Summary

1. Introduction

The Netherlands has set ambitious targets for achieving sustainable – renewable – energy production. Wind energy plays a prominent role in achieving that target. In 2022, the (former) Minister for Climate and Energy raised the target for offshore wind to a capacity of 21 GW. The Additional Offshore Wind Energy Roadmap 2030[5] 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 Water Decree lays down general rules for offshore wind farms.

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

In this summary the following sections are covered after this introduction (section 1):

2. the policy context and the reason for the Wind Farm Site Decision to be taken;
3. the choice of location for IJmuiden Ver wind farm zone;
4. the site subdivision of IJmuiden Ver wind farm zone;
5. the method of the EIA;
6. the result of the EIA;
7. cumulation;
8. transboundary effects;
9. mitigation;
10. considerations of the preferred alternative;
11. gaps in knowledge and information;
12. monitoring and evaluation.

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

2. Policy context and reason for Wind Farm Site Decisions

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

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

In accordance with this roadmap, approximately 11 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.

Figure S1 Offshore wind energy roadmap June 2022

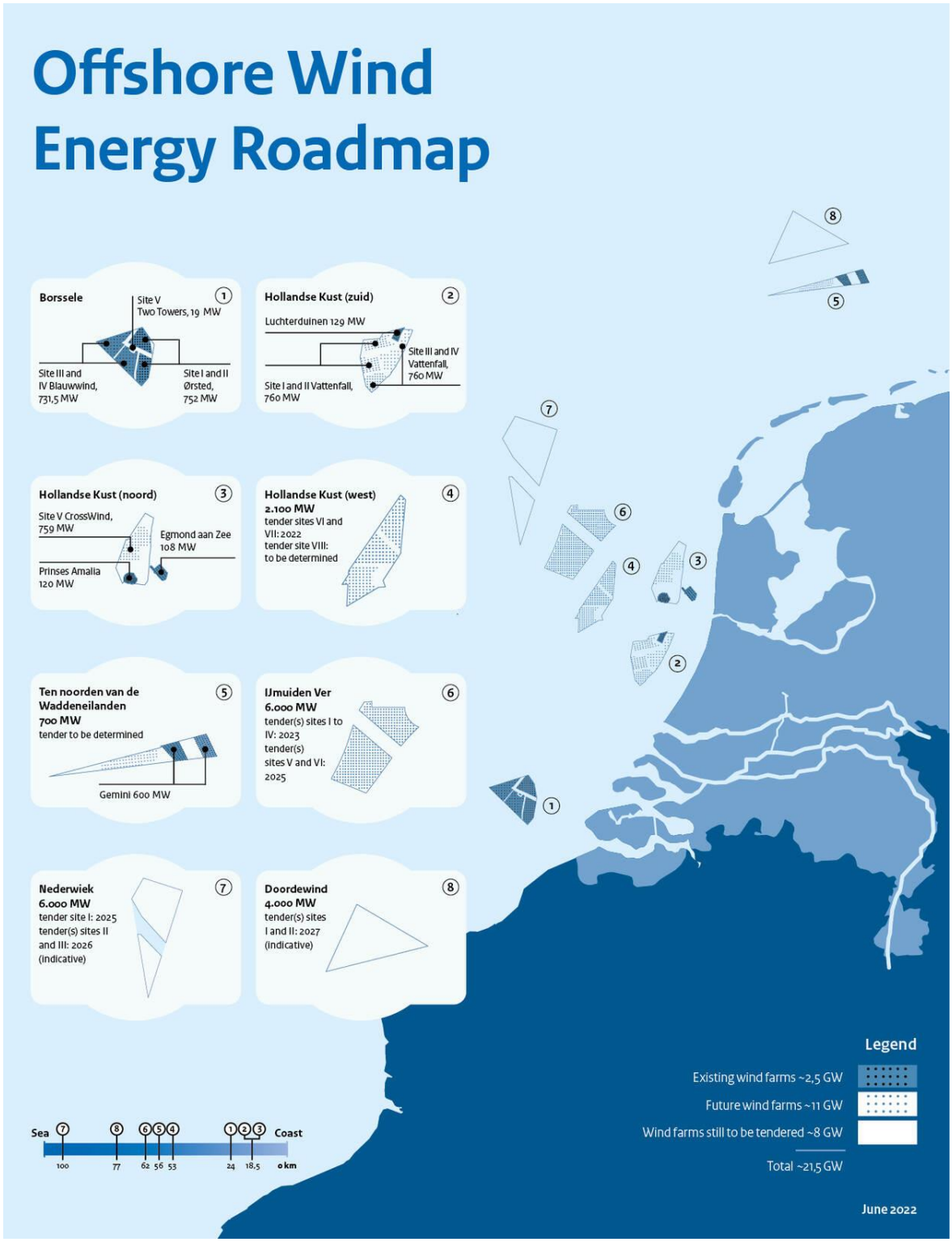

Table S1 Additional roadmap offshore wind energy 2030 (June 2022)

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

3. Site choice offshore wind farm zones

In the Environmental Impact Assessments for the Sites of Wind Farm Zone Borssele and Sites I and II of Hollandse Kust (South), a general comparison between the wind farm zones was made. This general comparison highlights specific aspects that need to be taken into account in the further development of wind energy in the wind farm zones, such as the effect on marine mammals and birds. This Environmental Impact Assessment will pay explicit attention to these aspects.

Site selection study in the North Sea Programme

The North Sea Programme (PNZ) 2022-2027, which is part of the National Water Programme (NWP), has mapped eight search areas eligible for designation as wind farm zones in the North Sea until 2040. There are also four already designated and not yet used (parts of) wind farm zones, which have been reconfirmed. In fulfilling the target and the required acceleration till 2030, offshore wind energy plays an vital role. According to the Additional Task Steering Group, 10 GW of offshore wind energy is needed to

achieve 55% CO_2 reduction. To this end, the study examined what is needed to fulfil the remaining target of the 49% target (0.7GW) in the existing wind farm zones and to find space for the additional EU acceleration target (55%) until 2030.

