A10 ring road

g industrial land

SITE
Ferry Route
Bicycle Ro

- 35 hectares of lands are reserved for offshore renewable energy
- CO2 reduction, 85 to 100%, compared to 2016
- Raw materials: 100% re-use in public spaces and buildings

- New neighbourhood park for local residents
- Green quay distinctive from the industrial ones

5

MEDIUM SCALE

In this chapter, the results of the landscape types analysis and the desirable future for these types are described. Both of these analyses are based on the medium scale level.

5.1 Conventional analysis

5.1.1 History analysis

The time-line mapping aims to summarize and give an overview of how the site was unfolded in the past. Moreover, it also helps to stretch the desirable vision.

While researching the history of the site, I focus mainly on the transition of the infrastructural system of the site, but also on the relationship between the people and this territory.

I. Amsterdammerpolder

Dating back to around 200 years before, the site used to be part of the IJ river and a small island called De Horn is located at the south-west corner. The trace of the island could be identified before the 1950s when a business park was built and then the island was excavated (Wikipedia b, 2020).

However, with the construction of the IJ polder, the water was drained and the IJ polder claimed this location and surrounding areas. This work began in 1865 and the polder was completed seven years later in 1872, occupying 5500 hectares. Being part of IJ polder, the polder located at the site is called Amsterdammerpolder.

At the beginning point, the IJ polder functioned as agricultural lands and was sold at an auction between 1873 and 1879. Nonetheless, only a small part is still severed for agriculture currently. Most parts of the IJ polder were redeveloped for business parks later, the same for the Amsterdammerpolder. Amsterdammerpolder almost disappeared entirely since the 1950s, some parts perform as the harbour area, while some become recreational areas, like the Spaarnwoude (Wikipedia b, 2020).

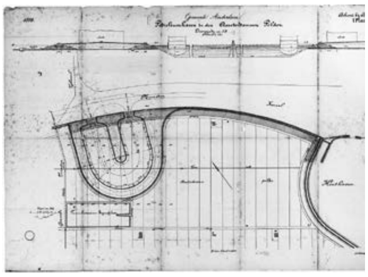


Figure 18: Design plan for Petroleumhaven, from Bakker(2011, p4)

II. Petroleumhaven

Then in 1883, shortly after the completion of the North Sea Canal, one port called Petroleumhaven, was first dug in the Amsterdammerpolder. The means of ship transportation and storage developed quite fast at that time. Pettroleumhaven, occupying around 14 hectares (Figure 18), was designed as a port which had the capacity for 19 ships berthing at the same time. The construction did not go smoothly at the first stages. However, with the promotion from the city council to define this port for uploading, transferring, and storing oil products for every supplier or buyer, the first oil tanker arrived in 1889 (Figure 19), and a volume of 21000 barrels was uploaded (Figure 20).

A new railway bridge was also constructed in 1907, for transportation with the development of the port, becoming the largest swing bridge of Europe at that time. Then because of the General Expansion Plan(AUP) of 1934, Petroleumhaven and the surrounding area have been formulated as a new big port region which is called Westhaven (Wikipedia, 2020).

III. Central Hemweg

In 1948, the coal-fired Central Hemweg was commissioned by GEB Amsterdam to build to replace the Central Noord plants. Then in 1952, the first part of the plant

Figure 19: Photo pictured when first boat arrive, from Bakker(2011, p7)

Figure 20: Transpiration picture of Petroleumhaven, from Bakker(2011, p9)

was put into operation and was officially opened by alderman Franke on the 3rd of October, 1953. One row of eight chimneys which almost reached 80 meters became places of interest of that time in Amsterdam before the demolishment of them in 1980 (Figure 21). Then more units, Unit 5 and 6, were added with the development of the plants and these two new units together called 'Hemweg II' in the 1960s. In the following 20 years, the gas-fired unit 7 and coal-fired unit 8, which used to be one of the most modern coal-fired power stations in Europe at that time came into operation. In 2012, unit 7 was replaced by Unit 9, a new gas-fired plant, to produce the power more efficiently with the growing heat demand from Amsterdam. Meanwhile, in order to accomplish the assignment from the Paris Climate Agenda, Unit 8 was decommissioned on the 23rd of December in 2019, which leads to an end to these coal-fired electricity plants after 67 years. Only a small part of the plant, the unit 9 will still be in operation in the following years (Wikipedia a, 2020).

Through the overview of the timeline (Figure 22), we can see the close relationship between energy production and the site. The map(Figure 23) below shows the places of historical value and some historical traces inside the site. These points and lines can provide the base for the design for the transition towards sustainable energy to continue this relationship(Wikipedia a, 2020).

Figure 22: History timeline for the site

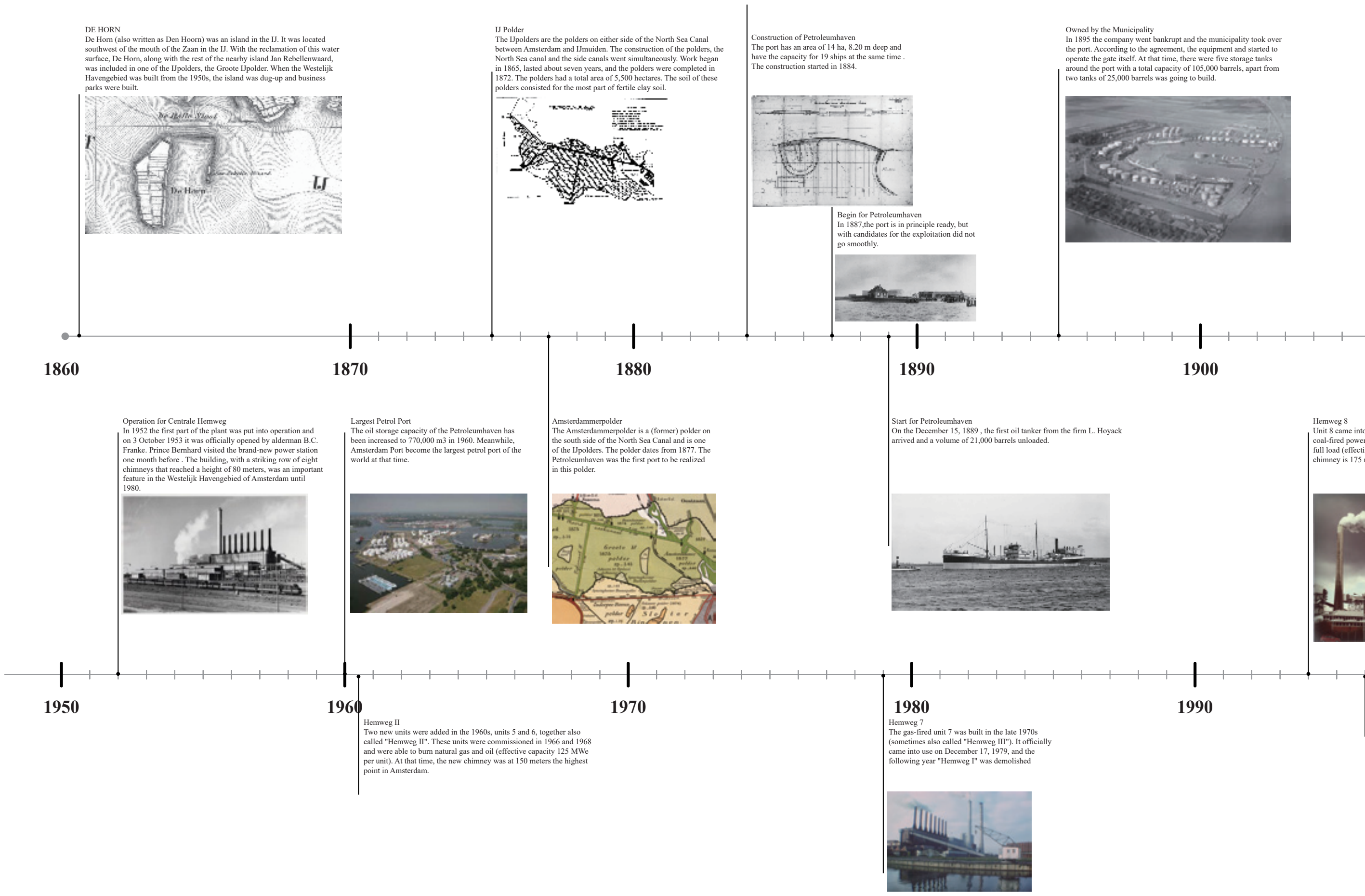


Figure 21: Photo of Central Hemweg in 1980, from Wikipedia a(2020)

Largest Swing Bridge
Across the North Sea Canal, west of Petroleumhaven, the State Railroad K was built. A bridge was built first for wagon, the Hembrug, before itbecame a railway. However, this bridge soon became an obstacle for shipping to Amsterdam. A new railway bridge was built to replace and the old onw was demolished in 1910. The new bridge was the largest swing bridge of Europe, at that time.

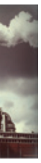
Record of Restoration
In 1913 that was over 1.8 million barrels with a record of NLG 22,500.

Expansion for Petroleumhaven in AUP
In the General Expansion Plan (AUP) of 1934, a new port was planned, which later would be called Westhaven. In 1937, Petroleumhaven became the first part of the Westhaven. This part was first called Fordhaven and was used by the Ford factory since 1926. Officially, it became Westhaven only after the extension of the port to the Basisweg in 1961. The length of the port then extended to around three kilometers.

Construction of Centrale Hemweg
The construction of coal-fired Centrale Hemweg, which tried to replace Central Noord, began in 1948. The building was commissioned by GEB Amsterdam for the Public Works Department of the municipality of Amsterdam. Initially, four units were provided, with the possibility of expansion to eight. The effective power was 52.8 MWe per unit.

1910 1920 1930 1940 1950

operation in 1994 and was then one of the most modern
stations in Europe. The central-fired powdered coal, at
ve capacity 630 MWe) more than 60 kg per second. The
meters high.



Hemweg II
Units 5 and 6 were demolished after 30 years in 1996.

Hemweg 9
In April 2010, Nuon decided to replace the Hemweg 7 unit with a new gas-fired STEG plant. The new plant, Hemweg 9, has a return of around 59%. This so-called singleshaft unit supplies approximately 435 MWe. Hemweg 9 is also suitable for supplying heat. Energy efficiency can be further increased by the production of heat. The new plant became operational in mid-2012.

Close of Hemweg 7
The Hemweg 7 unit was closed on January 1, 2013 after 34 years of service. The plant was almost completely demolished, only the building in which the gas turbine was located remained standing, to be demolished in due course.

In 2015, the last part of Hemweg 7 was demolished.

First Announce for the Close of Hemweg 8
On May 18, 2018, the Cabinet decided to close the coal units of the Hemweg power plant and the Amer power plant in Geertruidenberg before 2025, unless they would have switched completely to other fuels.

Close of Hemweg 8
On March 8, 2019, it was announced that the coal unit of the Hemweg power plant will be closed by the end of 2019.
The last coal was fired on 21 December 2019, after which Hemweg 8 was decommissioned on 23 December 2019. This puts an end to coal-fired electricity production on Nieuwe Hemweg after 67 years.

2000 2010 2020

Figure 23: History analysis map


dge)
Petroleumhaven
Central Hemweg

5.1.2 Energy analysis

I. Current energy infrastructure

Being more sustainable is on the list of the City council of Amsterdam. For example, ensuring gas-free in 2050 has been promoted with great efforts. By 2025, a 45% reduction compared to 1990 level is expected to be achieved for co2 emissions in Amsterdam. Then in 2050, Amsterdam has the ambition to cut out 95% co2 emissions and become a natural gas-free city by 2040. There are two main routes which can help to accomplish this assignment, and one is to save energy as much as possible; another is to generate renewable energy.

Generating renewable energy is quite crucial for the reduction of co2 emissions. The following map shows the current renewable energy infrastructure system in Amsterdam, including wind turbine generation, thermal energy network, and the installed solar panel situation. Few groups of wind turbines have been installed in the Port of Amsterdam area. Meanwhile, Solar panels are mostly employed in the suburban region of the city (Gemeente Amsterdam, 2012).

As mentioned in the last chapter, Port of Amsterdam also seeks the development of renewable energy. For now, as shown in the map, eight wind turbines have been constructed in one line across the site. Meanwhile, several groups of solar panels (Figure 24,25)are installed inside the Hemweg energy plant (Wind Power, 2020).

II. Potential renewable energy

In the following several decades, vast progress is envisioned in the Westpoort area for the plan of renewable energy. Being one of the largest coal and petrol transhipment ports in Europe, Westpoort is experiencing the transition towards a sustainable port. Huge potential can be seen in this region, especially for wind turbines and solar panels. For example, as the map shows, wind turbines can be installed in the whole region of Port of Amsterdam. Meanwhile, being different from the city centre of Amsterdam, the rooftops of the industrial buildings and abandoned plots can provide massive space for solar cells.

The total area of the site is approximately 378 hectares, and the potential for solar energy is around 1.3 PJ per year. Furthermore, the current line of wind turbines located on the site is around 65 meters high, with a diameter of 47 meters. Considering the minimum distance for installation of wind turbines, there is enough room for new wind turbines to be constructed.

The energy map below shows both the current situation and potential for energy (Figure 26).

