Summary (English)

1 Introduction

The Netherlands has set ambitious targets for achieving sustainable – renewable – energy production. Wind energy plays a prominent role in achieving that target. In 2022, the (former) Minister for Climate and Energy increased the target for offshore wind to a capacity of 21 GW. The Additional Offshore Wind Energy Roadmap[13] includes which (parts of) the new wind farm zones will be developed when. These are the wind farm zones IJmuiden Ver (North), Hollandse Kust (west) site VIII, Nederwiek, Lagelander and Doordewind – which are designated in the North Sea Programma 2022 – 2027.

The Offshore Wind Energy Act allows the national government to issue sites for the development of offshore wind farms. 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 Decision Activities Living Environment lays down general rules for offshore wind farms[14].

The Minister of Climate and Green Growth can issue a Wind Farm Site Decision. This is done in agreement with the Minister of Infrastructure and Water Management and the Minister of Agriculture, Fisheries, Food Security and Nature, 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 EIA for Site I-B in Wind Farm Zone Nederwiek (zuid) (see Figure S1). The Environmental Impact Assessment describes the environmental effects that occur during the construction, operation and removal of windturbines in the site.

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

[13] R.A.A. Jetten, Minister for Climate and Energy, Parliamentary Paper Additional Offshore Wind Energy Roadmap 2030, 21 June 2022
[14] Paragraph 7.2.3 articles 7.33 up to and including 7.45.

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 (Noord) with a capacity of 760 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 the roadmap, approximately 21 GW of offshore wind capacity should be operational by 2030. The offshore wind roadmap is shown in Figure S1. This EIA has been prepared for Site I-B.

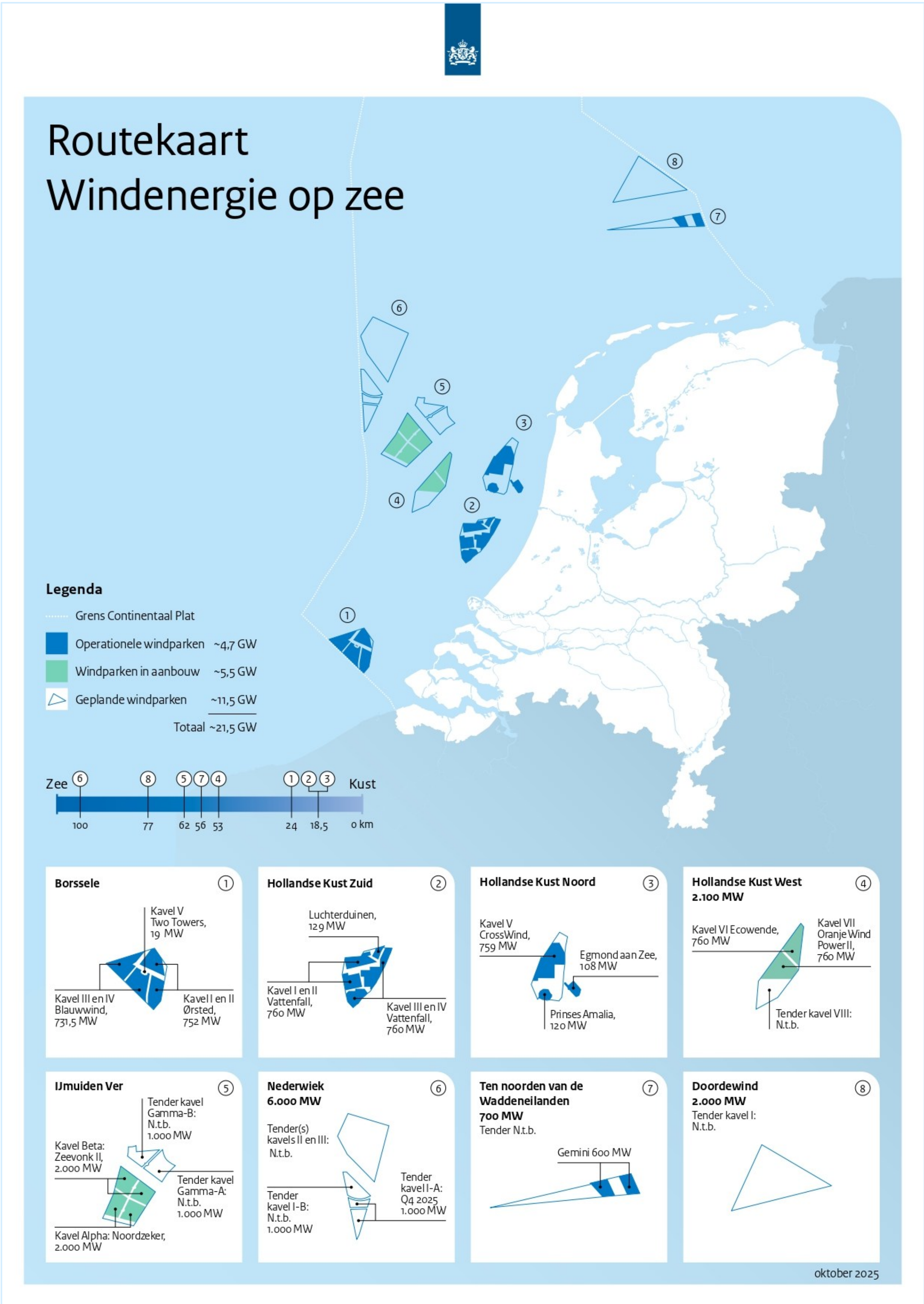

Figure S1 Offshore wind energy roadmap (October 2025)

3 Site choice offshore wind farm zones

In the North Sea Program (PNZ) 2022 - 2027, areas have previously been designated and areas reconfirmed as wind energy areas. In doing so, the choice was made to indicate only the outline of the zones and the exact sites have not been established yet.

