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Offshore Decommissioning Programme – Draft for Consultation

Norfolk Vanguard West Offshore Wind Farm

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0.1	DRAFT	For internal review.	IH	July 2024
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Executive Summary

Norfolk Vanguard West Offshore Wind Farm (NVW) is a consented Offshore Wind Farm (OWF) project comprising of up to 92 No. Wind Turbine Generators (WTGs), with a total project capacity of 1.38 Giga Watt (GW). NVW would be located approximately 47km from the coast of Norfolk (at the nearest point) in an area of water depths varying between approximately 25m and 50m below Lowest Astronomical Tide (LAT).

NVW was consented in February 2022 through the Norfolk Vanguard Offshore Wind Farm Order (the DCO) under the Planning Act 2008.

The DCO for the project has been amended in 2023 by the Norfolk Vanguard Offshore Wind Farm Amendment Order 2023; and in 2022 by the Norfolk Vanguard Offshore Windfarm (Amendment) Order 2022.

This document has been drafted to address Requirement 14 of the Norfolk Vanguard Offshore Wind Farm Order 2022 which states that '*No offshore works may commence until a written decommissioning programme in compliance with any notice served upon the undertaker by the Secretary of State pursuant to section 105(2) of the 2004 Act has been submitted to the Secretary of State for approval*'. In December 2023, the Secretary of State issued a notice under Section 105 (s.105 Notice) of the Energy Act 2004, requiring NVWL to submit a post consultation draft Decommissioning Programme to the Secretary of State no later than the 31 March 2026.

This version of the draft Decommissioning Programme has been prepared for consultation under the s.105 Notice in accordance with the latest Government guidance (Department of Business, Energy and Industrial Strategy (2019) Decommissioning of Offshore Renewable Energy Installations under the Energy Act 2004: Guidance notes for Industry (England and Wales)). The document provides preliminary information on the approaches to decommissioning the offshore components of the NVW wind farm including the WTGs, Offshore Substation (OSS), all offshore cabling and subsea protection. A summary of onshore waste management and recycling opportunities for the offshore are provided.

The decommissioning strategy assumes that the wind farm is dismantled in the reverse sequence of installation. The strategies take into account the 'As-built' details. Options for full and partial decommissioning of the monopile foundations of the site are discussed. Foundation full-decommissioning technology (for example, vibro lifting) that are under development are discussed along with proven conventional partial decommissioning technologies (for example, water jet cutting, diamond wire cutting and gas cutting). Options for full and partial decommissioning of array cables, export cables and scour protection are presented. The potential challenges that are faced in both the full decommissioning and partial decommissioning of the infrastructure are detailed.

The vessels and special equipment that are expected to be required for the decommissioning and the ports that are expected to be used to support the decommissioning are discussed. An indication of the decommissioning schedule is presented.

Cost estimates associated with the decommissioning strategies are presented in a separate annexe to this report.

The approach to decommissioning, detailed within the final Decommissioning Programme submitted to the Secretary of State for approval approximately 1-2 years prior to decommissioning commencing, will be subject to agreement with the relevant authorities based on environmental studies and surveys performed prior to decommissioning. The approach will be based on an assessment of relative net environmental benefit, taking into consideration the *in situ* ecological value of the offshore components alongside other factors such as navigational safety, available technology and the feasibility of recycling. This final report will also meet the conditions for decommissioning within The Crown Estate lease (for offshore assets up to the low water tide mark). A marine licence under the Marine and Coastal Access Act 2009 will be required alongside the approved Decommissioning Programme to authorise the decommissioning activities.

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ABBREVIATIONS

Abbreviation	Description
BATNEEC	Best Available Technique not Entailing Excessive Cost
BEIS	Department of Business, Energy and Industrial Strategy
BMAPA	National British Marine Aggregate Producers Association
BPEO	Best Practical Environmental Option
CD	Chart Datum
CDM	Construction Design and Management
CPA	Coastal Protection Act
CPS	Cable Protection Systems
CTV	Crew Transfer Vessel
DBS	Dynamic Bend Stiffeners
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
DESNZ	Department for Energy Security and Net Zero
Dia	Diameter
DP	Dynamic Positioning
EIA	Environmental Impact Assessment
EPR	Ethylene Propylene Rubber
ES	Environmental Statement
FEPA	Food and Environment Protection Act
FOC	Fibre Optic Cable
GW	Gigawatts
HAT	Highest Astronomical Tide
HH	Hub Height
HSSE	Health, Safety, Security and Environment
HV	High Voltage
HVDC	High Voltage Direct Current
IMO	International Maritime Organisation
IOG	Independent Oil and Gas Limited
JUV	Jack Up Vessel