Figure 24: Solar panel field inside Hemweg energy plant

Figure 25: Solar panel field inside Hemweg energy plant

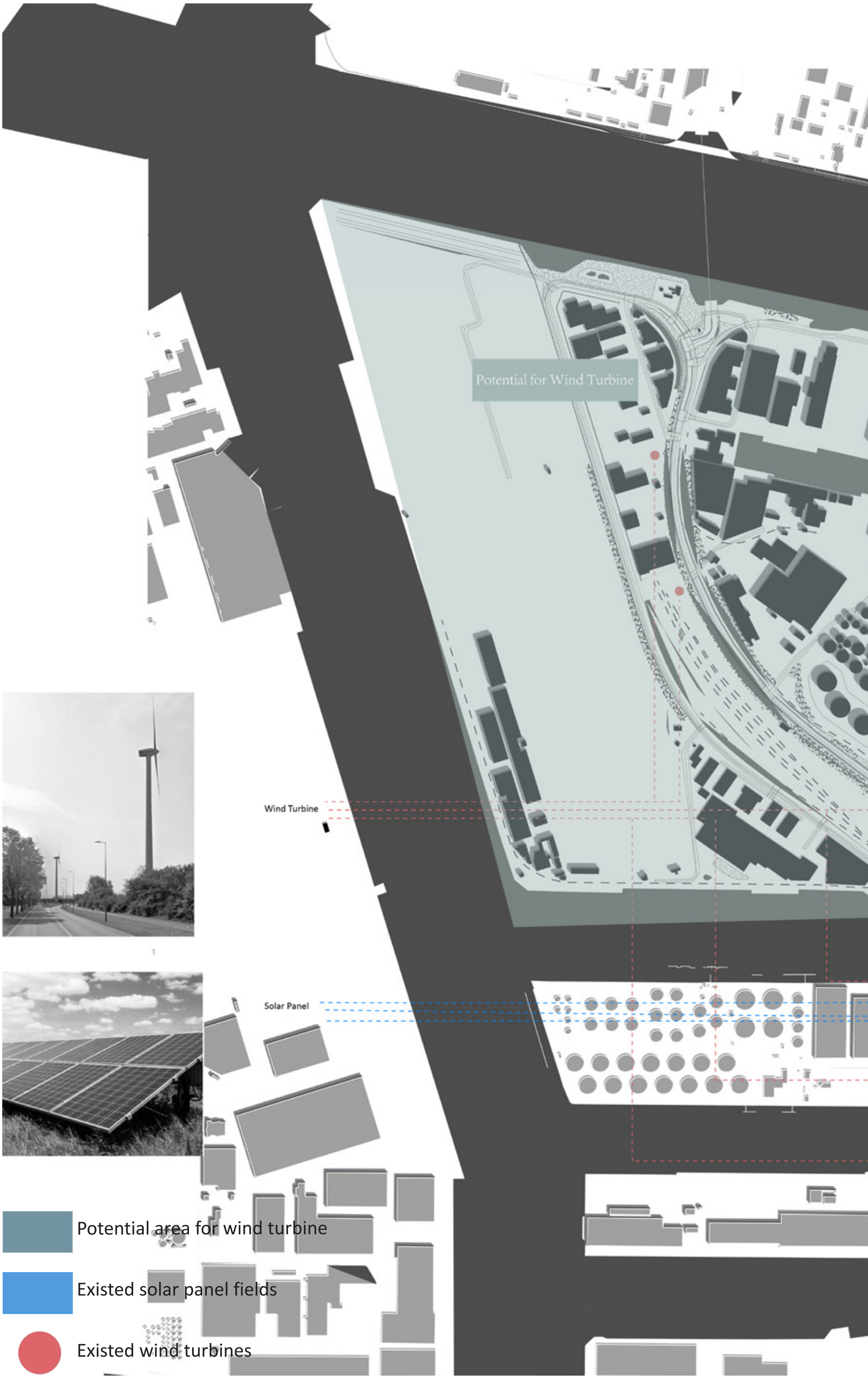


Figure 26: Energy analysis map

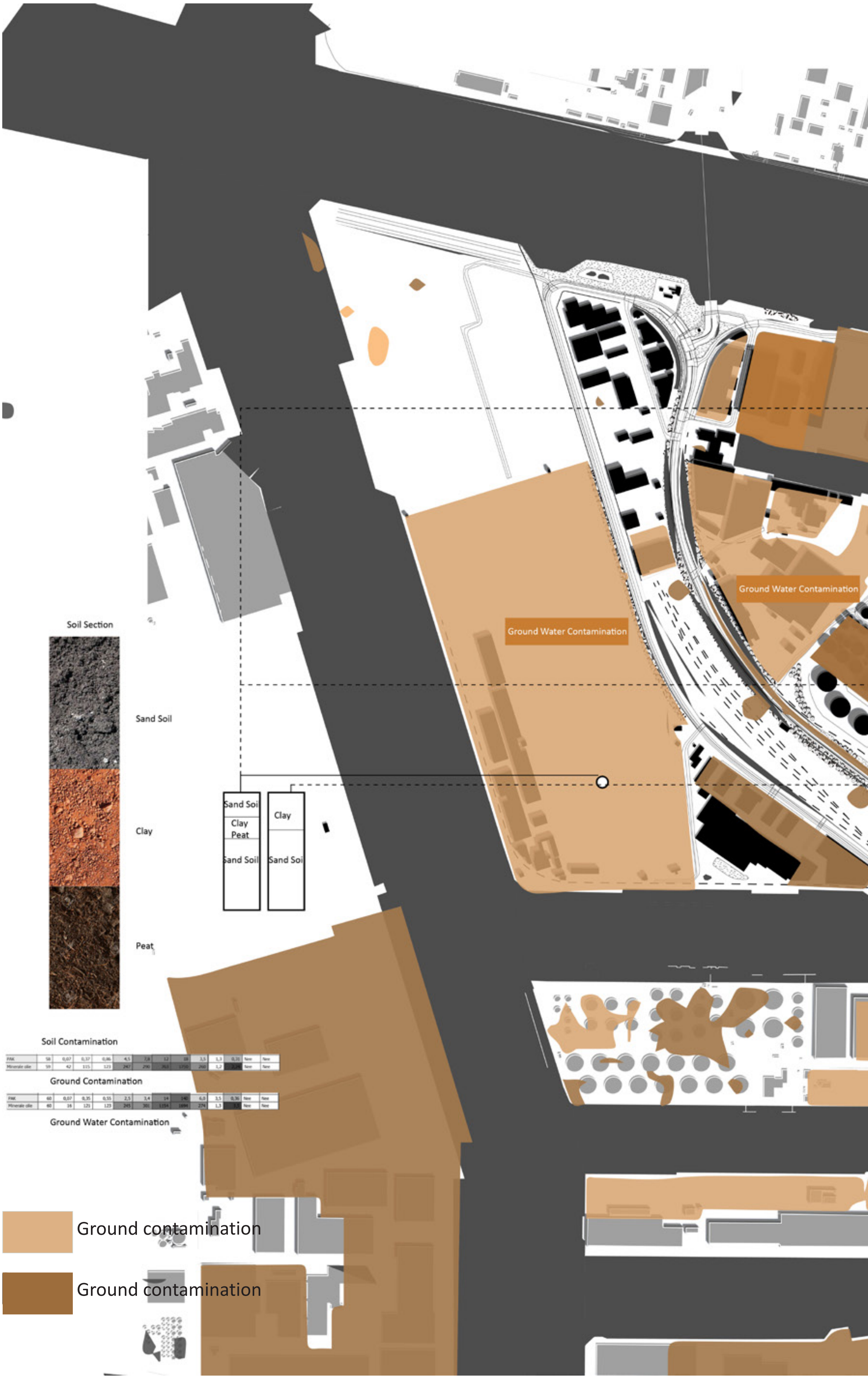


Figure 27: Soil analysis map


Ground Contamination
Ground Contamination
Ground Water Contamination
Ground Contamination

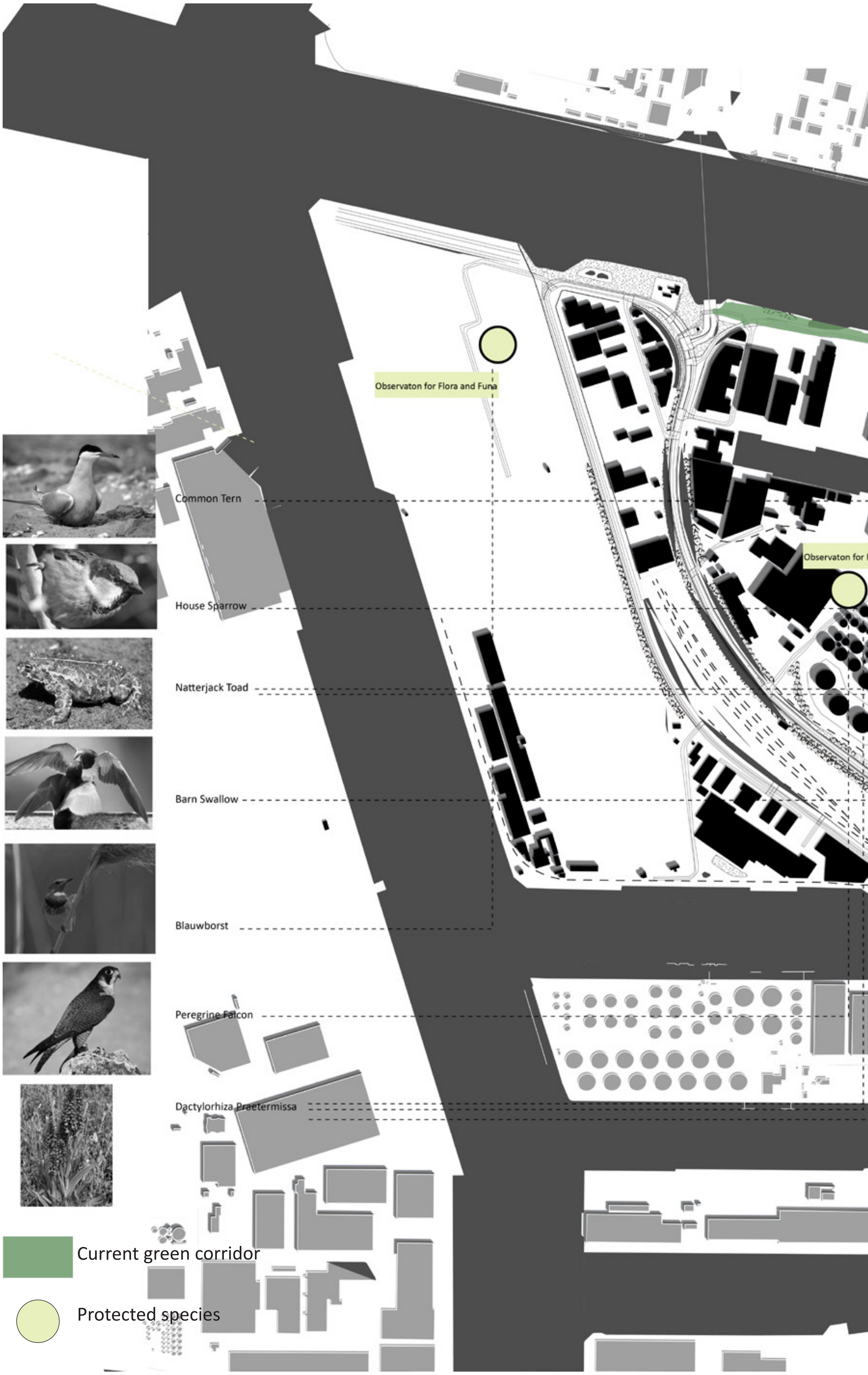


Figure 28: Ecology analysis map


Ecology Corridor
Ecology Corridor
Observaton for Flora and Funa
Flora and Funa
bservaton for Flora and Funa
Observaton for Flora and Funa
Observaton for Flora and Funa
Ecology Corridor
Observaton for Flora and Funa

5.1.3 Soil analysis

The soil of the site (Figure 27) used to be fertile clay and peat, and the land served as arable at the beginning point. However, to overcome the high groundwater level, a layer of sand was put on the top of the fertile layer. Meanwhile, due to the industrial activities of the last century, the layer of the sand has become polluted, as shown in the map (Rapportagemodule, 2020).

The pollution mainly consists of mineral oils, and the pollutants have infiltrated into the deeper soil layer and the groundwater level. Some metal pollutants are also surveyed from the groundwater, including xylenes, naphthalene, and benzene, as shown in the map.

For the future development of this site, some remediation methods need to be employed. Rather than merely placing a layer of clean soil on top of the polluted soil, which cannot solve this problem, some new solutions are expected in the design phase.

5.1.4 Ecology analysis

Being part of the ecological structure of Amsterdam, there is one ecological corridor covering part of the site. The main structure as shown in the figure, serves for the improvement of people's lives, the adaptation to climate change, and also some other functions for leisure, work, sports, play, and so on. This ecological passage (Figure 28) inside the site is crucial for biodiversity. According to the protected fauna and flora map from the municipality, this area provides habitats and migration for several animal species and plant species. However, as shown in the diagram, the most part of Port of Amsterdam is excluded from the main ecological structure, and the current ecological routes lose connections for the surrounding region. Thus, extensions for ecological corridors can be expected inside the site.

5.1.5 Infrastructure analysis

I. Hemweg Energy plant

The history of Central Hemweg as a coal-fired energy plant can be traced back to the middle of the last century. However, in order to reduce the emission of co2, most of the energy production activities have been closed since the end of 2019. The gas-fired Hemweg 9(Unit 9) is the single part still generating electricity with a capacity of 440 MW of an efficiency of 59%. At the same time, the Hemweg-site is expected to be a fossil-free hub for electricity and heat during the future conversion to renewable production in the coming years (Vattenfall Press Office, 2019).

II. OBA Bulk Terminal

Since 1952, with the opening of the Amsterdam-Rijnkanaal, the connection between Amsterdam and the German has been largely improved. Thus, two years later in 1954, OBA Bulk Terminal Amsterdam was initially constructed to provide iron ore for the West German steel industry. However, in order to respond to market developments, coal became the major cargo several years later (Figure 29). As mentioned before, OBA provided coal for Central Hemweg for energy production with a 2000-meters-long conveyor belt. Around 1000 tons per hour of coal used to be transported through this long belt. At the same time, through the connected train rails, OBA also provides coal for inland cities around Amsterdam (Figure 30). Nevertheless, during the transition towards renewable energy, coal-free activity will be implemented in Westpoort in 2030. Being part of Westpoort, OBA needs to adapt its portfolio to new market demands (OBA, 2020).

III. Euro Tank and other tank storage company

The history of this terminal can be traced back to the construction of Petroleumhaven in 1889. For now, with around 150 years of investment and upgrades, the terminal provides different kinds of minerals and chemicals, including gasoil as the significant cargo, for various countries throughout the world. Hundreds of huge tanks cover almost half of the land of the site. With the promotion of gas-free in 2050 from the council of Amsterdam and the transition towards sustainability from Port of Amsterdam, these huge tanks also need to seek new opportunities in the coming decades (VTTI, 2020).

