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 2030[15] 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[16].

The Minister of Climate and Green Growth, in agreement with the Minister of Infrastructure and Water Management, the Minister of Housing and Spatial Planning 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 Nederwiek (zuid) in the Nederwiek 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 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.

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:

[15] R.A.A. Jetten, Minister for Climate and Energy, Parliamentary Paper Additional Offshore Wind Energy Roadmap 2030, 21 June 2022

[16] Paragraph 7.2.3 articles 7.33 up to and including 7.45.

- 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.

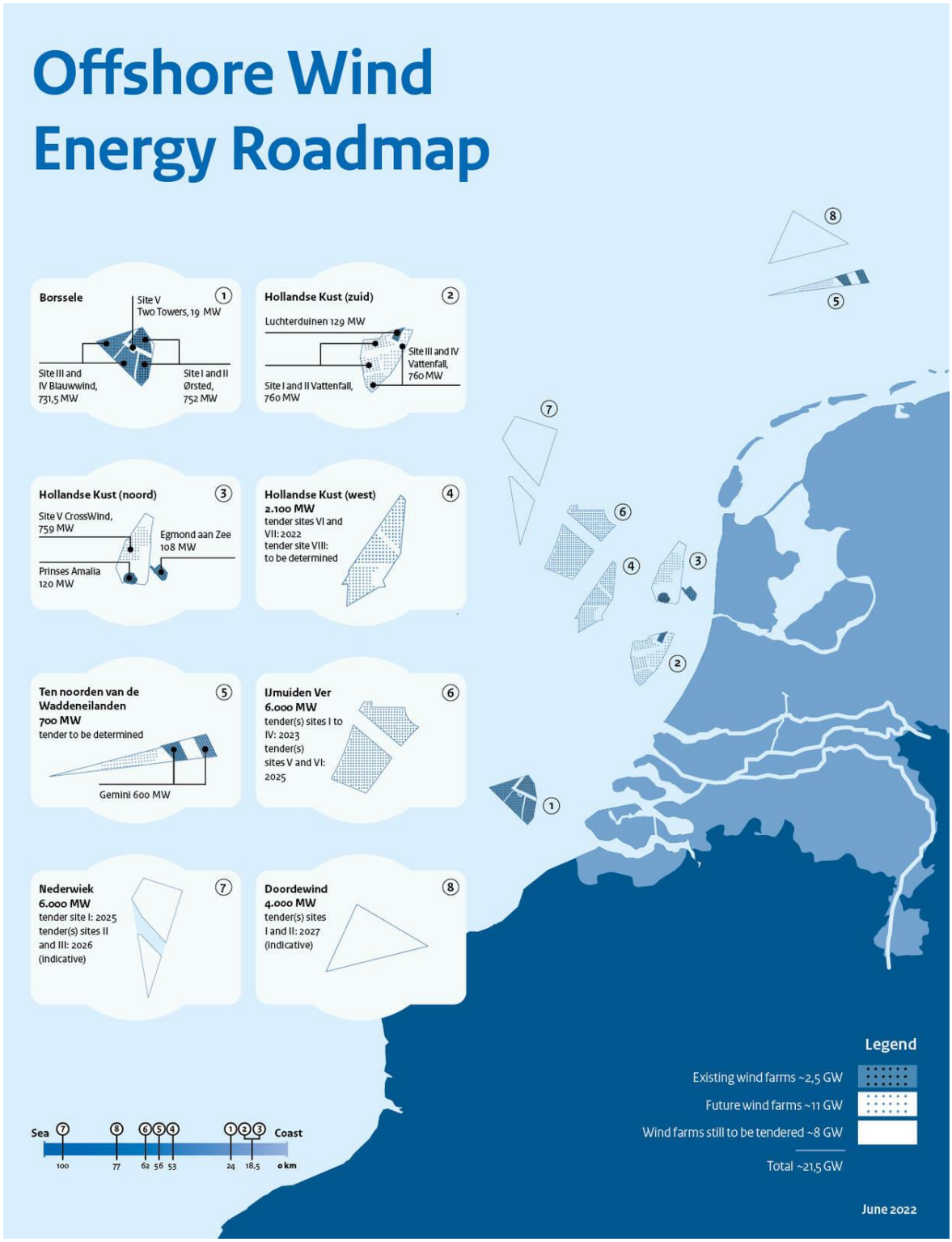
In accordance with this roadmap, approximately 21 GW of offshore wind capacity should be operational by 2030. The offshore wind roadmap is shown in Figure S1. Table S1 also shows the site subdivision for each wind farm zone. This EIA has been prepared for Site Gamma of the IJmuiden Ver Wind Farm Zone.