The Strategic Environmental Assessment for the supplement to the North Sea Programme shows that the 11 GW in the newly designated and partially reconfirmed wind farm zones are needed in their entirety to meet the 55% EU target. The northern part (site Gamma) of the IJmuiden Ver Wind Farm Zone was reconfirmed in the North Sea Programme. IJmuiden Ver is thus part of the roadmap to meet the CO_2 target in 2030. Additional CO_2 reduction will be achieved with the newly designated wind farm zones.

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

4. Site subdivision

The designated IJmuiden Ver Wind Farm Zone is located in the Dutch Exclusive Economic Zone (EEZ). The area lies approximately 53 kilometres from the coast, measured from the closest point in Texel. Zone originally had a total area of 1170 square kilometres. However, the North Sea Programme 2022-2027 adjusted the southern boundary of the IJmuiden Ver Wind Farm Zone due to the designation of the Brown Bank as a Birds Directive area. The intended area for site Gamma is situated in the northern part of this area and covers an area of approximately 227 square kilometres. The water depth in the entire (originally designated) wind energy area ranges from 16.8 to 46.9 metres (lowest astronomical tide – LAT).[6]

Within the IJmuiden Ver Wind Farm Zone, there is space for three sites of 2 GW. The tender of site Gamma is planned in the second quarter of 2025. One of the starting points of the North Sea Programma 2022-2027 is to combine the use of scarce space in the North Sea as much as possible with relatively compact sites of approximately 10 MW/km^2.

In the site subdivision process of the zones various frameworks and guidelines are used. For example, the North Sea Programme 2022-2027 includes the 'Design process: distance between mining sites and wind farms' and the 'Design criterion distance between shipping lanes and wind farms'. Studies have also been conducted on the effects of wake turbulence from wind turbines on flight safety and on the helicopter accessibility[7] of mining platforms.

Site Gamma

Site Gamma in the IJmuiden Ver Wind Farm Zone is situated on the north east side of the wind energy area. Site Gamma is bordered on the north side by the military training area EHD41, the helicopter safety zone of platform K14-FB1 and the southern subarea of the new wind energy area Lagelander. There is a shipping route on both the west and east side of site Gamma. In the middle of site Gamma, a zone is kept clear for the IJmuiden Ver Gamma Offshore Grid. The southern boundary of site Gamma is the proposed ‘clearway’ for the purpose of opening up the sea ports of IJmuiden and Amsterdam.

