PONDERA consult

719022
27 november 2020

MER KAVEL VI WINDENERGIEGEBIED HOLLANDSE KUST (WEST)

Ministeries van Economische Zaken en Klimaat,
Binnenlandse Zaken en Koninkrijkrelaties
Infrastructuur en Waterstaat en
Landbouw, Natuur en Voedselkwaliteit

Eindversie

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Documenttitel	MER kavel VI Windenergiegebied Hollandse Kust (west)
Soort document	Eindversie
Datum	27 november 2020
Projectnummer	719022
Opdrachtgever	Ministeries van Economische Zaken en Klimaat, Binnenlandse Zaken en Koninkrijkrelaties Infrastructuur en Waterstaat en Landbouw, Natuur en Voedselkwaliteit
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SUMMARY

1. Introduction

The Netherlands has formulated ambitious targets for the generation of sustainable - renewable - energy. Wind energy plays a prominent role in this. The Climate Agreement refers to the production of at least 49 TWh of offshore wind energy by 2030 and is in line with the Roadmap for offshore wind energy. The roadmap provides plans for approximately 11 gigawatts of wind farms at sea in 2030.

The Offshore Wind Energy Act gives the government the opportunity to issue sites for the development of offshore wind farms.

In order to achieve the target of 49 TWh in 2030, new sites will have to be established and issued in the coming years. The sites will be determined within the boundaries of the areas already designated as wind farm zone in the National Water Plan. This concerns 1.4 GW in the area of Hollandse Kust (west), 0.7 GW in the area Ten noorden van de Waddeneilanden, and approximately 4 GW in the area of IJmuiden Ver. The Wind Farm Site Decision (WFSD) determines where and under what conditions a wind farm may be built and operated. A decision on the site is followed by the issuing of a tender. The winner of the tender will receive a permit for the construction and operation of the wind farm. Only the permit holder has the right to build and operate a wind farm at the site.

The Water Decree lays down general rules for offshore wind farms.

The Minister of Economic Affairs and Climate (in agreement with the Minister of the Interior and Kingdom Relations, the Minister of Infrastructure and Water Management and the Minister of Agriculture, Nature and Food Quality) is responsible for issuing sites and, for that purpose, drafts an environmental impact assessment (EIA) for each wind farm site decision.

This document concerns the EIA for site VI in the wind farm zone Hollandse Kust (west). The EIA describes the environmental effects that occur during the construction, operation and removal of wind turbines in the sites.

The wind turbines installed in the Hollandse Kust (west) site must be connected to the high-voltage grid. TenneT is responsible for this connection. This concerns two platforms in the Hollandse Kust (west) zone, the cables from these platforms to and over land, and the connection to the onshore high-voltage grid. TenneT is carrying out a separate procedure for the offshore grid, including an environmental impact assessment (EIA).

This summary will cover the following topics:

- The policy context and the reason for the site decisions to be taken;
- The choice of location for the Hollandse Kust (west) wind farm zone;
- The site division within the Hollandse Kust (west) wind farm zone;
- The impact assessment method;
- The results of the impact assessment;
- Cumulation;

- Mitigating measures;
- The considerations;
- Any gaps in knowledge and information;
- Monitoring and evaluation.

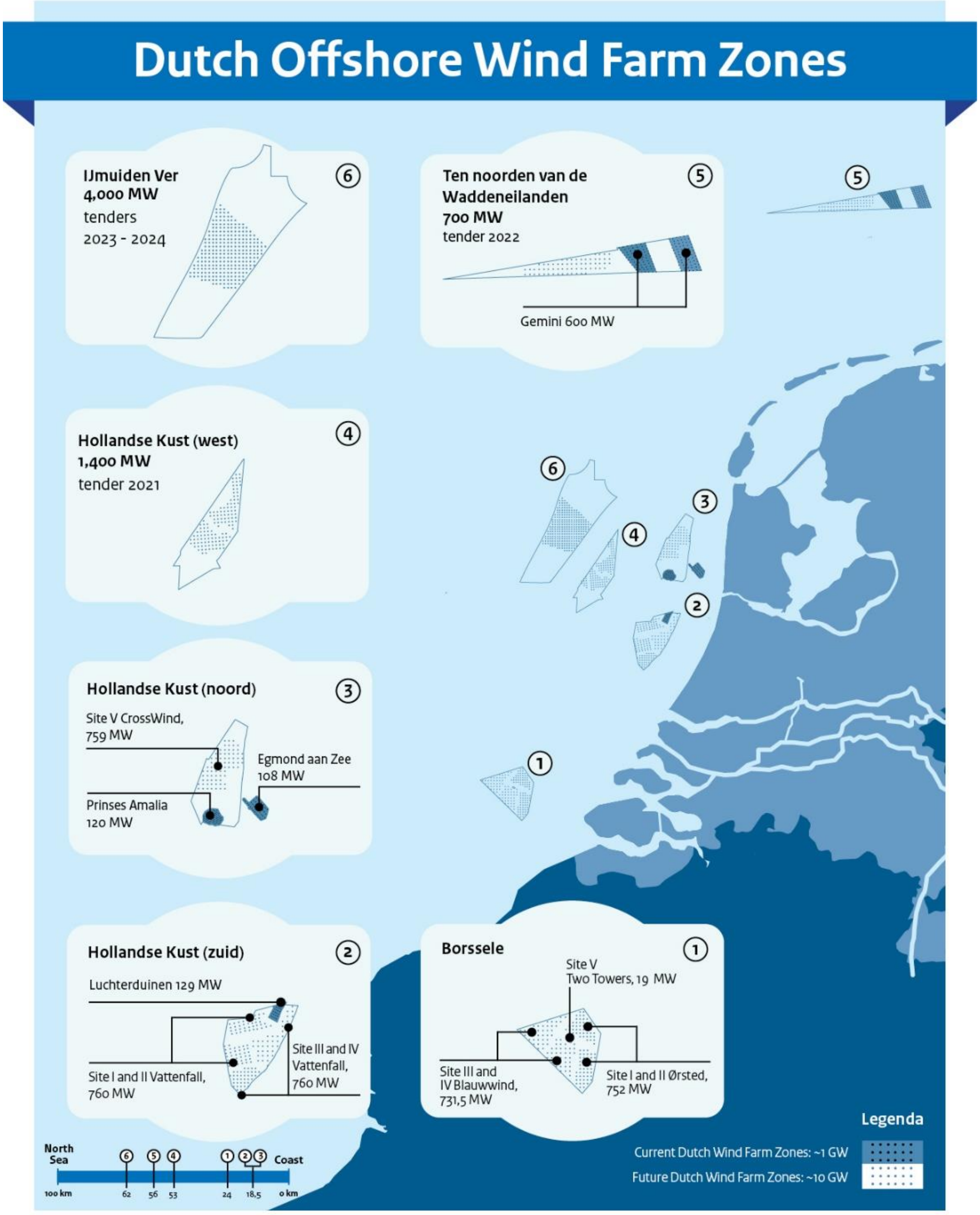
2. Policy context and reason for Wind Farm Site Decisions

On 7 December 2016, the Rutte II government presented the Energy Agenda to the House of Representatives (Parliamentary Papers II, 2016/17, 31 510, no. 64). In this document, the then Cabinet announced a new roadmap for offshore wind energy. On 27 March 2018, the Minister of Economic Affairs and Climate presented this roadmap for offshore wind energy to the Lower House of Parliament (Parliamentary Papers II, 2017/18, 33 561, no. 42).

The Roadmap for offshore wind energy includes plans to develop wind farms until 2030 with a total capacity of at least 6.1 GW in the following wind farm zones (see Figure S1):

- Dutch coast (west) with a capacity of 1,4 GW, whose commissioning should take place in 2024-2025;
- North of the Frisian islands with a capacity of 0,7 GW, planned to be put into service in 2026;
- IJmuiden Ver, with a capacity of approximately 4 GW, the largest wind farm zone, whose commissioning must take place in the period 2027-2030.

Figure S1 Wind farm zones



The government concludes that a coordinated grid connection of offshore wind farms will lead to lower social costs and a smaller impact on the living environment. The starting point for the roadmap is that the most cost-effective way to achieve the task of offshore wind energy is to use an offshore grid. The offshore grid is based on standard platforms to which approximately 700 MW of wind energy capacity can be connected per platform. The wind turbines of the wind farms will be directly connected to the platform. TenneT has been appointed as the offshore grid operator under the 1998 Electricity Act. The following table shows the schedule for the development of offshore wind energy from the roadmap. This EIA has been carried our for Hollandse Kust (west), site VI.

Size (GW)	Wind farm zone, site(s)	Site tender date	Commissioning year
1,0	Existing wind farms	-	-
0,7	Borssele, sites I en II	Realized in 2016	2020
0,7	Borssele, sites III, IV en V	Realized in 2016	2020
0,7	Hollandse Kust (zuid), sites I en II	Realized in 2017	2022
0,7	Hollandse Kust (zuid), sites III en IV	First quarter 2019	2023
0,7	Hollandse Kust (noord), site V	First quarter 2020	2024
0,7	Hollandse Kust (west), site VI	Second quarter 2021	2025 t/m 2026
0,7	Hollandse Kust (west), site VII		2025 t/m 2026
0,7	Ten noorden van de Waddeneilanden, site I	Fourth quarter 2022	2027
1,0	IJmuiden Ver, site I	Fourth quarter 2023	2028
1,0	IJmuiden Ver, site II		2028
1,0	IJmuiden Ver, site III	Fourth quarter 2024	2029
1,0	IJmuiden Ver, site IV		2029

3. Location choice for wind farm zone Hollandse Kust (west)

The National Structural Vision for Offshore Wind Energy examines whether wind farm zone Hollandse Kust (west) is suitable for the realisation of wind energy. In this structural vision and associated Strategic Environmental Assessment (SEA)[11], the effects of wind energy in the Hollandse Kust (west) area were investigated at an aggregate level in the following aspects: ecology, shipping safety, other uses (oil and gas, fishing, sand extraction, etc.), geology and hydrology, landscape (visibility), economy and recreation (navigation), cultural history and archaeology. This also looked at the suitability in comparison with the other areas designated for wind energy (IJmuiden Ver, Hollandse kust, Ten noorden van de Waddeneilanden, Borssele). The wind farm zone Hollandse Kust (west) has been found suitable.

In the EIAs for the site of the Borssele wind farm zone and for sites I and II of Hollandse Kust (zuid)[12], the main features of the comparison between the wind farm zones have been made. The main points of attention that emerge from this comparison should be taken into account in the further development of wind energy in the wind farm zones, such as the effect on marine mammals and birds. This EIA will also pay explicit attention to this.

[11] Environmental Impact Report National structural Vision for Offshore Wind Energy, PlanMER for the interim review of the National Water Plan for the offshore wind component, Royal HaskoningDHV, 2014

[12] Environmental Impact Assessment Wind farm site decision Borssele site I, 12 June 2015; Environmental Impact Assessment Wind farm site decision Borssele site II, 12 June 2015; Environmental Impact Assessment Wind farm site decision Borssele site III and Innovation site (site V), 13 November 2015; Environmental Impact Assessment Wind farm site decision Borssele site IV, 13 November 2015; EIA site I Wind Energy Region Hollandse Kust (south), 22 May 2016; EIA site II Wind Energy Region Hollandse Kust (south), 22 May 2016. All EIAs can be found on the following site: https://www.rvo.nl/subsidies-regelingen/bureau-energieprojecten/afgeronde-projecten/windparken.

4. Site Division

In the Roadmap for offshore wind energy the choice has been made to construct two wind farms of 700 MW in the wind farm zone Hollandse Kust (west) in 2024/2025. Of the total area of 349 km2 from wind farm zone Hollandse Kust (west), space will be reserved for the following(see also figure S2):

1. Cables and pipelines present in the wind farm zone and a zone of 500 meter around it;
2. TenneT's Hollandse kust (west) Alpha platform (and a zone of 500 meter around it) for the connection to the mainland for site VI;
3. TenneT's Hollandse kust (west) Beta platform (and a zone of 500 meter around it) for connection to the mainland for lot VII;
4. Future cables from TenneT's Alpha platform to land (500 m maintenance area on both sides and distance between the two 200 m cables is 1,200 m wide);
5. Future cables from TenneT's Beta platform to land (500 meter maintenance zone on both sides and distance between the two 200 meter cables totalling 1,200 meter wide);
6. A connection between platform Beta and Alpha (500 meter maintenance zone on both sides, i.e. 1,000 meter wide in total);
7. A safe distance to mining sites;
8. A safe distance from the ferry route between the Netherlands and the United Kingdom (northern point of the wind farm zone);
9. A clearer boundary of the south-western boundary for navigation (one corner of the area is not used);
10. A safety zone of 1,000 meter between the lots.

The exact location of platform Beta and the future cables from this platform originate from TenneT, but were not yet definitive at the time this EIA has been written. Minor changes in the location of the platform and/or the cables (in the order of a few hundred meter) do not directly lead to a different impact assessment for this EIA, but the location of the boundaries of site VII may be somewhat different, because the Beta platform and the cables from this platform are located in site VII. In particular, this could lead to changes in the coordinates given in Annex 3.

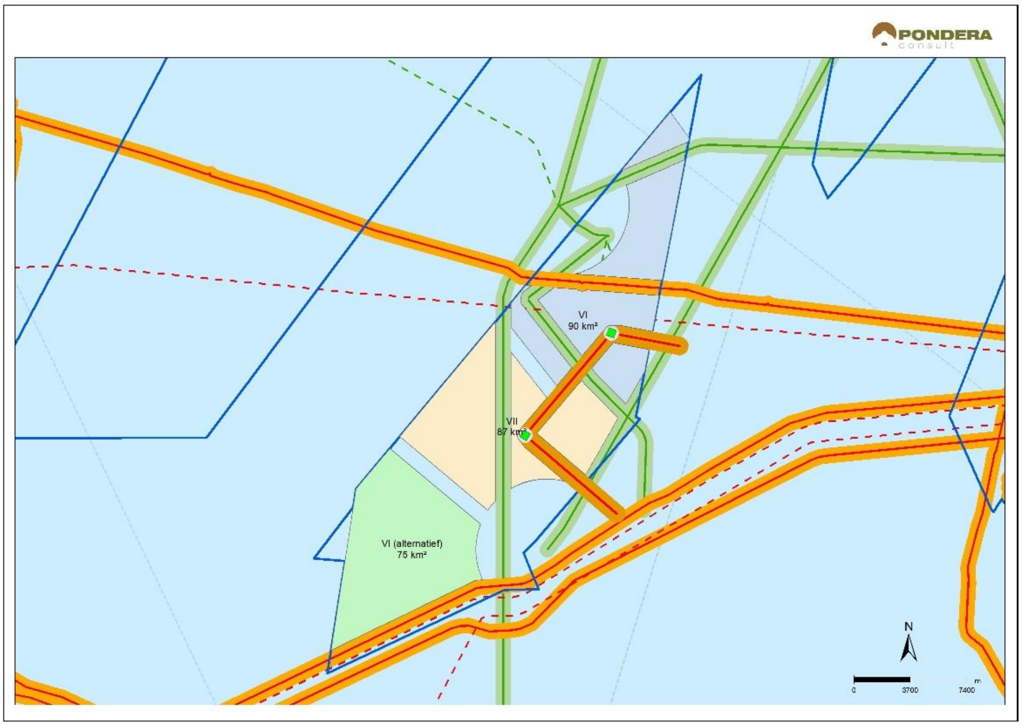
The remaining space is available for the installation of wind turbines. More space remains than two wind farms in the wind farm zone, which is why two location variants are distinguished for site VI in this EIA: a preferred site and an alternative site for VI.