Table S1 Updated roadmap offshore wind energy 2030 (April 2024)

Size (ca. GW)	Wind farm zone, site(s)	Site tenders	(expected) commissioning of wind parks
1,0	Existing offshore wind parks in 2015	-	-
0,7	Borssele, sites I en II	Realised in 2016	2020
0,7	Borssele, sites III, IV en V	Realised in 2016	2021
0,7	Hollandse Kust (zuid), sites I en II	Realised in 2017	2023
0,7	Hollandse Kust (zuid), sites III en IV	Realised in 2019	2023
0,7	Hollandse Kust (noord), site V	Realised in 2020	2023
0,7	Hollandse Kust (west), site VI	Realised in 2022	2026 - 2027
0,7	Hollandse Kust (west), site VII		2027
2,0	IJmuiden Ver, site Alpha	Realised in 2024	Q3 2029
2,0	IJmuiden Ver, site Beta		Q4 2029
2,0	IJmuiden Ver, site Gamma	Q3 2025	Q2 2031
2,0	Nederwiek (zuid), site I		Q4 2030
2,0	Nederwiek (zuid), site II	Q2 - Q4 2026	Q2 2032
2,0	Nederwiek (zuid), site III		Q4 2031
0,7	Hollandse Kust (west), site VIII	T.b.d.[17]	T.b.d.
0,7	North of the Wadden Islands, site I	2027[18]	2033
2,0	Doordewind, site I	Q1 – Q2 2027	Q4 2032[19]

[17] Hollandse Kust West site VIII is expected to be realised after 2031
[18] Voorlopige planning.
[19] De aanlandingen van zowel Ten noorden van de Waddeneilanden kavel I als Doordewind kavel I worden onderzocht in PAWOZ. De verwachte oplevering van deze aanlandingen is daarom nog onzeker.

Figure S1 Offshore wind energy roadmap (April 2024)



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 all been established yet.

Site selection study in the North Sea Programme

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 2030 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[20]. In addition, three new wind energy zones have been designated in PNZ 2022-2027, including Nederwiek. The other two are Lagelander and Doordewind. For wind energy area Lagelander, in a letter to the Parliament[15] it was later decided (2023) this area would not be used before 2030

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 2030 (21 GW), space for 17 GW is still needed for the period after 2030. For the actual designation of these identified wind energy zones, the PNZ 2022-2027 will be partially revised[21].

Wind energy area Nederwiek concerns a newly designated wind energy area in the PNZ, involving a southern and northern part separated by a clearway. Wind energy area Nederwiek is thus part of the roadmap to achieve the CO_2 reduction target in 2030 (it contributes to the 21 GW).

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. Site I is the only site in the southern part of wind energy area Nederwiek (hereinafter; Nederwiek (south)). The area of the Nederwiek (south) Zone is approximately 273 km^2. The proposed lot has a (net) area of approximately 156 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[22].