In order to achieve the European climate objective for 2030, namely a 55 percent reduction in emissions compared to 1990, Dutch offshore Wind Farms will have to produce approximately 90 TWh of sustainable electricity annually as compared to that baseline year. This amounts to approximately 21 GW of installed capacity. The (supplementary) Roadmap indicates in which designated wind energy areas wind farms can be realized to reach approximately 21 GW. These areas are designated as wind energy zones in the North Sea Program 2022-2027.

The PNZ 2022-2027 includes the areas in which wind farms have already been realized or planned, as well as areas where Site Decisions have been made. The areas IJmuiden Ver (noord) and the southern part of Hollandse Kust have been reconfirmed as designated wind energy zones[15]. In addition, new wind energy zones have been designated in PNZ 2022-2027, including Nederwiek.

The PNZ 2022-2027 has also identified search areas to further develop offshore wind energy after 2030, based on the minimum scenario of 38 GW total installed capacity at sea in 2050. In addition to the space in the Supplementary Roadmap (21 GW), space for 17 GW is still needed for the period after 2030. This space has been designated in the partially revised North Sea Programme 2022-2027. In this Partial Revision, existing Wind Farm Zones have been reconfirmed or new zones have been designated in order to achive de 17 GW target after 2030.

4 Site subdivision

The designated Nederwiek Wind Farm Zone is located in the Dutch Exclusive Economic Zone (EEZ). The area lies approximately 95-100 kilometres from the coast (approximately 51-54 nautical mile). The Wind Farm Zone consists of a northern and southern part, which is separated by an (intended) shipping clearway. The entire Wind Fram Zone Nederwiek (south and north) has an approximate area of 600 km². The area of the Nederwiek (south) Zone is approximately 273 km^2. The water depth in Nederwiek (south) varies between -34.0 and -24.8 meters relative to the Lowest Astronomical Tide (LAT) and averages at -28.5 meters LAT[16].

Within the Nederwiek (south) Wind Farm Zone, there is space for two sites, each with a capacity of approximately 1GW. Site I-B is on of these sites. The (maximum) boundary of site I-B is set out in the preparatory decision of 24 April 2025 in the National Gazette, pursuant to section 9 of the Offshore Wind Energy Act. Site I-B has a (net) area of approximately 69 km^2.

The site subdivision process has been drawn up taking into account the following existing and planned spatial constraints:

- Existing and planned cables and pipelines;
- A 2.5NM obstacle-free zone around the K13-A platform, which is located within the clearway;

[15] *Some Wind Farm Zones have been dropped or the boundaries of (designated) Wind Farm Zones have been defined more specifically.*

[16] *For more information on the characteristics of the area, please refer to the location studies at: https://offshorewind.rvo.nl/page/view/91063764-5eb7-428e-9c6e-e38fcf3adf22/general-information-nederwiek*

- The helicopter approach route to the Net op Zee Nederwiek I platform.

De verkaveling is tot stand gekomen door rekening te houden met de volgende bestaande en beoogde ruimtelijke belemmeringen:

- bestaande en toekomstige kabels en leidingen
- een 2,5 NM obstakelvrije zone rondom het platform K13-A dat is gelegen in de clearway
- de helikopteraanvliegroute naar het platform van Net op zee Nederwiek 1

