

Norfolk Boreas Offshore Wind Farm

Appendix 12.6

Additional Cumulative Impact Assessment (CIA) Scenarios

Environmental Statement

Volume 3

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Glossary of Acronyms

ADD	Acoustic Deterrent Device
CIA	Cumulative Impact Assessment
ES	Environmental Statement
GS	grey seal
HP	harbour porpoise
HS	harbour seal
km	Kilometre
km ²	Kilometre squared
MU	Management Unit
MW	Mega Watt
NS	North Sea
OWF	Offshore Wind Farm

Glossary of Terminology

Norfolk Boreas site	The Norfolk Boreas wind farm boundary. Located offshore, this will contain all the wind farm array.
Norfolk Vanguard	Norfolk Vanguard offshore wind farm, sister project of Norfolk Boreas.
Norfolk Vanguard OWF sites	Term used exclusively to refer to the two distinct offshore wind farm areas, Norfolk Vanguard East and Norfolk Vanguard West (also termed NV East and NV West) which will contain the Norfolk Vanguard arrays.
The Applicant	Norfolk Boreas Limited.
The project	Norfolk Boreas Wind Farm including the onshore and offshore infrastructure.

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1 Theoretical Worst-Case Scenario

1. A 'theoretical worst-case' scenario, based on the potential consent window (rather than the construction period) which allows for any delays and changes in project development, has been assessed.
2. For this approach, all Tier 3 UK and European offshore wind farm projects (i.e. projects which have been consented, but construction has not yet commenced) have been assessed based on a seven year construction window from the year of consent to determine their potential overlap with Norfolk Boreas (this is a precautionary approach as some project have five year consent window). All current UK Tier 4 offshore wind farm projects (i.e. projects which have an application submitted to the appropriate regulatory body that have not yet been determined or are consented) have been included in this theoretical scenario, with the possible construction windows based on the best available information. In addition, Tier 5 UK offshore wind farm projects (i.e. projects that the regulatory body are expecting to be submitted for determination / projects listed under the Planning Inspectorate programme of projects) have been listed and included in the theoretical worst-case scenario for in-combination effects during offshore wind farm piling although there is more uncertainty regarding, if and when, they could be constructed due to a lack of available information.
3. The UK Tier 3, 4 and 5 offshore wind farm projects included in the theoretical worst-case scenario to assess the potential for cumulative disturbance of marine mammals during piling at Norfolk Boreas, based on the periods of construction and piling are outlined in Table 1.1. The European Tier 3 offshore wind farm projects included in the theoretical worst-case scenario, are based on the periods of construction, where available, are also outlined in Table 1.1.
4. The potential consent window for Norfolk Boreas is 2020 to 2027, however the widest likely range of construction dates is 2025 with piling starting in 2026 to 2028, therefore for the 'theoretical' worst-case scenario, for Norfolk Boreas has been based on the 2020 to 2028 period.

Table 1.1 Offshore wind farms included in ‘theoretical’ worst-case scenario for the potential disturbance of harbour porpoise (HP), grey seal (GS) and harbour seal (HS) where there is the potential of piling occurring at the same time as piling at Norfolk Boreas.

Name and country of project	Distance from site (km)	Size (MW)	Maximum number of turbines	Month/year consent authorised / expected (7 year construction window)	Dates of offshore construction / piling ¹	‘Theoretical’ worst-case scenario where potential 7-year consent window overlaps with Norfolk Boreas construction period
Norfolk Boreas	0	1,800	200	2020 (2020-2027)	Possible piling: 2026-2028	Yes (HP, GS, HS)
Tier 3: consented						
Blyth Demonstration site (3A & 4), UK	351	58.4	10	2013 (2013-2020)	Unknown	Yes (HP, GS)
Creyke Beck A, UK	173	500-600	200	Feb-15 (2015-2022)	2021-2027	Yes (HP, GS, HS)
Creyke Beck B, UK	196	500-600	200	Feb-15 (2015-2022)	2021-2028	Yes (HP, GS, HS)
Teesside A, UK	191	1,200	200	Aug-15 (2015-2022)	2021-2028	Yes (HP, GS, HS)
Sofia, UK	185	1,200	200	Aug-15 (2015-2022)	2020-2028	Yes (HP, GS, HS)
East Anglia THREE, UK	13	1,200	172	Aug-17 (2017-2024)	Piling: 2020 – 2022	Yes (HP, GS, HS)
Hornsea Project Two, UK	101	1,800	225	Aug-16 (2016-2021) ⁶	2017-2021 Piling: 2017-2019	Yes (HP, GS, HS)
Triton Knoll phase 1-3, UK	124	1,200	288	Jul-13 (2013-2020)	2018-2021	Yes (HP, GS, HS)
Moray East (including MORL MacColl, MORL Stevenson and	657	504	46-62	2014	2016-2021	Yes (HP)