Preferred site division

Site VI has a total surface area of 90 km² and is situated in the north of the Hollandse Kust (west) zone, see figure S2. The TenneT platform Hollandse Kust (west) Alpha will be placed in the southeast of site VI. site VII is located in the centre of the Hollandse Kust (west) and has a gross surface area of 87 km². A search area for TenneT platform Beta is situated east of the centre of site VII.

The southernmost part of the Hollandse Kust (west) area, where "VI (alternatief) 75 km2" is shown in figure S2, is kept clear in the preferred division, as is the northernmost point. In order to limit other (existing) use of the area, such as fishing and shipping, as little as possible for the time being, it has been decided not to use a (continuous) area in the south. Also from the point of view of helicopter accessibility, the location of platform P09-Horizon-A makes it more favourable not to fill in the southern corner. In addition, it is possible that in the longer term there will be a greater need for offshore wind energy than is assumed in the Roadmap for offshore wind energy, in which case it would be advisable to keep one somewhat larger area free for this purpose instead of several smaller areas. This is because a continuous area is more efficient for the construction of a wind farm than several smaller areas. That is why one continuous area in the south of the wind farm zone is kept free.

Figure S2 Proposed site division of wind farm zone Hollandse Kust (west).



Alternative site division

The alternative site division is also shown in Figure S2. In this alternative, not all of the area of the Hollandse Kust (west) is in use either, so that for the time being space remains available for other (existing) uses, such as fishing and shipping. In addition, shared use within the wind farms is possible for certain activities. In the alternative division, site VI has a gross surface area of 75 km² instead of 90 km2 and is situated in the far south of Hollandse Kust (west). For reasons of shipping safety, the eastern corner is not used for the site. The western point also remains unused. Site VII is still, centrally located in the Hollandse Kust (west) area and has a gross surface area of 87 km². The TenneT platform Hollande Kust (west) Alpha is located to the north of both lots, at the same location as in the preferred subdivision. The alternative division concerns a 'southern use': to the west and north of the TenneT platform west Alpha, no turbines will be placed in the alternative division. Because the TenneT platform west Alpha is not (centrally) located in a site but outside it, the inter-array cables will be longer.

In the effect sections of this EIA, the preferred site division is investigated from the point of view of relevant aspects such as ecology, shipping safety and mining. To the extent that it can reasonably be relevant due to possible deviations in the results, the alternative site division will also be investigated and the effects between the preferred and the alternative site divisions will be compared.

5. The impact assessment method

Bandwidth

In an EIA, alternatives to an activity are assessed by examining their effects and comparing them with each other. An alternative is a possible way in which the intended activity, in this case the generation of energy with wind turbines, can be realised considering the purpose of this activity (see text box). In this EIA, alternatives per site (preferred site division and alternative site division) were investigated. 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 site within the wind farm zone Hollandse Kust (west) will thus be issued with the possibility for the wind farm developer to design it according to his own wishes. The bandwidth within which the project must be carried out will be laid down in the decision on the site.

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 scenario 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 of reducing 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 within the site is shown in the following table. The values of the bandwidth are based on the current state of the art and expectations regarding developments for the coming years. The bandwidth within which to remain is laid down in the following table.

Tabel S1 Bandwidth EIA.

Design	Bandwidth
Capacity of individual wind turbines	Minimum of 10 MW*
Highest tip point of individual wind turbines	189 – 304 meter

Design	Bandwidth
Lowest tip point of individual wind turbines	Minimum of 25 meter
Rotor diameter of individual wind turbines	164 – 279 meter**
Distance between each wind turbine	Minimum of 600 meter
Number of blades per wind turbine	2, 3, multirotor**
Type of foundations (substructures)	Monopile, multipile, 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: maximum sound level	168 dB re 1 mPa2s at 750 meter
In case of pile-driving foundations, diameter of foundation pile/piles and number of piles per turbine:	
Monopile	1 pile of 6 to 12 meter
Multipile	3 to 6 piles of 1 to 4 meter
In case of a foundation without pile driving, dimensions on seabed:	
Gravity-based	Up to 40 x 40 meter
Suction bucket	Bucket diameter: tbd
Electrical infrastructure (inter-array cabling)	66 kV, burrowed at 1to 3 meter depth[13]

* Implying a maximum of 76 turbines to reach 760 MW

** Multirotor turbines may deviate from this. The application of this innovative turbine design requires customization in the EIA.

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	
	Alternatief (Worst case)	Alternative (Best case)
Birds and bats	76 x 10 MW-turbines Lowest tip point 25 m, rotor diameter 164 m	47 x 16 MW-turbines Lowest tip point 25 m, rotor diameter 279 m
Underwater life*	47 x 16 MW-turbines 1 turbine location a day	76 x 10 MW-turbines 1 turbine location a day
Shipping	76 x 10 MW-turbines Jacket-foundation with 18 m diameter	47 x 16 MW-turbines Monopile foundation with12 m diameter
Geology and hydrology	76 x 10 MW-turbines	47 x 16 MW-turbines
Landscape**	76 x 10 MW-turbines	47 x 16 MW-turbines

[13] Two variants can be investigated: digging in at a depth of one metre and at a depth of three metres.

Environmental aspect	Bandwidth	
	Min. rotor diameter 164 m Min. axle height: 107 m	Max. rotor diameter 279 m Max. axle height: 164,5 m
Other use functions	76 x 10 MW-turbines	47 x 16 MW-turbines
Electricity yield**	76 x 10 MW-turbines	47 x 16 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 alternatives per aspect, they are assessed on a +/- scale in relation to the zero alternative (ie. the current situation and autonomous development). The following rating is used for this purpose, as shown in table S3. The assessment provides a justification for the scoring.

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 VI, cumulative effects of other wind farms and activities are considered and mitigating measures examined.

6. Results of the Environmental Assessment – Preferred site VI

The following tables show the assessments of the alternatives per aspect against the various assessment criteria, 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.

6.1 Birds and bats

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

Wind farm effect	Alternative 1	Alternative 2
	76 * 10 MW ø 164 m	**47 * 16 MW ø 279 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	-	-
- barrier effect	0	0
- habitat loss	-	-
- 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	+/-	+/-

The alternative 2 with 46 x 16 MW turbines and a rotor diameter of 279 meter is the most environmentally friendly alternative for birds and bats, due to the lower number of collision casualties compared to the other alternative.
The expected effect of two-bladed instead of three-bladed turbines was also discussed. If one takes into account the fact that a bird can come into contact with one blade less per turbine, but

the rotation speed is on average somewhat higher of the blades (approximately 1.33x), then it is expected that fewer casualties will occur with two-bladed turbines than with three-bladed turbines.

The effect of using multi-rotor turbines was also discussed in qualitative terms. No experience figures are available yet, but it can be expected that more collision victims will fall if the rotors are placed lower in comparison with single-rotor turbines. Even when the total rotor surface in the site increases, this will lead to more bird casualties. The presence of multiple rotors can increase the visibility of multirotors and this can lead to more disturbance for sensitive species, such as razorbills and divers. As far as bats are concerned, it is also expected that multi-rotor turbines will lead to more casualties, due to the possibly larger rotor surface area and the lower rotor height.

6.2 Underwater life

Table S5 Assessment of impact on underwater life without mitigating measures.

Assessment criteria	Impact assessment	Site VI	
		Alt. 1	Alt. 2
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 **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 Animal disturbance days Number of affected animals Population effects (North Sea) 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 0/- 0/- 0/- 0/- 0 0 0 0 0/- 0/-

The alternatives are not distinctive with regard to the effects of underwater noise. The application of the noise standard as included in the Framework Ecology and Cumulation (KEC) 3.0 results in a levelling off of the effects, as a result of which for both alternatives it can be stated with 95% certainty that the population of porpoises will not decrease by more than 5%. This 5% concerns 510 porpoises per site. The construction of the wind farm in both alternative 1 and alternative 2, results in a very small decrease in the number of porpoises (a maximum of 40 individuals). As far as seals are concerned, the effects are also minor, since seals have a higher threshold value with regard to disturbance. A maximum of 11 individuals will avoid the disturbance area. As regards bottom-dwellers and fish, the effects are very small.

6.3 Shipping safety

Tabel S6 Assessment of the effects of the preferred location for site VI - shipping and safety without any mitigating measures.

Assessment criteria	Impact assessment	Score Preferred location site VI with10 MW-turbines
Safety	Risk of collision and propulsion	0/-
	Consequential damage of collision and propulsion	0/-
Shipping	Deviation possibilities for vessels crossing	0/-
	Effects of passage of ships below 24 metres or below 45 m	0/-

For the preferred location of site VI, calculations have been carried out on the turbines' collision and propulsion probabilities. These calculations show that the total frequency of collisions and propulsion is 0.109282. This is equivalent to once every 9.2 years. This means that the preferred location scores slightly negative (0/-).

As a result of turbines in the preferred location of site VI, an outflow of oil is expected once every 568 years.

The expected average number of fatalities per year due to a collision or propulsion with a turbine is 0.004406.[14] A number of comments can be made about these figures (including the fact that a number of scenarios have been disregarded and that figures are based on smaller turbines than those currently being built, see section 8.4.3), but the figures between sites are comparable.

Intersecting ships

It is assumed that even if there are sometimes larger shadows (in the radar sight) at a shorter distance, the non-route bound ships are sufficiently manoeuvrable to react at a short distance when they meet another ship. However, it is expected that the limitation of visibility plays an less

[14] This does not take into account possible casualties in the event of collisions and propulsions where the mast and nacelle do not fall on the deck, such as when a fishing vessel overturns.

important role in these meetings, as opposed to the possible misjudgment of the intentions and maneuverability of the other ship. This effect is scored as 0/-.

Passage through the wind farm zone

The number of collisions with wind turbines is greater in the event of allowed passages of ships up to 45 metres, namely 1.87 collisions per year compared to 1.43 collisions per year. This is based on the presence of wind farms in accordance with the roadmap, i.e. not only the wind turbines in Hollandse Kust (west). The effect on the area outside the wind farms is also relevant: the verge and the waterway. This is an aspect that needs further investigation and on which no statements can be made at this stage. Because the chance of collisions and drives increases as a result of opening up wind farms to ships, the score is slightly negative (0/-).

6.4 Morfologie en hydrologie

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

Aspect (during installation, maintenance and operation)	Site VI, alternative 1	Site VI, alternative 2
	a 16 MW turbine on a monopile foundation with a diameter of 12.5 meter. Erosion protection (paving stones): three times the diameter of the base.	a 10 MW turbine on a gravity based foundation with a diameter of 50 meter. Erosion protection (dumping stones): three times the diameter of the base.
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 the morphological and hydrological changes resulting from the construction, use, removal and maintenance of the planned wind farm and the cables are very limited. In addition, the effects during construction and removal are temporary in nature. The changes, if any, are very small compared to the natural dynamics of the area. Due to the relatively small size of the foundation piles, the relatively large distance between the wind turbines and the number of wind turbines, these are very local changes. The impact is limited to the immediate vicinity of the foundation piles and the park cabling route and is of a temporary nature. Only in the case of a gravity-based foundation are the effects as a result of the larger dimensions of the foundation slightly larger and therefore score slightly negative.

As far as the difference between burying the cables at a depth of 1 or 3 meter is concerned, exposure of the cable occurs more quickly when the cable is buried at a depth of 1 metre, with the result that there is a greater chance that the cable will have to be brought back to the required depth. However, laying a cable at a depth of 3 meter has a greater effect in terms of the soil-disturbed surface through the trencher and the turbidity will increase as a result of stirred up sediment when 3 instead of 1 metre is buried. However, this still falls well within the limits of the natural dynamics of the North Sea.

6.5 Landscape

Table S8 Assessment of impact on landscape without mitigating measures.

Aspect	Score	
	Alternative 1 76 x 10 MW-turbines Max. tip height 189 m	Alternative 2 47 x 16 MW-turbines Max. tip height 304 m
Visibility in percentage of time	0	0

The visibility of wind turbines in lot VI is quantitatively represented by the percentage of time that the meteorological conditions are such that the wind farm can be seen. This is less than 1% of the time in the summer days (on average 1 day per summer, 7 minutes visible). This means that both alternatives are barely visible and no distinction is made in the assessment both score neutral (0). And if the meteorological conditions are such that the wind farm is visible, the distance (at least 51 kilometer) is so great that only some of the nearest turbines can be seen. The turbines of wind farms located between Hollandse Kust (west) and the coast will also ensure that the wind turbines in site VI are not or only to a very limited extent visible.

6.6 Other use functions

Tabel S9 Beoordeling effecten voorkeursverkaveling kavel VI - overige gebruiksfuncties zonder mitigerende maatregelen.

Aspect	Effect	Score site VI	
		Alternative 1 76 x 10 MW suction bucket	Alternative 2 47 x 16 MW 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	-	-
	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

Aspect	Effect	Score site VI	
		Alternative 1 76 x 10 MW suction bucket	**Alternative 2 47 x 16 MW gravity base**
Cables and pipelines	Interference with cables and pipelines	0/-	0/-
Telecommunications	Disruption to ray paths	-	-
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/-
Shellfish farming and aquaculture	Restrictions for shellfish farming and aquaculture installations	0	0
Existing wind farms	Effect on electricity output of existing wind farms	0	0
(local and regional) economies	Effect on economies and employment	0/+	0/+

Most of the impacts are assessed as neutral due to their limited magnitude. This is partly because in the choice of location, the existing (other) use functions have already been taken into account. Below is a brief description of each aspect. Within the range of the bandwidth alternatives (alternative 1 with 76 x 10 MW on suction bucket and alternative 2 with 47 x 16 MW on gravity base) no distinguishing effects were found.

For most of the other use functions, the effects are minor and the impact assessment is neutral. These include the effects on ship, shore and aviation radar, dredging, sand, gravel and shell extraction, shellfish farming and aquaculture, ammunition dumps and military activities, existing wind farms and recreation and tourism. The effects on (local and regional) economies are assessed as slightly positive.

The impacts on fishery are assessed as slightly negative because of the area lost and the value of the area to fisheries. There is also a slight negative effect on the available electrical and telecommunication cables and pipelines. For aviation, we see a neutral effect on the interference of civil and military aviation. The interference for the Coast Guard is slightly negative, because the presence of wind turbines poses a risk to flying at low altitudes. The effects on the flight movements of helicopter traffic are negative for site VI, due to the presence of a Helicopter Main Route (HMR KY653) which crosses site VI, and the reduced accessibility of platforms P06-A and P9-Horizon. With regard to cultural history and archaeology, site VI scores slightly negative due to the relatively high concentration of (potentially) archaeological objects. The effects on ray paths for site VI are assessed as negative due to the relatively high number of ray paths. The effects on ray paths are expected to be mitigated for both sites by taking the ray paths into account when determining the wind turbine positions. The effects of oil and gas production are generally assessed as slightly negative. Site VI is located in both licensed production and exploration areas but does not make the development of future fields in these areas impossible.

6.7 Electricity yield

Table S10 Assessment of impact on electricity yield without mitigating measures.

Aspects	Score	
	Alternative 1 76 x 10 MW-turbines	Alternative 2 47 x 16 MW-turbines
Electricity yield	++	++
Emissions avoided	++	++

For the 10 MW turbine alternative, a Vestas V164-10.0 MW has been calculated and a net electricity yield of 3,561,729 MWh/year has been calculated. For the alternative with 16 MW turbines a net electricity yield of 3,391,833 MWh/year follows from the calculations. The energy yield of the minimum alternative (76 turbines of 10 MW) is therefore approximately 5.0% higher than the maximum alternative (47 turbines of 16 MW). This is not necessarily the case, but it does apply to the turbine types under consideration. It is good to know that this assessment is based on a 10 MW turbine that can actually be supplied and that the 16 MW turbine is based on extrapolation of data, because no 16 MW turbine can be supplied at the time of writing of this EIA.

