Netherlands Enterprise Agency

IJmuiden Ver Wind Farm Zone

Sites Alpha and Beta

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

December 2023

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Contents

Reading guide

Dear reader,

This document, Appendix B, is part of the Project and Site Description IJmuiden Ver Wind Farm Sites Alpha and Beta. In this appendix you will find a summary of the Environmental Impact Assessments (EIA), conducted for both Wind Farm Sites. Before reading, please consider the following:

Appendix B provides only a summary of the more comprehensive Environmental Impact Assessments. For the complete, Dutch-language, documents, we refer to the pages of Bureau Energieprojecten at https://rvo.nl

The assignment for these assessments was given at a time when there were still four wind farm sites in IJmuiden Ver Wind Farm Zone: Site I, Site II, Site III and Site IV. These sites have now been divided into IJmuiden Ver Site Alpha (formerly sites I and II) and IJmuiden Ver Site Beta (formerly sites III and IV). In this document, the summaries of IJmuiden Ver I and IJmuiden Ver II relate to Site Alpha and IJmuiden Ver III and IJmuiden Ver IV pertain to Site Beta.

You might notice that the EIA summaries of IJmuiden Ver Alpha (I and II) and IJmuiden Ver Beta (III and IV) have a different appearance. This is due to the fact that two different companies wrote the initial four Environmental Impact Assessments.

This document has been produced for information purposes only and is not intended to replace any legal or formally communicated rules, regulations or requirements.

Summary Environmental Impact Assessment

Site Alpha (formerly Site I)

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English summary

1. Introduction

The Netherlands has set ambitious targets for achieving sustainable - renewable - energy production. Wind energy plays a prominent role in achieving that target. The period up to 2030 has so far focused on the Climate Accord target of producing 49 TWh of offshore wind energy annually by 2030. This requires a capacity of about 11.5 gigawatts (GW).

In addition to this target, by establishing three new wind farm zones in the North Sea Programme, the minister has indicated his intention to realise an additional 10.7 GW of offshore wind by 2030.

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

To meet these targets by 2030, new sites will be established and issued in the coming years. The sites will be established within the boundaries of the areas designated as wind farm zones in the North Sea Programme 2022 - 2027. The Wind Farm Site Decision determines where and under what conditions a wind farm may be built and operated. Following a Wind Farm Site Decision, licensing follows. Only the permit holder has the right to build and operate a wind park at the location of the site. The Water Decree lays down general rules for offshore wind farms.

The Minister for Climate and Energy, in agreement with the Minister for Infrastructure and Water Management, the Minister for Housing and Spatial Planning and the Minister for Nature and Nitrogen, can take a Wind Farm Site Decision and prepares an Environmental Impact Assessment (EIA) for the purpose of the Wind Farm Site Decision.

This document concerns the Environmental Impact Assessment for site I in the IJmuiden Ver Wind Farm Zone (see Figure S1). The Environmental Impact Assessment describes the environmental effects that occur during the construction, operation and removal of wind turbines.

In this summary, the following sections are covered after this introduction (section 1):
2. the policy context and the reason for the Wind Farm Site Decision to be taken;
3. the choice of location for IJmuiden Ver wind farm zone;
4. the site subdivision of IJmuiden Ver wind farm zone;
5. the method of the EIA;
6. the result of the EIA;
7. cumulation;
8. cross boundary effects;
9. mitigation;
10. considerations of the preferred alternative;
11. gaps in knowledge and information;
12. monitoring and evaluation.

2. Policy context and reason for Wind Farm Site Decisions

The Offshore Wind Energy Roadmap includes plans to develop wind farms with a total capacity of about 21.5 GW in the following wind farm zones:

- Borssele with a capacity of 1,502 MW;
- Hollandse Kust (zuid) with a capacity of 1,520 MW;
- Hollandse Kust (west) with a capacity of 2,100 MW;
- North of the Wadden Islands with a capacity of 700 MW;
- IJmuiden Ver with a capacity of approximately 6,000 MW;
- Nederwiek with a capacity of approximately 6,000 MW;
- Doordewind with a capacity of 4,000 MW;

In accordance with this roadmap, about 11 GW of offshore wind capacity should be operational by 2030. The offshore wind roadmap thus looks as shown in Figure S1. Table S1 also shows the site subdivision for each wind farm zone.

Figure S1 Offshore wind energy roadmap June 2022

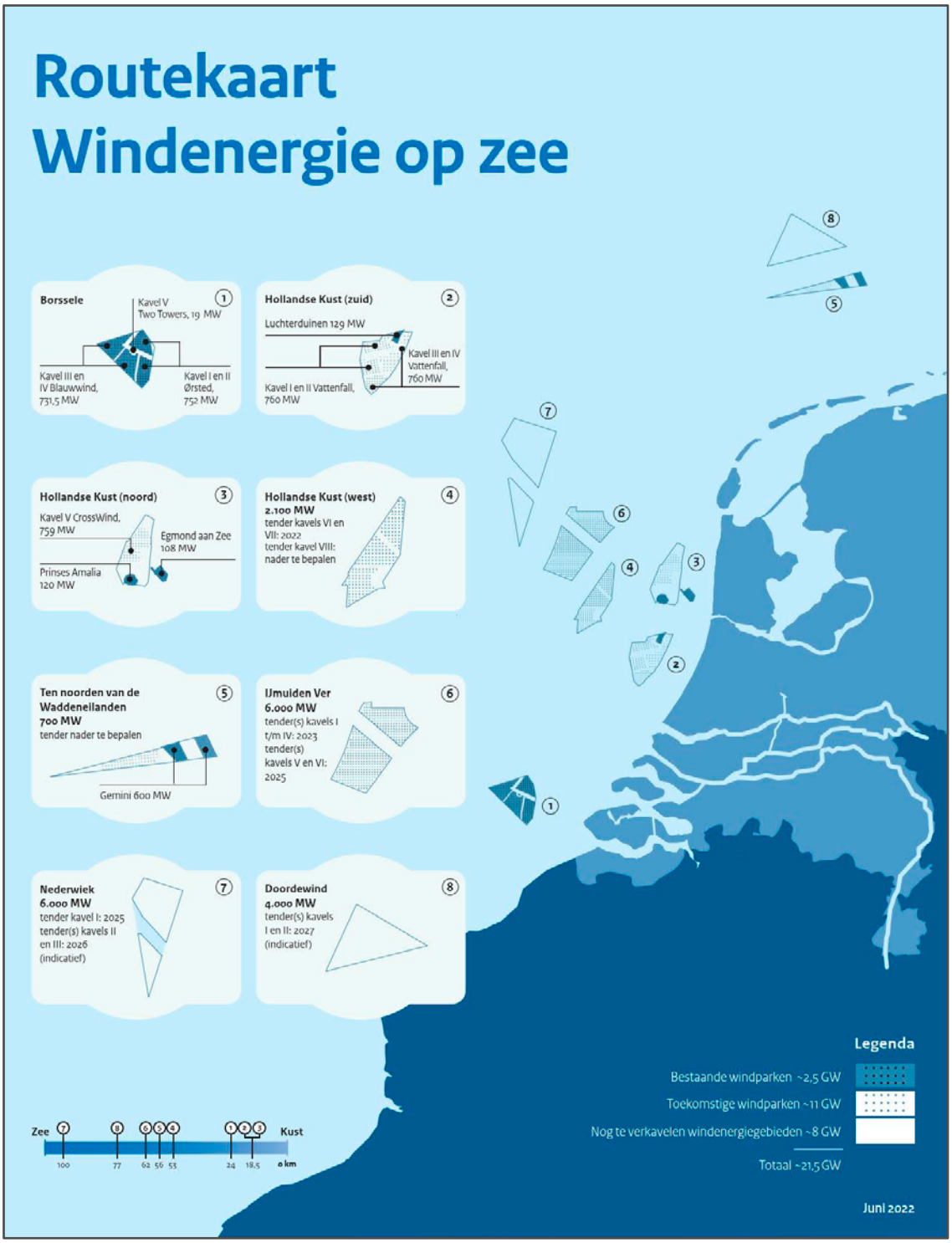


Table S1 Additional roadmap offshore wind energy 2030 (June 2022)

Size (ca. GW)	Wind farm zone, site(s)	Site tenders	(expected) commissioning of wind parks
1,0	In 2015 existing offshore wind parks	-	-
0,7	Borssele, sites I en II	Realised in 2016	2020
0,7	Borssele, sites III, IV en V	Realised in 2016	2020
0,7	Hollandse Kust (zuid), sites I en II	Realised in 2017	(2022 - 2023)
0,7	Hollandse Kust (zuid), sites III en IV	Realised in 2019	(2022 - 2023)
0,7	Hollandse Kust (noord), site V	Realised in 2020	(2023)
0,7	Hollandse Kust (west), site VI	Realised in 2022	(2025 - 2026)
0,7	Hollandse Kust (west), site VII		(2025 - 2026)
1,0	IJmuiden Ver, site III	Fourth quarter of 2023	(2028)
1,0	IJmuiden Ver, site IV		(2028)
1,0	IJmuiden Ver, site I		(2029)
1,0	IJmuiden Ver, site II		(2029)
1,0	IJmuiden Ver (noord), site V	Second quarter of 2025	(2029)
1,0	IJmuiden Ver (noord), site VI		(2029)
2,0	Nederwiek (zuid), site I		(2030)
2,0	Nederwiek (zuid), site II	2026	(2030)
2,0	Nederwiek (zuid), site III		(2031)
0,7	Hollandse Kust (west), site VIII	2026/2027	N.t.b.
0,7	Ten noorden van de Waddeneilanden, site I	2026/2027	(2031)
2,0	Doordewind, site I	2027	(2031)
2,0	Doordewind, site II	2027	(2031)

This Environmental Impact Assessment has been prepared for Site I of IJmuiden Ver Wind Farm Zone.

3. Site choice offshore wind farm zones

The North Sea Programme 2022 - 2027 reconfirmed previously designated areas as wind farm zones. In doing so, it was chosen to only indicate the contours of the wind farm zones. The sites have not yet all been defined. In the process, the IJmuiden Ver wind farm zone has been given a modified boundary so that there is no overlap with Natura 2000 area the Brown Bank. This had no effect on sites I - IV.

Site selection in previous Environmental Impact Assessment

In the Strategic Environmental Assessment accompanying the National Water Plan 2009 - 2015, it was investigated whether the IJmuiden Ver Wind Farm Zone is suitable for the realisation of wind energy. The effects of wind energy in the IJmuiden Ver Wind Farm zone were generally examined in terms of ecology, shipping safety, other user functions (oil and gas, fishery, sand extraction, defence, etc.), geology and hydrology, landscape (visibility), recreation (navigation), cultural history and archaeology. The Strategic Environmental Assessment accompanying the National Water Plan 2009-2015 also looked at suitability in

comparison to other wind farm zones designated for wind energy.[8] It follows that the area is no less suitable than the other designated zones. In a general negative effects are similar. In terms of shipping and recreation, the effects are less than for the Hollandse Kust Wind Farm Zone (zuid, noord and west).

In the Environmental Impact Assessment for the sites of Wind Farm Zone Borssele and for Sites I and II of Hollandse Kust (zuid), a general comparison was made between the wind farm zones. This general comparison highlights specific aspects that need to 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 Environmental Impact Assessment will pay explicit attention to these aspects.

North Sea Programme site selection study

The North Sea Programme (PNZ) 2022-2027, which is part of the National Water Programme (NWP), has mapped eight search areas eligible for designation as wind farm zones in the North Sea until 2040. There are also four already designated and not yet used (parts of) wind farm zones, which have been reconfirmed. In fulfilling the target and the required acceleration till 2030, offshore wind energy plays an vital role. According to the Additional Task Steering Group, 10 GW of offshore wind energy is needed to achieve 55% CO_2 reduction. To this end, the study examined what is needed to fulfil the remaining target of the 49% target (0.7GW) in the existing wind farm zones and to find space for the additional EU acceleration target (55%) until 2030.

Showing from the supplement Strategic Environmental Assessment for the North Sea Programme that the 10.7 GW in the newly designated and partly re-designated wind farm zones are needed in their entirety to meet the 55% EU target. It was also examined which previously designated wind energy areas have the most suitable space to realise the remaining task for the 49% target.

This space has been found in the Hollandse Kust (west) Wind Farm Zone. The southern part of this wind farm zone has been reconfirmed in the North Sea Programme. The two northern sites of the IJmuiden Ver Wind Farm Zone have also been reconfirmed in the North Sea Programme (see figure S2). IJmuiden Ver is thus part of the roadmap to meet the CO2 target in 2030. Further CO_2 reductions will be achieved with the newly designated wind farm zones.

A location trade-off between the newly designated and partly reconfirmed areas with the IJmuiden Ver Wind Farm Zone is not necessary since all designated areas are necessary to achieve the targets.

4. Site subdivision

The designated IJmuiden Ver Wind Farm Zone is located in the Dutch Exclusive Economic Zone (EEZ). The area is about 62 kilometres from the coast. The wind farm zone originally had a total area of 1170 square kilometres. However, the North Sea Programme 2022-2027 adjusted the southern boundary of the IJmuiden Ver Wind Farm Zone due to the designation of the Brown Bank as a Birds Directive area. The intended area for sites I-IV extends southwards to this new southern boundary and covers an area of about 388 square kilometres. The water depth in the entire (originally designated) wind energy area ranges from 16.8 to 46.9 metres (lowest astronomical tide - LAT).[9]

[8] Royal Haskoning, PlanMER Ontwerp Nationaal Waterplan, 31 maart 2009

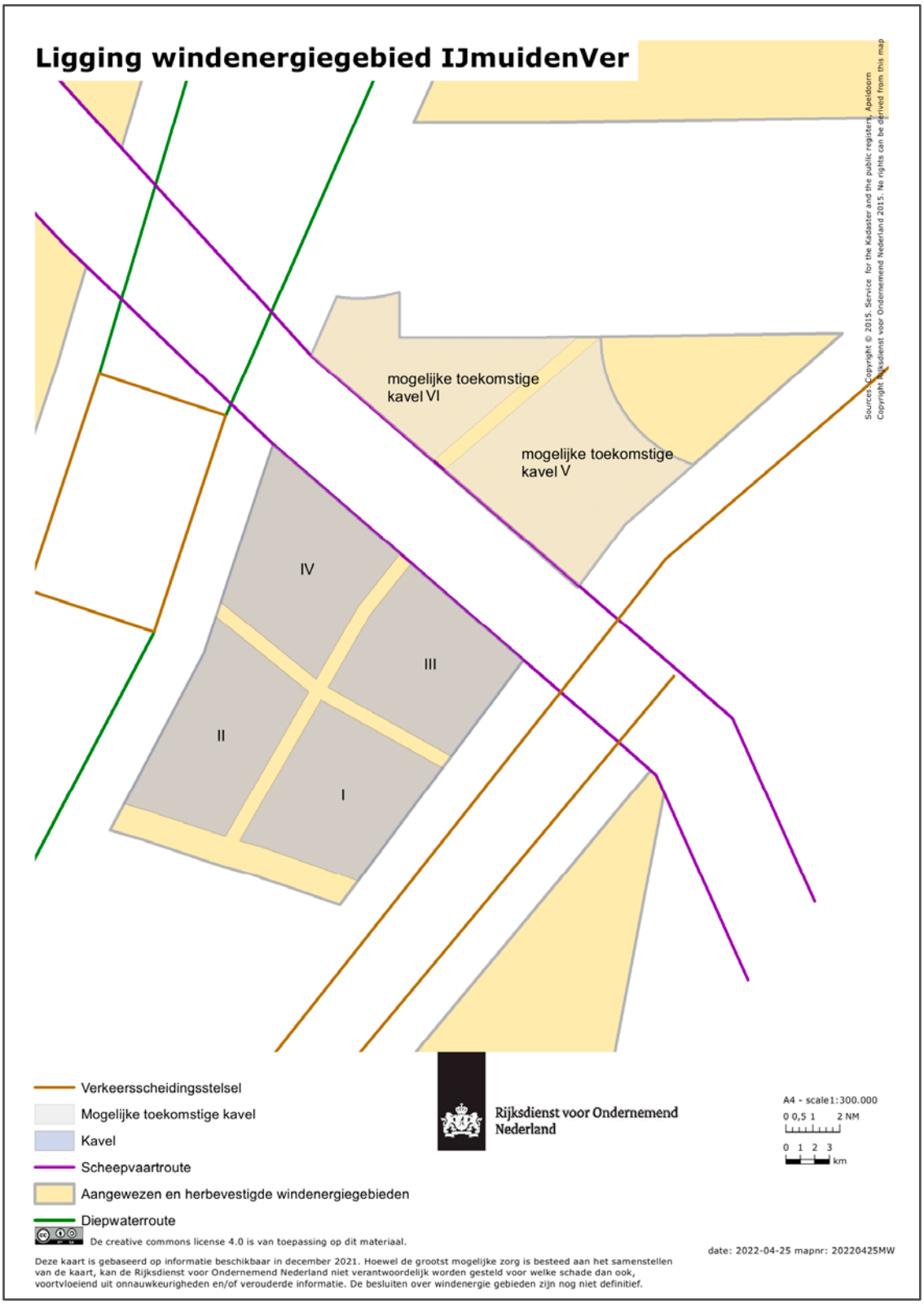
[9] Voor meer informatie over de kenmerken van het gebied, zie de locatiestudies op https://offshorewind.rvo.nl/generalIJmuiden

Within the IJmuiden Ver Wind Farm Zone, there is space for six sites of about 1 GW each. The tenders of sites I to IV are planned in the fourth quarter of 2023. The tenders for sites V and VI, north of the proposed clearway, are planned in the second quarter of 2025. One of the main points of departure of the North Sea Programme 2022-2027 is to combine the use of scarce space in the North Sea as much as possible with relatively compact sites of about 10 MW/km2.

In the site subdivision process of the zones various frameworks and guidelines are used. For example, the North Sea Programme 2022-2027 includes the 'Design process: distance between mining sites and wind farms' and the 'Design criterion distance between shipping lanes and wind farms'. Studies have also been conducted on the effects of wake turbulence from wind turbines on flight safety and on the helicopter accessibility[10] of mining platforms.

[10] NLR, in opdr. van Ministerie van Infrastructuur en Milieu, Offshore windturbinezog en veilige helikopteroperaties, ref. NLR-CR-2016-266, 2016. Zie ook: To70, in opdr. van RvO.nl, Effect of wind turbine wake turbulence on offshore helicopter operations in and around wind farms, ref 19.200.01, 2020.

Figure S2 Location of IJmuiden Ver Wind Farm Zone and site subdivision



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Site I

Site I of the IJmuiden Ver Wind Farm Zone is located on the southeast side of the wind farm zone. As indicated, the currently drawn southern boundary has been placed there because of the Brown Bank, which was recently designated as a Birds Directive area. On the eastern side of the site is a shipping lane and on the western side the boundary with Site II, including the future location of the offshore platform of the IJmuiden Ver wind farm zone Alpha. On the north side, the site is bordered by SIte III. In between Site I and Site III part of the cable route for the offshore grid IJmuiden Ver Beta is planned.

5. Method of impact Assessment

Bandwidth

In an Environmental Impact Assessment, alternatives of an activity are assessed by examining the effects an activity might have and comparing them side by side. As stated above this Environmental Impact Assessment does not examine site alternatives. Instead this Environmental Impact Assessment examined alternatives for one area with one wind farm (so-called 'site'). The alternatives consist of a range or bandwidth (see text box) of different wind turbine types and configurations possible within such a site.

The site within the IJmuiden Ver Wind Farm Zone is thus issued with the possibility for the wind farm developer configure the site as it wishes. The bandwidth within which it must remain is laid down in the Wind Farm Site Decision.

Bandwidth

This site is issued with a predetermined bandwidth. This allows for a flexible site design within which different types of turbines, configurations and foundations are possible. Within the bandwidth, the developer has the freedom to create an optimal design for the wind farm in terms of cost-effectiveness and energy yield. This bandwidth approach places specific requirements on the Environmental Impact Assessment. All environmental impacts associated with all possible configurations enabled by the wind farm site decision must be investigated. However, investigating all possible configurations is not possible due to the multitude of conceivable combinations. Therefore, a worst-case approach is adopted: if the worst-case situation of the bandwidth is acceptable in terms of impacts, then all setups within the bandwidth are possible.

Alternatives

The worst case situation will be different for different aspects (e.g. different for birds than for marine mammals). The study takes this into account by examining and comparing multiple worst case situations as alternatives in the Environmental Impact Assessment. The parameters delineating the worst case situations are named and described; for example, things like maximum number of turbines, maximum lower/upper limit of the rotor, maximum rotor swept area, characteristics of the foundation construction method, etc.

To obtain a picture of the possibilities to reduce impacts, mitigating measures are also identified and examined for each aspect. This prevents only a worst-case situation from being portrayed and identifies opportunities for optimisation.

The bandwidth of the site to be issued 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 upper and lower limits of the bandwidth will be laid down in the Wind Farm Site Decision.

Table S2 Bandwidth EIA

Subject	Bandwidth
Installed capacity site	approx. 1 GW
Maximum number of turbines	67
Power of individual wind turbines	Min15 MW
Tip height (top) individual wind turbines	Maximum 305 meter
Tip height (bottom) individual wind turbines	Minimum 25 meter
Rotor diameter individual wind turbines	236 – 280 meter
Spacing between wind turbines	Minimum 4 times the rotordiameter
Number of blades per wind turbine	2, 3
Type of foundations	Monopile, multipile, gravity based structure, suction bucket
Maximum noise level (in case of pile driving)	160 or 164 dB re 1 μPa^2s SELss 750 metres from the noise source
In case of foundation piling: diameter of foundation pile/piles and number of piles per turbine:	
Monopile	1 pile of 11,5 to 15 meter
Multipile (including 'tripods' en 'jackets')	3 to 4 piles of 3 - 5 meter
In case of foundation without piling: dimensions on seabed:	
Gravity Based	Up to 50 meter in diameter
Suction Bucket	Up to 30 meter in diameter
Electrical infrastructure (inter-array cabling)	66 kV, buried at a depth of 1 metre

The worst case situation may be different for different aspects, e.g. for birds and for marine mammals. The table below shows the worst case and best case for the different environmental aspects.

Table S3 Worst and best case within the bandwidth for each environmental aspect.

Bandwidth Environmental aspect	Alternative (Worst case)	Alternative (Best case)
Birds and bats	67 x 15 MW-turbines Tip (bottom) 25 m rotordiameter 236 m	50 x 20 MW-turbines Tip (bottom) 25 m rotordiameter 280 m
Marine life*	67 x 15 MW-turbines 1 turbine location per day	50 x 20 MW-turbines turbine location per day
Shipping	67 x 15 MW-turbines	50 x 20 MW-turbines

Geology and hydrology	50 x 20 MW-turbines with a Gravity Based foundation or suction bucket	67 x 15 MW-turbines with Tripod foundation
Landscape **	67 x 15 MW-turbines rotordiameter 280 m hub-height 165 m	
Other functions	50 x 20 MW-turbines with a Gravity Based foundation or suction bucket	67 x 15 MW-turbines with Tripod foundation
Electricity yield**	67 x 15 MW-turbines	

* For marine life, the worst case and best case situation is different for each 'sub aspect' (marine mammals, fish, benthic life).
** For landscape and electricity yield, one alternative was examined because the expected impacts within the range are not sufficiently distinctive.

Assessment

To compare the effects of the alternatives for each aspect, they are assessed on a +/- scale compared to the zero alternative (which is the current situation and autonomous development). The following rating scale is used for this purpose, as shown in Table S4. The assessment is elaborated.

Table S4 assessment methodology

Assessment relative to the zero alternative (the reference situation)	**Score**
The plan leads to a strong noticeable negative change	--
The plan leads to a noticeable negative change	-
The plan does not differ from the zero alternative	0
The plan leads to a noticeable positive change	+
The plan leads to a significant positive change	++

If the effects are marginal, this is indicated by 0/+ (marginal positive) or 0/- (marginal negative) where applicable.

The Appropriate Assessment quantifies effects in order to make statements on whether or not significant effects on Natura 2000 areas will occur.

Besides the effect of a wind farm in Site I, cumulative effects of other wind farms and activities have also been considered, as well as mitigating measures.

6. Result of environmental Assessment

The following tables show the ratings of the alternatives by aspects according to the different assessment criteria, without the use of mitigation measures[11]. The tables are then discussed for each aspect.

[11] For marine life, however, the noise standards from the Ecology and Cumulation Framework 4.0 have been used as a starting point. These noise standards can only be met if measures are taken during pile driving.

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6.1 Morphology and hydrodynamics

Table S5 Impact assessment morphology and hydrology Site I

Aspect (during construction, maintenance and operation)	Alternative 1 (15 MW)	Alternative 2 (20 MW)
Waves	0	0
Water movement (water level and current)	0	0/-
Water depth and bottom shape	0	0
Bottom composition	0	0
Turbidity and water quality	0	0
Stratification	0	0
Sediment transportation	0	0
Coastal defence	0	0

All morphological and hydrological changes resulting from the construction, use, removal and maintenance of the planned wind farm and cables are very limited in magnitude. In addition, the effects during construction and removal are only temporary. The changes, when they occur, 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, the changes are very localised. The impact is limited to the immediate vicinity of the foundation piles and the park cable route and is again only temporary. Only in the case of a gravity-based foundation are the effects on water movement slightly greater due to the larger dimensions of the foundation, thus scoring slightly negative.

6.2 Birds and bats

Alternative 1 (67 x 15MW turbines) results in several dozen more bird casualties than Alternative 2 (50 x 20 MW turbines). Based on current knowledge, Alternative 1, with more and smaller turbines, is expected to result in a higher number of bat casualties (an estimated 67) than Alternative 2 (an estimated 50). Alternative 2 is therefore the most environmentally friendly alternative from the perspective of birds and bats, mainly due to the lower number of collision casualties than the other alternative with more turbines. The complete impact assessment is summarised in Table 6.

Table S6 Impact assessment of the different IJmuiden Ver wind farm alternatives on colony birds, local seabirds, migratory birds and bats.