Name and country of project	Distance from site (km)	Size (MW)	Maximum number of turbines	Month/year consent authorised / expected (7 year construction window)	Dates of offshore construction / piling ¹	'Theoretical' worst-case scenario where potential 7-year consent window overlaps with Norfolk Boreas construction period
MORL Telford), UK				(2014-2021)		
Mermaid, Belgium	126	366-288	24-48	2015 (2015-2022)	2017-2019	Yes (HP, GS, HS)
Northwester 2, Belgium	130	224	22-38	2015 (2015-2022)	Unknown	Yes (HP, GS, HS)
SeaStar, Belgium	134	246-252	108	2014 (2014-2021)	2018-2020	Yes (HP, GS, HS)
Vesterhav Nord/Syd, Denmark	519	350	38-48	2016 (2016-2023)	Unknown	No*
OWP West, Germany	230	240	16-18	2014 (2014-2021)	Unknown	Yes (HP, GS, HS)
Borssele I and II, Netherlands	133	350+350	95+95	May-16 (2016-2023)	2019	Yes (HP, GS, HS)
Borssele III and IV, Netherlands	123	360+340	95+95	May-16 (2016-2023)	2020	Yes (HP, GS, HS)
Borssele Site V - Leeghwater - Innovation Plot, Netherlands	108	20	2	May-16 (2016-2023)	2020	Yes (HP, GS, HS)
Eoliennes du Calvados, France	441	450	75	2016 (2016-2023)	Unknown	Yes (HP)
Parc éolien en mer de Fécamp, France	363	498	83	2016 (2016-2023)	Unknown	Yes (HP)

Name and country of project	Distance from site (km)	Size (MW)	Maximum number of turbines	Month/year consent authorised / expected (7 year construction window)	Dates of offshore construction / piling ¹	'Theoretical' worst-case scenario where potential 7-year consent window overlaps with Norfolk Boreas construction period
Borkum Riffgrund West II, Germany	237	240	16-18	2017 (2017-2024)	Unknown	Yes (HP)
Gode Wind 03, Germany	280	110	8	2016 (2016-2023)	From 2020	Yes (HP)
Kaskasi, Germany	334	325	34	2018 (2018-2025)	Completed by 2022	Yes (HP)
Hollandse Kust Zuid Holland I and II, Netherlands	73	700	126	2018 (2018-2025)	2023	Yes (HP)
Windpark Fryslan, Netherlands	136	382.7	89	2018 (2018-2025)	2019-2021	Yes (HP)
Kvitsøy Wind Turbine Demonstration Area, Norway	662	10	2	2010 (2010-2017)	Unknown	No
Rennesøy Wind Turbine Demonstration Area, Norway	663	10	2	2010 (2010-2017)	Unknown	No
Tier 4: application submitted and project on-hold						
Firth of Forth Phase 1 Seagreen Alpha and Bravo, UK	500	1,050	150	Oct-14 (2014-2021)	Unknown – on-hold	Yes (HP)
Hornsea Project Three, UK	53	2,400	342	2019 (2019-2026)	Construction: 2022-2029 Piling: 2022-2023 and 2027-2028	Yes (HP, GS, HS)

Name and country of project	Distance from site (km)	Size (MW)	Maximum number of turbines	Month/year consent authorised / expected (7 year construction window)	Dates of offshore construction / piling ¹	'Theoretical' worst-case scenario where potential 7-year consent window overlaps with Norfolk Boreas construction period
Norfolk Vanguard, UK	30	1,800	120-257	2019 (2019-2026)	Construction and piling: 2024 – 2028	Yes (HP, GS, HS)
Thanet Extension, UK	175	340	34	2019 (2019-2026)	2021-2026	Yes (HP, GS, HS)
Inch Cape, UK	490	784	110	Oct-14 (2014-2021)	Unknown – on-hold	Yes (HP)
Near na Gaoithe, UK	468	448	75	Oct-14 (2014-2021)	Unknown – on-hold	Yes (HP)
Dounreay Tri, UK	766	10	2	2017 (2017-2024)	Unknown – project postponed	Yes (HP)
Moray Firth Western Development Area, UK	629	750	90	2014 (2014-2021)	Unknown – on-hold	Yes (HP)
Tier 5: application in preparation						
East Anglia ONE North, UK	51	600 - 800	Approx. 115	2021 (2021-2028)	2026 - 2029	Yes (HP, GS, HS)
East Anglia Two, UK	73	600 - 800	Approx. 115	2021 (2021-2028)	2025 - 2029	Yes (HP, GS, HS)
Hornsea Project Four, UK	119	1,000	180	2021 (2021-2028)	Unknown	Yes (HP, GS, HS)

¹Piling and offshore construction dates are based on the latest dates and information available.