An annual electricity production of 3,561,729 MWh is equivalent to the annual electricity consumption of approximately 1,200,000 households (assuming an average of 2,910[15] kWh/household/year).

The energy yield in the alternative with 16 MW turbines is realised with a fewer number of turbines than in the alternative with 10 MW turbines, i.e. 76 instead of 47 turbines. The contribution of the wind farm to the reduction of CO2, NOx and SO2 is directly proportional to the net energy yield. The reduction is calculated on the basis of the average use of fuels at power stations (mainly gas).

It is likely that turbines with a high capacity and a relatively large rotor will generate the most electricity yield. The future wind farm developer is free to determine an optimum in which the cost price will of course also play a role.

7. Results of the Environmental Assessment – Alternative site VI

For each aspect, the impact assessment of the alternative location of site VI (southern location, see Figure S2) is briefly presented below, in relative terms to the preferred site location.

[15] CBS (2016). Average household electricity use

Birds and bats

The site alternative with its location on the south side instead of the north side of Hollandse Kust (west) is virtually indistinguishable from the assessment of the preferred location of site VI. The expected number of bird casualties in the site alternative is slightly lower, due to the slightly lower densities. Also in terms of disturbance of birds, the alternative location will have less effect, because the site is somewhat smaller than the preferred location of site VI. However, the differences are so small that this does not lead to a different score for the site alternative. For example, the total number of bird victims is 13 fewer in the case of the site alternative out of a total of 1,511 victims for the preferred location of site VI (in alternative 1). No other effects are to be expected for bats either. The only difference in the assessment occurs in colony birds. This is due to the site alternative lying outside the maximum foraging distance of breeding little black-backed gulls from the Natura 2000 site Dunes and Low Land Texel, as a result of which a neutral (0) score is achieved when it comes to effects on colony birds.

Underwater life

The effects of the alternative site location do not differ from the preferred site location with respect to porpoises. The effect on seals is slightly more positive for the alternative location, however, to a small and indistinguishable extent regarding the assessment.

Geomorphology and hydrology

The effects of the alternative location of site VI are not significantly different from the effects of the preferred location of site VI.

Shipping and Safety

In terms of shipping and safety, the assessment of site VI (alternative) differs from that of site VI in that it has a negative assessment (-) on the risk of collision and propulsion, and consequential damage caused by collision or propulsion. For the preferred location of site VI, the assessment on these aspects is slightly negative (0/-). This is because the total frequency of collisions and propulsions for site VI (alternative) is higher than the preferred location of site VI. The total frequency of collisions and propulsions for the preferred location of site VI is 0.109282, while this is 0.117949 for the alternative location of site VI. The probability of oil outflow and the average number of deaths per year as a result of a collision or propulsions with a wind turbine is also slightly higher for the alternative location of site VI compared to the preferred location.

As far as alternative options for intersecting shipping and passage of up to 24 or 45 metres are concerned, the alternative location of lot VI scores no different than the preferred location, namely 0/-.

Landscape

The alternative location of site VI is at least 57 kilometer from the coast, which is a few kilometer further than the preferred location of site VI. As a result, the turbines of alternative 1 disappear completely behind the horizon due to kim diving and are therefore no longer visible. However, the meteorological conditions are such that, even if turbines could theoretically still be visible, as with alternative 2 (the largest turbines in this EIA), visibility is very limited (less than 1% of the time in the summer months). This means that for landscape, the alternative location of site VI does not lead to substantially different effects compared to the preferred site location.

Other use functions

The assessment shows that with regard to the aspects of helicopter traffic, cables and pipelines, ray paths and archaeology, the alternatives site location receives a different assessment than the preferred location. The preferred location of site VI has a more negative score on these aspects than the alternative location for site VI. With regard to helicopter traffic, this is because an existing HMR runs through this area and the minimum separation requirement cannot be met in all cases. There are also a total of 8 ray paths in this area, which means that the telecommunication aspect is scored more negatively, and there are more cables and pipelines in the preferred site location area. In addition, there is a higher expectation that archaeological objects and archaeological remains will be found.

Electricity yield

As the alternative location of site VI covers an area of 75 km2 compared to 90 km2 for the preferred site location, turbines will be located closer together. This will lead to a reduction in the electricity yield (more wind capture). This effect is not expected to be significant. In addition, the alternative location of site VI is in front of site VII, viewed from the prevailing wind direction (southwest). The preferred location of site VI is just behind it. As a result, the yield will be relatively higher for the alternative location of site VI compared to the preferred site location. On the other hand, however, there will then be more wind capture for site VII which may result in a lower electricity yield.

Conclusion

It can be concluded that the effects of the alternative location for site VI are comparable to the preferred location of site VI, but has less negative effects on the following aspects:

- The number of bird victims (very limited difference), disturbing effect on birds (due to more limited surface area) and has no effect on colony birds because the alternative site location lies outside the maximum foraging distance;
- Seals due to less disturbance (very limited difference);
- Helicopter traffic, cables and pipelines, ray paths and archaeology

and has more negative effects on:

- Shipping safety, due to increased collision and propulsion probabilities, and
- The electricity yield due to a higher density of wind turbines located in the smaller surface area of the alternative location of site VI.

8. Cumulation

The following table briefly lists the cumulative effects that occur and the consequences they have for the wind farm site decision. The first column indicates the aspect, the second column indicates which effects may be relevant in case of cumulation and the third column indicates implications for site VI.

Table S11 Overview of cumulative effects at site VI – Hollandse Kust (west)

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
Birds and bats	Exceeding the PBR in the (international) worst-case scenario studied with 3 MW turbines in the KEC in 2015 (lesser black-backed gull, great black-backed gull and herring gull) cannot be ruled out (Rijkswaterstaat (2015), Leopold et al. (2015) and Van der Wal et al. (2015)).	Compared to Rijkswaterstaat (2015), Leopold et al. (2015) and Van der Wal et al. (2015), this EIA is based on Ecology and Cumulation Framework (KEC) 3.0 and therefore a more realistic scenario is calculated for foreign wind farms (see appendix 4), and the input parameters for the sites of Borssele, Hollandse Kust (Zuid) and Hollandse Kust (noord) have been updated in line with the latest insights (see Gyimesi & Fijn 2015b, Gyimesi et al. 2017c, Gyimesi et al. 2018c). In the current calculations for Hollandse Kust (west), the cumulative number of collision victims in the southern North Sea for all locally residing species remains well below the PBR standard. Looking only at the cumulative effect of the Dutch parks on the Dutch population of locally residing species, the number of casualties for all species also remains well below the PBR standard. No cumulative effects are to be expected in respect to breeding colony birds that could be victims in a site in the wind farm zone of the Hollandse Kust (west) (small black-backed gulls from the Natura 2000 site of Dunes and the Low Land of Texel) that would lead to significant negative effects. With regard to migratory birds, the cumulative mortality among migratory birds resulting from collisions with all (future) wind turbines in the southern North Sea remains below the PBR for all species. On the basis of these results and the wind farm plans currently known, it can be concluded that the favourable conservation status of migratory bird species will not be called into question.
	Based on current knowledge, and in particular the lack of good information on the occurrence of bats in the North Sea on the one hand and the lack of reliable estimates of population sizes on the other, it cannot be ruled out that in the worst-case scenario negative effects on the favourable conservation status of some bat populations will occur, such as red-	Mitigation measures can be taken to reduce effects to an acceptable level (see sections 12.5 and 12.6).

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
	legged bats and rough dwarf bats.	
Underwater life, Marine mammals	Effects on the favourable conservation status cannot be excluded if no mitigating measures are taken.	By applying the noise standard as recorded in the KEC 3.0, effects on the favourable conservation status can be excluded.
Shipping safety	Wind farms at the sites Hollandse Kust (west) and existing wind farms may lead to other effects on shipping and safety.	The cumulative effect in this EIA has not been considered separately because, in deviation from previous studies carried out for wind farm zone Borssele, the other planned wind farms in the North Sea will not change the shipping traffic routes. The new route structure has been designed in such a way that it takes account of wind farms that have already been or will be built. The considered base case is therefore also the cumulative scenario. As part of the adjustment of the traffic system in August 2013, various risk studies have been carried out, such as 'Risk to shipping in the event of designation of the wind area "Dutch Coast". The cumulative effect is also discussed within this study. A cumulative study of shipping safety for the roadmap has also been carried out. This study has already been taken into account in this EIA (see appendix 9).
Morfologie en hydrologie	Wind farms in other sites in the wind farm zone Hollandse Kust (west) can also lead to effects on morphology and hydrology.	None. When filling in wind farm zone Hollandse Kust (west), practically the same local, temporary and negligible effects will occur as described for site VI. This means that there will be no cumulation, not even with other activities and other more distant wind farms.
Landscape	Wind farms in the Hollandse Kust (zuide) and Hollandse Kust (noord) wind farm zones also affect the visibility of wind turbines from the beach.	Minimal, because wind turbines in the Hollandse Kust (west) wind farm zone are only visible to a very limited extent.
Other use functions	Wind farms in the sites of the Hollandse Kust (zuid) and Borssele wind farm zones, as well as the wind farms according to the 2030 roadmap, will also affect other use functions.	Minimal with regard to fisheries. With the development of the Hollandse Kust (west) wind farm zone, the total surface area lost to fisheries becomes larger. In total the Wind Farm Zones cover approximately 4.78% (0.6% Borssele, 0.62% Hollandse Kust (zuid), 0.51% Hollandse Kust (noord), 0.61% Hollandse Kust (west), 2.05% IJmuiden Ver, and 0.38% Ten noorden van de Waddeneilanden) of the NCP, and therefore also the fishing area, are lost. However, the wind farm zones will not be completely closed, only the wind farm sites. After closing these, the total surface area amounts to 2.81% of the NCP (Natura

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
		2000 areas and the Bruine Bank cover 20% and 5% of the NCP respectively). In the event that, according to current governmental plans, all nature reserves and wind farm zones[16] were to be closed, the gross value added of Wind farm zone Hollandse Kust (west) to the Dutch kottersector will become 1.57%. If a Brexit induced closure of British waters is also taken into account the gross value added will increase to 1.93%. The larger number of turbines also increases the chance that archaeological remains will be affected. Wind farm zone Hollandse Kust (west) has a limited impact on recreational shipping, because recreational shipping is permitted up to 24 meter and mainly makes use of the 10 to 20 km zone along the coast. For vessels wishing to cross from the North Sea Canal to England and larger than 24 meter, the realisation of site VI will mean an extra detour. The effects on coastal recreation have been assessed as neutral and have no consequences for the Wind farm site decision.
Electricity yield	Wind farms in the vicinity can intercept wind from each other, decreasing the wind speeds at other wind farm sites.	None, the expected wind interception of, and on wind farms in the planned site in the vicinity is very small, as shown in chapter 11.

9. Mitigating measures

After assessment, it appears that the conditions in the legal framework can be satisfied for virtually every aspect. In order to guarantee the favorable conservation status of nitrogen-sensitive habitats, mitigating measures are necessary. Also 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 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 and removal from June to September due to the limited presence of species of sea birds susceptible to disturbance.

[16] Among these are parts of the following area's: Doggersbank, Centrale Oestergronden, Friese Front, Klaverbank, Borkumse Stenen, Noordzeekustzone, Voordelta en Vlakte van de Raan (Stichting de Noordzee, 2018)

Aspect	Effect	Mitigating measure
		• Minimising lighting on ships and/or use of a bird-friendly lighting colour. • Reduction of pile-driving or removal noise. However, the effect of the sound of pile driving or removal 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. • Installing two-blade instead of three-blade turbines. • Creating a corridor in the wind farm that birds may use. • Casualties can be avoided by smart planning of maintenance when turbines are shut down. • Increasing the chances of birds detecting the wind farm using 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).
Underwater life	Benthos and fish	• Remain hard substrate after decommissioning of wind farm.
	Disturbance and associated population reduction; PTS.	• Using 'Slow start' and 'Acoustic Deterrent Devices' (ADDs). • Noise mitigating measures such as a bubble screen to a) comply to the prescribed standard and b) to further reduce noise levels during pile driving.
Nitrogen-sensitive habitats	Construction phase	• Reducing the nitrogen emission in such a way that a maximum of 0.05 mol N / ha / year deposition occurs in nitrogen-sensitive habitat types
Shipping safety	Collision/propulsion and resulting damage	• Radar, AIS en VHF-coverage • Vessel Traffic Management • Additional marking and identification of wind turbines • Deployment of an Emergency Towing Vessel. • Extra SAR-capacity • Oil control
Morphology and hydrology	- (there are no significant effects)	-

Aspect	Effect	Mitigating measure
Landscape	- (there are no significant effects)	-
Other use functions	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.
	Site VI overlaps with mining permit holders and obstacle free zone around platforms	Consult with mining companies.
	Restriction of fishing areas	There are opportunities for the fisheries-friendly design of wind farm zones. However, this entails high costs (including significantly higher insurance premiums for wind farm operators and fishermen). For the parties involved, however, the benefits do not seem to outweigh the costs.
	Shellfish farming and aquaculture	Biological suitability for shellfish farming and aquaculture within wind energy zones has been demonstrated. However, follow-up studies have yet to demonstrate whether this is feasible in practice.
	Failure to comply with separation requirement HMR	Relocating HMR KY653
	Possible interference with existing ray paths	Take into account half rotor + 2nd fresnel-zone around ray paths when installing the wind turbines. Use of alternative 4G network infrastructure, planned to offer full coverage of the Dutch North Sea in 2020.
Electricity yields	- (there are no significant effects	-

10. Considerations for the preferred site division

This section contains a number of considerations for the selection of the preferred site division, which is made possible by the wind farm site decision. This concerns the choice of location of site VI, the bandwidth considered in this EIA and the mitigation measures to be taken. First of all, the assessment of the legal framework will be briefly discussed.

Assessment against the legal framework

Some mortality amongst birds and fish and a 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 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 Nature Conservation Act. For the purpose of testing against this Act, 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. Specifically when it comes to nitrogen deposition as a result of the construction of the wind farm, a regulation must be included in the site decision to maximize the amount of nitrogen. In this way it is prevented that a higher temporary deposition than 0.05 mol N / ha / year occurs as a result of the temporary nitrogen emission as a result of the construction of the project. The Appropriate Assessment indicates that a deposition of a maximum of 0.05 mol / ha / year during 2 years can never influence the size and spatial distribution of the deposition blanket as a result of the virtually continuous use of the equipment in the North Sea, which is also used for the project.

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 (NNN), applies to the whole of the North Sea (EEZ). Paragraph 1.3.1 of annex 4 states how the protection regime for the Nature Network Netherlands (NNN) works in the Dutch North Sea area.

Considerations regarding the location of site VI

In this EIA, effects of the location of site VI in the north and in the south of the wind farm zone Hollandse Kust (west) have been assessed. The differences in environmental effects of both locations of site VI have been explained. In addition to these environmental effects, other considerations may of course play a role in the choice of the location of site VI.

Considerations regarding the 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 and that has actually led to the minimum caacity per turbine being increased to 10 MW (instead of 3 MW at Borssele wind farm zone) The aspect of effects on birds has restricted the bandwidth primarily at the sites in the Borssele wind farm zone. However, mitigating measures on the basis of this EIA must be taken to eliminate or reduce the effects. The measures that must be taken are as follows:

The only exception is the use of multirotors. Because there is still little experience with them and the exact rotor surface area and rotor heights that determine the risk of bird victims are not known, it is not easy to quantify the effects. This does not rule out the possibility that effects will increase compared to single-rotor turbines, for example if several rotors are installed at a relatively low shaft height, where the bird density is higher.