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

[21] The concept Memorandum on Scope and Level of Detail for the partial revision of PNZ 2022-2027 has been open for consultation and can be found at: https://www.platformparticipatie.nl/programmanoordzee/concept-nrd-participatieplan-programmanoordzee/default.aspx

[22] 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

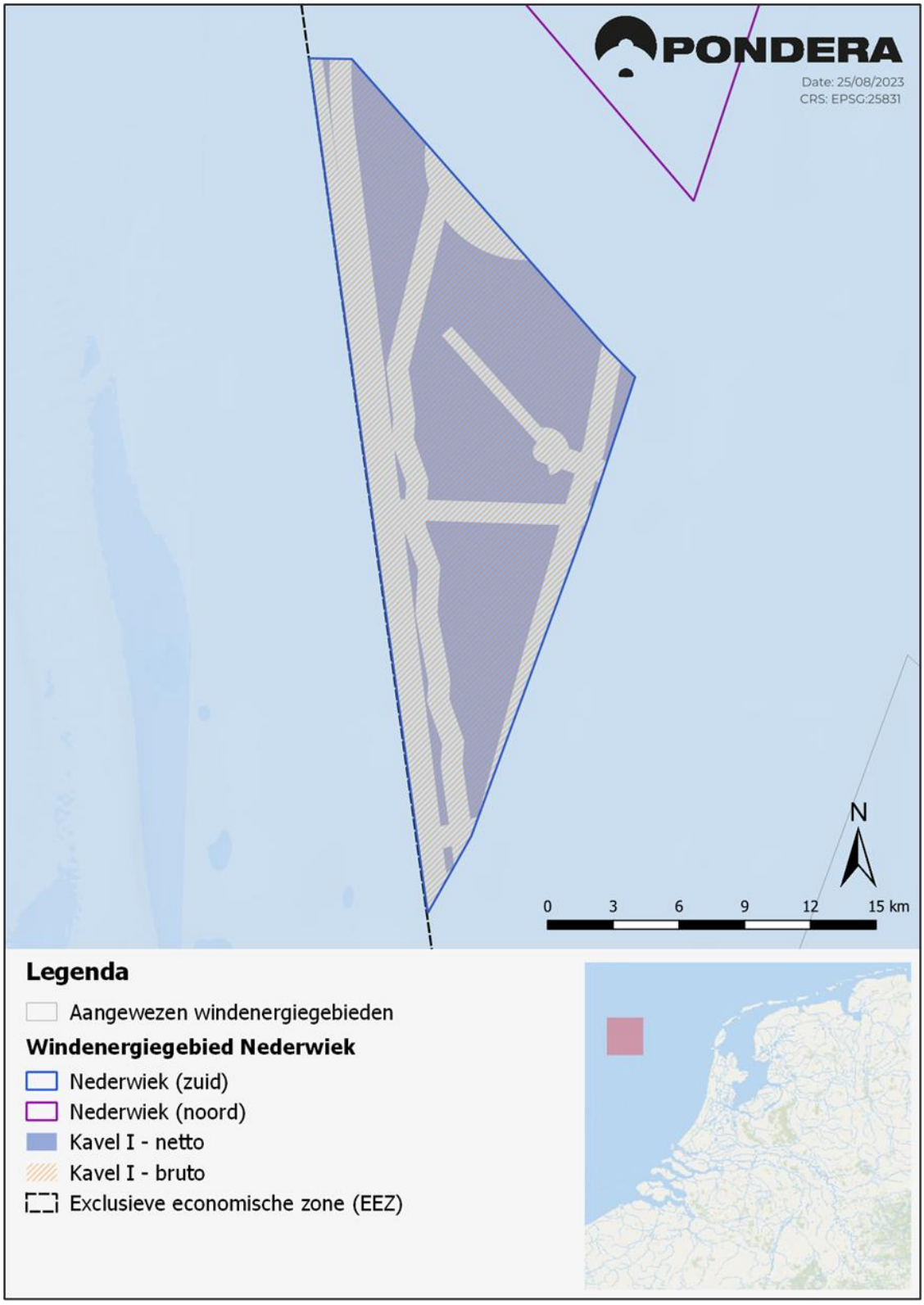
The Nederwiek Wind Farm Zone has space for three 2 GW sites: two sites in Nederwiek (north) and one site in Nederwiek (south). The tender for site I Nederwiek (south) is planned in the second quarter of 2025. The starting point of the North Sea Program 2022-2027 is to combine the use of scarce space in the North Sea as much as possible with relatively compact sites of about 10 MW/km^2.

