

Towards A Sustainable Blue Economy: How To Make An Industrial Zone More Environmentally Friendly? The Case Of Rotterdam Harbor

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1. ABSTRACT: Since the world-leaders decided to reduce the emission of Carbon to stay below the threshold of 1.5 °C warming-up of the atmosphere (Paris agreement, Dec. 2015), the large-scale industrial areas have to find ways to become more environmental-friendly. Especially areas developed in the 1960's - 1970's are often polluting the environment (air, water and soil) with high emission rates., due to their old fashioned modes of operation. One of the major sources of pollution is the use of fossil-fuel energy . Replacing this by more environmentally friendly alternatives is an effective step in the reduction of emissions.

Several approaches look promising. In regions with frequent winds the exploitation of windmills is profitable. In sunny regions the exploitation of solar-farms is profitable. Although still in an experimental stage, the use of green hydrogen-gas might become promising in the next years.

This paper is about the preparations for the construction of a large-scale

windfarm in the new, highly industrialized part of the Rotterdam harbor, where winds are all year round. It describes the different interests of the various stakeholders, and how these can be harmonized in a solid solution. Managing the differences in interest is important, because it can be the key to succession or to failure.. Which elements create a positive business case, so that it becomes profitable for investors to step in?

Creating a business case with a positive outcome can take much time, especially with many stakeholders with conflicting interests. In this case the area is not only industrial zone, also protection against flooding is a main topic and it is also an area for multiple types of recreation, including bathing, swimming, wave-surfing, wind-surfing, kite-surfing and board surfing. And this all is situated next to a protected nature reserve. The paper describes this process for the Rotterdam harbor. Once the business case is closed it will take a couple of years to select a qualified supplier/builder and to get electricity delivered.

The smart combination or else the exclusion of functions is the key to get the windfarm fitted into the spatial plans and functions. This is detailed in this paper.

Keywords: *Sustainable energy production, industrial zone, balancing interests.*

2. INTRODUCTION

The port of Rotterdam (fig.1) is the largest port of Europe. Ports are economic drivers. Large ports create much activity including emissions. Since the world-leaders decided to reduce the emission of carbon to stay below the threshold of 1.5 °C warming-up of

the atmosphere (Paris agreement, December 2015), the large-scale industrial areas have to find ways to operate more environmental- friendly. Especially areas developed in the 1960's - 1970's are often polluting the environment (air, water and soil) with high emission rates, due to their old fashioned modes of operation. Although more recent techniques might have reduced the emissions, they still remain fairly high. That is why energy- options that don't use fossil-fuel become more important. To become CO₂-neutral or to reduce other emissions significant renewable energy becomes more important.



Figure 1, location of the wind farm on Maasvlakte2, the Netherlands.

The Ministry of Infrastructure and Water in the Netherlands has decided in 2018 to become energy- neutral on all the networks they manage (main waterways and roads in the country) by 2030. To reach this goal a location needs to be found where renewable energy can be produced in high volumes. The energy-consumption of the Ministry is around 200 GWh/year and is increasing, due to the shift to electric vehicles and increasing use of smart-traffic options and reduction of gas-fueled installations.

Looking to the meteorological conditions we see that the northern countries in Europe in general have good opportunities for water as energy-source, the height differences allow for this. In the moderate zones wind force is the dominant source and more towards the southern European countries solar- plants are favorite (Segreto et. Al., 2020). In the Netherlands wind-born energy is coming in large volumes from the large wind farms on the North Sea. Onshore this production is in smaller volumes, due to restrictive conditions like spatial planning and nature-impacts that prohibit real large scale wind production farms. In the stretch along the coast not

much windfarms have been erected, since many other functions are already operational there and interfere with new wind farms. Therefore it is not easy to find suited locations for extra energy production in large volumes. In many industrial zones windfarms have been installed, but not on a very large scale. Mainly because the available area is relative small. Industrial zones are developed to organize economic activities in a smooth way, and not to optimize the energy-production of that area. The energy-production is a new loot on the stem and has to conquer with the existing functions, who also claim to have priority and reduce the options for new wind farms. And on those locations where some space is left the wind farm has to fit into the existing spatial plans, including the restrictions they have formulated in the different environmental issues, such as noise production, vertical building limits and safety for the surrounding buildings and people. This altogether creates opposition to locations situated near cities, villages and neighborhoods, and lengthy procedures. The impact of these objections on the business case may be large, sometimes too large to finalize the procedures.