[6] For more information, see the location studies at https://offshorewind.rvo.nl/generalIJmuiden

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

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

5. Method of impact Assessment

Bandwidth

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

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

Bandwidth

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

Alternatives

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

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

The bandwidth of the site to be issued is shown in the following table. The values of the bandwidth are based on the current state of the art and expectations regarding developments for the coming years. The upper and lower limits of the bandwidth will be laid down in the Wind Farm Site Decision.

Table S2 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
Tip height (bottom) individual wind turbines	Minimum 25 meter
Rotor diameter individual wind turbines	236 – 280 meter
Spacing between wind turbines	Minimum 4 times the rotordiameter
Number of blades per wind turbine	2, 3
Type of foundations	Monopile, multipile, gravity based structure, suction bucket
Maximum noise level (in case of pile driving)	160 or 164 dB re 1 μPa^2s SELss 750 metres from the noise source
In case of foundation piling: diameter of foundation pile/piles and number of piles per turbine:	
Monopile	1 pile of 11,5 to 15 meter
Multipile (including 'tripods' en 'jackets')	3 to 4 piles of 3 - 5 meter
In case of foundation without piling: dimensions on seabed:	
Gravity Based	Up to 50 meter in diameter
Suction Bucket	Up to 30 meter in diameter
Electrical infrastructure (inter-array cabling)	66 kV, buried at a depth of 1 metre

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).

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.

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 zero alternative (which is the current situation and autonomous development). The following rating scale is used for this purpose, as shown in Table S4. The assessment is elaborated.

Table S4 Assessment methodology

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

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

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

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

6. Result of environmental Assessment

The following tables show the ratings of the alternatives by aspects according to the different assessment criteria, without the use of mitigation measures[8]. The tables are then discussed for each aspect.

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.

[8] 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.

In addition to the baseline alternatives, four overplanting alternatives of 5 and 15 percent were assessed. In these cases, instead of 100 (20 MW) and 134 (15 MW) respectively, the following number of windturbines will be placed:

- 106 and 140 wind turbines (5%)
- 115 and 153 wind turbines (15%)

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. 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 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

Alternative 1 (134 to 153 turbines x 15 MW) results in several dozens to hundreds of bird casualties more than alternative 2 (100 to 115 turbines x 20 MW). Based on current knowledge, alternative 1, with more and smaller turbines, is expected to result in a higher number of bat casualties (an estimated max. 153) than alternative 2 (an estimated max. 115). Alternative 2 is therefore the most environmentally-friendly alternative from the perspective of birds and bats, mainly due to the lower number of collision casualties

than the other alternative with more turbines. The complete impact assessment is summarised in Table S6.

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

Effects of wind farm	**Alternative 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 effects	0/-	0/-	0/-	0/-	0/-	0/-
Breeding (colony) birds						
- collisions	-	-	-	-	-	-
- barrier effect	0	0	0	0	0	0
- habitat loss	-	-	-	-	-	-
- indirect effects	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 effects	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 effects	0	0	0	0	0	0
Bats						
- collisions	-	-	-	-	-	-
- barrier effect	0	0	0	0	0	0

- habitat loss	0	0	0	0	0	0
- indirect effects	-	-	-	-	-	-
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 Gamma outside the breeding season, cannot be ruled out. Significant effects, however, can be ruled out.
- Significant negative effects of Site Gamma on breeding populations of lesser black-backed gulls from the Dutch Natura 2000 areas Dunes and Lage Land Texel, Dunes Vlieland and Wadden Sea can be ruled out. The additional mortality caused by the wind farm is at most 0.06%, and this falls below the 1% natural mortality standard.
- Effects on some species of migratory birds on seasonal migration from Natura 2000 areas as a result of collisions cannot be ruled out. Significant effects, however, can be ruled out.

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

- For most species whose victims are expected in Site Gamma in IJmuiden Ver Wind Farm Zone, the predicted mortality for all species is less than 1.0% of the annual natural mortality of the population in the Dutch EEZ. The exceptions are the northern gannet, the great black-backed gull and the lesser black-backed gull. On this basis, for all species except the northern gannet, great black-backed gull and lesser black-backed gull, it can be said with certainty that the realisation of Site Gamma in IJmuiden Ver Wind Farm Zone will not lead to effects on the GSI of the populations concerned. This effect does still need to be assess for cumulation with other projects. This is described in paragraph 7 of this summary.

