Netherlands Enterprise Agency

Borssele Wind Farm Zone

Wind Farm Sites III, IV and V

Appendix B: Summary Environmental Impact Assessment

September 2017

>> *Sustainable. Agricultural. Innovative. International.*

Summary

Introduction

The Netherlands has formulated ambitious objectives for realising the generation of sustainable, renewable energy with wind energy playing a prominent role. Not only concrete objectives for onshore wind energy have been formulated but also for offshore wind energy. These were recently revised and concretised in the Energy Agreement (SER, 2013).

A choice has been made to achieve this objective using a new issuance system. The Offshore Wind Energy Bill was drawn up to this end and entered into force on 1 July 2015 (Parliamentary Papers I, 2014/15, 34 058). It contains a number of steps for the issuance system. Wind farms may only be built in locations (wind farm sites) that the State has designated in a wind farm site decision. Wind farm sites will only be allocated within an area designated in the National Water Plan (NWP). The wind farm site decision determines where and under what conditions a wind farm can be built and operated. Permits are granted after a wind farm site decision. Only the permit holder is allowed to build and operate a wind farm on the wind farm location. The Water Decree provides generic provisions for offshore wind farms.

The Minister of Economic Affairs, in coordination with the Minister of Infrastructure and the Environment, is the initiator for the wind farm site decisions. An EIA procedure was carried out for this purpose. On 11 June 2015, the intention to draw up this environmental impact assessment (EIA) was announced in the Notification on Borssele wind farm site decisions. The Draft Memo of the scope and level of detail EIA Borssele wind farm site decisions was published together with the notification (Government Gazette, no. 15324). This explained the initiative to issue these wind farm sites and sets out what was studied in this EIA. There was also the opportunity to submit opinions.

The wind turbines installed in the Borssele wind farm zone must be connected to the high-voltage grid. TenneT arranges for the offshore transmission system. This comprises two platforms in the Borssele wind farm zone, the cables from these platforms to and over land and the expansion of the Borssele high-voltage station on land. For this connection, TenneT will carry out a separate procedure including an EIA.

Policy context and cause for wind farm site decisions

The following figure is a summary of the most important policy documents with regard to offshore wind energy.

Figure S.1 Context and cause for Borssele wind farm site decisions

Four zones have been designated for the development of offshore wind, see also the following figure:

- Borssele;
- IJmuiden Ver;
- Dutch Coast;
- To the north of the Wadden Islands.

