Netherlands Enterprise Agency

Appendices Hollandse Kust (zuid)

Wind Farm Sites I & II

Appendix B: Summary Environmental Impact Assessment
Part of Project and Site Description

April 2017

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22 mei 2016

ENVIRONMENTAL IMPACT ASSESSMENT SITE I WINDENERGIEGEBIED HOLLANDSE KUST (ZUID)

Ministeries van Economische Zaken en Infrastructuur en Milieu

Definitief

Duurzame oplossingen in
energie, klimaat en milieu

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SUMMARY

1. Introduction

The Netherlands has formulated ambitious objectives for realising the generation of sustainable, renewable energy with wind energy playing a prominent role. In addition to onshore wind energy, concrete objectives are formulated for offshore wind energy. These objectives have been revised and elaborated in the Energy Agreement for Sustainable Growth (SER, Energy Agreement, 2013). A choice has been made to achieve these objectives using a new issuance system. The Offshore Wind Energy Bill has entered into force to this end, which gives the State the option of issuing sites for the development of offshore wind farms. A wind farm site decision stipulates where and under what conditions a wind farm may be constructed and operated. A permit is granted after a wind farm site decision is made. Only the permit holder has the right to construct and operate a wind farm at the site location. The Water Directive contains general regulations on offshore wind energy.

The Minister of Economic Affairs (in coordination with the Minister of Infrastructure and the Environment) is responsible for issuing sites and, for that purpose, drafts an environmental impact assessment (EIA) for each wind farm site decision. This document relates to the EIA for site II in the wind farm zone of Dutch Coast (south). The EIA describes the environmental impact of the construction, operation and decommissioning of wind turbines at that site.

The wind turbines installed in the Dutch Coast (south) wind farm zone must be connected to the high-voltage grid. TenneT is responsible for providing this connection. This comprises two platforms in the Dutch Coast (south) wind farm zone, the cables from these platforms to and over land, and the connection to the high-voltage grid on land. For the offshore grid, TenneT will carry out a separate procedure including an environmental impact assessment (EIA).

This summary addresses the following:

- The policy context and the reason for the site decisions to be taken;
- The choice of location for the Dutch Coast (south) wind farm zone;
- The division of the Dutch Coast (south) wind farm zone;
- The impact assessment method;
- The result of the impact assessment;
- The considerations;
- Any gaps in knowledge and information;
- Monitoring and evaluation;

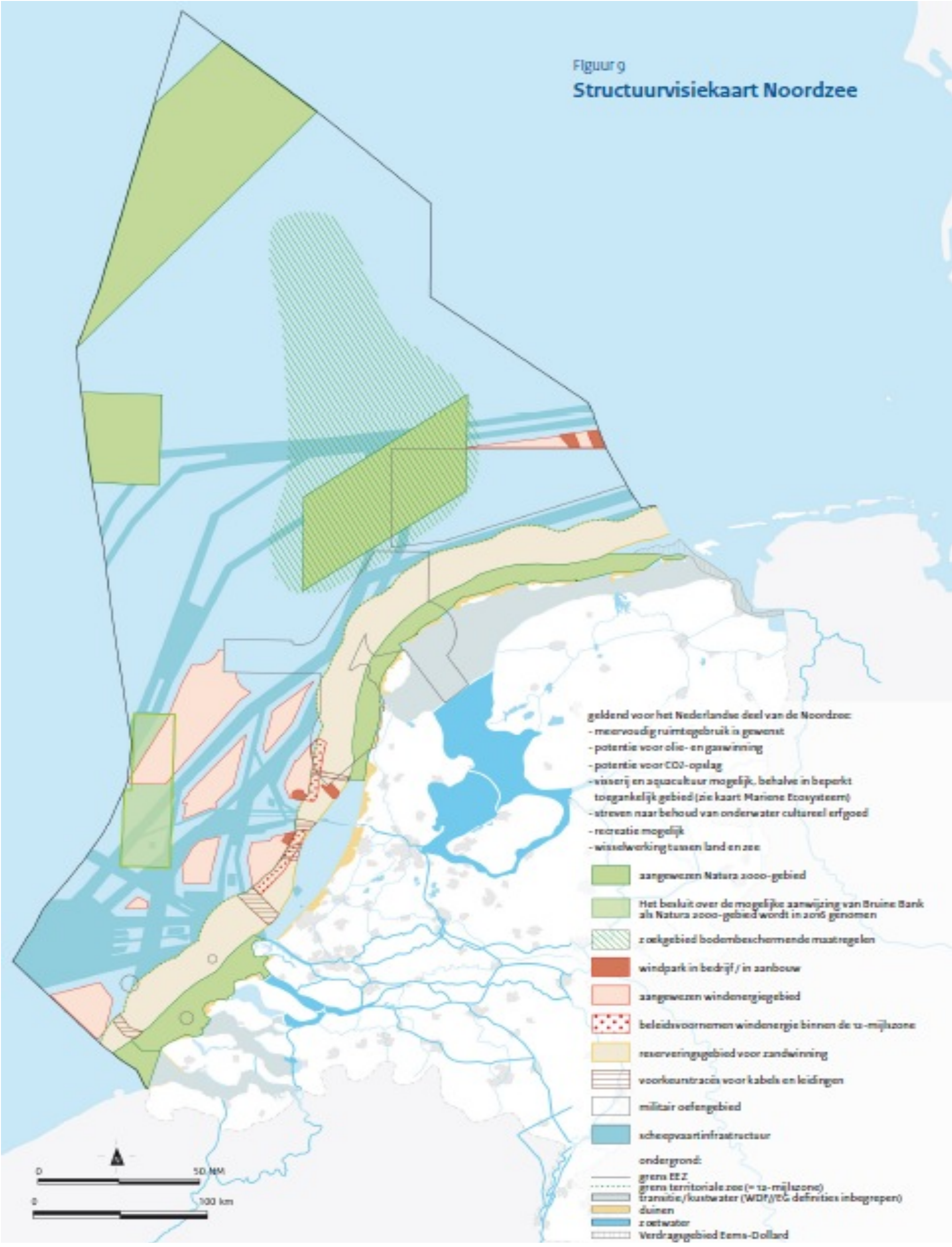
2. Policy context and cause for wind farm site decisions

Four zones have been designated for the development of offshore wind power generation. See also the following figure:

- Borssele;
- IJmuiden Ver;

- Dutch Coast;
- To the north of the Wadden Islands.

Figure S1 Wind energy zones (from: National Water Plan 2016-2021)



On 26 September 2014, the Minister of Economic Affairs and Minister of Infrastructure and the Environment sent a letter to the Lower and Upper House presenting the roadmap to promptly achieve the objective for offshore wind energy, as agreed in the Energy Agreement (Parliamentary Papers I/II, 2014-15, 33 561, A/no. 11 (reprint)). The letter discusses the

offshore grid (previously known as the offshore transmission system), the new system for generating offshore wind power, and the wind farm zones.

The Government concludes that a coordinated grid connection of offshore wind farms leads to less public spending and less impact on the environment. The starting point for the roadmap is that the task of generating offshore wind power can be realised in the most cost-effective manner by means of an offshore grid. This offshore grid is based on standard platforms where a wind power capacity of 700 MW can be connected per platform. Wind turbines within the wind farms can be connected directly to the platform. On the basis of the Electricity Act 1998, TenneT may now be appointed as the offshore grid operator.

The following table shows the timetable for the development of offshore wind power taken from the roadmap.

Year	Timetable (MW)	Roadmap zones
2015[1]	700	*Borssele*
2016	700	*Borssele*
2017	700	*Dutch Coast (south)*
2018	700	*Dutch Coast (south)*
2019	700	*Dutch Coast (north)*

3. Location choice

The National Structural Vision for Offshore Wind Energy (see annex Parliamentary Papers I/II, 2014-15, 33 561, A/no. 11 (reprint)) investigates whether the Dutch Coast (south) wind farm zone is suitable for generating wind power. This structural vision explores the effects of wind energy in the Dutch Coast (south) zone in detail in terms of ecology, maritime safety, other uses (oil and gas, fisheries, sand extraction, etc.), geology and hydrology, landscape (visibility), and cultural history and archaeology. It also examines suitability in relation to the other designated wind farm zones (IJmuiden Ver, Dutch Coast, To the north of the Wadden Islands and Borssele). The EIA for the Borssele wind farm zone sites makes a broad comparison between the zones, which is included as annex 2. A closer examination of the suitability of the Dutch Coast (south) zone for wind energy is therefore not required for this EIA.

The letter of 26 September 2014 also discusses a study into the sustainability of developing wind power in five zones situated 3 nautical miles (NM) from the coast. None of these five zones under study deemed wind power generation infeasible. However, in order to address concerns and ensure cost effectiveness, the Government sought to keep the use of the 12-mile zone to a minimum by only partially using two of the five zones studied. By connecting to a narrow strip between 10 and 12 NM in the Dutch Coast zones outside of the 12-mile zone, 1400 MW can be generated for the coast of South Holland and 700 MW for the coast of North Holland.

[1] January 2016

The various wind farm zones all entail both significant adverse effects (birds and marine mammals without any mitigating measures) and minor adverse effects. The differences between the zones in that respect are limited. The Dutch Coast wind farm zone is the cheapest to develop. If the zone can be extended to 10 NM from the coast, there is much more relatively cheap wind energy to be harnessed. This wind farm zone (much more so than the other zones) does however have an impact on visibility, maritime safety, oil and gas extraction, and fisheries. As a follow-up to the EIA, special attention should be paid to those effects on the basis of this analysis.

4. Division

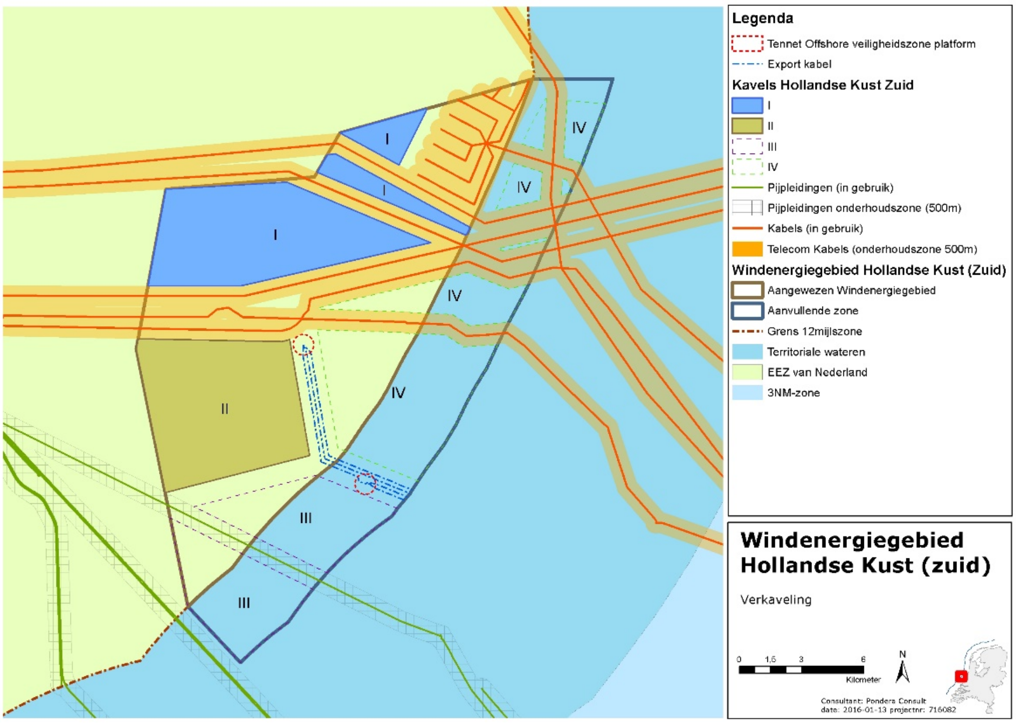
If the Dutch Coast (south) wind farm zone is expanded by a strip between 10 and 12 NM from the coast, there will be enough room for four sites. Due to the size of the TenneT offshore platforms envisaged, each with a capacity of around 700 MW, and the total available surface area (356 km^2), it is proposed to divide the zone into four sub-zones, each of which can be connected to these offshore platforms in twos. The four sub-zones together thus provide capacity for around 1400 MW. The zone beyond 12 NM already identified provides enough space for two sites.