Considerations regarding mitigating measures to be taken

A number of measures are needed to limit effects for nitrogen-sensitive habitat types and to limit cumulative effects on birds, bats and porpoises and to ensure a favourable conservation status. These include, for example, a standstill arrangement for bird and bat migration and compliance with a noise standard for underwater noise during pile driving. Table S12 also lists possible measures with further mitigating measures. The choice of measures to be prescribed is a matter for the competent authority and is explained in the wind farm site decision.

Consideration regarding an extended operating period from 30 to 40 years
In the site decisions taken for Borssele, Hollandse Kust (south) and Hollandse Kust (north) and so far also in this EIA, the starting point has been that the wind turbines can be operated for 30 years. Now that it is possible to extend the operating period from 30 years to 40 years for Hollandse Kust (west), the effect of this on the earlier conclusions of this EIA should be investigated. Because the effects during the exploitation period are often expressed per year, such as the number of expected bird victims per year or the collision risk for ships per year, the conclusions remain unchanged. However, effects last 10 years longer than described in this EIA. Think in particular of effects on birds and bats, effects on shipping safety and on other uses such as fishing. Sustainable electricity will also be generated for 10 years longer. The conclusions in this EIA will not change due to a change in the duration of operation from 30 to 40 years.

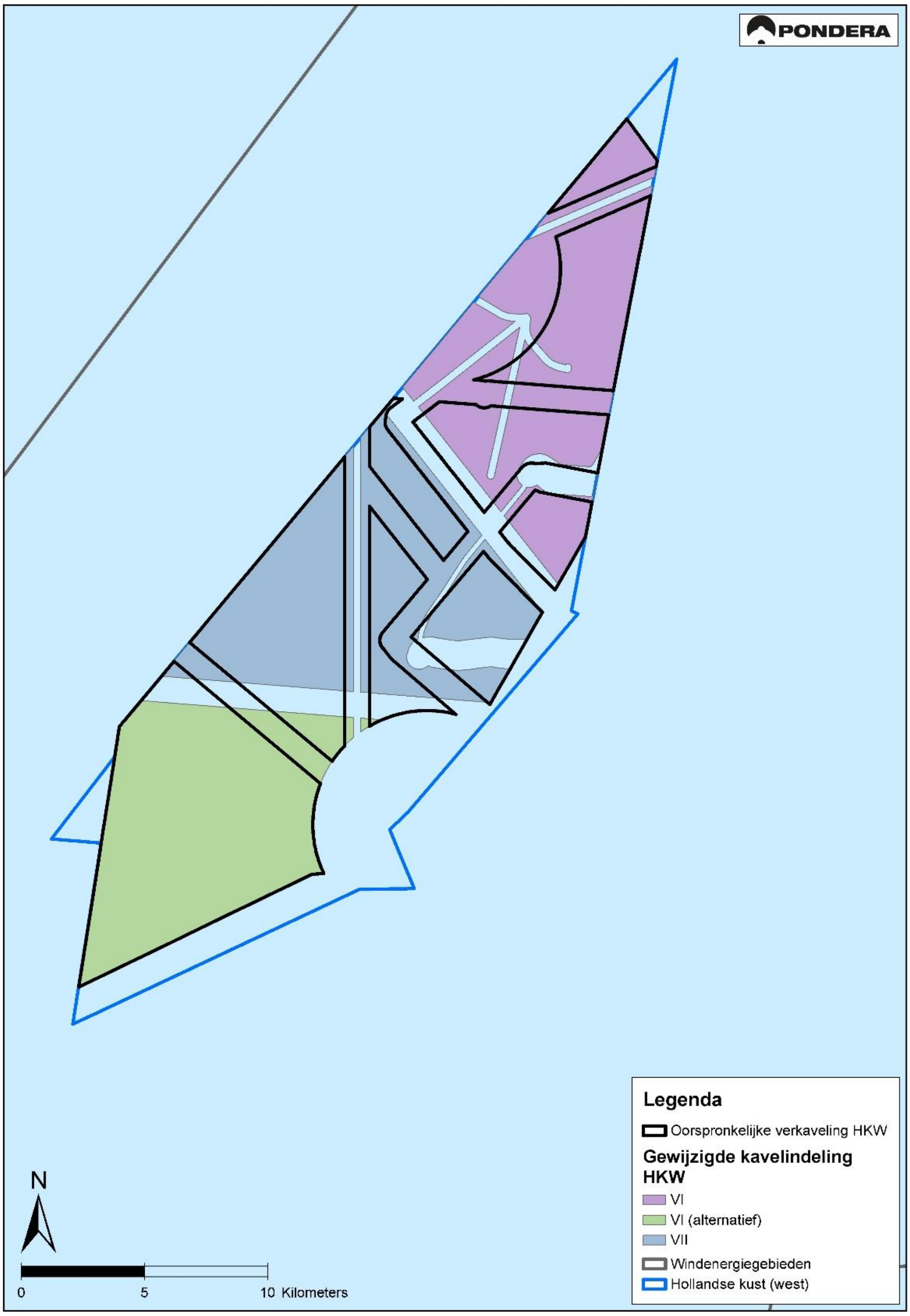
Modifications to the division of site VI
Recent developments lead to modifications in the boundaries of site VI and VI (alternative) (and site VII) in comparison to the boundaries that have been used so far in this EIA. This is due to newly available information regarding the planned decommissioning of part of the mining infrastructure in the Wind Farm Zone and the status of a telecom cable located in the area. This information has been received after the review of the NRD and after the completion of the draft EIA. In the revised site division, maintenance zones of pipelines no longer in use have been limited in size, and an obstacle-free zone around platform P6A has no longer been taken into account. In addition, shipping movements have been taken into account in more specific manner as a result of the recently signed North Sea Agreement. In the new division an area has been kept clear that can serve as a passageway for shipping in the future (up to 46 metres) between site VI and VII and between site VII and VI, respectively.

By modifying the division in anticipation of the above developments, more room will become available for the wind farm developers in each site.

Figure S3 shows the modified site division in relation to the original site division and appendix 11 contains more information about the modified division of the sites. These consider, among other things, the now know location of Tennet platform Beta and it’s interlinkg to platform Alpha. This appendix also describes the effects of the modified division for each environmental aspect.

In terms of effects, there are marginal differences between the new division and the original division. Because the differences are so small, they are not always reflected in a changed score in the impact assessment. However, the score does change for ‘Shipping’ and 'Other use functions', where positive effects occur due to the modifications. This leads to a more positive assessment score for oil and gas extraction, aviation, and telecommunications. Positive effects are also expected with regard to shipping for all sites, as collision probabilities decrease due to the shipping passages that can be used by ships up to 46 metres.

Figure S3 Modified site division in relation to the original site division



Bron: Pondera Consult

Conclusion

The wind farm site decision may permit the preferred bandwidth of the site at the location under consideration, with the exception of the use of multirotors. The application of (at least) the necessary mitigating measures must be guaranteed.

11. Gaps in knowledge and information

Introduction

The development of offshore wind farms has a relatively short history. The first monitoring evaluations for previously developed offshore wind farms in England, Denmark, Germany and the Netherlands have since been published. These are the results from relatively short monitoring periods. Certainty about the long-term effects can therefore not yet be given. However, current research and development 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 VI. 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 short history of offshore wind energy; in a broad sense, there is still a lot of knowledge to be acquired about animal species and their densities, diversity and behaviour. This section explains the knowledge gaps that are relevant in the context of this EIA. Gaps in knowledge are successively described in relation to the effect assessment on birds and bats, underwater life, morphology and hydrology, shipping, landscape, other use functions and electricity yield.

Birds and bats

For birds, there are gaps in knowledge about collision risks, barrier effects and disruption caused by offshore wind farms (both during the day and at night). In particular, species-specific knowledge is lacking. Validation of models to predict collision bird casualties at sea is lacking. There are also gaps in knowledge about disturbance sensitivities and disturbance distances of seabirds, as well as the extent to which birds can become accustomed to wind farms. Based on literature, it is assumed that 10% of the disturbed birds die. It is not known to what extent this assumption corresponds to reality.

For wind farm site decisions up to 2030, the PBR in the KEC calculations has been used so far. Bureau Waardenburg and Wageningen Marine Research (WMR) have developed species-specific (Leslie-Matrix) population models for use in both collision risk and habitat loss studies for potentially critical species. This project shows how population models can be used for a species-specific population impact assessment of mortality due to collisions of birds with turbines. Population models provide a better picture than other methods of the possible effects of offshore wind farms on these species. However, before the models can be used for wind farm site decisions, threshold values are needed for the statistics that they can produce. This is a policy decision rather than a scientific one. The report of Bureau Waardenburg and WMR is in the process of being completed and should be published shortly.

The only exception is the use of multirotors. Because there is still little experience with them and the exact rotor surface area and rotor heights that determine the risk of bird victims are not known, it is not easy to quantify the effects. This does not rule out the possibility that effects will increase compared to single-rotor turbines, for example if several rotors are installed at a relatively low shaft height, where the bird density is higher.

For bats, knowledge gaps exist with regard to the basic knowledge about population size and species-specific distribution. Unknown is the relative importance of the North Sea for different types of bats and their changes in behaviour as a result of wind farms.

Under water life

Benthos

knowledge gaps exist with regard to the ability to predict the consequences of 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

The main gaps in knowledge related to the consequences on the calculated effects relate to the estimation of effects on the porpoise population. This concerns gaps in knowledge in the area of quantifying the number of disturbed animals and animal disruption days, but also the translation of these to vital rates.

Threshold value for disturbance or behavioural change

Based on results of research conducted both under controlled conditions and in the field, it has been shown that the threshold value for sound disturbance can lie between SELss = 136 en 145 dB re 1μPa2s (Kastelein et al. 2013; BMU 2013; Diederichs et al. 2014; Brandt et al. 2018). This concerns broadband and unweighted noise levels. The most extensive study was carried out by Brandt et al (2018) regarding the effects of pile-driving noise on porpoises during the construction of the first seven German wind farms. In this study, a significant decrease in the presence of porpoises was found during broadband and unweighted noise levels of more than 143 dB re 1μPa2s. The threshold value of SELss = 140 dB re 1 μPa2s chosen for the EIA of Hollandse Kust (west) is therefore likely to be conservative. If a higher value of SELss = 143 dB re 1 μPa2s had been used in the calculations, the disturbed area and thus the number of days of porpoise disturbance would have been approximately 30 - 40% smaller (Heinis et al. 2019).

For the time being, the calculations for porpoises do not take into account the hearing sensitivity for differences in frequencies. It is likely that the use of a SEL value weighted by the frequency sensitivity of the porpoise's hearing gives a better prediction of the behavioural response. For projects where noise is mitigated by the use of bubble screens, the use of frequency weighting to determine behavioural disturbance in porpoises would result in much smaller predicted disturbance surfaces, because these weighted SELss mitigate more effectively than unweighted SELss (Dähne et al. 2017).

Quantifying the number of animals disturbed and days of animal disturbance

The number of animals disturbed will be calculated by multiplying the estimated area of disturbance (area within contour where the noise maps generated in AQUARIUS version 4.0 exceed the threshold for disturbance) by the estimated animal density (not disturbed by underwater noise) in that area for the time of the year in which the disturbance occurs.

Translating effects on individual porpoises into population effects (iPCoD)

- Size of vulnerable subpopulation, one of the parameters in the iPCoD model. The calculations for the KEC 3.0, which formed the basis for the calculations, are based on a vulnerable subpopulation of 350,000 animals, i.e. equal to the total size of the North Sea population. The choice of a relatively large vulnerable sub-population reduces the risk of effects being underestimated.
- The iPCoD model was thoroughly updated and improved in 2018, especially for the porpoise. In determining the relationship between disturbance and vital rates, use was made of a state-of-the-art energy budget model developed by the University of Amsterdam in collaboration with the University of St. Andrews. The model calculations clearly show that in many cases porpoises can compensate for a (temporary) loss of foraging opportunities. However, it is not yet clear whether and, if so, why the areas with the highest density are also the most suitable areas.
- The Interim PCoD model assumes that the porpoise population is stable and that population development does not depend on density. For the model results, this means that after an effect on the population has been applied, i.e. a decrease as a result of the activities, the population does not recover after termination of the activities. This is probably not realistic. For a more realistic estimate of population development in the years of disturbance, but especially after its termination, more knowledge is needed about density-dependent effects on population development.

Translating effects on individual seals into population effects

For the common and grey seals, transmitter research provides much more data on natural behaviour in the field than for the porpoises. This concerns both population estimates and knowledge about movement of individual animals. In combination with experimentally determined data on the energetic 'costs' of behavioural change (see, for example, Rosen et al. 2007; Sparling & Fedak 2004; Sparling et al. 2007), the effect on the population could be estimated by combining an agent based model (see, for example, Nabe-Nielsen et al. 2014) with a dynamic energy budget. WMR, in collaboration with SMRU/St. Andrews University, has now started to develop such a model. However, it will still take a few years before this model is operational.

Fish

For fish, all necessary research has been carried out into the effects of underwater noise on fish. This shows that fish are much less sensitive to underwater noise than marine mammals and that some species (with swimming bladder) are more sensitive than others. In addition, the magnitude of the effects is so small that the effect of pile-driving noise is not indicated as an essential knowledge gap. Although it is recommended that extra research is performed on (mature) species with closed swimming bladders.

There is a general picture of the occurrence of fish on the NCP. In view of the limited effect on fish populations, further insight into the occurrence of fish on the NCP is not a priority.

Specific knowledge gaps with regard to wind farms exist mainly with regard to the species and extent of changes to the fish fauna in the longer term as a result of the introduction of restrictions on fishing and the fitting of hard structures. In addition, in the wind farm site decision of Hollandse Kust (noord), only noise standards are mentioned for the construction phase (mainly because of the piling of the foundations), but not for the operational phase of the wind farm. This allows wind farm developers to increase the tip speed of rotors indefinitely, resulting in higher noise levels in the operational phase, probably also under water. As it is currently not well known whether the noise of wind turbines plays a role in the disturbance of fish, it is not possible to say whether an unlimited tip speed and the associated noise levels will lead to increased disturbance among fish.

Shipping and safety

A monitoring obligation will be imposed when the wind farms are opened. The number and type of ships occupying the area around the wind farm and any incidents are monitored. Based on the resulting data it will be decided whether it is desirable to develop an assessment framework and a probability model for this. The behaviour and traffic flows of non-route related traffic, which in the SAMSON model is placed outside the wind farm zone, can also be monitored. Furthermore, the scenarios and impact of collisions with turbines can be further investigated and developed. For example, assumptions have been made in this EIA for the determination of personal injury. For example, it is not known what the probability is that the mast will fall on the ship, or fall away from the ship during collisions. Also with regard to the failure behaviour of wind turbines in this EIA, the findings of a study from 2000 have been used (Barentse, 2000), while wind turbines have since become considerably larger.

In addition, in the context of the continued growth of offshore wind energy, a cumulative assessment was made of shipping safety and thought was given on how to fill in the knowledge gaps and gaps identified. MARIN also conducted an assessment of shipping safety and mitigation options for the combined effect of autonomous development, and the roadmap 2023 and 2030[17]. A recommendation from the Directorate-General for Public Works and Water Management proposed a draft programme of monitoring and research.[18]

Morfology in hydrology

Further research is needed into the possible effects on stratification processes and the water movement of a large-scale (international) development of wind energy in the North Sea. The actual impact of developments on the Dutch continental shelf on the stratification processes and the water movement in the North Sea cannot be stated unequivocally.

Landscape

For the landscape aspect, no significant gaps in knowledge and information have been identified that influence the decision-making process.

Other use functions

For other use functions, no significant gaps in knowledge and information have been identified that influence the decision-making process.