Effects of wind farm	Alternative 1	Alternative 2
	67 * 15 MW ø 236 m	50 * 20 MW ø 280 m
Construction phase birds		
- construction of foundations	0/-	0/-
- increased shipping	0/-	0/-
Use phase birds		
Local seabirds		
- collisions	-	-
- barrier effect	0	0
- habitat loss	-	-
- indirect effects	0/-	0/-

Effects of wind farm	Alternative 1	Alternative 2
	67 * 15 MW ø 236 m	50 * 20 MW ø 280 m
Breeding (colony) birds		
- collisions	-	-
- barrier effect	0	0
- habitat loss	0/-	0/-
- indirect effects	0/-	0/-
Migratory birds		
- collisions	-	-
- barrier effect	0	0
- habitat loss	0	0
- indirect effects	0	0
Removal phase birds		
- deconstruction of foundations	0/-	0/-
- increased shipping	0/-	0/-
Bats		
- collisions	--/-	-
- barrier effect	0	0
- habitat loss	0	0
- indirect effects	0/-	0/-

The expected effect of two-bladed instead of three-bladed turbines was also considered. Taking into account the fact that a bird may come into contact with one less blade per turbine, but the rotational speed of the blades is somewhat higher on average (about 1.33x), fewer casualties are expected to occur with two-blade turbines than with three-blade turbines.

An Appropriate Assessment has also been prepared for this Environmental Impact Assessment. This shows the following:

- Effects due to collisions and habitat loss on non-breeding birds from Natura 2000 areas, which use Site I outside the breeding season, cannot be ruled out. Significant effects, however, can be ruled out.
- Significant negative effects of Site I on breeding populations of lesser black-backed gulls from the Dutch Natura 2000 areas Dunes and Lage Land Texel, Dunes Vlieland and Wadden Sea can be ruled out. The additional mortality caused by the wind farm is at most 0.06%, and this falls below the 1% natural mortality standard.
- Effects on some species of migratory birds on seasonal migration from Natura 2000 areas as a result of collisions cannot be ruled out. Significant effects, however, can be ruled out.

A Species Assessment was also carried out for this Environmental Impact Assessment. This shows the following:

- For most species whose victims are expected in Site I in IJmuiden Ver Wind Farm Zone, the predicted mortality for all species is less than 1.0% of the annual natural mortality of the population in the Dutch EEZ. The exceptions are the gannet and great black-backed gull. On this basis, for all species except gannet and great black-backed gull, it can be said with certainty that the realisation of Site I in IJmuiden Ver Wind Farm Zone will not lead to effects on the GSI of the populations concerned.

6.3 Marine life

Impacts on benthic animals and fish are small in magnitude. An exception applies to Sabellaria banks. This is a critical habitat potentially present in the plan area. This reef-forming species, which can reach a reef width of several metres, thus creating habitat for other species, may be destroyed by turbine construction. In the worst case alternative where 17 more turbines are installed than in the best case, this effect will be greater. Furthermore, a gravity-based foundation covers a larger area than a monopile foundation.

For marine mammals (porpoises and seals), effects will occur during the construction phase of the wind farm due to the underwater noise created by pile-driving activities. During pile driving, animals may be disturbed by being within the noise contour within which a change in behaviour occurs. The Assessment shows that, when applying an underwater noise level of 160 dB re 1μPa^2s or 164 dB re 1μPa^2s on 750 meters of the noise source, this disturbance will not lead to population effects for either seals or porpoises, so the effects will not lead to a deterioration of the State of Conservation (Svi).

Table S7 Impact assessment IJmuiden Ver marine life

Type	Fase	Impact assessment	Alternative 1	Alternative 2
			67 x 15MW	50 x 20MW
Benthos	All	Disturbance	0	0
		Impairment	-	-
		Habitat loss	0	0
Fish	Construction	Noise vibrations from pile driving	N/A	0/-
		Soil disturbance: turbidity	0	0
		Bottom disturbance: habitat destruction	0/-	0/-
	Use	Exclusion of fishing	0/+	0/+
		EMF due to cables	0/-	0/-
		Artificial hard substrate	0/+	0/+
	Removal	Loss of new habitat	0	0
Marine Mammals	Construction	Disturbed area (km2)	0/-	0/-
		Number of animals affected	0/-	0/-
		Number of animals disturbed	0/-	0/-
		Duration of disturbance	0/-	0/-
		Population effects	0/-	0/-

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6.4 Shipping and safety

Table S8 Impact assessment marine safety

Assessment criteria	Impact assessment	Assessment
Safety	Probability of collision and drift with wind turbines	-
	Consequential damage from collision and drift	0/-
Shipping	Diversion possibilities for crossing shipping	0

Contrary to the other topics, for shipping safety, the cumulative effect of the various wind farms have been taken into account from the outset. This is because the planned shipping routes for route-related traffic do not change. The route structure at sea is designed to take into account the wind farms already constructed and to be constructed. The considered zero alternative is therefore also the cumulative scenario.

From the most recent study (which assumes that there will be no passage in the wind farms), the total expected collision and drift frequency (with a turbine) for the scenario RK2030 is 0.987 per year (once every 1.0 year). This is the scenario from the original roadmap (up to IJmuiden Ver I-IV) plus the assignment to accelerate, but without the future roadmap 2040. Therefore, the assessment in terms of probability of collisions and drifts is negative (-).

6.5 Landscape

For both sites, the worst-case turbines will not be visible at eye level. At a height of 20 metres (on the coast), the turbines are theoretically visible. However, meteorological conditions will almost always obscure the turbines from view. The wind farm will theoretically be visible less than 1% of the time (less than 1 day per summer, and for less than 7 minutes on that day).

Assessment criterion	Assessment
Visibility in percentage of time	0

6.6 Other functions

Most impacts on the other uses are assessed neutrally because they are minor in magnitude, or can be ruled out in advance. This applies to mining, aviation (excluding helicopter traffic), sand, gravel and shell extraction, dredging dumping, ship, shore and aviation radar, cables and pipes, telecommunications, military activities, and recreation and tourism.

Table S9 Impact assessment of the investigated subject of the environmental aspect other functions.

Functions	Assessment Criteria	Alternative 1 67 x 15 MW	Alternative 2 50 x 20MW
Fisheries	Fishing restrictions	0/-	0/-
Mining	Restrictions on oil and gas extraction	0	0
Aviation	Interference civil aviation	0	0
	Interference helicopter traffic	-	-
	Coast Guard interference	0	0
	Interference military aviation	0	0

Sand, gravel and shell mining	Restrictions on shallow mineral extraction	0	0
Dredge dumping	Dredging restrictions	0	0
Ship, shore and aviation radar	Radar interference	0	0
Cables and pipelines	Interference to cables and pipelines	0	0
Telecommunications	Wave interference	0	0
Military activities and NGE	Interference Military activities	0	0
	Presence of unexploded ordnance	-	-
Recreation and tourism	Restrictions on recreational navigation	0	0
	Restrictions on coastal recreation	0	0
Cultural history and archaeology	Damage to archaeological remains	0/-	0/-
Existing wind farms	Influence on electricity yield of existing wind farms	0/-	0/-

The effects on fisheries as a whole are assessed slightly negatively. The area closure of the site is small compared to the area available to fishermen. However, individual fishermen may experience greater impacts than others if they frequently use fishing grounds within the site. The effects for cultural history and archaeology have also been assessed and is slightly negatively due to the presence of (possible) archaeological values that need to be taken into account. There is also a slightly negative effect on existing wind farms due to the proximity to Hollandse Kust (west). The proximity of other wind farms can negatively influence the amount of wind another wind farm can capture.

For helicopter traffic (aviation) and NGE (unexploded ordinances), the assessment is negative. This is because the site is crossed by a Helicopter Main Route. The arrival of a wind farm limits the minimum flight altitude and makes it necessary to raise it. Additionally, within the sites, the presence of NGE is very likely making necessary measures essential. With these measures, the possible effects will be mitigated.

6.7 Electricity yield

Table S10 Summary of impact assessments Electricity yield and avoided emissions without mitigation

Sub aspects	**Assessment criteria**	**Impact assessment Alternative 15 MW**
Electricity yield	Electricity yield	++
Avoided emissions	CO2 emission reduction	++
	SO2 emission reduction	++
	NOx emission reduction	++

A net electricity yield of 4,164 GWh/year has been calculated for the 15 MW turbine. Other alternatives with other wind turbine types will be able to provide approximately the same electricity yield. Environmental Impact Assessments for the sites of other wind energy areas consistently found that a layout with a different number of turbines and capacity per turbine but an installed total capacity that was about the same (1 GW) resulted in more or less the same electricity yield.

The mentioned electricity production is equivalent to 0.77% of the national final energy consumption of 1,994 PJ (in 2020, according to total gross final energy consumption, source: CBS). Site I at IJmuiden Ver can supply electricity to approximately 1,525,000 households[12].

The contribution of the wind farm to the reduction of CO_2, NO_x and SO_2 is proportional to the net energy output. The reduction has been calculated using the average use of fuels at power plants.

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

7. Cumulation

The following table briefly indicates the cumulative effects and the consequences this has for the Wind Farm Site Decision. The first column indicates the aspect, the second column indicates which effects may be relevant in cumulation and the third column indicates the implications for the Wind Farm Site Decision.

Table S11 Relevant cumulative effects and impacts

Aspects	Relevant cumulative effects	Consequences of Wind Farm Site Decision
Morphology and hydrodynamics	At the level of the IJmuiden Ver Wind Farm Zone, the effect on morphology and geology will be neutral. However, recent studies have shown that very large-scale developments of wind farm zones in the North Sea could potentially affect (mixing) and water movement and morphology. However, the extent of effects regarding these aspects and the repercussions on other geological and ecological processes is highly uncertain.	No consequences
Birds and bats	<u>Birds</u> Cumulatively, significant negative impacts can be ruled out for all bird species. The acceptable level of impact (ALI) for both alternatives is also not exceeded for gannet and herring gull. This was the case within the KEC 4.0. Cumulatively, significant negative impacts can also be ruled out on the basis of new ALI standards, with the exception of auk and guillemot in the international scenario (all wind farms in the southern North Sea up to and including 2027), in the national scenario (all wind farms in the Dutch part of the North Sea up to and including 2027) also for auk and guillemot. <u>Bats</u> Much less information is available on bats than on birds. The bats that fly over the North Sea are well established, but their numbers, the population sizes from which these animals originate and their behaviour at sea are not well	<u>Birds</u> Several studies on possible mitigation measures to reduce impacts are ongoing. These measures could potentially reduce the number of casualties. <u>Bats</u> Based on current knowledge, it cannot be ruled out with certainty that negative effects on the conservation status of rough-legged dwarf bat will occur in the worst-case scenario, even after applying downtime as a mitigation measure.

[12] This is not the same as the electricity actually going to so many households and being used by householders. It gives an indication of the scale of generation, but the electricity will feed the public electricity grid and be taken by potentially all electricity users connected to the public electricity grid.

	known. According to the calculation method used, the number of casualties among pipistrelle bats, at 4,109 animals, is well above the PBR of 1,905 animals.	
Marine life	Benthos and fish The increase in the number of wind turbines and foundations could lead to changes in flow, stratification or primary production of benthos. It is also possible that it facilitates colonisation by exotic species. However, not enough information is available to estimate these effects. Marine mammals Applying an underwater noise level of 160 dB re 1μPa^2s or 164 dB re 1μPa^2s on 750 meters of the noise source, the disturbance will not lead to significant cumulative effects for either seals or porpoises, so the effects will not lead to a deterioration of the State of Conservation (Svi).	If the noise standard described in this EIA is applied, effects on the GSI of marine mammals can be ruled out.
Navigation and safety	In this Environmental Impact Assessment, the cumulative impact of the different offshore wind farms is not considered separately. The considered zero alternative is therefore also the cumulative scenario. Most recent research indicates that the total expected collision and drift frequency (with a turbine) for the scenario Rk2030 (1281 turbines) is 0.56 per year (once every 1.8 years). For the scenario that includes acceleration, this frequency increases to 0.987 (once every 1.0 years).	No consequences
Landscape	The IJmuiden Ver Wind Farm Zone is located at a great distance from the coast. Only because of this, it is visible for less than 24 hours on an annual basis. The same applies to nearby wind energy zones such as Hollandse Kust (west) and Nederwiek. Therefore, no significant contribution to cumulative effects is expected and no mitigating measures are required.	No consequences
Other uses	Fisheries The arrival of more offshore wind farms increases the total land used. As a result, a larger area will be closed to fishing. The future cumulative effect of this area closure for fisheries is partly determined by future developments in the ecology of the North Sea and the policy and socio-economic context. The possibility of more nature areas being closed to fishing in the future, and the possible closure of UK waters after 2025 increases this effect. Archaeology With a greater number of turbines in the North Sea, the likelihood of archaeological remains being affected, or NGE being struck, also increases. The realisation of the sites within the IJmuiden Ver Wind Farm Zone increases this	No consequences

	chance, although good mitigation measures are available for this. Recreational navigation For recreational shipping, the cumulative effects are limited because it is allowed for ships up to 24 metres in length within certain wind farms, and for wind farms where this is not allowed, passages are designated that ships up to 46 metres can use. In addition, recreational shipping mainly uses the 10 to 20 km wide zone along the coast, so area closures further out to sea have a limited effect.	
Electricity yield	The increase of wind farms in the North Sea increases the potential wake effects. For Site I of IJmuiden Ver Wind Farm Zone, the number of full-load hours decreases from 4,190 to 3,926. When taking into account the other sites in IJmuiden Ver, as well as the future UK wind farms, the wake losses increase by 5.5 percentage points from 12.1% to 17.6%. As a result, net electricity output and the amount of emissions avoided decrease by 6.3% from 4,211 GWh/y to 3,946 GWh/y.	No consequences

8. Transboundary effects

For the aspects of bats and birds as well as marine life, transboundary effects are potentially to be expected.

8.1 Birds and bats

8.1.1 Breeding birds

IJmuiden Ver Wind Farm Zone is out of reach for most breeding colonies located in Natura 2000 areas. Only breeding lesser black-backed gulls originating from colonies in the Dutch Natura 2000 areas Dunes and Low Land Texel, Dunes Vlieland and Wadden Sea can theoretically reach the wind farm zone. IJmuiden Ver Wind Farm Zone is not within the foraging range of other Dutch or foreign colonies in Natura 2000 areas for which a conservation target for lesser black-backed gull as a breeding bird has been formulated.

8.1.2. Non-nesting birds

With the assumption that seabirds move nomadically throughout the North Sea outside the breeding season, individuals in the (southern) North Sea can be seen as a single population. It is therefore expected that individuals using Natura 2000 areas, and thus the 'population' of such a Natura 2000 area, will be similarly impacted as the North Sea population as a whole.

This chapter and the Appropriate Assessment have concluded that in cumulation significant effects on populations within Natura 2000 areas have also been ruled out. This also applies to foreign Natura 2000 areas.

PONDERA

8.2 Marine life

Fish

For fish, the effects of piling are marginal and also highly site-specific. Pile-driving will therefore not result in any transboundary effects. Operational noise from a wind turbine has no demonstrable effect on the fish community and therefore no transboundary effects.

Sea mammals

The calculations made regarding the effects on marine mammals apply to the population within the NCP. No calculations have been done for other populations. The disturbed area lies entirely outside Natura 2000 areas designated for porpoises or seals in the Netherlands or abroad. There are therefore no transboundary effects or direct externalities.

9. Mitigation

Assessments show that the conditions of the legal framework can be met for most aspects. Mitigating measures are required to limit cumulative effects on birds, bats and porpoises and to ensure that the conservation status does not deteriorate. However, the occurrence of (residual) negative effects due to construction, operation and removal of the wind farm cannot be excluded. These possible residual effects can be mitigated by the following measures. These are therefore measures that can be taken additionally. Decisions making on which mitigating measures will be implemented are made in the Wind Farm Site Decision.

Table S12 Possible mitigating measures

Aspect	Effect	Possible mitigating measures
Birds and bats	Disturbance	Build in June to September when few disturbance-sensitive species are present. Apply minimal lighting on vessels, with a 'bird-friendly' colour.
	Disturbance and casualties	Apply design measures, such as creating corridors or using an alternative shape of the wind farm (diamond, square, etc.). However, not much is yet known about the effectiveness and exact design. Increase detection probability of the wind farm for birds by reflectors, lasers and noise (depending on bird species and thus bound by various restrictions). Shutting down of wind turbines during certain weather conditions in combination with detected migration peaks. Install the smallest possible number of large wind turbines instead of larger number of smaller wind turbines. Install two-bladed instead of three-bladed turbines. Smart planning of maintenance work. When turbines are shut down it can prevent casualties (consider periods of increased bird activity.
	Disturbance	Dismantle at a time when few disturbance-sensitive species are present.
Aquatic life	Disturbance and habitat destruction	Benthos Use the smallest possible foundation. Marine mammals

		Use acoustic measures (piling walls, bubble screens, etc.). Choose the shallowest locations in the planned area. Conduct piling work when the density of marine mammals is low (autumn). Choose a small number of, relatively large turbines rather than several smaller ones. Use alternative foundation techniques, such as vibrating, screwing or blue piling. Use other foundations, such as tripods, jackets or suction buckets.
	Disturbance and habitat destruction	Benthos Do not remove wind turbine pillars and embankments so that the developed aquatic communities remain. Use biodegradable concrete structures.
Shipping and safety	Collision risk and vessel movements	Using the Automatic Identification System (AIS) and VHF antenna in the park. Vessel traffic management (VTM). Additional marking and identification of wind turbines. Deployment of an Emergency Towing Vessel. Additional SAR capacity. ETV equipped with pesticides against oil pollution. Physical barrier at wind farms to prevent collision.
Morphology and hydrodynamics	N/A	N/A
Landscape	N/A	N/A
Other uses	Restriction on fishing areas	There are opportunities for fishery-friendly design of wind energy areas. However, for stakeholders as a whole, the benefits do not seem to outweigh the costs.
	Separation requirement HMR KY650	Move the HMR or increase the minimum flight path.
	Unexploded ordnances	Further investigation is required to detect unexploded ordnances and then clear them.
	Impact on archaeological values	Changing the location of a wind turbine or cable to avoid a (possible) archaeological objects.
	Possible disruption of existing (radio) wave paths	Take into account the half-rotor + 2nd fresnel zone around (radio) wave path when wind turbines are placed.
Electricity yield	N/A	N/A

10. Considerations on preferred alternative

Introduction

In this section, some considerations are given for the choice of the preferred alternative, which will be made possible in the Wind Farm Site Decision. It concerns the bandwidth considered in this Environmental Impact Assessment and the mitigating measures to be taken.

Bandwidth considerations

There are no aspects in this Environmental Impact Assessment that constrain the considered range.

Considerations on mitigating measures

A number of measures are needed to limit effects on nitrogen-sensitive habitat types, cumulative effects on birds, bats and porpoises, and to guarantee the GSI. These include, for example, a shutdown provision during bird and bat migration and compliance with an underwater noise standard during pile driving. Table S12 lists the possible measures identified in this Environmental Impact Assessment that could mitigate impacts. The choice will be explained in the Wind Farm Site Decision.

Conclusion

The Wind Farm Site Decision can enable the preferred site bandwidth at the considered location. However, the application of (at least) the necessary measures should be secured in the context of birds, bats and porpoises.

11. Knowledge gaps

Introduction

Although there has been significant construction of new offshore wind farms in recent years, offshore wind farm development still has a relatively short history. There are known monitoring evaluations of offshore wind farms in England, Denmark, Germany and the Netherlands, among others. These are results of relatively short monitoring periods. Better insight into the exact nature and extent of the effects with (empirical) research can only be expected in the long term. However, current development and research programmes do provide tools for impact prediction, as presented in this Environmental Impact Assessment with a worst-case approach. During (the preliminary investigation of) the impact prediction for the present Environmental Impact Assessment, several knowledge gaps were identified that limit the understanding of the nature and extent of the impacts of a wind farm in Site I. Knowledge gaps remain about the effects, including the cumulative effects of multiple wind farms among themselves and in cumulation with other activities in the North Sea.

The gaps in knowledge that exist are not only due to the recent past of offshore wind energy. In general, much knowledge about animal species and their densities, diversity and behaviour still needs to be expanded. This section explains gaps in knowledge that are relevant in the context of this Environmental Impact Assessment. Gaps in knowledge are described successively with regard to the impact estimate on birds, marine life, morphology and hydrodynamics, shipping, landscape, other user functions and electricity yield.

Birds and bats

There are gaps in knowledge on collision risks, barrier effects and disturbances from offshore wind farms (both day and night). Particularly, species-specific knowledge in is lacking. Validation of models to predict collision victims at sea is lacking. There are also gaps in knowledge about disturbance sensitivity and disturbance distances of seabirds, as well as the extent to which birds can become accustomed to wind farms. Based on literature, it has been assumed that 10% of disturbed birds die. It is not known to what extent this assumption corresponds to reality, but it can be said that 10% is on the safe side (worst-case assumption).

For bats, there are gaps in knowledge regarding basic knowledge about population size and species-specific distribution. The relative importance of the North Sea for different species of bats and their changes in behaviour due to the presence of wind farms is currently unknown.

Aquatic life

Benthos

Knowledge gaps exist in regard to being able to predict the effects of abiotic changes (especially sediment change in the vicinity of the wind farm) on benthos. The effects of electromagnetic fields along the cables are currently also not well known. In addition, research on the effects of seabed vibrations due to pile driving is still in its infancy (Roberts & Elliot 2017). Further research is needed to show whether these effects are reversible, and whether these effects can be transmitted to community and population levels.

Due to wind farm construction modelling studies have been developed on indirect effects on plankton and benthos in protected areas (Boon et al. 2018; Zijl et al. 2021). The model results are currently not yet suitable to make predictions about the future. Positive or negative effects cannot be ruled out.

As more (or larger) offshore wind farms are built, this will result in a greater area of available hard substrate surface due to turbine pillars, protective embankments and increases in vessel movements. This may facilitate/accelerate colonisation by exotic marine fauna associated with hard substrates of this part of the North Sea. To date to what extent this actually occurs has never been investigated.

Fish

An important gap in knowledge concerns the impact of human induced noise on fish and invertebrates living in or near the sea floor (Hawkins et al. 2021). It is likely there are fish and certain invertebrates that can perceive this. Whether this also leads to effects on behaviour and fitness is unknown. For fish, some research has already been conducted on the effects of underwater noise on fish (Bolle et al, 2012, Debusschere et al. 2014, Popper et al. 2014). This shows that fish are much less sensitive to underwater noise than marine mammals and that some species (with swim bladders) are more sensitive than others.

Also, the Wind Farm Site Decisions only mention noise standards for the construction phase (mainly due to piling of foundations), but not for the operational phase of the wind farm. This allows wind farm developers to increase the tip speed of rotors without limit, which implies higher noise levels in the operational phase, including probably underwater. Since it is currently not well known whether wind turbine noise plays a role in fish disturbance, it cannot be said whether an unlimited tip speed and associated noise levels lead to increased disturbance among fish. For the time being, it is not known whether unlimited tip speed and associated operational noise levels lead to increased disturbance among fish. Targeted research on the effect of different operational noise levels on fish behaviour will have to show this.

Sea mammals

The main gaps in knowledge affecting the magnitude of the calculated effects relate to the underlying assumptions regarding:

- Uncertainties in the procedure for determining population effects;
- Quantification of source noise and noise propagation;
- Dose-response relationship for disturbance/behaviour change;
- Quantifying the number of disturbed animals;
- Translating effects on individual porpoises into population effects (iPCoD);
- Translating porpoise disturbance to effects on vital rates;
- Assumptions in iPCoD model on population trends and demographic parameters;
- Application of Interim PCoD model to translate effects on common and grey seals;

- Applicability of alternative installation techniques;
- Uncertainty about effects of application of other foundation types;
- Continuous noise during the construction and operation phases;
- Removal of existing wind farms and underwater noise.

Shipping and safety

In the case of rotating offshore wind farms, the number and type of ships using the area around the wind farm will be monitored, as well as the number and type of incidents that occur in the process. The resulting data will be used to decide whether it is desirable to develop an assessment framework and probability model. The behaviour and traffic flows of non-route traffic, which is placed outside IJmuiden Ver Wind Farm Zone in the SAMSON model, can also be monitored. Furthermore, the scenarios and impact of collisions and drifts with wind turbines can be further investigated and developed.

For example, certain assumptions have been made in this Environmental Impact Assessment for determining personal injury. For instance, it is not known what the probability is of the mast falling on or away from the vessel during collisions and drifts. Also, the collapse behaviour of wind turbines comes from a study from 2000 (Barentse, 2000), while wind turbines have become considerably larger. In the context of the continued growth of offshore wind energy, shipping safety has been looked at cumulatively and consideration has been given to how identified knowledge gaps and how these gaps can be filled. A study was carried out by MARIN on shipping safety and possible mitigating measures due to the combined effect of autonomous development and the roll-out of the 2030 Offshore Wind Energy Roadmap[13]. More recently, a similar study was carried out which also included the 2030 assignment to accelerate[14]. Following both studies, it was decided to set up a monitoring and research programme for shipping to fill in the knowledge gaps. Part of those gaps is the effectiveness of the proposed mitigation measures. This programme started in spring 2021 under the name MOSWOZ (Monitoring and Research Programme Shipping Safety Wind at Sea).

Morphology and hydrodynamics

Further research is needed regarding the possible effects on stratification processes and water movement of a large-scale (international) development of wind energy in the North Sea. A good start on cumulative mapping of wind farm developments in the North Sea has already been made in Van Duren et. al 2021. However, they give a number of important recommendations to carry out further research on cumulative effects. The actual impact on stratification processes and water movement in the North Sea of developments on the Dutch continental shelf cannot be unambiguously identified.

Landscape

No substantial gaps in knowledge and information affecting the impact description were identified for the Landscape theme.

Other uses

Apart from the topics already mentioned that require further investigation, no substantial gaps in knowledge and information were identified for the environmental aspect ‘other uses’.