The proposed division is initially created by mapping obstacles that prevent wind turbines from being sited there and any existing cables or pipes in the zone. In figure S2, the Dutch Coast (south) wind farm zone is marked with existing obstacles. The division is then made on the basis of the following:

- No cables or pipes through multiple sites;
- Cables between turbines and the platform (inter-array cables) are to be as short as possible. For the cable route from the platforms to the coast, another shorter route is envisaged than the route through the preferred zone for cables and pipes from the National Water Plan 2, as it would be more cost effective.
- The area to the west and south of the wind farm zone is exposed to wind from the more eastern or north-eastern zones. Sites less exposed to the wind are therefore bigger in order to have a greater distance between the wind turbines.

Based on the foregoing, the zone is distributed as highlighted in figure S2.

Figure S2 Proposed division of the Dutch Coast (south) wind farm zone



Firstly, the procedure for the two sites beyond 12 NM will be initiated (site I and II in figure 3.1). If the National Structural Vision for Offshore Wind Energy – Dutch Coast supplement is established as intended, the procedure for the two sites partially lying within 12 NM (site III and IV) will be initiated. In order to connect the sites in twos to the TenneT offshore platforms over time, they must be positioned close together. The combinations of wind farm sites I and II and wind farm sites III and IV are therefore the most obvious.

Sites III and IV lie partially between 10 and 12 NM away. This area has yet to be designated for the development of wind power. Sites III and IV depend on the partial revision of the National Water Plan 2 (NWP2) and National Structural Vision for Offshore Wind Energy – Dutch Coast supplement. This plan offers the option of developing wind power between 10 and 12 NM off the Dutch Coast. The revision of the NWP2 is expected to be completed by mid-June 2016. If the area between 10 and 12 NM is not designated, this may have an impact on the location, size and development of sites I and II. It has been decided not to consider that scenario in this EIA, but to draft a new EIA if the area between 10 and 12 NM is not designated.

In the letter of 19 May 2015 (Parliamentary Papers II, 2014-15, 33 561, no. 19), the Minister of Economic Affairs indicated that allowing up to 380 MW per site may offer economies of scale and optimal usage, on the understanding however that a maximum connection and transmission capacity is guaranteed for 350 MW per site. These benefits may result in lower costs per kWh. For those reasons, a total of 380 MW is assumed for each site (so that the effects are not underestimated).

5. Impact assessment method

Bandwidth

An EIA assesses alternatives to an activity by examining their effects and comparing them. An alternative is a possible way in which the proposed activity, in this case power generation with wind turbines, can be realised considering the purpose of this activity. In this EIA, alternatives for two areas, each with one wind farm, were examined (two so-called 'wind farm sites'). The alternatives are based on a bandwidth for various wind turbine set-ups and types that are possible within such a wind farm site.

The wind farm sites within the Dutch Coast (south) wind farm zone are therefore issued with the option for the wind farm developer to do this at its own discretion. The bandwidth that must be adhered to is recorded in the wind farm site decision.

Bandwidth

By issuing wind farm sites in which various wind turbine set-ups and types and foundation methods are possible, within a certain bandwidth, a flexible design of the wind farm sites is possible. The developer is free to make the wind farm design optimal in terms of cost effectiveness and energy yield. This bandwidth approach makes specific requirements of this EIA. All environmental effects associated with all possible set-ups made possible by the wind farm site decisions should be examined. Researching all possible set-ups is not possible however due to the multitude of potential combinations. Therefore, a worst-case approach is assumed: if the worst-case scenario for potential effects is permissible, then all other set-ups within it are also possible.

Alternatives

The worst-case scenario will differ for different aspects (for example for birds and marine mammals). This is taken into consideration in the study by researching and comparing several worst-case scenarios as alternatives in the EIA. The parameters defined in the worst-case scenario must be named and described, such as the maximum number of turbines, maximum upper and lower limit of the rotor, maximum rotor surface area, characteristics of the foundation method, etc.

To obtain an idea of the possibilities to reduce the effects, mitigating measures are designated and examined for each aspect. This means possibilities for optimisation are identified and prevents solely

The bandwidth of design possibilities for the wind farm site to be issued is shown in the following table.

Table S1 EIA bandwidth

Design	Bandwidth
Capacity of individual wind turbines	6 – 10 MW
Highest tip point of individual wind turbines	167 – 251 metres
Lowest tip point of individual wind turbines	25 – 30 metres
Rotor diameter of individual wind turbines	142 – 221 metres
Distance between each wind turbine	At least 4 x rotor diameter
Number of blades per wind turbine	2 – 3
Type of foundations (substructures)	Monopile, jacket, tripile, tripod, gravity-based structure
Type of foundation	Pile foundations, suction buckets, gravity-based structures
Installation method for pile foundations	Vibrohammering, pile driving, drilling, suction
In case of pile-driving foundations: pile-driving energy related to turbine type/pile	1,000 – 3,000 kJ, depending on soil conditions and diameter of foundation
In case of pile-driving foundations, diameter of foundation pile/piles and number of piles per turbine:	
Jacket	4 piles of 1.5 – 3.5 metres
Monopile	1 pile of 6 to 10 metres
Tripod	3 piles of 2 to 4 metres
In case of a foundation without pile driving, dimensions on seabed:	
Gravity-based	Up to 40 x 40 metres
Suction bucket	Bucket diameter: tbd
Electrical infrastructure (inter-array cabling)	66 kV

As indicated, the worst-case scenario for different aspects, for example for birds and marine mammals, can be different. The table below shows the different environmental aspects in the worst-case and best-case scenarios.

Table S2 Worst-case and best-case scenarios within the bandwidth per environmental aspect

Environmental aspect	Bandwidth	
	Alternative (Worst case)	*Alternative (Best case)*
Birds and bats	63 x 6 MW turbines Lowest tip point 25 m, rotor diameter 142 m	38 x 10 MW turbines Lowest tip point 30 m, rotor diameter 221 m
Underwater life*	38 x 10 MW turbines Pile-driving energy: 3,000 kJ 1 turbine location per day	63 x 6 MW turbines Pile-driving energy: 1,000 kJ 1 turbine location per day
Shipping	63 x 6 MW turbines Jacket foundation with 15 m diameter	38 x 10 MW turbines Monopile foundation with 10 m diameter
Geology and hydrology	63 x 6 MW turbines	38 x 10 MW turbines
Landscape**	63 x 6 MW turbines Min. rotor diameter 142 m Min. axle height: 96 m	38 x 10 MW turbines Max. rotor diameter 221 m Max. axle height: 140 m
Other use functions	63 x 6 MW turbines	38 x 10 MW turbines
Electricity yield**	63 x 6 MW turbines	38 x 10 MW turbines

* For underwater life, the worst-case and best-case scenario differ per 'sub-aspect' (marine mammals, fish and benthic life) and can also not be clearly defined in advance. Although the sound production during pile driving at 3,000 kJ is higher than at 1,000 kJ, the number of piles that are driven with greater pile-driving energy is lower, meaning the overall environmental impact may be lower.
** For landscape and electricity yield, there is not really a worst-case or best-case scenario, but the alternatives do specify a bandwidth.

Assessment

In order to be able to compare the effects of the options per aspect, these are assessed on a +/- scale in relation to the zero option (i.e. the current situation and autonomous development). The following rating scale is used for this purpose, as shown in table S3. The assessment provides a justification.

Table S3 Scoring methodology

Score	Opinion in relation to the reference situation (zero alternative)
--	The intention leads to an extremely noticeable adverse change
-	The intention leads to a noticeable adverse change
0	The intention does not differ from the reference situation
+	The intention leads to a noticeable positive change
++	The intention leads to an extremely noticeable positive change

If the effect is marginal, this is indicated in such cases as 0/+ (marginally positive) or 0/- (marginally negative).

The Appropriate Assessment quantifies the effects in order to evaluate whether the preferred alternative has any significant impact on Natura 2000 areas.

In addition to the effect of a wind farm at wind farm site II, cumulative effects of other wind farms and activities are considered and mitigating measures also examined.

6. Result of environmental assessment

The following tables show the assessments of the alternatives per aspect against the various assessment criteria, again without the application of mitigating measures. The tables are then discussed per aspect. This is a summary of the impact assessment, simplifying the description of the assessment criteria.

Birds and bats

Table S4 Assessment of impact on birds and bats without mitigating measures

Wind farm effect	Alternative 1	Alternative 2
	63 x 6 MW ø 142 m	38 x 10 MW ø 221 m
Construction phase, birds		
- installing foundations	0/-	0/-
- increased shipping	0/-	0/-
Use phase, birds		
Local sea birds		
- collisions	-	-
- barrier effect	0	0
- habitat loss	-	-
- indirect effects	0/-	0/-
Colony birds		
- collisions	0/-	0/-
- barrier effect	0	0
- habitat loss	0/-	0/-
- indirect effects	0/-	0/-
Migratory birds		
- collisions	-	-
- barrier effect	0/-	0/-
- habitat loss	0	0
- indirect effects	0	0
Removal phase, birds		
- installing foundations	0/-	0/-
- increased shipping	0/-	0/-

Wind farm effect	Alternative 1	Alternative 2
	63 x 6 MW ø 142 m	38 x 10 MW ø 221 m
Bats		
- collisions	--/-	-
- barrier effect	0	0
- habitat loss	0	0
- indirect effects	+/-	+/-
OVERALL ASSESSMENT	--	-

The alternative with 38 x 10 MW turbines and a rotor diameter of 221 metres is the most environmentally friendly alternative for birds and bats, due to the lower number of collision casualties compared to the other alternatives (which is actually not always reflected in the score). The worst-case scenario is the alternative with 63 x 6 MW turbines and a rotor diameter of 142 metres.

Underwater life

Table S5 Assessment of impact on underwater life without mitigating measures

Assessment criteria	Impact assessment	Assessment	
		Alternative 1 (63 x 6 MW 1000kJ)	**Alternative 2 (38 x 10 MW 3000kJ)**
Effects of installation, use and removal on: Biodiversity Recruitment Densities/biomass Special species	*Benthic animals* Seabed activities Habitat loss *Fish* Noise/vibration Seabed activities Habitat loss	 0/- 0 0/- 0/- 0	 0/- 0 0/- 0/- 0
Marine mammals Installation Disturbance, barrier effect, habitat loss, change in foraging possibilities due to sound and vibration from installation of foundations	 Disturbed surface (km²) Number of disturbed animals Animal disturbance days Number of affected animals Population effects (North Sea)	 - - -- -- --	 - -- -- -- --

Assessment criteria	Impact assessment	Assessment	
		Alternative 1 (63 x 6 MW 1000kJ)	**Alternative 2 (38 x 10 MW 3000kJ)**
Physical harm Use Disturbance due to noise and vibration of turbines Disturbance due to noise and vibration of shipping (maintenance) Removal Disturbance, barrier effect, habitat loss, change in foraging possibilities due to sound and vibration from installation of foundations	Disturbed surface (km^2) Number of disturbed animals Disturbed surface (km^2) Number of disturbed animals Disturbed surface (km^2) Number of disturbed animals	0 0 0 0 0/- 0/-	0 0 0 0 0/- 0/-

As regards the impact caused by underwater noise, alternative 1 (63 x 6 MW turbines) seems to be the best case for marine mammals. This is due to the smaller disturbed surface (decreased pile-driving energy) and despite of the increase in disturbance duration in comparison to alternative 2 (38 x 10 MW turbines). The difference in disturbed surface however is so minimal that it is not visible in this criterion itself of the impact assessment (both alternatives score -). The effects on porpoises can be extremely negative if either alternative is applied. In this scenario, population reduction of porpoises is greater than is considered to be permissible under the Ecology and Cumulation Framework and additional studies (Heinis, 2015). It has been agreed that the population must not fall by more than 5% (previously 20%) as a result of the installation of 10 offshore wind farms under the SER agreement. This means that the population decrease calculated for each wind farm must not exceed **255** animals. The application of mitigating measures means this effect can be limited to beneath this threshold (see paragraph 12.5 and 12.6). As regards benthic animals and fish, the effects are extremely minor.