6.3 Marine life

Impacts on benthic animals and fish are small in magnitude and sometimes even slightly positive (see Table S7). However, for Sabellaria reefs there is a possible negative effect caused by the habitat destruction during bottom trawling activities. This effect is therefore assessed as slightly negative for benthic animals. Sabellaria reefs are a critical habitat potentially present in the plan area. This reef-forming species, which can reach a reef width of several metres, thus creating a habitat for other species, may be destroyed by turbine construction and scour protection. This effect will be greater for alternative (1c) where 53 more turbines are placed than alternative (2a). Compared to a monopile foundation, a gravity-based

foundation covers a larger area and a tripod foundation a smaller area. Because of this, the effect will be greater and smaller, respectively. Nevertheless, the differences do not result in a distinctive assessment.

For marine mammals (porpoises and seals), effects will occur during the construction phase of the wind farm due to the underwater noise created by pile-driving activities (see Table S7). During pile driving, animals may be disturbed in their behaviour in a relatively large area around the sound source. Repeated exposure within a smaller area around the sound source could potentially lead to impairment of the auditory organ, but is unlikely due to the realisation of site Gamma. The noise calculations show that, when applying a noise level standard of 160 dB or 164 dB (SEL_{ss} at 750m (dB re 1 µPa2s)), this disturbance will not lead to population effects for either seals or porpoises, so the effects will not lead to a deterioration of the State of Conservation (Svi). For the overplanting alternative 1c, however, the disturbance days are exceeded, as calculated in the KEC 4.0. This alternative scores more negatively in the impact assessment. Even without exceeding the KEC 4.0 value, a limited disturbance occurs in marine mammal's behaviour. This effect increases especially as more turbines are installed. During operation, no effect occurs as a result of the presence of ships, turbines and hard substrate, and the absence of bottom trawling.

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/-
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/-

Table S8 Impact assessment marine mammals

Phase / effect		Alternative 1a	1b	1c	2a	2b	2c
Construction							
Distrubance days (impulsive noise):	Porpoises	0/-	0/-	-	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):	Porpoises	0/-	0/-	-	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

6.4 Shipping and safety

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

The total expected collision and drift frequency for site Gamma is 0.0468, which comes down to one collision every 21 years. From the most recent study (which assumes that there will be no passage in the wind farms), the total expected collision and drift frequency (with a turbine) for the scenario RK2030 is 0.987 per year (once every 1.0 year). This is the scenario from the original roadmap (up to IJmuiden Ver I-IV) plus the assignment to accelerate, but without the future roadmap 2040. Therefore, the assessment in terms of probability of collisions and drifts is negative (-).

For site Gamma the expected average number of casualties per year due to a collision or drift with a wind turbine is 0.034953 (score 0/-). That figure assumes a nacelle and mast falling on the deck of the ship.

There are few to no situations where site Gamma affects the sightlines for crossing shipping (score 0).

6.5 Landscape

For site Gamma, the worst-case turbines will be theoretically visible at an eye level of 1.6 metres and at a height of 20 metres (on the coast). However, the meteorological conditions will almost always obscure the turbines from view. The wind farm will theoretically be visible less than 1% of the time (less than 1 day per summer, and for less than 7 minutes on that day). Visibility receives a neutral score (0).

Table S10 Impact assessment landscape

Assessment criterion	Assessment
Visibility in percentage of time	0

6.6 Other use functions

The impact assessments for the various alternatives are not distinctive. Most effects on the other use functions are assessed neutrally because they are minor in magnitude, or can be ruled out beforehand. This applies to Aviation (excluding helicopter traffic), Sand, gravel and shell mining, Dredged sediment, Ship, shore and aviation radar, Cables and pipes, Telecommunications, Military activities, and Recreation and tourism.

Table S11 Impact assessment other use functions

Functions	Assessment criteria	Effectscore
Fisheries	Restrictions on fisheries	0/-
Mining	Restrictions on oil and gas extraction	-
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	0
Telecommunications	Wave interference	0
Military activities and UXO	Interference military activities	0
	Presence unexploded ordnance	-
Recreation en tourism	Restrictions recreational navigation	0
	Restrictions coastal recreation	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 slightly negatively. The area closure of the site is small compared to the area available to fishermen. However, individual fishermen may experience greater impacts than others if they frequently use fishing grounds within the site. The effects on helicopter traffic are also assessed slightly negatively due to the crossing of the Helicopter Main Route (KZ45) and limited overlap with Helicopter Protection Zone Unicorn B. The effects on cultural history and archaeology are also assessed slightly negatively due to the presence of (possible) 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 area HKW, which can negatively influence the amount of wind another wind farm can capture.