[13] See Zie https://www.noordzeeloket.nl/functies-gebruik/windenergie-zee/scheepvaart/ voor meer informatie en het onderzoek.
[14] Koldenhof, Y. SAMSON-analyse Wind op Zee; versnellingsopgave 2030 met doorkijk naar 2040, MARIN, 31797-1-MO-rev0.2, 7 maart 2022

Electricity yield

The environmental aspect of electricity yield and avoided emissions has significant gaps in knowledge. The yield calculations in this chapter are expected to give a good indication of the actual yield to be achieved. A wind measurement campaign can be used to simulate a more accurate approximation of the wind climate leading to more reliable results, however, these are not available at the time of writing and are expected to be carried out by the final permit holder. Also, no data of actual 15 MW offshore turbines in production are currently available. Turbine characteristics prepared by the IEA for a notional, 15 MW research turbine (Offshore reference-15,000 IEA) have been used in the calculations. Its use is not expected to lead to significantly different results.

Conclusion

The gaps in knowledge do not mean that a good picture has not been obtained of the effects of a wind farm in Site I in IJmuiden Ver Wind Farm Zone. However, it is important for the decision-making process to have insight into the uncertainties that played a role in the impact predictions. This insight has been provided with this Environmental Impact Assessment.

13 Monitoring en evaluation

13.1 WOZEP

The monitoring and evaluation programme WOZEP focuses on important ecological questions around construction and operation of wind farms at sea that are mainly of a generic nature rather than wind farm specific.

The Wozep covers both the ongoing development of the KEC tool (update and implementation of knowledge) and the MEP (the monitoring and research programme). The MEP covers monitoring and research as mandated by the Environmental Management Act.

The Wozep thus replaces the monitoring obligation per wind farm. In this way, an efficiency improvement is also achieved which also contributes to cost-efficient realisation of the offshore wind energy targets.

On the one hand the evaluation of the Wozep pays attention to the translation of new knowledge into the KEC tool (this can also mean checking assumptions and/or effect calculations) and on the other hand as a translation into policy and management consequences. Example of the latter is the imposition or adaptation of mitigation measures. In the Wozep, the study focuses in particular on gaining more insight into the cumulative ecological effects and visualises and advises the competent authorities.

Current situation

A multi-year monitoring and research programme was delivered at the end of 2016, broadly outlining the research lines for the period 2017-2023. Choice of research lines is determined by consideration on two time frames:

- Short-term (up to 2023): focusing on use of results in planned wind farms. Central to this is examining the assumptions made in the ecological assessment for these farms. It also examines the usefulness, necessity and effectiveness of measures imposed on the wind sector to reduce ecological damage;
- Long term (after 2023): what knowledge is needed to allow further expansion of offshore wind farms in a responsible manner, what are the expected effects of further expanding 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 sufficiently avoided, etc.

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

The gaps in knowledge from this Environmental Impact Assessment provide input for monitoring within WOZEP (for the ecological aspects) and for monitoring for the shipping and morphology and hydrology aspects.

13.2 MOSWOZ

In 2019, Rijkswaterstaat investigated the cumulative effects of wind farms on shipping safety. It concerns the wind farms to be built on the southern part of the Dutch North Sea until 2030. In total, it concerns some 850 additional wind turbines over an area of some 1,600 km2.

Despite much research and the involvement of all kinds of experts, there are still uncertainties about the actual risks and about the effectiveness of a number of measures. This is the reason why the Monitoring and Research Programme on Marine Safety Wind at Sea (MOSWOZ) was launched. Running until 2029, the programme will monitor shipping safety developments in relation to implementation of offshore wind farms over the next few years. The ultimate goals is to gain more insight into the effect on shipping safety of offshore wind farms and to be able to respond to innovations in this area in a timely manner.

To achieve these goals, MOSWOZ has worked out the aforementioned knowledge gaps into research questions and then bundled them into various themes. Within these themes, answers to research questions will be sought over the next few years, in order to be able to properly support and advise policymakers and other stakeholders.

The programme is designed to make use of progressive understanding. Choices and priorities are geared to current events.

Table S13 MOSWOZ Thema's

Theme	Explanation theme
Monitoring	Focused on current risk development at sea due to wind farms for all shipping
Safety	Consequences of collisions and drifts of wind turbines
Transit	Risks of wind farm passage versus detours
Vessel traffic monitoring	Vessel traffic monitoring (VTM) equipment requirements
Emergency Towing Vessels	Explore deployment of multiple Emergency Towing Vessels (ETVs) - effectiveness and modus operandi
Hydro-meteo	Hydro-meteo in relation to shipping safety - effects of wind farms on wind, waves and visibility - improving weather warnings
Anchorage areas	Better use of anchorages
Crisis organization	Explore impact on crisis organization (due to complexity)
Foreign benchmarking	Foreign benchmarking wind farms include structural requirements for wind turbines, deployment measures, harmonization.

For more information, see website: https://www.noordzeeloket.nl/functies-gebruik/windenergie/scheepvaart-moswoz/

Summary Environmental Impact Assessment

Site Alpha (formerly Site II)

PONDERA

English summary

1. Introduction

The Netherlands has set ambitious targets for achieving sustainable - renewable - energy production. Wind energy plays a prominent role in achieving that target. The period up to 2030 has so far focused on the Climate Accord target of producing 49 TWh of offshore wind energy annually by 2030. This requires a capacity of about 11.5 gigawatts (GW).

In addition to this target, by establishing three new wind farm zones in the North Sea Programme, the minister has indicated his intention to realise an additional 10.7 GW of offshore wind by 2030.

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

To meet these targets by 2030, new sites will be established and issued in the coming years. The sites will be established within the boundaries of the areas designated as wind farm zones in the North Sea Programme 2022 - 2027. The Wind Farm Site Decision determines where and under what conditions a wind farm may be built and operated. Following a Wind Farm Site Decision, licensing follows. Only the permit holder has the right to build and operate a wind park at the location of the site. The Water Decree lays down general rules for offshore wind farms.

The Minister for Climate and Energy, in agreement with the Minister for Infrastructure and Water Management, the Minister for Housing and Spatial Planning and the Minister for Nature and Nitrogen, can take a Wind Farm Site Decision and prepares an Environmental Impact Assessment (EIA) for the purpose of the Wind Farm Site Decision.

This document concerns the Environmental Impact Assessment for Site II in the IJmuiden Ver Wind Farm Zone (see Figure S1). The Environmental Impact Assessment describes the environmental effects that occur during the construction, operation and removal of wind turbines.

In this summary, the following sections are covered after this introduction (section 1):
2. the policy context and the reason for the Wind Farm Site Decision to be taken;
3. the choice of location for IJmuiden Ver wind farm zone;
4. the site subdivision of IJmuiden Ver wind farm zone;
5. the method of the EIA;
6. the result of the EIA;
7. cumulation;
8. cross boundary effects;
9. mitigation;
10. considerations of the preferred alternative;
11. gaps in knowledge and information;
12. monitoring and evaluation.

PONDERA

2. Policy context and reason for Wind Farm Site Decisions

The Offshore Wind Energy Roadmap includes plans to develop wind farms with a total capacity of about 21.5 GW in the following wind farm zones:

- Borssele with a capacity of 1,502 MW;
- Hollandse Kust (zuid) with a capacity of 1,520 MW;
- Hollandse Kust (west) with a capacity of 2,100 MW;
- North of the Wadden Islands with a capacity of 700 MW;
- IJmuiden Ver with a capacity of approximately 6,000 MW;
- Nederwiek with a capacity of approximately 6,000 MW;
- Doordewind with a capacity of 4,000 MW;

In accordance with this roadmap, about 11 GW of offshore wind capacity should be operational by 2030. The offshore wind roadmap thus looks as shown in Figure S1. Table S1 also shows the site subdivision for each wind farm zone.

Figure S1 Offshore wind energy roadmap June 2022

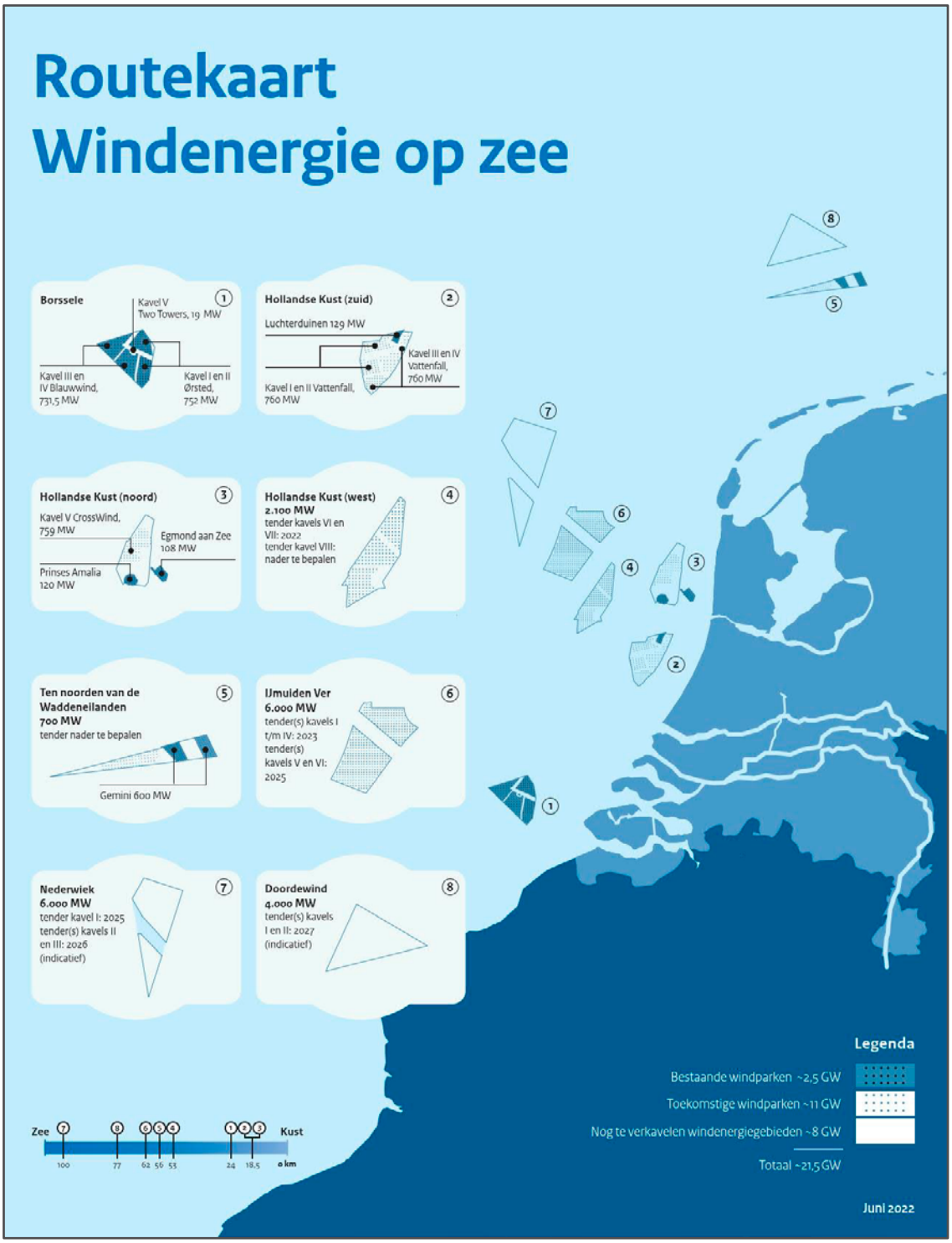

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Table S1 Additional roadmap offshore wind energy 2030 (June 2022)

Size (ca. GW)	Wind farm zone, site(s)	Site tenders	(expected) commissioning of wind parks
1,0	In 2015 existing offshore wind parks	-	-
0,7	Borssele, sites I en II	Realised in 2016	2020
0,7	Borssele, sites III, IV en V	Realised in 2016	2020
0,7	Hollandse Kust (zuid), sites I en II	Realised in 2017	(2022 - 2023)
0,7	Hollandse Kust (zuid), sites III en IV	Realised in 2019	(2022 - 2023)
0,7	Hollandse Kust (noord), site V	Realised in 2020	(2023)
0,7	Hollandse Kust (west), site VI	Realised in 2022	(2025 - 2026)
0,7	Hollandse Kust (west), site VII		(2025 - 2026)
1,0	IJmuiden Ver, site III	Fourth quarter of 2023	(2028)
1,0	IJmuiden Ver, site IV		(2028)
1,0	IJmuiden Ver, site I		(2029)
1,0	IJmuiden Ver, site II		(2029)
1,0	IJmuiden Ver (noord), site V	Second quarter of 2025	(2029)
1,0	IJmuiden Ver (noord), site VI		(2029)
2,0	Nederwiek (zuid), site I		(2030)
2,0	Nederwiek (zuid), site II	2026	(2030)
2,0	Nederwiek (zuid), site III		(2031)
0,7	Hollandse Kust (west), site VIII	2026/2027	N.t.b.
0,7	Ten noorden van de Waddeneilanden, site I	2026/2027	(2031)
2,0	Doordewind, site I	2027	(2031)
2,0	Doordewind, site II	2027	(2031)

This Environmental Impact Assessment has been prepared for Site II of IJmuiden Ver Wind Farm Zone.

3. Site choice offshore wind farm zones

The North Sea Programme 2022 - 2027 reconfirmed previously designated areas as wind farm zones. In doing so, it was chosen to only indicate the contours of the wind farm zones. The sites have not yet all been defined. In the process, the IJmuiden Ver wind energy zone has been given a modified boundary so that there is no overlap with Natura 2000 area the Brown Bank. This had no effect on sites I - IV.

Site selection in previous Environmental Impact Assessment

In the Strategic Environmental Assessment accompanying the National Water Plan 2009 - 2015, it was investigated whether the IJmuiden Ver Wind Farm Zone is suitable for the realisation of wind energy. The effects of wind energy in the IJmuiden Ver wind Farm Zone were generally examined in terms of ecology, shipping safety, other user functions (oil and gas, fishery, sand extraction, defence, etc.), geology and hydrology, landscape (visibility), recreation (navigation), cultural history and archaeology. The Strategic Environmental Assessment accompanying the National Water Plan 2009-2015 also looked at suitability in

comparison to other wind farm zones designated for wind energy.[8] It follows that the area is no less suitable than the other designated zones. In a general negative effects are similar. In terms of shipping and recreation, the effects are less than for the Hollandse Kust Wind Farm Zone (zuid, noord and west).

In the Environmental Impact Assessment for the sites of Wind Farm Zone Borssele and for Sites I and II of Hollandse Kust (zuid), a general comparison was made between the wind farm zones. This general comparison highlights specific aspects that need to 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 Environmental Impact Assessment will pay explicit attention to these aspects.

North Sea Programme site selection study

The North Sea Programme (PNZ) 2022-2027, which is part of the National Water Programme (NWP), has mapped eight search areas eligible for designation as wind farm zones in the North Sea until 2040. There are also four already designated and not yet used (parts of) wind farm zones, which have been reconfirmed. In fulfilling the target and the required acceleration till 2030, offshore wind energy plays an vital role. According to the Additional Task Steering Group, 10 GW of offshore wind energy is needed to achieve 55% CO_2 reduction. To this end, the study examined what is needed to fulfil the remaining target of the 49% target (0.7GW) in the existing wind farm zones and to find space for the additional EU acceleration target (55%) until 2030.

Showing from the supplement Strategic Environmental Assessment for the North Sea Programme that the 10.7 GW in the newly designated and partly re-designated wind farm zones are needed in their entirety to meet the 55% EU target. It was also examined which previously designated wind energy areas have the most suitable space to realise the remaining task for the 49% target.

This space has been found in the Hollandse Kust (west) Wind Farm Zone. The southern part of this Wind Farm Zone has been reconfirmed in the North Sea Programme. The two northern sites of the IJmuiden Ver Wind Farm Zone have also been reconfirmed in the North Sea Programme (see figure S2). IJmuiden Ver is thus part of the roadmap to meet the CO2 target in 2030. Further CO_2 reductions will be achieved with the newly designated wind farm zones.

A location trade-off between the newly designated and partly reconfirmed areas with the IJmuiden Ver Wind Farm Zone is not necessary since all designated areas are necessary to achieve the targets.

4. 4. Site subdivision

The designated IJmuiden Ver Wind Farm Zone is located in the Dutch Exclusive Economic Zone (EEZ). The area is about 62 kilometres from the coast. The Wind Farm Zone originally had a total area of 1170 square kilometres. However, the North Sea Programme 2022-2027 adjusted the southern boundary of the IJmuiden Ver Wind Farm Zone due to the designation of the Brown Bank as a Birds Directive area. The intended area for sites I-IV extends southwards to this new southern boundary and covers an area of about 388 square kilometres. The water depth in the entire (originally designated) wind energy area ranges from 16.8 to 46.9 metres (lowest astronomical tide - LAT).[9]

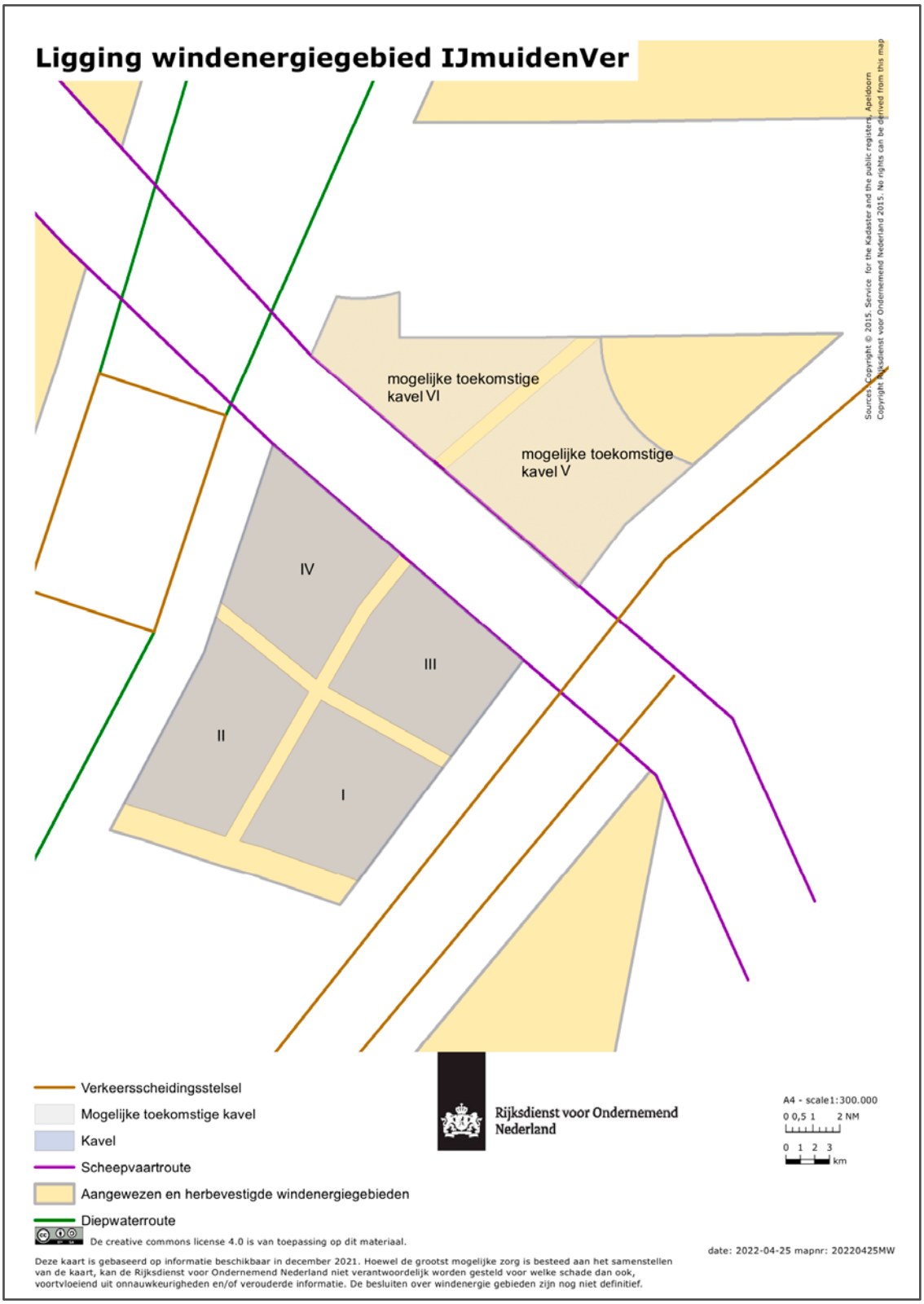
[8] Royal Haskoning, PlanMER Ontwerp Nationaal Waterplan, 31 maart 2009
[9] Voor meer informatie over de kenmerken van het gebied, zie de locatiestudies op https://offshorewind.rvo.nl/generalIJmuiden

Within the IJmuiden Ver Wind Farm Zone, there is space for six sites of about 1 GW each. The tenders of sites I to IV are planned in the fourth quarter of 2023. The tenders for sites V and VI, north of the proposed clearway, are planned in the second quarter of 2025. One of the main points of departure of the North Sea Programme 2022-2027 is to combine the use of scarce space in the North Sea as much as possible with relatively compact sites of about 10 MW/km2.

In the site subdivision process of the zones various frameworks and guidelines are used. For example, the North Sea Programme 2022-2027 includes the 'Design process: distance between mining sites and wind farms' and the 'Design criterion distance between shipping lanes and wind farms'. Studies have also been conducted on the effects of wake turbulence from wind turbines on flight safety and on the helicopter accessibility[10] of mining platforms.

[10] NLR, in opdr. van Ministerie van Infrastructuur en Milieu, Offshore windturbinezog en veilige helikopteroperaties, ref. NLR-CR-2016-266, 2016. Zie ook: To70, in opdr. van RvO.nl, Effect of wind turbine wake turbulence on offshore helicopter operations in and around wind farms, ref 19.200.01, 2020.

Figure S2 Location of IJmuiden Ver Wind Farm Zone and site subdivision



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Site II

Site II in the IJmuiden Ver Wind Farm Zone is located on the south-west side of the wind energy area. As indicated, the currently drawn southern boundary was placed there because of the Brown Bank, which was recently designated as a Birds Directive area. On the western side of the site is a deep-water route and on the eastern side the boundary with Kavel I, including the future location of the platform of the offshore grid IJmuiden Ver Alpha. On the north side, the site is bordered by Site IV.

5. Method of impact Assessment

Bandwidth

In an Environmental Impact Assessment, alternatives of an activity are assessed by examining the effects an activity might have and comparing them side by side. As stated above this Environmental Impact Assessment does not examine site alternatives. Instead this Environmental Impact Assessment examined alternatives for one area with one wind farm (so-called 'site'). The alternatives consist of a range or bandwidth (see text box) of different wind turbine types and configurations possible within such a site.

The site within the IJmuiden Ver Wind Farm Zone is thus issued with the possibility for the wind farm developer configure the site as it wishes. The bandwidth within which it must remain is laid down in the Wind Farm Site Decision.

Bandwidth

This site is issued with a predetermined bandwidth. This allows for a flexible site design within which different types of turbines, configurations and foundations are possible. Within the bandwidth, the developer has the freedom to create an optimal design for the wind farm in terms of cost-effectiveness and energy yield. This bandwidth approach places specific requirements on the Environmental Impact Assessment. All environmental impacts associated with all possible configurations enabled by the Wind Farm Site Decision must be investigated. However, investigating all possible configurations is not possible due to the multitude of conceivable combinations. Therefore, a worst-case approach is adopted: if the worst-case situation of the bandwidth is acceptable in terms of impacts, then all setups within the bandwidth are possible.

Alternatives

The worst case situation will be different for different aspects (e.g. different for birds than for marine mammals). The study takes this into account by examining and comparing multiple worst case situations as alternatives in the Environmental Impact Assessment. The parameters delineating the worst case situations are named and described; for example, things like maximum number of turbines, maximum lower/upper limit of the rotor, maximum rotor swept area, characteristics of the foundation construction method, etc.

To obtain a picture of the possibilities to reduce impacts, mitigating measures are also identified and examined for each aspect. This prevents only a worst-case situation from being portrayed and identifies opportunities for optimisation

The bandwidth of the site to be issued 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 upper and lower limits of the bandwidth will be laid down in the Wind Farm Site Decision.

Table S2 Bandwidth EIA

Subject	Bandwidth
Installed capacity site	approx. 1 GW
Maximum number of turbines	67
Power of individual wind turbines	Min15 MW
Tip height (top) individual wind turbines	Maximum 305 meter
Tip height (bottom) individual wind turbines	Minimum 25 meter
Rotor diameter individual wind turbines	236 – 280 meter
Spacing between wind turbines	Minimum 4 times the rotordiameter
Number of blades per wind turbine	2, 3
Type of foundations	Monopile, multipile, gravity based structure, suction bucket
Maximum noise level (in case of pile driving)	160 or 164 dB re 1 μPa^2s SELss 750 metres from the noise source
In case of foundation piling: diameter of foundation pile/piles and number of piles per turbine:	
Monopile	1 pile of 11,5 to 15 meter
Multipile (including 'tripods' en 'jackets')	3 to 4 piles of 3 - 5 meter
In case of foundation without piling: dimensions on seabed:	
Gravity Based	Up to 50 meter in diameter
Suction Bucket	Up to 30 meter in diameter
Electrical infrastructure (inter-array cabling)	66 kV, buried at a depth of 1 metre

The worst case situation may be different for different aspects, e.g. for birds and for marine mammals. The table below shows the worst case and best case for the different environmental aspects.

Table S3 Worst and best case within the bandwidth for each environmental aspect.