Electricity yield

[17] Go to https://www.noordzeeloket.nl/functies-gebruik/windenergie-zee/scheepvaart/ for more information and the research itself.

It is expected that the calculations in this EIA give a good indication of the electricity yield. There are no significant gaps in knowledge or information on the aspect of energy yield and avoided emissions that influence decision-making.

Ecosystem research

Within the framework of the Wozep (wind energy at sea ecological programme), an ecosystem study has been carried out. [19] The possible increase in scale in offshore wind for 2030 and 2050 in the southern North Sea will probably have a fundamental impact on its functioning. Large-scale generation of wind energy from the lower atmosphere can influence local wind patterns, wave generation, tidal amplitude, stratification of the water column, dynamics of suspended particles and sand transport. In addition, the infrastructure provides hard substrate, not only on the soil (erosion protection), but also provides mounting possibilities for organisms in the upper layers of the water column.

Conclusion

The gaps in knowledge do not prevent a reliable assessment of the effects of a wind farm in site VI of the Hollandse Kust (west) wind farm zone. However, in the decision-making process it is important to have an insight into the uncertainties that played a role in the effect predictions. These are presented in this Section 11.

13. Monitoring and evaluation

The Energy Agreement for Sustainable Development (SER agreement, September 2013) agreed to accelerate the realisation of sustainable objectives and to achieve a 40% reduction in the costs of energy production through off shore wind energy (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 implement an integrated monitoring programme to investigate the knowledge gaps regarding the effects of offshore wind farms on the North Sea ecosystem and to achieve a further cost reduction within ecological boundaries.

This monitoring and evaluation programme, Wozep (offshore wind energy ecological programme), focuses on important ecological questions concerning the construction and operation of offshore wind farms. It is generic in nature as it does not focus on a specific wind farm, but on offshore wind farms in general.

Part of Wozep is the MEP (the monitoring and research programme). The MEP includes monitoring and research as required by the Environmental Management Act. In addition to WOZEP, the KEC instrument is also being developed (updating and implementing knowledge).

The Wozep replaces the monitoring obligation imposed seperatly on each wind farm. This will also lead to an increase in efficiency, which will also contribute to the cost-efficient realisation of the objectives for offshore wind energy.

[19] https://www.noordzeeloket.nl/functies-gebruik/windenergie-zee/ecologie/wind-zee-ecologisch/documenten-wozep-0/ecosysteemonderzoek/

During the evaluation in the Wozep, attention is paid to the translation of the new knowledge into the KEC instrument (this can also mean checking assumptions and/or effect calculations) on the one hand, and on the other, as a translation into policy and management consequences. An example of the latter is the imposition or modification of mitigating measures. In the Wozep, the research focuses in particular on those parts that can have a cost-increasing effect and presents this in a visual way and advises the competent authorities in this regard.

Current state of Wozep

In the starting year 2016, Wozep set up a number of preparatory activities within the aforementioned themes. These included feasibility studies, possibilities for model-based approaches, preparation of measuring systems and inventories of existing knowledge and data. This takes account of what has been and is being done in the North Sea countries surrounding us.

At the end of 2016, a multi-annual monitoring and research programme was completed, which roughly outlined the research guidelines for the period 2017-2023. The choice of these guidelines is determined by an assessment of two time horizons:

- Short-term (until 2023): focusing on using the results in the planned wind farms. Central to this is the study of the assumptions made in the ecological assessment for these wind farms. In addition, the usefulness, necessity and effectiveness of the measures imposed on the wind sector to limit ecological damage will also be investigated;
- Long term (after 2023): what knowledge is needed to enable further expansion of offshore wind farms in a responsible manner, what are the expected effects of further expansion of the number of wind farms in the North Sea, where exactly can they be located and with what possible consequences, how can negative effects be avoided to a sufficient extent, etc.?

For more information see the website: https://www.noordzeeloket.nl/functies-gebruik/windenergie-zee/ecologie/wind-zee-ecologisch.

The knowledge gaps in this EIA provide input for prioritising monitoring within WOZEP (for the ecological aspects, morphology and hydrology) and for monitoring of the shipping aspects.

719022
27 november 2020

MER KAVEL VII WINDENERGIEGEBIED HOLLANDSE KUST (WEST)

Ministeries van Economische Zaken en Klimaat, Binnenlandse Zaken en Koninkrijkrelaties, Infrastructuur en Waterstaat en Landbouw, Natuur en Voedselkwaliteit

Eindversie

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Documenttitel	MER kavel VII Windenergiegebied Hollandse Kust (west)
Soort document	Eindversie
Datum	27 november 2020
Projectnummer	719022
Opdrachtgever	Ministeries van Economische Zaken en Klimaat, Binnenlandse Zaken en Koninkrijkrelaties, Infrastructuur en Waterstaat en Landbouw, Natuur en Voedselkwaliteit
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SUMMARY

1. Introduction

The Netherlands has formulated ambitious targets for the generation of sustainable - renewable - energy. Wind energy plays a prominent role in this. The Climate Agreement refers to the production of at least 49 TWh of offshore wind energy by 2030 and is in line with the Roadmap for offshore wind energy. The roadmap provides plans for approximately 11 gigawatts of wind farms at sea in 2030.

The Offshore Wind Energy Act gives the government the opportunity to issue sites for the development of offshore wind farms.

In order to achieve the target of 49 TWh in 2030, new sites will have to be established and issued in the coming years. The sites will be determined within the boundaries of the areas already designated as wind farm zone in the National Water Plan. This concerns 1.4 GW in the area of Hollandse Kust (west), 0.7 GW in the area Ten noorden van de Waddeneilanden, and approximately 4 GW in the area of IJmuiden Ver. The Wind Farm Site Decision (WFSD) determines where and under what conditions a wind farm may be built and operated. A decision on the site is followed by the issuing of a tender. The winner of the tender will receive a permit for the construction and operation of the wind farm. Only the permit holder has the right to build and operate a wind farm at the site.

The Water Decree lays down general rules for offshore wind farms.

The Minister of Economic Affairs and Climate (in agreement with the Minister of the Interior and Kingdom Relations, the Minister of Infrastructure and Water Management and the Minister of Agriculture, Nature and Food Quality) is responsible for issuing sites and, for that purpose, drafts an environmental impact assessment (EIA) for each wind farm site decision.

This document concerns the EIA for site VII in the wind farm zone Hollandse Kust (west). The EIA describes the environmental effects that occur during the construction, operation and removal of wind turbines in the sites.

The wind turbines installed in the Hollandse Kust (west) site must be connected to the high-voltage grid. TenneT is responsible for this connection. This concerns two platforms in the Hollandse Kust (west) zone, the cables from these platforms to and over land, and the connection to the onshore high-voltage grid. TenneT is carrying out a separate procedure for the offshore grid, including an environmental impact assessment (EIA).

This summary will cover the following topics:

- The policy context and the reason for the site decisions to be taken;
- The choice of location for the Hollandse Kust (west) wind farm zone;
- The site division within the Hollandse Kust (west) wind farm zone;
- The impact assessment method;
- The results of the impact assessment;
- Cumulation;

- Mitigating measures;
- The considerations;
- Any gaps in knowledge and information;
- Monitoring and evaluation.

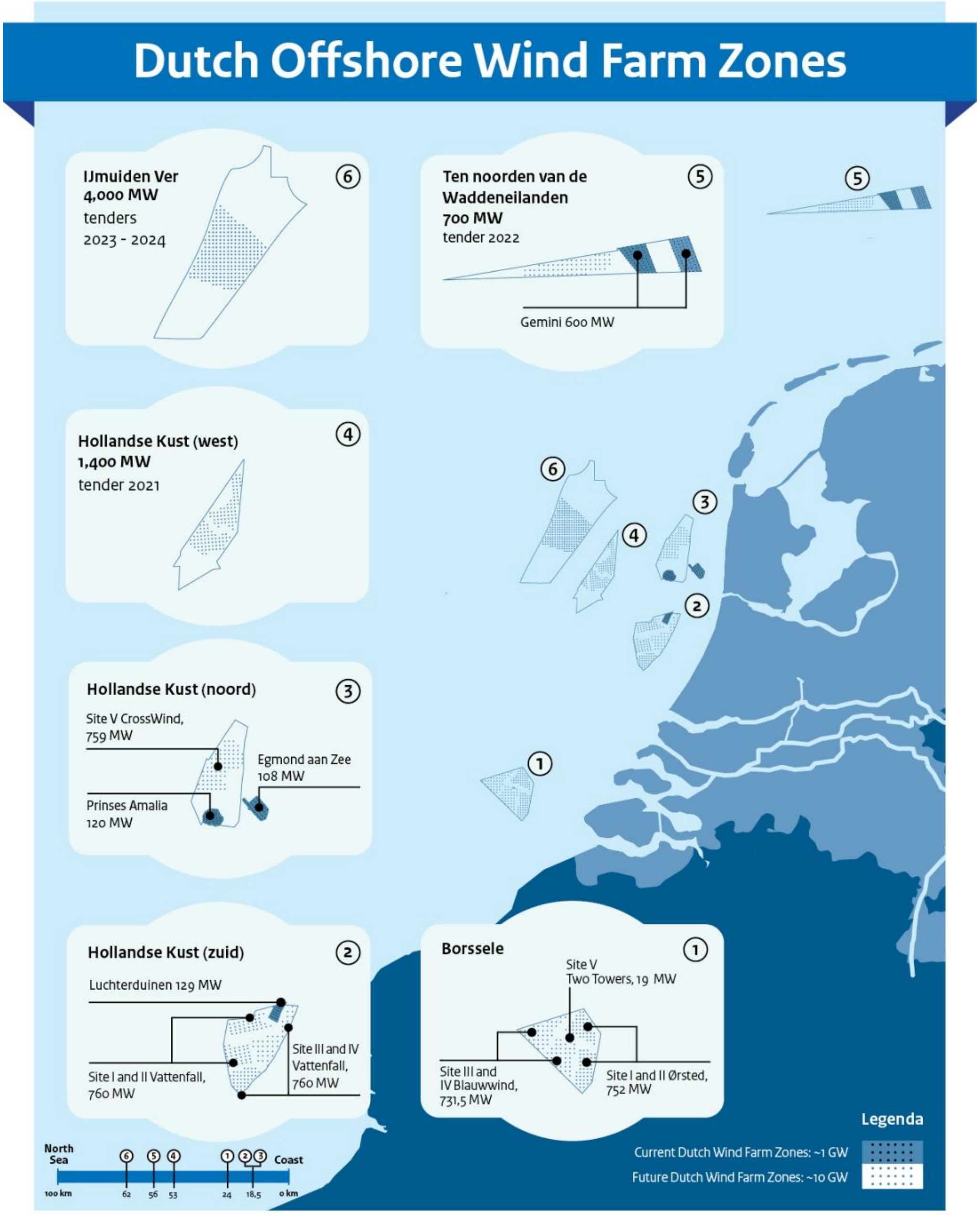
2. Policy context and reason for Wind Farm Site Decisions

On 7 December 2016, the Rutte II government presented the Energy Agenda to the House of Representatives (Parliamentary Papers II, 2016/17, 31 510, no. 64). In this document, the then Cabinet announced a new roadmap for offshore wind energy. On 27 March 2018, the Minister of Economic Affairs and Climate presented this roadmap for offshore wind energy to the Lower House of Parliament (Parliamentary Papers II, 2017/18, 33 561, no. 42).

The Roadmap for offshore wind energy includes plans to develop wind farms until 2030 with a total capacity of at least 6.1 GW in the following wind farm zones (see Figure S1):

- Dutch coast (west) with a capacity of 1,4 GW, whose commissioning should take place in 2024-2025;
- North of the Frisian islands with a capacity of 0,7 GW, planned to be put into service in 2026;
- IJmuiden Ver, with a capacity of approximately 4 GW, the largest wind farm zone, whose commissioning must take place in the period 2027-2030.

Figure S1 Wind farm zones



The government concludes that a coordinated grid connection of offshore wind farms will lead to lower social costs and a smaller impact on the living environment. The starting point for the roadmap is that the most cost-effective way to achieve the task of offshore wind energy is to use an offshore grid. The offshore grid is based on standard platforms to which approximately 700 MW of wind energy capacity can be connected per platform. The wind turbines of the wind farms will be directly connected to the platform. TenneT has been appointed as the offshore grid operator under the 1998 Electricity Act. The following table shows the schedule for the development of offshore wind energy from the roadmap. This EIA has been carried our for Hollandse Kust (west), site VII.

Size (GW)	Wind farm zone, site(s)	Site tender date	Commissioning year
1,0	Existing wind farms	-	-
0,7	Borssele, sites I en II	Realized in 2016	2020
0,7	Borssele, sites III, IV en V	Realized in 2016	2020
0,7	Hollandse Kust (zuid), sites I en II	Realized in 2017	2022
0,7	Hollandse Kust (zuid), sites III en IV	First quarter 2019	2023
0,7	Hollandse Kust (noord), site V	First quarter 2020	2024
0,7	Hollandse Kust (west), site VI	Second quarter 2021	2025 t/m 2026
0,7	Hollandse Kust (west), site VII		2025 t/m 2026
0,7	Ten noorden van de Waddeneilanden, site I	Fourth quarter 2022	2027
1,0	IJmuiden Ver, site I	Fourth quarter 2023	2028
1,0	IJmuiden Ver, site II		2028
1,0	IJmuiden Ver, site III	Fourth quarter 2024	2029
1,0	IJmuiden Ver, site IV		2029

3. Location choice for wind farm zone Hollandse Kust (west)

The National Structural Vision for Offshore Wind Energy examines whether wind farm zone Hollandse Kust (west) is suitable for the realisation of wind energy. In this structural vision and associated Strategic Environmental Assessment (SEA)[12], the effects of wind energy in the Hollandse Kust (west) area were investigated at an aggregate level in the following aspects: ecology, shipping safety, other uses (oil and gas, fishing, sand extraction, etc.), geology and hydrology, landscape (visibility), economy and recreation (navigation), cultural history and archaeology. This also looked at the suitability in comparison with the other areas designated for wind energy (IJmuiden Ver, Hollandse kust, Ten noorden van de Waddeneilanden, Borssele). The wind farm zone Hollandse Kust (west) has been found suitable.

In the EIAs for the site of the Borssele wind farm zone and for sites I and II of Hollandse Kust (zuid)[13], the main features of the comparison between the wind farm zones have been made. The main points of attention that emerge from this comparison should be taken into account in the further development of wind energy in the wind farm zones, such as the effect on marine mammals and birds. This EIA will also pay explicit attention to this.

[12] Environmental Impact Report National structural Vision for Offshore Wind Energy, PlanMER for the interim review of the National Water Plan for the offshore wind component, Royal HaskoningDHV, 2014
[13] Environmental Impact Assessment Wind farm site decision Borssele site I, 12 June 2015; Environmental Impact Assessment Wind farm site decision Borssele site II, 12 June 2015; Environmental Impact Assessment Wind farm site decision Borssele site III and Innovation site (site V), 13 November 2015; Environmental Impact Assessment Wind farm site decision Borssele site IV, 13 November 2015; EIA site I Wind Energy Region Hollandse Kust (south), 22 May 2016; EIA site II Wind Energy Region Hollandse Kust (south), 22 May 2016. All EIAs can be found on the following site: https://www.rvo.nl/subsidies-regelingen/bureau-energieprojecten/afgeronde-projecten/windparken.