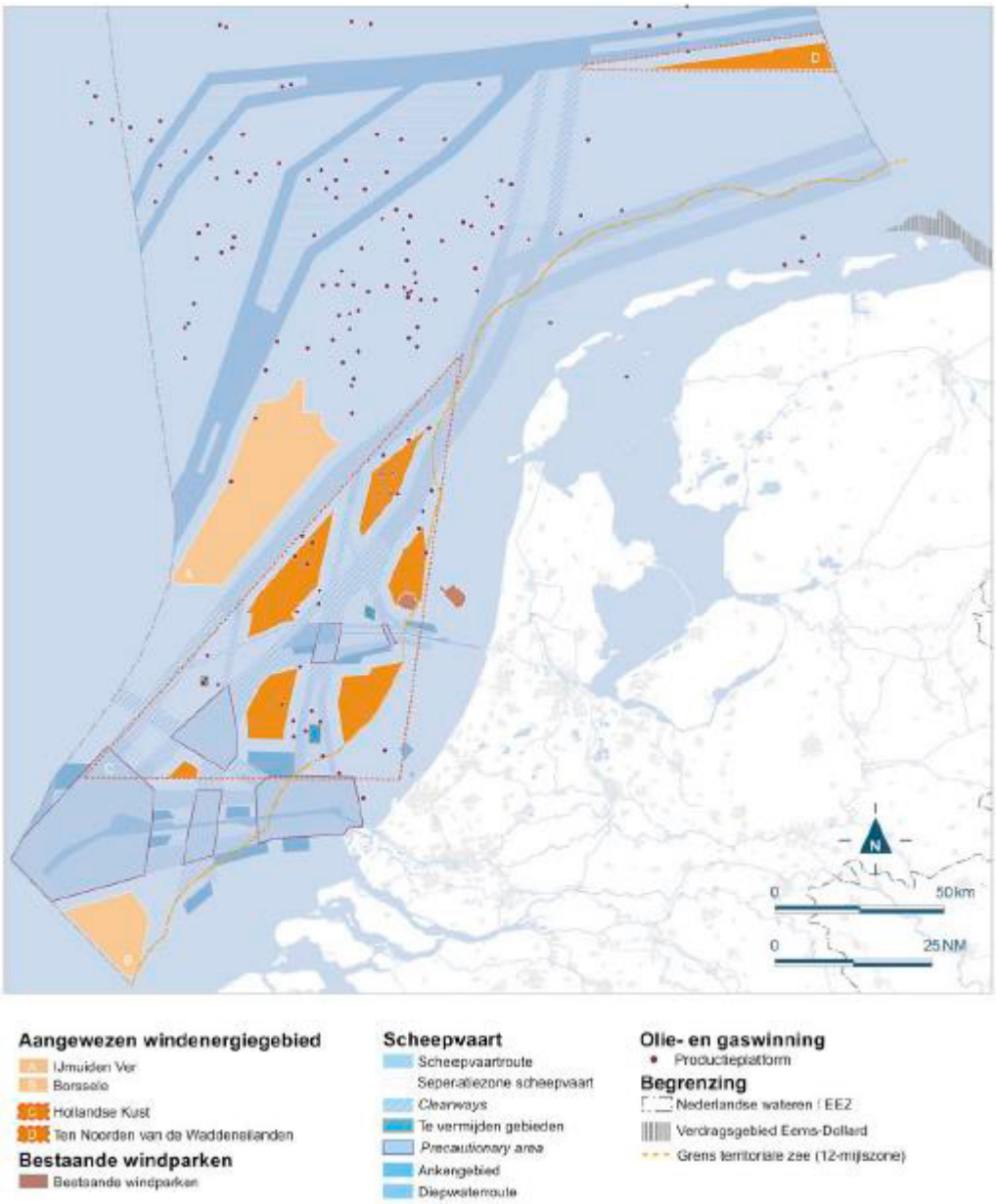

Figure S.2Zones for wind energy (from: National Structural Vision Offshore Wind Energy, 2014)

On 26 September 2014, the Ministers of Economic Affairs and Infrastructure and the Environment sent a letter to the Lower House presenting the roadmap (Parliamentary Papers I/II, 2014/15, 33 561, A/no. 11 (reprint)). This roadmap details the objective for offshore wind energy, as agreed in the Energy Agreement. The Government concludes that a coordinated grid connection of offshore wind farms leads to less public spending and less impact on the environment. The starting point for the roadmap is that the estimate for offshore wind energy can be realised in the most cost effective manner by assuming a new concept of grid operator TenneT for an offshore grid. This concept assumes standard platforms where 700 MW wind energy capacity can be connected per platform. The wind turbines of the wind farms are connected directly to the platform.

The following table shows the timetable for the development of offshore wind energy taken from the roadmap.

Year	Timetable roadmap (MW)	Zones roadmap
2015	700	*Borssele*
2016	700	*Borssele*
2017	700	*Dutch Coast: South Holland*
2018	700	*Dutch Coast: South Holland*
2019	700	*Dutch Coast: North Holland*

Location choice

In the assessment of the Borssele wind farm zone, the aim is to show that the zone is suitable for wind energy, not whether it is the *most* suitable zone for wind energy. In addition to the Borssele wind farm zone, other areas are also needed after all to reach the objectives of the SER agreement.

The following table summarises the assessment of the wind energy zones.

Topic	Aspect	Borssele	Dutch Coast	IJmuiden Ver	To the north of the Wadden Islands
Ecology	Birds				
	Marine mammals				
Landscape	Visibility				
Other features	Shipping safety				
	Oil and gas				
	Fishery				
Costs					

Colour	Explanation
Red	adverse effects expected, major obstacles/many mitigating measures needed; relatively high cost
Orange	limited adverse effects expected, possible obstacles/few mitigating measures needed; relatively moderate cost
Yellow	limited adverse effects expected, no obstacles/no mitigating measures required; relatively limited cost
Green	little to no adverse effects expected; relatively low cost

The various wind farm zones all entail both significant adverse effects as well as minor adverse effects. The differences between the zones are limited. The Borssele wind farm zone can therefore be regarded as an average suitable area. The Borssele wind farm zone is the only area with no effects on oil and gas interests because they are absent.

Division

The Borssele wind farm zone has a gross surface area of 344 km^2. A significantly smaller part is available for wind farms however because various obstacles are present in the area. These include cables and pipelines including the distances to be kept to these cables and pipelines, see the following figure. The Borssele wind farm zone is located at a distance of 500 metres to the continental shelf of the border with Belgium.