Shipping safety

Table S6 Assessment of impact on shipping and safety without mitigating measures

Assessment criteria	Impact assessment	Assessment	
		Alternative 1 with 6 MW turbines	**Alternative 2 with 10 MW turbines**
Safety	Risk of collision and propulsion	0/-	0
	Consequential damage of collision and propulsion	0	0
Shipping	Deviation possibilities for vessels crossing	0	0
	Effects of passage of ships below	0	0

Assessment criteria	Impact assessment	Assessment	
		Alternative 1 with 6 MW turbines	Alternative 2 with 10 MW turbines
	24 metres		

For two alternatives of site II, the calculations are based on the chances of a turbine collision or propulsion. For the 6 MW turbine variant, the chances are higher than with the 10 MW turbine variant. This is due to the higher number of turbines and the use of jackets in the former variant. The total frequency of collision and propulsion caused by traffic above 24 metres is 0.002912 per year for the alternative with 6 MW turbines, or once every 34.3 years. The total frequency of collision and propulsion caused by traffic above 24 metres is 0.01641 per year for the alternative with 10 MW turbines, or once every 60.9 years. For traffic below 24 metres, the frequency of collision and propulsion is 0.00426 for the 6 MW variant and 0.00152 for the 10 MW variant, or once every 234.7 and 657.9 years respectively.

As a result of the 6 MW turbine alternative, an oil spill is expected once every 721 years, or once every 1,250 years for the 10 MW turbine alternative. The chance of a bunker or cargo oil spill across the whole DCS increases by 0.28% for the 6 MW turbine alternative as a result of the risk of collision with a wind turbine at site II. This is lower for the 10 MW turbine alternative (0.16%).

The expected average number of deaths as a result of a turbine collision or propulsion for the 6 MW variant is 2.14×10^{-4}. The expected number of deaths for the 10 MW variant is 1.51×10^{-4}.

Geology and hydrology

Table S7 Assessment of impact on geology and hydrology without mitigating measures

Aspect (during installation, maintenance and operation)	Alternative 1	Alternative 2
	A 6 MW turbine on a suction bucket foundation with a diameter of 15 metres. Erosion protection (rock fill): none.	A 10 MW turbine on a gravity-based foundation with a diameter of 40 metres on the seabed. Erosion protection (rock fill): three times the pile diameter.
Waves	0	0
Water movement (water level/current)	0	0
Water depth and soil morphology	0	0
Soil composition	0	0
Turbidity and water quality	0	0
Sediment transport	0	0
Coastal safety	0	0

All morphological and hydrological changes resulting from the construction, operation, removal and maintenance of the wind farm and cables are highly limited and temporary in nature. The changes, if any, are very low compared to the natural dynamics of the area. Due to the relatively small dimensions of the foundation piles, the relatively large distance between the wind turbines and the number of wind turbines, any changes are highly localised. The effect is temporary and restricted to the immediate surroundings of the foundation piles and cable route. Both alternatives hardly differ in this respect and are therefore practically the same.

Landscape

Table S8 Assessment of impact on landscape without mitigating measures

Assessment criteria	Assessment	
	Alternative 1	Alternative 2
	63 x 6 MW turbines Max. tip height 167 m	38 x 10 MW turbines Max. tip height 251 m
Visibility in percentage of time Interpretation of visibility on the basis of visualisations	-	0/-

The visibility of a wind farm at site II is quantified by the percentage of time that meteorological conditions allow the wind farm to be seen. That is 18.4% of the daytime during summer months (1 May - 30 September) from the nearest point on land (Scheveningen). Outside of this period, the visibility percentage is lower. The percentage is also lower at other locations situated farther away from the site.

Furthermore, photo visualisations indicate that the wind farm is visible in good meteorological conditions. The difference between the alternatives is minimal. The large turbines are still (theoretically) visible at a distance of 44 kilometres or more; the smallest turbines not anymore (due to the horizon effect). In reality this difference is rather small, however.

Based on De Vries et al. (2008) in particular, it has been concluded that the perception is subjective and depends on the background of the observer, such as education, income and attitude towards renewable energy. The largest common denominator from the perception study shows that disruption to the maritime landscape by fixed objects, such as wind farms and oil rigs, is slightly negative, whereby the first disrupting object is deemed to be the most negative and the following objects relatively less and less negative, and that a greater distance results in a less negative perception. Some groups of people also appear to have positive feelings towards offshore wind power and wind turbines in general.

The lighting applied to the nacelle of the wind turbines ensures that the wind farm can be seen from the coast even at night in good meteorological conditions. The more wind turbines there are, the more visible they will be at night. The alternative with the most turbines scores worse on visibility at night than the alternative with the fewest turbines. This effect is reduced if the outer lying turbines only are illuminated – see new circular (draft information circular on offshore wind turbines and offshore wind farms, in relation to aviation, no. 2.2, 4 April 2016) – whereby the lighting effect can potentially be mitigated, see also table S12 containing mitigating measures.

Other use functions

Table S9 Assessment of impact on other use functions without mitigating measures

Assessment criteria	Impact assessment	Assessment	
		Alt 1 (63 x 6 MW on suction bucket)	Alt 2 (38 x 10 MW on gravity base)
Fishery	Fishery restrictions	0/-	0/-
Oil and gas extraction	Restrictions on oil and gas extraction	0/-	0/-
Aviation	Interference with civil aviation	0	0
	Interference with military aviation	0	0
	Interference with Coast Guard	0/-	0/-
	Interference with helicopter traffic	0/-	0/-
Sand, gravel and shell extraction	Restrictions on shallow mineral extraction	0	0
Dredging disposal	Restrictions on dredging disposal dumping areas	0	0
Ship, onshore and aviation radar	Interference with radar	0	0
Cables and pipelines	Interference with cables and pipelines	0/-	0/-
Telecommunications	Disruption to cable connections	0	0
	Disruption to ray paths	0	0
Ammunition dumping areas and military areas	Presence of ammunition dumping areas and military areas	0	0
	Presence of unexploded devices	0	0
Recreation and tourism	Recreational boating restrictions	0	0
	Coastal recreation restrictions	0	0
Cultural history and archaeology	Damage to archaeological remains	0	0
Mussel seed collection installations	Restrictions on mussel seed collection installations	0	0
Existing wind farms	Effect on electricity output of existing wind farms	0/-	0/-

The effects with regard to already existing use functions appear only to be very low. This is partly because the existing use functions were taken into account in the choice of location. There are minor effects on the use functions of sand extraction, ship and aviation radar, recreation and tourism, cultural history and archaeology in the form of loss of space (sand extraction and recreation), degradation (archaeology) or influence (ship radar). The effects are rated neutral given the small extent and the alternatives are not distinctive.

The effects on fishing as a whole, given the surface that is lost (61 km^2) and the value of that area for fishing, are rated slightly negative. In addition, the effects on wind farms are also slightly negative, because the wind interception has an adverse effect on the energy yield of Luchterduinen wind farm (and potentially OWEZ and Princess Amalia wind farms as well). For cables and pipelines, a maintenance area of 500 m on both sides is laid down in the wind farm site decision. This is smaller than the 750 metres that is generally applied. The North Sea policy documents (2016-2021) maintain that it is permitted to reduce the maintenance area in order to make efficient use of space in the North Sea. In terms of oil and gas extraction, a slightly negative rating is also given, since an extraction licence has been granted for mining block P15 (a and b), which partially overlaps with site II. Finally, a slightly negative score is given to the effects on helicopter traffic, because site II lies within the obstacle free zone of 5 nautical miles from the P15-ACD platform. The minimum distance, however, is exceeded to a certain extent, which results in a slightly negative score. The alternatives here are not distinctive.

Electricity yield

Table S10 Assessment of impact on electricity yield without mitigating measures

Aspects	Assessment	
	Alternative 1	Alternative 2
	63 x 6 MW turbines	48 x 8 MW turbines (10 MW turbines are not yet on the market)
Electricity yield Emissions avoided	++ ++	++ ++

To determine the electricity yield, calculations were made with a pair of turbines for which data is available and that are as different as possible from each other in size. Virtually no difference in yield is apparent from these calculations. Both alternatives barely differ in terms of electricity production and emissions avoided. It can be noted here that this does not mean that all turbine types should score the same, even though the set capacity is 380 MW in each case (starting point in the direction towards the site). Turbines with relatively large rotors (and therefore a low W/m^2 value) will generate more power than turbines with a relatively small rotor. The underlying wind interception and the wind interception at Luchterduinen also come into play here. Turbines with a high capacity and relatively large rotor will probably score the best. The future wind farm developer is free to determine the best option, whereby the cost price inherently plays a major role.

Cumulation

The following table briefly lists the cumulative effects that occur and the consequences this has for the wind farm site decision to be taken.

Table S11 Overview of cumulative effects at site II – Dutch Coast (south)

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
Birds and bats	Exceeding the PBR in the international worst-case scenario examined with 3 MW turbines in the KEC for the lesser black-backed gull, greater black-backed gull and herring gull cannot be ruled out.	If realistic wind turbine types are used in the calculations for the existing and planned wind farms in the southern North Sea (Borssele I/II: 4 MW, Borssele III-V: 6 MW, Dutch Coast (south) I – IV: 6 MW and Dutch Coast (north): 8 MW), only the number of lesser black-backed gull casualties would lie above the PBR threshold (Gyimesi & Fijn 2015b). If we examined the number of casualties caused by Dutch wind farms against the Dutch PBR threshold[2], then the cumulative number of casualties would lie at or below the PBR threshold for species of greater gull, so it can be said with confidence that these populations are

[2] More reliable and detailed data is available for the DCS and in turn for the entire southern North Sea. There is also more certainty with regard to the wind farms earmarked for the DCS up to and including 2023. The degree of uncertainty in results is therefore smaller for this analysis. The effects of operation in the 10-12 mile zone in the Dutch Coast wind farm zone are also reflected in these analyses. Therefore, a decision was made to carry out an analysis whereby the number of casualties caused by Dutch wind farms is compared with a PBR based on Dutch populations.

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
	In a worst-case scenario in combination with the wind farm developments in the North Sea as considered in the KEC, the provisional PBR value calculated for the Nathusius's pipistrelle would be exceeded.	resilient enough to withstand the increased mortality rate. Moreover, previous population modelling of the lesser black-backed gull showed that the Dutch population of this species is not at risk (Poot et al. 2011). Mitigating measures could be taken in order to reach acceptable effects (see section 12.5 and 12.6).
Marine mammals	Effects on the FCS cannot be ruled out	Mitigating measures could be taken in order to reach acceptable effects (see section 12.5 and 12.6).
Shipping and safety	Wind farms at other sites in the Dutch Coast (south) wind farm zone may lead to other effects on shipping and safety.	No consequences for wind farm site decision. The cumulative effect of other wind farms on navigation safety, in contrast to previous safety studies, has not been separately detailed but is considered as the basic situation. The distances between the shipping separation regime and future wind farms are determined in the design criteria of distance between shipping routes and wind farms from the North Sea policy documents (2016-2021). Those distances are implemented in the new route structure that entered into force in August 2013. The calculations for wind farm site II are also cumulated over wind farm sites I, III and IV; the route structure for wind farm site II does not change if wind farm sites I, III and IV are also included.
Morphology and hydrology	Wind farms at other sites in the Dutch Coast (south) wind farm zone may lead to effects on morphology and hydrology.	None. In the further implementation of the Dutch Coast (south) wind farm zone (wind farm sites I, III and IV), practically the same local, temporary and negligible effects will occur. That means that there is no cumulation, not even with other activities and other more distant wind farms.
Landscape	Wind farms at other wind farm sites in the Dutch Coast (south) wind farm zone also affect the visibility of wind turbines from the beach.	None. The development of these wind turbines will increase the intrusion on the horizontal angle of view by wind turbines at the Dutch Coast (south) wind farm site compared to the current situation. The distance to the coast from these wind turbines is generally so great that the meteorological conditions greatly reduce the visibility of the

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
		wind turbines. The shortest distance between the offshore wind turbines at wind farm site II and the beach is 23.6 kilometres (Scheveningen). At this distance, a wind farm in the summer period is visible during the day on average 18.4% of the time. The wind farms that might be developed at Dutch Coast (south) are slightly closer to the coast, meaning that they will be visible for a higher percentage of the time.
Other use functions	Wind farms at other wind farm sites in the Dutch Coast (south) wind farm zone also affect the other use functions.	None. In the further implementation of the Dutch Coast (south) wind farm zone (wind farm sites I, III and IV), the total space used is larger meaning a larger area is lost for fishing. The area that is lost for fishing is relatively good fishing ground. In total, approximately 0.16% of the fishable surface of the DCS is lost, meaning that in cumulation there are limited adverse effects on fishery. Due to the greater number of turbines, it is also more likely that archaeological remains will be harmed. The further implementation of the Dutch Coast (south) wind farm zone has limited effects on recreation and tourism because recreational boating uses the 10 to 20 km wide zone along the coast in particular. This also has a slight negative impact (in accordance with the Decisio report 2015) on coastal recreation. This does not have any direct consequences on the wind farm site decision. The creation of other wind farm sites in the Dutch Coast (south) wind farm zone also increasingly affects onshore radar. This does not have any direct consequences on the wind farm site decision.
Electricity yield	Wind farms at other wind farm sites in the Dutch Coast (south) wind farm zone and Luchterduinen can also affect the wind intercepted by each other.	None. The realisation of wind farm sites I, III and IV will lead to more wind interception for wind farm site II. The degree of wind interception depends on the exact details of these wind farm sites.