Abbreviation	Description
Km	Kilometre
kV	Kilo Vaults
LAT	Lowest Astronomical Tide
Ltd.	Limited
m	Metre
m/s	Metres per second
MFE	Mass Flow Excavator
mm	Milimetre
MGN	Marine Guidance Note
MP	Monopile
MPA	Marine Protected Area
MW	Mega Watts
MWR	Marine Works Regulations
Nm	Nautical Mile
No.	Number
NVE	Norfolk Vanguard East
NVW	Norfolk Vanguard West
NVWL	Norfolk Vanguard West Limited
OEM	Original Equipment Manufacture
OFTO	Offshore Transmission Owner
OREI	Offshore Renewable Energy Installation
OSPAR	Oslo and Paris Conventions – OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic
OSS	Offshore Substation
OWF	Offshore Wind Farm
PEXA	Practice and exercise area
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SJOR	Slip Joint Offshore Research
SPA	Special Protection Area
SSCV	Semi-Submersible Crane Vessel

Abbreviation	Description
t	Metric tonnes
TP	Transition Piece
TCE	The Crown Estate
UNCLOS	United Nations Convention on the Law of the Sea
WTG	Wind Turbine Generator
XLPE	Cross linked polyethylene

1 Introduction

1.1 Purpose of Document

Under Requirement 14 of the Norfolk Vanguard Offshore Wind Farm Order 2022 and the s.105 Notice under the Energy Act 2024, Norfolk Vanguard West Limited (NVWL) is required to submit a draft Decommissioning Programme for the Norfolk Vanguard Offshore Wind Farm (NVW) to the Department of Energy Security and Net Zero (DESNZ) for approval prior to the start of offshore construction.

This draft Decommissioning Programme has been prepared and submitted to DESNZ and provides an outline of the current strategy and indicative cost estimates (included as a separate, confidential annexe to this document), for the decommissioning of the marine infrastructure associated with the transmission and generation assets, namely the proposed wind turbine generators, the monopile foundations, the inter-array cables, the export cables and the offshore substation (OSS).

Requirements 14 (2), (3) and (4) of the Norfolk Vanguard West Offshore Wind Farm Order 2022 provide for the preparation of, and approval of, documentation relating to the proposed installation of cable protection within the Haisborough, Hammond and Winterton Special Area of Conservation (SAC). No cable protection can be deployed within the SAC until this documentation is submitted and approved by the Secretary of State. This Decommissioning Programme provides an outline of the proposed cable protection, however, the required suite of documents (as detailed in 2.3.3 of this report) will be prepared and submitted for approval separately.

This report is prepared to support the development of a final approach to decommissioning which will be presented in the concluding version of the Decommissioning Programme required, under the provisions of the Energy Act 2004 (as amended), to be submitted to DESNZ for approval. The final Decommissioning Programme will also meet the provisions for decommissioning set out within the relevant clauses of The Crown Estate leases for the generation and transmission assets.

The strategies detailed in this Decommissioning Programme have also considered all relevant guidelines, including the Department for Business, Energy & Industrial Strategy (BEIS) 'Decommissioning of Offshore Renewable Energy Installations under the Energy Act 2004 (as amended), Guidance Notes for Industry (England and Wales)' (March 2019) (referred to as the BEIS Guidance (2019)) and are based on proven commercially available technologies at the time of writing.

2 Norfolk Vanguard West OWF || Overview

2.1 Ownership

NVW is 100% owned by RWE Renewables UK Ltd. under the subsidiary NVWL.

The NVW project is an offshore wind farm located in the North Sea, in a strategic area identified by the Government for the 3rd Round of offshore wind farm development. NVW has been awarded Agreements for Lease for the array area and export cable route to shore from The Crown Estate.

The NVW project is situated in the North Sea approximately 47km north of Norfolk (from the nearest point). The array area occupies an area of approximately 295km^2 and has water depths ranging from 25m to 50m below LAT.