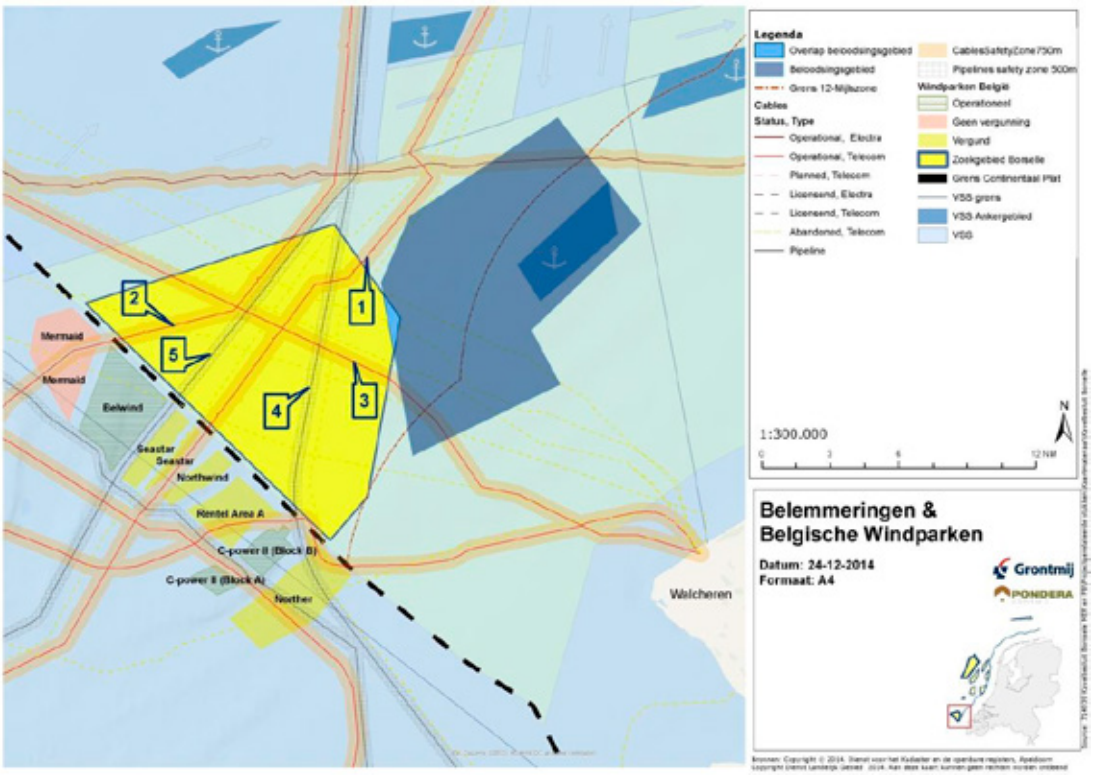

Figure S.3 Obstacles Borssele and location of Belgian wind farms

The wind farms will eventually be connected to the high-voltage grid through offshore transformer platforms, which TenneT will install in the zone. These platforms and the cables running from these platforms to land also take up space in the zone. Accessibility zones for helicopters to land on these platforms will also be kept clear. All this results in a net available area of about 240 km^2, see the following figure.

Using approximately 6 MW/km^2 (a common ratio for set capacity of offshore wind turbines) there is space for approximately 1,440 MW of wind turbines. TenneT intends to make each platform suitable for connecting 700 MW to wind energy. Division of the wind energy zone into units of 700 MW is therefore obvious. The State has chosen to issue four wind farm sites of about 350 MW each, connected two by two to the two transformer stations to be built.

The wind farm sites must be next to each other so that in time they can be connected two by two to the TenneT offshore transformer platforms Alpha and Beta. The combinations of wind farm sites III and IV and wind farm sites I and II are therefore the most obvious. In addition, the cables for connection to the TenneT offshore platforms for these combinations can be kept as short as possible. This EIA is about wind farm site I (see the following figure).

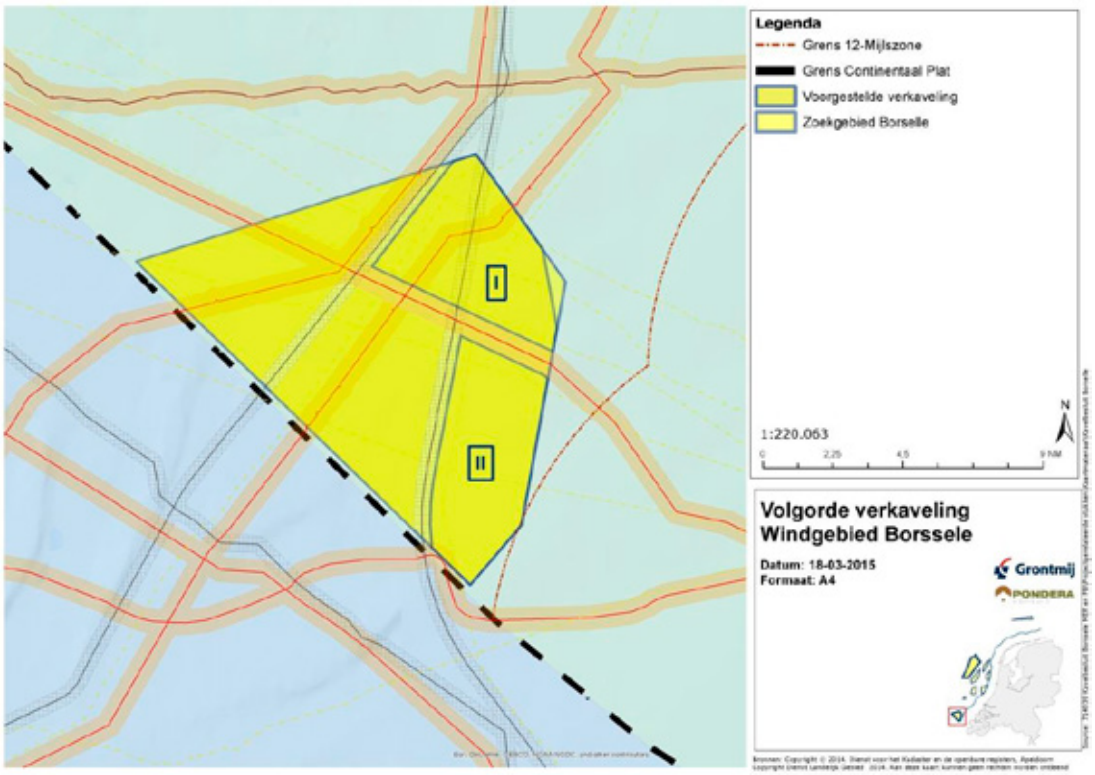

Figure S.4Proposed subdivision Borssele, location of first two wind farm sites I and II to be issued (hypotenuse to east side of wind farm site I is the pilotage zone, this is not part of wind farm site I)

Impact assessment method

Bandwidth

An EIA assesses alternatives to an activity by examining their effects and comparing them. An alternative is a possible way in which the proposed activity, in this case energy generation with wind turbines, can be realised considering the purpose of this activity. In this EIA, alternatives for two areas, each with one wind farm, were examined (two so-called 'wind farm sites'). The alternatives are made up of a bandwidth to various wind turbine set-ups and types that are possible within such a wind farm site.