The assessments for mining and unexploded ordnance are negative. For mining the effects are assessed negatively due to hydrocarbon extraction areas (with permits in force) that largely overlap with site Gamma. Within the sites the presence of UXO are highly likely, making necessary measures essential. With these measures, the possible effects will be mitigated.

6.7 Electricity yield

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	++	++	++

For the alternative with 134 x 15MW turbines (no overplanting) there is a calculated net electricity yield of 8,301 GWh/year. For the 5% overplanting scenario (140 x 15 MW) this is 8,589 GWh/year, and for the 15% overplanting scenario (153 x 15 MW) 9,297 GWh/year. The yields and avoided emissions are, logically, greater for a larger number of turbines (153 > 140 > 134). This, however, does not make a difference to the impact assessment.

7. Cumulation

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

Table S13 Relevant cumulative effects and consequences

Aspects	Relevant cumulative effects	Consequences of Wind Farm Site Decision
Morphology and hydrodynamics	At the level of the IJmuiden Ver Wind Farm Zone, the effect on morphology and geology will be neutral. However, recent studies have shown that very large-scale developments of wind farm zones in the North Sea could potentially affect (mixing) and water movement and morphology. However, the extent of effects regarding these aspects and the repercussions on other geological and ecological processes is highly uncertain.	No consequences
Birds and bats	<u>Birds</u> On the basis of new cumulative casualty calculations as a result of, among other things, new density maps (see Appendix 10), significant negative effects can be ruled out for all species in the accumulation, including for razorbills and guillemots in the international scenario, where previous EIAs still exceed the acceptable level of impact (ALI) of these bird species. The ALI standard is also met for gannets and herring gulls, where the ALI standard was still exceeded within KEC 4.0. <u>Bats</u>	<u>Birds</u> Several studies on possible mitigation measures to reduce impacts are ongoing. These measures could potentially reduce the number of casualties. <u>Bats</u> Based on current knowledge, it cannot be ruled out with certainty that negative effects on the conservation status of rough-legged dwarf bat will occur in the worst-case scenario, even after applying downtime as a mitigation measure.

Aspects	Relevant cumulative effects	Consequences of Wind Farm Site Decision
	Much less information is available on bats than on birds. The bats that fly over the North Sea are well established, but their numbers, the population sizes from which these animals originate and their behaviour at sea are not well known. According to the calculation method used, the number of casualties among pipistrelle bats, at 4,620 animals, is well above the PBR of 1,905 animals.	
Marine life	<u>Benthos and fish</u> The increase in the number of wind turbines and foundations could lead to changes in flow, stratification or primary production of benthos. It is also possible that it facilitates colonisation by exotic species. However, not enough information is available to estimate these effects. <u>Marine mammals</u> Applying an underwater noise level of 160 dB re 1μPa^{2}s or 164 dB re 1μPa^{2}s on 750 meters of the noise source, the disturbance will not lead to significant cumulative effects for either seals or porpoises, so the effects will not lead to a deterioration of the State of Conservation (Svi).	There is a knowledge gap when it comes to changes in flow, stratification and primary production as a result of wind farms, as well as the possible effect of colonization by exotic species. If the noise standard described in this EIA is applied, effects on the GSI of marine mammals can be ruled out.
Navigation and safety	In this Environmental Impact Assessment, the cumulative impact of the different offshore wind farms is not considered separately. The considered zero alternative is therefore also the cumulative scenario. Most recent research indicates that the total expected collision and drift frequency (with a turbine) for the scenario Rk2030 (1281 turbines) is 0.56 per year (once every 1.8 years). For the scenario that includes acceleration, this frequency increases to 0.987 (once every 1.0 years).	No consequences
Landscape	IJmuiden Ver site Gamma is located at a great distance from the coast. Only because of this, it is visible for less than 24 hours on an annual basis. The same applies to nearby wind energy zones such as Hollandse Kust (west) and Nederwiek. Therefore, no significant contribution to cumulative effects is expected and no mitigating measures are required.	No consequences
Other uses	<u>Fisheries</u> The arrival of more offshore wind farms increases the total land used. As a result, a larger area will be closed to fishing. The future cumulative effect of this area closure for fisheries is partly determined by future developments in the ecology of the North Sea and the policy and socio-economic context. The possibility of more nature areas being closed to fishing in the future, and the possible closure of UK waters after 2025 increases this effect.	No consequences