3. A WINDFARM ON MAASVLAKTE2

Already during the phase of design and construct of the recently constructed Maasvlakte2 many functions were thought to have a place in the sea-defense (fig 2) (Bestemmingsplan Maasvlakte2, 2008). Note that in this figure a windmill is positioned in the infra-bundle, which was seen as the most logical location at that time. We see that within the area of protection against storm surges and flooding also recreation, nature, industry and infrastructure conquer for space. Each of these functions can be subdivided into more specific aspects. When we look into recreation we can find beach-leisure, bathing, swimming, wave-surfing, board-surfing, kite-surfing and horse-riding. This is done on different stretches of the sea wall. The same holds for infrastructure. Roads, railroads and cables and pipes use different alignments. Also for nature we can subdivide into nature in the shallow sea, on the beach and in the dunes. From industrial perspective each square meter is used for either containers, distribution or chemical purposes, as decided during the phase of planning and design of Maasvlakte2 (Environmental Impact Assessment Maasvlakte2).

Multifunctional seawall

- Coastal defence
- Recreation
- Dune landscape
- Nature
- Infrastructure
- Wind mills

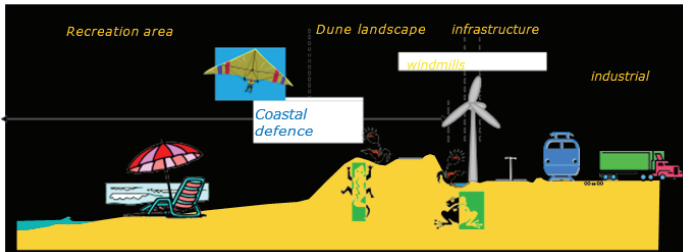


Figure 2: different functions located in the cross-section of the seawall

Looking in more detail we see that there is no square meter that has no function. So, if we want to bring in a new function, or change an existing one into a higher impact or volume, we have to weigh the pros and cons of the options. We also need to take into account that next to the industrial zone a nature protected area is situated, the so called Voordelta. A shallow zone with undep water and changing salinity concentrations. This is never done before and will be elaborated in the next paragraph.

4. THE FUNCTIONS AND CONFLICTING INTERESTS.

In the original design of Maasvlakte2 there was room created for wind energy, but only with high extra costs (E.I.A. Maasvlakte2) . To build a wind farm an extra banquet of sand was needed along the whole stretch (ca. 6.5 km) of the sandy coast, to fulfill the boundary conditions for safety. The costs for this extra sand were so high that no positive business case for a wind farm was possible. The location of the windmills in the cross section is also a source for debate. From a social point a framework is developed by Gamboa (2007). This takes the impact on various landowners into account, where on Maasvlakte2 the Port of Rotterdam Authority is the only organizations to lease land for any purpose. From an strict economic point of view, where all aspects are deduced to an amount of money a comparison is made for a Scottish case (Moran, 2007). Here we need to balance between ecological and economic aspects. Differing from most inland locations we don't have

citizens near the proposed location, with the complaints coming from the local residents (Langbroek, 20212) and differing from most offshore locations we can see the result also when you are remote from the location, since the size of the windmills fits more with offshore sizes than with onshore sizes.

-From an industrial point of view they should be put as far as possible to the seaside, to have the maximum options for industrial use without limitations.

-From infrastructural point of view it is important to avoid blockade of the road, railway and cables and pipes-zone. If something goes wrong with a wind mill and a wick comes down it has to be assured that this will not hinder the traffic and cannot interrupt the transport via the pipes and cables. The so called high-impact zone has to be free of parts of the windmills at all times. This forces the possible locations of the mills to move seawards, more remote from the infra-bundle.

-Within or on the dunes we face another type of problem. Dunes are not fixed, but moving units, so the shape is not fixed. This creates problems when you need to enter the windmill for maintenance purposes etc. and vehicles have problems to come close to the windmill, because of possible disturbance of nature values. So delivering spare parts e.g. is problematic. The nature values need to be protected as well.