Figure 29: photo for OBA bulk terminal, from Code Rood(2017)

Figure 30: photo for OBA bulk terminal, from Code Rood(2017)

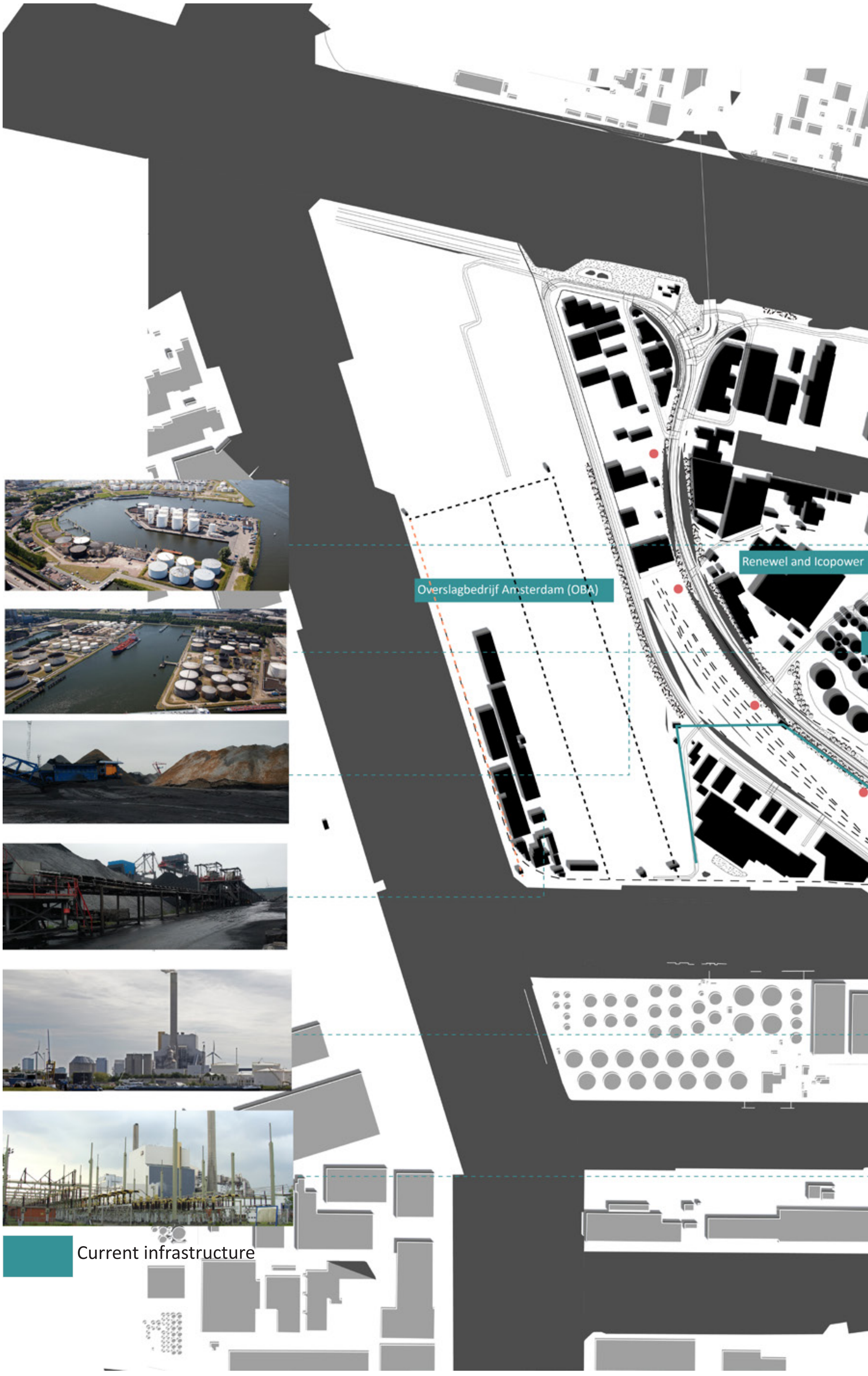


Figure 31: Infrastructure analysis map


Renewel and Icopower
Storage Tank
Storage Tank
Storage Tank
Storage Tank
Storage Tank
Storage Tank
Gas Station
Coal Station
Train line
Hemwegcentrale
Power Station

5.2 Landscape types analysis

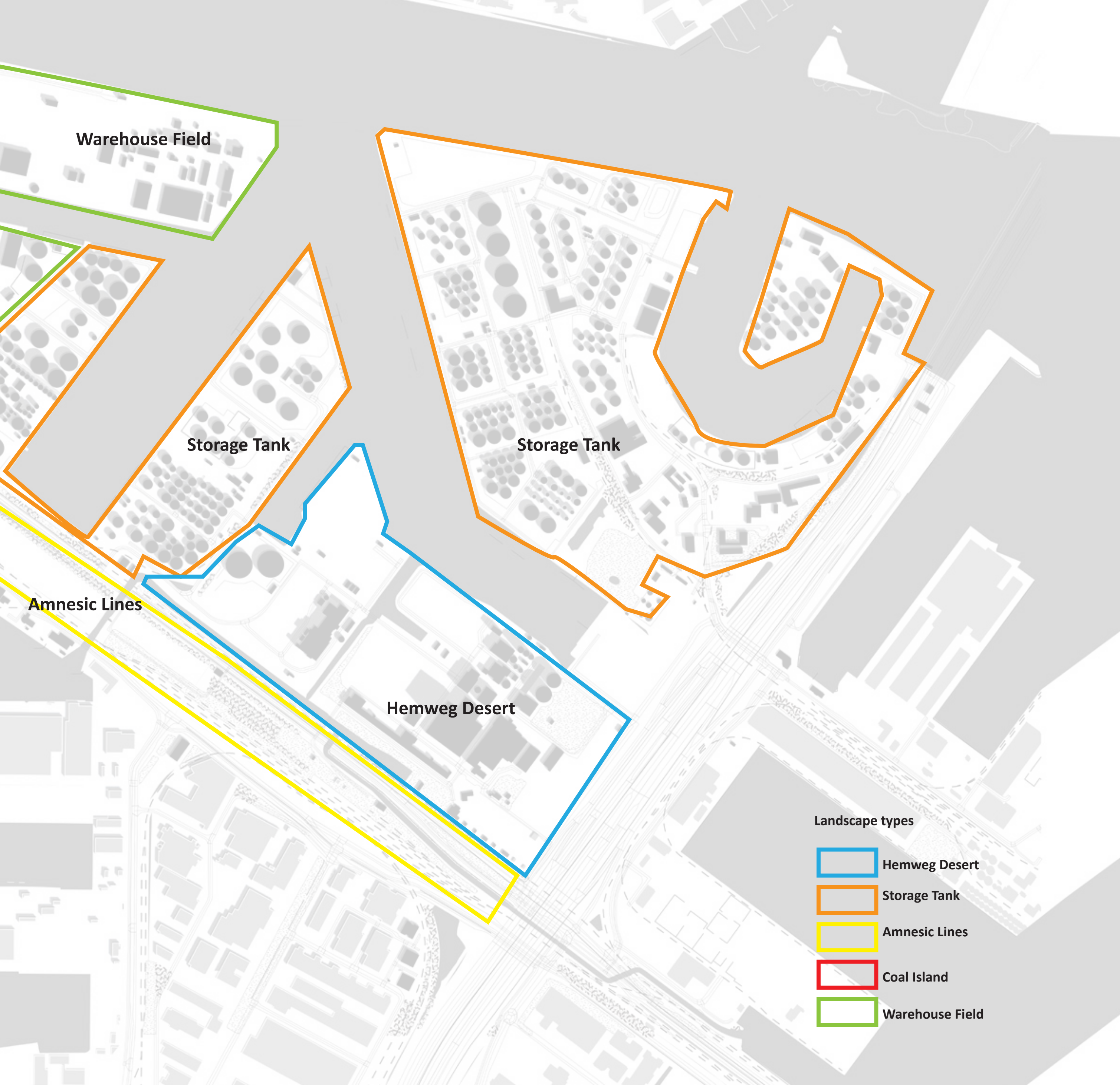
The conventional analysis can provide us with information for landscape types map. Two major qualities to decide these landscape types are the 'containment and openness' and 'textural and sensuous qualities' (Kristen et al., 2004, P310). They are also helpful for us to know how to engage the renewable energy infrastructure within the landscape.

Figure 32: Landscape types map

Derived from the method that sought to engage within these character of 'old' landscape units, analytical drawings are also developed that excavated the characteristics for each landscape type. The shape of the landscape, how renewable infrastructure, including wind turbines and solar panels, interact with that shape, and how human possibly take part in the combinations of renewable infrastructure and the 'old' landscape are the concerning points (Kristen et al., 2004).

The evaluation form for landscape types is in the appendix.

The following types map (Figure 32) show the result of the analysis above, a map of five types.



Storage Tanks

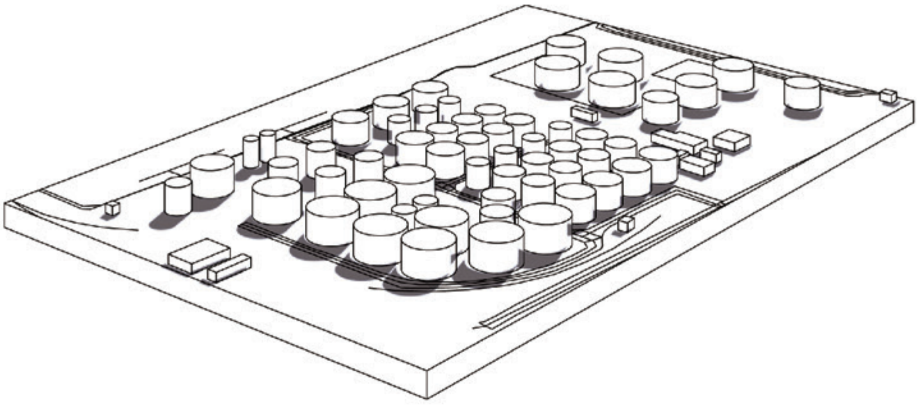


Figure 33: 3d model

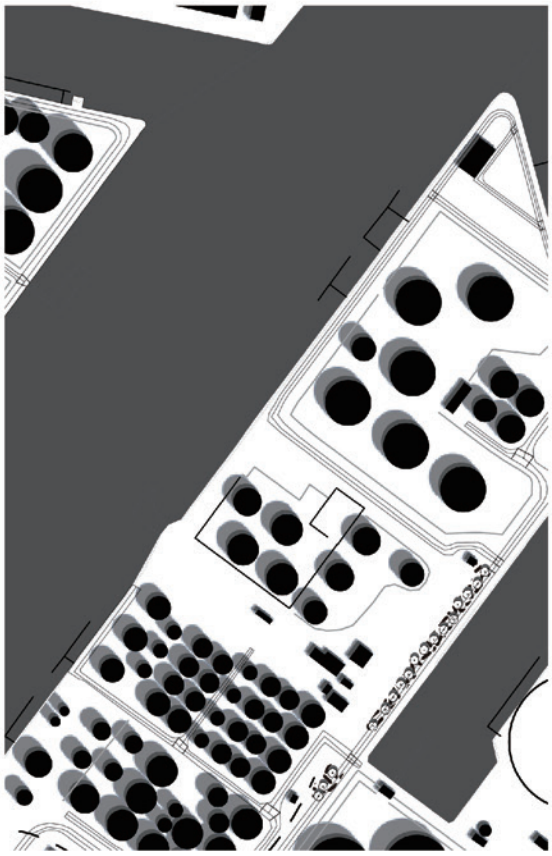


Figure 34: plan

a) containment and openness

Figure 35: photo

Figure 36: photo

Currently, hundreds of enormous storage tanks (Figure 35,36)characterize this landscape type. It is quite hard to find space to engage in renewable energy infrastructure at this time. However, according to the gas-free from the counsel of Amsterdam in 2050, some storage tanks are expected to be discarded to meet the market demand: Less usage of fossil fuel will result in fewer charges for storage. Since that time, medium scale of solar panels fields is expected to be installed inside the space of this landscape type. Some new wind turbines can also be constructed.

b) textural and sensuous qualities of the site's existing materiality

•Iron tanks
•Protected species: Common Tern, Dactylorhize Praetermissa, Natterjack Toad, House Sparrow
•Contamination in the ground
•Historical Petroleumhaven

Coal Island

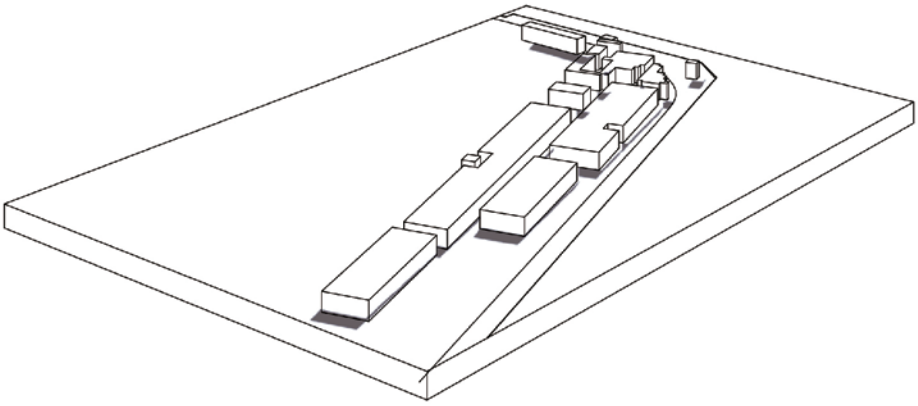


Figure 37: 3d model

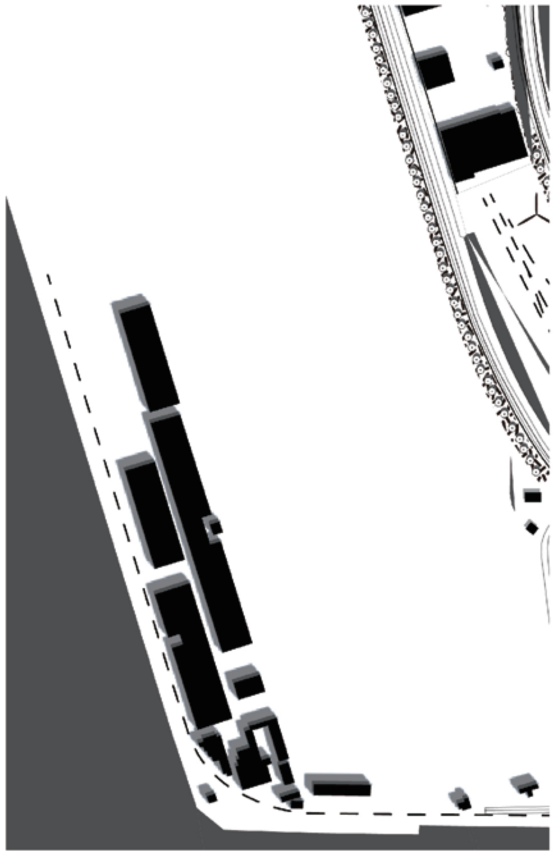


Figure 38: plan

a) containment and openness

Figure 39: photo

Figure 40: photo

Figure 41: photo

For now, hills of coal occupy (Figure 39,40,41) the land of this landscape type. Several warehouses are constructed along the boundary. It is also difficult to find space for renewable energy infrastructure. With the implementation of the policy coal-free in 2030, the OBA terminal needs to adapt its portfolio to meet the market demand. It means great potential for renewable energy infrastructure since that time, both for solar panels and wind turbines.

b) textural and sensuous qualities of the site's existing materiality

- Coal Hills, transport machine, and warehouses
- Protected species: Blauwborst
- Contamination in the ground water
- Coal-energy plant nearyby was close
- Profile of historical island