Various frameworks and guidelines are used in the site subdivision process. For example, the North Sea 2022-2027 Program includes the “Process design: distance between mining sites and wind farms” and the “Design criteria distance between shipping lanes and wind farms”. Studies have also been conducted on the effects of wake turbulence from wind turbines on aviation safety[23] and on helicopter accessibility of mining platforms.

Site I Nederwiek (south) in the Nederwiek Wind Farm Zone is located in the southern part of the Wind Farm Zone. Site I Nederwiek (south) is bordered on the north side by a (intended) shipping clearway and a zone to be kept obstacle-free for the purpose of safe helicopter accessibility of platform K13-A. On the east side, Nederwiek (south) is bounded by the North Sea Traffic Separation System (TSS). The west side is bounded by the EEZ border between the Netherlands and the United Kingdom (UK). In the middle of Plot I Nederwiek (south), a zone is kept clear for the platform of the Net op zee Nederwiek I and for the helicopter accessibility of that platform. A passage through Nederwiek (south) is provided for smaller vessels (up to a length of 46 meters).

[23] Netherlands Aerospace Centre, commisioned by the Ministry for Infrastructure and Water Management, Offshore Wind Turbine Wake effects and safe helicopter opration, ref. NLR-CR-2016-266, 2016. See also: To70, commissioned by Netherlands Enterprise Agency, Effect of wind turbine wake turbulence on offshore helicopter operations in and around wind farms, ref 19.200.01, 2020.

Figure S2 Location of Wind Farm Zone Nederwiek and site subdivision.



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.

Site I Nederwiek (zuid) within the Nederwiek Wind Farm Zone is thus issued with the possibility for the 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 S2). 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 S2 Bandwith EIA

Subject	Bandwidth
Installed capacity site	2,0 – 2,3 GW
Maximum number of turbines	153
Power of individual wind turbines	Minimum 15 MW
Tip height (top) individual wind turbines	Maximum 305 meter[24]
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 rotor diameter
Number of blades per wind turbine	2, 3
Type of foundations	Monopile, multipile, gravity based structure, suction bucket, floating foundation
Maximum noise level (in case of pile driving)	160 or 164 dB re 1 μPa^2s SELss 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 μPa^2s SELss (at 750 meter 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 metre

Table S3 shows the alternatives to be assessed. The alternatives consist out of two baseline alternatives, and for both baseline alternatives an overplanting scenario of approximately 5 percent (2,1 GW) and of approximately 15 percent (2,3 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.

[24] In the Memorandum on Scope and Level of Detail of site I Nederwiek (zuid) a maximum tip height of 1000 foot, which translates to 304.8 meters. In the EIA, this 304.8 meters will is rounded to 305 meters. A worst-case (maximum) tip height of 305 meters will thus be used to determine the environmental effects under investigation in this EIA.

Table S3 Alternatives

Alternative 1a	Alternative 2a	Alternative 1b (overplanting 5%)	Alternative 2b (overplanting 5%)	Alternative 1c (overplanting 15%)	Alternative 2c (overplanting 15%)
134 x 15 MW-turbines rotordiameter 236 m	100 x 20 MW-turbines rotordiameter 280 m	140 x 15 MW-turbines rotordiameter 236 m	106 x 20 MW-turbines rotordiameter 280 m	153 x 15 MW-turbines rotordiameter 236 m	115 x 20 MW-turbines rotordiameter 280 m

Assessment

To compare the effects of the alternatives for each aspect, they are assessed on a +/- scale compared to the baseline 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 will be motivated. 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 Nederwiek (zuid), cumulative effects of other wind farms and activities have also been considered, as well as mitigating measures.