-The front-side of the sea wall is the area for the different types of recreation and leisure. We find the people who want to bath in the sun, or like to walk along the water, or to swim. But also the people who want to be active with all kinds of sports. This area is very suitable for different styles of surfing. Wave surfing is possible here, board surfing and windsurfing as well. And various forms of kiting are popular. From a safety point of view the wind mill should not be placed in an area where people can be in crowds. So on intensive used stretches this cannot be combined, but on extensive used parts this might be combined, with some types of recreation. As long as you don't collide with the mast of the turbine and can avoid to become entangled in the wicks, you can use the area. But high speed activities become problematic. Also kite surfing, where jumping is one of the attractive elements of this type of sport is dangerous. From a safety point of view this cannot be combined.

-From a point of safety against flooding it has to be assured that the construction is capable to withstand a certain storm with a chance of occurrence. In a sandy environment this means that enough sand has to remain after the unwanted event took place. This create very strict boundary conditions for possible locations for wind mills.

-from the point of external influences is has to be avoided to create negative impact on the nature protected Voordelta, with high but fragile nature values.

So we see that form the individual standpoints of each of the functions the driving force is always to avoid negative impacts of the wind mill. Overlooking the cross-section there is no place that is not disputed. So the question is, how to find a place without unacceptable negative impacts.

As described above initially a very costly sand banquet is needed when the mills are put in the zone where safety is required. This is the zone were a certain volume of sand needs to remain after a severe storm which erodes a large volume of sand. These costs for a sand banquet will outrange a positive business case. In a place outside of this safety-buffer it might be easier to get a positive business case, since there is no (or much lesser) need for extra sand. As paragraph 4 explains the functions in the cross-section are multiple and the impact zone of each overlaps with the impact zone of one or more other functions. The solution is created in a combination of boundary conditions and taking up responsibilities.

One of the main aspects for a business case is the guarantee for the yield of the produced energy for a certain period. As described in the introduction the Ministry of Infrastructure & Water wants to be energy neutral by 2030. This means that all necessary energy is produced in a renewable production unit. The Ministry has guaranteed to buy all produced electricity for the next coming 25 year. This is a great step for a business developer, since it is not only guaranteed that the electricity can be used, but also for a fixed price for this whole period. On the income-side of the business case there is certainty, which is very important when you want your project to get financed. Then remains the question where the windmills can be incorporated into the cross section.

Looking to the stretch along the coastline of Maasvlakte2 there is a difference is priority along the longshore of the coast. In the southern part the focus is on nature values. These should be protected and remain uninterrupted. In the southwestern part is the more intensive used beach, much beach recreation including sun-bathing due to the good orientation towards the sun. The northwestern part is a much less intensive used beach. This is the extensive used area where sportsmen go for kiting and surfing etc. In the northern part the spotting of the ship that sail in and out of the harbor is the major activity (see fig. 3). It will be clear that the impact of the different types of recreation on the surrounding area differs. When you lay on your towel on the beach, there is no impact on other functions, when you sit or stand to spot the traffic neither. When you are kiting you need a lot of space that cannot be used for other activities at the same moment.

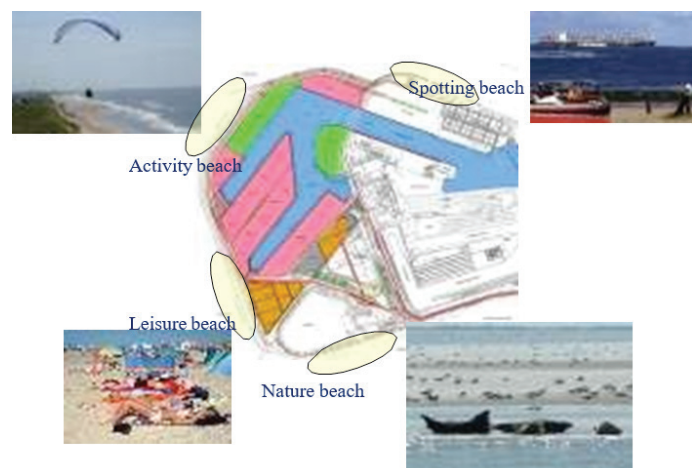


Figure 3: different types of recreation of specified places of the contour

6. MITIGATING ACTIONS

The conflicting interests in the cross-section cannot be solved without any harm. They are dissimilar and their weight will be judged different by different people. To optimize the choice is made to move the windmills into the tidal-zone. This has one great advantage, that there is no need for an extra sand banquet. Meanwhile it introduces a new challenge, that is to build nearly onshore with mainly off-shore techniques. The impact of the wind farm on the industrial zone is eliminated. The impact on the sea wall with all nature values that it holds is also eliminated or at least sharply reduced. The impact on the recreation on the beach is minimal. The shadow of the wicks is not on the beach. The windmill