Amnesic lines

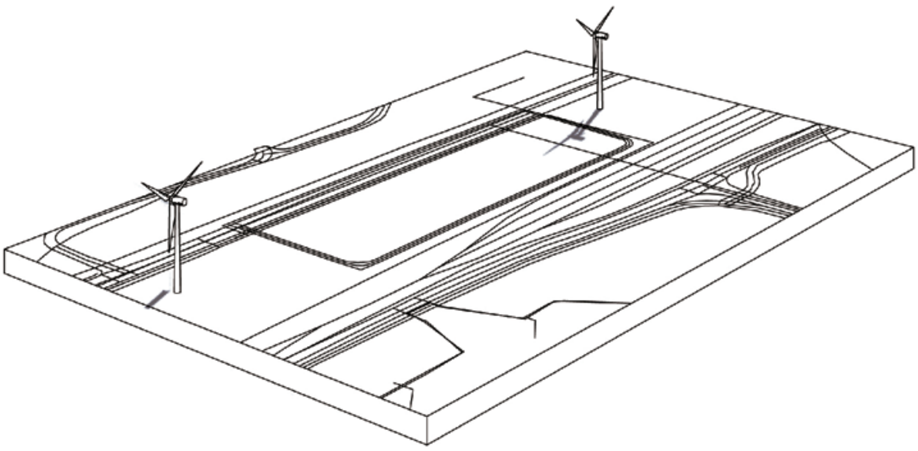


Figure 42: 3d model

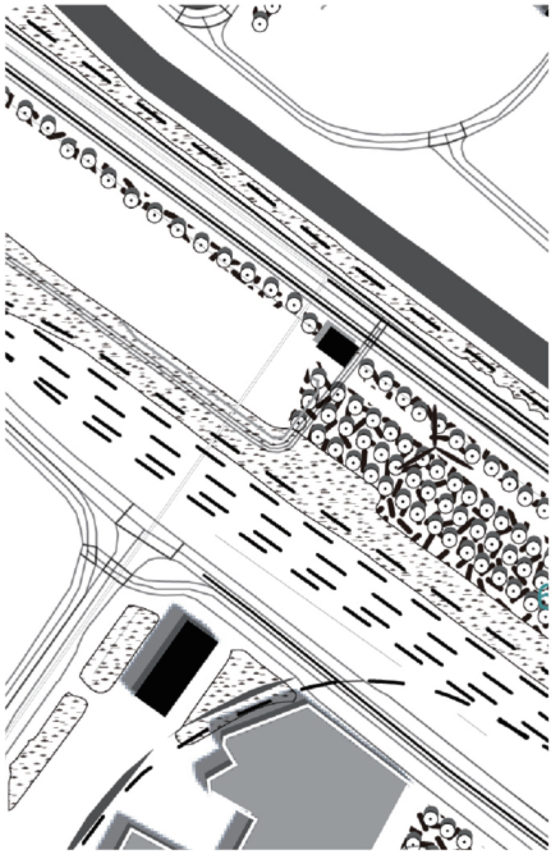


Figure 43: plan

a) containment and openness

Figure 44: photo

Figure 45: photo

The train lines sometimes take the role of transporting coal to other cities. However, it looks like an amnesic corner for the city region. Some discarded trains scatter along the train lines. Human beings seldom visit it. On the contrary, nature dominates these spaces covered with various kinds of plants, and you can hear the birds twittering sometimes (Figure 45).
Furthermore, coal transportation is expected to be stopped since 2030 (Port of Amsterdam, 2017). It means it will be totally abandoned in the future. On the other hand, a new development of renewable energy is expected in this train line. Liner but narrow spaces can be provided for solar panel fields as the train line is abandoned in 2030.

b) textural and sensuous qualities of the site's existing materiality
•train lines with green spaces along
•one line of wind turbines in the middle
•Protected species: Common Tern, Dactylorhize Praetermissal, Peregrine Falcon
Pixel ecology corridor

Hemweg Desert

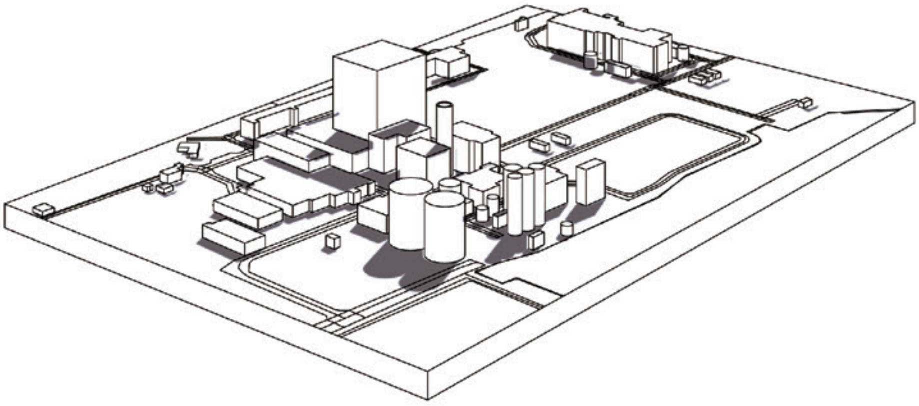


Figure 46: 3d model

a) containment and openness

Figure 47: plan

Figure 48: photo

Figure 49: photo

Some interval spaces can be found between the warehouses (Figure 49) for solar panels, and it is what has been done by the energy plant itself. Furthermore, due to closure of the coal-fired energy production part, most of the warehouses (Figure 48) are expected to be demolished in the following years. A large scale of solar panels accompanied by wind turbines can be installed since then.

b) textural and sensuous qualities of the site's existing materiality

- •Some clusters of solar panels
- •Protected species: Common Tern, Dactylorhize Praetermissa
- •Contamination in the ground
- •Hemweg central plants, most part of it has been closed
- •historical coal-energy factory

Warehouse Field

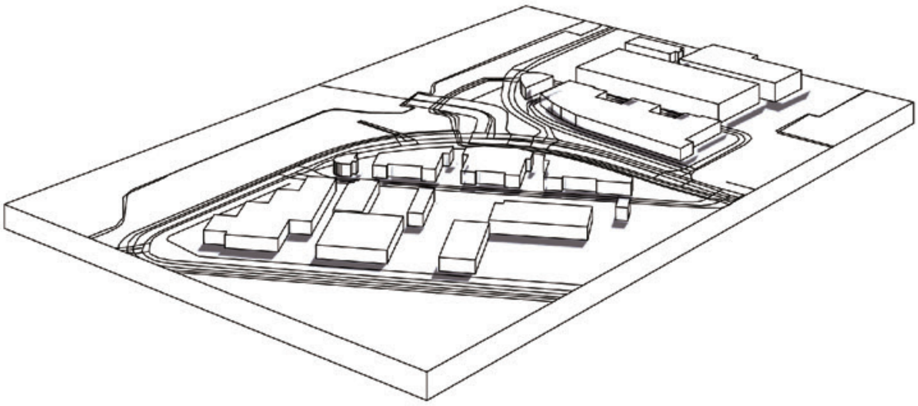


Figure 50: 3d model

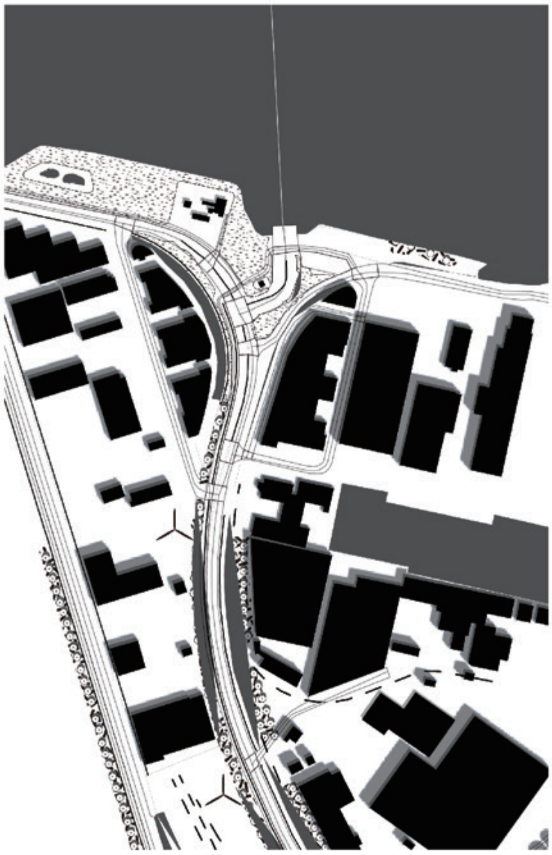


Figure 51: plan

a) containment and openness

Figure 52: photo

Figure 53: photo

Be different from the land types (Figure 52,53) mentioned above; most of the industries are expected to be operated in the following decades. Thus, it is hard to find space for solar panels on the ground level. The roof of these warehouses will be the only choice to install solar panel fields. Meanwhile, several wind turbines can also be installed.

b) textural and sensuous qualities of the site's existing materiality

- •Protected species: Peregrine Falcon, Blauwborst, Dactylorhize Praetermissa
- •contamination in the ground water and ground
- •renewl waste factory and some manufacture industry
- •Ferry connceting the north and south bank
- •historical rail bridge in the last century

5.3 Design principles

From the analysis above and the theory about landscape infrastructure and sustainable energy landscape mentioned before, the design principles are formulated:

Enough energy should be provided for surrounding areas.
Renewable energy infrastructures can also provide other functions, including recreation, ecology, and so on.
Renewable energy infrastructures can structure the landscape for future development.
New interventions should preserve the 'old' landscape characters.

5.4 Desirable futures

The designs on the medium scale show how the transition towards sustainable energy can be fulfilled in the Amsterdamerpolder area. Through redeveloping and reinterpreting the current landscape and basing on the characteristics of every landscape type, renewable energy infrastructure can engage this transition, provide more functions, and improve the landscape qualities.

Storage Tank

Figure 54: Photo for Storage Tank

Figure 56: Desirable Future for Storage Tank

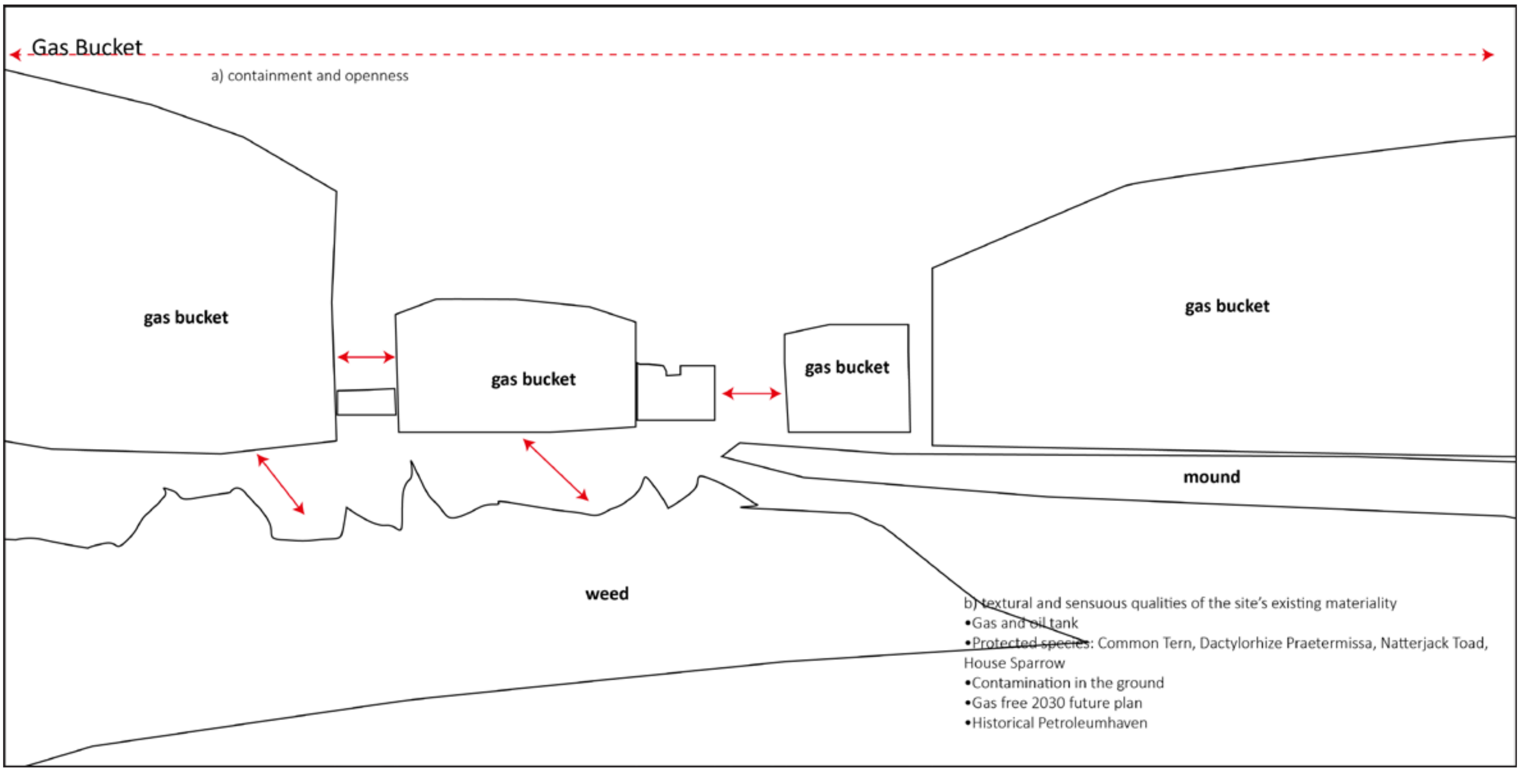


Figure 55: Analytical Drawing for Storage Tank

1) Medium scale solar panel field to provide energy

2) Several wind turbines to provide energy

3) Some abandoned storage tanks preserved and regenerated for leisure

Coal Island

Figure 57: Photo for Coal Island

Figure 59: Desirable Future for Coal Island

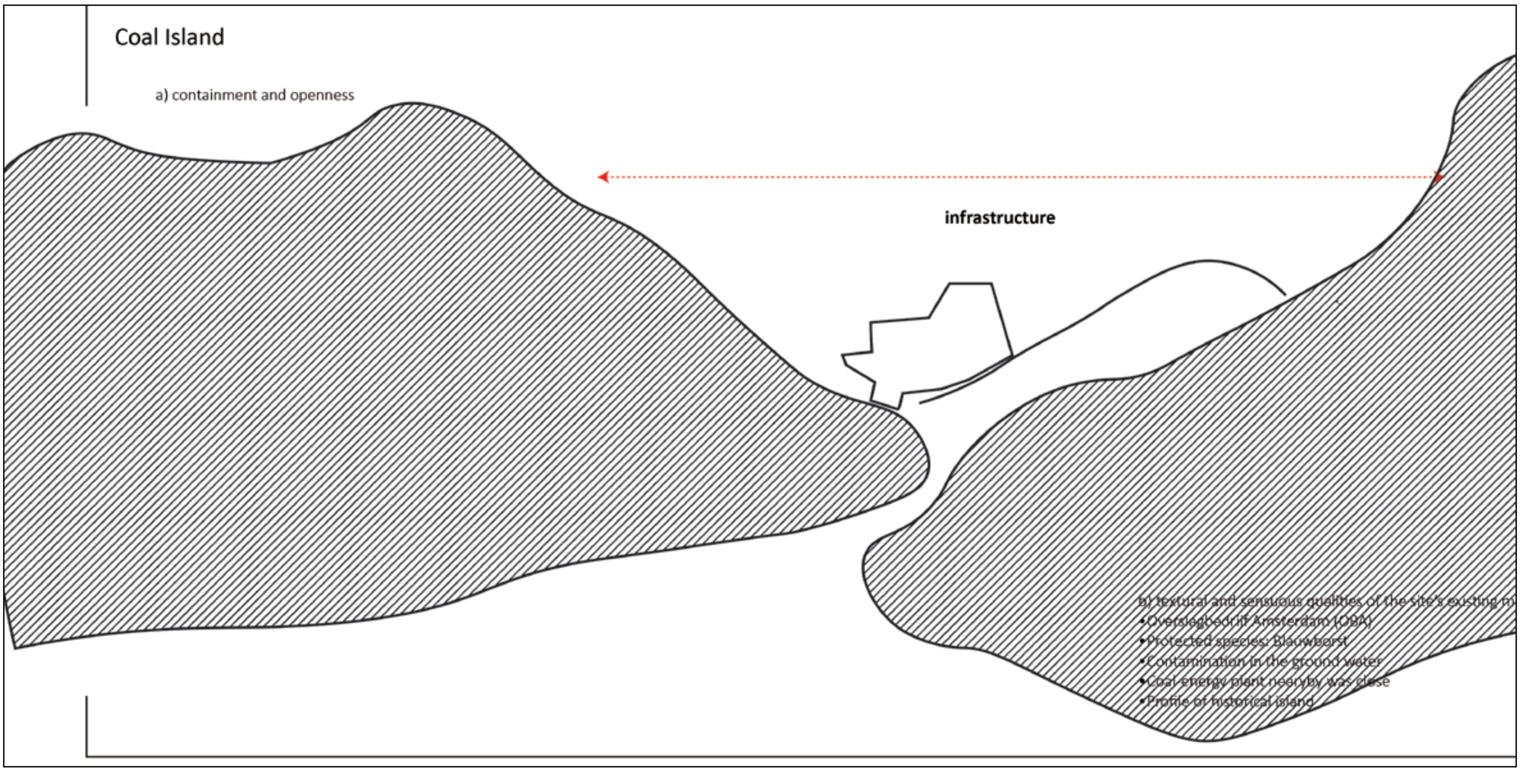


Figure 58: Analytical Drawing for Coal Island

1) Large scale solar panel field to provide energy

2) Offshore wind turbines along the bank and inland wind turbines to provide energy