Table S4 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. Result 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[25]. 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 S5.

- 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, four overplanting alternatives of 5 and 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 does bring long-term 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 100 to 134 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 S5).

[25] 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.

Table S5 Impact assessment morphology and hydrology

Aspect (during construction, maintenance and operation)	Alternative 1a (15 MW)	Alternative 2a (20 MW)	Overplanting alternative 1b (5%) (15 MW)	Overplanting alternative 2b (5%) (20 MW)	Overplanting alternative 1c (15%) (15 MW)	Overplanting alternative 2c (15%) (20 MW)
Waves	0/-	0/-	0/-	0/-	0/-	0/-
Water movement (water level and current)	0/-	-	0/-	-	0/-	-
Water depth and bedforms	0/-	0/-	0/-	0/-	0/-	0/-
Soil composition	0/-	0/-	0/-	0/-	0/-	0/-
Turbidity	0/-	0/-	0/-	0/-	0/-	0/-
Water quality	0	0	0	0	0	0
Stratification	0/-	0/-	0/-	0/-	0/-	0/-
Sediment transportation	0/-	0/-	0/-	0/-	0/-	0/-

6.2 Birds and bats

Alternatives 1a/b/c (134 to 153 turbines x 15 MW) result in several tens to hundreds more bird casualties than alternatives 2a/b/c (100 to 115 turbines x 20 MW). Based on current knowledge, alternatives 1a/b/c with more and smaller turbines are expected to result in a larger number of bat casualties (estimated max 153) than alternatives 2a/b/c (estimated max 115). 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 S6.

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

Effects of windfarms	Alternative 1a	Alternative 1b	Alternative 1c	Alternative 2a	Alternative 2b	Alternative 2c
Wind turbines	134 * 15 MW ø 236 m	140 * 15 MW ø 236 m	153 * 15 MW ø 236 m	100 * 20 MW ø 280 m	106 * 20 MW ø 280 m	115 * 20 MW ø 280 m
Construction phase birds						
Construction of foundations	0/-	0/-	0/-	0/-	0/-	0/-
Increased shipping	0/-	0/-	0/-	0/-	0/-	0/-
Construction phase bats						
Construction of foundations	0	0	0	0	0	0
Increased shipping	0/+	0/+	0/+	0/+	0/+	0/+
Operation phase birds						
Local seabirds						
Collisions	--	--	--	-	-	-
Barrier effect	0	0	0	0	0	0
Habitat loss	-	-	-	-	-	-
Indirect effect	0/-	0/-	0/-	0/-	0/-	0/-
Breeding (colony) birds						
Collisions	-	-	-	-	-	-

Effects of windfarms Wind turbines	Alternative 1a 134 * 15 MW ø 236 m	Alternative 1b 140 * 15 MW ø 236 m	Alternative 1c 153 * 15 MW ø 236 m	Alternative 2a 100 * 20 MW ø 280 m	Alternative 2b 106 * 20 MW ø 280 m	Alternative 2c 115 * 20 MW ø 280 m
Barrier effect	0	0	0	0	0	0
Habitat loss	-	-	-	-	-	-
Indirect effect	0/-	0/-	0/-	0/-	0/-	0/-
Non breeding birds from Natura 2000						
Collisions	-	-	-	-	-	-
Barrier effect	0/-	0/-	0/-	0/-	0/-	0/-
Habitat loss	0	0	0	0	0	0
Indirect effect	0/-	0/-	0/-	0/-	0/-	0/-
Migratory birds						
Collisions	--	--	--	-	-	-
Barrier effect	0/-	0/-	0/-	0/-	0/-	0/-
Habitat loss	0	0	0	0	0	0
Indirect effect	0	0	0	0	0	0
Operation phase bats						
Collisions	-	-	-	-	-	-
Barrier effect	0	0	0	0	0	0
Habitat loss	0	0	0	0	0	0
Indirect effect	-	-	-	-	-	-
Removal phase birds						
Deconstruction of foundations	0/-	0/-	0/-	0/-	0/-	0/-
Increased shipping	0/-	0/-	0/-	0/-	0/-	0/-
Removal phase bats						
Deconstruction of foundations	0	0	0	0	0	0
Increased shipping	0/+	0/+	0/+	0/+	0/+	0/+