Bandwidth / Environmental aspect	Alternative (Worst case)	Alternative (Best case)
Birds and bats	67 x 15 MW-turbines Tip (bottom) 25 m rotordiameter 236 m	50 x 20 MW-turbines Tip (bottom) 25 m rotordiameter 280 m
Marine life*	67 x 15 MW-turbines 1 turbine location per day	50 x 20 MW-turbines turbine location per day
Shipping	67 x 15 MW-turbines	50 x 20 MW-turbines
Geology and hydrology	50 x 20 MW-turbines with a Gravity Based foundation or suction bucket	67 x 15 MW-turbines with Tripod foundation
Landscape **	67 x 15 MW-turbines rotordiameter 280 m	

	hub-hight 165 m	
Other functions	50 x 20 MW-turbines with a Gravity Based foundation or suction bucket	67 x 15 MW-turbines with Tripod foundation
Electricity yield**	67 x 15 MW-turbines	

* For marine life, the worst case and best case situation is different for each 'sub aspect' (marine mammals, fish, benthic life).
** For landscape and electricity yield, one alternative was examined because the expected impacts within the range are not sufficiently distinctive.

Assessment

To compare the effects of the alternatives for each aspect, they are assessed on a +/- scale compared to the zero alternative (which is the current situation and autonomous development). The following rating scale is used for this purpose, as shown in Table S4. The assessment is elaborated.

Table S4 assessment methodology

Assessment relative to the zero alternative (the reference situation)	Score
The plan leads to a strong noticeable negative change	--
The plan leads to a noticeable negative change	-
The plan does not differ from the zero alternative	0
The plan leads to a noticeable positive change	+
The plan leads to a significant positive change	++

If the effects are marginal, this is indicated by 0/+ (marginal positive) or 0/- (marginal negative) where applicable.

The Appropriate Assessment quantifies effects in order to make statements on whether or not significant effects on Natura 2000 areas will occur.

Besides the effect of a wind farm in Site II, cumulative effects of other wind farms and activities have also been considered, as well as mitigating measures.

6. Result of environmental Assessment

The following tables show the ratings of the alternatives by aspects according to the different assessment criteria, without the use of mitigation measures[11]. The tables are then discussed for each aspect.

6.1 Morphology and hydrodynamics

Table S5 Impact assessment morphology and hydrology Site II

Aspect (during construction, maintenance and operation)	Alternative 1 (15 MW)	Alternative 2 (20 MW)
Waves	0	0
Water movement (water level and current)	0	0/-

[11] For marine life, however, the noise standards from the Ecology and Cumulation Framework 4.0 have been used as a starting point. These noise standards can only be met if measures are taken during pile driving.

Water depth and bottom shape	0	0
Bottom composition	0	0
Turbidity and water quality	0	0
Stratification	0	0
Sediment transportation	0	0
Coastal defence	0	0

All morphological and hydrological changes resulting from the construction, use, removal and maintenance of the planned wind farm and cables are very limited in magnitude. In addition, the effects during construction and removal are only temporary. The changes, when they occur, 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, the changes are very localised. The impact is limited to the immediate vicinity of the foundation piles and the park cable route and is again only temporary. Only in the case of a gravity-based foundation are the effects on water movement slightly greater due to the larger dimensions of the foundation, thus scoring slightly negative.

6.2 Birds and bats

Alternative 1 (67 x 15MW turbines) results in several dozen more bird casualties than Alternative 2 (50 x 20 MW turbines). Based on current knowledge, Alternative 1, with more and smaller turbines, is expected to result in a higher number of bat casualties (an estimated 67) than Alternative 2 (an estimated 50). Alternative 2 is therefore the most environmentally friendly alternative from the perspective of birds and bats, mainly due to the lower number of collision casualties than the other alternative with more turbines. The complete impact assessment is summarised in Table 6.

Table S6 Impact assessment of the different IJmuiden Ver wind farm alternatives on colony birds, local seabirds, migratory birds and bats.

Effects of wind farm	**Alternative 1**	**Alternative 2**
	67 * 15 MW ø 236 m	**50 * 20 MW ø 280 m**
Construction phase birds		
- construction of foundations	0/-	0/-
- increased shipping	0/-	0/-
Use phase birds		
Local seabirds		
- collisions	-	-
- barrier effect	0	0
- habitat loss	-	-
- indirect effects	0/-	0/-
Breeding (colony) birds		
- collisions	-	-
- barrier effect	0	0
- habitat loss	0/-	0/-

Effects of wind farm	Alternative 1	Alternative 2
	67 * 15 MW ø 236 m	50 * 20 MW ø 280 m
- indirect effects	0/-	0/-
Migratory birds		
- collisions	-	-
- barrier effect	0	0
- habitat loss	0	0
- indirect effects	0	0
Removal phase birds		
- deconstruction of foundations	0/-	0/-
- increased shipping	0/-	0/-
Bats		
- collisions	--/-	-
- barrier effect	0	0
- habitat loss	0	0
- indirect effects	0/-	0/-

The expected effect of two-bladed instead of three-bladed turbines was also considered. Taking into account the fact that a bird may come into contact with one less blade per turbine, but the rotational speed of the blades is somewhat higher on average (about 1.33x), fewer casualties are expected to occur with two-blade turbines than with three-blade turbines.

An Appropriate Assessment has also been prepared for this Environmental Impact Assessment. This shows the following:

- Effects due to collisions and habitat loss on non-breeding birds from Natura 2000 areas, which use Site II outside the breeding season, cannot be ruled out. Significant effects, however, can be ruled out.
- Significant negative effects of Site II on breeding populations of lesser black-backed gulls from the Dutch Natura 2000 areas Dunes and Lage Land Texel, Dunes Vlieland and Wadden Sea can be ruled out. The additional mortality caused by the wind farm is at most 0.06%, and this falls below the 1% natural mortality standard.
- Effects on some species of migratory birds on seasonal migration from Natura 2000 areas as a result of collisions cannot be ruled out. Significant effects, however, can be ruled out.

A Species Assessment was also carried out for this Environmental Impact Assessment. This shows the following:

- For most species whose victims are expected in Site II in IJmuiden Ver Wind Farm Zone, the predicted mortality for all species is less than 1.0% of the annual natural mortality of the population in the Dutch EEZ. The exceptions are the gannet and great black-backed gull. On this basis, for all species except gannet and great black-backed gull, it can be said with certainty that the realisation of Site II in IJmuiden Ver Wind Farm Zone will not lead to effects on the GSI of the populations concerned.

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6.3 Marine life

Impacts on benthic animals and fish are small in magnitude. An exception applies to Sabellaria banks. This is a critical habitat potentially present in the plan area. This reef-forming species, which can reach a reef width of several metres, thus creating habitat for other species, may be destroyed by turbine construction. In the worst case alternative where 17 more turbines are installed than in the best case, this effect will be greater. Furthermore, a gravity-based foundation covers a larger area than a monopile foundation.

For marine mammals (porpoises and seals), effects will occur during the construction phase of the wind farm due to the underwater noise created by pile-driving activities. During pile driving, animals may be disturbed by being within the noise contour within which a change in behaviour occurs. The Assessment shows that, when applying an underwater noise level of 160 dB re 1μPa^2s or 164 dB re 1μPa^2s on 750 meters of the noise source, this disturbance will not lead to population effects for either seals or porpoises, so the effects will not lead to a deterioration of the State of Conservation (Svi).

Table S7 Impact assessment IJmuiden Ver marine life

Type	Fase	Impact assessment	Alternative 1	Alternative 2
			67 x 15MW	50 x 20MW
Benthos	All	Disturbance	0	0
		Impairment	-	-
		Habitat loss	0	0
Fish	Construction	Noise vibrations from pile driving	N/A	0/-
		Soil disturbance: turbidity	0	0
		Bottom disturbance: habitat destruction	0/-	0/-
	Use	Exclusion of fishing	0/+	0/+
		EMF due to cables	0/-	0/-
		Artificial hard substrate	0/+	0/+
	Removal	Loss of new habitat	0	0
Marine Mammals	Construction	Disturbed area (km2)	0/-	0/-
		Number of animals affected	0/-	0/-
		Number of animals disturbed	0/-	0/-
		Duration of disturbance	0/-	0/-
		Population effects	0/-	0/-

6.4 Shipping and safety

Table S8 Impact assessment marine safety

Assessment criteria	Impact assessment	Assessment
Safety	Probability of collision and propulsion with wind turbines	-
	Consequential damage from collision and propulsion	0/-
Shipping	Diversion possibilities for crossing shipping	0

Contrary to the other topics, for shipping safety, the cumulative effect of the various wind farms have been taken into account from the outset. This is because the planned shipping routes for route-related traffic do not change. The route structure at sea is designed to take into account the wind farms already constructed and to be constructed. The considered zero alternative is therefore also the cumulative scenario.

From the most recent study (which assumes that there will be no passage in the wind farms), the total expected collision and drift frequency (with a turbine) for the scenario RK2030 is 0.987 per year (once every 1.0 year). This is the scenario from the original roadmap (up to IJmuiden Ver I-IV) plus the assignment to accelerate, but without the future roadmap 2040. Therefore, the assessment in terms of probability of collisions and drifts is negative (-).

6.5 Landscape

For both sites, the worst-case turbines will not be visible at eye level. At a height of 20 metres (on the coast), the turbines are theoretically visible. However, meteorological conditions will almost always obscure the turbines from view. The wind farm will theoretically be visible less than 1% of the time (less than 1 day per summer, and for less than 7 minutes on that day).

Assessment criterion	Assessment
Visibility in percentage of time	0

6.6 Other functions

Most impacts on the other uses are assessed neutrally because they are minor in magnitude, or can be ruled out beforehand. This applies to Mining, Aviation (excluding helicopter traffic), Sand, gravel and shell mining, Dredging landfill, Ship, shore and aviation radar, Telecommunications, Military activities, and Recreation and tourism.

Table S9 Impact assessment of the investigated subject of the environmental aspect other functions.

Functions	Assessment Criteria	Alternative 1 67 x 15 MW	Alternative 2 50 x 20MW
Fisheries	Fishing restrictions	0/-	0/-
Mining	Restrictions on oil and gas extraction	0	0
Aviation	Interference civil aviation	0	0
	Interference helicopter traffic	-	-
	Coast Guard interference	0	0
	Interference military aviation	0	0
Sand, gravel and shell mining	Restrictions on shallow mineral extraction	0	0

Dredge dumping	Dredging restrictions	0	0
Ship, shore and aviation radar	Radar interference	0	0
Cables and pipelines	Interference to cables and pipelines	0/-	0/-
Telecommunications	Wave interference	0	0
Military activities and NGE	Interference Military activities	0	0
	Presence of unexploded ordnance	-	-
Recreation and tourism	Restrictions on recreational navigation	0	0
	Restrictions on coastal recreation	0	0
Cultural history and archaeology	Damage to archaeological remains	0/-	0/-
Existing wind farms	Influence on electricity yield of existing wind farms	0/-	0/-

The effects on fisheries as a whole are assessed slightly negatively. The area closure of the site is small compared to the area available to fishermen. However, individual fishermen may experience greater impacts than others if they frequently use fishing grounds within the site. The effects on Cables and Pipelines are slightly negative as there may have to be crossings with an abandoned pipeline. The effects for cultural history and archaeology have also been assessed and is slightly negatively due to the presence of (possible) archaeological values that need to be taken into account. There is also a slightly negative effect on existing wind farms due to the proximity to Hollandse Kust (west). The proximity of other wind farms can negatively influence the amount of wind another wind farm can capture.

For helicopter traffic (aviation) and NGE (unexploded ordinances), the assessment is negative. This is because the site is crossed by a Helicopter Main Route. The arrival of a wind farm limits the minimum flight altitude and makes it necessary to raise it. Additionally, within the sites, the presence of NGE is very likely making necessary measures essential. With these measures, the possible effects will be mitigated.

6.7 Electricity yield

Table S10 Summary of impact assessments Electricity yield and avoided emissions without mitigation

Sub aspects	**Assessment criteria**	**Impact assessment Alternative 15 MW**
Electricity yield	Electricity yield	++
Avoided emissions	CO2 emission reduction	++
	SO2 emission reduction	++
	NOx emission reduction	++

A net electricity yield of 4,198 GWh/year has been calculated for the 15 MW turbine. Other alternatives with other wind turbine types will be able to provide approximately the same electricity yield. Environmental Impact Assessments for the sites of other wind energy areas consistently found that a layout with a different number of turbines and capacity per turbine but an installed total capacity that was about the same (1 GW) resulted in more or less the same electricity yield.

The mentioned electricity production is equivalent to 0.78% of the national final energy consumption of 1,994 PJ (in 2020, according to total gross final energy consumption, source: CBS). Site II at IJmuiden Ver can supply electricity to around 1,538,000 households[12].

The contribution of the wind farm to the reduction of CO_2, NO_x and SO_2 is proportional to the net energy yield. The reduction was calculated using the average use of fuels at power plants.

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

7. Cumulation

The following table briefly indicates the cumulative effects and the consequences this has for the Wind Farm Site Decision. The first column indicates the aspect, the second column indicates which effects may be relevant in cumulation and the third column indicates the implications for the Wind Farm Site Decision.

Table S11 Relevant cumulative effects and impacts

Aspects	Relevant cumulative effects	Consequences of Wind Farm Site Decision
Morphology and hydrodynamics	At the level of the IJmuiden Ver Wind Farm Zone, the effect on morphology and geology will be neutral. However, recent studies have shown that very large-scale developments of wind farm zones in the North Sea could potentially affect (mixing) and water movement and morphology. However, the extent of effects regarding these aspects and the repercussions on other geological and ecological processes is highly uncertain.	No consequences
Birds and bats	<u>Birds</u> Cumulatively, significant negative impacts can be ruled out for all bird species. The acceptable level of impact (ALI) for both alternatives is also not exceeded for gannet and herring gull. This was the case within the KEC 4.0. Cumulatively, significant negative impacts can also be ruled out on the basis of new ALI standards, with the exception of auk and guillemot in the international scenario (all wind farms in the southern North Sea up to and including 2027), in the national scenario (all wind farms in the Dutch part of the North Sea up to and including 2027) also for auk and guillemot. <u>Bats</u> Much less information is available on bats than on birds. The bats that fly over the North Sea are well established, but their numbers, the population sizes from which these animals originate and their behaviour at sea are not well	<u>Birds</u> Several studies on possible mitigation measures to reduce impacts are ongoing. These measures could potentially reduce the number of casualties. <u>Bats</u> Based on current knowledge, it cannot be ruled out with certainty that negative effects on the conservation status of rough-legged dwarf bat will occur in the worst-case scenario, even after applying downtime as a mitigation measure.

[12] This is not the same as the electricity actually going to so many households and being used by householders. It gives an indication of the scale of generation, but the electricity will feed the public electricity grid and be taken by potentially all electricity users connected to the public electricity grid.

	known. According to the calculation method used, the number of casualties among pipistrelle bats, at 4,109 animals, is well above the PBR of 1,905 animals.	
Marine life	Benthos and fish The increase in the number of wind turbines and foundations could lead to changes in flow, stratification or primary production of benthos. It is also possible that it facilitates colonisation by exotic species. However, not enough information is available to estimate these effects. Marine mammals Applying an underwater noise level of 160 dB re 1μPa^2s or 164 dB re 1μPa^2s on 750 meters of the noise source, the disturbance will not lead to significant cumulative effects for either seals or porpoises, so the effects will not lead to a deterioration of the State of Conservation (Svi).	If the noise standard described in this EIA is applied, effects on the GSI of marine mammals can be ruled out.
Navigation and safety	In this Environmental Impact Assessment, the cumulative impact of the different offshore wind farms is not considered separately. The considered zero alternative is therefore also the cumulative scenario. Most recent research indicates that the total expected collision and drift frequency (with a turbine) for the scenario Rk2030 (1281 turbines) is 0.56 per year (once every 1.8 years). For the scenario that includes acceleration, this frequency increases to 0.987 (once every 1.0 years).	No consequences
Landscape	The IJmuiden Ver Wind Farm Zone is located at a great distance from the coast. Only because of this, it is visible for less than 24 hours on an annual basis. The same applies to nearby wind energy zones such as Hollandse Kust (west) and Nederwiek. Therefore, no significant contribution to cumulative effects is expected and no mitigating measures are required.	No consequences
Other uses	Fisheries The arrival of more offshore wind farms increases the total land used. As a result, a larger area will be closed to fishing. The future cumulative effect of this area closure for fisheries is partly determined by future developments in the ecology of the North Sea and the policy and socio-economic context. The possibility of more nature areas being closed to fishing in the future, and the possible closure of UK waters after 2025 increases this effect. Archaeology With a greater number of turbines in the North Sea, the likelihood of archaeological remains being affected, or NGE being struck, also increases. The realisation of the sites within the IJmuiden Ver Wind Farm Zone increases this	No consequences

	chance, although good mitigation measures are available for this. Recreational navigation For recreational shipping, the cumulative effects are limited because it is allowed for ships up to 24 metres in length within certain wind farms, and for wind farms where this is not allowed, passages are designated that ships up to 46 metres can use. In addition, recreational shipping mainly uses the 10 to 20 km wide zone along the coast, so area closures further out to sea have a limited effect.	
Electricity yield t	The increase of wind farms in the North Sea increases the potential wake effects. For Site II of IJmuiden Ver Wind Farm Zone, the number of full-load hours decreases from 4,177 to 3,866. When taking into account the other sites in IJmuiden Ver, as well as the future UK wind farms, the wake losses increase by 6.5 percentage points from 12.4% to 18.9%. As a result, net electricity output and the amount of emissions avoided decrease by 7.5% from 4,198 GWh/y to 3,886 GWh/y.	No consequences

8. Transboundary effects

For the aspects of bats and birds as well as marine life, transboundary effects are potentially to be expected.

8.1 Birds and bats

8.1.1 Breeding birds

IJmuiden Ver Wind Farm Zone is out of reach for most breeding colonies located in Natura 2000 areas. Only breeding lesser black-backed gulls originating from colonies in the Dutch Natura 2000 areas Dunes and Low Land Texel, Dunes Vlieland and Wadden Sea can theoretically reach the wind farm zone. IJmuiden Ver Wind Farm Zone is not within the foraging range of other Dutch or foreign colonies in Natura 2000 areas for which a conservation target for lesser black-backed gull as a breeding bird has been formulated.

8.1.2. Non-nesting birds

With the assumption that seabirds move nomadically throughout the North Sea outside the breeding season, individuals in the (southern) North Sea can be seen as a single population. It is therefore expected that individuals using Natura 2000 areas, and thus the 'population' of such a Natura 2000 area, will be similarly impacted as the North Sea population as a whole.

This chapter and the Appropriate Assessment have concluded that in cumulation significant effects on populations within Natura 2000 areas have also been ruled out. This also applies to foreign Natura 2000 areas.

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8.2 Marine life

Fish

For fish, the effects of piling are marginal and also highly site-specific. Pile-driving will therefore not result in any transboundary effects. Operational noise from a wind turbine has no demonstrable effect on the fish community and therefore no transboundary effects.

Sea mammals

The calculations made regarding the effects on marine mammals apply to the population within the NCP. No calculations have been done for other populations. The disturbed area lies entirely outside Natura 2000 areas designated for porpoises or seals in the Netherlands or abroad. There are therefore no transboundary effects or direct externalities.

9. Mitigation

Assessments show that the conditions of the legal framework can be met for most aspects. Mitigating measures are required to limit cumulative effects on birds, bats and porpoises and to ensure that the conservation status does not deteriorate. However, the occurrence of (residual) negative effects due to construction, operation and removal of the wind farm cannot be excluded. These possible residual effects can be mitigated by the following measures. These are therefore measures that can be taken additionally. Decisions making on which mitigating measures will be implemented are made in the Wind Farm Site Decision.

Table S12 Possible mitigating measures

Aspect	Effect	Possible mitigating measures
Birds and bats	Disturbance	Build in June to September when few disturbance-sensitive species are present. Apply minimal lighting on vessels, with a 'bird-friendly' colour.
	Disturbance and casualties	Apply design measures, such as creating corridors or using an alternative shape of the wind farm (diamond, square, etc.). However, not much is yet known about the effectiveness and exact design. Increase detection probability of the wind farm for birds by reflectors, lasers and noise (depending on bird species and thus bound by various restrictions). Shutting down of wind turbines during certain weather conditions in combination with detected migration peaks. Install the smallest possible number of large wind turbines instead of larger number of smaller wind turbines. Install two-bladed instead of three-bladed turbines. Smart planning of maintenance work. When turbines are shut down it can prevent casualties (consider periods of increased bird activity.
	Disturbance	Dismantle at a time when few disturbance-sensitive species are present.
Aquatic life	Disturbance and habitat destruction	Benthos Use the smallest possible foundation. Marine mammals Use acoustic measures (piling walls, bubble screens, etc.).

		Choose the shallowest locations in the planned area. Conduct piling work when the density of marine mammals is low (autumn). Choose a small number of, relatively large turbines rather than several smaller ones. Use alternative foundation techniques, such as vibrating, screwing or blue piling. Use other foundations, such as tripods, jackets or suction buckets.
	Disturbance and habitat destruction	Benthos Do not remove wind turbine pillars and embankments so that the developed aquatic communities remain. Use biodegradable concrete structures.
Shipping and safety	Collision risk and vessel movements	Using the Automatic Identification System (AIS) and VHF antenna in the park Vessel traffic management (VTM) Additional marking and identification of wind turbines Deployment of an Emergency Towing Vessel Additional SAR capacity ETV equipped with pesticides against oil pollution Physical barrier at wind farms to prevent collision
Morphology and hydrodynamics	N/A	N/A
Landscape	N/A	N/A
Other uses	Restriction on fishing areas	There are opportunities for fishery-friendly design of wind energy areas. However, for stakeholders as a whole, the benefits do not seem to outweigh the costs.
	Separation requirement HMR KY650	Move the HMR or increase the minimum flight path
	Unexploded ordnances	Further investigation is required to detect unexploded ordnances and then clear them.
	Impact on archaeological values	Changing the location of a wind turbine or cable to avoid a (possible) archaeological objec
	Possible disruption of existing (radio) wave paths	Take into account the half-rotor + 2nd fresnel zone around (radio) wave path when wind turbines are placed.
Electricity yield	N/A	N/A

10. Considerations on preferred alternative

Introduction

In this section, some considerations are given for the choice of the preferred alternative, which will be made possible in the Wind Farm Site Decision. It concerns the bandwidth considered in this Environmental Impact Assessment and the mitigating measures to be taken.

Bandwidth considerations

There are no aspects in this Environmental Impact Assessment that constrain the considered range.

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Considerations on mitigating measures

A number of measures are needed to limit effects on nitrogen-sensitive habitat types, cumulative effects on birds, bats and porpoises, and to guarantee the GSI. These include, for example, a shutdown provision during bird and bat migration and compliance with an underwater noise standard during pile driving. Table S12 lists the possible measures identified in this Environmental Impact Assessment that could mitigate impacts. The choice will be explained in the Wind Farm Site Decision.

Conclusion

The Wind Farm Site Decision can enable the preferred site bandwidth at the considered location. However, the application of (at least) the necessary measures should be secured in the context of birds, bats and porpoises.

11. Knowledge gaps

Introduction

Although there has been significant construction of new offshore wind farms in recent years, offshore wind farm development still has a relatively short history. There are known monitoring evaluations of offshore wind farms in England, Denmark, Germany and the Netherlands, among others. These are results of relatively short monitoring periods. Better insight into the exact nature and extent of the effects with (empirical) research can only be expected in the long term. However, current development and research programmes do provide tools for impact prediction, as presented in this Environmental Impact Assessment with a worst-case approach. During (the preliminary investigation of) the impact prediction for the present Environmental Impact Assessment, several knowledge gaps were identified that limit the understanding of the nature and extent of the impacts of a wind farm in Site II. Knowledge gaps remain about the effects, including the cumulative effects of multiple wind farms among themselves and in cumulation with other activities in the North Sea.

The gaps in knowledge that exist are not only due to the recent past of offshore wind energy. In general, much knowledge about animal species and their densities, diversity and behaviour still needs to be expanded. This section explains gaps in knowledge that are relevant in the context of this Environmental Impact Assessment. Gaps in knowledge are described successively with regard to the impact estimate on birds, marine life, morphology and hydrodynamics, shipping, landscape, other user functions and electricity yield.

Birds and bats

There are gaps in knowledge on collision risks, barrier effects and disturbances from offshore wind farms (both day and night). Particularly, species-specific knowledge in is lacking. Validation of models to predict collision victims at sea is lacking. There are also gaps in knowledge about disturbance sensitivity and disturbance distances of seabirds, as well as the extent to which birds can become accustomed to wind farms. Based on literature, it has been assumed that 10% of disturbed birds die. It is not known to what extent this assumption corresponds to reality, but it can be said that 10% is on the safe side (worst-case assumption).

For bats, there are gaps in knowledge regarding basic knowledge about population size and species-specific distribution. The relative importance of the North Sea for different species of bats and their changes in behaviour due to the presence of wind farms is currently unknown.

Aquatic life

Benthos

Knowledge gaps exist in regard to being able to predict the effects of abiotic changes (especially sediment change in the vicinity of the wind farm) on benthos. The effects of electromagnetic fields along the cables are currently also not well known. In addition, research on the effects of seabed vibrations due to pile driving is still in its infancy (Roberts & Elliot 2017). Further research is needed to show whether these effects are reversible, and whether these effects can be transmitted to community and population levels.

Modelling studies have been developed on indirect effects on plankton and benthos in protected areas due to wind farm construction (Boon et al. 2018; Zijl et al. 2021). The model results are currently not yet suitable to make predictions about the future. Positive or negative effects cannot be ruled out.

As more (or larger) offshore wind farms are built, this will result in a greater area of available hard substrate surface due to turbine pillars, protective embankments and increases in vessel movements. This may facilitate/accelerate colonisation by exotic marine fauna associated with hard substrates of this part of the North Sea. To date to what extent this actually occurs has never been investigated.

Fish

An important gap in knowledge concerns the impact of human induced noise on fish and invertebrates living in or near the sea floor (Hawkins et al. 2021). It is likely there are fish and certain invertebrates that can perceive this. Whether this also leads to effects on behaviour and fitness is unknown. For fish, some research has already been conducted on the effects of underwater noise on fish (Bolle et al, 2012, Debusschere et al. 2014, Popper et al. 2014). This shows that fish are much less sensitive to underwater noise than marine mammals and that some species (with swim bladders) are more sensitive than others.