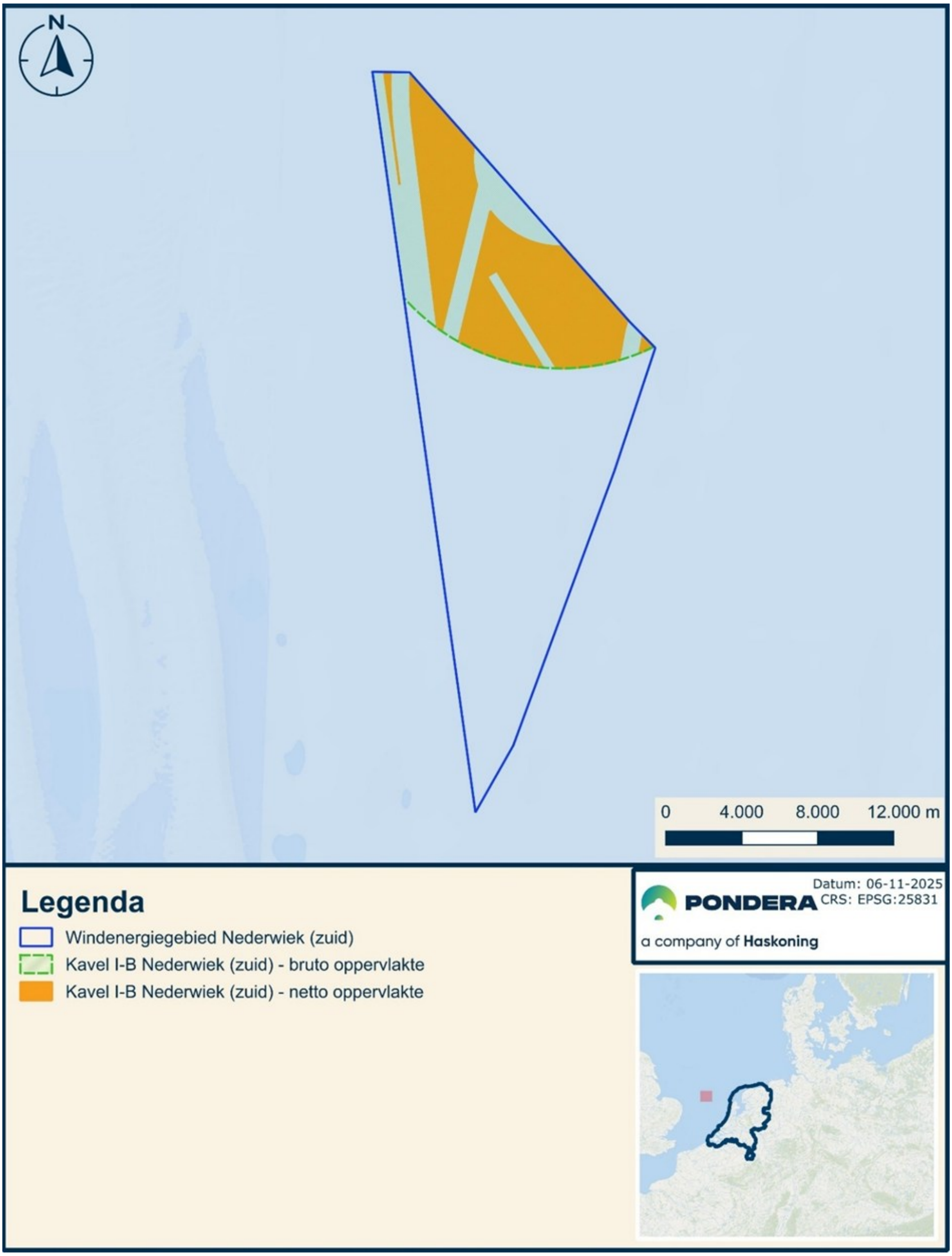

Figure S2 Location of Wind Farm Zone Nederwiek and site subdivision of Nederwiek (south)

5 Method of impact Assessment

5.1 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.

Site I-B is issued with the possibility fort he wind farm developer to configure the site as it wishes. The bandwidth within which it must remain is laid down in the Wind Farm Site Decision. The wind farm developer must comply with the binding regulations that are recorded in the 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 an indicationof 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 (Table S1). The values of the bandwidth are based on the current technological state 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 S1 Bandwidth EIA

Subject	Bandwidth
Installed capacity site	1,0 – 1,15 GW
Maximum number of turbines	76

Power of individual wind turbines	Minimum 20 MW, maximum 20 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
Maximum rotor area[17]	3.509.787 m^2 across sites of approximately 1,15 GW (57 windturbines)
Number of blades per wind turbine	3
Type of foundations	Monopile, multipile, gravity based structure, suction bucket
Maximum noise level (in case of pile driving)	Premise: 160 to a maximum of 164 dB re 1 $\mu Pa^2 s$ SELss (at 750 metres from the noise source)
Maximaal noise level in case of a foundation technique other than pile driving (continuous noise)	Premise: for continuous noise, a comparable protection level for harbour porpoises as the sound for piling with a noise standard of 160 dB re 1 $\mu Pa^2 s$ SELss (at 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 in diameter
Multipile (including ‘tripods’ en ‘jackets’)	3 to 4 piles of 3 - 5 meter in diameter
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 and kept at a depth of 1 – 3 metres

Table S2 shows the alternatives to be assessed. The alternatives consist out of two baseline alternatives, and for both baseline alternatives an overplanting scenario of approximately 15 percent (1,15 GW). These overplanting scenarios are considered so that more electricity can be produced and transmitted at lower wind speeds as long as the amount of electricity produced does not exceed the guaranteed transmission capacity of 2 GW of the TenneT platform.

The worst-case situation may be different for different aspects. The worst case situations, being alternatives per aspect, are assessed and compared. Where useful, the possible best case situation has also been examined, to gain an understanding of the full range of effects. The theme chapters (chapters 5 through 11) describe the alternatives to be investigated (including the type of foundation) in more detail.

[17] *The maximum rotor area is based on 57 wind turbines with a rotor diameter of 280 m.*

Table S2 Alternatives

Alternative	Capacity wind turbine (MW)	Number of wind turbines	Approximate total capacity (MW)	Maximum rotor diameter (m)	Maximum tip height (m)
Alternative 1a	15	67	1.005	236	261
Alternative 1b (15%-overplanting)	15	76	1.140	236	261
Alternative 2a	20	50	1.000	280	305
Alternative 2b (15%-overplanting)	20	57	1.140	280	305

5.2 Assessment

To compare the effects of the alternatives for each environmental aspect, they are assessed on a +/- scale compared to the baseline alternative (which is the current situation and autonomous developments). The following rating scale is used for this purpose, as shown in Table S3.

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-B Nederwiek (south), cumulative effects of other wind farms and activities have also been considered, as well as mitigating measures.

Table S3 Assessment methodology

Assessment relative to the baseline alternative (the reference situation)	Score
The plan leads to a strongly noticeable negative change	--
The plan leads to a noticeable negative change	-
The plan lead to a marginal negative change	0/-
The plan does not differ from the baseline alternative	0
The plan leads to a marginal positive change	0/+
The plan leads to a noticeable positive change	+
The plan leads to a strongly noticeable positive change	++

6 Results of environmental assessment

The following paragraphs show the ratings of the alternatives by aspects according to the different assessment criteria, without the use of mitigation measures[18]. For each environmental aspect, this is summarized in the tables and further described in the accompanying text.

6.1 Morphology and hydrodynamics

For the aspect morphology and hydrodynamics, two baseline alternatives and four overplanting alternatives were assessed. The two baseline alternatives are those in which placing the foundation and installing the soil protection results in the least and most soil disturbance, respectively. The two baseline alternatives are described below. The impact assessment is shown in Table S4.

- Alternative 1 (least soil disturbance, **best case**): a 15 MW turbine on a tripod foundation with a diameter of 3 meter per foundation pile. Scour protection (armour stone): three times the diameter of the foundation pile.
- Alternative 2 (most soil disturbance, **worst case**): a 20 MW turbine on a gravity-based foundation met a diameter of 50 meter, or on a suction bucket foundation with a diameter of 30 meter on the seabed. Scour protection for both cases (armour stones): three times the diameter of the foundation pile.

In addition to the baseline alternatives, two overplanting scenarios 15 percent were assessed as included in Table S3.