4. Site Division

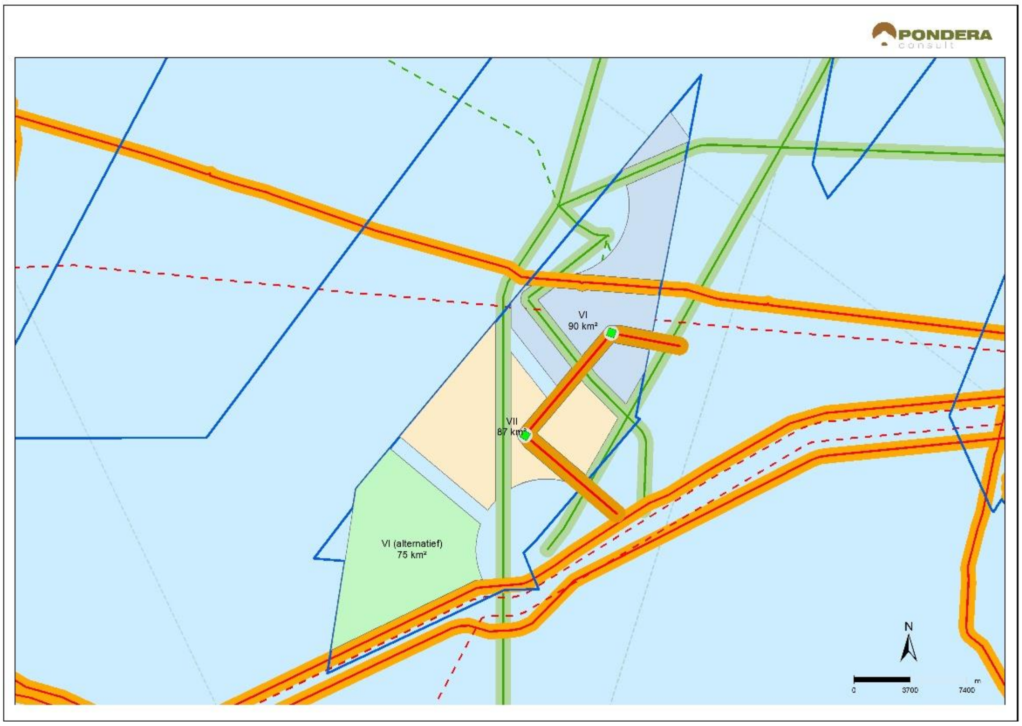
In the Roadmap for offshore wind energy the choice has been made to construct two wind farms of 700 MW in the wind farm zone Hollandse Kust (west) in 2024/2025. Of the total area of 349 km2 from wind farm zone Hollandse Kust (west), space will be reserved for the following(see also figure S2):

1. Cables and pipelines present in the wind farm zone and a zone of 500 meter around it;
2. TenneT's Hollandse kust (west) Alpha platform (and a zone of 500 meter around it) for the connection to the mainland for site VI;
3. TenneT's Hollandse kust (west) Beta platform (and a zone of 500 meter around it) for connection to the mainland for lot VII;
4. Future cables from TenneT's Alpha platform to land (500 m maintenance area on both sides and distance between the two 200 m cables is 1,200 m wide);
5. Future cables from TenneT's Beta platform to land (500 meter maintenance zone on both sides and distance between the two 200 meter cables totalling 1,200 meter wide);
6. A connection between platform Beta and Alpha (500 meter maintenance zone on both sides, i.e. 1,000 meter wide in total);
7. A safe distance to mining sites;
8. A safe distance from the ferry route between the Netherlands and the United Kingdom (northern point of the wind farm zone);
9. A clearer boundary of the south-western boundary for navigation (one corner of the area is not used);
10. A safety zone of 1,000 meter between the lots.

The exact location of platform Beta and the future cables from this platform originate from TenneT, but were not yet definitive at the time this EIA has been written. Minor changes in the location of the platform and/or the cables (in the order of a few hundred meter) do not directly lead to a different impact assessment for this EIA, but the location of the boundaries of site VII may be somewhat different, because the Beta platform and the cables from this platform are located in site VII. In particular, this could lead to changes in the coordinates given in Annex 3.

There is a search area for the TenneT platform Beta east of the centre of site VII.

Figure S2 Proposed site division of wind farm zone Hollandse Kust (west).



5. The impact assessment method

Bandwidth

In an EIA, alternatives to an activity are assessed by examining their effects and comparing them with each other. An alternative is a possible way in which the intended activity, in this case the generation of energy with wind turbines, can be realised considering the purpose of this activity (see text box). In this EIA, alternatives per site (preferred site division and alternative site division) were investigated. 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 site within the wind farm zone Hollandse Kust (west) will thus be issued with the possibility for the wind farm developer to design it according to his own wishes. The bandwidth within which the project must be carried out will be laid down in the decision on the site.

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 scenario 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 of reducing 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 within the site is shown in the following table. The values of the bandwidth are based on the current state of the art and expectations regarding developments for the coming years. The bandwidth within which to remain is laid down in the following table.

Table S1 Bandwidth EIA.

Design	Bandwidth
Capacity of individual wind turbines	Minimum of 10 MW*
Highest tip point of individual wind turbines	189 – 304 meter
Lowest tip point of individual wind turbines	Minimum of 25 meter
Rotor diameter of individual wind turbines	164 – 279 meter**
Distance between each wind turbine	Minimum of 600 meter
Number of blades per wind turbine	2, 3, multirotor**
Type of foundations (substructures)	Monopile, multipile, 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: maximum sound level	168 dB re 1 mPa2s at 750 meter
In case of pile-driving foundations, diameter of foundation pile/piles and number of piles per turbine:	
Monopile	1 pile of 6 to 12 meter
Multipile	3 to 6 piles of 1 to 4 meter

Design	Bandwidth
In case of a foundation without pile driving, dimensions on seabed:	
Gravity-based	Up to 40 x 40 meter
Suction bucket	Bucket diameter: tbd
Electrical infrastructure (inter-array cabling)	66 kV, burrowed at 1to 3 meter depth[14]

* Implying a maximum of 76 turbines to reach 760 MW

** Multirotor turbines may deviate from this. The application of this innovative turbine design requires customization in the EIA.

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	76 x 10 MW-turbines Lowest tip point 25 m, rotor diameter 164 m	47 x 16 MW-turbines Lowest tip point 25 m, rotor diameter 279 m
Underwater life*	47 x 16 MW-turbines 1 turbine location a day	76 x 10 MW-turbines 1 turbine location a day
Shipping	76 x 10 MW-turbines Jacket-foundation with 18 m diameter	47 x 16 MW-turbines Monopile foundation with12 m diameter
Geology and hydrology	76 x 10 MW-turbines	47 x 16 MW-turbines
Landscape**	76 x 10 MW-turbines Min. rotor diameter 164 m Min. axle height: 107 m	47 x 16 MW-turbines Max. rotor diameter 279 m Max. axle height: 164,5 m
Other use functions	76 x 10 MW-turbines	47 x 16 MW-turbines
Electricity yield**	76 x 10 MW-turbines	47 x 16 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 alternatives per aspect, they are assessed on a +/- scale in relation to the zero alternative (ie. the current situation and autonomous development). The following rating is used for this purpose, as shown in table S3. The assessment provides a justification for the scoring.

[14] Two variants can be investigated: digging in at a depth of one metre and at a depth of three metres.

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 VII, cumulative effects of other wind farms and activities are considered and mitigating measures examined.

6. Results of the Environmental Assessment – site VII

The following tables show the assessments of the alternatives per aspect against the various assessment criteria, 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.

6.1 Birds and bats

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

Wind farm effect	Alternative 1	Alternative 2
	76 * 10 MW ø 164 m	47 * 16 MW ø 279 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	-	-
- barrier effect	0	0
- habitat loss	-	-

Wind farm effect	Alternative 1	Alternative 2
	76 * 10 MW ø 164 m	**47 * 16 MW ø 279 m**
- 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	+/-	+/-

The alternative 2 with 46 x 16 MW turbines and a rotor diameter of 279 meter is the most environmentally friendly alternative for birds and bats, due to the lower number of collision casualties compared to the other alternative.

The expected effect of two-bladed instead of three-bladed turbines was also discussed. If one takes into account the fact that a bird can come into contact with one blade less per turbine, but the rotation speed is on average somewhat higher of the blades (approximately 1.33x), then it is expected that fewer casualties will occur with two-bladed turbines than with three-bladed turbines.

The effect of using multi-rotor turbines was also discussed in qualitative terms. No experience figures are available yet, but it can be expected that more collision victims will fall if the rotors are placed lower in comparison with single-rotor turbines. Even when the total rotor surface in the site increases, this will lead to more bird casualties. The presence of multiple rotors can increase the visibility of multirotors and this can lead to more disturbance for sensitive species, such as razorbills and divers. As far as bats are concerned, it is also expected that multi-rotor turbines will lead to more casualties, due to the possibly larger rotor surface area and the lower rotor height.

6.2 Underwater life

Table S5 Assessment of impact on underwater life without mitigating measures.

Assessment criteria	Impact assessment	Site VII	
		Alt. 1	Alt. 2
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)	 0 0/- 0/- 0/- 0/-	 0 0/- 0/- 0/- 0/-
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/-

The alternatives are not distinctive with regard to the effects of underwater noise. The application of the noise standard as included in the Framework Ecology and Cumulation (KEC) 3.0 results in a levelling off of the effects, as a result of which for both alternatives it can be stated with 95% certainty that the population of porpoises will not decrease by more than 5%. This 5% concerns 510 porpoises per site. The construction of the wind farm in both alternative 1 and alternative 2, results in a very small decrease in the number of porpoises (a maximum of 40 individuals). As far as seals are concerned, the effects are also minor, since seals have a higher threshold value with regard to disturbance. A maximum of 11 individuals will avoid the disturbance area. As regards bottom-dwellers and fish, the effects are very small.

6.3 Shipping safety

Table S6 Assessment of the effects of the preferred location for site VII - shipping and safety without any mitigating measures.

Assessment criteria	Impact assessment	Score Preferred location site VI with10 MW-turbines
Safety	Risk of collision and propulsion	0/-
	Consequential damage of collision and propulsion	0/-
Shipping	Deviation possibilities for vessels crossing	0/-
	Effects of passage of ships below 24 metres or below 45 m	0/-

For site VII, calculations have been carried out on the turbines' collision and propulsion probabilities. These calculations show that the total frequency of collisions and propulsion is 0.101195. This is equivalent to once every 9.9 years. This means that the preferred location scores slightly negative (0/-).

As a result of turbines in site VII, an outflow of oil is expected once every 567 years.

The expected average number of fatalities per year due to a collision or propulsion with a turbine is 0.002311.[15] A number of comments can be made about these figures (including the fact that a number of scenarios have been disregarded and that figures are based on smaller turbines than those currently being built, see section 8.4.3), but the figures between sites are comparable.

Intersecting ships

It is assumed that even if there are sometimes larger shadows (in the radar sight) at a shorter distance, the non-route bound ships are sufficiently manoeuvrable to react at a short distance when they meet another ship. However, it is expected that the limitation of visibility plays an less important role in these meetings, as opposed to the possible misjudgement of the intentions and manoeuvrability of the other ship. This effect is scored as 0/-.

Passage through the wind farm zone

The number of collisions with wind turbines is greater in the event of allowed passages of ships up to 45 metres, namely 1.87 collisions per year compared to 1.43 collisions per year. This is based on the presence of wind farms in accordance with the roadmap, i.e. not only the wind turbines in Hollandse Kust (west). The effect on the area outside the wind farms is also relevant: the verge and the waterway. This is an aspect that needs further investigation and on which no statements can be made at this stage. Because the chance of collisions and drives increases as a result of opening up wind farms to ships, the score is slightly negative (0/-).

[15] This does not take into account possible casualties in the event of collisions and propulsions where the mast and nacelle do not fall on the deck, such as when a fishing vessel overturns.

6.4 Morphology and Hydrology

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

Aspect (during installation, maintenance and operation)	**Site VII, alternative 1**	**Site VII, alternative 2**
	a 16 MW turbine on a monopile foundation with a diameter of 12.5 meter. Erosion protection (paving stones): three times the diameter of the base.	a 10 MW turbine on a gravity based foundation with a diameter of 50 meter. Erosion protection (dumping stones): three times the diameter of the base.
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 the morphological and hydrological changes resulting from the construction, use, removal and maintenance of the planned wind farm and the cables are very limited. In addition, the effects during construction and removal are temporary in nature. The changes, if any, are very small compared to the natural dynamics of the area. Due to the relatively small size of the foundation piles, the relatively large distance between the wind turbines and the number of wind turbines, these are very local changes. The impact is limited to the immediate vicinity of the foundation piles and the park cabling route and is of a temporary nature. Only in the case of a gravity-based foundation are the effects as a result of the larger dimensions of the foundation slightly larger and therefore score slightly negative.

As far as the difference between burying the cables at a depth of 1 or 3 meter is concerned, exposure of the cable occurs more quickly when the cable is buried at a depth of 1 metre, with the result that there is a greater chance that the cable will have to be brought back to the required depth. However, laying a cable at a depth of 3 meter has a greater effect in terms of the soil-disturbed surface through the trencher and the turbidity will increase as a result of stirred up sediment when 3 instead of 1 metre is buried. However, this still falls well within the limits of the natural dynamics of the North Sea.

6.5 Landscape

Table S8 Assessment of impact on landscape without mitigating measures.

Aspect	Score	
	Alternative 1 76 x 10 MW-turbines Max. tip height 189 m	Alternative 2 47 x 16 MW-turbines Max. tip height 304 m
Visibility in percentage of time	0	0

The visibility of wind turbines in lot VI is quantitatively represented by the percentage of time that the meteorological conditions are such that the wind farm can be seen. This is less than 1% of the time in the summer days (on average 1 day per summer, 7 minutes visible). This means that both alternatives are barely visible and no distinction is made in the assessment both score neutral (0). And if the meteorological conditions are such that the wind farm is visible, the distance (at least 51 kilometer) is so great that only some of the nearest turbines can be seen. The turbines of wind farms located between Hollandse Kust (west) and the coast will also ensure that the wind turbines in site VII are not or only to a very limited extent visible.

6.6 Other use functions

Tabel S9 Beoordeling effecten voorkeursverkaveling kavel VI - overige gebruiksfuncties zonder mitigerende maatregelen.

Aspect	Effect	Score site VII	
		Alternative 1 76 x 10 MW suction bucket	Alternative 2 47 x 16 MW 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 ray paths	0/-	0/-

Aspect	Effect	Score site VII	
		Alternative 1 76 x 10 MW suction bucket	**Alternative 2 47 x 16 MW gravity base**
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
Shellfish farming and aquaculture	Restrictions for shellfish farming and aquaculture installations	0	0
Existing wind farms	Effect on electricity output of existing wind farms	0	0
(local an regional) economies	Effect on economies and employment	0/+	0/+

Most of the impacts are assessed as neutral due to their limited magnitude. This is partly because in the choice of location, the existing (other) use functions have already been taken into account. Below is a brief description of each aspect. Within the range of the bandwidth alternatives (alternative 1 with 76 x 10 MW on suction bucket and alternative 2 with 47 x 16 MW on gravity base) no distinguishing effects were found.

For most of the other use functions, the effects are minor and the impact assessment is neutral. These include the effects on ship, shore and aviation radar, dredging, sand, gravel and shell extraction, shellfish farming and aquaculture, ammunition dumps and military activities, existing wind farms, cultural history and archaeology, and recreation and tourism. The effects on (local and regional) economies are assessed as slightly positive.

The impacts on fishery are assessed as slightly negative because of the area lost and the value of the area to fisheries. There is also a slight negative effect on the available electrical and telecommunication cables and pipelines. For aviation, we see a neutral effect on the interference of civil and military aviation. The interference for the Coast Guard is slightly negative, because the presence of wind turbines poses a risk to flying at low altitudes. The effects on ray paths for site VII are assessed as slightly negative. The effects of oil and gas production are generally assessed as slightly negative. Site VII is located in both licensed production and exploration areas but does not make the development of future fields in these areas impossible.