Also, the Wind Farm Site Decisions only mention noise standards for the construction phase (mainly due to piling of foundations), but not for the operational phase of the wind farm. This allows wind farm developers to increase the tip speed of rotors without limit, which implies higher noise levels in the operational phase, including probably underwater. Since it is currently not well known whether wind turbine noise plays a role in fish disturbance, it cannot be said whether an unlimited tip speed and associated noise levels lead to increased disturbance among fish. For the time being, it is not known whether unlimited tip speed and associated operational noise levels lead to increased disturbance among fish. Targeted research on the effect of different operational noise levels on fish behaviour will have to show this.

Sea mammals

The main gaps in knowledge affecting the magnitude of the calculated effects relate to the underlying assumptions regarding:

- Uncertainties in the procedure for determining population effects;
- Quantification of source noise and noise propagation;
- Dose-response relationship for disturbance/behaviour change;
- Quantifying the number of disturbed animals;
- Translating effects on individual porpoises into population effects (iPCoD);
- Translating porpoise disturbance to effects on vital rates;
- Assumptions in iPCoD model on population trends and demographic parameters;
- Application of Interim PCoD model to translate effects on common and grey seals;

- Applicability of alternative installation techniques;
- Uncertainty about effects of application of other foundation types;
- Continuous noise during the construction and operation phases;
- Removal of existing wind farms and underwater noise.

Shipping and safety

In the case of rotating offshore wind farms, the number and type of ships using the area around the wind farm will be monitored, as well as the number and type of incidents that occur in the process. The resulting data will be used to decide whether it is desirable to develop an assessment framework and probability model. The behaviour and traffic flows of non-route traffic, which is placed outside IJmuiden Ver Wind Farm Zone in the SAMSON model, can also be monitored. Furthermore, the scenarios and impact of collisions and drives with wind turbines can be further investigated and developed.

For example, certain assumptions have been made in this Environmental Impact Assessment for determining personal injury. For instance, it is not known what the probability is of the mast falling on or away from the vessel during collisions and drifts. Also, the collapse behaviour of wind turbines comes from a study from 2000 (Barentse, 2000), while wind turbines have become considerably larger. In the context of the continued growth of offshore wind energy, shipping safety has been looked at cumulatively and consideration has been given to how identified knowledge gaps and how these gaps can be filled. A study was carried out by MARIN on shipping safety and possible mitigating measures due to the combined effect of autonomous development and the roll-out of the 2030 Offshore Wind Energy Roadmap[13]. More recently, a similar study was carried out which also included the 2030 assignment to accelerate [14]. Following both studies, it was decided to set up a monitoring and research programme for shipping to fill in the knowledge gaps. Part of those gaps is the effectiveness of the proposed mitigation measures. This programme started in spring 2021 under the name MOSWOZ (Monitoring and Research Programme Shipping Safety Wind at Sea).

Morphology and hydrodynamics

Further research is needed regarding the possible effects on stratification processes and water movement of a large-scale (international) development of wind energy in the North Sea. A good start on cumulative mapping of wind farm developments in the North Sea has already been made in Van Duren et. al 2021. However, they give a number of important recommendations to carry out further research on cumulative effects. The actual impact on stratification processes and water movement in the North Sea of developments on the Dutch continental shelf cannot be unambiguously identified.

Landscape

No substantial gaps in knowledge and information affecting the impact description were identified for the Landscape theme.

Other uses

Apart from the topics already mentioned that require further investigation, no substantial gaps in knowledge and information were identified for the environmental aspect ‘other uses’.

[13] See Zie https://www.noordzeeloket.nl/functies-gebruik/windenergie-zee/scheepvaart/ voor meer informatie en het onderzoek.
[14] Koldenhof, Y. SAMSON-analyse Wind op Zee; versnellingsopgave 2030 met doorkijk naar 2040, MARIN, 31797-1-MO-rev0.2, 7 maart 2022

PONDERA

Electricity yield

The environmental aspect of electricity yield and avoided emissions has significant gaps in knowledge. The yield calculations in this chapter are expected to give a good indication of the actual yield to be achieved. A wind measurement campaign can be used to simulate a more accurate approximation of the wind climate leading to more reliable results, however, these are not available at the time of writing and are expected to be carried out by the final permit holder. Also, no data of actual 15 MW offshore turbines in production are currently available. Turbine characteristics prepared by the IEA for a notional, 15 MW research turbine (Offshore reference-15,000 IEA) have been used in the calculations. Its use is not expected to lead to significantly different results.

Conclusion

The gaps in knowledge do not mean that a good picture has not been obtained of the effects of a wind farm in Site II in IJmuiden Ver Wind Farm Zone. However, it is important for the decision-making process to have insight into the uncertainties that played a role in the impact predictions. This insight has been provided with this Environmental Impact Assessment.

13 Monitoring en evaluation

13.1 WOZEP

The monitoring and evaluation programme WOZEP focuses on important ecological questions around construction and operation of wind farms at sea that are mainly of a generic nature rather than wind farm specific.

The Wozep covers both the ongoing development of the KEC tool (update and implementation of knowledge) and the MEP (the monitoring and research programme). The MEP covers monitoring and research as mandated by the Environmental Management Act.

The Wozep thus replaces the monitoring obligation per wind farm. In this way, an efficiency improvement is also achieved which also contributes to cost-efficient realisation of the offshore wind energy targets.

On the one hand the evaluation of the Wozep pays attention to the translation of new knowledge into the KEC tool (this can also mean checking assumptions and/or effect calculations) and on the other hand as a translation into policy and management consequences. Example of the latter is the imposition or adaptation of mitigation measures. In the Wozep, the study focuses in particular on gaining more insight into the cumulative ecological effects and visualises and advises the competent authorities.

Current situation

A multi-year monitoring and research programme was delivered at the end of 2016, broadly outlining the research lines for the period 2017-2023. Choice of research lines is determined by consideration on two time horizons:

- Short-term (up to 2023): focusing on use of results in planned wind farms. Central to this is examining the assumptions made in the ecological assessment for these farms. It also examines the usefulness, necessity and effectiveness of measures imposed on the wind sector to reduce ecological damage;
- Long term (after 2023): what knowledge is needed to allow further expansion of offshore wind farms in a responsible manner, what are the expected effects of further expanding 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 sufficiently avoided, etc.

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

The gaps in knowledge from this Environmental Impact Assessment provide input for monitoring within WOZEP (for the ecological aspects) and for monitoring for the shipping and morphology and hydrology aspects.

13.2 MOSWOZ

In 2019, Rijkswaterstaat investigated the cumulative effects of wind farms on shipping safety. It concerns the wind farms to be built on the southern part of the Dutch North Sea until 2030. In total, it concerns some 850 additional wind turbines over an area of some 1,600 km2.

Despite much research and the involvement of all kinds of experts, there are still uncertainties about the actual risks and about the effectiveness of a number of measures. This is the reason why the Monitoring and Research Programme on Marine Safety Wind at Sea (MOSWOZ) was launched. Running until 2029, the programme will monitor shipping safety developments in relation to implementation of offshore wind farms over the next few years. The ultimate goals is to gain more insight into the effect on shipping safety of offshore wind farms and to be able to respond to innovations in this area in a timely manner.

To achieve these goals, MOSWOZ has worked out the aforementioned knowledge gaps into research questions and then bundled them into various themes. Within these themes, answers to research questions will be sought over the next few years, in order to be able to properly support and advise policymakers and other stakeholders.

The programme is designed to make use of progressive understanding. Choices and priorities are geared to current events.

Table S13 MOSWOZ Thema's

Theme	Explanation theme
Monitoring	Focused on current risk development at sea due to wind farms for all shipping
Safety	Consequences of collisions and drifts of wind turbines
Transit	Risks of wind farm passage versus detours
Vessel traffic monitoring	Vessel traffic monitoring (VTM) equipment requirements
Emergency Towing Vessels	Explore deployment of multiple Emergency Towing Vessels (ETVs) - effectiveness and modus operandi
Hydro-meteo	Hydro-meteo in relation to shipping safety - effects of wind farms on wind, waves and visibility - improving weather warnings
Anchorage areas	Better use of anchorages
Crisis organization	Explore impact on crisis organization (due to complexity)
Foreign benchmarking	Foreign benchmarking wind farms include structural requirements for wind turbines, deployment measures, harmonization.

For more information, see website: https://www.noordzeeloket.nl/functies-gebruik/windenergie/scheepvaart-moswoz/

Summary Environmental Impact Assessment

Site Beta (formerly Site III)

2

SUMMARY

2.1 Introduction

2.1.1 Motivation

The Netherlands has set ambitious targets for the reduction of CO_2 emissions and, accordingly, the production of sustainable energy. Important steps have already been taken with the Energy Agreement for Sustainable Growth (the 'Energy Agreement') of 2013[1]. Following that, the Energy Report[2], subsequent Energy Dialogue[3] and the Energy Agenda[4] laid the foundation for longer-term energy policy leading up to 2050. Offshore wind energy plays a key role in the energy policy.

Offshore wind energy roadmap

The Offshore Wind Energy Act (*Wet windenergie op zee*) gives the government the ability to define and then issue wind farm sites for the development of offshore wind farms. In alignment with the policy intentions in the 'roadmap for offshore wind energy'[5] from 2014, wind farm sites have been defined in the Borssele, Hollandse Kust (south) and Hollandse Kust (north) wind energy regions. The commissioning of wind farms on these wind farm sites will meet the target for offshore wind energy set out in the Energy Agreement, that is approx. 4.5 GW of offshore wind energy capacity by 2023.

In alignment with the Energy Agenda, the follow-up roadmap for 2018, the 'roadmap for offshore wind energy 2030'[6] plots out the general principles for the further roll-out of offshore wind energy for the period leading up to 2030. The roadmap provides for the issue of a capacity of 6.1 GW up to 2030, coming on top of the 4.5 GW already referred to in the 2023 roadmap. This addition of capacity will require the definition and issue of new wind farm sites in coming years. The wind farm sites will be defined within the boundaries of the areas already designated as wind energy areas in the National Water Plan. This concerns 1.4 GW in the Hollandse Kust (west) area, 0.7 GW in the area to the north of the Wadden Islands and approx. 4 GW in the IJmuiden Ver area.

In 2022, the roadmap for offshore wind energy 2030 was supplemented by an anticipated issue of 10.7 GW on top of the original 10.6 GW. This was made up of an additional 2 GW in IJmuiden Ver wind farm sites V and VI, 2 GW in Nederwiek (south) and 2 GW in Nederwiek (north), with wind farm sites still to be identified for a total capacity of 4.7 GW in the Doordewind, Nederwiek (north) and Hollandse Kust (west) wind energy areas.

[1] Energy Agreement for Sustainable Growth Parliamentary Papers II, 2012/13, 30 196, no. 202.
[2] Energy Report 'Transitie naar duurzaam ('Transition to sustainable'), Parliamentary Papers II, 2015/16, 31 510, no. 50.
[3] Parliamentary Papers II, 2016/17, 30 196, no. 484.
[4] Energy Agenda 'Naar een CO2-arme energievoorziening' ('Towards a low-CO_2 energy supply'), Parliamentary Papers II, 2016/17, 31 510, no.
64.
[5] Parliamentary Papers I/II, 2014/15, 33 561, A/no. 11 Reprint.
[6] Parliamentary Papers II, 2017/18, 33 561, no. 42.

Environmental impact report for the wind farm site decision

The Minister for Climate and Energy, in agreement with the Minister for Infrastructure and Water Management, the Minister for Housing, Spatial Planning and the Environment and the Minister for Nature and Nitrogen, can take wind farm site decisions and formulate an environmental impact assessment for the decision.
This document is the EIA for wind farm site III in the IJmuiden Ver wind energy area (see Afbeelding 1.1). The EIA examines the environmental impacts that occur during construction, operation and removal of the wind turbines on/from the wind farm site.

The wind farm will be connected to the onshore high-voltage grid. This connection is not part of the wind farm site decision, nor part of this EIA procedure. The proposed wind farm sites I and II will be connected to the grid at sea, at IJmuiden Ver Alpha. The proposed wind farm sites III and IV will be connected to the grid at sea, at IJmuiden Ver Beta. A separate state coordination procedure will be followed for each grid at sea, including a separate EIA procedure. These will look at the offshore platform, the cables routed from the platform onshore and connection to the onshore high-voltage grid via a converter station.

2.1.2 EIA procedure

Why an environmental impact assessment?

The environmental impact assessment (EIA) procedure is prescribed on the basis of European and national legislation if there is a possibility of activities (or decision-making regarding such activities) with potentially significant environmental impacts. These activities are described in the Environmental Impact Report Decree. As this project will see the development of more than 20 wind turbines, the wind farm site decision (as referred to in Section 2 of the Offshore Wind Energy Act) requires an EIA. The EIA procedure gives rise to a report – the environmental impact report.
In addition, in view of the fact that impacts on Natura 2000 areas cannot be ruled out beforehand, an 'appropriate assessment' has also been put together. This is appended to this EIA in full as Annex III – Nature assessment. To ensure readability, the key findings relating to the impacts on qualified values in relation to specific Natura 2000 areas have also been incorporated into the main text of this EIA.
The purpose of the EIA is to fully consider the environmental interest in the decision-making relating to the wind farm site decision. The environmental impact assessment offers insight into the following elements:

- It underpins the suitability of the IJmuiden Ver location as a wind energy area (see Section 5 of the EIA).
- It underpins the subdivision of the IJmuiden Ver wind energy area (see Section 5 of the EIA).

It offers insight into the impacts of positioning alternatives for the wind turbines within the wind farm sites. To this end, the features of the wind turbines, including foundation, shaft height and rotor diameter, have been varied (see Sections 7 to 12 of the EIA).

The EIA procedure

The EIA is formulated by order of the Minister for Climate and Energy, the wind farm site decision is taken in liaison with the Minister for Infrastructure and Water Management, the Minister for Housing, Spatial Planning and the Environment and the Minister for Nature and Nitrogen.

There are two points within the EIA procedure at which input is invited. The first took place on the basis of the 'Memorandum regarding Scope and Level of Detail' (NRD) for wind farm site decisions I, II, III and IV for the IJmuiden Ver wind energy area. This NRD was available for inspection from 25 February to 8 April 2022 and the public was invited to submit its views. One was received. The NRD was also submitted to the statutory advisors for consultation. The Minster then adopted a final NRD, which provides the framework for this EIA. The second input point will occur with the draft wind farm site decisions for wind farm sites III and IV for IJmuiden Ver. This input period will be announced by means of publication in the Official Gazette or by other suitable means. Views will be worked into the ultimate wind farm site decisions. Appeals against the decisions may be submitted to the Administrative Jurisdiction Division of the Council of State.

2.1.3 Reading guide

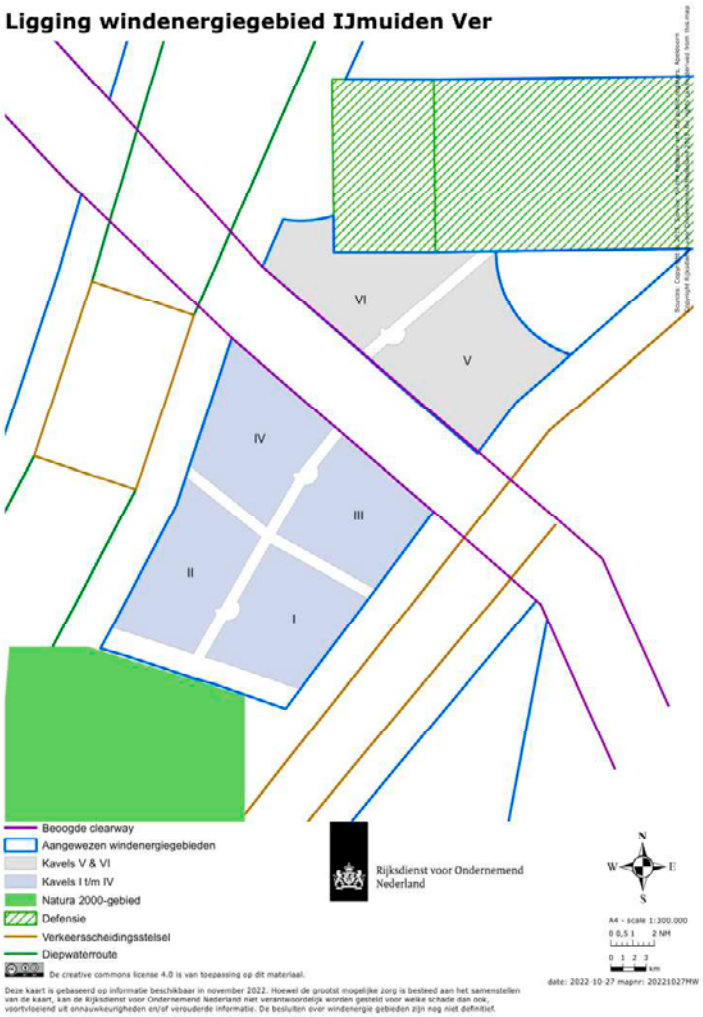
The is a summary of the EIA for wind farm site III of the IJmuiden Ver wind energy area. Following the introduction in paragraph 2.1, paragraph 2.2 examines the choice of location and subdivision, while paragraph 2.3 outlines the approach to the impact assessment. Paragraph 2.4 outlines the conclusions of the impact assessment, followed by a description of the cumulation in paragraph 2.5, and cross-boundary impacts in paragraph 2.6. Paragraph 2.7 examines mitigating measures. The summary concludes with a description of the preferred alternative in paragraph 2.8 and gaps in knowledge, monitoring and evaluation in paragraph 2.9.

2.2 Choice of location and subdivision

The extent of the IJmuiden Ver wind energy area for the realisation of wind energy was explored in (the plan EIA to) the National Water Plan. As part of the process, the impacts of wind energy in the IJmuiden Ver wind energy area were broadly examined in terms of ecology, the safety of shipping, other usage functions (oil and gas, fishery, sand extraction, defence, et cetera.), geology and hydrology, landscape (visibility), recreation (navigation), cultural history and archaeology.
The plan EIA also considered the suitability when compared with other areas designated for wind energy.[1] The outcome of this consideration is that the area is no less suitable than the other designated areas. Negative impacts are generally comparable. When it comes to shipping and recreation, the impacts are less than those for the Hollandse Kust (south, north and west) wind energy area. The designated IJmuiden Ver wind energy area is located within the Exclusive Economic Zone (EEZ) of the Netherlands, at around 62 km from the coast. The proposed area for wind farm sites I - IV has a total surface area of around 400 km^2. See the location of the wind energy area in Figure 2.1.

[1] www.zoek.officielebekendmakingen.nl/blg-14240.pdf.

Figure 2.1 Location of wind farm site III in the IJmuiden Ver wind energy area (the locations of wind farm sites I and II are also visible)[1]



There is space within the IJmuiden Ver wind energy area for six wind farm sites, each of approx. 1 GW. The six wind farm sites and areas of IJmuiden Ver are shown in Figure 2.1Afbeelding 1.1. This EIA looks at the proposed wind farm site IV from the area to the south of the proposed clearway. The TenneT platform Beta will come between wind farm sites III and IV.

No subdivision alternatives

A point of departure in the 2022 - 2027 North Sea Programme is the preservation of Natura 2000 areas. A second point of departure is the need for a clearway in the designated IJmuiden Ver wind energy area, to enable safe passage for shipping. Vessels requiring safe passage in this area are ferries on the Newcastle, UK route and more generally, those on busy shipping routes to the ports of IJmuiden and Amsterdam. A third point of departure is that the northernmost reaches of the IJmuiden Ver wind energy area are an additional wind energy area according to the supplement to the roadmap. The northernmost reaches of the IJmuiden Ver wind energy area will be used for two wind farm sites, V and VI, each of 1 GW. These two additional wind farm sites are needed to allow offshore wind energy to meet the agreement for 2030 as set out in the Climate Agreement in time (a 49 per cent reduction in CO_2) and the tighter European target of a 55 per cent reduction in CO_2 by 2030. With this in mind, a separate proposal, including corresponding draft NRD, was available for inspection between 1 July and 11 August 2022. Given these points of departure, no alternative subdivision has been examined for wind farm site III in this EIA.

[1] This map was drawn in April 2022; the wind farm site boundary has been adjusted, see below in the EIA.

2.3 Approach to the impact assessment

This EIA surveys and assesses the environmental impacts of the proposed activity, the construction of the IJmuiden Ver (wind farm site III) wind farm. This impact analysis and assessment were carried out on the basis of different alternatives. An alternative is a potential way in which the proposed activity – in this case the generation of an installed capacity of approx. 1 GW with wind turbines – can be accomplished taking into account the purpose of this activity. The alternative approach includes surveying a range of different wind turbine setups and types within the wind farm site

Range of setup options
Issuing a wind farm site that allows for different turbine setups, types and foundation methods, within a pre-determined range, facilitates a flexible layout of the wind farm site. Within that range, the developer has the freedom to create as optimal a layout as possible for the wind farm in terms of both cost effectiveness and energy yield. The range approach imposes specific requirements on the EIA. All environmental impacts that are associated with potential setups that facilitate the wind farm site decision must be looked at. In view of the number of conceivable combinations, however, surveying all possible setups is not possible. Consequently, a worst-case approach is assumed – if the worst-case situation for the range is permissible in terms of impact, then all setups within the range are possible.

Alternatives
The worst-case situation will vary according to the environmental impact or user interest – for example, consider the various intervention/impact relationships for birds and marine mammals. Moreover, a best-case situation can also be conceived for each environmental impact – that is the situation in which the least impact on the environment is anticipated. The study takes this into consideration by defining and assessing both the likely worst-case and best-case situation for each environmental impact. The parameters that define the worst-case and best-case situations are named and described – these include aspects such as the maximum number of turbines, maximum rotor surface area, characteristics of the foundation method, et cetera.

The range of possible implementations within the wind farm site to be issued is indicated in the following table. Range values are based on the current state of the art and on expectations relating to developments for coming years. The range that must be adhered to will be defined in the wind farm site decision.

Table 2.1 Roadmap of the range to be used for wind farm site III in the EIA

Topic	Range
Total installed capacity per wind farm site	approximately 1 GW
Maximum number of turbines	50 - 67
Capacity of individual wind turbines	Minimum 15 MW, maximum 20 MW
Tip high point of individual wind turbines	Maximum 305 m
Tip low point of individual wind turbines	Minimum 25 m
Rotor diameter of individual wind turbines	236 - 280 m
Distance between individual wind turbines	Minimum 4x the rotor diameter
Number of blades per wind turbine	2, 3
Foundation type	Monopile, multipile, gravity-based structure, suction bucket
Noise level in case of foundation pile driving	160 dB and 164 dB µP2s SELss (at 750 m from source)
In the case of foundation pile driving: diameter of foundation pile/ piles and number of piles per turbine:	
Monopile	1 pile of 11.5 - 15 m in diameter

Topic	Range
Multipile (including 'tripods' and 'jackets')	3 to 4 piles of 3 - 5 m in diameter
In the case of a foundation without pile driving: dimensions at seabed:	
Gravity-based	To 50 m in diameter
Suction bucket	To 30 m in diameter
Electrical infrastructure (inter-array cabling)	66 kV, buried at approx. 1 m and maintained at depth

The worst-case situation may vary for certain aspects, such as for birds and for marine mammals. The table below indicates the worst-case and best-case situations for different environmental aspects.

Table 2.2 Worst case and best case within the range for each environmental aspect

Environmental aspect	Range	
	Alternative A: best case/lowest impact	Alternative B: worst case/highest impact
Morphology and hydrodynamics	67 x 15 MW turbines, tripod	50 x 20 MW turbines, gravity-based
Birds and bats*	50 x 20 MW turbines, tip low point 25 m, rotor diameter 280 m	67 x 15 MW turbines, tip low point 25 m, rotor diameter 236 m
Aquatic life	50 x 20 MW turbines, tip low point 25 m, rotor diameter 280 m, gravity-based	67 x 15 MW turbines, tip low point 25 m, rotor diameter 236 m, monopile/jacket
Shipping	50 x 20 MW turbines, monopile	67 x 15 MW turbines, jacket
Energy and climate	50 x 20 MW turbines	67 x 15 MW turbines
Landscape	67 x 15 MW turbines	50 x 20 MW turbines
Other usage functions*	50 x 20 MW turbines	67 x 15 MW turbines

* It may be necessary to reverse the worst-case and best-case situations; this is ultimately based on the impact assessment.

Assessment

To be able to compare the impacts of the variants by aspect, these are assessed on the basis of a +/- scale in respect of the zero alternative. The following assessment scale is used here, as shown in the table below. The assessment is substantiated.

Table 2.3 Scoring method

Score	Verdict in respect of the zero alternative (reference situation)
--	The proposal leads to a very noticeable negative change
-	The proposal leads to a noticeable negative change
0	The proposal cannot be distinguished from the zero alternative
+	The proposal leads to a noticeable positive change
++	The proposal leads to a very noticeable positive change

In the event that the impacts are marginal, this is indicated by 0/+ (marginal positive) or 0/- (marginal negative) in the cases in question. Cross-boundary impacts are considered separately in this EIA. Insight is also offered into cumulative impacts. For each aspect, it is then explored whether mitigating measures might be conceived in order to either minimise or eliminate the scope of the impact. Where possible, impacts with and without the measures are considered separately in this EIA.

2.4 Conclusions of the impact assessment

Sections 7 to 12 outline the impacts of alternatives A and B and assess them in respect of the reference situation. Alternatives A and B in this EIA comprise the extreme points of departure for each aspect that are possible. This EIA thus looks at the maximum range within which environmental impacts could occur. The tables in this section provide the assessments of the alternatives for wind farm site III for each assessment criteria. This is based on a seven-point scale as outlined in the Method section (Section 6). The following paragraphs summarise the overall impact assessment for both alternatives for each environmental topic.