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. Additionally, the effects during construction and removal are only temporary in nature and therefore indistinguishable from natural events like storms. This results in many neutral assessments. Operation, during the lifespan of the wind farms, brings changes that are mainly assessed slightly negatively. 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 the effects on water movement are slightly greater due to the larger dimensions of the foundation, thus scoring negative.

The expected changes as a result of the wind energy area are the same for the overplanting and baseline alternatives. The overplanting alternatives marginally lead to greater effects, especially the overplanting of 15%. However, the increase in effects for the overplanting alternatives due to additional turbines, compared to the baseline alternatives with 50 to 67 turbines is so small that the effects are very limited. This has resulted in the same impact assessment for the overplanting alternatives and the baseline alternatives (Table S4).

[18] For marine life, however, the noise standards from the Ecology and Cumulation Framework 4.0 have been used as a starting point and therefore 164 dB re 1 μPa2s SELss at 750 metres have been assessed. These noise standards can only be met if measures are taken during pile driving.

Table S4 Impact assessment morphology and hydrology

Aspect (during construction, maintenance and operation)	Alternative 1a (15 MW)	Alternative 2a (20 MW)	Overplanting alternative 1b (15%) (15 MW)	Overplanting alternative 2b (15%) (20 MW)
Waves	0/-	0/-	0/-	0/-
Water movement (water level and current)	0/-	-	0/-	-
Water depth and bedforms	0/-	0/-	0/-	0/-
Soil composition	0/-	0/-	0/-	0/-
Turbidity	0/-	0/-	0/-	0/-
Water quality	0	0	0	0
Stratification	0/-	0/-	0/-	0/-
Sediment transportation	0/-	0/-	0/-	0/-

6.2 Birds and bats

Concering birds and bats, the four alternatieves as described in Table S2 have been assessed. Alternatives 1a/b (67 to 76 turbines x 15 MW) result in several tens to hundreds more bird casualties than alternatives 2a/b (50 to 57 turbines x 20 MW). Based on current knowledge, alternatives 1a/b with more and smaller turbines are expected to result in a larger number of bat casualties (estimated max 76) than alternatives 2a/b (estimated max 57). Therefore, specifically alternative 2a is the most environmentally friendly alternative from a bird and bat point of view, mainly due to the lower number of collision casualties than the other alternative with more turbines. The complete impact assessment is summarised in Table S5.

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-B outside the breeding season, cannot be entirely ruled out. Significant effects concerning the conservation objectives on these non-breeding birds, can be ruled out.
- Significant negative effects of Site I-B 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 in Site I-B is at most 0.03%, and this falls below the 1% natural mortality standard. It can be concluded with certainty that the additional mortality does not affect the attainment of the conservation objectives of the Natura 2000 sites.
- Effects as a result of collision on some species of migratory birds on seasonal migration from Natura 2000 areas cannot be ruled out. Significant effects concerning the conservation objectives on these migratory birds, can be ruled out.

Table S5 Impact assessment birds and bats

Effect/activity	Alternative 1a (67x**15** MW)	Alternative 1b (76x**15** MW)	Alternative 2a (50x**20** MW)	Alternative 2b (57x**20** MW)
Construction phase				
Birds				
Aanleg windturbines	0/-	0/-	0/-	0/-
Toename scheepvaart	0/-	0/-	0/-	0/-
Bats				
Aanleg windturbines	0	0	0	0
Toename scheepvaart	0/+	0/+	0/+	0/+
Operation phase				
Birds				
Local seabirds				
Collisions	--	--	-	-
Barrier effect	0	0	0	0
Habitat loss	-	-	-	-
Indirect effect	0/-	0/-	0/-	0/-
Breeding (colony) birds				
Collisions	-	-	-	-
Barrier effect	0	0	0	0
Habitat loss	-	-	-	-
Indirect effect	0/-	0/-	0/-	0/-
Non breeding birds from Natura 2000				
Collisions	-	-	-	-
Barrier effect	0	0	0	0
Habitat loss	0	0	0	0
Indirect effect	0/-	0/-	0/-	0/-
Migratory birds				
Collisions	--	--	-	-
Barrier effect	0/-	0/-	0/-	0/-
Habitat loss	0	0	0	0
Indirect effect	0	0	0	0

Bats				
Collisions	-	-	-	-
Barrier effect	0	0	0	0
Habitat loss	0	0	0	0
Indirect effect	-	-	-	-
Removal phase				
Birds				
Deconstruction of foundations	0/-	0/-	0/-	0/-
Increased shipping	0/-	0/-	0/-	0/-
Vleermuizen				
Deconstruction of foundations	0	0	0	0
Increased shipping	0/+	0/+	0/+	0/+

6.3 Marine life

Benthos and fish
Impacts on benthic animals and fish are small in magnitude and sometimes even slightly positive (see Table S6). For benthos and fish, the various alternatives (see Table S2) do not result in anay differences in the impact assessment. For benthic animals, a negative assessment is given for habitat destruction by bottom disturbance during construction.

Seabed fauna present at the sites of bottom disturbance will be destroyed in the process.
For fish with a strongly demersal lifestyle, individuals may be harmed where soft-bottom habitat is replaced by hard substrate at turbine foundations, scour protection and inter-array cables. However, the proportion of the population of relevant (OSPAR) species, such as rays, that may be affected in this way is very small compared to the total population in this part of the North Sea. Moreover, rays are mobile species that can relocate quickly. Therefore, the effects of habitat destruction caused by bottom disturbance are assessed as slightly negative for fish.