6.7 Electricity yield

Table S10 Assessment of impact on electricity yield without mitigating measures.

Aspects	Score	
	Alternative 1 76 x 10 MW-turbines	Alternative 2 47 x 16 MW-turbines
Electricity yield	++	++
Emissions avoided	++	++

For the 10 MW turbine alternative, a Vestas V164-10.0 MW has been calculated and a net electricity yield of 3,541,986 MWh/year has been calculated. For the alternative with 16 MW turbines a net electricity yield of 3,396,982 MWh/year follows from the calculations. The energy yield of the minimum alternative (76 turbines of 10 MW) is therefore approximately 4.3% higher than the maximum alternative (47 turbines of 16 MW). This is not necessarily the case, but it does apply to the turbine types under consideration. It is good to know that this assessment is based on a 10 MW turbine that can actually be supplied and that the 16 MW turbine is based on extrapolation of data, because no 16 MW turbine can be supplied at the time of writing of this EIA.

An annual electricity production of 3,541,986 MWh is equivalent to the annual electricity consumption of approximately 1,200,000 households (assuming an average of 2,910[16] kWh/household/year).

The energy yield in the alternative with 16 MW turbines is realised with a fewer number of turbines than in the alternative with 10 MW turbines, i.e. 76 instead of 47 turbines. The contribution of the wind farm to the reduction of CO2, NOx and SO2 is directly proportional to the net energy yield. The reduction is calculated on the basis of the average use of fuels at power stations (mainly gas).

It is likely that turbines with a high capacity and a relatively large rotor will generate the most electricity yield. The future wind farm developer is free to determine an optimum in which the cost price will of course also play a role.

7. Cumulation

The following table briefly lists the cumulative effects that occur and the consequences they have for the wind farm site decision. The first column indicates the aspect, the second column indicates which effects may be relevant in case of cumulation and the third column indicates implications for site VII.

Table S11 Overview of cumulative effects at site VII – Hollandse Kust (west)

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
Birds and bats	Exceeding the PBR in the (international) worst-	Compared to Rijkswaterstaat (2015), Leopold et al. (2015) and Van der Wal et al. (2015), this EIA is based on Ecology

[16] CBS (2016). Average household electricity use

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
	case scenario studied with 3 MW turbines in the KEC in 2015 (lesser black-backed gull, great black-backed gull and herring gull) cannot be ruled out (Rijkswaterstaat (2015), Leopold et al. (2015) and Van der Wal et al. (2015)).	and Cumulation Framework (KEC) 3.0 and therefore a more realistic scenario is calculated for foreign wind farms (see appendix 4), and the input parameters for the sites of Borssele, Hollandse Kust (Zuid) and Hollandse Kust (noord) have been updated in line with the latest insights (see Gyimesi & Fijn 2015b, Gyimesi et al. 2017c, Gyimesi et al. 2018c). In the current calculations for Hollandse Kust (west), the cumulative number of collision victims in the southern North Sea for all locally residing species remains well below the PBR standard. Looking only at the cumulative effect of the Dutch parks on the Dutch population of locally residing species, the number of casualties for all species also remains well below the PBR standard. No cumulative effects are to be expected in respect to breeding colony birds that could be victims in a site in the wind farm zone of the Hollandse Kust (west) (small black-backed gulls from the Natura 2000 site of Dunes and the Low Land of Texel) that would lead to significant negative effects. With regard to migratory birds, the cumulative mortality among migratory birds resulting from collisions with all (future) wind turbines in the southern North Sea remains below the PBR for all species. On the basis of these results and the wind farm plans currently known, it can be concluded that the favourable conservation status of migratory bird species will not be called into question.
	Based on current knowledge, and in particular the lack of good information on the occurrence of bats in the North Sea on the one hand and the lack of reliable estimates of population sizes on the other, it cannot be ruled out that in the worst-case scenario negative effects on the favourable conservation status of some bat populations will occur, such as red-legged bats and rough dwarf bats.	Mitigation measures can be taken to reduce effects to an acceptable level (see sections 12.5 and 12.6).

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
Underwater life, Marine mammals	Effects on the favourable conservation status cannot be excluded if no mitigating measures are taken.	By applying the noise standard as recorded in the KEC 3.0, effects on the favourable conservation status can be excluded.
Shipping safety	Wind farms at the sites Hollandse Kust (west) and existing wind farms may lead to other effects on shipping and safety.	The cumulative effect in this EIA has not been considered separately because, in deviation from previous studies carried out for wind farm zone Borssele, the other planned wind farms in the North Sea will not change the shipping traffic routes. The new route structure has been designed in such a way that it takes account of wind farms that have already been or will be built. The considered base case is therefore also the cumulative scenario. As part of the adjustment of the traffic system in August 2013, various risk studies have been carried out, such as 'Risk to shipping in the event of designation of the wind area "Dutch Coast". The cumulative effect is also discussed within this study. A cumulative study of shipping safety for the roadmap has also been carried out. This study has already been taken into account in this EIA (see appendix 9).
Morfologie en hydrologie	Wind farms in other sites in the wind farm zone Hollandse Kust (west) can also lead to effects on morphology and hydrology.	None. When filling in wind farm zone Hollandse Kust (west), practically the same local, temporary and negligible effects will occur as described for site VI. This means that there will be no cumulation, not even with other activities and other more distant wind farms.
Landscape	Wind farms in the Hollandse Kust (zuide) and Hollandse Kust (noord) wind farm zones also affect the visibility of wind turbines from the beach.	Minimal, because wind turbines in the Hollandse Kust (west) wind farm zone are only visible to a very limited extent.
Other use functions	Wind farms in the sites of the Hollandse Kust (zuid) and Borssele wind farm zones, as well as the wind farms according to the 2030 roadmap, will also affect other use functions.	Minimal with regard to fisheries. With the development of the Hollandse Kust (west) wind farm zone, the total surface area lost to fisheries becomes larger. In total the Wind Farm Zones cover approximately 4.78% (0.6% Borssele, 0.62% Hollandse Kust (zuid), 0.51% Hollandse Kust (noord), 0.61% Hollandse Kust (west), 2.05% IJmuiden Ver, and 0.38% Ten noorden van de Waddeneilanden) of the NCP, and therefore also the fishing area, are lost. However, the wind farm zones will not be completely closed, only the wind farm sites. After closing these, the total surface area amounts to 2.81% of the NCP (Natura 2000 areas and the Bruine Bank cover 20% and 5% of the NCP respectively).

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
		In the event that, according to current governmental plans, all nature reserves and wind farm zones[17] were to be closed, the gross value added of Wind farm zone Hollandse Kust (west) to the Dutch kottersector will become 1.57%. If a Brexit induced closure of British waters is also taken into account the gross value added will increase to 1.93%. The larger number of turbines also increases the chance that archaeological remains will be affected. Wind farm zone Hollandse Kust (west) has a limited impact on recreational shipping, because recreational shipping is permitted up to 24 meter and mainly makes use of the 10 to 20 km zone along the coast. For vessels wishing to cross from the North Sea Canal to England and larger than 24 meter, the realisation of site VI will mean an extra detour. The effects on coastal recreation have been assessed as neutral and have no consequences for the Wind farm site decision.
Electricity yield	Wind farms in the vicinity can intercept wind from each other, decreasing the wind speeds at other wind farm sites.	None, the expected wind interception of, and on wind farms in the planned site in the vicinity is very small, as shown in chapter 11.

8. Mitigating measures

After assessment, it appears that the conditions in the legal framework can be satisfied for virtually every aspect. In order to guarantee the favorable conservation status of nitrogen-sensitive habitats, mitigating measures are necessary. Also 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 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 and removal from June to September due to the limited presence of species of sea birds susceptible to disturbance. • Minimising lighting on ships and/or use of a bird-friendly lighting colour. • Reduction of pile-driving or removal noise. However, the effect of the sound of pile driving or removal on birds is

[17] Among these are parts of the following area's: Doggersbank, Centrale Oostergronden, Friese Front, Klaverbank, Borkumse Stenen, Noordzeekustzone, Voordelta en Vlakte van de Raan (Stichting de Noordzee, 2018)

Aspect	Effect	Mitigating measure
		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. • Installing two-blade instead of three-blade turbines. • Creating a corridor in the wind farm that birds may use. • Casualties can be avoided by smart planning of maintenance when turbines are shut down. • Increasing the chances of birds detecting the wind farm using 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).
Underwater life	Benthos and fish	• Not removing foundation structures after the end of the exploitation phase.
	Disturbance and associated population reduction; PTS.	• Using 'Slow start' and 'Acoustic Deterrent Devices' (ADDs). • Noise mitigating measures such as a bubble screen to a) comply to the prescribed standard and b) to further reduce noise levels during pile driving
Nitrogen-sensitive habitats	Construction phase	• Reducing the nitrogen emission in such a way that a maximum of 0.05 mol N / ha / year deposition occurs in nitrogen-sensitive habitat types
Shipping safety	Collision/propulsion and resulting damage	• Radar, AIS en VHF-coverage • Vessel Traffic Management • Additional marking and identification of wind turbines • Deployment of an Emergency Towing Vessel. • Extra SAR-capacity • Oil control
Morphology and hydrology	- (there are no significant effects)	-
Landscape	- (there are no significant effects)	-

Aspect	Effect	Mitigating measure
Other use functions	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.
	Site VII overlaps with mining permit holders and obstacle free zone around platforms	Consult with mining companies.
	Restriction of fishing areas	There are opportunities for the fisheries-friendly design of wind farm zones. However, this entails high costs (including significantly higher insurance premiums for wind farm operators and fishermen). For the parties involved, however, the benefits do not seem to outweigh the costs.
	Shellfish farming and aquaculture	Biological suitability for shellfish farming and aquaculture within wind energy zones has been demonstrated. However, follow-up studies have yet to demonstrate whether this is feasible in practice.
	Possible interference with existing ray paths	Take into account half rotor + 2nd fresnel-zone around ray paths when installing the wind turbines. Use of alternative 4G network infrastructure, planned to offer full coverage of the Dutch North Sea in 2020.
Electricity yields	- (there are no significant effects	-

9. Considerations

The assessment can be divided into the verification against the legal framework, the choice of the preferred bandwidth and the mitigating measures to be taken.

Assessment against the legal framework

Some mortality amongst birds and fish and a 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 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 Nature Conservation Act. For the purpose of testing against this Act, 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. Specifically when it comes to nitrogen deposition as a result of the construction of the wind farm, a regulation must be included in the site decision to maximize the amount of nitrogen. In this way it is prevented that a higher temporary deposition than 0.05 mol N / ha / year occurs as a result of the temporary nitrogen emission as a result of the construction of the project. The Appropriate Assessment indicates that a deposition of a maximum of 0.05 mol / ha / year during 2 years can never influence the size and spatial distribution of the deposition blanket as a result of the virtually continuous use of the equipment in the North Sea, which is also used for the project.

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 (NNN), applies to the whole of the North Sea (EEZ). Paragraph 1.3.1 of annex 4 states how the protection regime for the Nature Network Netherlands (NNN) works in the Dutch North Sea area.

Considerations regarding the 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 and that has actually led to the minimum caacity per turbine being increased to 10 MW (instead of 3 MW at Borssele wind farm zone) The aspect of effects on birds has restricted the bandwidth primarily at the sites in the Borssele wind farm zone. However, mitigating measures on the basis of this EIA must be taken to eliminate or reduce the effects. The measures that must be taken are as follows:

The only exception is the use of multirotors. Because there is still little experience with them and the exact rotor surface area and rotor heights that determine the risk of bird victims are not known, it is not easy to quantify the effects. This does not rule out the possibility that effects will increase compared to single-rotor turbines, for example if several rotors are installed at a relatively low shaft height, where the bird density is higher.

Considerations regarding mitigating measures to be taken

A number of measures are needed to limit effects for nitrogen-sensitive habitat types and to limit cumulative effects on birds, bats and porpoises and to ensure a favourable conservation status. These include, for example, a standstill arrangement for bird and bat migration and compliance with a noise standard for underwater noise during pile driving. Table S12 also lists possible measures with further mitigating measures. The choice of measures to be prescribed is a matter for the competent authority and is explained in the wind farm site decision.

Consideration regarding an extended operating period from 30 to 40 years

In the site decisions taken for Borssele, Hollandse Kust (south) and Hollandse Kust (north) and so far also in this EIA, the starting point has been that the wind turbines can be operated for 30 years. Now that it is possible to extend the operating period from 30 years to 40 years for Hollandse Kust (west), the effect of this on the earlier conclusions of this EIA should be investigated. Because the effects during the exploitation period are often expressed per year, such as the number of expected bird victims per year or the collision risk for ships per year, the conclusions remain unchanged. However, effects last 10 years longer than described in this EIA. Think in particular of effects on birds and bats, effects on shipping safety and on other uses such as fishing. Sustainable electricity will also be generated for 10 years longer. The conclusions in this EIA will not change due to a change in the duration of operation from 30 to 40 years.

Modifications to the division of site VII

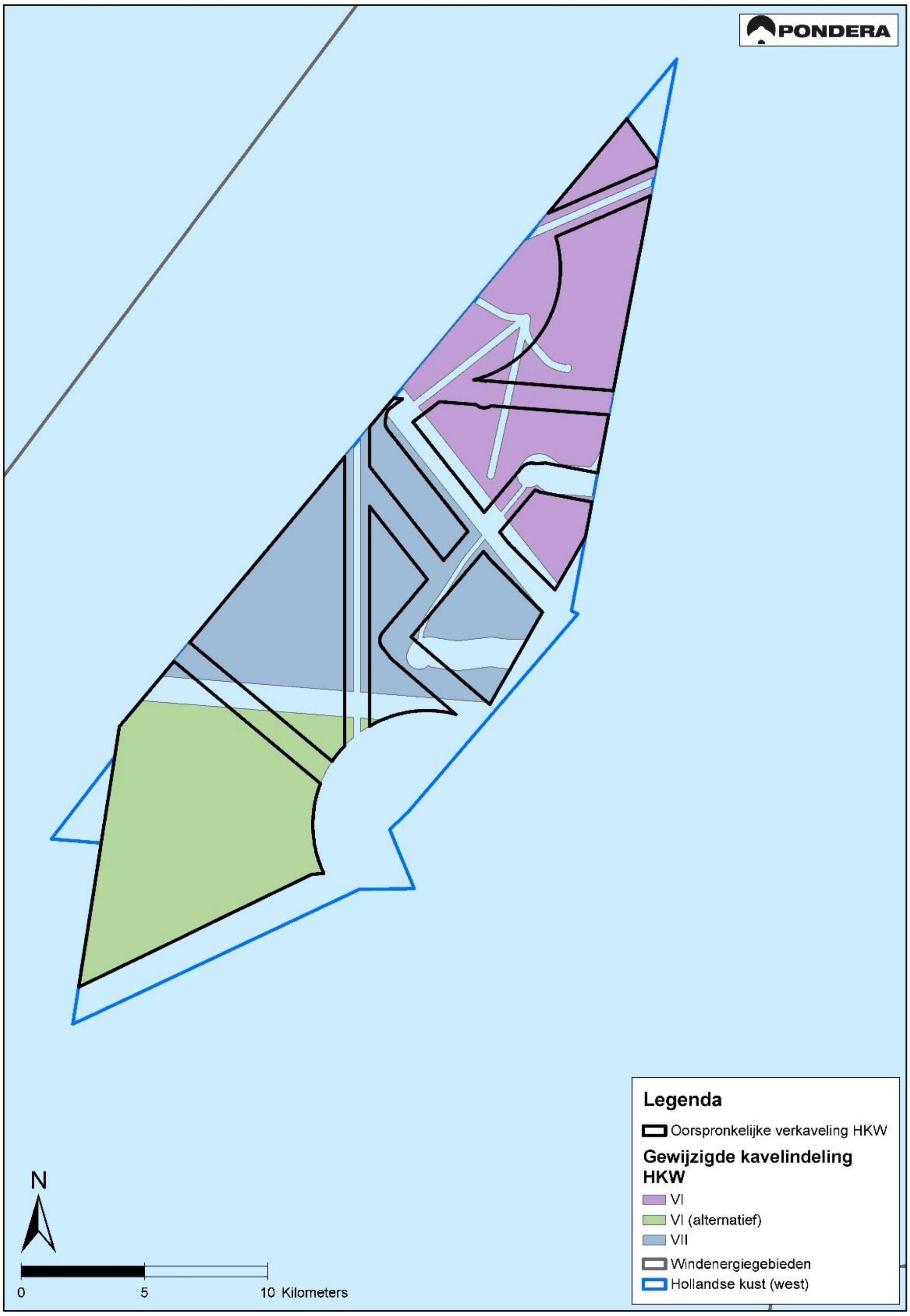
Recent developments lead to modifications in the boundaries of site VII (and site VI, and VI (alternative)) in comparison to the boundaries that have been used so far in this EIA. This is due to newly available information regarding the planned decommissioning of part of the mining infrastructure in the Wind Farm Zone and the status of a telecom cable located in the area. This information has been received after the review of the NRD and after the completion of the draft EIA. In the revised site division, maintenance zones of pipelines no longer in use have been limited in size, and an obstacle-free zone around platform P6A has no longer been taken into account. In addition, shipping movements have been taken into account in more specific manner as a result of the recently signed North Sea Agreement. In the new division an area has been kept clear that can serve as a passageway for shipping in the future (up to 46 metres) between site VI and VII and between site VII and VI, respectively.