3) Beautify the solar panel infrastructure

4) Abandoned industry infrastructure and terrain preserved and regenerated for entertainment

Amnesic Lines

Figure 60: Photo for Amnesic Lines

Figure 62: Desirable Future for Amnesic Lines

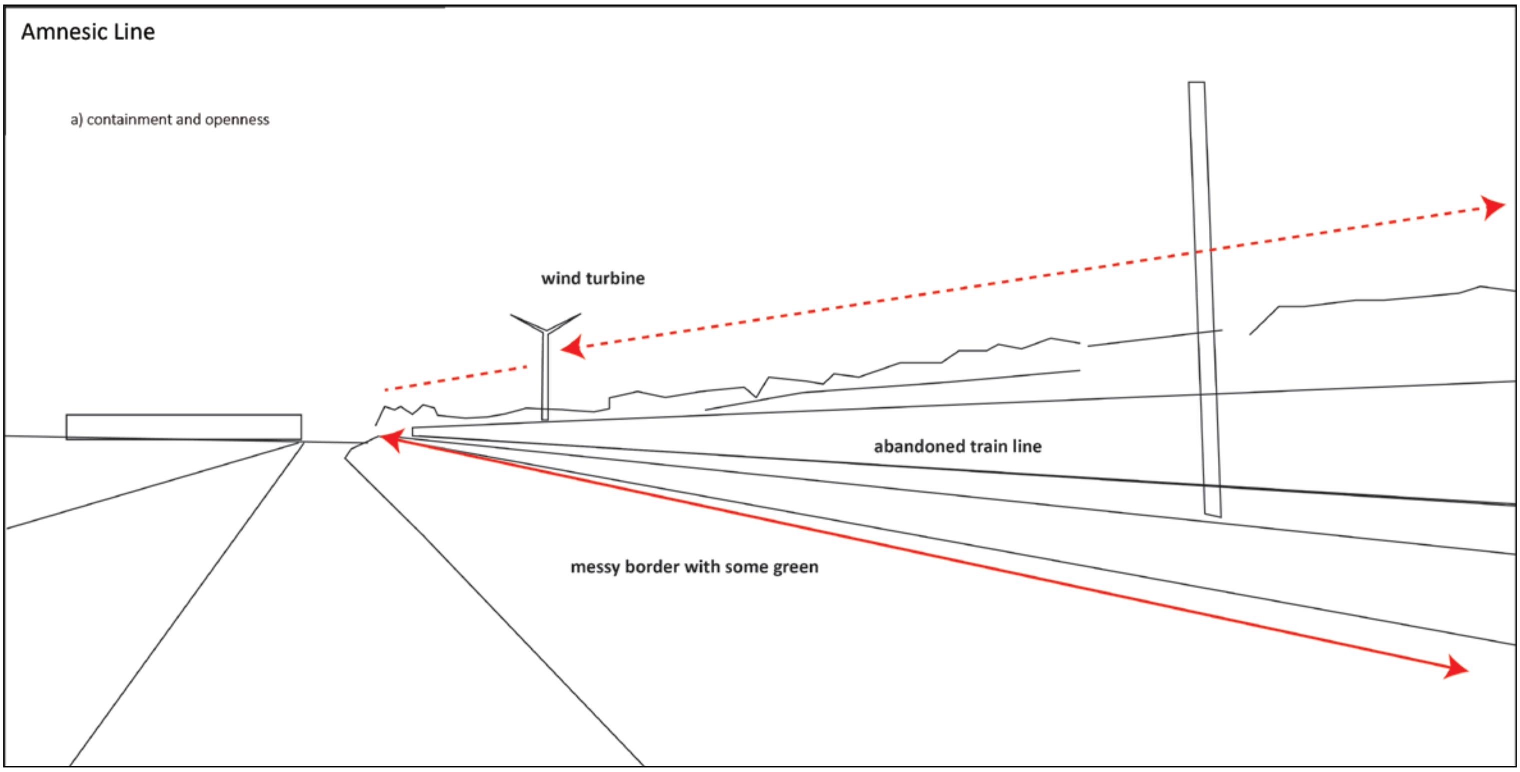


Figure 61: Analytical Drawing for Amnesic Lines

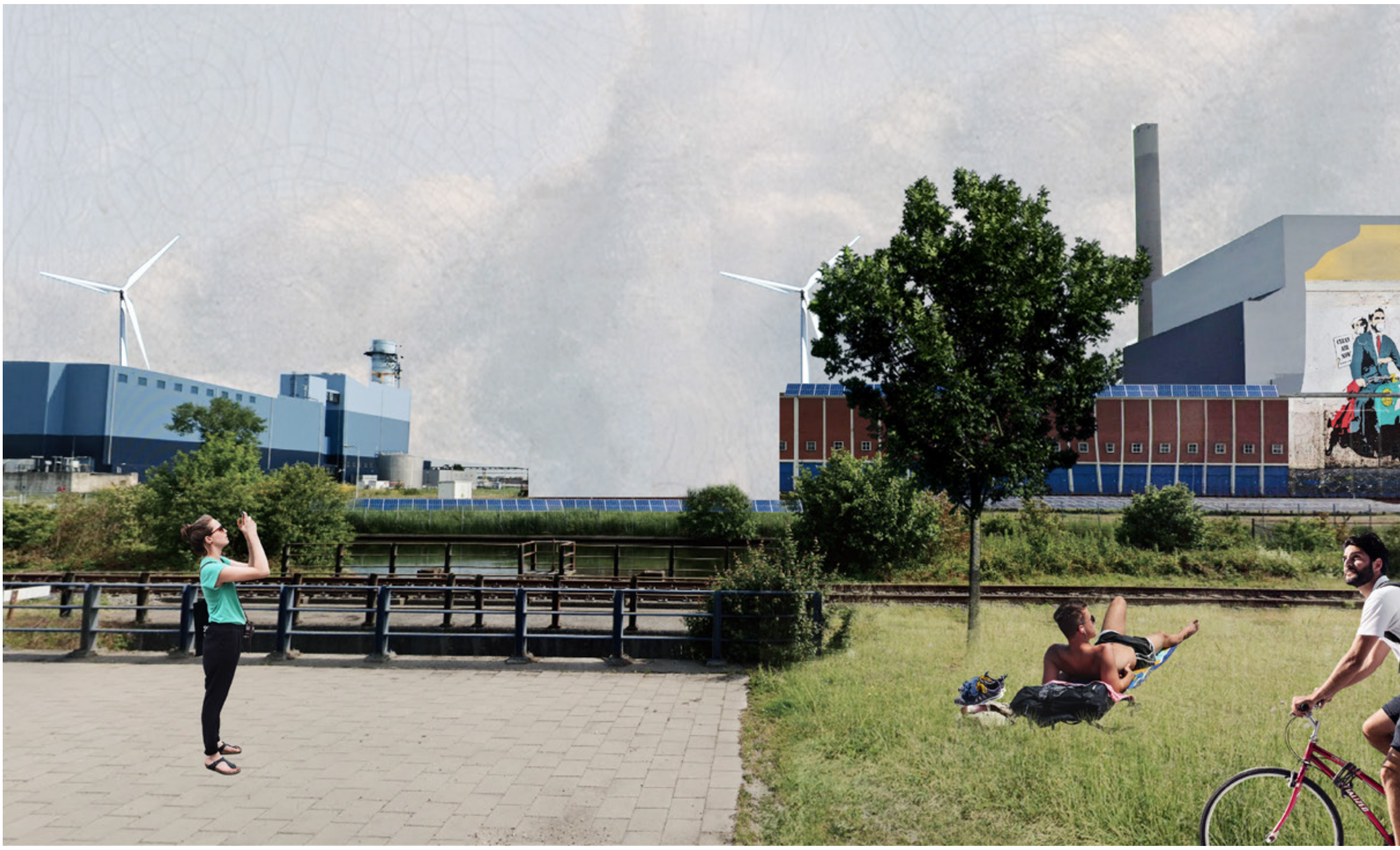
1) Liner and narrow solar panel field to provide energy

2) Ecological corridor preserved and improved to provide habitats for animals and plants and leisure for surrounding neighbourhood

Hemweg Desert

Figure 63: Photo for Hemweg Desert

Figure 65: Desirable Future for Hemweg Desert



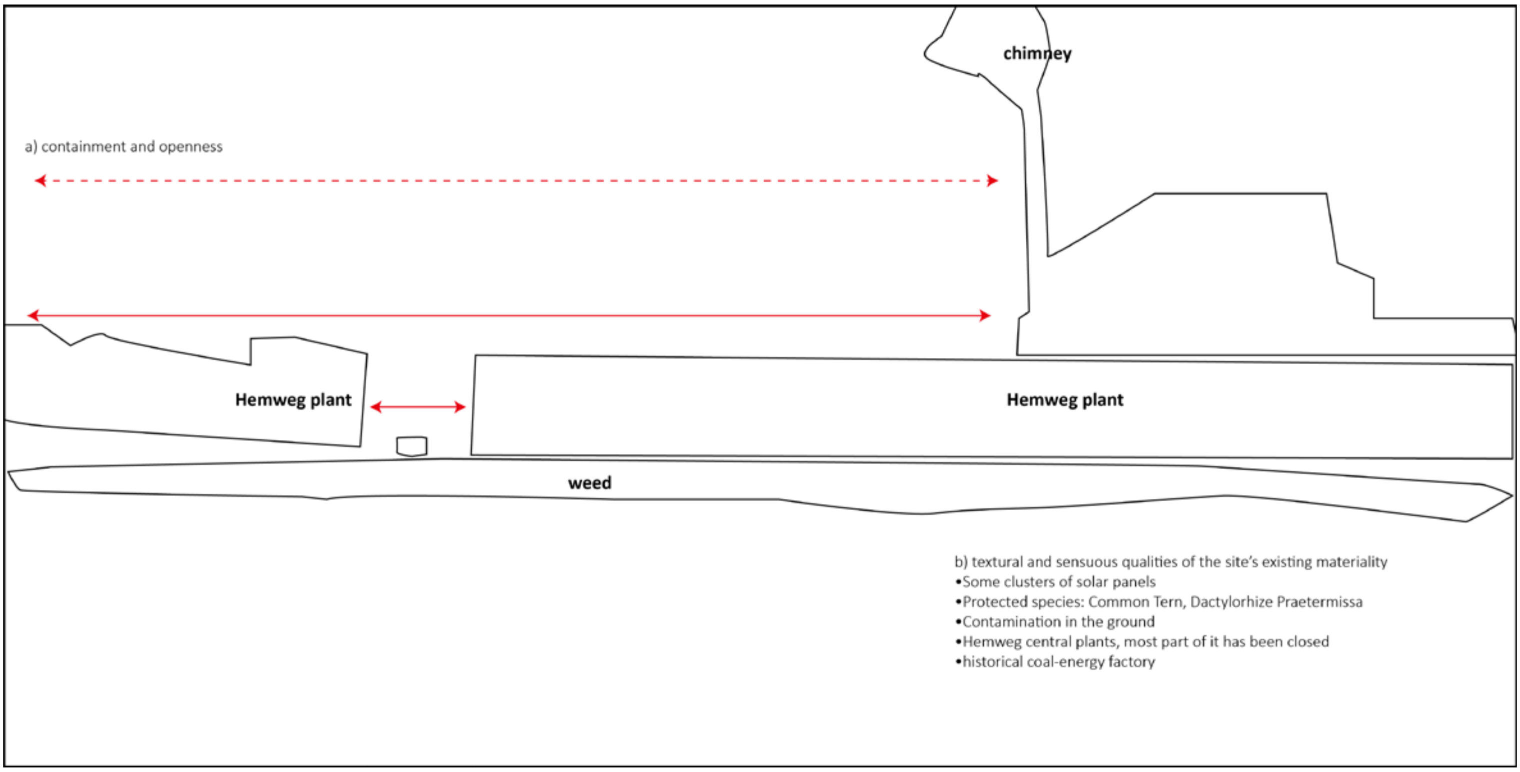


Figure 64: Analytical Drawing for Hemweg Desert

1) Large scale solar panel field to provide energy

2) Several wind turbines to provide energy

3) Abandoned plants preserved and regenerated for storage of renewable energy as a fossil-free hub