The wind farm sites within the Borssele wind farm zone are issued therefore with the possibility for the wind farm developer to do this at its own discretion. The bandwidth that must be adhered to is recorded in the wind farm site decision.

Bandwidth

By issuing wind farm sites in which various wind turbine set-ups and types and foundation methods are possible, within a certain bandwidth, a flexible design of the wind farm site is possible. The developer is free to make the wind farm design optimal in terms of cost effectiveness and energy yield. This bandwidth approach makes specific requirements of this EIA. All environmental effects associated with all possible set-ups made possible by the wind farm site decisions should be examined. Researching all possible set-ups is not possible however due to the multitude of potential combinations. Therefore, a worst-case approach is assumed: if the worst-case situation for potential effects is permissible, then all other set-ups within it are also possible.

Alternatives

The worst-case situation can differ for different aspects, for example for birds and marine mammals. This was taken into consideration in the study by researching and comparing several worst-case situations as alternatives in the EIA.

To obtain an idea of the possibilities to reduce the effects, mitigating measures were designated and examined for each aspect. This means possibilities for optimisation are identified and only a worst-case situation being presented is prevented. Where appropriate, in this respect the potential best-case situation was also examined so that the range of possible effects is clear.

The bandwidth of design possibilities for the wind farm sites to be issued is shown in the following table.

Subject/variable	Bandwidth
Capacity individual wind turbines	3 – 10 MW
Tip height individual wind turbines	125 – 250 metres
Tip lowness individual wind turbines	25 – 30 metres
Rotor diameter individual wind turbines	100 – 220 metres
Distance between each wind turbine	At least 4 x rotor diameter
Number of blades per wind turbine	2 – 3
Type of foundations *(substructures*)	*Monopile, jacket, tripile, tripod, gravity-based structure*
Type of foundation (*foundation*)	Pile foundations, *suction buckets, gravity-based structures*
Installation method pile foundations	Vibrohammering, pile driving, drilling, *suction*
In case of pile-driving foundations: pile-driving energy related to turbine type/pile	1,000 – 3,000 kJ, depending on soil conditions and diameter of foundation
In case of pile-driving foundations, diameter of foundation pile/piles and number of piles per turbine:	
Jacket	4 piles of 1.5 – 3.5 metres
Monopile	1 pile of 4 to 10 metres
Tripod	3 piles of 2 to 4 metres
In case of a foundation without pile-driving, dimensions on seabed:	
Gravity Based	Up to 40 x 40 metres
Suction Bucket	Diameter of *bucket*: 15-20 metres
Electrical infrastructure (*inter-array* cabling)	33 kV/66 kV

As indicated, the worst-case situation for different aspects, for example for birds and marine mammals, can be different. The table here below shows the different environmental aspects for the worst-case and best-case scenarios.

Environmental aspect	Bandwidth	
	Alternative (Worst case)	*Alternative (Best case)*
Birds and bats	117 x 3 MW turbines tip lowness 25 m, rotor diameter 100 m	35 x 10 MW turbines tip lowness 30 m, rotor diameter 220 m

	and 121 m	
Underwater life[1]	35 x 10 MW turbines Pile-driving energy: 3,000 kJ 1 turbine location per day	117 x 3 MW turbines Pile-driving energy: 1,000 kJ 1 turbine location per day
Shipping	117 x 3 MW turbines *Jacket* foundation with diameter 15 m Scenario 1: open up wind farm for shared use and passage (ships < 24 m)	35 x 10 MW turbines Monopile foundation with diameter 10 m Scenario 2: do not open up wind farm for shared use and passage (ships < 24 m)
Geology and hydrology	117 x 3 MW turbines Electrical infrastructure on 33 kV	35 x 10 MW turbines Electrical infrastructure on 66 kV
Landscape[2]	35 x 10 MW turbines Max. rotor diameter: 220 m Max. axle height: 140 m	117 x 3 MW turbines Min. rotor diameter: 220 m Min. axle height: 75 m
Other use functions	117 x 3 MW turbines	35 x 10 MW turbines
Electricity yield	set-up with small total rotor surface	set-up with large total rotor surface

[1] For underwater life the worst case and best case situation differs per 'sub-aspect' (marine mammals, fish, benthic life) and can also not be clearly defined in advance. Although the sound production under water during pile driving at 3,000 KJ is higher than at 1,000 kJ, the number of piles that are driven with greater pile-driving energy is lower, meaning the total environmental impact may be lower.

[2] It is also not clear which set up is worst case and which set up is best case for landscape. The difference between more small turbines that are less visible and less large turbines that are more visible is not clear-cut.

Innovation

The bandwidth considered in this EIA is so broad that all relevant innovation options can be realised within this bandwidth. Innovation is not considered separately. In some cases, innovative solutions – although not explicitly named as such – are dealt with in the mitigating measures.

Assessment

In order to be able to compare the effects of the options per aspect, these were assessed on a +/- scale in relation to the zero option, the current situation and autonomous development. The rating scale shown in the following table was used.

Score	Opinion in relation to the reference situation (zero alternative)
--	The intention leads to an extremely noticeable adverse change
-	The intention leads to a noticeable adverse change
0	The intention does not differ to the reference situation
+	The intention leads to a noticeable positive change
++	The intention leads to an extremely noticeable positive change

In addition to the effect of a wind farm in wind farm site I, cumulative effects of other wind farms and activities were considered and mitigating measures were also examined.