2.4.1 Morphology and hydrodynamics

All morphological and hydrodynamic changes that are the consequence of the construction, operating and removal of the proposed IJmuiden Ver wind farm site III wind farm and the inter-array cables are limited in scope. Moreover, the impacts during construction and removal are only temporary in nature. The changes, where they occur, are minor when compared with the natural dynamics of the area. In view of the relatively small dimensions of the foundation piles, the relatively large distance between the wind turbines and the number of wind turbines, changes are very local changes. The impact is limited to the immediate vicinity of the foundation piles and the farm cabling route and is temporary in nature.

Table 2.4 Impact assessment for morphology and hydrodynamics – usage phase and construction and removal – wind farm site III

Aspect	Assessment criteria	Alternative A (15 MW)	Alternative B (20 MW)
Morphology and hydrodynamics	Impact on water movement (water level/flow)	Neutral (0)	Neutral (0)
	Impact on water depth and seabed shapes	Neutral (0)	Neutral (0)
	Impact on seabed composition	Neutral (0)	Neutral (0)
	Impact on turbidity and water quality (including the impact of cathodic protection)	Neutral (0)	Neutral (0)
	Impact on sediment transport	Neutral (0)	Neutral (0)
	Impact on coastal defence	Not surveyed	Not surveyed

2.4.2 Birds

Wind farm site III construction/removal

Construction and removal activities are temporary in nature and spread over a relatively small area. The impacts are assessed as slightly negative (0/-) for both alternatives. The additional shipping movements during the construction and removal phase are temporary in nature and spread over a relatively small area. The impacts are assessed as slightly negative (0/-) for both alternatives.

Table 2.5 Impact assessment for birds – construction/removal – wind farm site III

Aspect	Assessment criteria	Alternative A (20 MW)	Alternative B (15 MW)
Birds (all groups)	Disruption during construction/removal of foundation	Slightly negative (0/-)	Slightly negative (0/-)
	Disruption due to increase in shipping	Slightly negative (0/-)	Slightly negative (0/-)

Wind farm site III usage phase

Local sea birds

Based on the original model calculations, relatively high mortality rates were predicted for gannets, causing the 1 per cent mortality standard to be surpassed. With the availability of new data, Waardenburg Ecology has carried out a revision of the input parameters used. The new data have led to the predicted number of collision victims being revised downwards, with the 1 per cent mortality standard now no longer surpassed. A negative impact on the favourable conservation status of gannets can thus be ruled out – a negative impact on the conservation status of other sea birds has also been ruled out. Although there is a difference in the number of collisions, both alternatives are assessed as slightly negative (0/-).

The number of birds predicted to die each year due to loss of habitat as a consequence of the IJmuiden Ver wind farm site III wind farm during the usage phase is less than ten for all species with the exception of the guillemot. These have the highest presence in the IJmuiden Ver wind farm and, using this calculation method, it can be assumed that nineteen birds will die each year per wind farm site due to loss of habitat. This impact is assessed as slightly negative (0/-) for both alternatives. For local, non-breeding sea birds, the IJmuiden Ver wind farm site III wind farm will have no significant impact of barrier effects as for these species, as there are no targeted movements at sea where a wind farm could act as an obstruction to the flight path. The impact is assessed as neutral (0) for both alternatives.

The anticipated increase in benthos and fish (Lindeboom *et al.* 2011) in the IJmuiden Ver wind farm site III wind farm may help to improve foraging conditions. The impacts are assessed as slightly positive (0/+) for both alternatives as a result. The additional use of ships for wind farm maintenance in the IJmuiden Ver wind energy area may lead to some disruption to sea birds. The duration and scope of maintenance activities in the IJmuiden Ver wind energy area are of (much) more limited scope than activities for construction and removal. Although there is a difference between the alternatives (different numbers and types of turbine), no distinction is drawn in this assessment in view of the limited scope of the impacts. The (additional) impacts of maintenance are assessed as slightly negative (0/-) for both alternatives.

Coastal (breeding) birds

Only the lesser black-backed gull is a relevant as a breeding bird; the wind farm is well beyond the range of other species of breeding bird. The 1 per cent standard is not surpassed for this species, which means that negative impacts on the favourable conservation status can be ruled out. The impact (collision risk) is assessed as slightly negative (0/-) for both alternatives.

IJmuiden Ver is located at the outer extreme of the foraging range of the lesser black-backed gull. As such, the area is not especially important for breeding birds, which means that the impact on loss of habitat is negligibly small. The impact in terms of loss of habitat is assessed as slightly negative (0/-) for both alternatives.

The wind farm is located at the outer extreme of the foraging range of the species that travels the farthest from the Dutch coast – the lesser black-backed gull. It follows, therefore, that only a negligible number of breeding birds travel farther out to sea than this wind farm, which means that the wind farm will not act as an obstacle to their route to foraging areas located farther from the coast. The impact for barrier effects is assessed as neutral (0) for both alternatives.

The anticipated increase in benthos and fish (Lindeboom *et al.* 2011) in a future wind farm in the IJmuiden Ver wind energy area may help to improve foraging conditions, including for breeding birds like the lesser black-backed gull. The wind turbines themselves, as well as any metering masts or transformer platforms, could offer resting and breeding sites for some species of sea bird, including gulls. The impacts in relation to the presence of wind turbines are assessed as slightly positive (0/+) for both alternatives as a result. The additional use of ships for wind farm maintenance in the IJmuiden Ver wind farm may lead to some disruption to sea birds, including breeding birds. The duration and scope of maintenance activities in the IJmuiden Ver wind energy area are of (much) more limited scope than activities for construction and removal. Although there is a difference between the alternatives (different numbers and types of turbine), no distinction is drawn in this assessment in view of the limited scope of the impacts. The (additional) impacts of maintenance are assessed as slightly negative (0/-) for both alternatives.

Migratory birds

When it comes to migratory birds, the mortality rate for wind farm site III per species is sufficiently low when compared with the 1 per cent standard that negative impacts on the favourable conservation status can be ruled out. Although there is a difference between the alternatives (different numbers and types of turbine), no distinction is drawn in this assessment in view of the limited scope of the impacts. The impacts are assessed as slightly negative (0/-) for both alternatives. There is the potential for barrier effects amongst migratory birds, but the distance required for a detour is negligible when compared with the overall migration route. The impacts are assessed as neutral (0) for both alternatives as a result.

Table 2.6 Impact assessment for birds – usage phase – wind farm site III

Aspect	Assessment criteria	Alternative A (20 MW)	Alternative B (15 MW)
Local sea birds	Collision risk	Slightly negative (0/-)	Slightly negative (0/-)
	Loss of habitat/change in foraging circumstances	Slightly negative (0/-)	Slightly negative (0/-)
	Barrier effects	Neutral (0)	Neutral (0)
	Disruption by wind turbines	Slightly positive (0/+)	Slightly positive (0/+)
	Disruption due to wind farm maintenance	Slightly negative (0/-)	Slightly negative (0/-)
Breeding birds from Natura 2000	Collision risk	Slightly negative (0/-)	Slightly negative (0/-)
	Loss of habitat/change in foraging circumstances	Slightly negative (0/-)	Slightly negative (0/-)
	Barrier effects	Neutral (0)	Neutral (0)
	Presence of wind turbines	Slightly positive (0/+)	Slightly positive (0/+)
	Disruption due to wind farm maintenance	Slightly negative (0/-)	Slightly negative (0/-)
Migratory birds	Collision risk	Slightly negative (0/-)	Slightly negative (0/-)
	Barrier effects	Neutral (0)	Neutral (0)

2.4.3 Bats

Wind farm site III usage phase

The mortality rate for bats in wind farm site III remains well below the 1 per cent standard. There is no suggestion of an impact on the favourable conservation status. This impact is assessed as slightly negative (0/-) for both alternatives. In cumulation with the planned wind farms in accordance with the supplementary roadmap, negative impacts on the favourable conservation status of the nathusius' pipistrelle bat cannot be ruled.

Table 2.7 Impact assessment for bats – usage phase – wind farm site III

Aspect	Assessment criteria	Alternative A (20 MW)	Alternative B (15 MW)
Bats	Collision risk/barotrauma	Slightly negative (0/-)	Slightly negative (0/-)

2.4.4 Aquatic life

Wind farm site III usage phase, bottom-dwellers

The potential nuisance experienced by bottom-dwellers and fish as a result of underwater noise and vibration (from maintenance ships) is assessed as slightly negative (0/-). Looking at the total habitat of the bottom-dweller and fish communities in the North Sea, the potentially disrupted area as result of electromagnetic radiation is negligibly small. The impact is assessed as slightly negative (0/-) as a result. The presence of wind turbines and stones to protect against erosion (alternative B – 67 x 15 MW) will change the habitat of bottom-dwellers from a wholly sandy substrate to a partly hard substrate. This may benefit biodiversity and biomass. The negative impact of surface loss is minimal, but greater in the case of alternative A owing to the larger surface area with use of gravity-based foundations. Alternative A is assessed as slightly positive (0/+), alternative B is assessed as neutral (0). Stopping current fishing activities in the area may have a positive impact on the development of bottom-dweller and fish communities. This is assessed as slightly positive (0/+) for both alternatives.

Table 2.8 Impact assessment for bottom-dwellers – usage phase – wind farm site III

Aspect	Assessment criteria	Alternative A (50 x 20 MW)	Alternative B (67 x 15 MW)
Bottom-dwellers	Disruption due to underwater noise and vibrations	Slightly negative (0/-)	Slightly negative (0/-)
	Disruption due to electromagnetic fields	Slightly negative (0/-)	Slightly negative (0/-)
	Increase in hard substrate	Neutral (0)	Slightly positive (0/+)
	Ban on fishing activities affecting the seabed	Slightly positive (0/+)	Slightly positive (0/+)

Wind farm site III construction and removal phase, bottom-dwellers

No demonstrable change on seabed fauna is observed due to construction of a wind farm. Very little is currently known about the impacts of the removal of a wind farm. The total area of disrupted seabed is negligibly small when compared with the overall habitat of the respective bottom-dweller communities in the North Sea. The impact is assessed as slightly negative (0/-).

It is observed that bottom-dwellers could experience nuisance from underwater noise (impulse nose during construction of monopiles and jackets and ongoing noise during removal) and vibrations and that species respond differently to this nuisance. In the case of alternative A, a gravity-based foundation is used and there is no pile driving, which means that the increase in noise is only minimal and the impact of wind farm site III is assessed as neutral for alternative A. In view of the temporary nature of the impacts and the relatively small surface area subject to disruption from pile driving, this impact of wind farm site III is assessed as slightly negative (0/-) for alternative B.

Table 2.9 Impact assessment for bottom-dwellers – construction and removal phase – wind farm site III

Aspect	Assessment criteria	Alternative A (50 x 20 MW)	Alternative B (67 x 15 MW)
Bottom-dwellers	Disruption of the seabed	Slightly negative (0/-)	Slightly negative (0/-)
	Disruption due to noise and vibrations	Neutral (0)	Slightly negative (0/-)

Wind farm site III usage phase, marine mammals

Ongoing noise from operational wind turbines is generally only of importance if the ambient noise from the wind and shipping is relatively minimal. Impacts from shipping may occur, but surveys suggest that a greater number of porpoises were present during the usage phase of the OWEZ wind farm than during its construction, possibly as a result of more prey fish being present. This indicates that porpoises do not avoid the wind farm. The impact of the noise of the turbines and shipping (ongoing noise) during the usage phase of wind farm site III is small (0/-).

Very little is known about the impacts of barrier effects and loss of habitat on marine mammals, but it is not expected that this impact will occur with an individual wind farm. In the case of a large number of wind farms in the North Sea, this impact could occur, in which case there would be a cumulative impact. The impact is assessed as slightly negative (0/-) for both alternatives.

With the current distribution and use of habitat by marine mammals, it is expected that potential impacts are likely to affect behaviour for only a short period of time, and locally. The impacts would be sufficiently small as not to have a considerable impact on marine mammals (0/-).

Table 2.10 Impact assessment for marine mammals – usage phase – wind farm site III

Aspect	Assessment criteria	Alternative A (50 x 20 MW)	Alternative B (67 x 15 MW)
Marine mammals	Disruption due to underwater noise and vibrations from turbines and shipping	Slightly negative (0/-)	Slightly negative (0/-)
	Barrier effects, loss of habitat	Slightly negative (0/-)	Slightly negative (0/-)
	Electromagnetic radiation	Slightly negative (0/-)	Slightly negative (0/-)

Wind farm site III construction and removal phase, marine mammals

The calculations indicate that for the scenarios that were studied, the number of days of disruption due to the construction of turbine foundations in wind farm site III being higher than the number calculated for the IJmuiden Ver wind energy area in the KEC 4.0 can be ruled out. The KEC 4.0 concluded that this disruption will not have an impact on the population of porpoises and seals – this also applies to the results in this EIA. The impact of alternative B is slightly higher than that of alternative A due to the difference in the number of turbines and because, in the case of alternative A, a gravity-based foundation is assumed (in which case there is no pile driving). As such, the impact for alternative A is assessed as neutral (0) and for alternative B as slightly negative (0/-). There is no impact on the hearing of porpoises or seals (PTS), as noise-reducing measures are used.

Table 2.11 Impact assessment for marine mammals – construction and removal phase – wind farm site III

Aspect	Assessment criteria	Alternative A (50 x 20 MW)	Alternative B (67 x 15 MW)
Marine mammals	Disruption, barrier effects, loss of habitat, changed foraging circumstances due to noise and vibrations during construction of foundations and geophysical surveying	Neutral (0)	Slightly negative (0/-)
	Physical degradation (temporary hearing damage)	Neutral (0)	Slightly negative (0/-)

2.4.5 Safety of shipping

Calculations of the likelihood of collision with wind turbines have been performed for wind farm site III. The total collision frequency for wind farm site III is 0.0242 per year, which is equivalent to once every 41 years. This impact of wind farm site III is assessed as slightly negative (0/-). Based on outdated points of departure relating to outflow of oil as a consequence of a collision with a wind turbine (thickness of a ship's hull and size of the turbines) and in expectation of the probable use of the SAMSON model, it has been decided not take the outflow of oil into account in this report as the uncertainties would otherwise become too great. In earlier impact assessments for environmental damage as a consequence of collisions with wind turbines, the impacts were assessed as neutral or slightly negative. As the existing points of departure do not directly suggest a conservative or optimistic approach, this aspect is assessed as slightly negative (0/-) on account of the uncertainty.

It is expected that there will be few if any situations in which wind farm site III will impact lines of sight. As such situations cannot be ruled out in their entirety, the impact of wind farm site III is assessed as slightly negative (0/-).

Table 2.12 Impact assessment for the safety of shipping – construction/removal and usage phase – wind farm site III

Aspect	Assessment criteria	Alternative A	Alternative B
Shipping and safety	Risk of a collision, route-bound and non-route bound shipping	Slightly negative (0/-)	Slightly negative (0/-)
	Consequential damage as a result of a collision, route-bound and non-route bound shipping	Slightly negative (0/-)	Slightly negative (0/-)
	Possibilities for diversion for crossing shipping	Slightly negative (0/-)	Slightly negative (0/-)

2.4.6 Landscape and visibility

In view of the large distance from the coast to the wind farm site, the wind turbines on wind farm site III at IJmuiden Ver will not be visible on account of the dip on the horizon, observation capacity and weather conditions. In the case of alternative A, the lighting on the nacelle will be beyond the horizon, which means that the wind turbine lighting will not be visible at night. In the case of alternative B, the lighting will not disappear beyond the horizon. In theory, this lighting could be visible in extremely clear conditions. This is highly likely to occur, however, as visibility rarely exceeds 50 km due to weather conditions. As a

consequence, both alternatives are assessed as neutral (0) as there is no impact on visibility and perception from the coast.

Table 2.13 Impact assessment for landscape and visibility – construction/removal and usage phase – wind farm site III

Aspect	Assessment criteria	Alternative A	Alternative B
Landscape and visibility	Impacts on landscape and visibility	Neutral (0)	Neutral (0)

2.4.7 Other usage functions

As co-use for other functions is only possible to a limited extent in the case of offshore wind farms, the exclusion of these areas sometimes has a negative (-) impact on these functions. The impacts are limited by the relatively small size of the wind farm site when compared with the totality of the Dutch Continental Shelf (NCP). Fishermen will need to sail around the area to achieve the same catch. New gas extraction will be possible with angled drilling but will be made more complicated by the wind farm. By raising the lowermost flying altitude, the negative impacts on aviation can be avoided. Thorough surveying for unexploded explosives will minimise the risk of damage during construction. The impacts between the alternatives differ for NGE, as in the case of a larger area of foundations (alternative B), the likelihood of encountering NGE is higher. Further surveying for NGE will, however, be carried out prior to construction activities in order to mitigate the impacts. Although the impacts may sometimes be marked as slightly negative, they can all be managed and thus have no effect on the wind farm site decision.

Table 2.14 Impact assessment for other usage functions – construction/removal and usage phase – wind farm site III

Aspect	Assessment criteria	Alternative A	Alternative B
Fishing	Impact on area available and fishing grounds	Slightly negative (0/-)	Slightly negative (0/-)
	Impact on economic value	Negative (-)	Negative (-)
	Impact on circumnavigation	Negative (-)	Negative (-)
Oil and gas extraction	Impact on accessibility of helicopter platforms	Neutral (0)	Neutral (0)
	Impact on future use of platforms for CCS or hydrogen	Neutral (0)	Neutral (0)
	Impact on exploitation of fields in the ground	Negative (-)	Negative (-)
Aviation	Civil aviation	Neutral (0)	Neutral (0)
	Helicopter traffic	Negative (-)	Negative (-)
	Accessibility of TenneT platforms	Neutral (0)	Neutral (0)
	Aircraft movements by the coastguard (SAR)	Negative (-)	Negative (-)
	Military aviation	Neutral (0)	Neutral (0)
Dredging spoil	Restrictions on dredging spoil areas	Neutral (0)	Neutral (0)

Aspect	Assessment criteria	Alternative A	Alternative B
Ship, shore and aviation radar	Impacts on ship, shore and aviation radar	Neutral (0)	Neutral (0)
Cables and pipes	Impacts on cables and pipes	Neutral (0)	Neutral (0)
NGE	Risk of unexploded explosives	Neutral (0)	Slightly negative (0/-)
Telecommunications	Disruption to cable connections and beam paths	Neutral (0)	Neutral (0)
Military activities and munitions dumping areas	Impacts on the use of space by defence (air force, navy) due to the presence of training areas and munitions dumping areas above and on the sea	Neutral (0)	Neutral (0)
Recreation and tourism	Accessibility of recreational waterways	Neutral (0)	Neutral (0)
	Impacts on coastal tourism	Neutral (0)	Neutral (0)
Cultural history and archaeology	Impacts on archaeological values, such as mineral resources, shipwrecks, flooded landscapes	Neutral (0)	Neutral (0)
Shellfish farming and aquaculture	Impacts on mussel-seed collection systems and seaweed cultivation	Neutral (0)	Neutral (0)
Existing wind farms	Impacts of electricity yield on existing wind farms (wind capture)	Neutral (0)	Neutral (0)
Electricity yield and emissions prevented	Electricity generation	Very positive (++)	Very positive (++)
	Amortisation period, construction energy	Positive (+)	Positive (+)
	CO_2 emissions reduction	Very positive (++)	Very positive (++)
	NO_x emissions reduction	Very positive (++)	Very positive (++)
	SO_2 emissions reduction	Very positive (++)	Very positive (++)
	Impact on climate change	Very positive (++)	Very positive (++)

2.5 Cumulation

The following outlines the cumulative impacts that could occur for each aspect and the consequences of these for the wind farm site decision. The aspect is given in the first column; the second column states the impacts relevant to cumulation; the third column outlines the outcome of this for wind farm site III.

Table 2.15 Cumulative impacts

Aspect	Relevant cumulative impacts	Consequences for the wind farm site decision
Morphology and hydrodynamics	Recent studies suggest that very large-scale wind energy development	None

Aspect	Relevant cumulative impacts	Consequences for the wind farm site decision
	in the North Sea could have an impact on the (mixing of) stratification (Carpenter, et al., 2016; Deltares, 2021) and water movement and morphology (van der Veen, 2008). Deltares has looked at the impact of wind farms on stratification for various areas of the North Sea (Deltares, 2021). Afbeelding 7.13 shows the different areas that were surveyed. The study indicates that the area in which IJmuiden Ver is located (Southern English Coast in Afbeelding 7.13) is fully mixed, and changes in stratification as a consequence of the presence of the wind farm do not occur. The area to the east of IJmuiden Ver, closer to the coast (Rhine ROFI), is, however, sensitive to the impacts of stratification. Due to improved mixing and the availability of more nutrients in the upper layers, this could lead to an increase in primary production. Further studies are needed into the potential impacts of wind farms outside this area (such as IJmuiden Ver) on stratification in the area close to the coast that is sensitive to stratification. The impacts in relation to cumulation at the level of the IJmuiden Ver wind energy area are assessed as neutral	
Birds and bats	For birds, there is no indication of significant cumulative effects of Dutch offshore wind farms. Cumulative effects of international wind farms on the auk and guillemot cannot be ruled out. However, it is likely that the assessment of international wind farms will lead to a different outcome if the worst-case assumptions are better aligned. Significant cumulative effects cannot be ruled out for the rough pipistrelle	Shutdown function for bats
Aquatic life	Cumulative impacts can be ruled out for bottom-dwellers, fish and marine mammals	None
Safety of shipping	The cumulative impact of the various wind farms on potential collisions between ships and turbines (ship-turbine collisions) is significant. The total anticipated collision frequency for the RK2030 scenario is 0.56, which is equal to once every 1.8 years. For the scenario that includes an acceleration of development of wind energy, this frequency rises to 0.987, which is equivalent to roughly once per year	None

Aspect	Relevant cumulative impacts	Consequences for the wind farm site decision
Landscape and visibility	More offshore wind farms are planned. Cumulation can come about due to the development of multiple wind farms that, from a distance, are perceived as one whole, causing the horizon to appear 'full'. The wind farms could actually shield one another, as they are located behind one another. The IJmuiden Ver wind farm will have little contribution to cumulation on account of its very low visibility from the coast.	None
Other usage functions	Additional area closures will mean that the area available for fishing will be reduced and there will be fewer locations for oil and gas extraction, dumping dredging spoils and recreation. The impacts of this limitation are low due to the development of wind farm sites I - IV. The precise scope of other area closures is unknown, which means that the cumulative impacts cannot be quantified. These cumulative impacts have no impact on the wind farm site decision	None

2.6 Cross-boundary impacts

When it comes to cross-boundary impacts, the impacts on birds and marine mammals are important. The following looks at this in more detail.

Birds

The eastern coast of Great Britain is home to colonies of breeding sea birds. Some of those birds could reach the IJmuiden Ver wind farm site III wind farm during foraging trips from the colonies. If these birds were to avoid the IJmuiden Ver wind farm area after its completion, it would represent a loss of habitat. In view of the location of the wind farm, far from the English coast, the number of breeding birds that could reach this area will be low. In the case of the gannet, even though birds may travel up to 200 km from their colonies to forage, most birds travel much shorter distances, which means that very few birds will reach the wind farm from British colonies (Wakefield et al. 2013). For both species, the loss of habitat for breeding birds on account of IJmuiden Ver is negligibly small. IJmuiden Ver is well outside of the foraging range of all other British, Belgian and German breeding birds. As such, significant impacts on breeding birds from foreign colonies can be ruled out.

Marine mammals

Significant impacts of the IJmuiden Ver wind farm site III wind farm and cumulation of all wind farms (including international wind farms) on marine mammals have been ruled out (See Section 9). This means that there are no significant cross-boundary impacts.

2.7 Mitigating measures

Following assessment, the conditions from the legal framework can be satisfied for virtually all aspects. Mitigating measures, such as the underwater noise standard (taken into consideration in the impact assessment), are needed to limit the cumulative impacts on birds, bats and porpoises in order to ensure that

there is no deterioration to the conservation status. The occurrence of (residual) negative impacts from construction, usage and removal of the wind farm cannot, however, be ruled out. These potential residual impacts can be mitigated by means of the measures shown in the table below. These are additional measures. Decision-making relating to which mitigating measures to take will form part of the wind farm site decision.

Table 2.16 Potentially applicable mitigating impacts

Aspect	Impact	Potentially applicable mitigating measures
Morphology and hydrodynamics	There are no significant impacts. There is, therefore, no need for mitigating measures	None
Birds and bats	Significant negative impacts on birds can be ruled out; the conservation status of birds will not be affected. With cumulation, negative impacts on the conservation status of nathusius' pipistrelle cannot be ruled out	A number of mitigating measures are available to limit the number of deaths due to bird collisions. Generally speaking, mitigation options come down to the following measures: Improving the visibility of the turbines Using a smart camera detection system linked to a shutdown function Periodic shutdown during the most critical periods Choosing a turbine type with a more favourable relationship between energy yield and the number of collision victims (tip low point) An effective form of mitigation for bats could be to increase the cut-in speed (the wind speed at which the turbine begins to rotate). An elaboration of a shutdown function for the IJmuiden Ver wind farm can be found in Booman and Japink (2022 in draft)
Aquatic life	There are no significant impacts on aquatic life as a consequence of the construction and commissioning of the IJmuiden Ver wind farm site III wind farm if the underwater noise standard and soft/slow start examined in the assessment are applied. As a result, no additional mitigating measures are needed. There may be residual negative impacts of underwater noise on marine mammals	There are a number of ways to limit the negative impacts of underwater noise on marine mammals during the construction of offshore wind farms: Limiting the area disrupted by noise and/or Carrying out pile driving in a season with a relatively low density of marine mammals and/or Limiting the number of days of disruption (= the number of foundations) or Using a different installation method and foundation type that produces less noise (such as vibrating, blue piling or screwing)
Safety of shipping	There are no significant impacts on the safety of shipping as a consequence of the construction and commissioning of the IJmuiden Ver wind farm site III wind farm. A limited number of negative impacts can, however, be expected	The following mitigating measures may be taken to reduce the impacts on the safety of shipping: As a base station, radar and VHF antenna Vessel Traffic Management Additional marking and identification of wind turbines

Aspect	Impact	Potentially applicable mitigating measures
		Use of an Emergency Towing Vessel Additional SAR capacity Capacity to tackle oil spills Physical security of wind farms
Landscape and visibility	There are no significant impacts. There is, therefore, no need for mitigating measures	None
Other usage functions	There are no significant impacts on the other usage functions as a consequence of the construction and commissioning of the IJmuiden Ver wind farm site III wind farm. A limited number of negative impacts can, however, be expected	The following mitigating measures may help to reduce the negative impacts on other usage functions: Raising the lowermost flying altitude of the helicopter route Carry out an extensive geophysical (bathymetric) survey to prepare for NGE-specific detection

2.8 Preferred alternative

A preferred alternative can be proposed on the basis of the assessment of the alternatives, which will be defined in the wind farm site decision. This requires insight into the range that has been considered and into the mitigating measures that need to be taken.
Some of the mitigating measures and/or standards that must be taken/adopted have already been determined in the KEC 4.0 and are reflected in the range of the alternatives that can be used – as is the case with the underwater noise standard, for example. The point of departure in the EIA is that these measures will be laid down as binding in the wind farm site decision. Additional mitigating measures can be taken on the basis of the EIA to either eliminate or minimise the impacts (see paragraph 14.6).
The following table indicates which measures need to be taken in order to arrive at a permissible impact from the construction and operation of the IJmuiden Ver wind farm site III wind farm. These measures also need to be defined in the wind farm site decision.