By modifying the division in anticipation of the above developments, more room will become available for the wind farm developers in each site.

appendix 11 contains more information about the modified division of the sites. These consider, among other things, the now know location of Tennet platform Beta and it’s interlinkg to platform Alpha. This appendix also describes the effects of the modified division for each environmental aspect.

In terms of effects, there are marginal differences between the new division and the original division. Because the differences are so small, they are not always reflected in a changed score in the impact assessment. However, the score does change for ‘Shipping’ and 'Other use functions', where positive effects occur due to the modifications. This leads to a more positive assessment score for oil and gas extraction, aviation, and telecommunications. Positive effects are also expected with regard to shipping for all sites, as collision probabilities decrease due to the shipping passages that can be used by ships up to 46 metres.

Figure S3 Modified site division in relation to the original site division



Bron: Pondera Consult

Conclusion

The wind farm site decision may permit the preferred bandwidth of the site at the location under consideration, with the exception of the use of multirotors. The application of (at least) the necessary mitigating measures must be guaranteed.

10. Gaps in knowledge and information

Introduction

The development of offshore wind farms has a relatively short history. The first monitoring evaluations for previously developed offshore wind farms in England, Denmark, Germany and the Netherlands have since been published. These are the results from relatively short monitoring periods. Certainty about the long-term effects can therefore not yet be given. However, current research and development 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 VII. 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 short history of offshore wind energy; in a broad sense, there is still a lot of knowledge to be acquired about animal species and their densities, diversity and behaviour. This section explains the knowledge gaps that are relevant in the context of this EIA. Gaps in knowledge are successively described in relation to the effect assessment on birds and bats, underwater life, morphology and hydrology, shipping, landscape, other use functions and electricity yield.

Birds and bats

For birds, there are gaps in knowledge about collision risks, barrier effects and disruption caused by offshore wind farms (both during the day and at night). In particular, species-specific knowledge is lacking. Validation of models to predict collision bird casualties at sea is lacking. There are also gaps in knowledge about disturbance sensitivities and disturbance distances of seabirds, as well as the extent to which birds can become accustomed to wind farms. Based on literature, it is assumed that 10% of the disturbed birds die. It is not known to what extent this assumption corresponds to reality.

For wind farm site decisions up to 2030, the PBR in the KEC calculations has been used so far. Bureau Waardenburg and Wageningen Marine Research (WMR) have developed species-specific (Leslie-Matrix) population models for use in both collision risk and habitat loss studies for potentially critical species. This project shows how population models can be used for a species-specific population impact assessment of mortality due to collisions of birds with turbines. Population models provide a better picture than other methods of the possible effects of offshore wind farms on these species. However, before the models can be used for wind farm site decisions, threshold values are needed for the statistics that they can produce. This is a policy decision rather than a scientific one. The report of Bureau Waardenburg and WMR is in the process of being completed and should be published shortly.

The only exception is the use of multirotors. Because there is still little experience with them and the exact rotor surface area and rotor heights that determine the risk of bird victims are not known, it is not easy to quantify the effects. This does not rule out the possibility that effects will increase compared to single-rotor turbines, for example if several rotors are installed at a relatively low shaft height, where the bird density is higher.

For bats, knowledge gaps exist with regard to the basic knowledge about population size and species-specific distribution. Unknown is the relative importance of the North Sea for different types of bats and their changes in behaviour as a result of wind farms.

Under water life

Benthos

knowledge gaps exist with regard to the ability to predict the consequences of 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

The main gaps in knowledge related to the consequences on the calculated effects relate to the estimation of effects on the porpoise population. This concerns gaps in knowledge in the area of quantifying the number of disturbed animals and animal disruption days, but also the translation of these to vital rates.

Threshold value for disturbance or behavioural change

Based on results of research conducted both under controlled conditions and in the field, it has been shown that the threshold value for sound disturbance can lie between SELss = 136 en 145 dB re 1μPa2s (Kastelein et al. 2013; BMU 2013; Diederichs et al. 2014; Brandt et al. 2018). This concerns broadband and unweighted noise levels. The most extensive study was carried out by Brandt et al (2018) regarding the effects of pile-driving noise on porpoises during the construction of the first seven German wind farms. In this study, a significant decrease in the presence of porpoises was found during broadband and unweighted noise levels of more than 143 dB re 1μPa2s. The threshold value of SELss = 140 dB re 1 μPa2s chosen for the EIA of Hollandse Kust (west) is therefore likely to be conservative. If a higher value of SELss = 143 dB re 1 μPa2s had been used in the calculations, the disturbed area and thus the number of days of porpoise disturbance would have been approximately 30 - 40% smaller (Heinis et al. 2019).

For the time being, the calculations for porpoises do not take into account the hearing sensitivity for differences in frequencies. It is likely that the use of a SEL value weighted by the frequency sensitivity of the porpoise's hearing gives a better prediction of the behavioural response. For projects where noise is mitigated by the use of bubble screens, the use of frequency weighting to determine behavioural disturbance in porpoises would result in much smaller predicted disturbance surfaces, because these weighted SELss mitigate more effectively than unweighted SELss (Dähne et al. 2017).

Quantifying the number of animals disturbed and days of animal disturbance

The number of animals disturbed will be calculated by multiplying the estimated area of disturbance (area within contour where the noise maps generated in AQUARIUS version 4.0 exceed the threshold for disturbance) by the estimated animal density (not disturbed by underwater noise) in that area for the time of the year in which the disturbance occurs.

Translating effects on individual porpoises into population effects (iPCoD)

- Size of vulnerable subpopulation, one of the parameters in the iPCoD model. The calculations for the KEC 3.0, which formed the basis for the calculations, are based on a vulnerable subpopulation of 350,000 animals, i.e. equal to the total size of the North Sea population. The choice of a relatively large vulnerable sub-population reduces the risk of effects being underestimated.
- The iPCoD model was thoroughly updated and improved in 2018, especially for the porpoise. In determining the relationship between disturbance and vital rates, use was made of a state-of-the-art energy budget model developed by the University of Amsterdam in collaboration with the University of St. Andrews. The model calculations clearly show that in many cases porpoises can compensate for a (temporary) loss of foraging opportunities. However, it is not yet clear whether and, if so, why the areas with the highest density are also the most suitable areas.
- The Interim PCoD model assumes that the porpoise population is stable and that population development does not depend on density. For the model results, this means that after an effect on the population has been applied, i.e. a decrease as a result of the activities, the population does not recover after termination of the activities. This is probably not realistic. For a more realistic estimate of population development in the years of disturbance, but especially after its termination, more knowledge is needed about density-dependent effects on population development.

Translating effects on individual seals into population effects

For the common and grey seals, transmitter research provides much more data on natural behaviour in the field than for the porpoises. This concerns both population estimates and knowledge about movement of individual animals. In combination with experimentally determined data on the energetic 'costs' of behavioural change (see, for example, Rosen et al. 2007; Sparling & Fedak 2004; Sparling et al. 2007), the effect on the population could be estimated by combining an agent based model (see, for example, Nabe-Nielsen et al. 2014) with a dynamic energy budget. WMR, in collaboration with SMRU/St. Andrews University, has now started to develop such a model. However, it will still take a few years before this model is operational.

Fish

For fish, all necessary research has been carried out into the effects of underwater noise on fish. This shows that fish are much less sensitive to underwater noise than marine mammals and that some species (with swimming bladder) are more sensitive than others. In addition, the magnitude of the effects is so small that the effect of pile-driving noise is not indicated as an essential knowledge gap. Although it is recommended that extra research is performed on (mature) species with closed swimming bladders.

There is a general picture of the occurrence of fish on the NCP. In view of the limited effect on fish populations, further insight into the occurrence of fish on the NCP is not a priority.

Specific knowledge gaps with regard to wind farms exist mainly with regard to the species and extent of changes to the fish fauna in the longer term as a result of the introduction of restrictions on fishing and the fitting of hard structures. In addition, in the wind farm site decision of Hollandse Kust (noord), only noise standards are mentioned for the construction phase (mainly because of the piling of the foundations), but not for the operational phase of the wind farm. This allows wind farm developers to increase the tip speed of rotors indefinitely, resulting in higher noise levels in the operational phase, probably also under water. As it is currently not well known whether the noise of wind turbines plays a role in the disturbance of fish, it is not possible to say whether an unlimited tip speed and the associated noise levels will lead to increased disturbance among fish.

Shipping and safety

A monitoring obligation will be imposed when the wind farms are opened. The number and type of ships occupying the area around the wind farm and any incidents are monitored. Based on the resulting data it will be decided whether it is desirable to develop an assessment framework and a probability model for this. The behaviour and traffic flows of non-route related traffic, which in the SAMSON model is placed outside the wind farm zone, can also be monitored. Furthermore, the scenarios and impact of collisions with turbines can be further investigated and developed. For example, assumptions have been made in this EIA for the determination of personal injury. For example, it is not known what the probability is that the mast will fall towards or away from the ship during collisions. Also, with regard to the failure behaviour of wind turbines in this EIA, the findings of a study from 2000 have been used (Barentse, 2000), while wind turbines have since become considerably larger.

In addition, in the context of the continued growth of offshore wind energy, a cumulative assessment was made of shipping safety and thought was given on how to fill in the knowledge gaps and gaps identified. MARIN also conducted an assessment of shipping safety and mitigation options for the combined effect of autonomous development, and the roadmap 2023 and 2030[18].

Morphology in hydrology

Further research is needed into the possible effects on stratification processes and the water movement of a large-scale (international) development of wind energy in the North Sea. The actual impact of developments on the Dutch continental shelf on the stratification processes and the water movement in the North Sea cannot be stated unequivocally.

Landscape

For the landscape aspect, no significant gaps in knowledge and information have been identified that influence the decision-making process.

Other use functions

For other use functions, no significant gaps in knowledge and information have been identified that influence the decision-making process.

Electricity yield

It is expected that the calculations in this EIA give a good indication of the electricity yield. There are no significant gaps in knowledge or information on the aspect of energy yield and avoided emissions that influence decision-making.

[18] Go to https://www.noordzeeloket.nl/functies-gebruik/windenergie-zee/scheepvaart/ for more information and the research itself.

Ecosystem research

Within the framework of the Wozep (wind energy at sea ecological programme), an ecosystem study has been carried out.[19] The possible increase in scale in offshore wind for 2030 and 2050 in the southern North Sea will probably have a fundamental impact on its functioning. Large-scale generation of wind energy from the lower atmosphere can influence local wind patterns, wave generation, tidal amplitude, stratification of the water column, dynamics of suspended particles and sand transport. In addition, the infrastructure provides hard substrate, not only on the soil (erosion protection), but also provides mounting possibilities for organisms in the upper layers of the water column.

Conclusion

The gaps in knowledge do not prevent a reliable assessment of the effects of a wind farm in site VII of the Hollandse Kust (west) wind farm zone. However, in the decision-making process it is important to have an insight into the uncertainties that played a role in the effect predictions. These are presented in this Section 11.

[19] https://www.noordzeeloket.nl/functies-gebruik/windenergie-zee/ecologie/wind-zee-ecologisch/documenten-wozep-0/ecosysteemonderzoek/

12. Monitoring and evaluation

The Energy Agreement for Sustainable Development (SER agreement, September 2013) agreed to accelerate the realisation of sustainable objectives and to achieve a 40% reduction in the costs of energy production through off shore wind energy (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 implement an integrated monitoring programme to investigate the knowledge gaps regarding the effects of offshore wind farms on the North Sea ecosystem and to achieve a further cost reduction within ecological boundaries.

This monitoring and evaluation programme, Wozep (offshore wind energy ecological programme), focuses on important ecological questions concerning the construction and operation of offshore wind farms. It is generic in nature as it does not focus on a specific wind farm, but on offshore wind farms in general.

Part of Wozep is the MEP (the monitoring and research programme). The MEP includes monitoring and research as required by the Environmental Management Act. In addition to WOZEP, the KEC instrument is also being developed (updating and implementing knowledge).

The Wozep replaces the monitoring obligation imposed seperatly on each wind farm. This will also lead to an increase in efficiency, which will also contribute to the cost-efficient realisation of the objectives for offshore wind energy.

During the evaluation in the Wozep, attention is paid to the translation of the new knowledge into the KEC instrument (this can also mean checking assumptions and/or effect calculations) on the one hand, and on the other, as a translation into policy and management consequences. An example of the latter is the imposition or modification of mitigating measures. In the Wozep, the research focuses in particular on those parts that can have a cost-increasing effect and presents this in a visual way and advises the competent authorities in this regard.

Current state of Wozep

In the starting year 2016, Wozep set up a number of preparatory activities within the aforementioned themes. These included feasibility studies, possibilities for model-based approaches, preparation of measuring systems and inventories of existing knowledge and data. This takes account of what has been and is being done in the North Sea countries surrounding us.

At the end of 2016, a multi-annual monitoring and research programme was completed, which roughly outlined the research guidelines for the period 2017-2023. The choice of these guidelines is determined by an assessment of two time horizons:

- Short-term (until 2023): focusing on using the results in the planned wind farms. Central to this is the study of the assumptions made in the ecological assessment for these wind farms. In addition, the usefulness, necessity and effectiveness of the measures imposed on the wind sector to limit ecological damage will also be investigated;
- Long term (after 2023): what knowledge is needed to enable further expansion of offshore wind farms in a responsible manner, what are the expected effects of further expansion of the number of wind farms in the North Sea, where exactly can they be located and with

what possible consequences, how can negative effects be avoided to a sufficient extent, etc.?

For more information see the website: https://www.noordzeeloket.nl/functies-gebruik/windenergie-zee/ecologie/wind-zee-ecologisch.

The knowledge gaps in this EIA provide input for prioritising monitoring within WOZEP (for the ecological aspects, morphology and hydrology) and for monitoring of the shipping aspects.