Mitigating measures

After assessment, it appears that the conditions in the legal framework can be satisfied for virtually every aspect. Mitigating measures are required to limit the cumulative effects on birds, bats and porpoises. However, the occurrence of other adverse effects due to the construction, operation and removal of the wind farm cannot be excluded. These possible other effects can be mitigated by the following measures. A number of these potential mitigating measures will be selected for the purpose of the preferred alternative.

Table S12 Potential mitigating measures

Aspect	Effect	Mitigating measure
Birds and bats	Construction and removal phase	Construction from June to September due to the limited presence of species of sea bird susceptible to disturbance. Minimising lighting on ships and/or use of a bird-friendly lighting colour. Reducing of pile-driving noise. However, the effect of the sound of pile driving on birds is unknown and therefore it is not known how necessary this measure is.
	Operational phase	Installing fewer large turbines instead of more small ones as much as possible. Connecting Dutch Coast (south) to Luchterduinen wind farm to the greatest extent possible in order to keep the disturbance area as small as possible. Installing two-blade instead of three-blade turbines. Creating a corridor in the wind farm that birds may use. Increasing the chances of birds detecting the wind farm through the use of reflectors, lasers and sound (depending on the species of bird and subject to various restrictions). Avoiding maintenance works at night and above all during the migration season. Minimising lighting on ships and/or use of a bird-friendly lighting colour. Shutting down in certain weather conditions in combination with identified peaks in migration. Increasing cut-in wind speed (for bats) in the relevant season and at relevant time of day (dusk). Increasing maximum lowest tip point. As small as possible wind farm surface (least habitat loss).
Marine mammals	Disturbance and associated population reduction; PTS.	Limiting the construction period. Using 'Slow start' and 'Acoustic Deterrent Devices' (ADDs). Establishing a maximum permissible noise level.
Shipping and safety	Propulsion	Using the Automatic Identification System (AIS). Deploying an Emergency Towing Vessel.
Morphology and hydrology	-	-
Landscape	Visibility during the day	Use of vertical colour strips on the turbines. Distribution of information on the what, how and why of the wind farms, so that observers understand why the wind farm is needed. Selection of as large turbines as possible, so that fewer need to be erected. This also provides a more pleasant landscape.
	Visibility at night	With the use of radar detection, lighting can be switched on

Aspect	Effect	Mitigating measure
		when an aircraft is detected within a certain range of the wind farm. With the use of visibility meters, lighting can be dimmed in good visibility conditions, so lights do not always need to turned on.
Other use functions	Closer than 750 metres to active cables	Consult with cable operators.
	Damage to archaeological values	Changing the location of a wind turbine or cable so as to avoid a possible archaeological object.
	Risk of unexploded devices	Further investigation is required to locate and remove unexploded devices.
	Effect of wind turbines on shore-based radar system	Installation of radar on the TenneT platforms to be constructed or between wind farms and shipping routes.
	Site II overlaps with obstacle free zone for platform P15-ACD.	Consult with mining companies.
Electricity yield	-	-

A number of measures will be carried out in any case, such as the use of a 'slow start' and ADDs. For the other mitigating measures, it has not yet been determined whether and to what extent they will be applied. The wind farm site decision includes the measures that have been adopted.

7. Considerations

Testing against the legal framework

Some mortality amongst birds and fish and decrease in populations of marine mammals cannot be ruled out in advance. The Offshore Wind Energy Bill integrates the assessment to be carried out under the Nature Conservation Act 1998 and the Flora and Fauna Act into the wind farm site decision. By virtue of Article 7 of the Offshore Wind Energy Bill, the competent authority has authority over exemption within the framework of the Flora and Fauna Act. For the purpose of testing against the Nature Conservation Act 1998, an Appropriate Assessment has been carried out. This Appropriate Assessment shows that any significant impact on the conservation objectives of Natura 2000 areas as a result of the preferred alternative can be ruled out.

Other laws and regulations are discussed where relevant in the various aspect chapters and translated into specific standards where necessary. For example, the chapter on underwater life describes the set of standards that is taken as a basis within ASCOBANS and used to determine a measure of acceptable population reduction for porpoises. The planning protection regime for the National Ecological Network, now known as the Nature Network Netherlands, applies to the whole of the North Sea (EEZ). Paragraph 1.3.1 of annex 5 states how the protection regime for the Nature Network Netherlands (NNN) works in the Dutch North Sea area.

Choice of preferred bandwidth

There are no aspects in this EIA that restrict the bandwidth considered. As a starting point for the bandwidth used, consideration was given in particular to the study into the (cumulative) effects on birds. This aspect restricted bandwidth primarily at the sites in the Borssele wind farm zone. However, mitigating measures on the basis of this environmental impact assessment must be taken to eliminate or reduce the effects. The measures that must be taken are as follows:

Mitigating measures that must be taken

Measures that are adopted to reduce the effects as required are:

Birds and bats

- During the night (from sunset to sunrise) at times of mass migration, the number of rpm is reduced to less than 1 for each turbine.
- The cut-in wind speed of the turbines is 5.0 m/s at axle height between one hour after sunset and two hours before sunrise from 15 August until 30 September.

Underwater life

Noise standards have been determined for the entire Dutch Coast (south) wind farm zone. The wind farm site where the most stringent noise standards must be enforced will determine the noise standards for other sites. Furthermore, the standards have been selected in a way that takes into account any potential excesses during the learning phase in the start-up period. The standards determined are provided in the table below.

Table S13 Standards for wind farms in the Dutch Coast (south) zone, including the start-up excess of 1 dB

Dutch Coast (south)	**Maximum noise impact (dB re 1 $\mu Pa^2 s$ over 750 m)***		
380 MW per site	Period		
# turbines	Jan-May	Jun-Aug	Sept-Dec
63 (assessed here)	163	169	171
54	164	170	172
48	165	171	173
42	166	172	174
38 (assessed here)	167	172	175

In addition to the noise standards, ‘Acoustic Deterrent Devices’ and ‘soft start’ procedures to prevent permanent effects on hearing must be used (PTS: *permanent threshold shift*).

Other use functions

There are various cables located in the vicinity of and within wind farm site II. For cables and pipelines, a maintenance area of 500 m on both sides is laid down in the wind farm site decision. This is smaller than the 750 metres that is generally applied. The North Sea policy documents (2016-2021) maintain that it is permitted to reduce the maintenance area in order to make efficient use of space in the North Sea.

Consultation is required with the mining company with regard to the site II overlap with the obstacle free zone for platform P15-ACD.
Further investigation is required to locate and remove unexploded devices.

Moreover, any archaeological values present may influence the location of wind turbines at site II.

Conclusion on preferred alternative

The wind farm site decision should make the preferred bandwidth possible and safeguard necessary mitigating measures; together the preferred bandwidth and measures form the preferred alternative.

8. Gaps in knowledge and information

The development of offshore wind farms has a relatively brief history. The first monitoring evaluations for other offshore wind farms in England, Denmark, Germany and the Netherlands have since been published. These are results from relatively brief monitoring periods. Certainty about the long-term effects can therefore not be given yet. However, current development and research programmes offer tools for an impact forecast, as presented in this EIA. In investigating and predicting the impact for this EIA, various gaps in knowledge were identified that might limit the understanding of the nature and extent of the impact of a wind farm at site II. There are still some uncertainties surrounding the impact, especially the cumulative effects of multiple wind farms on each other and in combination with other activities in the North Sea.

The gaps in knowledge that exist are not only due to the recent history of offshore wind energy; in a broad sense a lot of knowledge about animal species and their densities, diversity and behaviour needs to be supplemented.

In short, the following gaps have been noted:

- Local birds: in general, knowledge of the distribution in space and time of seabirds at sea is still incomplete;
- Migratory birds: in general, knowledge of the duration and the spatial extent of bird migration is still incomplete. The lack of representative data is related to the often hard-to-access habitat and the absence of standardised counting methods. There are indications for various migration routes in the North Sea area. Quantitative data on this, on how large

the share of these migration routes is in relation to migration as a whole, as well as data on local densities in the different areas of the North Sea are missing.

- Bats: knowledge gaps exist regarding the occurrence of bats at sea and their behaviour in wind farms as well as the number of collision casualties.
- Benthos: knowledge gaps exist with regard to the ability to predict the consequences of the abiotic changes (especially sediment change in the surroundings of the wind farm) on benthos. In addition, the effects of electromagnetic fields along the cables are not yet well known.
- Marine mammals: there are gaps in knowledge on aspects such as distribution and prevention of marine mammals, migration patterns, threshold values for TTS, PTS and avoidance, behavioural reactions as a result of underwater sound and foraging behaviour. Model calculations of the distribution of underwater sound in combination with threshold values derived from several studies predict the occurrence of avoidance, TTS and PTS in marine mammals. Further research in the form of monitoring in the field, additional laboratory research and further model development is needed to fill gaps in knowledge.
- Fish: specific knowledge gaps with respect to wind farms exist, especially with regard to species and extent of changes on fish fauna in the longer term as a result of setting restrictions on fishery and applying hard substrate.
- Other use functions: The actual economic effects of tourist activities following the construction of visible wind farms have never been investigated before in the Netherlands.
- Electricity yield: the wind interception from Luchterduinen and from the other wind farm sites within the Dutch Coast (south) wind farm zone can be calculated fairly accurately once the exact set-ups of those wind farms are known. It is expected that the calculations in this EIA are a good indication.

The gaps in knowledge do not mean that it is not possible to get a good idea of the effects of a wind farm at wind farm site II in the Dutch Coast (south) wind farm zone. A wind farm site decision can be taken despite the existing gaps in knowledge and uncertainties. In the decision-making process it is important to understand the uncertainties that played a role in the impact predictions. This understanding is provided by this EIA.

9. Monitoring and evaluation

The Energy Agreement for Sustainable Growth (SER agreement, September 2013) contains an agreement to achieve the objectives more quickly and reduce offshore wind power costs by 40% (Parliamentary Papers II, 2012/13, 30 196, no. 202). For these reasons, the Ministry of Economic Affairs and the Ministry of Infrastructure and the Environment decided in 2015 to launch an integral monitoring programme in order to investigate the knowledge gaps with regard to the impact on offshore wind farms in the North Sea ecosystem and to achieve further cost reduction within the ecological boundaries.

This Wozep (*windenergie op zee ecologisch programma* – offshore wind energy ecological programme) monitoring and evaluation programme focuses on key environmental issues related to the construction and operation of offshore wind farms. Such issues are predominantly generic rather than specific to wind farms.

Both the development of the KEC instrument (update and implementation of knowledge) and the MEP (monitoring and research programme) fall under Wozep. In turn, monitoring and research – in so far as required by the Environmental Management Act – fall under the MEP.

Wozep therefore replaces the monitoring obligation for each wind farm. This results in improved efficiency, which also makes it more cost efficient to achieve the objectives for offshore wind power.