Aspects	Relevant cumulative effects	Consequences of Wind Farm Site Decision
	Archaeology With a greater number of turbines in the North Sea, the likelihood of archaeological remains being affected, or NGE being struck, also increases. The realisation of the sites within the IJmuiden Ver Wind Farm Zone increases this chance, although good mitigation measures are available for this. Recreational navigation For recreational shipping, the cumulative effects are limited because it is allowed for ships up to 24 metres in length within certain wind farms, and for wind farms where this is not allowed, passages are designated that ships up to 46 metres can use. In addition, recreational shipping mainly uses the 10 to 20 km wide zone along the coast, so area closures further out to sea have a limited effect.	
Electricity yield	The increase of wind farms in the North Sea increases the potential wake effects. For site Gamma of IJmuiden Ver Wind Farm Zone, the number of full-load hours decreases from 4,130 to 3,605 due to the 'wind capture' of other wind farms. The wake losses increases by 11.0 percentage points, from 13.2 to 24.2% (for the layout with 134 turbines), and the net electricity yield decreases by 12.7% from 8,300 GWh/y to 7,245 GWh/y. The amount of avoided emissions decreases by 12.7%.	No consequences

8. Transboundary effects

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

8.1 Birds and bats

Breeding birds

IJmuiden Ver Wind Farm Zone is out of reach of breeding colonies situated in foreign Natura 2000 areas.

Non-breeding birds

Based on the cumulative calculations, significant negative effects for all non-breeding birds can be ruled out. While the standards for the international scenario (all wind farms in the central and southern North Sea expected to be operational until 2029) were previously exceeded for both razorbill and guillemot, this is no longer the case based on more recent calculations based on new density maps and more current data regarding wind farms. This also means that significant negative effects on the razorbill and guillemot can be ruled out. For further substantiation, please refer to paragraph 11.1 of Appendix 4.

Chapter 6 and the Appropriate Assessment have concluded that, in cumulation, significant effects on populations within Natura 2000 areas are ruled out. This also applies to foreign Natura 2000 areas.

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 identified in the KEC 4.0 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 disturbed area for sea mammals lies entirely inside the Dutch EEZ. The calculations made regarding the effects on marine mammals apply to the population within the NCP. No calculations have been done for other populations. The disturbed area lies entirely outside Natura 2000 areas designated for porpoises or seals in the Netherlands or abroad. There are no transboundary effects or direct externalities.

9. Mitigation

Mitigating measures can ensure that adverse environmental effects are avoided, prevented or limited. In the EIA of site Gamma IJmuiden Ver, 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.

Table S14 Mitigation measures

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

Aspect	Effect	Possible mitigating measures
		Smart planning of maintenance work. When turbines are shut down it can prevent casualties (consider periods of increased bird activity. Increasing the tip height
	Disturbance	Dismantle at a time when few disturbance-sensitive species are present.
Aquatic life	Disturbance and habitat destruction	Benthos Use the smallest possible foundation. Sparing locations of biogenic reefs. In future possibly (after operation) biodegradable materials for erosion protection Marine mammals Use acoustic measures (piling walls, bubble screens, etc.). Choose the shallowest locations in the planned area. Conduct piling work when the density of marine mammals is low (autumn). Choose a small number of, relatively large turbines rather than several smaller ones. Use alternative foundation techniques, such as vibrating, screwing or blue piling. Use other foundations, such as tripods, jackets or suction buckets.
	Disturbance and habitat destruction	Benthos Do not remove wind turbine pillars and embankments so that the developed aquatic communities remain. Use biodegradable concrete structures.
Shipping and safety	Collision risk and vessel movements	Using the Automatic Identification System (AIS) and VHF antenna in the park Vessel traffic management (VTM) Additional marking and identification of wind turbines Deployment of an Emergency Towing Vessel Additional SAR capacity ETV equipped with pesticides against oil pollution
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 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.