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 Nederwiek (zuid) outside the breeding season, cannot be ruled out. Significant effects, however, can be ruled out.
- Significant negative effects of Site I Nederwiek (zuid) 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 0.09%, 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.

6.3 Marine life

Impacts on benthic animals and fish are small in magnitude and sometimes even slightly positive (see Table S7). 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. 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 negatively for all alternatives.

Table S7 Impact assessment benthos and fish

Phase	Effects wind farm	Benthos (1a – 2c)	Fish (1a – 2c)
Construction	Noise vibrations from pile driving	0	0/-
	Turbidity due to bottom trawling	0	0
	Habitat loss due to bottom trawling	0/-	0/-
Operation	Artificial hard substrate	0/+	0/+
	Exclusion of fishing	0/+	0
	EMF due to cables	0/-	0/-
Removal	Removal hard substrate	0	0
	Noise vibrations from removal	0	0/-

For marine mammals, effects occur during the construction of the wind farm for both harbour porpoises and seals due to underwater noise generated by pile-driving activities. During pile driving, the behaviour of marine mammals in a relatively large area may be disturbed for a period of time (animal disturbance days). Repeated exposure within a smaller area of the noise source could lead to hearing impairment, but is unlikely due to the realisation of Site I Nederwiek (south). Noise calculations show that, when applying a noise standard of 160 dB or 164 dB (SELSS at 750m (dB re 1 μPa^2s)), these effects do not lead to a deterioration of the State of Conservation (SoC) for both porpoise and seal populations. However, alternatives 1a, b and c do exceed the number of animal disturbance days as calculated in KEC 4.0 for harbour porpoises. These alternatives therefore score more negatively in the impact assessment. Even without exceeding the KEC 4.0 value, limited disturbance in the behaviour of marine mammals occurs. This effect increases especially as more turbines are installed. During operation, no effect occurs due to the presence of vessels, turbines and hard substrate, and the absence of bottom-feeding fisheries.

The effects of the number of animal disturbance days and physically affected animals during removal have not been studied separately. The effects are considered equal or smaller than those arising during the construction phase. Therefore, the impact scores (worst-case) of removal are equal to construction.

Table S8 Impact assessment marine mammals

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

6.4 Shipping and safety

The total expected collision and drift frequency for site I Nederwiek (zuid) is 0.0387, which comes down to one collision every 26 years. For site I Nederwiek (zuid), the expected number of fatalities per year from a collision with a wind turbine is 0.007852. That figure assumes a nacelle and mast falling onto the deck of the vessel. Given the various traffic routes and traffic flows around the wind farm, there are few if any situations where site I Nederwiek (zuid) affects sightlines. The impact assessment of the shipping safety theme is shown in Table S9.

Table S9 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 Nederwiek (zuid), the wind turbines will theoretically 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 S10).