Result of environmental assessment

Assessment criteria	Alternative 1 117 x 3 MW turbines tip lowness 25 m, rotor diameter 100 m and 121 m	Alternative 2 35 x 10 MW turbines tip lowness 30 m, rotor diameter 220 m
Construction phase birds		
- installing foundations	0/-	0/-
- increased shipping	0/-	0/-
Use phase birds		
Local sea birds		
- collisions	-	-
- barrier effect	0	0
- habitat loss	-	-
- indirect effects	0/-	0/-
Colony birds		
- collisions	-	-
- barrier effect	0	0
- habitat loss	0/-	0/-
- indirect effects	0/-	0/-
Migratory birds		
- collisions	-	-
- barrier effect	0/-	0/-
- habitat loss	0	0
- indirect effects	0	0
Removal phase birds		
- installing foundations	0/-	0/-
- increased shipping	0/-	0/-
Bats		
- collisions	--/-	-
- barrier effect	0	0
- habitat loss	0	0
- indirect effects	+/-	+/-

The following tables show the assessments of the alternatives per aspect against the various assessment criteria. The tables are then discussed per aspect. This is a summary of the impact assessment, simplifying the description of the assessment criteria. These tables lend no weight to the scores.

Birds and bats

The alternative with 35 x 10 MW turbines and a rotor diameter of 221 metres is the most environmentally friendly alternative for birds and bats, due to the lower number of collision victims compared to the other alternatives. The worst-case situation is the alternative with 117 x 3 MW turbines and a rotor diameter of 121 metres.

Underwater life

Assessment criteria	Impact assessment	Assessment	
		Alternative 1	**Alternative 2**
		117 x 3 MW turbines Pile-driving energy: 1,000 kJ 1 turbine location per day	35 x 10 MW turbines Pile-driving energy: 3,000 kJ 1 turbine location per day
Effects of installation, use and removal on: - Biodiversity - Recruitment - Densities/biomass - Special species	*Benthic animals* - Space taken - Change in substrate - Noise/vibration - Turbidity - Soil disturbance - Radiation - Change in fishery	 0/- + 0 0 0/- 0 0/+	 0/- + 0 0 0/- 0 0/+
	Fish - Space taken - Change in substrate - Noise/vibration - Turbidity - Radiation - Change in fishery	0/- 0/+ - 0 0 0/+	0/- 0/+ 0/- 0 0 0/+
Marine mammals Installation - Disturbance, barrier effect, habitat loss, change in foraging possibilities due to sound and vibration from installation of foundations - Physical harm	- Disturbed surface (km^2) - Number of disturbed animals - Animal disturbance days - Number of affected animals - Population effects (North Sea)	- -- - - 0/-	- - -- - 0/-
Use - Disturbance due to noise and vibration of turbines - Disturbance due to noise and vibration of shipping (maintenance)	- Disturbed surface (km^2) - Number of disturbed animals - Disturbed surface (km^2) - Number of disturbed animals	0 0 0 0	0 0 0 0
Removal - Disturbance, barrier effect, habitat loss, change in foraging possibilities due to sound and vibration from installation of foundations	- Disturbed surface (km^2) - Number of disturbed animals	0/- 0/-	0/- 0/-

As regards the impact caused by noise, alternative 2 (35 x 10 MW turbines) is the best case for marine mammals. This is due to the shorter duration of disturbance in comparison to alternative 1 (117 x 3 MW turbines); on balance this shorter duration weighs positively against the higher pile-driving energy. The effects on porpoises can be extremely negative if the worst case is applied. In this scenario, population reduction of porpoises is greater than is considered to be permissible under the Ecology and Cumulation Framework. The application of mitigating measures means this effect can be limited to beneath this threshold. As regards benthic animals and fish, the effects are extremely minor.

Shipping safety

Assessment criteria	**Impact assessment**	**Assessment**	
		Alternative 1	**Alternative 2**
		117 x 3 MW turbines *Jacket* foundation with 15 m diameter Scenario 1: open up wind farm for shared use and passage (ships < 24 m)	35 x 10 MW turbines Monopile foundation with 10 m diameter Scenario 2: do not open up wind farm for shared use and passage (ships < 24 m)
Safety	Risk of collision and propulsion	0/-	0
	Consequential damage of collision or propulsion	0	0
Shipping	Change in route structure	0	0
	Deviation possibilities for crossing shipping	0	0

For alternative 1, the risks are higher than for alternative 2. This is mainly because of the higher number of turbines and to a lesser extent the greater diameter. The total collision and propulsion frequency for alternative 1 is 0.074934 per year (once every 13.3 years). This is more than three times more than alternative 2. In terms of shipping and safety, alternative 1 is the worst case and alternative 2 is the best case.

Geology and hydrology

Assessment criteria	**Impact assessment**	**Assessment**	
		Alternative 1	**Alternative 2**
		a 10 MW turbine on a tripile/tripod foundation with three foundation piles with a diameter of 4 metres. Erosion protection (rock fill): five times the pile diameter.	a 3 MW turbine on a gravity-based foundation with a diameter of 25 metres on the seabed. Erosion protection (rock fill): three times the diameter of the base.
- Effect on waves	- Qualitative and quantitative	0	0
- Effect on water movement (water level/current)		0	0
- Effect on water depth and soil morphology		0	0
- Effect on soil composition		0	0
- Effect on turbidity and water quality		0	0
- Effect on sediment transport		0	0
- Effect on coastal security		0	0

All morphological and hydrological changes resulting from the construction, operation, removal and maintenance of the wind farm are local, limited and temporary in nature. Both alternatives hardly differ in this respect and are therefore practically the same.