*Vesterhav Nord/Syd: License sets out construction to be complete by the end of 2020, therefore no overlap with Norfolk Boreas construction

2 Potential disturbance of harbour porpoise during Offshore Wind Farm piling

2.1 UK and European offshore wind farm projects: 'theoretical' worst-case scenario

5. For the 'theoretical' worst-case scenario, based on the 35 UK and European offshore wind farms (including Norfolk Boreas; listed in Table 1.1), the CIA indicates that if all 35 offshore wind farms were piling at exactly the same time, using concurrent piling with two locations on each offshore wind farm site with no overlap in the impact areas (4,248km² per project), the estimated maximum cumulative impact area is 148,680km². The maximum number of harbour porpoise that could potentially be disturbed is 98,685 individuals (based on the SCANS-III density estimate for each relevant Survey Block (Hammond et al., 2017)), which represents approximately 28.6% of the North Sea Management Unit (MU) reference population (Table 2.1).
6. The CIA indicates that if all 35 UK and European offshore wind farms (including Norfolk Boreas) were piling at exactly the same time, based on a single pile installation, the estimated maximum cumulative impact area is 74,340km² and the maximum number of harbour porpoise that could potentially be disturbed is 49,336 individuals which represents approximately 14.3% of the North Sea MU (Table 2.1).
7. It is highly unlikely that all 35 UK and European offshore wind farms ('theoretical' worst-case scenario) could be concurrently or single piling at exactly the same time. Therefore the 'likely' scenario assessed in the ES Chapter is a more realistic, yet very precautionary, worst-case scenario.

Table 2.1 Quantified CIA for the potential disturbance of harbour porpoise during single and concurrent piling of offshore wind farms for the ‘theoretical’ worst-case’ scenario

Name of Project	Tier	Distance to NB (km)	SCANS-III Survey Block	SCANS-III density estimate (No/km ²)	Potential number of harbour porpoise impacted during single piling (2,124km ²)	Potential number of harbour porpoise impacted during concurrent piling with no overlap (4,248km ²)
Norfolk Boreas	5	0	O¹	0.888	1,886	3,772
Blyth Demonstration site (3A & 4)	3	351	R	0.599	1,272	2,545
Creyke Beck A	3	173	O	0.888	1,886	3,772
Creyke Beck B	3	196	O	0.888	1,886	3,772
Teesside A	3	191	N	0.837	1,778	3,556
Sofia	3	185	O ²	0.888	1,886	3,772
East Anglia THREE	3	13	L	0.607	1,289	2,579
Hornsea Project Two	3	101	O	0.888	1,886	3,772
Triton Knoll Phase 1-3	3	124	O	0.888	1,886	3,772
Moray Firth Eastern Development Area	3	657	S	0.152	323	646
Inch Cape	3	490	R	0.599	1,272	2,545
Near na Gaoithe	3	468	R	0.599	1,272	2,545
Dounreay Ti	3	766	S	0.152	323	646
Firth of Forth Phase 1 Seagreen Alpha and Bravo	3	500	R	0.599	1,272	2,545
Norfolk Vanguard	4	30	O ³	0.888	1,886	3,772
Hornsea Project THREE	4	53	O	0.888	1,886	3,772
Moray Firth Western Development Area	4	629	S	0.152	323	646
Thanet Extension	5	175	L	0.607	1,289	2,579
East Anglia ONE North	5	51	L	0.607	1,289	2,579

Name of Project	Tier	Distance to NB (km)	SCANS-III Survey Block	SCANS-III density estimate (No/km ²)	Potential number of harbour porpoise impacted during single piling (2,124km ²)	Potential number of harbour porpoise impacted during concurrent piling with no overlap (4,248km ²)
East Anglia TWO	5	73	L	0.607	1,289	2,579
Hornsea Project Four	5	119	O	0.888	1,886	3,772
Mermaid	3	125	N	0.837	1,778	3,556
Northwester 2	3	130	N	0.837	1,778	3,556
SeaStar	3	134	L	0.607	1,289	2,579
OWP West	3	230	N	0.837	1,778	3,556
Borssele I and II	3	133	N	0.837	1,778	3,556
Borssele III and IV	3	123	N	0.837	1,778	3,556
Borssele Site V - Leeghwater - Innovation Plot	3	108	N	0.837	1,778	3,556
Eoliennes du Calvados	3	441	C	0.213	452	905
Parc éolien en mer de Fécamp	3	363	C	0.213	452	905
Borkum Riffgrund West II	3	237	N	0.837	1,778	3,556
Gode Wind 03	3	280	M	0.277	588	1,177
Kaskasi	3	334	M	0.277	588	1,177
Hollandse Kust Zuid Holland I and II	3	126	N	0.837	1,778	3,556
Windpark Fryslan	3	89	N	0.837	1,778	3,556
Total					49,336	98,685
% of North Sea reference population (345,373 harbour porpoise)					14.3%	28.6%

¹Norfolk Boreas overlaps SCANS-III survey block O & L; therefore, higher density estimate from survey block O is used.