Table S10 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 S11). (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 S11 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	0/-
	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	Interference aviation radar	0
	Interference shore and ship radar	0
Cables and pipes	Interference cables and pipes	-
Telecommunications	Wave interference	0
Military activities and UXO	Interference military activities	0
	Presence unexploded ordnance	0
Recreation en tourism	Restrictions recreational navigation	-
	Restrictions coastal recreation	0
Cultural history and archaeology	Damage to archaeological remains	
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 slight negative impact on mining as the plot overlaps with an area where an exploration licence has been applied for. 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 slightly 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 Nederwiek (south) 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 2 GW of installed capacity is achieved with a higher number of smaller turbines (134 x 15 MW = 2,000 MW), or with a smaller number of larger turbines (100 x 20 MW = 2,000 MW), is limited. The impact assessment is therefore the same for both alternatives. Three alternatives were therefore considered for the electricity yield and avoided emissions theme (see Table S12). The overplanting alternatives with 140 x 15 MW and 153 x 15 MW wind turbines give slightly higher electricity yields and avoided emissions. The yields and avoided emissions are logically higher for a larger number of turbines (153 > 140 > 134). However, this makes no difference in the impact assessment. The impacts on the electricity yield and avoided emissions sub-aspects are assessed very positively for the three alternatives (see Table S12).

Table S12 Impact assessment electricity yield

Sub aspects	Assessment criteria	Impact assessment alternative 134 x 15 MW	Impact assessment alternative 140 x 15 MW	Impact assessment alternative 153 x 15 MW
Electricity yield	Electricity yield	++	++	++
Avoided emissions	CO_2-emission reduction	++	++	++
	SO_2-emission reduction	++	++	++
	NO_x-emission reduction	++	++	++

7. 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 S13 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.
Birds and bats	Birds Significant negative effects in cumulation can be ruled out for all bird species. For gannet and herring gull, where the ALI standard was still exceeded within KEC 4.0, the ALI standard is met. 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 moulting dwarf bat, at 4,659 animals, is well above the Potential Biological Removal (PBR) value 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 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 μPa^2s or 164 dB re 1 μPa^2s on 750 meters of the noise source, the disturbance will not lead to significant cumulative effects for either seals or harbour porpoises.
Navigation and safety	Cumulative effects of the various offshore wind farms have not been considered separately because the location of Wind Farm Zone Nederwiek in relation to the existing shipping lanes means a wind farm at site I has little to no impact on the route structure in the North Sea. From the most recent research (which assumes that there will be no passage in the wind farms), the total expected collision and drive frequency (with a turbine) is 0.56 per year for the scenario of the original 2030 route map. This is equivalent to once every 1.8 years. For the scenario that includes offshore wind acceleration, this frequency increases to 0.987. This is equivalent to once every 1.0 years.
Landscape	A wind farm in Site I Nederwiek (zuid) 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. As a result, a larger area will be closed to fishing. The future cumulative effect of this area closure for fisheries is

Aspects	Relevant cumulative effects
	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. This reduces the total area available for fisheries at the North Sea. 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 the sites within the Nederwiek Wind Farm Zone increases this 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 to travel within certain wind farms (Prinses Amalia Wind Farm and Offshore Wind Farm Egmond aan Zee). For wind farms where recreational shipping is not allowed, like Niederwiek (zuid), 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 at sea have a limited effect.
Electricity yield	The increase of wind farms in the North Sea increases the potential wake effects. For site I Nederwiek (zuid) of the Nederwiek Wind Farm Zone, the wake losses increase by 5.0%-points from 15.0 to 20.0% (for the 134-turbine arrangement), with further filling of wind energy areas in the Dutch and UK North Sea, and the net electricity yield decreases by 5.6% from 8,323 GWh/y to 7,589 GWh/y. The amount of avoided emissions decreases by 5.6% as a result.

8. Transboundary effects

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

8.1 Birds and bats

Breeding birds

Wind Farm zone Nederwiek (zuid) 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 Nederwiek (zuid). It appears that, for example, individuals from colonies of gannets, kittiwakes and lesser black-backed gulls may reach Nederwiek, but that these are either non-protected colonies or that their flight movements through Nederwiek (zuid) are expected to be incidental. Therefore no significant negative effects are expected for protected colonies.