For benthos, however, the area of seabed that will be affected in the plan area is negligible compared to the total bottom area in this part of the North Sea. In addition, the species concerned are relatively common and have high population growth rates, and species listed by OSPAR as threatened and/or declining have not been observed in the plan area. This does not apply to *Sabellaria* Banks, a critical OSPAR habitat that is likely to be present in the plan area. This reef-forming species may be destroyed by the installation of turbine foundations, erosion protection and cables at these sites. However, in the current situation, *Sabellaria* banks will have limited development due to bottom trawling. Due to the possible negative effect on *Sabellaria* banks and long-lived species, the effect of habitat destruction is assessed slightly negatively for all alternatives.

No long-term monitoring series are available, but existing studies indicate that pile-driving noise during wind farm construction generally has little effect on fish. Only at very short distances from the source is there a risk of mortality. Scientific field studies have so far not demonstrated direct or indirect fish mortality caused by pile-driving, although research on species with a closed swim bladder and on the effects of particle motion remains limited. Therefore, the effects of underwater noise during the construction phase are assessed as slightly negative, while harmful effects from vibration itself are considered unlikely.

The effects of electromagnetic fields (EMF) on fish and benthos remain largely uncertain. Sharks, rays and certain migratory fish may be particularly sensitive due to their use of electroreception and the Earth's magnetic field. Any potential effects, such as behavioural changes, are expected to be limited to the immediate vicinity of inter-array cables. To date, there is no evidence of significant biologically harmful consequences (e.g., mortality). However, knowledge gaps remain regarding the precise effects of EMF. Therefore, the impact of EMF is assessed as slightly negative, primarily due to these uncertainties.

All other effects are neutral or even slightly positive (see Table S6).

Table S6 Impact assessment benthos and fish

Phase	Effects wind farm	Benthos	Fish
Construction	Noise vibrations from pile driving	0	0/-
	Turbidity due to bottom trawling	0	0
	Habitat loss due to bottom trawling	0/-	0/-
Operation	Continuous noise	N.a.	0
	Artificial hard substrate	0/+	0/+
	Exclusion of fishing	0/+	0
	EMF due to cables	0/-	0/-
Removal	Removal hard substrate[19]	0	0

Marine Mammals

For all alternatives, the number of days on which harbour porpoises and seals are disturbed (animal disturbance days) in this EIA for Site I-B is lower than the number of disturbance days calculated for Site I-B in KEC 5.0. As long as the calculated number of disturbance days in KEC 5.0 is not exceeded, the ecological standard is automatically met: namely, that the construction of offshore wind farms will, with high certainty (>95%), maintain the populations of harbour porpoises, harbour seals and grey seals in the Dutch Continental Shelf at a minimum of 95% of their current size.

Therefore, it can be concluded that when applying the noise standard of SELss = 164 dB re 1 μPa²s (750 m), the conservation objectives of harbour porpoises and seals is not at risk. With regard to the number of animal disturbance days caused by impulsive noise during construction, the effects of all alternatives are assessed as slightly negative. However, alternatives 2a and 2b result in fewer disturbance days compared to alternatives 1a and 1b, due to the lower number of wind turbines.
All other effects in Table S7, aside from animal disturbance days, are assessed as neutral for each alternative during both construction and operation.
The effects on marine mammals during decommissioning of the wind farm have not been studied separately. The effects during removal are considered to be equal to or smaller than those occurring

[19] *In the EIA, decommissioning is also assessed negatively (–) compared to the new situation, as the newly established benthic community on the hard substrate would be removed, which is considered a negative impact on the benthic community in the North Sea.*

during construction. Therefore, the impact scores (worst-case) for decommissioning are equal to those for construction.

Table S7 Impact assessment marine mammals

Phase/effect	Alternative 1a (67x15 MW)	Alternative 1b (76x15 MW)	Alternative 2a (50x20 MW)	Alternative 2b (57x20 MW)
Construction				
Disturbance days (impulsive noise): *Harbour Porpoises* *Common seal* *Grey seal*	0/- 0/- 0/-	0/- 0/- 0/-	0/- 0/- 0/-	0/- 0/- 0/-
Number of animals affected	0	0	0	0
Operation				
Disturbance by ships and turbines (continuous noise)	0	0	0	0
Presence hard substrate	0	0	0	0
Ban on bottom trawling	0	0	0	0
Removal				
Disturbance days (impulsive noise): *Harbour Porpoises* *Common seal* *Grey seal*	0/- 0/- 0/-	0/- 0/- 0/-	0/- 0/- 0/-	0/- 0/- 0/-
Number of animals affected	0	0	0	0

6.4 Shipping and safety

The total expected collision and drift frequency for Site I-B is 0.0187, which comes down to one collision or drift event every 53 years. Because of this probability of collision and/or drift involving a wind turbine, this aspect is assessed negatively, as in the current situation there is no risk of collision or drift with a turbine in the wind farm area of Site I-B.

For Site I-B, the expected number of fatalities per year from a collision with a wind turbine is 0.006583. This represents one form of consequential damage. Another form of consequential damage concerns damage to the vessel or to the wind turbine. In 47.6% of collision or drift events, damage to the ship's hull or a situation in which the nacelle or mast falls onto the vessel is expected. In 74% of collision or drift

events, damage to the wind turbine is expected due to collapse or tilting. The effect of consequential damage is assessed as slightly negative, because fatalities may occur and damage to the vessel or turbine is possible. However, these estimates are considered (very) conservative, particularly with regard to the probability of fatalities.
Given the various traffic routes and traffic flows around the wind farm, there are few if any situations where Site I-B affects sightlines. As a result, there are good possibilities for evasive manoeuvres, and this aspect is therefore assessed as neutral.

The impact assessment of the shipping safety theme is shown in Table S8. For shipping safety, the worst-case alternative (alternative 1b, 15% overplanting) consists of 76 wind turbines of 15 MW. With a lower number of turbines—the other alternatives—the effects will always be less negative.

Table S8 Impact assessment shipping and safety

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

6.5 Landscape

For site I-B, the wind turbines will not be visible from the coast. The wind turbines will be completely hidden from view by bilge diving. Features of the wind turbines other than size, such as colour and material, are therefore not relevant. Visibility is assessed as neutral (see Table S9).