Warehouse Field

Figure 66: Photo for Warehouse field

Figure 68: Desirable Future for Warehouse field

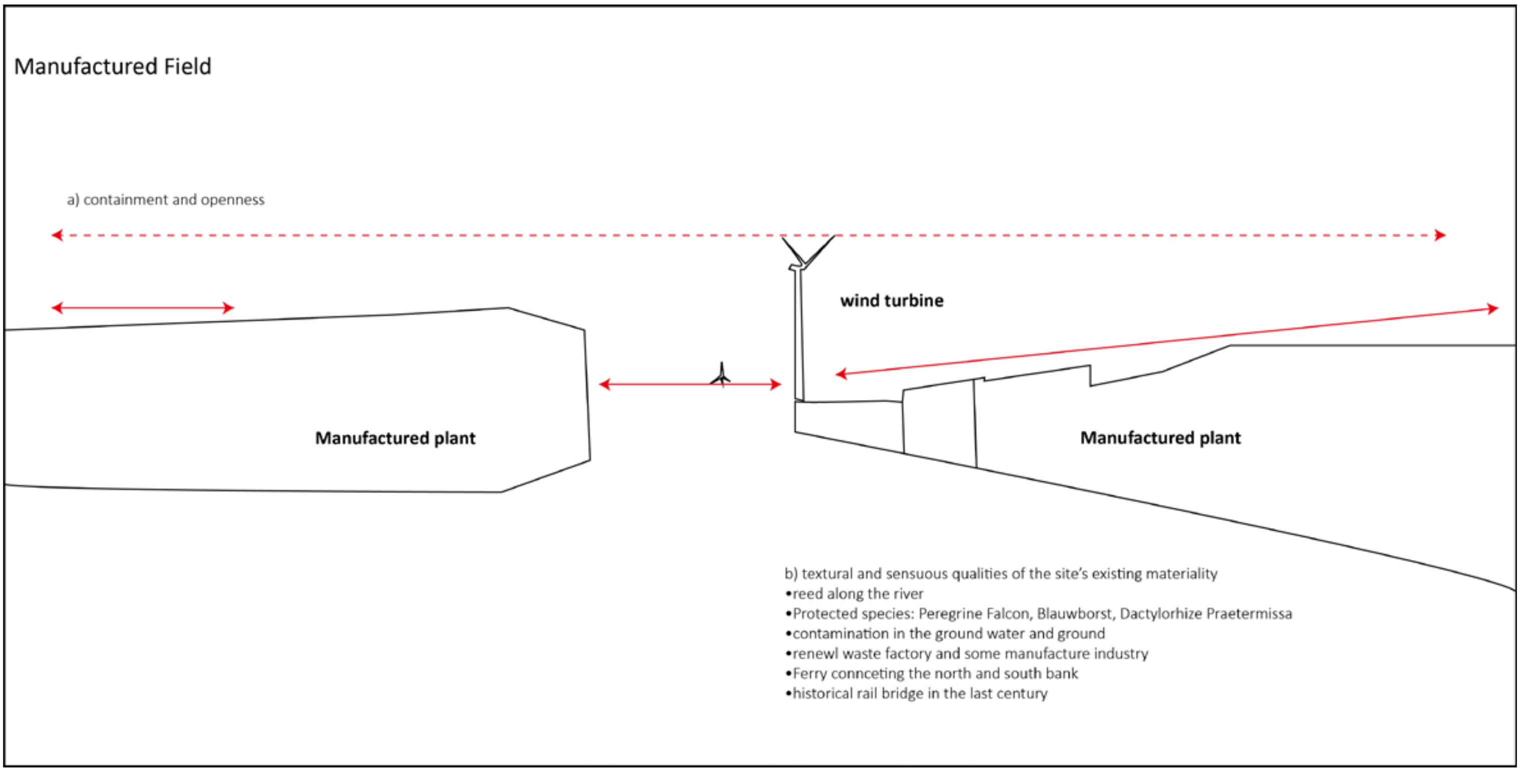


Figure 67: Analytical Drawing for Warehouse

1) Solar panel on the roof to provide energy

2) The warehouse regenerated to be more sustainable

3) Several wind turbines to provide energy

6

SMALL SCALE

The site will be regenerated into an energy park(Figure 43), providing both energy use, as well as recreation and so other functions for local inhabitants. Furthermore, it also functions as an exhibition of the renewable energy infrastructure, making people closer to these renewable energy-producing technologies and then becoming accustomed to them.

Small scale

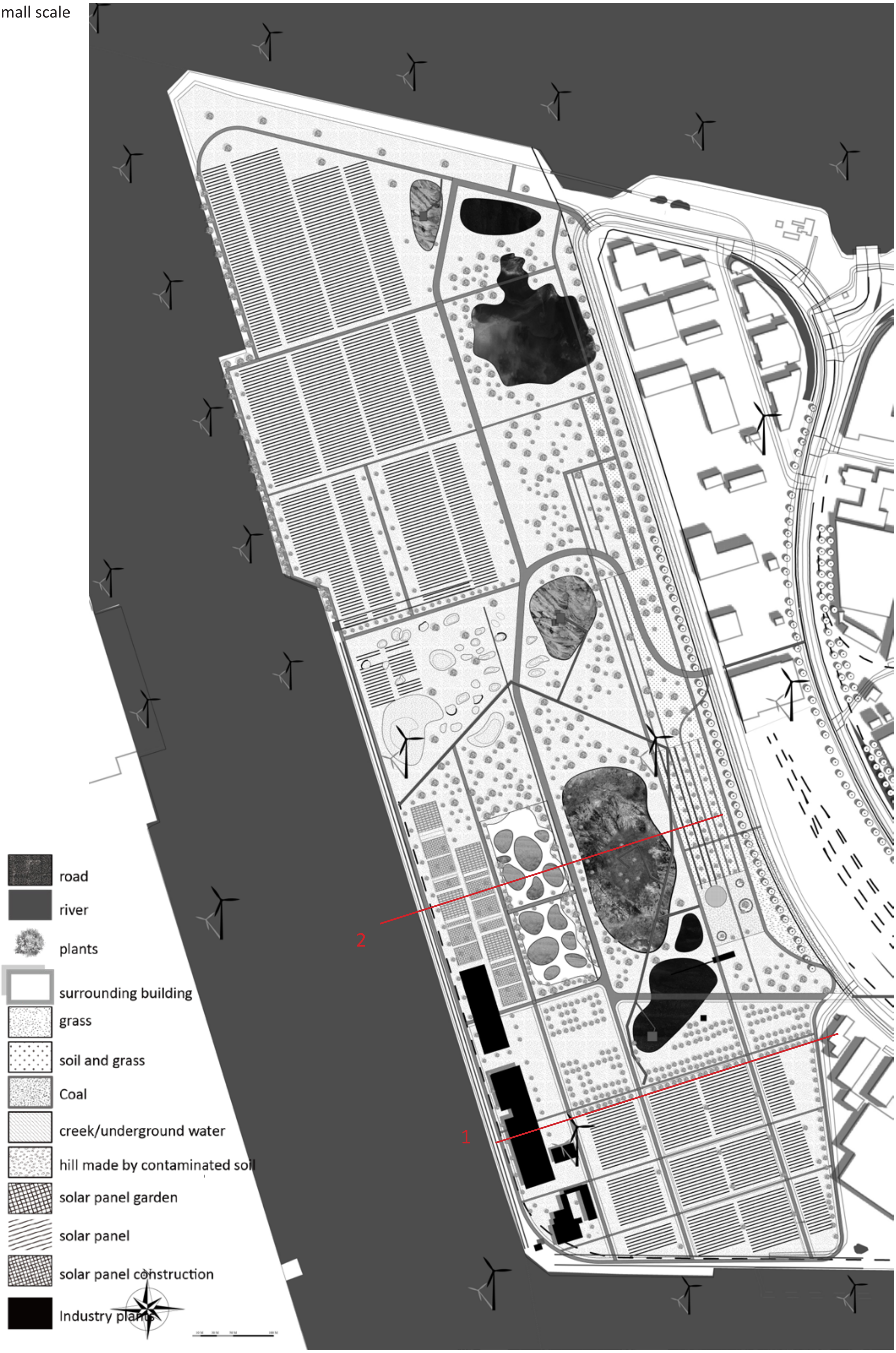


Figure 69: Site plan

6.1 Designing strategy

Following the desirable vision mentioned before, the park will be built step by step (Figure 70). It will take decades and will be adaptive to future uncertainty. The first phase is between 2020 to 2029, which is called 'seeding'. The closure for the coal-related industry will not happen in one day by 2030. During the 'production' phase, the north part of the site will be employed firstly. Production more renewable energy will be the main focus of this phase. Solar panel fields will also be constructed at this location (Figure 71). The scale of these solar panels will be big, around 4-5 meters to produce more energy. Meanwhile, considering the contamination in the soil, reed and herbaceous ryegrass will be planted to remediate the land.

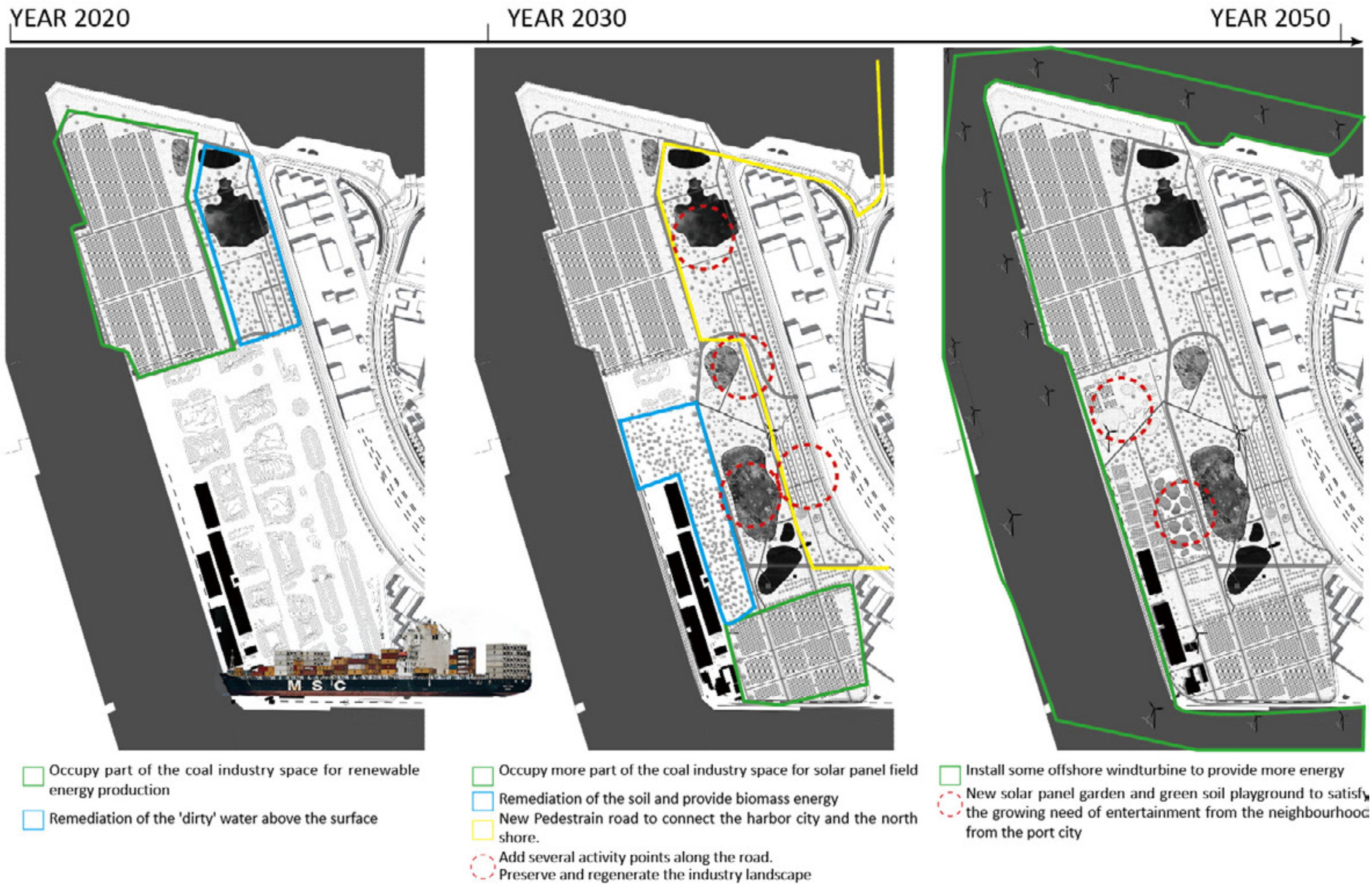


Figure 70: Phase Development

Then the second phase, from 2030 to 2040, is called seeding. During this phase, some new districts for living and working are expected to be built in the surrounding according to the Port city plan. This means more energy consumption and renewable energy production is still one central focus. Several wind turbines will be built, following the historical trace of the disappeared island, the De Horn. Another solar panel fields will be constructed in the south part (Figure 72), with the same size as the north solar panel fields to produce more energy. Remediation of the contaminated soil will be carried on and expand to the whole site. At the same time, with more people living around, there is a growing trend for the needs of leisure and some other functions. One new pedestrian road which will connect the south part of the port city and the north of Amsterdam will be another major

Figure 71: North solar panel field

Figure 72: South solar panel field

focus. The historical remains will be employed and regenerated to provide several places of interest during the road. Furthermore, ecology will be progressed from this pedestrian to the whole former industry site.

The last phase is called 'programming', and it will end in 2050. One new solar panel garden and green terrain playground will be built to satisfy the growing needs of entertainment from the surrounding area. Some offshore wind turbines will be built along the river bank. In 2050, the ambition of energy park will be fulfilled at the location, providing renewable energy, leisure, ecology and some other functions.

The whole park is divided into three regions. The north part and the south part will mainly function for energy production. Industrial remains combined with several hills which tries to depict the shape of the coal hills will form the middle part, which is mainly for visitors. The history of the site will be reserved visible in the new design. The shapes and forms derived from the historical trace will be employed to structure both the renewable energy infrastructure and road system. For example, following the historical trace of the disappeared island, one iron bridge, using the previous industrial materials, will guide people through this part. There two main entrances. One located at the north side, which is close to the ferry point and another is located at the west-east. A road will be built to connect these two main entrances across the park.

The existing patterns and fragments formed by industrial use will be reserved, redeveloped, and reinterpreted with renewable energy infrastructure into a new syntax (Figure 76). Elements like former transfer lines which used to deliver coal will be incorporated into the design and are highly visible, becoming a symbol of the park. A metaphor that the existing industrial structure can be redeveloped for public space. These consisted part of the transfer lines, the iron pillars, will provide the structure of a new square (Figure 77). From time goes on, these cast iron will be eroded by natural physical process. Furthermore, they are also controversy to the renewable energy infrastructure with the memory of fossil fuel. It will help people to understand the importance of the development of renewable energy, recalling the delay and expecting the future.

As mentioned, dealing with the soil contamination will be one focus through the whole design. Two main methods will be employed here. Because the topsoil, around 0.5 meters, of the site is mixed with coal particles and is highly contaminated. Thus, the first method is to gather this 0.5-meter soil into the warehouse remains and make them inaccessible to people (Figure 78). Some chemical medicine and plants will be employed to remediate the soil, and it will take decades. At the same time, dredge soil from the IJ river will be transported to replace this 0.5 topsoil to keep the ground level. The soil from the IJ river is also contaminated. Then, the second method, called phyto-remediation, will be employed. In other words, several species of plants will be used to remediate the pollutants. Bromus inermis, Dactylis glomerate, lolium perenne, and phragmites will be planted on the ground. Above them, salix and populus (Figure 79)will be the main trees which can remediate the pollutants and provide biomass at the same time (Figure 80). Deep-root tree likes albus glutinosa is employed to remediate the pollution in underground water (Figure 81, 82).