Conclusion

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

11. Knowledge gaps

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

The 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 Gamma in IJmuiden Ver Wind Farm Zone. However, it is important for the decision-making process to have insight into the uncertainties that played a role in the impact predictions. This insight has been provided with this Environmental Impact Assessment.

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 Management Act.

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

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

Current situation

A multi-year monitoring and research programme was 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.

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

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

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. 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 Response 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.

13. Splitting of sites

This Environmental Impact Assessment (hereinafter referred to as EIA) has been prepared for the purpose of taking a site decision for site Gamma in wind energy area Ijmuiden VEr. Site Ijmuiden Ver Gamma has space for a windfarm with a total installed capacity of at least 2 GW. The Dutch Ministry of Climate Policy and Green Growth intends to split the 2 GW site into two smaller 1 GW sites.

The EIA for site Gamma is used for making site decisions for both site IJmuiden Ver Gamma-A as well as site IJmuiden Ver Gamma-B. Chapter 13 of the EIA provides an explanation for each environmental aspect on how the subdivision of the sites may impact the impact assessment in the EIA, Appropriate Assessment, a Species Assessment and the Marine Strategy Framework Directive.

Figure S3 shows the proposed split of site Gamma. The net area of site Gamma, as assessed in the EIA, is consistently larger than the combined area of site IJmuiden Ver Gamma-A and site IJmuiden Ver Gamma-B. The reason for this is that, as a result of the subdivision of the two sites, a free corridor has been introduced between the sites. Therefore, the combined environmental impacts of the subdivided sites, are always equal to or less than the assessed impacts of the original site Gamma. It should be noted that by taking to site decisions, two distinct tender procedures will be initiated. This may lead to the allocation of two plots to two different licence holder, resulting in the wind farms being developed, operated and decommissioned by two separate developers. This may give the following relevant implications:

- Increased probability of varying durations for construction, maintenance and decommissioning due to the involvement of different developers and their associated environmental impacts. However, the extent of difference in construction and decommissioning timelines will be limited, as the schedule aligns with the most recent roadmap for bringing site Gamma into operation by Q1 2031 and the equal permit duration (40 years).
- An increased number of working vessels during the construction, maintenance and decommissioning phase of the wind farm in the case of two different wind farm developers, due to reduced economies of scale. However, a wind farm developer will deploy the working vessels as efficiently as possible, given the considerable distance to the coast and the associated high costs. Therefore, any increase in shipping activity is expected remain limited. Furthermore, different wind farm developer may collaborate to facilitate wind farm maintenance.

The subdivision of the site may result in minor differences regarding environmental impacts. Nevertheless, it is concluded that the subdivision does not result in a differing impact assessment or lead to different conclusions for any of the environmental aspects.

For each environmental aspect, the effects have also been described in relation to cumulative impact with other wind farms in the North Sea, where relevant. For both site Gamma and the subdivided sites (site IJmuiden Ver Gamma-A and site IJmuiden Ver Gamma-B), an equal cumulative impact scenario applies to all environmental aspects in conjunction with other wind farms in the North Sea. Moreover, the main assessment with regard to species protection and area protection, in the Species Assessment and the Appropriate Assessment respectively, is conducted in conjunction with the cumulative impact of other wind farms in the North Sea. As long as a significant cumulative effect on the conservation status of protected species or conservation objectives of Natura 2000 can be ruled out, the same conclusion applies to subdivided sites. Therefore, it is not relevant to conduct separate impact assessments for each site or to prepare a separate Species Assessment or Appropriate Assessment for each site.

14. KEC 5.0

In order to take a final site decision for site Gamma, the underlying EIA and associated documents must be completed based on the most recent knowledge. The Framework Ecology and Cumulation 5.0 (KEC 5.0) is published (see https://www.noordzeeloket.nl/). KEC 5.0 gives a cumulative assessment of the impacts of the Dutch offshore wind energy Roadmap 2030/2031 on bird species, marine mammal species and ecosystem impacts, based on the most recent knowledge. Annex 12 of this EIA outlines the knowledge that has been updated in KEC 5.0, the conclusions that follow from KEC 5.0 and the implications of KEC 5.0 for the impact assessment of the EIA of site Gamma and associated assessments. The results of KEC 5.0 with regard to marine mammals, birds and ecosystem effects do not lead to a different impact assessment in the EIA or assessment in the Appropriate Assessment, Species Assessment and Test and Marine Strategy Framework Directive.