Table S9 Impact assessment landscape

Assessment criterion	Assessment
Visibility in percentage of time	0

6.6 Other marine functions

The impact assessments for the various alternatives are not distinctive. Most effects on the other marine functions are assessed neutrally because they are minor in magnitude, or can be ruled out beforehand (see Table S10). (Slight) negative effects are expected for the following subjects:

- Fisheries
- Mining
- Aviation, specifically the interference of helicopter traffic
- Ship, shore and aviation radar and other measuring equipment, specifically interference from measuring equipment on and around offshore platforms
- Telecommunications
- Military activities, specifically the presence of Unexploded Ordnance (UXO)
- Cultural history and archaeology
- Existing wind farms

Table S10 Impact assessment other marine functions

Functions	Assessment criteria	Effectscore
Fisheries	Restrictions on fisheries	0/-
Mining	Restrictions on oil and gas extraction	0/-
Aviation	Interference civil aviation	0
	Interference helicopter traffic	-
	Interference Coast Guard	0/-
	Interference military aviation	0
Sand, gravel and shell mining	Restrictions on shallow mineral extraction	0
Dredged sediment	Restrictions of dredging locations	0
Ship, shore and aviation radar and	Interference aviation radar	0
	Interference shore and ship radar	0
	Interference measuring equipment on and around offshore platforms	-
Cables and pipes	Interference cables and pipes	0
Telecommunications	Wave interference	0
Military activities and UXO	Interference military activities	0
	Presence unexploded ordnance	-
Recreation en tourism	Restrictions recreational vessel traffic	0
Cultural history and archaeology	Damage to archaeological remains	0/-
Existing wind farms	Influence on electricity yield from existing wind farms	0/-

The effects on fisheries as a whole are assessed as slightly negative. The area closure of the plot is small compared to the area available to fishermen. However, individual fishermen may experience greater impacts than others, if they frequently use fishing bays within the plot.

There is a slightly negative effect on the mining sector because, during construction, removal and maintenance works, working vessels may cause temporary disruption to transport to mining platform K13-A. There are also a number of abandoned boreholes at the site that may affect the routing of park cabling and the selection of turbine positions.

The impact on helicopter traffic is assessed as negative due to overlap with HTZ K13-A and because helicopter routes KY645 and KY646 cross the plot. Helicopter traffic, which is used by the Coast Guard, is also assessed as slightly negative because research shows that effects due to wind turbines on helicopter traffic cannot be ruled out when turbines are rotating and/or bad weather occurs, and that there is a disruptive effect on the proper functioning of Coast Guard radio communications.

The effects for cultural history and archaeology are also assessed slightly negatively, due to the presence of (potential) archaeological values that need to be taken into account.

Finally, there is a slightly negative effect on existing wind farms due to the proximity of wind energy areas both in the Dutch EEZ and the UK EEZ. A wind farm in site I-B will then cause wake effects on surrounding wind farms.

With regard to Unexploded Ordnence (UXO), the assessment is negative because of the likelihood of OO being present, requiring necessary measures to be taken. There is also a negative effect on the interference of measuring equipment on platform K13-A. This is because a wind farm at the site interferes with wind measurements on platform K13-A in almost all directions.

6.7 Electricity yield

Previous EIAs have shown that for electricity output, the difference whether 1 GW of installed capacity is achieved with a higher number of smaller turbines (67 x 15 MW = 1,005 MW), or with a smaller number of larger turbines (50 x 20 MW = 1,000 MW), is limited. The impact assessment is therefore the same for both alternatives. For the theme of electricity yield, the assessment therefore considers the difference between the scenarios with and without 15% overplanting when installing 15 MW wind turbines (alternatives 1a and 1b; see Table S11). The overplanting alternative with 76 × 15 MW wind turbines results in a slightly higher electricity yield and avoided emissions. However, this does not lead to a difference in the impact assessment. The effects on the sub-aspects electricity production and avoided emissions are assessed as highly positive (++) for both alternatives (see Table S11).

Table S11 Impact assessment electricity yield

Sub aspects	Assessment criteria	Impact assessment alternative 1a¨(67 x 15 MW)	Impact assessment alternative 1b (76 x 15 MW)
Electricity yield	Electricity yield	++	++
Avoided emissions	CO_2-emission reduction	++	++
	SO_2-emission reduction	++	++
	NO_x-emission reduction	++	++

6.8 Cumulation

The following table briefly indicates the cumulative effects and the consequences this has for the Wind Farm Site Decision. For cumulative effects on birds, there is a national and international cumulation scenario. The national scenario involves all Dutch wind farms in the North Sea and the international scenario involves all wind farms in the North Sea (i.e. including foreign wind farms).

Table S12 Relevant cumulative effects and consequences

Aspects	Relevant cumulative effects
Morphology and hydrodynamics	Recent studies have shown that very large-scale developments of wind farm zones in the North Sea affects on (the mixing of) the stratification, water movement and morphology. Quantification of the effects needs to be further determined in further studies. However, it