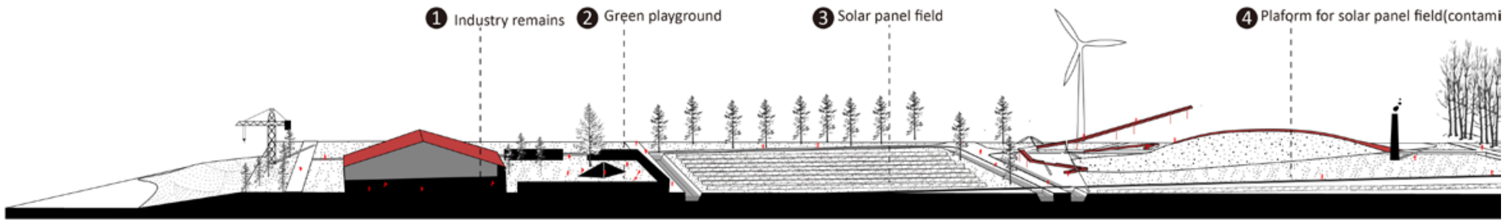


Figure 73: Section 1(2050)

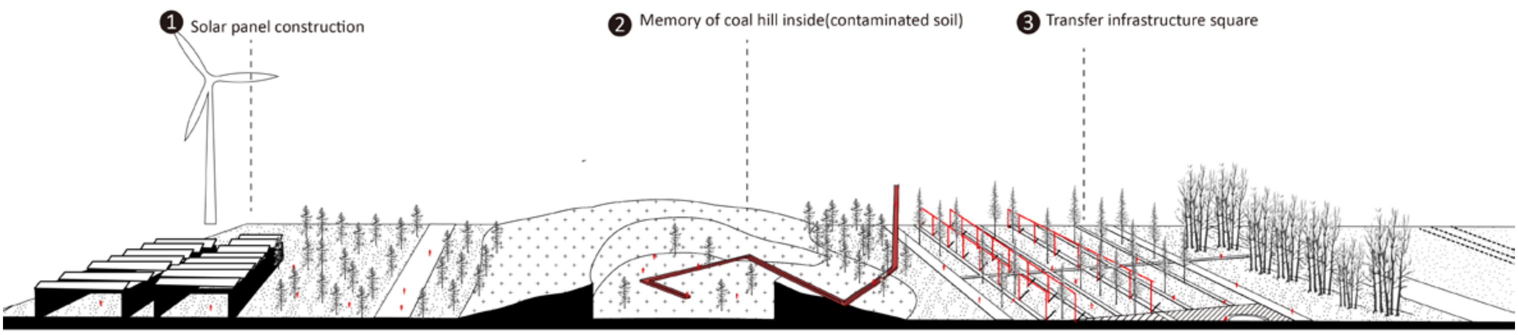
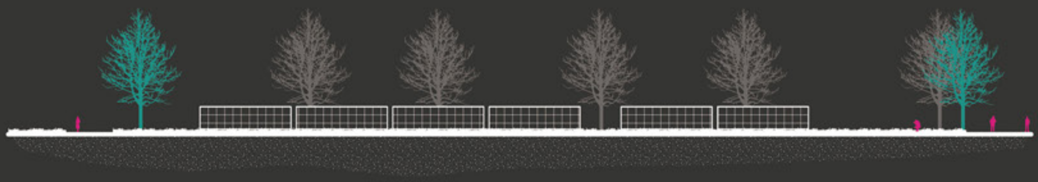
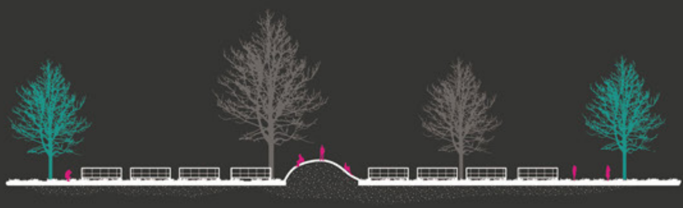


Figure 74: Section 2(2030)

Solar Panel Field



Solar Panel Terrain Playing



Solar Panel Construction

Solar Panel Garden

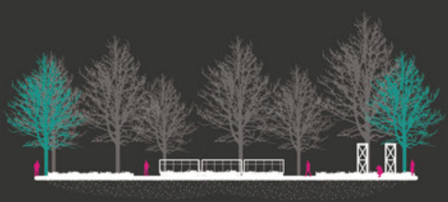
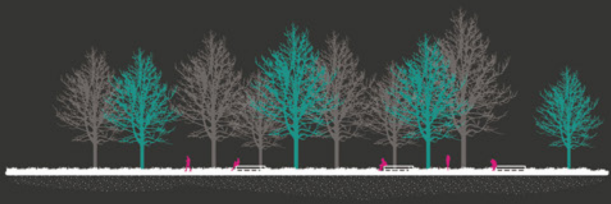


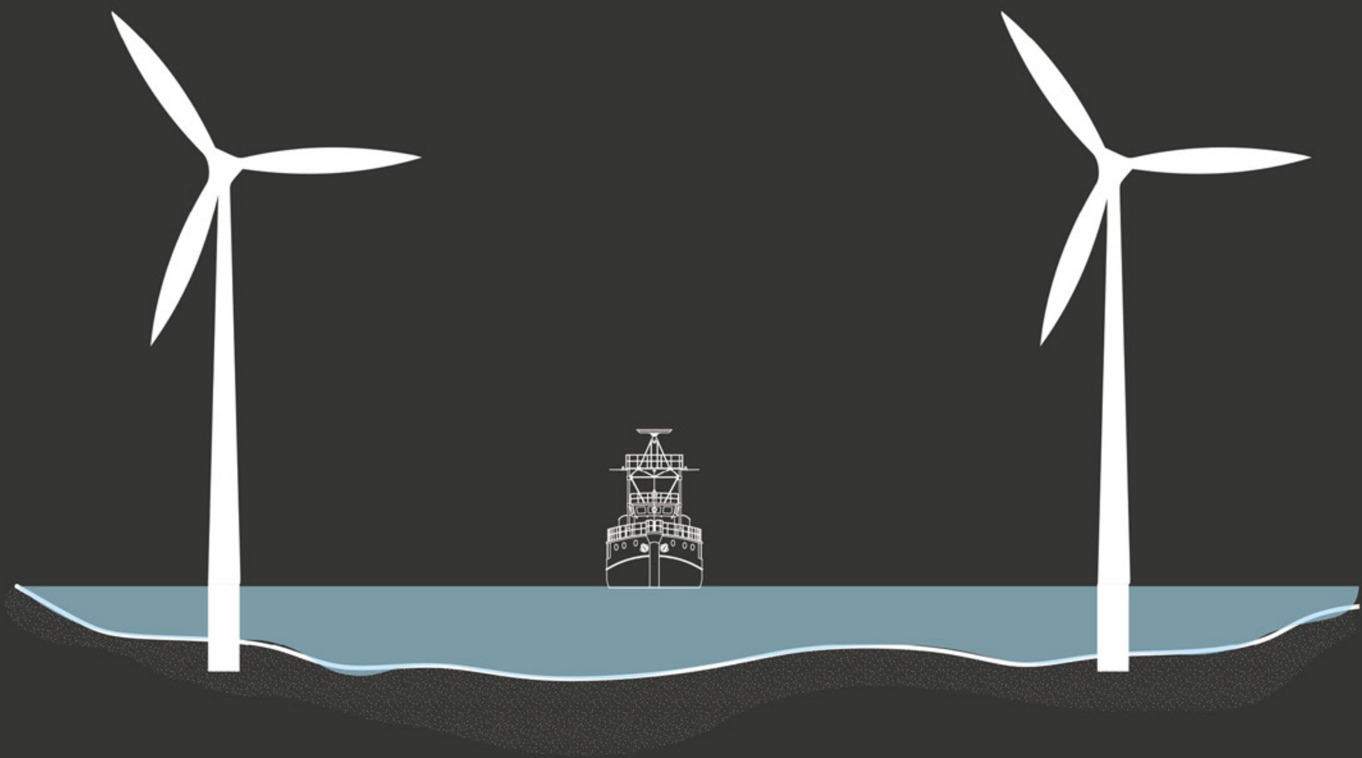
Figure 75: Section of energy production

Biomass



Wind Turbine on the land

Offshore Wind Turbine



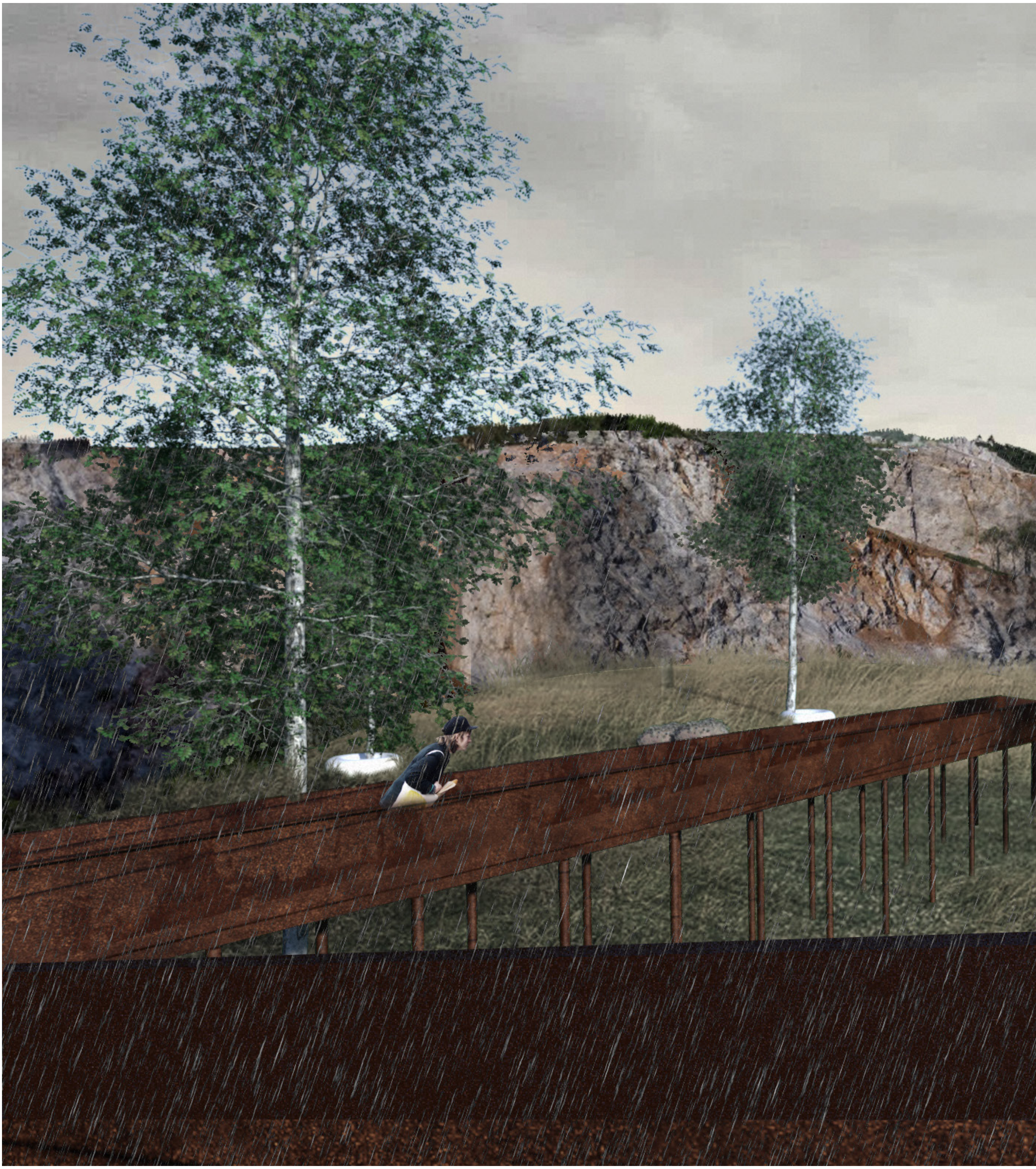


Figure 76: Inside the ‘coal’ hill

Figure 77: Transfer line square

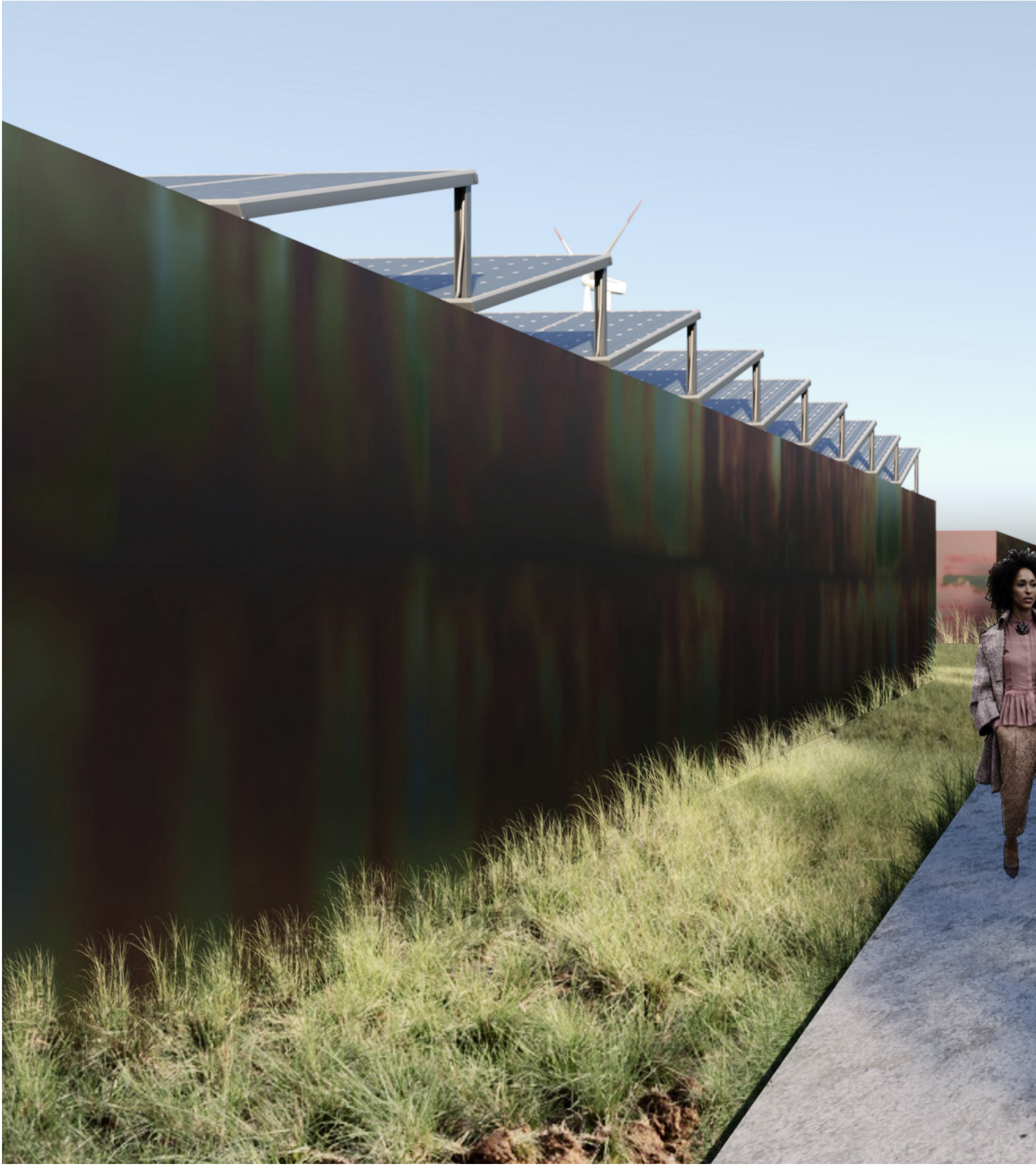


Figure 78: Solar panel garden and warehouse remains with contaminated soil inside and solar panel above