In the Wozep evaluation, attention is paid to the translation of new knowledge in the KEC instrument (this can also mean verifying assumptions and/or impact calculations) on the one hand, and translation into policy and management implications on the other hand. This is demonstrated by the establishment or modification of mitigating measures. In Wozep, the investigation focuses in particular on those aspects that may increase costs, provides a clear view of them and advises the competent authorities on them. Wozep will begin in 2016 and last for five years.

715082
22 mei 2016

ENVIRONMENTAL IMPACT ASSESSMENT SITE I WINDENERGIEGEBIED HOLLANDSE KUST (ZUID)

Ministeries van Economische Zaken en Infrastructuur en Milieu

Definitief

Duurzame oplossingen in
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SUMMARY

10. Introduction

The Netherlands has formulated ambitious objectives for realising the generation of sustainable, renewable energy with wind energy playing a prominent role. In addition to onshore wind energy, concrete objectives are formulated for offshore wind energy. These objectives have been revised and elaborated in the Energy Agreement for Sustainable Growth (SER, Energy Agreement, 2013). A choice has been made to achieve these objectives using a new issuance system. The Offshore Wind Energy Bill has entered into force to this end, which gives the State the option of issuing sites for the development of offshore wind farms. A wind farm site decision stipulates where and under what conditions a wind farm may be constructed and operated. A permit is granted after a wind farm site decision is made. Only the permit holder has the right to construct and operate a wind farm at the site location. The Water Directive contains general regulations on offshore wind energy.

The Minister of Economic Affairs (in coordination with the Minister of Infrastructure and the Environment) is responsible for issuing sites and, for that purpose, drafts an environmental impact assessment (EIA) for each wind farm site decision. This document relates to the EIA for site I in the wind farm zone of Dutch Coast (south). The EIA describes the environmental impact of the construction, operation and decommissioning of wind turbines at that site.

The wind turbines installed in the Dutch Coast (south) wind farm zone must be connected to the high-voltage grid. TenneT is responsible for providing this connection. This comprises two platforms in the Dutch Coast (south) wind farm zone, the cables from these platforms to and over land, and the connection to the high-voltage grid on land. For the offshore grid, TenneT will carry out a separate procedure including an environmental impact assessment (EIA).

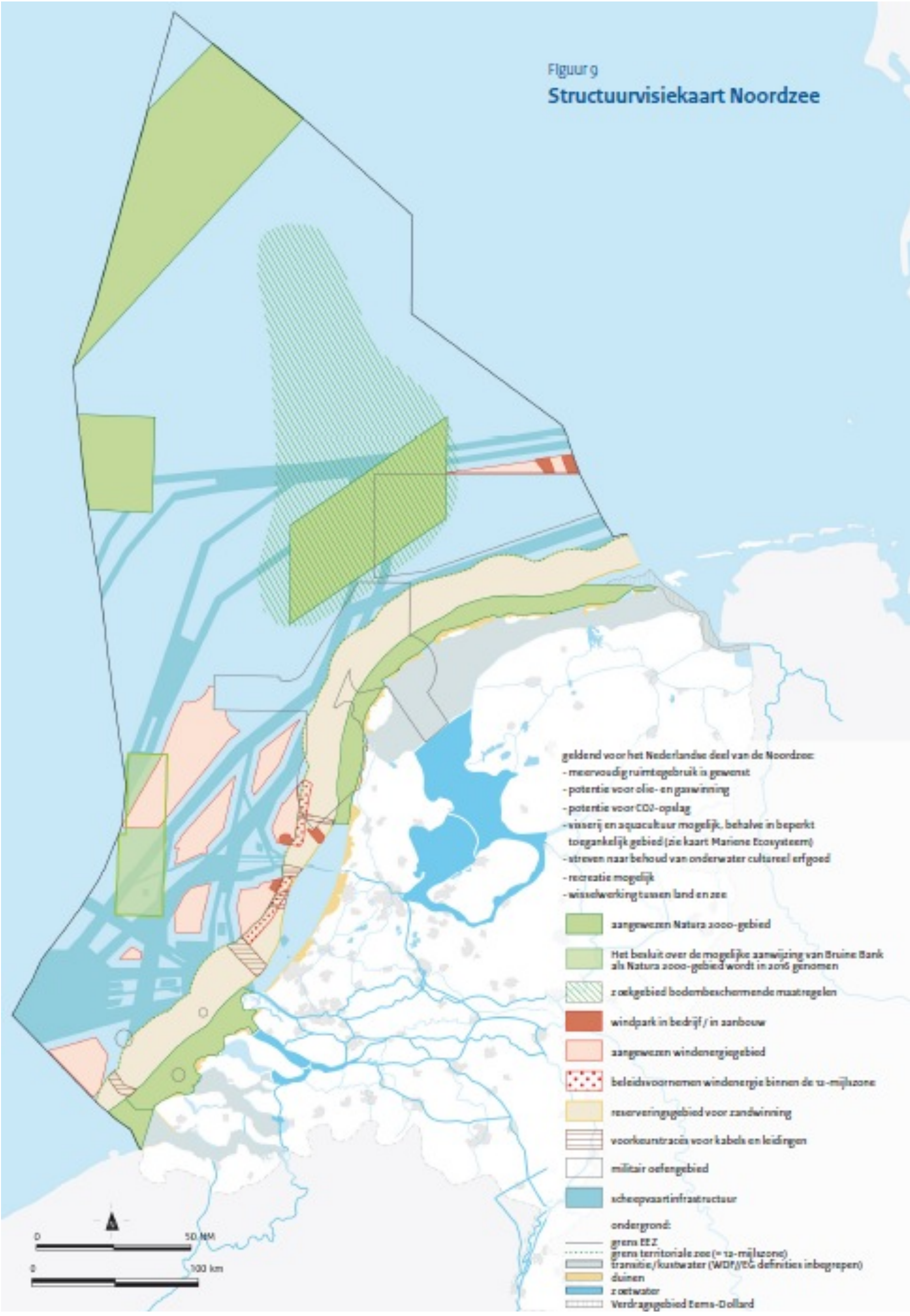
This summary addresses the following:
- The policy context and the reason for the site decisions to be taken;
- The choice of location for the Dutch Coast (south) wind farm zone;
- The division of the Dutch Coast (south) wind farm zone;
- The impact assessment method;
- The result of the impact assessment;
- The considerations;
- Any gaps in knowledge and information;
- Monitoring and evaluation;

11. Policy context and cause for wind farm site decisions

Four zones have been designated for the development of offshore wind power generation. See also the following figure:

- Borssele;
- IJmuiden Ver;
- Dutch Coast;
- To the North of the Wadden Islands.

Figure S1 Wind energy zones (from: National Water Plan 2016-2021)



On 26 September 2014, the Minister of Economic Affairs and Minister of Infrastructure and the Environment sent a letter to the Lower and Upper House presenting the roadmap to promptly achieve the objective for offshore wind energy, as agreed in the Energy Agreement (Parliamentary Papers I/II, 2014-15, 33 561, A/no. 11 (reprint)). The letter discusses the offshore grid (previously known as the offshore transmission system), the new system for generating offshore wind power, and the wind farm zones.

The Government concludes that a coordinated grid connection of offshore wind farms leads to less public spending and less impact on the environment. The starting point for the roadmap is that the task of generating offshore wind power can be realised in the most cost-effective manner by means of an offshore grid. This offshore grid is based on standard platforms where a wind power capacity of 700 MW can be connected per platform. Wind turbines within the wind farms can be connected directly to the platform. On the basis of the Electricity Act 1998, TenneT may now be appointed as the offshore grid operator.

The following table shows the timetable for the development of offshore wind power taken from the roadmap.

Year	Timetable (MW)	Roadmap zones
2015[1]	700	*Borssele*
2016	700	*Borssele*
2017	700	*Dutch Coast (south)*
2018	700	*Dutch Coast (south)*
2019	700	*Dutch Coast (north)*

12. Location choice

The National Structural Vision for Offshore Wind Energy (see annex Parliamentary Papers I/II, 2014-15, 33 561, A/no. 11 (reprint)) investigates whether the Dutch Coast (south) wind farm zone is suitable for generating wind power. This structural vision explores the effects of wind energy in the Dutch Coast (south) zone in detail in terms of ecology, maritime safety, other uses (oil and gas, fisheries, sand extraction, etc.), geology and hydrology, landscape (visibility), and cultural history and archaeology. It also examines suitability in relation to the other designated wind farm zones (IJmuiden Ver, Dutch Coast, To the north of the Wadden Islands and Borssele). The EIA for the Borssele wind farm zone sites makes a broad comparison between the zones, which is included as annex 2. A closer examination of the suitability of the Dutch Coast (south) zone for wind energy is therefore not required for this EIA.

The letter of 26 September 2014 also discusses a study into the sustainability of developing wind power in five zones situated 3 nautical miles (NM) from the coast. None of these five zones under study deemed wind power generation infeasible. However, in order to address concerns and ensure cost effectiveness, the Government sought to keep the use of the 12-mile zone to a minimum by only partially using two of the five zones studied. By connecting to a narrow strip between 10 and 12 NM in the Dutch Coast zones outside of the 12-mile zone, 1400 MW can be generated for the coast of South Holland and 700 MW for the coast of North Holland.

The various wind farm zones all entail both significant adverse effects (birds and marine mammals without any mitigating measures) and minor adverse effects. The differences between the zones in that respect are limited. The Dutch Coast wind farm zone is the cheapest to

[1] January 2016

develop. If the zone can be extended to 10 NM from the coast, there is much more relatively cheap wind energy to be harnessed. This wind farm zone (more so than the other zones) does however have an impact on visibility, maritime safety, oil and gas extraction, and fisheries. As a follow-up to the EIA, special attention should be paid to those effects on the basis of this analysis.

13. Division

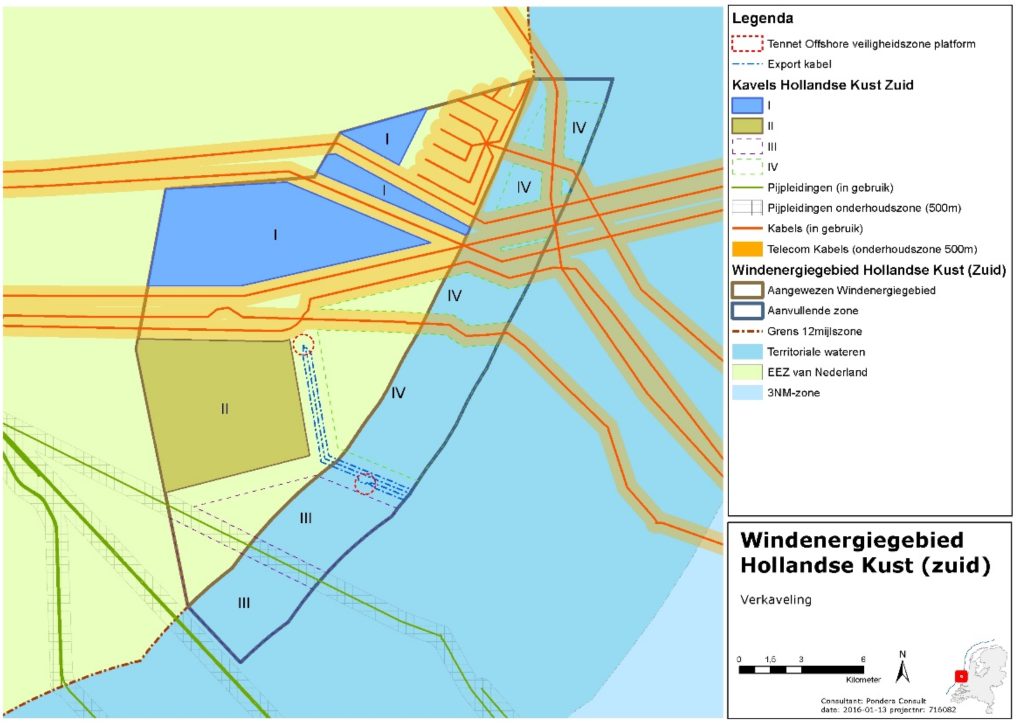
If the Dutch Coast (south) wind farm zone is expanded by a strip between 10 and 12 NM from the coast, there will be enough room for four sites. Due to the size of the TenneT offshore platforms envisaged, each with a capacity of around 700 MW, and the total available surface area (356 km^2), it is proposed to divide the zone into four sub-zones, each of which can be connected to these offshore platforms in twos. The four sub-zones together thus provide capacity for around 1400 MW. The zone beyond 12 NM already identified provides enough space for two sites.