Landscape

Assessment criteria	Impact assessment	Assessment	
		Alternative 1	Alternative 2
		117 x 3 MW turbines Max. tip height 125 m	35 x 10 MW turbines Max. tip height 250 m
- Visibility in percentage of time - Interpretation of visibility on the basis of photo visualisations	- Qualitative (based on photo visualisations) and quantitative (% visibility over time)	0/-	0/-

Both alternatives score the same, because the meteorological conditions mainly determine the visibility of the wind farm and the size of the turbines is therefore less relevant. The large turbines are still occasionally visible at a distance of 42 kilometres or more; the smallest turbines are not. However, because of the fact that the meteorological conditions often limit visibility at such a great distance, this difference in effect is estimated as so small that there is no clear distinction between best or worst case.

Other use functions

Assessment criteria	Impact assessment	Assessment	
		Alternative 1	Alternative 2
		117 x 3 MW wind turbines (tip height 130 m) on a gravity-based foundation with a diameter of 25 metres on the seabed. Erosion protection (rock fill): three times the diameter of the foot.	35 x 10 MW wind turbines (tip height 250 m) on a tripile/tripod foundation with 3 foundation piles with a diameter of 4 metres. Erosion protection (rock fill): five times the pile diameter.
Fishery	Fishery restrictions	0/-	0/-
Oil and gas extraction	Restrictions on oil and gas extraction	0	0
Aviation	Interference civil aviation	0	0
	Interference military aviation	0	0
	Interference Coast Guard	0	0
Sand, gravel and shell extraction	Restrictions shallow mineral extraction	0	0
Dredging landfill	Restrictions dredging landfill dumping areas	0	0
Ship's and aviation radar	Shadow effect	0	0
	Multipath/Bouncing	0	0
Cables and pipelines	Interference cables and pipelines	0	0
Telecommunications	Disruption in cable connections	0	0
	Disruption in ray paths	0	0
Ammunition dumping areas and military	Presence of ammunition dumping areas and	0	0

Assessment criteria	Impact assessment	Assessment	
		Alternative 1	Alternative 2
		117 x 3 MW wind turbines (tip height 130 m) on a gravity-based foundation with a diameter of 25 metres on the seabed. Erosion protection (rock fill): three times the diameter of the foot.	35 x 10 MW wind turbines (tip height 250 m) on a tripile/tripod foundation with 3 foundation piles with a diameter of 4 metres. Erosion protection (rock fill): five times the pile diameter.
areas	military areas		
Recreation and tourism	Recreational boating restrictions	0	0
	Coastal recreation restrictions	0	0
Cultural history and archaeology	Damage to archaeological remains	0	0
Mussel seed collection installations	Mussel seed collection installations restrictions	0	0
Wind farms	Influence of wind farms	0/-	0/-

There appear to be hardly any effects with regard to use functions already in use. This is partly because the use functions present were taken into account in the choice of location. There are minor effects on the use functions of ship's and aviation radar, recreation and tourism, cultural history and archaeology in the form of loss of space (recreation and tourism), degradation (archaeology) or influence (ship's radar). The effects are rated neutral given the small size, the alternatives are not distinctive.

The effects on fishery, given the surface that is lost (60 km^2) and the value of that area for fishing are rated limitedly negative. The effects on wind farms are also rated limitedly negative because wind interception has a negative impact on the energy yield of Belgian wind farms. The alternatives are not distinctive.

Electricity yield

Assessment criteria	Assessment	
	Alternative 1	Alternative 2
	117 x 3 MW turbines	35 x 10 MW turbines
Energy yield	++	++
Avoided emissions	++	++

To determine the electricity yield, calculations were made with two turbines for which data is available and that are as different as possible from each other in size. Virtually no difference in yield is apparent from these calculations. Both alternatives barely differ in terms of electricity production and avoided emissions. The turbines vary in the number of Watt/m^2 rotor surface. If data were available for large and small turbines with an equal number of Watt/m^2 rotor surface, then there would be a difference in energy yield.

Cumulation

The following table briefly lists the cumulative effects that occur and the consequences this has for the wind farm site decision to be taken.

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
Birds and bats	Exceeding the PBR1 for the European herring gull cannot be ruled out	Mitigating measures could be taken in order to reach acceptable effects (see section 13.7).
Marine mammals	Effects on the FCS[2] cannot be ruled out	Mitigating measures could be taken in order to reach acceptable effects (see section 13.7).
Shipping and security	Wind farms in Belgium and in the other wind farm sites in the Borssele wind area can lead to other effects on navigation and safety	None. The cumulative effect of other wind farms on navigation safety, in contrast to previous safety studies, has not been separately detailed but is considered as the basic situation. The new route structure that entered into force from 1 August 2013 already takes future wind farms into account. The cumulative effect that these future wind farms can have on the shipping routes are all taken care of by the new route structure. The calculations for wind farm site I are also cumulated over wind farm sites II, III and IV; the route structure for wind farm site I does not change if wind farm sites II, III and IV are also included. The Borssele wind farm zone means that a corridor may arise as a result of the maintenance areas present for grid connection and other cables, where whether or not to allow passage is considered. A separate study will be carried out into the safety effects.
Geology and hydrology	Wind farms in Belgium and in the other wind farm sites in the Borssele wind area can also have effects on geology and hydrology	None. In the further implementation of the Borssele wind farm zone (wind farm sites II, III and IV) practically the same local, temporary and negligible effects will occur. That means that there is no cumulation, not even with other activities and other more distant wind farms.
Landscape	Wind farms in Belgium and in the other wind farm sites in the Borssele wind area also affect the visibility of wind turbines from the beach.	None. The development of these wind turbines will increase the intrusion on the horizontal angle of view by wind turbines compared to the current situation. The distance to the coast of these wind turbines is generally so great that the meteorological conditions dramatically reduce the visibility of the wind turbines. The shortest distance between the offshore wind turbines and the beach is 27 kilometres. At this distance, a wind farm in the summer period is visible during the day on average 14.3% of the time. Most wind farms are located further from the beach and are therefore visible on average for a smaller percentage of the time. In addition to wind farms, plenty of ships are also visible on the horizon, as well as in good weather the existing wind farms C-Power and Northwind in the Belgian part of the North Sea at 29 and 35 kilometres from the coast of Walcheren respectively and licensed wind farms still to be built in the Belgian part of the North Sea.