Table 2.17 EIA survey and determination of range to be issued

Aspect	Impact	Permissibility	Measures	To be defined in the wind farm site decision
Birds	The number of collisions per species per year is included in Tabel 8.10	The 1 per cent mortality standard is not surpassed	Shutdown function, increased tip low point	No, not applicable, as the impact is permissible and the measure has serious consequences for the proposal
	Barrier effects causing birds to have to divert	The impact is marginal and permissible	Adjustment to wind farm perimeter	No, not applicable, as the impact is permissible and the measure has serious consequences for the proposal
Bats	Number of collisions is 50 per year for alternative A and 67 per year for alternative B	The 1 per cent mortality standard is not surpassed for wind farm site III, significant impacts in	Increase in the cut-in wind speed[1] in the risk period	Yes, in order to minimise the impacts

[1] The cut-in wind speed is the specified wind speed at which the wind turbine begins to generate. The wind turbine operates in neutral below this speed. The cut-in wind speed varies between turbine types, but is usually around 3.5 m/s. An intervention could increase the cut-in wind speed.

Aspect	Impact	Permissibility	Measures	To be defined in the wind farm site decision
		cumulation cannot be ruled out		
Porpoises and seals	The number of days of disruption to animals is included in Tabel 9.8, Tabel 9.9, Tabel 9.10, and Tabel 9.11	There is no significant impact on populations of porpoises or seals, provided that the noise standard, soft start and ADD are applied	Maximum underwater noise level of 164 dB µPa2s SELss (750 m from the source) in the case of pile driving	Yes, in the form of the noise standard 164 dB µPa2s SELss (750 m from the source) in the case of pile driving

2.9 Gaps in knowledge, monitoring and evaluation

The point of departure for the EIA is use of the most current and best available knowledge on the topic. The EIA provides an indication wherever important information is unavailable and what the consequences of this gap in knowledge are for impact determination and assessment. The gaps in knowledge do not give rise to an incomplete picture of the impacts of the development of the IJmuiden Ver wind farm site III wind energy area. It is, however, important that there is insight during the decision-making process into the uncertainties that played a role in the impact predictions.

The Wozep (offshore wind energy ecological programme) monitoring and evaluation programme focuses on key ecological issues relating to the construction and operation of offshore wind farms – these issues are primarily generic in nature and less specific to wind farms. The Wozep covers both the further development of the KEC tool (update and implementation of knowledge) and the MEP (the monitoring and surveying programme). The latter covers monitoring and surveying as required under the Environmental Management Act (*Wet Milieubeheer*). The Wozep thus supersedes the monitoring obligation for each wind farm. This represents an improvement in efficiency that also contributes to cost-efficient realisation of the objectives for offshore wind energy. Evaluation of the Wozep focuses in particular on the translation of new knowledge into the KEC tool on the one hand (this could also include checking assumptions and/or impact calculations) and on translation into consequences for policy and management on the other.

The gaps in knowledge from the EIA offer input for monitoring within Wozep (for the ecological aspects) and for monitoring for the shipping, morphology and hydrodynamics aspects.

Summary Environmental Impact Assessment

Site Beta (formerly Site IV)

2

SUMMARY

2.1 Introduction

2.1.1 Motivation

The Netherlands has set ambitious targets for the reduction of CO_2 emissions and, accordingly, the production of sustainable energy. Important steps have already been taken with the Energy Agreement for Sustainable Growth (the 'Energy Agreement') of 2013[1]. Following that, the Energy Report[2], subsequent Energy Dialogue[3] and the Energy Agenda[4] laid the foundation for longer-term energy policy leading up to 2050. Offshore wind energy plays a key role in the energy policy.

Offshore wind energy roadmap

The Offshore Wind Energy Act (*Wet windenergie op zee*) gives the government the ability to define and then issue wind farm sites for the development of offshore wind farms. In alignment with the policy intentions in the 'roadmap for offshore wind energy'[5] from 2014, wind farm sites have been defined in the Borssele, Hollandse Kust (south) and Hollandse Kust (north) wind energy regions. The commissioning of wind farms on these wind farm sites will meet the target for offshore wind energy set out in the Energy Agreement, i.e. approx. 4.5 GW of offshore wind energy capacity by 2023.

In alignment with the Energy Agenda, the follow-up roadmap for 2018, the 'roadmap for offshore wind energy 2030'[6] plots out the general principles for the further roll-out of offshore wind energy for the period leading up to 2030. The roadmap provides for the issue of a capacity of 6.1 GW up to 2030, coming on top of the 4.5 GW already referred to in the 2023 roadmap. This addition of capacity will require the definition and issue of new wind farm sites in coming years. The wind farm sites will be defined within the boundaries of the areas already designated as wind energy areas in the National Water Plan. This concerns 1.4 GW in the Hollandse Kust (west) area, 0.7 GW in the area to the north of the Wadden Islands and approx. 4 GW in the IJmuiden Ver area.

In 2022, the roadmap for offshore wind energy 2030 was supplemented by an anticipated issue of 10.7 GW on top of the original 10.6 GW. This was made up of an additional 2 GW in IJmuiden Ver wind farm sites V and VI, 2 GW in Nederwiek (south) and 2 GW in Nederwiek (north), with wind farm sites still to be identified for a total capacity of 4.7 GW in the Doordewind, Nederwiek (north) and Hollandse Kust (west) wind energy areas.

Environmental impact report for the wind farm site decision

The Minister for Climate and Energy, in agreement with the Minister for Infrastructure and Water Management, the Minister for Housing, Spatial Planning and the Environment and the Minister for Nature

[1] Energy Agreement for Sustainable Growth Parliamentary Papers II, 2012/13, 30 196, no. 202.
[2] Energy Report 'Transitie naar duurzaam ('Transition to sustainable'), Parliamentary Papers II, 2015/16, 31 510, no. 50.
[3] Parliamentary Papers II, 2016/17, 30 196, no. 484.
[4] Energy Agenda 'Naar een CO2-arme energievoorziening' ('Towards a low-CO_2 energy supply'), Parliamentary Papers II, 2016/17, 31 510, no. 64.
[5] Parliamentary Papers I/II, 2014/15, 33 561, A/no. 11 Reprint.
[6] Parliamentary Papers II, 2017/18, 33 561, no. 42.

and Nitrogen, can take wind farm site decisions and formulate an environmental impact assessment for the decision.

This document is the EIA for wind farm site IV in the IJmuiden Ver wind energy area (see afbeelding 1.1). The EIA examines the environmental impacts that occur during construction, operation and removal of the wind turbines on/from the wind farm site.

The wind farm will be connected to the onshore high-voltage grid. This connection is not part of the wind farm site decision, nor part of this EIA procedure. The proposed wind farm sites I and II will be connected to the grid at sea, at IJmuiden Ver Alpha. The proposed wind farm sites III and IV will be connected to the grid at sea, at IJmuiden Ver Beta. A separate state coordination procedure will be followed for each grid at sea, including a separate EIA procedure. These will look at the offshore platform, the cables routed from the platform onshore and connection to the onshore high-voltage grid via a converter station.

2.1.2 EIA procedure

Why an environmental impact assessment?

The environmental impact assessment (EIA) procedure is prescribed on the basis of European and national legislation if there is a possibility of activities (or decision-making regarding such activities) with potentially significant environmental impacts. These activities are described in the Environmental Impact Report Decree. As this project will see the development of more than 20 wind turbines, the wind farm site decision (as referred to in Section 2 of the Offshore Wind Energy Act) requires an EIA. The EIA procedure gives rise to a report – the environmental impact report.

In addition, in view of the fact that impacts on Natura 2000-areas cannot be ruled out beforehand, an 'appropriate assessment' has also been put together. This is appended to this EIA in full as Annex III – Nature assessment. To ensure readability, the key findings relating to the impacts on qualified values in relation to specific Natura 2000-areas have also been incorporated into the main text of the this EIA.

The purpose of the EIA is to fully consider the environmental interest in the decision-making relating to the wind farm site decision. The environmental impact assessment offers insight into the following elements:

- It underpins the suitability of the IJmuiden Ver location as a wind energy area (see Section 5 of the EIA).
- It underpins the subdivision of the IJmuiden Ver wind energy area (see Section 5 of the EIA).

It offers insight into the impacts of positioning alternatives for the wind turbines within the wind farm sites. To this end, the features of the wind turbines, including foundation, shaft height and rotor diameter, have been varied (see Sections 7 to 12 of the EIA).

The EIA procedure

The EIA is formulated by order of the Minister for Climate and Energy, the wind farm site decision is taken in liaison with the Minister for Infrastructure and Water Management, the Minister for Housing, Spatial Planning and the Environment and the Minister for Nature and Nitrogen.

There are two points within the EIA procedure at which input is invited. The first took place on the basis of the 'Memorandum regarding Scope and Level of Detail' (NRD) for wind farm site decisions I, II, III and IV for the IJmuiden Ver wind energy area. This NRD was available for inspection from 25 February to 8 April 2022 and the public was invited to submit its views. One was received. The NRD was also submitted to the statutory advisors for consultation. The Minster then adopted a final NRD, which provides the framework for this EIA. The second input point will occur with the draft wind farm site decisions for wind farm sites III and IV for IJmuiden Ver. This input period will be announced by means of publication in the Official Gazette or by other suitable means. Views will be worked into the ultimate wind farm site decisions. Appeals against the decisions may be submitted to the Administrative Jurisdiction Division of the Council of State.

2.1.3 Reading guide

The is a summary of the EIA for wind farm site IV of the IJmuiden Ver wind energy area. Following the introduction in paragraph 2.1, paragraph 2.2 examines the choice of location and subdivision, while paragraph 2.3 outlines the approach to the impact assessment. Paragraph 2.4 outlines the conclusions of the impact assessment, followed by a description of the cumulation in paragraph 2.5, and cross-boundary impacts in paragraph 2.6. Paragraph 2.7 examines mitigating measures. The summary concludes with a description of the preferred alternative in paragraph 2.8 and gaps in knowledge, monitoring and evaluation in paragraph 2.9.

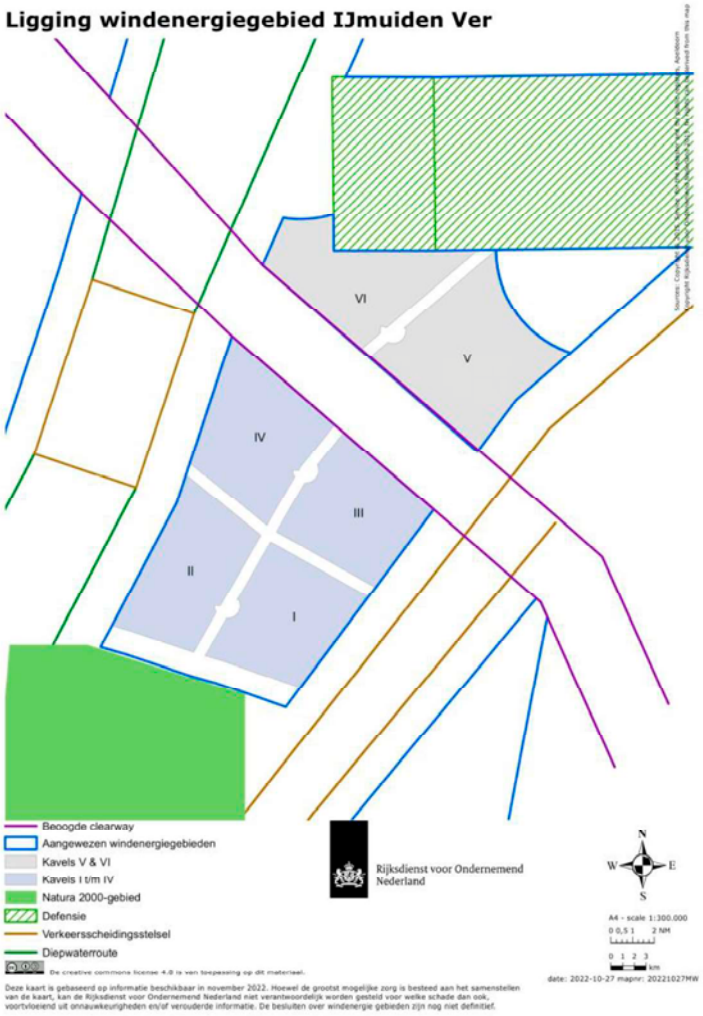
2.2 Choice of location and subdivision

The extent of the IJmuiden Ver wind energy area for the realisation of wind energy was explored in (the plan EIA to) the National Water Plan. As part of the process, the impacts of wind energy in the IJmuiden Ver wind energy area were broadly examined in terms of ecology, the safety of shipping, other usage functions (oil and gas, fishery, sand extraction, defence, etc.), geology and hydrology, landscape (visibility), recreation (navigation), cultural history and archaeology.

The plan EIA also considered the suitability when compared with other areas designated for wind energy.[1] The outcome of this consideration is that the area is no less suitable than the other designated areas. Negative impacts are generally comparable. When it comes to shipping and recreation, the impacts are less than those for the Hollandse Kust (south, north and west) wind energy area. The designated IJmuiden Ver wind energy area is located within the Exclusive Economic Zone (EEZ) of the Netherlands, at around 62 km from the coast. The proposed area for wind farm sites I - IV has a total surface area of around 400 km^2. See the location of the wind energy area in figure 1.1.

[1] www.zoek.officielebekendmakingen.nl/blg-14240.pdf.

Figure 2.1 Location of wind farm site IV in the IJmuiden Ver wind energy area (the locations of wind farm sites I and II are also visible)[1]



There is space within the IJmuiden Ver wind energy area for six wind farm sites, each of approx. 1 GW. The six wind farm sites and areas of IJmuiden Ver are shown in figure 2.1. This EIA looks at the proposed wind farm site IV from the area to the south of the proposed clearway. The TenneT platform Beta will come between wind farm sites III and IV.

No subdivision alternatives

A point of departure in the 2022 - 2027 North Sea Programme is the preservation of Natura 2000-areas. A second point of departure is the need for a clearway in the designated IJmuiden Ver wind energy area, to enable safe passage for shipping. Vessels requiring safe passage in this area are ferries on the Newcastle, UK route and more generally, those on busy shipping routes to the ports of IJmuiden and Amsterdam. A third point of departure is that the northernmost reaches of the IJmuiden Ver wind energy area are an additional wind energy area according to the supplement to the roadmap. The northernmost reaches of the IJmuiden Ver wind energy area will be used for two wind farm sites, V and VI, each of 1 GW. These two additional wind farm sites are needed to allow offshore wind energy to meet the agreement for 2030 as set out in the Climate Agreement in time (a 49 per cent reduction in CO_2) and the tighter European target of a 55 per cent reduction in CO_2 by 2030. With this in mind, a separate proposal, including corresponding draft NRD, was available for inspection between 1 July and 11 August 2022. Given these points of departure, no alternative subdivision has been examined for wind farm site IV in this EIA.

[1] This map was drawn in April 2022; the wind farm site boundary has been adjusted, see below in the EIA.

2.3 Approach to the impact assessment

This EIA surveys and assesses the environmental impacts of the proposed activity, the construction of the IJmuiden Ver (wind farm site IV) wind farm. This impact analysis and assessment were carried out on the basis of different alternatives. An alternative is a potential way in which the proposed activity – in this case the generation of an installed capacity of approx. 1 GW with wind turbines – can be accomplished taking into account the purpose of this activity. The alternative approach includes surveying a range of different wind turbine setups and types within the wind farm site

Range of setup options
Issuing a wind farm site that allows for different turbine setups, types and foundation methods, within a pre-determined range, facilitates a flexible layout of the wind farm site. Within that range, the developer has the freedom to create as optimal a layout as possible for the wind farm in terms of both cost effectiveness and energy yield. The range approach imposes specific requirements on the EIA. All environmental impacts that are associated with potential setups that facilitate the wind farm site decision must be looked at. In view of the number of conceivable combinations, however, surveying all possible setups is not possible. Consequently, a worst-case approach is assumed – if the worst-case situation for the range is permissible in terms of impact, then all setups within the range are possible.

Alternatives
The worst-case situation will vary according to the environmental impact or user interest – for example, consider the various intervention/impact relationships for birds and marine mammals. Moreover, a best-case situation can also be conceived for each environmental impact – i.e. the situation in which the least impact on the environment is anticipated. The study takes this into consideration by defining and assessing both the likely worst-case and best-case situation for each environmental impact. The parameters that define the worst-case and best-case situations are named and described – these include aspects such as the maximum number of turbines, maximum rotor surface area, characteristics of the foundation method, etc.

The range of possible implementations within the wind farm site to be issued is indicated in the following table. Range values are based on the current state of the art and on expectations relating to developments for coming years. The range that must be adhered to will be defined in the wind farm site decision.

Table 2.1 Roadmap of the range to be used for wind farm site IV in the EIA

Topic	Range
total installed capacity per wind farm site	approx. 1 GW
maximum number of turbines	50 - 67
capacity of individual wind turbines	minimum 15 MW, maximum 20 MW
tip high point of individual wind turbines	maximum 305 m
tip low point of individual wind turbines	minimum 25 m
rotor diameter of individual wind turbines	236 - 280 m
distance between individual wind turbines	minimum 4x the rotor diameter
number of blades per wind turbine	2, 3
foundation type	monopile, multipile, gravity-based structure, suction bucket
noise level in case of foundation pile driving	160 dB and 164 dB µP2s SELss (at 750 m from source)
in the case of foundation pile driving: diameter of foundation pile/ piles and number of piles per turbine:	
monopile	1 pile of 11.5 - 15 m in diameter
multipile (including 'tripods' and 'jackets')	3 to 4 piles of 3 - 5 m in diameter

Topic	Range
in the case of a foundation without pile driving: dimensions at seabed:	
gravity-based	to 50 m in diameter
suction bucket	to 30 m in diameter
electrical infrastructure (inter-array cabling)	66 kV, buried at approx. 1 m and maintained at depth

The worst-case situation may vary for certain aspects, such as for birds and for marine mammals. The table below indicates the worst-case and best-case situations for different environmental aspects.

Table 2.2 Worst case and best case within the range for each environmental aspect

Environmental aspect	Range	
	Alternative A: best case/lowest impact	Alternative B: worst case/highest impact
Morphology and hydrodynamics	67 x 15 MW turbines, tripod	50 x 20 MW turbines, gravity-based
Birds and bats*	50 x 20 MW turbines, tip low point 25 m, rotor diameter 280 m	67 x 15 MW turbines, tip low point 25 m, rotor diameter 236 m
Aquatic life	50 x 20 MW turbines, tip low point 25 m, rotor diameter 280 m, gravity-based	67 x 15 MW turbines, tip low point 25 m, rotor diameter 236 m, monopile/jacket
Shipping	50 x 20 MW turbines, monopile	67 x 15 MW turbines, jacket
Energy and climate	50 x 20 MW turbines	67 x 15 MW turbines
Landscape	67 x 15 MW turbines	50 x 20 MW turbines
Other usage functions*	50 x 20 MW turbines	67 x 15 MW turbines

* It may be necessary to reverse the worst-case and best-case situations; this is ultimately based on the impact assessment.

Assessment

To be able to compare the impacts of the variants by aspect, these are assessed on the basis of a +/- scale in respect of the zero alternative. The following assessment scale is used here, as shown in the table below. The assessment is substantiated.

Table 2.3 Scoring method

Score	Verdict in respect of the zero alternative (reference situation)
--	the proposal leads to a very noticeable negative change
-	the proposal leads to a noticeable negative change
0	the proposal cannot be distinguished from the zero alternative
+	the proposal leads to a noticeable positive change
++	the proposal leads to a very noticeable positive change

In the event that the impacts are marginal, this is indicated by 0/+ (marginal positive) or 0/- (marginal negative) in the cases in question. Cross-boundary impacts are considered separately in this EIA. Insight is also offered into cumulative impacts. For each aspect, it is then explored whether mitigating measures might

be conceived in order to either minimise or eliminate the scope of the impact. Where possible, impacts with and without the measures are considered separately in this EIA.

2.4 Conclusions of the impact assessment

Sections 7 to 12 outline the impacts of alternatives A and B and assess them in respect of the reference situation. Alternatives A and B in this EIA comprise the extreme points of departure for each aspect that are possible. This EIA thus looks at the maximum range within which environmental impacts could occur. The tables in this section provide the assessments of the alternatives for wind farm site IV for each assessment criteria. This is based on a seven-point scale as outlined in the Method section (Section 5). The following paragraphs summarise the overall impact assessment for both alternatives for each environmental topic.

2.4.1 Morphology and hydrodynamics

All morphological and hydrodynamic changes that are the consequence of the construction, operating and removal of the proposed IJmuiden Ver wind farm site IV wind farm and the inter-array cables are limited in scope. Moreover, the impacts during construction and removal are only temporary in nature. The changes, where they occur, are minor when compared with the natural dynamics of the area. In view of the relatively small dimensions of the foundation piles, the relatively large distance between the wind turbines and the number of wind turbines, changes are very local changes. The impact is limited to the immediate vicinity of the foundation piles and the farm cabling route and is temporary in nature.

Table 2.4 Impact assessment for morphology and hydrodynamics – usage phase and construction and removal – wind farm site IV

Aspect	Assessment criteria	Alternative A (15 MW)	Alternative B (20 MW)
Morphology and hydrodynamics	impact on water movement (water level/flow)	neutral (0)	neutral (0)
	impact on water depth and seabed shapes	neutral (0)	neutral (0)
	impact on seabed composition	neutral (0)	neutral (0)
	impact on turbidity and water quality (including the impact of cathodic protection)	neutral (0)	neutral (0)
	impact on sediment transport	neutral (0)	neutral (0)
	impact on coastal defence	not surveyed	not surveyed

2.4.2 Birds

Wind farm site IV construction/removal

Construction and removal activities are temporary in nature and spread over a relatively small area. The impacts are assessed as slightly negative (0/-) for both alternatives. The additional shipping movements during the construction and removal phase are temporary in nature and spread over a relatively small area. The impacts are assessed as slightly negative (0/-) for both alternatives.

Table 2.5 Impact assessment for birds – construction/removal – wind farm site IV

Aspect	Assessment criteria	Alternative A (20 MW)	Alternative B (15 MW)
birds (all groups)	disruption during construction/removal of foundation	slightly negative (0/-)	slightly negative (0/-)
	disruption due to increase in shipping	slightly negative (0/-)	slightly negative (0/-)

Wind farm site IV usage phase

Local sea birds

Based on the original model calculations, relatively high mortality rates were predicted for gannets, causing the 1 per cent mortality standard to be surpassed. With the availability of new data, Waardenburg Ecology has carried out a revision of the input parameters used. The new data have led to the predicted number of collision victims being revised downwards, with the 1 per cent mortality standard now no longer surpassed. A negative impact on the favourable conservation status of gannets can thus be ruled out – a negative impact on the conservation status of other sea birds has also been ruled out. Although there is a difference in the number of collisions, both alternatives are assessed as slightly negative (0/-).

The number of birds predicted to die each year due to loss of habitat as a consequence of the IJmuiden Ver wind farm site IV wind farm during the usage phase is less than ten for all species with the exception of the guillemot. These have the highest presence in the IJmuiden Ver wind farm and, using this calculation method, it can be assumed that nineteen birds will die each year per wind farm site due to loss of habitat. This impact is assessed as slightly negative (0/-) for both alternatives. For local, non-breeding sea birds, the IJmuiden Ver wind farm site IV wind farm will have no significant impact of barrier effects as for these species, as there are no targeted movements at sea where a wind farm could act as an obstruction to the flight path. The impact is assessed as neutral (0) for both alternatives.

The anticipated increase in benthos and fish (Lindeboom *et al.* 2011) in the IJmuiden Ver wind farm site IV wind farm may help to improve foraging conditions. The impacts are assessed as slightly positive (0/+) for both alternatives as a result. The additional use of ships for wind farm maintenance in the IJmuiden Ver wind energy area may lead to some disruption to sea birds. The duration and scope of maintenance activities in the IJmuiden Ver wind energy area are of (much) more limited scope than activities for construction and removal. Although there is a difference between the alternatives (different numbers and types of turbine), no distinction is drawn in this assessment in view of the limited scope of the impacts. The (additional) impacts of maintenance are assessed as slightly negative (0/-) for both alternatives.

Coastal (breeding) birds

Only the lesser black-backed gull is a relevant as a breeding bird; the wind farm is well beyond the range of other species of breeding bird. The 1 per cent standard is not surpassed for this species, which means that negative impacts on the favourable conservation status can be ruled out. The impact (collision risk) is assessed as slightly negative (0/-) for both alternatives.