The proposed division is initially created by mapping obstacles that prevent wind turbines from being sited there and any existing cables or pipes in the zone. In figure S2, the Dutch Coast (south) wind farm zone is marked with existing obstacles. The division is then made on the basis of the following:

- No cables or pipes through multiple sites;
- Cables between turbines and the platform (inter-array cables) are to be as short as possible. For the cable route from the platforms to the coast, another shorter route is envisaged than the route through the preferred zone for cables and pipes from the National Water Plan 2, as it would be more cost effective.
- The area to the west and south of the wind farm zone is exposed to wind from the more eastern or north-eastern zones. Sites less exposed to the wind are therefore bigger in order to have a greater distance between the wind turbines.

Based on the foregoing, the zone is distributed as highlighted in figure S2.

Figure S2 Proposed division of the Dutch Coast (south) wind farm zone



Firstly, the procedure for the two sites beyond 12 NM will be initiated (site I and II in figure 3.1). If the National Structural Vision for Offshore Wind Energy – Dutch Coast supplement is established as intended, the procedure for the two sites partially lying within 12 NM (site III and IV) will be initiated. In order to connect the sites in twos to the TenneT offshore platforms over time, they must be positioned close together. The combinations of wind farm sites I and II and wind farm sites III and IV are therefore the most obvious.

Sites III and IV lie partially between 10 and 12 NM away. This area has yet to be designated for the development of wind power. Sites III and IV depend on the partial revision of the National Water Plan 2 (NWP2) and National Structural Vision for Offshore Wind Energy – Dutch Coast supplement. This plan offers the option of developing wind power between 10 and 12 NM off the Dutch Coast. The revision of the NWP2 is expected to be completed by mid-June 2016. If the area between 10 and 12 NM is not designated, this may have an impact on the location, size and development of sites I and II. It has been decided not to consider that scenario in this EIA, but to draft a new EIA if the area between 10 and 12 NM is not designated.

In the letter of 19 May 2015 (Parliamentary Papers II, 2014-15, 33 561, no. 19), the Minister of Economic Affairs indicated that allowing up to 380 MW per site may offer economies of scale and optimal usage, on the understanding however that a maximum connection and transmission capacity is guaranteed for 350 MW per site. These benefits may result in lower costs per kWh. For those reasons, a total of 380 MW is assumed for each site (so that the effects are not underestimated).

14. Impact assessment method

Bandwidth

An EIA assesses alternatives to an activity by examining their effects and comparing them. An alternative is a possible way in which the proposed activity, in this case power generation with wind turbines, can be realised considering the purpose of this activity. In this EIA, alternatives for two areas, each with one wind farm, were examined (two so-called 'wind farm sites'). The alternatives are based on a bandwidth for various wind turbine set-ups and types that are possible within such a wind farm site.

The wind farm sites within the Dutch Coast (south) wind farm zone are therefore issued with the option for the wind farm developer to do this at its own discretion. The bandwidth that must be adhered to is recorded in the wind farm site decision.

Bandwidth

By issuing wind farm sites in which various wind turbine set-ups and types and foundation methods are possible, within a certain bandwidth, a flexible design of the wind farm sites is possible. The developer is free to make the wind farm design optimal in terms of cost effectiveness and energy yield. This bandwidth approach makes specific requirements of this EIA. All environmental effects associated with all possible set-ups made possible by the wind farm site decisions should be examined. Researching all possible set-ups is not possible however due to the multitude of potential combinations. Therefore, a worst-case approach is assumed: if the worst-case scenario for potential effects is permissible, then all other set-ups within it are also possible.

Alternatives

The worst-case scenario will differ for different aspects (for example for birds and marine mammals). This is taken into consideration in the study by researching and comparing several worst-case scenarios as alternatives in the EIA. The parameters defined in the worst-case scenario must be named and described, such as the maximum number of turbines, maximum upper and lower limit of the rotor, maximum rotor surface area, characteristics of the foundation method, etc.

To obtain an idea of the possibilities to reduce the effects, mitigating measures are designated and examined for each aspect. This means possibilities for optimisation are identified and prevents solely presenting a worst-case scenario.

The bandwidth of design possibilities for the wind farm site to be issued is shown in the following table.

Table S1 EIA bandwidth

Design	Bandwidth
Capacity of individual wind turbines	6 – 10 MW
Highest tip point of individual wind turbines	167 – 251 metres
Lowest tip point of individual wind turbines	25 – 30 metres
Rotor diameter of individual wind turbines	142 – 221 metres
Distance between each wind turbine	At least 4 x rotor diameter
Number of blades per wind turbine	2 – 3
Type of foundations (substructures)	Monopile, jacket, tripile, tripod, gravity-based structure
Type of foundation	Pile foundations, suction buckets, gravity-based structures
Installation method for pile foundations	Vibrohammering, pile driving, drilling, suction
In case of pile-driving foundations: pile-driving energy related to turbine type/pile	1,000 – 3,000 kJ, depending on soil conditions and diameter of foundation
In case of pile-driving foundations, diameter of foundation pile/piles and number of piles per turbine:	
Jacket	4 piles of 1.5 – 3.5 metres
Monopile	1 pile of 6 to 10 metres
Tripod	3 piles of 2 to 4 metres
In case of a foundation without pile driving, dimensions on seabed:	
Gravity based	Up to 40 x 40 metres
Suction bucket	Bucket diameter: tbd
Electrical infrastructure (inter-array cabling)	66 kV

As indicated, the worst-case scenario for different aspects, for example for birds and marine mammals, can be different. The table below shows the different environmental aspects in the worst-case and best-case scenarios.

Table S2 Worst-case and best-case scenarios within the bandwidth per environmental aspect

Environmental aspect	Bandwidth	
	Alternative (Worst case)	*Alternative (Best case)*
Birds and bats	63 x 6 MW turbines Lowest tip point 25 m, rotor diameter 142 m	38 x 10 MW turbines Lowest tip point 30 m, rotor diameter 221 m
Underwater life*	38 x 10 MW turbines Pile-driving energy: 3,000 kJ 1 turbine location per day	63 x 6 MW turbines Pile-driving energy: 1,000 kJ 1 turbine location per day

Environmental aspect	Bandwidth	
Shipping	63 x 6 MW turbines Jacket foundation with 15 m diameter	38 x 10 MW turbines Monopile foundation with 10 m diameter
Geology and hydrology	63 x 6 MW turbines	38 x 10 MW turbines
Landscape**	63 x 6 MW turbines Min. rotor diameter 142 m Min. hub height: 96 m	38 x 10 MW turbines Max. rotor diameter 221 m Max. hub height: 140 m
Other use functions	63 x 6 MW turbines	38 x 10 MW turbines
Electricity yield**	63 x 6 MW turbines	38 x 10 MW turbines

* For underwater life, the worst-case and best-case scenario differ per 'sub-aspect' (marine mammals, fish and benthic life) and can also not be clearly defined in advance. Although the sound production during pile driving at 3,000 kJ is higher than at 1,000 kJ, the number of piles that are driven with greater pile-driving energy is lower, meaning the overall environmental impact may be lower.
** For landscape and electricity yield, there is not really a worst-case or best-case scenario, but the alternatives do specify a bandwidth.

Assessment

In order to be able to compare the effects of the options per aspect, these are assessed on a +/- scale in relation to the zero option (i.e. the current situation and autonomous development). The following rating scale is used for this purpose, as shown in table S3. The assessment provides a justification.

Table S3 Scoring methodology

Score	Opinion in relation to the reference situation (zero alternative)
--	The intention leads to an extremely noticeable adverse change
-	The intention leads to a noticeable adverse change
0	The intention does not differ from the reference situation
+	The intention leads to a noticeable positive change
++	The intention leads to an extremely noticeable positive change

If the effect is marginal, this is indicated in such cases as 0/+ (marginally positive) or 0/- (marginally negative).

The Appropriate Assessment quantifies the effects in order to evaluate whether the preferred alternative has any significant impact on Natura 2000 areas.

In addition to the effect of a wind farm at wind farm site I, cumulative effects of other wind farms and activities are considered and mitigating measures also examined.

15. Result of environmental assessment

The following tables show the assessments of the alternatives per aspect against the various assessment criteria, again without the application of mitigating measures. The tables are then discussed per aspect. This is a summary of the impact assessment, simplifying the description of the assessment criteria.

Birds and bats

Table S4 Assessment of impact on birds and bats without mitigating measures

Wind farm effect	Alternative 1	Alternative 2
	63 x 6 MW ø 142 m	38 x 10 MW ø 221 m
Construction phase, birds		
- installing foundations	0/-	0/-
- increased shipping	0/-	0/-
Use phase, birds		
Local sea birds		
- collisions	-	-
- barrier effect	0	0
- habitat loss	-	-
- indirect effects	0/-	0/-
Colony birds		
- collisions	0	0
- barrier effect	0	0
- habitat loss	0	0
- indirect effects	0	0
Migratory birds		
- collisions	-	-
- barrier effect	0/-	0/-
- habitat loss	0	0
- indirect effects	0	0
Removal phase, birds		
- installing foundations	0/-	0/-
- increased shipping	0/-	0/-
Bats		
- collisions	--/-	-
- barrier effect	0	0
- habitat loss	0	0
- indirect effects	+/-	+/-
OVERALL ASSESSMENT	--	-

The alternative with 38 x 10 MW turbines and a rotor diameter of 221 metres is the most environmentally friendly alternative for birds and bats, due to the lower number of collision casualties compared to the other alternatives (which is actually not always reflected in the score). The worst-case scenario is the alternative with 63 x 6 MW turbines and a rotor diameter of 142 metres.

Underwater life

Table S5 Assessment of impact on underwater life without mitigating measures

Assessment criteria	Impact assessment	Assessment	
		Alternative 1 (63 x 6 MW 1000kJ)	**Alternative 2 (38 x 10 MW 3000kJ)**
Effects of installation, use and removal on: Biodiversity Recruitment Densities/biomass Special species	*Benthic animals* Seabed activities Habitat loss *Fish* Noise/vibration Seabed activities Habitat loss	 0/- 0 0/- 0/- 0	 0/- 0 0/- 0/- 0
Marine mammals Installation Disturbance, barrier effect, habitat loss, change in foraging possibilities due to sound and vibration from installation of foundations Physical harm	 Disturbed surface (km^2) Number of disturbed animals Animal disturbance days Number of affected animals Population effects (North Sea)	 - - -- -- --	 - -- -- -- --
Use Disturbance due to noise and vibration of turbines Disturbance due to noise and vibration of shipping (maintenance)	 Disturbed surface (km^2) Number of disturbed animals Disturbed surface (km^2) Number of disturbed animals	 0 0 0 0	 0 0 0 0
Removal Disturbance, barrier effect, habitat loss, change in foraging possibilities due to sound and vibration from installation of foundations	 Disturbed surface (km^2) Number of disturbed animals	 0/- 0/-	 0/- 0/-

As regards the impact caused by underwater noise, alternative 1 (63 x 6 MW turbines) seems to be the best case for marine mammals. This is due to the smaller disturbed surface (decreased pile-driving energy) and despite of the increase in disturbance duration in comparison to alternative 2 (38 x 10 MW turbines). The difference in disturbed surface however is so minimal that it is not visible in this criterion itself of the impact assessment (both alternatives score -). The effects on porpoises can be extremely negative if either alternative is applied. In this scenario, population reduction of porpoises is greater than is considered to be permissible under the Ecology and Cumulation Framework and additional studies (Heinis, 2015). It has been agreed that the population must not fall by more than 5% (previously 20%) as a result of the installation of 10 offshore wind farms under the SER agreement. This means that the population decrease calculated for each wind farm must not exceed **255** animals. The application of mitigating measures means this effect can be limited to beneath this threshold (see paragraph 12.5 and 12.6). As regards benthic animals and fish, the effects are extremely minor.