	can be expected based on modelling studies outlining a scenario for 2050, a large part of southern and central North Sea (scale: hundreds of square kilometres) will be effected to some extent due to the increasing amount of (planned) offshore wind farms. The effects affect hydrodynamics, stratification and turbidity, among others. For instance, the stratification regime (seasonal, permanently or sporadically stratified) may change compared to the natural situation due to more vertical mixing. Moreover, currents and hence residual flow are affected which has effects to long-term sediment transport. The impact assessment for Site I-B (see Section 6.1) shows that no significant effects occur. All effects are therefore negligible and occur only on a very local scale. In addition, the effects during construction, maintenance and decommissioning are also very temporary.
Birds and bats	Birds Significant negative cumulative effects can be ruled out for all seabird and migratory bird species. However, in the cumulative impact assessment, exceedances of the ALI threshold values have been identified for northern gannet and common guillemot, resulting respectively from collisions and habitat loss. The current conservation objectives are favourable for both species, with a moderately increasing population trend for northern gannet and a positive trend for common guillemot. Therefore, based on current knowledge, significant negative effects on northern gannet and common guillemot can be excluded. It should be noted, however, that in light of the effects of avian influenza in 2022 on northern gannet, the population development of this species must be monitored particularly closely. The population is showing the first signs of recovery, and the current conservation objectives therefore remain favourable. Bats Much less information is available on bats than on birds. It is certain that bats fly over the North Sea, but their numbers, the population sizes from which these animals originate and their behaviour at sea are not well known. According to the calculation method used, the number of casualties among the Nathusius' pipistrelle exceeds the applied assessment threshold. Due to existing knowledge gaps, this outcome reflects a stacking of worst-case assumptions, meaning the effect is very likely overestimated.
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 benthic animals. It is also possible that it facilitates colonisation by exotic species. However, not enough information is available (at the moment) to estimate these effects. Marine mammals Applying an underwater noise level of 160 dB re 1 mPa^{2}s or 164 dB re 1 mPa^{2}s on 750 meters of the noise source for site I-B and and other planned wind farms in the Dutch North Sea, the disturbance will not lead to significant cumulative effects for either seals or harbour porpoises.
Navigation and safety	In recent years, various studies have been carried out on the cumulative effects of constructing offshore wind farms in the North Sea (see Chapter 8 and Annex 6). These studies show—based on the assumption that no vessel transit through wind farms will take place—that the total expected collision and drift frequency (with a wind turbine) is 0.56 per year, which corresponds to once every 1.8 years. If offshore wind development is accelerated, this frequency increases to 0.987, equivalent to once every 1.0 years. Because the cumulative studies have been fully incorporated into the calculations for Site I-B (see Annex 6), cumulative effects have not been assessed separately. In addition, due to the location of the Nederwiek wind energy area in relation to existing shipping lanes, the construction of wind farms in this area has little to no influence on the overall route structure in the North Sea.

Landscape	A wind farm in Site I-B is not visible from the coast. Therefore, there are no cumulative effects.
Other uses	Fisheries The arrival of more offshore wind farms increases the total land used. (Assuming that all (future) offshore wind farms will be closed to fisheries.) 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 increases this effect. The relative importance of the fishing grounds within the planned wind energy areas on the Dutch Continental Shelf will therefore increase for the Dutch demersal fisheries as other areas become closed and alternative fishing grounds become increasingly limited. Archaeology With a greater number of turbines in the North Sea, the likelihood of archaeological remains being affected, or UXO being struck, also increases. The realisation of site I-B increases this chance, although good mitigation measures are available for this.
Electricity yield	The increase of wind farms in the North Sea increases the potential wake effects. For site I-B, the wake losses increase by 5.0%-points from 15.0 to 20.0% (for the 67-turbine arrangement), with further filling of wind energy areas in the Dutch and UK North Sea, and the net electricity yield decreases by 5.56% from 4,162 GWh/y to 3,930 GWh/y. The amount of avoided emissions decreases by 5.56% as a result.

7 Transboundary effects

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

7.1 Birds and bats

7.1.1 Breeding birds

Site I-B is outside average range of breeding colonies located in foreign Natura 2000 areas. Therefore, no significant negative effects are expected on these breeding colonies as a result of a wind farm at site I-B. It appears that, for example, individuals from northern gannet colonies could theoretically reach the Nederwiek Wind Farm Zone, but flight movements through site I-B are expected to be incidental, and therefore no significant negative effects are anticipated for protected colonies.

7.1.2 Non-breeding birds

Based on cumulative calculations for the international scenario, significant negative effects can be ruled out.

7.1.3 Migratory birds

Population models were established for the eight most critical migratory bird species as part of the KEC 5.0 study. Population models of the eight most critical migratory bird species indicate that among these migratory bird species, the applicable ALI standards will not be exceeded for the national and international scenario. Therefore, significant effects on migratory bird populations and significant effects on (foreign) Natura 2000-areas can be ruled out.

7.2 Marine life

The western side of the plan area for site I of Nederwiek (zuid) lies on the border with the UK and thus also borders a Special Area of Conservation (SAC), the Southern North Sea. SACs are similar to Natura 2000 sites and are designated for habitat types and species. The Southern North Sea was designated for harbour porpoises in 2019 and has a surface area of 36,951 km^2. The maximum overlap of the disturbance contour with the SAC is about 800 km^2 if a noise standard of SELss = 164 dB re 1 $\mu Pa^2 s$ (750 m) is assumed. This is 2.14% of the total area of the SAC. This represents the overlap in the situation where 2 GW of wind farms are developed in de Nederwiek (zuid) Wind Farm Zone. For this area, disturbance from underwater noise resulting from a project or plan is assessed as significant if it displaces harbour porpoises from more than an average of 10% of the area relevant for harbour porpoises during a season[20]. Significant effects through external effects can therefore be ruled out.

8 Mitigation

Mitigating measures can ensure that adverse environmental effects are avoided, prevented or limited. In the EIA of site I-B, mitigating measures were described and the effectiveness of these measures in relation to the construction and use phase. This was done for the aspects where adverse environmental effects are to be expected and were assessed mildly to very negatively in the EIA. Cumulative effects could also be reduced with the application of mitigation measures. Table S13 below summarises the possible mitigating measures. In the Wind Farm Site Decision, a decision is made on which mitigation measures will be prescribed. These measures are considered in an integrated manner, and their effectiveness is weighed against potential drawbacks, such as additional construction costs (for example, in the case of increasing tip height). Measures may also have benefits for one aspect while creating disadvantages for another. For instance, from an ecological perspective there is a preference for installing larger wind turbines (up to 20 MW) instead of a greater number of smaller ones (up to 15 MW), although this results in increased seabed disturbance. Another example is allowing overplanting (up to 15% additional capacity), which increases the production of renewable electricity but is also expected to lead to a higher number of bird fatalities.