Non-breeding birds

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

Migratory birds

Population models were established for the eight most critical migratory bird species as part of the KEC 4.0 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 effect on (foreign) Natura 2000-areas can be ruled out.

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 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. The maximum overlap of the disturbance contour with the SAC is about 630 km if a noise standard of SELss = 160 dB re 1 μPa^2s (750 m) is assumed and about 800 km if the higher noise standard of SELss = 164 dB re 1 μPa^2s (750 m) is assumed. These are 1.7% and 2.14% of the total area of the SAC, respectively. 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[26]. Significant effects through external effects can therefore be ruled out.

9. Mitigation

Mitigating measures can ensure that adverse environmental effects are avoided, prevented or limited. In the EIA of site I Nederwiek (zuid), 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 S14 below summarises the possible mitigating measures.

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

Table S144 Possible mitigating measures

Aspect	Effect	Possible mitigating measures
Birds and bats	Disturbance (construction)	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 (operation)	Apply minimal lighting on vessels, with a ‘bird-friendly’ colour Increase detection probability of the wind farm for birds by reflectors, lasers and sound (depending on bird species and thus bound by various restrictions). 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. Install the smallest possible number of large wind turbines instead of a larger number of smaller wind turbines. Install two-bladed rather than three-bladed turbines. Smart planning of maintenance work, when turbines are shut down, can prevent casualties (consider periods of increased bird activity)
	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. Sparing locations of biogenic reefs. In future possibly (after operation) biodegradable materials for erosion protection Use alternative foundation techniques than piling such as vibrating, screwing or blue piling. <u>Marine mammals</u> Use acoustic measures (piling walls, bubble screens, Acoustic Deterrent Devices (ADDs), etc.). 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, such as vibrating, screwing or blue piling.

Aspect	Effect	Possible mitigating measures
	Disturbance and habitat destruction (removal)	Benthos and fish Do not remove wind turbine pillars and embankments so that the developed aquatic communities remain, possibly in conjunction with biodegradable concrete structures (for erosion protection).
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.
	Mining	Move drilling site outside wind farm and reach field with oblique drilling.
	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

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 cumulative effects on birds, bats and harbour 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 S14 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.

Splitting of site 1 Nederwiek (zuid)

This EIA has been prepared for the purpose of taking a site decision for site 1 in wind energy area Nederwiek (zuid) with a capacity of at least 2 GW. The Minister of Climate and Green Growth intends to split the site of about 2 GW into two sites of about 1 GW. Upon request, chapter 13 explains for each environmental aspect what the splitting of site 1 of Nederwiek (zuid) into a site I-A Nederwiek (zuid) en I-B Nederwiek (zuid) may mean for the impact assessment in the EIA, Appropriate Assessment (AA) and Species Assessment (SA) and Marine Strategy Framework Directive (MSFD). The split may result in more

diverse periods of operations and possibly more working vessels. This additional effect is expected to be very limited. In addition, the main assessment with regard to the ecological themes in the SA (Appendix 7) and AA (Appendix 8) and MSFD test (Appendix 9) takes place in cumulation with other wind farms in the North Sea. For both site 1 of Nederwiek (zuid) and the split sites (I-A & I-B), an equal cumulation scenario with other wind farms in the North Sea applies. It is concluded that the splitting of site 1 of Nederwiek (zuid) does not affect the conclusions and impact assessments presented in the EIA, AA, SA and MSFD.

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 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. 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 the Nederwiek 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.

12. Monitoring and evaluation

12.1 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.

Current situation

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[27].

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.

12.2 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.

The programme is designed to make use of progressive understanding. Choices and priorities are geared to current events[28].

[27] For more information see website: https://www.noordzeeloket.nl/functies-gebruik/windenergie-zee/ecologie/wind-zee-ecologisch.
[28] For more information, see website: https://www.noordzeeloket.nl/functies-gebruik/windenergie/scheepvaart-moswoz/

Table S15 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.