²Teesside B overlaps SCANS-III survey block O & N, but majority of site is in block O.

³NV East is located in SCANS-III survey block L, NV West is located in both SCANS-III survey block L and survey block O; therefore, higher density estimate from survey block O is used.

3 Potential disturbance of grey and harbour seal during offshore wind farm piling

3.1 UK and European offshore wind farm projects: 'theoretical' worst-case scenario

8. For the 'theoretical' worst-case scenario based on the 22 UK and European offshore wind farms (listed in Table 1.1) the CIA indicates that if all 22 UK and European offshore wind farms (including Norfolk Boreas) were concurrent piling at exactly the same time, the maximum number of grey seal that could potentially be disturbed is 4,526 individuals (Table 3.1) which represents approximately 20% of the reference population. The maximum number of harbour seal that could potentially be disturbed is 1,911 individuals (Table 3.1) which represents approximately 4% of the reference population.
9. If all 22 UK and European offshore wind farms (including Norfolk Boreas) were piling at exactly the same time, based on a single pile installation, the maximum number of grey seal that could potentially be disturbed is 2,265 individuals (Table 3.1) which represents approximately 10% of the reference population. The maximum number of harbour seal that could potentially be disturbed is 956 individuals (Table 3.1) which represents approximately 2% of the reference population.
10. As previously discussed, it is highly unlikely that all 22 UK and European offshore wind farms ('theoretical' worst-case scenario) could be concurrently or single piling at exactly the same time. Therefore the 'likely' scenario assessed in the ES Chapter is a more realistic, yet very precautionary, worst-case scenario.

Table 3.1 Quantified CIA for the potential disturbance of grey and harbour seal during single and concurrent piling of offshore wind farms for the 'theoretical' worst-case scenario

Name of Project	Tier	Distance to NB (km)	Grey seal density estimate (No/km ²) ¹	Harbour seal density estimate (No/km ²) ¹	Potential number of grey seal impacted		Potential number of harbour seal impacted	
					single piling	concurrent piling	single piling	concurrent piling
Norfolk Boreas	5	0	0.0006	0.00006	1.27	2.55	0.13	0.25
Blyth Demonstration site (3A & 4)	3	351	0.006	-	12.7	25.5	-	-
Creyke Beck A	3	173	0.05	0.0004	106.20	212.40	0.85	1.70
Creyke Beck B	3	196	0.09	0.001	191.16	382.32	2.12	4.25
Teesside A	3	191	0.01	0.00004	21.24	42.48	0.08	0.17
Sofia	3	185	0.09	0.001	191.16	382.32	2.12	4.25
East Anglia THREE	3	13	0.00009	0.00009	0.19	0.38	0.19	0.38
Hornsea Project Two	3	101	0.08	0.008	169.92	339.84	16.99	33.98
Triton Knoll phase 1-3	3	124	0.465	0.322	987.7	1,975	684.0	1,367.9
Norfolk Vanguard	4	30	0.002	0.0001	4.25	8.50	0.21	0.42
Hornsea Project THREE	4	53	0.08	0.008	169.92	339.84	16.99	33.98
Thanet Extension	4	175	0.02	0.06	42.48	84.96	127.44	254.88
East Anglia ONE North	5	51	0.0009	0.0006	1.91	3.82	1.27	2.55
East Anglia TWO	5	73	0.01	0.002	21.24	42.48	4.25	8.50
Hornsea Project Four	5	119	0.14	0.04	297.4	594.7	85.0	169.9
Mermaid	3	126	0.0079	0.004	17	33	8	16
Northwester 2	3	130	0.003	0.0002	6.4	12.7	0.4	0.8
SeaStar	3	134	0.0037	0.002	8	16	4	7

Name of Project	Tier	Distance to NB (km)	Grey seal density	Harbour seal density	Potential number of grey seal impacted		Potential number of harbour seal impacted	
OWP West		230	0.000003	0.00004	0.006	0.013	0.08	0.17
Borssele I and II	3	133	0.002	0.0003	5	9	0.7	1.3
Borssele III and IV	3	123	0.002	0.0003	5	9	0.7	1.3
Borssele Site V - Leeghwater - InNvation Plot	3	108	0.002	0.0003	5	9	0.7	1.3
Total					2,265	4,526	956	1,911
% of reference population (22,290 grey seal; 43,161 harbour seal)					10.2%	20.3%	2.2%	4.4%

4 References

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Boerjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M., Scheidat, M. and Teilmann, J. (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Wageningen Marine Research.