[20] *https://data.jncc.gov.uk/data/206f2222-5c2b-4312-99ba-d59dfd1dec1d/SouthernNorthSea-conservation-advice.pdf*

Table S13 Possible mitigating measures

Aspect	Effect	Possible mitigating measures
Birds and bats	Disturbance (construction)	Build in periods when few disturbance-sensitive species are present. Apply minimal lighting on vessels, with a 'bird-friendly' colour.
	Disturbance and casualties (operation)	Apply minimal lighting on vessels, with a ‘bird-friendly’ colour Applying reflectors, lasers and acoustic warning signals to ‘scare off’ birds and reduce collision fatalities. Shut down wind turbines during certain weather conditions in combination with detected migration peaks. For bats, reduce the rotating speed of the rotor blades during times when many bats can be expected in the wind farm. This can be done in combination with the development of bat-detection technologies. Install the smallest possible number of large wind turbines instead of a larger number of smaller wind turbines. Smart planning of maintenance work, when turbines are shut down, can prevent casualties (consider periods of increased bird activity) Increasing the minimum tip height: Raising the tip height to 35 metres resulted, in model calculations carried out for Nederwiek I-A, in a relative reduction in the number of seabird fatalities ranging from approximately 20% (for great black-backed gulls) to around 60% (for kittiwakes), although for Nederwiek I-B this concerns an absolute reduction of only a few individuals. This pattern was observed for both lower-capacity turbines (15 MW) and higher-capacity turbines (20 MW). However, no empirical data are yet available to confirm this effect in practice. The first projects to test this are currently underway. Increasing tip height also affects the costs of the required (heavier) foundations.
	Disturbance (removal)	Dismantle at a time when few disturbance-sensitive species are present and apply a removal method with less noise production than during the construction phase Apply minimal lighting on vessels, with a ‘bird-friendly’ colour.
Aquatic life	Disturbance and habitat destruction (construction)	<u>Benthos and fish</u> Use the smallest possible foundation to reduce disturbance and habitat loss during the construction phase. At the same time, a larger foundation provides more hard substrate, which can lead to positive effects during the operational phase. Sparing locations of biogenic reefs.

		Use alternative foundation techniques than piling such as vibrating, screwing or blue piling. Marine mammals Use acoustic measures (piling walls, bubble screens etc.). Use deterrent measures (slow/soft start or Acoustic Deterrent Devices). Choose the shallowest locations in the planned area. Conduct piling work when the density of marine mammals is low (August till December). Choose a small number of relatively large turbines rather than several smaller ones. Use alternative foundation techniques
	Disturbance and habitat destruction (removal)	Benthos and fish Alternative, biodegradable materials can be used for erosion protection that provide sufficient protection during the operational phase of the wind farm and can remain in place afterwards. These materials gradually degrade and may, in the long term, provide beneficial functions for benthos and fish.
Shipping and safety	Collision risk and vessel movements	Using the Automatic Identification System (AIS) and VHF antenna in the park Vessel traffic management (VTM)/Monitoring (VTMon) Additional marking and identification of wind turbines Deployment of an Emergency Towing Vessel Additional SAR capacity ETV and MPV equipped with control agents against oil pollution
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.
	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.
Electricity yield	N/A	N/A

9 Considerations on preferred alternative

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.

There are no aspects in this Environmental Impact Assessment that constrain the considered range. From an environmental perspective, it is favourable to install larger wind turbines (up to 20 MW), as the 1 GW requirement for site I-B can be met with fewer turbines, resulting in fewer effects on ecology and shipping.

10 Considerations on mitigating measures

A number of measures are needed to limit cumulative effects on birds, bats and harbour porpoises, and to guarantee the conservation objectives. These include, for example, a shutdown provision during bird and bat migration and compliance with an underwater noise standard during pile driving. Table S13 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.

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 harbour porpoises.

11 Knowledge gaps

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-B. 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 knowledge gaps 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. Each impact assessment chapter explains the gaps in knowledge per environmental theme that are relevant in the context of this EIA.

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-B. 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.

11.1 Monitoring and evaluation

11.1.1 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 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.

A multi-year monitoring and research programme was published at the end of 2016, broadly outlining the research lines for the period 2017-2023. Meanwhile, the Wozep Multi-Year Programme 2024-2030 has also been adopted. Every year, progress, results and whether new questions have arisen are reviewed. Each year, this results in an Annual Plan that lists the new subprojects that will be carried out the following year[21].

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.

11.1.2 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 km^2.

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.

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

The programme is designed to make use of progressive understanding. Choices and priorities are geared to current events[22].

Table S14 MOSWOZ themes

Theme	Explanation theme
Hydro/Meteo	Analysing if there are hydrodynamic or meteorological effects that are relevant for shipping safety in the vicinity of wind farms.
Collisions	Analysing what the possible scenarios are when a ship collides or drifts into a wind turbine.
Emergency towing vessels	Explore deployment of multiple Emergency Rescue and Towing Vessels (ERTV's) – effectiveness and modus operandi.
Transit	Mapping the risks of wind farm transit versus rerouting.
Traffic control	Establish a form of traffic control together with the Coast Guard.
Monitoring	Tracking how shipping traffic and maritime safety risks change as a result of wind farm construction.
Anchorage areas	Investigate whether and, if so, how better use of anchorage areas can help improve shipping safety.
Crisis organisation	Exploring the impact on crisis organisation (related to complexity).
Foreign benchmarking	Exchange knowledge and insights with our neighbouring countries on policy and management issues for shipping safety in and around offshore wind farms.

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