IJmuiden Ver is located at the outer extreme of the foraging range of the lesser black-backed gull. As such, the area is not especially important for breeding birds, which means that the impact on loss of habitat is negligibly small. The impact in terms of loss of habitat is assessed as slightly negative (0/-) for both alternatives.

The wind farm is located at the outer extreme of the foraging range of the species that travels the farthest from the Dutch coast – the lesser black-backed gull. It follows, therefore, that only a negligible number of breeding birds travel farther out to sea than this wind farm, which means that the wind farm will not act as an obstacle to their route to foraging areas located farther from the coast. The impact for barrier effects is assessed as neutral (0) for both alternatives.

The anticipated increase in benthos and fish (Lindeboom *et al.* 2011) in a future wind farm in the IJmuiden Ver wind energy area may help to improve foraging conditions, including for breeding birds like the lesser black-backed gull. The wind turbines themselves, as well as any metering masts or transformer platforms, could offer resting and breeding sites for some species of sea bird, including gulls. The impacts in relation to the presence of wind turbines are assessed as slightly positive (0/+) for both alternatives as a result. The additional use of ships for wind farm maintenance in the IJmuiden Ver wind farm may lead to some disruption to sea birds, including breeding birds. The duration and scope of maintenance activities in the IJmuiden Ver wind energy area are of (much) more limited scope than activities for construction and removal. Although there is a difference between the alternatives (different numbers and types of turbine), no distinction is drawn in this assessment in view of the limited scope of the impacts. The (additional) impacts of maintenance are assessed as slightly negative (0/-) for both alternatives.

Migratory birds

When it comes to migratory birds, the mortality rate for wind farm site IV per species is sufficiently low when compared with the 1 per cent standard that negative impacts on the favourable conservation status can be ruled out. Although there is a difference between the alternatives (different numbers and types of turbine), no distinction is drawn in this assessment in view of the limited scope of the impacts. The impacts are assessed as slightly negative (0/-) for both alternatives. There is the potential for barrier effects amongst migratory birds, but the distance required for a detour is negligible when compared with the overall migration route. The impacts are assessed as neutral (0) for both alternatives as a result.

Table 2.6 Impact assessment for birds – usage phase – wind farm site IV

Aspect	Assessment criteria	Alternative A (20 MW)	Alternative B (15 MW)
Local sea birds	collision risk	slightly negative (0/-)	slightly negative (0/-)
	loss of habitat/change in foraging circumstances	slightly negative (0/-)	slightly negative (0/-)
	barrier effects	neutral (0)	neutral (0)
	disruption by wind turbines	slightly positive (0/+)	slightly positive (0/+)
	disruption due to wind farm maintenance	slightly negative (0/-)	slightly negative (0/-)
Breeding birds from Natura 2000	collision risk	slightly negative (0/-)	slightly negative (0/-)
	loss of habitat/change in foraging circumstances	slightly negative (0/-)	slightly negative (0/-)
	barrier effects	neutral (0)	neutral (0)
	presence of wind turbines	slightly positive (0/+)	slightly positive (0/+)
	disruption due to wind farm maintenance	slightly negative (0/-)	slightly negative (0/-)
Migratory birds	collision risk	slightly negative (0/-)	slightly negative (0/-)
	barrier effects	neutral (0)	neutral (0)

2.4.3 Bats

Wind farm site IV usage phase

The mortality rate for bats in wind farm site IV remains well below the 1 per cent standard. There is no suggestion of an impact on the favourable conservation status. This impact is assessed as slightly negative (0/-) for both alternatives. In cumulation with the planned wind farms in accordance with the supplementary roadmap, negative impacts on the favourable conservation status of the nathusius' pipistrelle bat cannot be ruled.

Table 2.7 Impact assessment for bats – usage phase – wind farm site IV

Aspect	Assessment criteria	Alternative A (20 MW)	Alternative B (15 MW)
bats	collision risk/barotrauma	slightly negative (0/-)	slightly negative (0/-)

2.4.4 Aquatic life

Wind farm site IV usage phase, bottom-dwellers

The potential nuisance experienced by bottom-dwellers and fish as a result of underwater noise and vibration (from maintenance ships) is assessed as slightly negative (0/-). Looking at the total habitat of the bottom-dweller and fish communities in the North Sea, the potentially disrupted area as result of electromagnetic radiation is negligibly small. The impact is assessed as slightly negative (0/-) as a result. The presence of wind turbines and stones to protect against erosion (alternative B – 67 x 15 MW) will change the habitat of bottom-dwellers from a wholly sandy substrate to a partly hard substrate. This may benefit biodiversity and biomass. The negative impact of surface loss is minimal, but greater in the case of alternative A owing to the larger surface area with use of gravity-based foundations. Alternative A is assessed as slightly positive (0/+), alternative B is assessed as neutral (0). Stopping current fishing activities in the area may have a positive impact on the development of bottom-dweller and fish communities. This is assessed as slightly positive (0/+) for both alternatives.

Table 2.8 Impact assessment for bottom-dwellers – usage phase – wind farm site IV

Aspect	Assessment criteria	Alternative A (50 x 20 MW)	Alternative B (67 x 15 MW)
Bottom-dwellers	disruption due to underwater noise and vibrations	slightly negative (0/-)	slightly negative (0/-)
	disruption due to electromagnetic fields	slightly negative (0/-)	slightly negative (0/-)
	increase in hard substrate	neutral (0)	slightly positive (0/+)
	ban on fishing activities affecting the seabed	slightly positive (0/+)	slightly positive (0/+)

Wind farm site IV construction and removal phase, bottom-dwellers

No demonstrable change on seabed fauna is observed due to construction of a wind farm. Very little is currently known about the impacts of the removal of a wind farm. The total area of disrupted seabed is negligibly small when compared with the overall habitat of the respective bottom-dweller communities in the North Sea. The impact is assessed as slightly negative (0/-).

It is observed that bottom-dwellers could experience nuisance from underwater noise (impulse nose during construction of monopiles and jackets and ongoing noise during removal) and vibrations and that species respond differently to this nuisance. In the case of alternative A, a gravity-based foundation is used and there is no pile driving, which means that the increase in noise is only minimal and the impact of wind farm site IV is assessed as neutral for alternative A. In view of the temporary nature of the impacts and the relatively small surface area subject to disruption from pile driving, this impact of wind farm site IV is assessed as slightly negative (0/-) for alternative B.

Table 2.9 Impact assessment for bottom-dwellers – construction and removal phase – wind farm site IV

Aspect	Assessment criteria	Alternative A (50 x 20 MW)	Alternative B (67 x 15 MW)
bottom-dwellers	disruption of the seabed	slightly negative (0/-)	slightly negative (0/-)
	disruption due to noise and vibrations	neutral (0)	slightly negative (0/-)

Wind farm site IV usage phase, marine mammals

Ongoing noise from operational wind turbines is generally only of importance if the ambient noise from the wind and shipping is relatively minimal. Impacts from shipping may occur, but surveys suggest that a greater number of porpoises were present during the usage phase of the OWEZ wind farm than during its construction, possibly as a result of more prey fish being present. This indicates that porpoises do not avoid the wind farm. The impact of the noise of the turbines and shipping (ongoing noise) during the usage phase of wind farm site IV is small (0/-).

Very little is known about the impacts of barrier effects and loss of habitat on marine mammals, but it is not expected that this impact will occur with an individual wind farm. In the case of a large number of wind farms in the North Sea, this impact could occur, in which case there would be a cumulative impact. The impact is assessed as slightly negative (0/-) for both alternatives.

With the current distribution and use of habitat by marine mammals, it is expected that potential impacts are likely to affect behaviour for only a short period of time, and locally. The impacts would be sufficiently small as not to have a considerable impact on marine mammals (0/-).

Table 2.10 Impact assessment for marine mammals – usage phase – wind farm site IV

Aspect	Assessment criteria	Alternative A (50 x 20 MW)	Alternative B (67 x 15 MW)
marine mammals	disruption due to underwater noise and vibrations from turbines and shipping	slightly negative (0/-)	slightly negative (0/-)
	barrier effects, loss of habitat	slightly negative (0/-)	slightly negative (0/-)
	electromagnetic radiation	slightly negative (0/-)	slightly negative (0/-)

Wind farm site IV construction and removal phase, marine mammals

The calculations indicate that for the scenarios that were studied, the number of days of disruption due to the construction of turbine foundations in wind farm site IV being higher than the number calculated for the IJmuiden Ver wind energy area in the KEC 4.0 can be ruled out. The KEC 4.0 concluded that this disruption will not have an impact on the population of porpoises and seals – this also applies to the results in this EIA. The impact of alternative B is slightly higher than that of alternative A due to the difference in the number of turbines and because, in the case of alternative A, a gravity-based foundation is assumed (in which case there is no pile driving). As such, the impact for alternative A is assessed as neutral (0) and for alternative B as slightly negative (0/-). There is no impact on the hearing of porpoises or seals (PTS), as noise-reducing measures are used.

Table 2.11 Impact assessment for marine mammals – construction and removal phase – wind farm site IV

Aspect	Assessment criteria	Alternative A (50 x 20 MW)	Alternative B (67 x 15 MW)
marine mammals	disruption, barrier effects, loss of habitat, changed foraging circumstances due to noise and vibrations during construction of foundations and geophysical surveying	neutral (0)	slightly negative (0/-)
	physical degradation (temporary hearing damage)	neutral (0)	slightly negative (0/-)

2.4.5 Safety of shipping

Calculations of the likelihood of collision with wind turbines have been performed for wind farm site IV. The total collision frequency for wind farm site IV is 0.0242 per year, which is equivalent to once every 41 years. This impact of wind farm site IV is assessed as slightly negative (0/-). Based on outdated points of departure relating to outflow of oil as a consequence of a collision with a wind turbine (thickness of a ship's hull and size of the turbines) and in expectation of the probable use of the SAMSON model, it has been decided not take the outflow of oil into account in this report as the uncertainties would otherwise become too great. In earlier impact assessments for environmental damage as a consequence of collisions with wind turbines, the impacts were assessed as neutral or slightly negative. As the existing points of departure do not directly suggest a conservative or optimistic approach, this aspect is assessed as slightly negative (0/-) on account of the uncertainty.

It is expected that there will be few if any situations in which wind farm site IV will impact lines of sight. As such situations cannot be ruled out in their entirety, the impact of wind farm site IV is assessed as slightly negative (0/-).

Table 2.12 Impact assessment for the safety of shipping – construction/removal and usage phase – wind farm site IV

Aspect	Assessment criteria	Alternative A	Alternative B
shipping and safety	risk of a collision, route-bound and non-route bound shipping	slightly negative (0/-)	slightly negative (0/-)
	consequential damage as a result of a collision, route-bound and non-route bound shipping	slightly negative (0/-)	slightly negative (0/-)
	possibilities for diversion for crossing shipping	slightly negative (0/-)	slightly negative (0/-)

2.4.6 Landscape and visibility

In view of the large distance from the coast to the wind farm site, the wind turbines on wind farm site IV at IJmuiden Ver will not be visible on account of the dip on the horizon, observation capacity and weather conditions. In the case of alternative A, the lighting on the nacelle will be beyond the horizon, which means that the wind turbine lighting will not be visible at night. In the case of alternative B, the lighting will not disappear beyond the horizon. In theory, this lighting could be visible in extremely clear conditions. This is highly likely to occur, however, as visibility rarely exceeds 50 km due to weather conditions. As a

consequence, both alternatives are assessed as neutral (0) as there is no impact on visibility and perception from the coast.

Table 2.13 Impact assessment for landscape and visibility – construction/removal and usage phase – wind farm site IV

Aspect	Assessment criteria	Alternative A	Alternative B
landscape and visibility	impacts on landscape and visibility	neutral (0)	neutral (0)

2.4.7 Other usage functions

As co-use for other functions is only possible to a limited extent in the case of offshore wind farms, the exclusion of these areas sometimes has a negative (-) impact on these functions. The impacts are limited by the relatively small size of the wind farm site when compared with the totality of the Dutch Continental Shelf (NCP). Fishermen will need to sail around the area to achieve the same catch. New gas extraction will be possible with angled drilling, but will be made more complicated by the wind farm. By raising the lowermost flying altitude, the negative impacts on aviation can be avoided. Thorough surveying for unexploded explosives will minimise the risk of damage during construction. The impacts between the alternatives differ for NGE, as in the case of a larger area of foundations (alternative B), the likelihood of encountering NGE is higher. Further surveying for NGE will, however, be carried out prior to construction activities in order to mitigate the impacts. Although the impacts may sometimes be marked as slightly negative, they can all be managed and thus have no effect on the wind farm site decision.

Table 2.14 Impact assessment for other usage functions – construction/removal and usage phase – wind farm site IV

Aspect	Assessment criteria	Alternative A	Alternative B
fishing	impact on area available and fishing grounds	slightly negative (0/-)	slightly negative (0/-)
	impact on economic value	negative (-)	negative (-)
	impact on circumnavigation	negative (-)	negative (-)
oil and gas extraction	impact on accessibility of helicopter platforms	neutral (0)	neutral (0)
	impact on future use of platforms for CCS or hydrogen	neutral (0)	neutral (0)
	impact on exploitation of fields in the ground	neutral (0)	neutral (0)
aviation	civil aviation	neutral (0)	neutral (0)
	helicopter traffic	neutral (0)	neutral (0)
	accessibility of TenneT platforms	neutral (0)	neutral (0)
	aircraft movements by the coastguard (SAR)	negative (-)	negative (-)
	military aviation	neutral (0)	neutral (0)
dredging spoil	restrictions on dredging spoil areas	neutral (0)	neutral (0)

Aspect	Assessment criteria	Alternative A	Alternative B
ship, shore and aviation radar	impacts on ship, shore and aviation radar	neutral (0)	neutral (0)
cables and pipes	impacts on cables and pipes	neutral (0)	neutral (0)
NGE	risk of unexploded explosives	neutral (0)	slightly negative (0/-)
telecommunications	disruption to cable connections and beam paths	neutral (0)	neutral (0)
military activities and munitions dumping areas	impacts on the use of space by defence (air force, navy) due to the presence of training areas and munitions dumping areas above and on the sea	neutral (0)	neutral (0)
recreation and tourism	accessibility of recreational waterways	slightly negative (0/-)	slightly negative (0/-)
	impacts on coastal tourism	neutral (0)	neutral (0)
cultural history and archaeology	impacts on archaeological values, such as mineral resources, shipwrecks, flooded landscapes	neutral (0)	neutral (0)
shellfish farming and aquaculture	impacts on mussel-seed collection systems and seaweed cultivation	neutral (0)	neutral (0)
existing wind farms	impacts of electricity yield on existing wind farms (wind capture)	neutral (0)	neutral (0)
electricity yield and emissions prevented	electricity generation	very positive (++)	very positive (++)
	amortisation period, construction energy	positive (+)	positive (+)
	CO_2 emissions reduction	very positive (++)	very positive (++)
	NO_x emissions reduction	very positive (++)	very positive (++)
	SO_2 emissions reduction	very positive (++)	very positive (++)
	impact on climate change	very positive (++)	very positive (++)

2.5 Cumulation

The following outlines the cumulative impacts that could occur for each aspect and the consequences of these for the wind farm site decision. The aspect is given in the first column; the second column states the impacts relevant to cumulation; the third column outlines the outcome of this for wind farm site IV.

Table 2.15 Cumulative impacts

Aspect	Relevant cumulative impacts	Consequences for the wind farm site decision
morphology and hydrodynamics	recent studies suggest that very large-scale wind energy development in the	none

Aspect	Relevant cumulative impacts	Consequences for the wind farm site decision
	North Sea could have an impact on the (mixing of) stratification (Carpenter, et al., 2016; Deltares, 2021) and water movement and morphology (van der Veen, 2008). Deltares has looked at the impact of wind farms on stratification for various areas of the North Sea (Deltares, 2021). afbeelding 7.13 shows the different areas that were surveyed. The study indicates that the area in which IJmuiden Ver is located (Southern English Coast in afbeelding 7.13) is fully mixed, and changes in stratification as a consequence of the presence of the wind farm do not occur. The area to the east of IJmuiden Ver, closer to the coast (Rhine ROFI), is, however, sensitive to the impacts of stratification. Due to improved mixing and the availability of more nutrients in the upper layers, this could lead to an increase in primary production. Further studies are needed into the potential impacts of wind farms outside this area (such as IJmuiden Ver) on stratification in the area close to the coast that is sensitive to stratification. The impacts in relation to cumulation at the level of the IJmuiden Ver wind energy area are assessed as neutral	
birds and bats	for birds, there is no indication of significant cumulative effects of Dutch offshore wind farms. Cumulative effects of international wind farms on the auk and guillemot cannot be ruled out. However, it is likely that the assessment of international wind farms will lead to a different outcome if the worst-case assumptions are better aligned. Significant cumulative effects cannot be ruled out for the rough pipistrelle	shutdown function for bats
aquatic life	cumulative impacts can be ruled out for bottom-dwellers, fish and marine mammals	none
safety of shipping	the cumulative impact of the various wind farms on potential collisions between ships and turbines (ship-turbine collisions) is significant. The total anticipated collision frequency for the RK2030 scenario is 0.56, which is equal to once every 1.8 years. For the scenario that includes an acceleration of development of wind energy, this frequency rises to 0.987, which is equivalent to roughly once per year	none
landscape and visibility	more offshore wind farms are planned. Cumulation can come about due to the development of multiple wind farms that, from a distance, are perceived as one whole, causing the horizon to appear 'full'. The wind farms could actually shield one another, as they are located behind	none

Aspect	Relevant cumulative impacts	Consequences for the wind farm site decision
	one another. The IJmuiden Ver wind farm will have little contribution to cumulation on account of its very low visibility from the coast	
Other usage functions	additional area closures will mean that the area available for fishing will be reduced and there will be fewer locations for oil and gas extraction, dumping dredging spoils and recreation. The impacts of this limitation are low due to the development of wind farm sites I - IV. The precise scope of other area closures is unknown, which means that the cumulative impacts cannot be quantified. These cumulative impacts have no impact on the wind farm site decision	none

2.6 Cross-boundary impacts

When it comes to cross-boundary impacts, the impacts on birds and marine mammals are important. The following looks at this in more detail.

Birds

The eastern coast of Great Britain is home to colonies of breeding sea birds. Some of those birds could reach the IJmuiden Ver wind farm site IV wind farm during foraging trips from the colonies. If these birds were to avoid the IJmuiden Ver wind farm area after its completion, it would represent a loss of habitat. In view of the location of the wind farm, far from the English coast, the number of breeding birds that could reach this area will be low. In the case of the gannet, even though birds may travel up to 200 km from their colonies to forage, most birds travel much shorter distances, which means that very few birds will reach the wind farm from British colonies (Wakefield et al. 2013). For both species, the loss of habitat for breeding birds on account of IJmuiden Ver is negligibly small. IJmuiden Ver is well outside of the foraging range of all other British, Belgian and German breeding birds. As such, significant impacts on breeding birds from foreign colonies can be ruled out.

Marine mammals

Significant impacts of the IJmuiden Ver wind farm site IV wind farm and cumulation of all wind farms (including international wind farms) on marine mammals have been ruled out (See Section 9). This means that there are no significant cross-boundary impacts.

2.7 Mitigating measures

Following assessment, the conditions from the legal framework can be satisfied for virtually all aspects. Mitigating measures, such as the underwater noise standard (taken into consideration in the impact assessment), are needed to limit the cumulative impacts on birds, bats and porpoises in order to ensure that there is no deterioration to the conservation status. The occurrence of (residual) negative impacts from construction, usage and removal of the wind farm cannot, however, be ruled out. These potential residual impacts can be mitigated by means of the measures shown in the table below. These are additional measures. Decision-making relating to which mitigating measures to take will form part of the wind farm site decision.

Table 2.16 Potentially applicable mitigating impacts

Aspect	Impact	Potentially applicable mitigating measures
morphology and hydrodynamics	there are no significant impacts. there is, therefore, no need for mitigating measures	none
birds and bats	significant negative impacts on birds can be ruled out; the conservation status of birds will not be affected. with cumulation, negative impacts on the conservation status of nathusius' pipistrelle cannot be ruled out	a number of mitigating measures are available to limit the number of deaths due to bird collisions. Generally speaking, mitigation options come down to the following measures: - improving the visibility of the turbines - using a smart camera detection system linked to a shutdown function - periodic shutdown during the most critical periods - choosing a turbine type with a more favourable relationship between energy yield and the number of collision victims (tip low point) an effective form of mitigation for bats could be to increase the cut-in speed (the wind speed at which the turbine begins to rotate). An elaboration of a shutdown function for the IJmuiden Ver wind farm can be found in Booman and Japink (2022 in draft)
aquatic life	there are no significant impacts on aquatic life as a consequence of the construction and commissioning of the IJmuiden Ver wind farm site IV wind farm if the underwater noise standard and soft/slow start examined in the assessment are applied. As a result, no additional mitigating measures are needed. There may be residual negative impacts of underwater noise on marine mammals	there are a number of ways to limit the negative impacts of underwater noise on marine mammals during the construction of offshore wind farms: - limiting the area disrupted by noise and/or - carrying out pile driving in a season with a relatively low density of marine mammals and/or - limiting the number of days of disruption (= the number of foundations) or - using a different installation method and foundation type that produces less noise (such as vibrating, blue piling or screwing)
safety of shipping	there are no significant impacts on the safety of shipping as a consequence of the construction and commissioning of the IJmuiden Ver wind farm site IV wind farm. A limited number of negative impacts can, however, be expected	the following mitigating measures may be taken to reduce the impacts on the safety of shipping: - as a base station, radar and VHF antenna - vessel Traffic Management - additional marking and identification of wind turbines - use of an Emergency Towing Vessel - additional SAR capacity - capacity to tackle oil spills - physical security of wind farms
landscape and visibility	there are no significant impacts. There is, therefore, no need for mitigating measures	none

Aspect	Impact	Potentially applicable mitigating measures
other usage functions	there are no significant impacts on the other usage functions as a consequence of the construction and commissioning of the IJmuiden Ver wind farm site IV wind farm. A limited number of negative impacts can, however, be expected	the following mitigating measures may help to reduce the negative impacts on other usage functions: - raising the lowermost flying altitude of the helicopter route - carry out an extensive geophysical (bathymetric) survey to prepare for NGE-specific detection

2.8 Preferred alternative

A preferred alternative can be proposed on the basis of the assessment of the alternatives, which will be defined in the wind farm site decision. This requires insight into the range that has been considered and into the mitigating measures that need to be taken.

Some of the mitigating measures and/or standards that must be taken/adopted have already been determined in the KEC 4.0 and are reflected in the range of the alternatives that can be used – as is the case with the underwater noise standard, for example. The point of departure in the EIA is that these measures will be laid down as binding in the wind farm site decision. Additional mitigating measures can be taken on the basis of the EIA to either eliminate or minimise the impacts (see paragraph 14.6).

The following table indicates which measures need to be taken in order to arrive at a permissible impact from the construction and operation of the IJmuiden Ver wind farm site IV wind farm. These measures also need to be defined in the wind farm site decision.

Table 2.17 EIA survey and determination of range to be issued

Aspect	Impact	Permissibility	Measures	To be defined in the wind farm site decision
birds	the number of collisions per species per year is included in tabel 8.10	the 1 per cent mortality standard is not surpassed	shutdown function, increased tip low point	no, not applicable, as the impact is permissible and the measure has serious consequences for the proposal
	Barrier effects causing birds to have to divert	the impact is marginal and permissible	adjustment to wind farm perimeter	no, not applicable, as the impact is permissible and the measure has serious consequences for the proposal
bats	number of collisions is 50 per year for alternative A and 67 per year for alternative B	the 1 per cent mortality standard is not surpassed for wind farm site IV, significant impacts in cumulation cannot be ruled out	increase in the cut-in wind speed1 in the risk period	yes, in order to minimise the impacts
porpoises and seals	the number of days of disruption to animals is included in tabel 9.8, tabel 9.9,	there is no significant impact on populations of porpoises or seals, provided that the noise	maximum underwater noise level of 164 dB µPa2s SELss (750 m from the source) in the case of pile driving	yes, in the form of the noise standard 164 dB µPa2s SELss (750 m from the source) in the case of pile driving

[1] The cut-in wind speed is the specified wind speed at which the wind turbine begins to generate. The wind turbine operates in neutral below this speed. The cut-in wind speed varies between turbine types, but is usually around 3.5 m/s. An intervention could increase the cut-in wind speed.

Aspect	Impact	Permissibility	Measures	To be defined in the wind farm site decision
	tabel 9.10, and tabel 9.11	standard, soft start and ADD are applied		

2.9 Gaps in knowledge, monitoring and evaluation

The point of departure for the EIA is use of the most current and best available knowledge on the topic. The EIA provides an indication wherever important information is unavailable and what the consequences of this gap in knowledge are for impact determination and assessment. The gaps in knowledge do not give rise to an incomplete picture of the impacts of the development of the IJmuiden Ver wind farm site IV wind energy area. It is, however, important that there is insight during the decision-making process into the uncertainties that played a role in the impact predictions.

The Wozep (offshore wind energy ecological programme) monitoring and evaluation programme focuses on key ecological issues relating to the construction and operation of offshore wind farms – these issues are primarily generic in nature and less specific to wind farms. The Wozep covers both the further development of the KEC tool (update and implementation of knowledge) and the MEP (the monitoring and surveying programme). The latter covers monitoring and surveying as required under the Environmental Management Act (*Wet Milieubeheer*). The Wozep thus supersedes the monitoring obligation for each wind farm. This represents an improvement in efficiency that also contributes to cost-efficient realisation of the objectives for offshore wind energy. Evaluation of the Wozep focuses in particular on the translation of new knowledge into the KEC tool on the one hand (this could also include checking assumptions and/or impact calculations) and on translation into consequences for policy and management on the other.

The gaps in knowledge from the EIA offer input for monitoring within Wozep (for the ecological aspects) and for monitoring for the shipping, morphology and hydrodynamics aspects.

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