Shipping safety

Table S6 Assessment of impact on shipping and safety without mitigating measures

Assessment criteria	Impact assessment	Assessment	
		Alternative 1 with 6 MW turbines	**Alternative 2 with 10 MW turbines**
Safety	Risk of collision and propulsion	0/-	0
	Consequential damage of collision and propulsion	0	0
Shipping	Deviation possibilities for vessels crossing	0	0
	Effects of passage of ships below 24 metres	0	0

For two alternatives of site I, the calculations are based on the chances of a turbine collision or propulsion. For the 6 MW turbine variant, the chances are higher than with the 10 MW turbine variant. This is due to the higher number of turbines and the use of jackets in the former variant. The total frequency of collision and propulsion caused by ships above 24 metres is 0.03489 per year for the alternative with 6 MW turbines, or once every 28.7 years. The total frequency of collision and propulsion caused by ships above 24 metres is 0.01808 per year for the alternative with 10 MW turbines, or once every 55.3 years. For ships below 24 metres, the frequency of collision and propulsion is 0.01072 for the 6 MW variant and 0.00364 for the 10 MW variant, or once every 93.3 and 274.7 years respectively.

As a result of the 6 MW turbine alternative, an oil spill is expected once every 716 years, or once every 1259 years for the 10 MW turbine alternative. The chance of a bunker or cargo oil spill across the whole DCS increases by 0.28% for the 6 MW turbine alternative as a result of the risk of collision with a wind turbine at site I. This is lower for the 10 MW turbine alternative (0.16%).

The expected average number of deaths as a result of a turbine collision or propulsion for the 6 MW variant is 0.000169 (1.69×10^{-4}). The expected number of deaths for the 10 MW variant is 0.000094 (9.4×10^{-5}).

Geology and hydrology

Table S7 Assessment of impact on geology and hydrology without mitigating measures

Aspect (during installation, maintenance and operation)	Alternative 1	Alternative 2
	A 6 MW turbine on a suction bucket foundation with a diameter of 15 metres. Erosion protection (rock fill): none.	A 10 MW turbine on a gravity-based foundation with a diameter of 40 metres on the seabed. Erosion protection (rock fill): three times the pile diameter.
Waves	0	0
Water movement (water level/current)	0	0
Water depth and soil morphology	0	0
Soil composition	0	0
Turbidity and water quality	0	0
Sediment transport	0	0
Coastal safety	0	0

All morphological and hydrological changes resulting from the construction, operation, removal and maintenance of the wind farm and cables are highly limited and temporary in nature. The changes, if any, are very low compared to the natural dynamics of the area. Due to the relatively small dimensions of the foundation piles, the relatively large distance between the wind turbines and the number of wind turbines, any changes are highly localised. The effect is temporary and restricted to the immediate surroundings of the foundation piles and cable route. Both alternatives hardly differ in this respect and are therefore practically the same.

Landscape

Table S8 Assessment of impact on landscape without mitigating measures

Assessment criteria	Assessment	
	Alternative 1	Alternative 2
	63 x 6 MW turbines Max. tip height 167 m	38 x 10 MW turbines Max. tip height 251 m
Visibility in percentage of time Interpretation of visibility on the basis of visualisations	-	0/-

The visibility of a wind farm at site I is quantified by the percentage of time that meteorological conditions allow the wind farm to be seen. That is 18.8% of the daytime during summer months (1 May - 30 September) from the nearest point on land (Noordwijk). Outside of this period, the visibility percentage is lower. The percentage is also lower at other locations situated farther away from the site.

Furthermore, photo visualisations indicate that the wind farm is visible in good meteorological conditions. The difference between the alternatives is minimal. The large turbines are still (theoretically) visible at a distance of 44 kilometres or more; the smallest turbines not anymore (due to the horizon effect). In reality this difference is rather small, however.

Based on De Vries et al. (2008) in particular, it has been concluded that the perception is subjective and depends on the background of the observer, such as education, income and attitude towards renewable energy. The largest common denominator from the perception study shows that disruption to the maritime landscape by fixed objects, such as wind farms and oil rigs, is slightly negative, whereby the first disrupting object is deemed to be the most negative and the following objects relatively less and less negative, and that a greater distance results in a less negative perception. Some groups of people also appear to have positive feelings towards offshore wind power and wind turbines in general.

The lighting applied to the nacelle of the wind turbines ensures that the wind farm can be seen from the coast even at night in good meteorological conditions. The more wind turbines there are, the more visible they will be at night. The alternative with the most turbines scores worse on visibility at night than the alternative with the fewest turbines. The effect of the lighting can potentially be mitigated based on a new circular (draft information circular on offshore wind turbines and offshore wind farms, in relation to aviation, no. 2.2, 4 April 2016). See also table S12 containing mitigating measures.

Other use functions

Table S9 Assessment of impact on other use functions without mitigating measures

Assessment criteria	Impact assessment	Assessment	
		Alt 1 (63 x 6 MW on suction bucket)	Alt 2 (38 x 10 MW on gravity base)
Fishery	Fishery restrictions	0/-	0/-
Oil and gas extraction	Restrictions on oil and gas extraction	0/-	0/-
Aviation	Interference with civil aviation	0	0
	Interference with military aviation	0	0
	Interference with Coast Guard	0/-	0/-
	Interference with helicopter traffic	-	-
Sand, gravel and shell extraction	Restrictions on shallow mineral extraction	0	0
Dredging disposal	Restrictions on dredging disposal dumping areas	0	0
Ship, onshore and aviation radar	Interference with radar	0	0
Cables and pipelines	Interference with cables and pipelines	0/-	0/-
Telecommunications	Disruption to cable connections	0	0
	Disruption to ray paths	0	0
Ammunition dumping areas and military areas	Presence of ammunition dumping areas and military areas	0	0
	Presence of unexploded devices	0	0
Recreation and tourism	Recreational boating restrictions	0	0
	Coastal recreation restrictions	0/-	0/-
Cultural history and archaeology	Damage to archaeological remains	0	0
Mussel seed collection installations	Restrictions on mussel seed collection installations	0	0
Existing wind farms	Effect on electricity output of existing wind farms	0/-	0/-

The effects with regard to already existing use functions appear only to be very low. This is partly because the existing use functions were taken into account in the choice of location. However, there may be an adverse effect on helicopter traffic. There are minor effects on the use functions of sand extraction, ship and aviation radar, cultural history and archaeology in the form of loss of space (sand extraction and recreation), degradation (archaeology) or influence (ship radar). The effects are rated neutral given the small extent and the alternatives are not distinctive.

The effects on fishing as a whole, given the surface that is lost (90 km^2) and the value of that area for fishing, are rated slightly negative. In addition, the effects on wind farms are also rated slightly negative, because the wind interception has an adverse effect on the energy yield of Luchterduinen wind farm (and potentially OWEZ and Princess Amalia wind farms as well). For cables and pipelines, a maintenance area of 500 m on both sides is laid down in the wind farm site decisions. This is smaller than the 750 metres that is generally applied. The North Sea policy documents (2016-2021) maintain that it is permitted to reduce the maintenance area in order to make efficient use of space in the North Sea. In terms of oil and gas extraction, a slightly negative rating is also given, since an extraction licence has been granted for mining block P12, which partially overlaps with site I. Effects on Recreation and tourism are also rated as slightly negative. Finally, a negative score is given to the effects on helicopter traffic. Helicopter Main Route KZ60 is less than 2 NM away. The alternatives here are not distinctive.

Electricity yield

Table S10 Assessment of impact on electricity yield without mitigating measures

Aspects	Assessment	
	Alternative 1	Alternative 2
	63 x 6 MW turbines	48 x 8 MW turbines (10 MW turbines are not yet on the market)
Electricity yield Emissions avoided	++ ++	++ ++

To determine the electricity yield, calculations were made with a pair of turbines for which data is available and that are as different as possible from each other in size. Virtually no difference in yield is apparent from these calculations. Both alternatives barely differ in terms of electricity production and emissions avoided. It can be noted here that this does not mean that all turbine types should score the same, even though the set capacity is 380 MW in each case (starting point in the direction towards the site). Turbines with relatively large rotors (and therefore a low W/m^2 value) will generate more power than turbines with a relatively small rotor. The underlying wind interception and the wind interception at Luchterduinen also come into play here. Turbines with a high capacity and relatively large rotor will probably score the best. The future wind farm developer is free to determine the best option, whereby the cost price inherently plays a major role.

Cumulation

The following table briefly lists the cumulative effects that occur and the consequences this has for the wind farm site decision to be taken.

Table S11 Overview of cumulative effects at site I – Dutch Coast (south)

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
Birds and bats	Exceeding the PBR in the international worst-case scenario examined with 3 MW turbines in the KEC for the lesser black-backed gull, greater black-backed gull and herring gull cannot be ruled out. In a worst-case scenario in combination with the wind farm developments in the North Sea as considered in the KEC, the provisional PBR value calculated for the Nathusius's pipistrelle would be exceeded.	If realistic wind turbine types are used in the calculations for the existing and planned wind farms in the southern North Sea (Borssele I/II: 4 MW, Borssele III-V: 6 MW, Dutch Coast (south) I – IV: 6 MW and Dutch Coast (north): 8 MW), only the number of lesser black-backed gull casualties would lie above the PBR threshold (Gyimesi & Fijn 2015b). If we examined the number of casualties caused by Dutch wind farms against the Dutch PBR threshold[2], then the cumulative number of casualties would lie at or below the PBR threshold for species of greater gull, so it can be said with confidence that these populations are resilient enough to withstand the increased mortality rate. Moreover, previous population modelling of the lesser black-backed gull showed that the Dutch population of this species is not at risk (Poot et al. 2011). Mitigating measures could be taken in order to reach acceptable effects (see section 12.5 and 12.6).
Marine mammals	Effects on the FCS cannot be ruled out	Mitigating measures could be taken in order to reach acceptable effects (see section 12.5 and 12.6).
Shipping and safety	Wind farms at other sites in the Dutch Coast (south) wind farm zone	No consequences for wind farm site decision. The cumulative effect of other wind farms on navigation safety, in contrast to previous safety studies, has not been

[2] More reliable and detailed data is available for the DCS and in turn for the entire southern North Sea. There is also more certainty with regard to the wind farms earmarked for the DCS up to and including 2023. The degree of uncertainty in results is therefore smaller for this analysis. The effects of operation in the 10-12 mile zone in the Dutch Coast wind farm zone are also reflected in these analyses. Therefore, a decision was made to carry out an analysis whereby the number of casualties caused by Dutch wind farms is compared with a PBR based on Dutch populations.

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
	may lead to other effects on shipping and safety.	separately detailed but is considered as the basic situation. The distances between the shipping separation regime and future wind farms are determined in the design criteria of distance between shipping routes and wind farms from the North Sea policy documents (2016-2021). Those distances are implemented in the new route structure that entered into force in August 2013. The calculations for wind farm site I are also cumulated over wind farm sites II, III and IV; the route structure for wind farm site I does not change if wind farm sites II, III and IV are also included.
Morphology and hydrology	Wind farms at other sites in the Dutch Coast (south) wind farm zone may lead to effects on morphology and hydrology.	None. In the further implementation of the Dutch Coast (south) wind farm zone (wind farm sites II, III and IV), practically the same local, temporary and negligible effects will occur. That means that there is no cumulation, not even with other activities and other more distant wind farms.
Landscape	Wind farms at other wind farm sites in the Dutch Coast (south) wind farm zone also affect the visibility of wind turbines from the beach.	None. The development of these wind turbines will increase the intrusion on the horizontal angle of view by wind turbines at the Dutch Coast (south) wind farm site compared to the current situation. The distance to the coast from these wind turbines is generally so great that the meteorological conditions greatly reduce the visibility of the wind turbines. The shortest distance between the offshore wind turbines at wind farm site I and the beach is 22.2 kilometres (Noordwijk). At this distance, a wind farm in the summer period is visible during the day on average 18.8% of the time. The wind farms that might be developed at Dutch Coast (south) are slightly closer to the coast, meaning that they will be visible for a higher percentage of the time.
Other use functions	Wind farms at other wind farm sites in the Dutch Coast (south) wind farm zone also affect the other use functions.	None. In the further implementation of the Dutch Coast (south) wind farm zone (wind farm sites II, III and IV), the total space used is larger meaning a larger area is lost for fishing. The area that is lost for fishing is relatively good fishing ground. In total, approximately 0.16% of the fishable surface of the DCS is lost, meaning that in cumulation there are limited adverse effects on fishery. Due to the greater number of turbines, it is also more likely that archaeological remains will be harmed. The further implementation of the Dutch Coast (south) wind farm zone has limited effects on recreation and tourism because recreational boating uses the 10 to 20 km wide zone along the coast in particular. This also has a slight

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
		negative impact (in accordance with the Decisio report 2015) on coastal recreation. This does not have any direct consequences on the wind farm site decision. The creation of other wind farm sites in the Dutch Coast (south) wind farm zone also increasingly affects onshore radar. This does not have any direct consequences on the wind farm site decision.
Electricity yield	Wind farms at other wind farm sites in the Dutch Coast (south) wind farm zone and Luchterduinen can also affect the wind intercepted by each other.	None. The construction of wind farm sites II, III and IV will lead to more wind interception for wind farm site I. The degree of wind interception depends on the exact details of these wind farm sites.