[1] PBR stands for *Potential Biological Removal*. This is the number of birds that can be removed from a population by mortality (in this analysis, the population of the southern North Sea) while maintaining optimum sustainable population.

[2] FCS stands for Favourable Conservation Status

Aspect	Relevant cumulative effects	Consequences for wind farm site decision
Other use functions	Wind farms in Belgium and in the other wind farm sites in the Borssele wind area also affect other use functions.	None. In the further implementation of the Borssele wind farm zone (wind farm sites II, III and IV), the total space used is larger meaning a larger area is lost for fishing. In total, approximately 0.6% of the fishable surface of the DCS[3] is lost. The area that is lost for fishery is relatively good fishing ground, meaning that in cumulation there are limited adverse effects on fishery. Due to the greater number of turbines, it is also more likely that archaeological remains will be harmed. The further implementation of the Borssele wind farm zone has limited effects on recreation and tourism because recreational boating uses the 10 to 20 km wide zone along the coast in particular. For vessels from Zeeland wanting to cross to England the additional realisation of wind farm site II means extra circumnavigation. Wind farm sites III and IV do not lead to more circumnavigation because these wind farm sites are to the west of wind farm sites I and II. The Belgian wind farm zone will probably barely lead to extra circumnavigation because the Belgian wind farm zone is immediately southwest of the Borssele wind farm zone. Due to the Borssele wind farm zone a corridor may arise as a result of the maintenance areas present for grid connection and other cables, meaning whether or not to make passage possible will be considered. If a passable corridor is realised this reduces circumnavigation. Opening up the wind farm for passage and shared use for vessels up to 24 m as proposed in the NWP 2 draft means that recreational vessels, but also certain types of sport fishery, may navigate through the wind farm and stay there. The wind farm would then become a recreational destination. Recreational vessels wanting to cross to England can then navigate through the Borssele wind farm zone, possibly using the corridor that runs in an east-westerly direction through the Borssele wind farm zone. The effects of opening up the wind farm are currently being further examined. A pilot will first take place elsewhere before the wind farm is opened for shared use.
Electricity yield	Wind farms in Belgium and in the other wind farm sites in the Borssele wind area can intercept wind	None. The realisation of wind farm sites II, III and IV will lead to more wind interception for wind farm site I. The degree of wind interception depends on the exact details of these wind farm sites; further wind interception from Belgium will therefore not take place. When calculating the energy yield it is assumed that all planned farms in Belgium have already been built.

Mitigating measures

After assessment, it appears that the conditions in the legal framework can be satisfied for virtually every aspect. Mitigating measures are required to limit the effects on birds and porpoises. However, the occurrence of other adverse effects due to the construction, operation and removal of the wind farm cannot be excluded. These possible effects can be mitigated by the following measures:

[3] DCS stands for Dutch Continental Shelf

Possible mitigating measures

Aspect	Effect	Mitigating measure
Birds and bats	Collision/disturbance	• Shutting down in certain weather conditions in combination with identified migration • Increasing cut-in wind speed (for bats) in the relevant season and at relevant time of day (dusk). • Increasing maximum tip lowness • Larger dimensions of turbines (increasing the lower limit of the bandwidth (greater than 3 MW)) • As small as possible surface wind farm (least habitat loss)
Marine mammals	Disturbance and associated population reduction; PTS	• Limiting the construction period • Using 'Slow start' and 'Acoustic Deterrent Devices' (ADDs) • Maximum permissible sound level (e.g. 160 dB at 750 metres distance (German standard))
Shipping and safety	Propulsion	• Using the Automatic Identification System (AIS) • Deploying an Emergency Towing Vessel
Geology and hydrology	-	-
Landscape	-	-
Other use functions	Circumnavigation for fishery (and other shipping)	• opening up corridor through the Borssele wind farm zone for ships to limit the sailing time to fishing grounds (and other destinations).
	Damage to archaeological values	• changing the location of a wind turbine or cable so as to avoid a possible archaeological object.
Electricity yield	-	-

A number of measures will be carried out in any case, such as the use of a 'slow start' and ADDs. For the other mitigating measures it has not yet been determined whether and to what extent they will be applied. The wind farm site decision includes the measures that have been adopted.