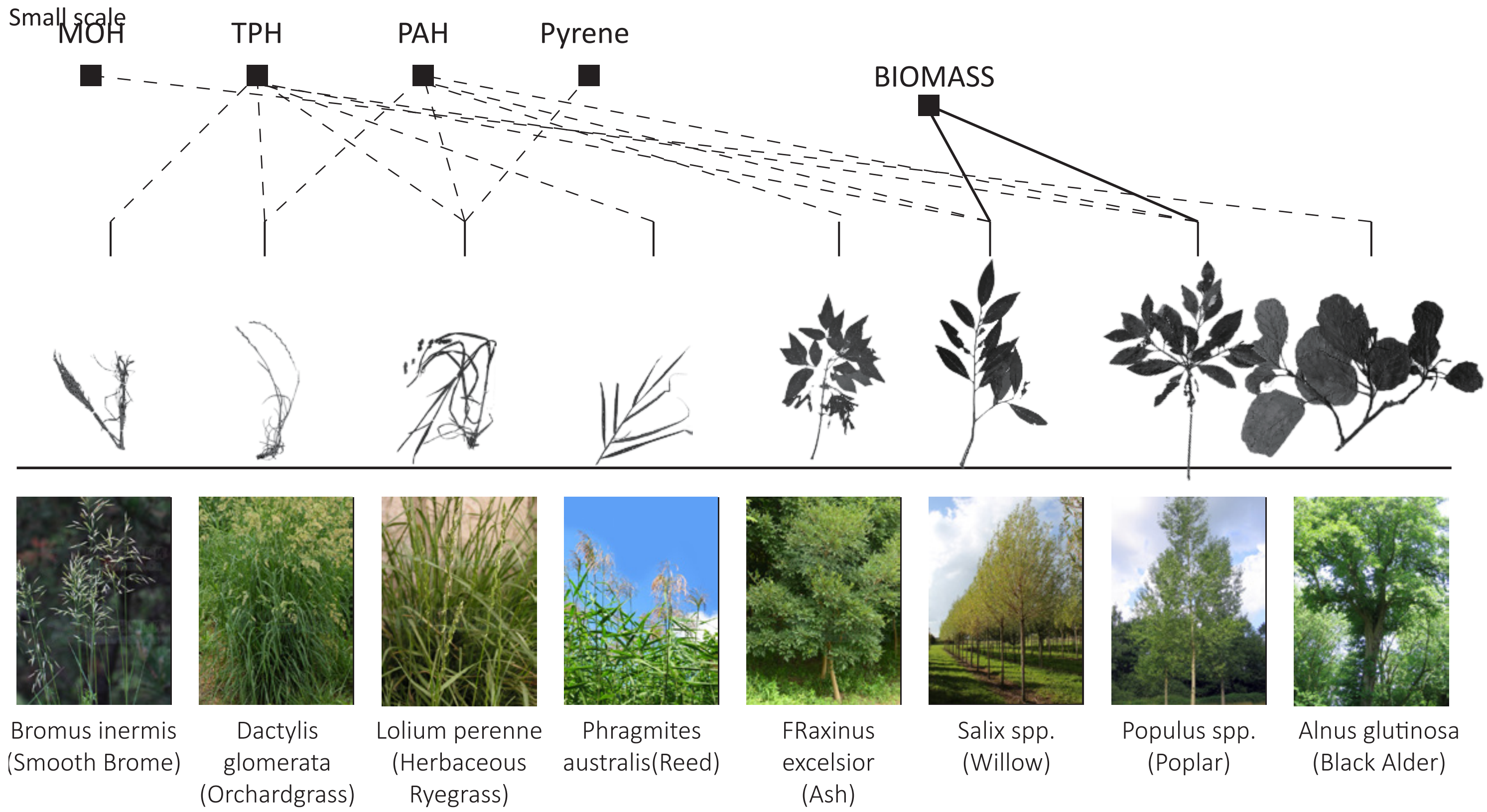


Figure 79 Plants for remediation

For Biomass: At the beginning, the poplar and willow will be planted densely for biomass and also for the first round of contamination. After around 2.5 years, the first round of trees will be cut and new round will be planted less densely. Most of them will be growed with time goes on and remediate the soil and underground water.

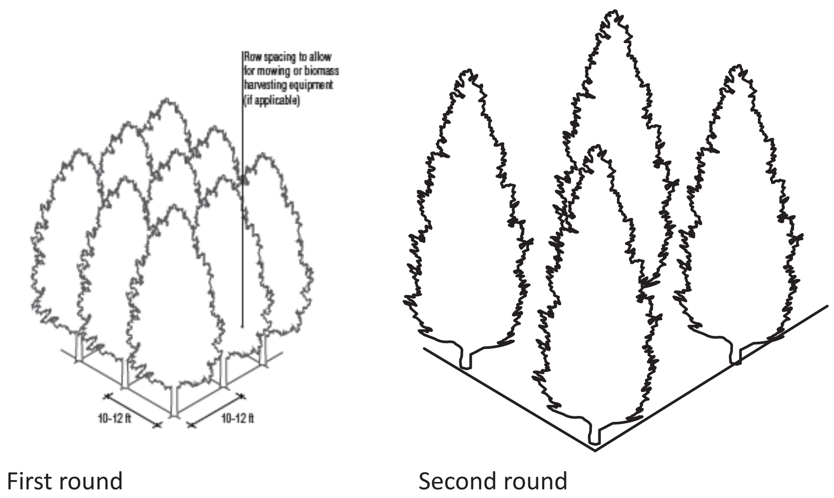


Figure 80: Provide Biomass, from Kennen & Kirkwood (2017, p50)

The plants with deep roots like alnus glutinosa will be employed to redemediate the contamination in the underground water level.

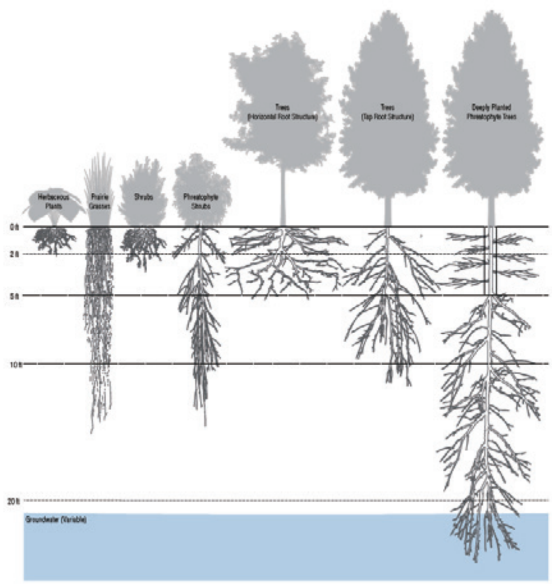


Figure 82: Typical plant root depths for remediation, from Kennen & Kirkwood (2017, p43)

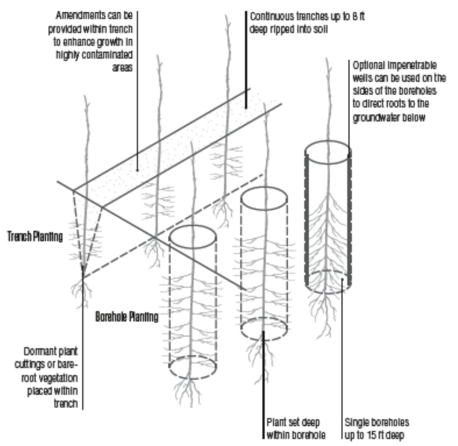


Figure 81: Deep root remediation, from Kennen & Kirkwood (2017, p46)

6.2 Detailed design

One solar garden (Figure 83) will be designed to tackle the negative attitudes toward renewable energy. A lot of people sense the solar panels are ugly. Thus, the solar garden will be more than just something to produce electricity. It will be a space that people can walk through and spend time in it (Figure 84). People will see a contemporary garden filled with plants, butterflies, bushes, and transparent solar panels. Meanwhile, plants will be ranging heights and establish a sense of closure around these panels. People can come to this orchard to enjoy a nice sunshine afternoon, being far away from the dense city.

Figure 83: Detailed design plan

Figure 84: Solar panel garden

7

DISCUSSION & CONCLUSION

7.1 Discussion

7.1.1 significance of this study

Although the importance of the development of renewable energy is widely acknowledged, the majority of renewable energy infrastructures are constructed in the countryside. The major premise of this thesis is that city-integrated renewable energy can provide various advantages. In order to find the solution of how to construct these infrastructures, this study provides approaches to assess the qualities of the 'old' landscape, and the potential for renewable energy infrastructure to fit in it. Furthermore, from the academic perspective, this study contributes to research on current trends in the transition towards sustainable energy. Moreover, the research results were tested in the Amsterdammerpolder area, one of the representative fossil-fuel dominated harbour areas in the Netherlands. As such, the outcomes of this study can provide an example to several other Dutch ports yearning for sustainability.

7.1.2 Reflection on synchronicity landscape approach

This thesis explored the possibility to install renewable energy infrastructure in urban territory through the synchronicity landscape approach. As stated by Kristen, Julian, and Chris, this method allows to find the way to implement a new program into an 'old' landscape, based on landscape qualities(Kristen et al., 2004). Considering the spatial possibility to install renewable energy infrastructure, this approach is, therefore, quite different from the rules for the design of solar panel fields in the countryside. Based on the 'Handreiking ruimtelijke kwaliteit zonne-energie Zuid-Holland', solar panel fields are required to be constructed so as to fit into the block-shaped plot structure of the countryside and of the village in terms of scale. In addition, they should be used to reshape the messy edge of the village, and strengthen the connection between the village and the surrounding countryside. Furthermore, a well-designed edge should also be taken into account to reduce the impact on local residents (Provincie Zuid-Holland, 2019). The block-shaped structure is crucial for the design of solar panel fields in the countryside. On the contrary, multiple factors should be considered for the installation of renewable energy infrastructure in urban territory. As mentioned by Perec, no preconceived ideas should be adopted before the start of the project (Perec & John, 2008).

Through the landscape types map and the analytical drawings, a better understanding of the landscape qualities of the site was obtained, which is helpful to build a 'logic' for the design principles.

7.1.3 Reflections on design

The Amsterdammerpolder area is a typical Dutch industrial, fossil fuel-dominated harbour. Its sustainability is planned to be achieved in the future. However, the current visions for its sustainability transition mainly focus on the production sector, thus neglecting the landscape qualities and the possibility to make the renewable energy spaces more multifunctional. The integration of energy production with other functions such as ecology, entertainment, education, and remediation, seems to provide a better solution. As mentioned in chapter one, two general problems affect city-integrated renewable energy: the uncertainty and variability of energy use across the urban territory, and the objections from the public. The new design offers solutions to deal with these two problems. Firstly, the Amsterdammerpolder area is regenerated and be adaptive to future uncertainty. Secondly, the energy park provide people with a chance to be close to the renewable energy infrastructure with a relaxed mood, observing also the differences between fossil and renewable energy sources.

Moreover, this area is not unique, as several other similar fossil fuel-dominated port areas can be found in the Netherlands.

7.1.4 Limitations

This study has a few limitations. Firstly, considering the complexity of the port, more landscape types can probably be identified during the implementation of the synchronicity landscape approach, which implies further potential for design. In addition, the design of the site is strongly specific to the local environment, and can only be an example, and not a model, for other harbours, whose differences in terms of landscape types should always be investigated.

7.2 Conclusion

The conclusions are interpreted in this section. In order to answer the main research question, the two sub-questions were answered first:

The first sub-research:

What kind of functions should the Amsterdammerpolder area have during the transition towards sustainable energy?

The transition of the Amsterdammerpolder area towards sustainable energy is inevitably influenced by the peripheral environment and, therefore, by the kind of functions the area should have.

Firstly, the case study area is part of the port of Amsterdam, which is one of Europe's largest energy-related harbours. Currently, coal and oil account for 77% of the industrial activities in the port of Amsterdam (Port of Amsterdam, 2017). On the other hand, the port of Amsterdam is seeking to expand and enrich its renewable energy sources to replace some coal-related industries. This ambition definitely promotes the transition of the Amsterdammerpolder area towards sustainable energy. Secondly, another influencing factor is the Port City plan. The Municipality of Amsterdam is planning a new city region near the site, where more than 150,000 people are expected to work and live. With the accomplishment of this project in 2050, the Amsterdammerpolder should be designed so as to meet, to the maximum possible extent, the future increasing needs for energy, recreation, and for some other functions. Finally, the Hemweg energy plant is a crucial element of the case study area, as it is a fossil fuel energy plant and occupies one-fourth of all land. The coal-fired part of the plant was closed at the end of 2019, and only the gas-fired Unit 9 is currently in operation. Furthermore, the plant management company is planning a new fossil-free hub at this location, which will include the production, transit, and temporary storage of renewable energy.

As mentioned in chapter four, the Amsterdammerpolder area should fulfil several functions during its sustainable energy transition. In order to deal with the dynamic temporal changes of the required functions, this transition is also expected to be fulfilled step by step.

The second sub-research question:

Which types of landscape in the Amsterdammerpolder area are suitable for the renewable energy infrastructure, and how?
1) Which are these landscape types?
2) How can renewable energy infrastructure be implemented in these landscape types?

The landscape of the Amsterdammerpolder area is complex, and five landscape types can be distinguished, based on the containment and openness, as well as on the textural and sensuous qualities. For each landscape type, a future was envisioned in which their characteristics were conserved and redeveloped while installing renewable energy infrastructure. Synergies between energy production, industrial remains, industrial production, entertainment, and ecology were discovered to meet the standards of landscape sustainability.

The design question:

How can this transition be realized incorporating the recycling of the previous post-industrial landscape of OBA coal field?

The post-industrial landscape of OBA coal field can be redeveloped with the transition towards sustainable energy. The design of this energy park shows the potential of making use of the remains. With the incorporation of the history and the remediation methods, the energy park can provide multiple functions for visitors. Meanwhile, renewable energy can fit well into this park and also help to interpret the narrative of the site, as well as providing recreation and ecological functions, to add extra values to the site and fulfil the transition towards sustainable energy.

The main research question:

What is the potential of renewable energy infrastructure to be multifunctional during the transition towards sustainable energy in the Amsterdammerpolder area?

A multi-perspective, cultural, and historic design strategy can be employed to achieve the sustainable energy transition in the Amsterdammerpolder area. This transition needs to be accomplished step by step to satisfy different needs and has to be adaptive to the uncertainty emerging during urban development. Renewable energy infrastructure can be incorporated into the regeneration of old extraction facilities. By treating renewable energy as part of the landscape system, a type of landscape element, i.e., the industrial port, can be changed into a new landscape, thus satisfying the future needs for production and other functions.

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APPENDIX

Landscape types evaluation form

Landscape types evaluation (Amsterdammerpolder area)

Containment and openness	Yes or no	Description
For solar panel	Y/N	______
For wind turbine	Y/N	______
For other	Y/N	______
Overall		______

Textural and sensuous	Yes or no	Description
Protected species	Y/N	______
Ecology corridor	Y/N	______
Commination	Y/N	______
History value	Y/N	______
Infrastructure	Y/N	______
Overall		______

Potential for other functions

______

______

Reflection(opinions, potential towards present and future)

Photo

Photo

Analytical Drawing

Site Photo