Mitigating measures

After assessment, it appears that the conditions in the legal framework can be satisfied for virtually every aspect. Mitigating measures are required to limit the cumulative effects on birds, bats and porpoises. However, the occurrence of other adverse effects due to the construction, operation and removal of the wind farm cannot be excluded. These possible other effects can be mitigated by the following measures. A number of these potential mitigating measures will be selected for the purpose of the preferred alternative.

Table S12 Potential mitigating measures

Aspect	Effect	Mitigating measure
Birds and bats	Construction and removal phase	Construction from June to September due to the limited presence of species of sea bird susceptible to disturbance. Minimising lighting on ships and/or use of a bird-friendly lighting colour. Reducing of pile-driving noise. However, the effect of the sound of pile driving on birds is unknown and therefore it is not known how necessary this measure is.
	Operational phase	Installing fewer large turbines instead of more small ones as much as possible. Connecting Dutch Coast (south) to Luchterduinen wind farm to the greatest extent possible in order to keep the disturbance area as small as possible. Installing two-blade instead of three-blade turbines. Creating a corridor in the wind farm that birds may use. Increasing the chances of birds detecting the wind farm through the use of reflectors, lasers and sound (depending on the species of bird and subject to various restrictions). Avoiding maintenance works at night and above all during the migration season. Minimising lighting on ships and/or use of a bird-friendly lighting

Aspect	Effect	Mitigating measure
		colour. Shutting down in certain weather conditions in combination with identified peaks in migration. Increasing cut-in wind speed (for bats) in the relevant season and at relevant time of day (dusk). Increasing maximum lowest tip point. As small as possible wind farm surface (least habitat loss).
Marine mammals	Disturbance and associated population reduction; PTS.	Limiting the construction period. Using 'Slow start' and 'Acoustic Deterrent Devices' (ADDs). Establishing a maximum permissible noise level.
Shipping and safety	Propulsion	Using the Automatic Identification System (AIS). Deploying an Emergency Towing Vessel.
Morphology and hydrology	-	-
Landscape	Visibility during the day	Use of vertical colour strips on the turbines Distribution of information on the what, how and why of the wind farms, so that observers understand why the wind farm is needed. Selection of as large turbines as possible, so that fewer need to be erected. This also provides a more pleasant landscape.
	Visibility at night	With the use of radar detection, lighting can be switched on when an aircraft is detected within a certain range of the wind farm. With the use of visibility meters, lighting can be dimmed in good visibility conditions, so lights do not always need to turned on.
Other use functions	Closer than 750 metres to active cables	Consult with cable operators.
	Damage to archaeological values	Changing the location of a wind turbine or cable so as to avoid a possible archaeological object.
	Risk of unexploded devices	Further investigation is required to locate and remove unexploded devices.
	Effect of wind turbines on shore-based radar system	Installation of radar on the TenneT platforms to be constructed or between wind farms and shipping routes.
	Interference with helicopter traffic	Helicopter main route (HMR) can be increased or decreased. By shifting the NEKAS point westwards, the usable area of 2

Aspect	Effect	Mitigating measure
		nautical miles will be preserved on both sides of the HMR.
Electricity yield	-	-

A number of measures will be carried out in any case, such as the use of a 'slow start' and ADDs. For the other mitigating measures, it has not yet been determined whether and to what extent they will be applied. The wind farm site decision includes the measures that have been adopted.

16. Considerations

Testing against the legal framework

Some mortality amongst birds and fish and decrease in populations of marine mammals cannot be ruled out in advance. The Offshore Wind Energy Bill integrates the assessment to be carried out under the Nature Conservation Act 1998 and the Flora and Fauna Act into the wind farm site decision. By virtue of Article 7 of the Offshore Wind Energy Bill, the competent authority has authority over exemption within the framework of the Flora and Fauna Act. For the purpose of testing against the Nature Conservation Act 1998, an Appropriate Assessment has been carried out. This Appropriate Assessment shows that any significant impact on the conservation objectives of Natura 2000 areas as a result of the preferred alternative can be ruled out.

Other laws and regulations are discussed where relevant in the various aspect chapters and translated into specific standards where necessary. For example, the chapter on underwater life describes the set of standards that is taken as a basis within ASCOBANS and used to determine a measure of acceptable population reduction for porpoises. The planning protection regime for the National Ecological Network, now known as the Nature Network Netherlands, applies to the whole of the North Sea (EEZ). Paragraph 1.3.1 of annex 5 states how the protection regime for the Nature Network Netherlands (NNN) works in the Dutch North Sea area.

Choice of preferred bandwidth

There are no aspects in this EIA that restrict the bandwidth considered. As a starting point for the bandwidth used, consideration was given in particular to the study into the (cumulative) effects on birds. This aspect restricted bandwidth primarily at the sites in the Borssele wind farm zone. However, mitigating measures on the basis of this environmental impact assessment must be taken to eliminate or reduce the effects. The measures that must be taken are as follows:

Mitigating measures that must be taken

Measures that are adopted to reduce the effects as required are:

Birds and bats

- During the night (from sunset to sunrise) at times of mass migration, the number of rpm is reduced to less than 1 for each turbine.
- The cut-in wind speed of the turbines is 5.0 m/s at hub height between one hour after sunset and two hours before sunrise from 15 August until 30 September.

Underwater life

Noise standards have been determined for the entire Dutch Coast (south) wind farm zone. The wind farm site where the most stringent noise standards must be enforced will determine the noise standards for other sites. Furthermore, the standards have been selected in a way that takes into account any potential excesses during the learning phase in the start-up period. The standards determined are provided in the table below.

Table S13 Standards for wind farms in the Dutch Coast (south) zone, including the start-up excess of 1 dB

Dutch Coast (south)	Maximum noise impact (dB re 1 $\mu Pa^2 s$ over 750 m)*		
380 MW per site	Period		
# turbines	Jan-May	Jun-Aug	Sept-Dec
63 (assessed here)	163	169	171
54	164	170	172
48	165	171	173
42	166	172	174
38 (assessed here)	167	172	175

In addition to the noise standards, ‘Acoustic Deterrent Devices’ and ‘soft start’ procedures to prevent permanent effects on hearing must be used (PTS: *permanent threshold shift*).

Other use functions
There are various cables located in the vicinity of and within wind farm site I. For cables and pipelines, a maintenance area of 500 m on both sides is laid down in the wind farm site decision. This is smaller than the 750 metres that is generally applied. The North Sea policy documents (2016-2021) maintain that it is permitted to reduce the maintenance area in order to make efficient use of space in the North Sea.

Further investigation is required to locate and remove unexploded devices.

Moreover, any archaeological values present may influence the location of wind turbines at site I.

Conclusion on preferred alternative
The wind farm site decision should make the preferred bandwidth possible and safeguard necessary mitigating measures; together the preferred bandwidth and measures form the preferred alternative.

17. Gaps in knowledge and information

The development of offshore wind farms has a relatively brief history. The first monitoring evaluations for other offshore wind farms in England, Denmark, Germany and the Netherlands have since been published. These are results from relatively brief monitoring periods. Certainty about the long-term effects can therefore not be given yet. However, current development and research programmes offer tools for an impact forecast, as presented in this EIA. In investigating and predicting the impact for this EIA, various gaps in knowledge were identified that might limit the understanding of the nature and extent of the impact of a wind farm at site I. There are still some uncertainties surrounding the impact, especially the cumulative effects of multiple wind farms on each other and in combination with other activities in the North Sea.

The gaps in knowledge that exist are not only due to the recent history of offshore wind energy; in a broad sense a lot of knowledge about animal species and their densities, diversity and behaviour needs to be supplemented.

In short, the following gaps have been noted:

- Local birds: in general, knowledge of the distribution in space and time of seabirds at sea is still incomplete;
- Migratory birds: in general, knowledge of the duration and the spatial extent of bird migration is still incomplete. The lack of representative data is related to the often hard-to-access habitat and the absence of standardised counting methods. There are indications for various migration routes in the North Sea area. Quantitative data on this, on how large the share of these migration routes is in relation to migration as a whole, as well as data on local densities in the different areas of the North Sea are missing.
- Bats: knowledge gaps exist regarding the occurrence of bats at sea and their behaviour in wind farms as well as the number of collision casualties.
- Benthos: knowledge gaps exist with regard to the ability to predict the consequences of the abiotic changes (especially sediment change in the surroundings of the wind farm) on benthos. In addition, the effects of electromagnetic fields along the cables are not yet well known.
- Marine mammals: there are gaps in knowledge on aspects such as distribution and prevention of marine mammals, migration patterns, threshold values for TTS, PTS and avoidance, behavioural reactions as a result of underwater sound and foraging behaviour. Model calculations of the distribution of underwater sound in combination with threshold values derived from several studies predict the occurrence of avoidance, TTS and PTS in marine mammals. Further research in the form of monitoring in the field, additional laboratory research and further model development is needed to fill gaps in knowledge.
- Fish: specific knowledge gaps with respect to wind farms exist, especially with regard to species and extent of changes on fish fauna in the longer term as a result of setting restrictions on fishery and applying hard substrate.
- Other use functions: The actual economic effects of tourist activities following the construction of visible wind farms have never been investigated before in the Netherlands.
- Electricity yield: the wind interception from Luchterduinen and from the other wind farm sites within the Dutch Coast (south) wind farm zone can be calculated fairly accurately once the exact set-ups of those wind farms are known. It is expected that the calculations in this EIA are a good indication.

The gaps in knowledge do not mean that it is not possible to get a good idea of the effects of a wind farm at wind farm site I in the Dutch Coast (south) wind farm zone. A wind farm site decision can be taken despite the existing gaps in knowledge and uncertainties. In the decision-making process it is important to understand the uncertainties that played a role in the impact predictions. This understanding is provided by this EIA.

18. Monitoring and evaluation

The Energy Agreement for Sustainable Growth (SER agreement, September 2013) contains an agreement to achieve the objectives more quickly and reduce offshore wind power costs by 40% (Parliamentary Papers II, 2012/13, 30 196, no. 202). For these reasons, the Ministry of Economic Affairs and the Ministry of Infrastructure and the Environment decided in 2015 to launch an integral monitoring programme in order to investigate the knowledge gaps with regard to the impact on offshore wind farms in the North Sea ecosystem and to achieve further cost reduction within the ecological boundaries.

This Wozep (*windenergie op zee ecologisch programma* – offshore wind energy ecological programme) monitoring and evaluation programme focuses on key environmental issues related to the construction and operation of offshore wind farms. Such issues are predominantly generic rather than specific to wind farms.

Both the development of the KEC instrument (update and implementation of knowledge) and the MEP (monitoring and research programme) fall under Wozep. In turn, monitoring and research – in so far as required by the Environmental Management Act – fall under the MEP.

Wozep therefore replaces the monitoring obligation for each wind farm. This results in improved efficiency, which also makes it more cost efficient to achieve the objectives for offshore wind power.

In the Wozep evaluation, attention is paid to the translation of new knowledge in the KEC instrument (this can also mean verifying assumptions and/or impact calculations) on the one hand, and translation into policy and management implications on the other hand. This is demonstrated by the establishment or modification of mitigating measures. In Wozep, the investigation focuses in particular on those aspects that may increase costs, provides a clear view of them and advises the competent authorities on them. Wozep will begin in 2016 and last for five years.

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