Considerations

Testing against the legal framework

Some mortality of birds and fish and decrease in populations of marine mammals and fish cannot be ruled out in advance. The Offshore Wind Energy Bill integrates the assessment to be carried out under the Nature Conservation Act 1998 and the Flora and Fauna Act into the wind farm site decision. For testing against the Nature Conservation Act 1998, an appropriate assessment has been carried out (see annex 8). This appropriate assessment shows that significant impact on the conservation objectives of Natura 2000 areas can be ruled out.

Other laws and regulations are discussed where relevant and translated to specific standards where necessary. For example, the standard setting within ASOBANS is used to determine a measure of acceptable population reduction for porpoises. Provisions relating to EHS will not apply; EHS is within the 12 nautical miles while the Borssele wind farm zone is entirely outside the 12 nautical miles.

Choice of preferred bandwidth

As regards the following aspects no obstacles were identified in this EIA which limit the bandwidth:

- Shipping and safety;
- Geology and hydrology;
- Landscape;
- Other use functions;
- Electricity yield.

That is the case for birds and bats, and underwater life.

Aspects that do limit the bandwidth

Measures which do limit the bandwidth and which are adopted to reach a necessary reduction of effects are:

Birds and bats

- The lower limit of the turbines to be applied is expected to be increased from 3 MW to an as yet to be determined capacity of 4 to 6 MW per turbine.
- Shut down option when a bird migration in combination with certain weather conditions is established.
- Increasing the cut-in wind speed (time when the rotor starts to turn at a certain minimum wind speed) to a value of 5 m/s at night during the bat migration period (mid-August to September).

Underwater life

- Limiting sound production during pile-driving to a maximum value to be determined between 160 and 172 dB re μPa^2s at 750 metres, depending on the period when pile-driving takes place and possibly also depending on the number of piles to be driven.

Conclusion

The wind farm site decision should make the preferred bandwidth possible and safeguard necessary mitigating measures; together the preferred bandwidth and measures form the preferred alternative. This bandwidth is tightened compared to the bandwidth which this EIA started with due to effects on birds and bats, and underwater life.

Gaps in knowledge and information

The development of offshore wind farms has a relatively brief history. Meanwhile the first monitoring evaluations for other offshore wind farms in England, Denmark, Germany and Netherlands are known. These are results from relatively brief monitoring periods. Certainty about the long-term effects can therefore not be given yet. However, current development and research programmes offer tools for an impact forecast, as presented in this EIA. During the preliminary study of the impact forecast for this EIA, several gaps in knowledge were established that can limit the understanding of the nature and extent of the effects of a wind farm in wind farm site I. Uncertainties remain as to the effects, including the cumulative effects of several wind farms mutually and in cumulation with other activities in the North Sea.

The gaps in knowledge that exist are not only due to the recent past of offshore wind energy; in a broad sense a lot of knowledge about animal species and their densities, diversity and behaviour needs complementing.

In short, the following gaps have been noted:

- Local birds: in general, knowledge of the distribution in space and time of seabirds at sea is still incomplete;
- Migratory birds: in general, knowledge of the duration and the spatial extent of bird migration is still incomplete. The lack of representative data is related to the often hard to access habitat and the

absence of standardised counting methods. There are indications for various migration routes in the North Sea area. Quantitative data on this, how large the share of these migration routes is in the migration as a whole, as well as data about local densities in the different areas of the North Sea are missing.
- Bats: knowledge gaps exist regarding the occurrence of bats at sea and their behaviour in wind farms as well as the number of collision victims.
- Benthos: knowledge gaps exist with regard to being able to predict consequences of the abiotic changes (especially sediment change in the surroundings of the wind farm) on benthos. In addition, the effects of electromagnetic fields along the cables are not yet well known.
- Marine mammals: there are gaps in knowledge on aspects such as distribution and prevention of marine mammals, migration patterns, threshold values for TTS, PTS and avoidance, behavioural reactions as a result of underwater sound and foraging behaviour. Model calculations of the distribution of underwater sound in combination with threshold values derived from several studies predict the occurrence of avoidance, TTS and PTS in marine mammals. Further research in the form of monitoring in the field, additional laboratory research and further model development is needed to fill gaps in knowledge.
- Fish: specific knowledge gaps with respect to wind farms exist, especially with regard to species and extent of changes on fish fauna in the longer term as a result of setting restrictions on fishery and applying hard substrate.
- Electricity yield: the wind interception from Belgium and from the other wind farm sites within the Borssele wind farm zone can be calculated fairly well once the exact set-ups of those wind farms are known. It is expected that the calculations in this EIA are a good indication.

The gaps in knowledge do not mean that it is not possible to form a good idea of the effects of a wind farm in wind farm site I in the Borssele wind area. A wind farm site decision can be taken despite the existing gaps in knowledge and uncertainties. In the decision-making process it is important to understand the uncertainties that played a role in the impact predictions. This understanding is provided by this EIA.

Plan for monitoring and evaluation

In the decision-making it will be indicated by what means and in which period an evaluation study will have to be carried out. This evaluation study aims, on the one hand, to compare the predicted impact to the actually occurring effects and, on the other hand, to assess the extent to which the identified gaps in knowledge are filled where needed.

In general, the monitoring and evaluation programme is needed to improve knowledge about the effects that wind farms have on the natural environment. As regards the specific monitoring topics, the expected actual effects as set out in this EIA are a starting point in addition to the identified gaps in knowledge. Given the expected adverse effects of the construction of the foundations of the wind farm on marine mammals, research on sound transmission, behavioural reactions and removal of marine mammals deserves special attention. In addition, bird research is important given the collision victims and the possible disturbance and barrier effect of the wind farm.

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