closest to the recreation zone will get special wicks to reduce the noise with 2 dBa. The impact on swimming is minimal, since you need to go further into the sea when you want to swim, and for those who want to paddle there is no problem. For windsurfing there is also no impact. For board-surfing neither, since the water depth is too low to surf near the pillar of the windmill. For kite-surfers who don't jump there is no problem, but for kite-surfers who jump and make acrobatic turns the situation changes dramatic, since it cannot be allowed to do these exercises in the neighborhood of the windmills. Their ropes may hit a wick with disastrous result. So it is decided to forbid to kite in the area where the windmills will be erected. In the season with few recreation activities on the beach it can be allowed to kite in that area. So zoning in space and in time can create an acceptable outcome, albeit that it is not possible to avoid any negative impact. Being situated on the edge of a nature-protected area (the Voordelta), it is also important to look at possible impacts on this area. The nature values are the shallow water, with salt and brackish water and turbulent bottom.

Furthermore additional measures are taken. To minimize the number of birds that will be killed by hitting a wick a very advanced radar-system is developed. This radar identifies large numbers of birds and their tracking. When we combine the atmospheric conditions (wind direction and -speed, twilight or dawn, rain or dry) with the season and the radar-information, gathered at different locations, along the coast and on the North Sea, it is possible to predict at which time migratory birds will go either to the south or the north. That is important because the whole European coast is a major migration-route for many kinds of birds. There is a provision to stop the windmills timely, so that the birds can migrate without disturbance and without being hit by a wick.

A comparable system will be used to identify bats. With bat-detectors on some of the windmills the bats are able to avoid collision with the windmills, thus reducing the number of victims. The pillars will be built in the intertidal area. This means that sea mammals might be impacted when they come closer towards the construction work. To reduce this impact a hydro-hammer will be used, which reduced the noise under water and also allows for a shorter time per pillar to be drilled into the sea bottom.

The possible impact of the windmills on the mammals that travel through the North Sea on their normal routes will be acceptable. They travel on large distance from the location, so there is much damping of the produced noise during the pile driving.

There will be an extensive monitoring program to gather information of the possible impacts. The data that will be collected will be shared with the data that comes from offshore windfarms, in an open source. So everybody who is interested can dive into this information and check the findings or measurements they prefer. This sharing improves the knowledge that will be needed for next generation wind-farms, both offshore and onshore. The combination of cooperative partners on one hand and a business case with a positive outcome on the other hand delivers boundary conditions and a level playing field to come to a solid and robust plan. To project these results on other circumstances both sides, the level playing field, and the business case are equal important. A level playing field can only be reached when all relevant information is shared, so that the parties can make a good judgement of their position. And a business case with too much undefined or open end variables will never convince a bank to invest in this project.

The outcome of this process is that no objection is adopted by the court, so that this plan now is in the phase of realization and that starting from the second half of this year the energy produced by this windfarm will be delivered to the client. The goals for an energy neutral and sustainable production of electricity will be reached in 2023, already 7 year before the deadline.

7. SUMMARY AND CONCLUSIONS

Although an industrial area might seem very suitable for renewable energy-production, it turns out to be challenging to find a location where a production unit can be installed without interference with other functions. For wind-energy the required space is not as large as for a solar-production unit with equal production, but still it is a conquer of space with other functions.

A business case has many variables, including involved parties and their interests, unforeseen costs and varying revenues. Sometimes it is necessary to fix some of

these variables in order to come to a solid basis, on which investors are willing to participate.

To find acceptable locations it is necessary to create an atmosphere in which all parties can realize something of their interest. Cooperation and mutual understanding benefits from open discussions, and will be interrupted or disappear when hidden agenda's seem to exist. Also in situations where this open mode of operation is not common use, it is recommended to follow this approach.

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Create enough budget and space to realize mitigation and compensation, to alleviate the negative impacts for sectors. Be pro-active in the setup of monitoring and evaluation programs and share the information with involved parties, to build trust and to decide together on possible (mitigating) steps where necessary.

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