2.2 Authorisation

The construction and operation of NVW was consented in February 2022 through the Norfolk Vanguard Offshore Wind Farm Order 2022. The Norfolk Vanguard Order also covers a portion of the Norfolk Vanguard East Site. For context, Norfolk Vanguard East is also partly authorised under the Norfolk Boreas DCO following a transfer of benefits. A separate Decommissioning Programme will be prepared and submitted by Norfolk Vanguard East Limited in accordance with the s.105 Notice issued on the 19 December 2023.

The Norfolk Vanguard Order also contains deemed Marine Licences covering Generation (Schedules 9 and 10) and Transmission (Schedules 11 and 12).

The Order was amended by the by the Norfolk Vanguard Offshore Windfarm (Amendment) Order 2022 and the Norfolk Vanguard Offshore Wind Farm Order 2023 in December 2023. The consent requires that the authorised project must commence no later than the expiration of five years beginning with the date the Order came into force (5 March 2022). The Order does not authorise decommissioning of the wind farm infrastructure.

2.3 The Decommissioning Programme Approval Process

2.3.1 The Energy Act 2004 (as amended)

Sections 105 to 114 of the Energy Act 2004 (as amended) contain the statutory decommissioning scheme for OWFs and their related electric lines (collectively, Offshore Renewable Energy Installations – "OREIs"). Under the terms of the Act, the Secretary of State may require a person who is responsible for one of these OREIs to submit (and eventually carry out) a decommissioning programme.

Section 105 (8) of the Energy Act 204 (as amended) requires that:

'*A decommissioning programme—*

(a) *must set out measures to be taken for decommissioning the relevant object;*

(b) *must contain an estimate of the expenditure likely to be incurred in carrying out those measures;*

(c) *must make provision for the determination of the times at which, or the periods within which, those measures will have to be taken;*

(d) *if it proposes that the relevant object will be wholly or partly removed from a place in waters regulated under this Chapter, must include provision about restoring that place to the condition that it was in prior to the construction of the object; and*

(e) *if it proposes that the relevant object will be left in position at a place in waters regulated under this Chapter or will not be wholly removed from a place in such waters, must include provision about whatever continuing monitoring and maintenance of the object will be necessary.*'

The BEIS Guidance (2019) produced to assist developers/owners to understand their obligations under the Energy Act 2004 (as amended) decommissioning scheme applies to NVW and this report follows the structure outlined in Annex C of the Guidance.

2.3.2 The Crown Estate Agreements for Lease

Agreements for lease and subsequent Deeds of Variation for the generation and transmission assets have been signed.

Deed of Variation of An Agreement for Lease of Substation Site and Cable Connection Corridor upon Bed of Sea for a Wind Farm Project off the Coast of East Anglia (NVW) was signed on the 27 March 2024 between The Crown Estate Commissioners and Norfolk Vanguard West Limited and Vattenfall AB (PUBL). Within this, Clause 3.17 requires that that prior to Determination of the Term, the Works and Substation Site and Designated Area are decommissioned in accordance with the Decommissioning Programme and in accordance with all relevant Legal Obligations. Within 1.1 Definitions, " '*Decommissioning Programme' means a decommissioning programme applicable to the Works approved by the Secretary of State under the Energy Act 2004, including any modifications or conditions which the Secretary of State may from time to time specify'*."

Deed of Variation of An Agreement for Lease of Windfarm Site known as East Anglia North Tranche 1 (Norfolk Vanguard West) upon Bed of the Sea at East Anglia (NVW) was signed on the 27 March 2024 between The Crown Estate Commissioners and Norfolk Vanguard West Limited and Vattenfall AB (PUBL). Within this, Clause 3.16 requires that that prior to Determination of the Term, the Works are decommissioned and the Site restored in accordance with the Decommissioning Programme and in accordance with all Legal Obligations. Within 1.1 Definitions, " '*Decommissioning Programme' means a decommissioning programme applicable to the Works approved by the Secretary of State under the Energy Act 2004, including any modifications or conditions which the Secretary of State may from time to time specify'*."

2.3.3 Submission of Decommissioning Programmes

This Decommissioning Programme for generation and transmission assets has been prepared and submitted to DESNZ for approval. Once approved, a Notice under Section 106 of the Energy Act 2004 will be issued. The document and the approach and commitments made within it may be affected by commitments made in other DCO discharge documents, such the Benthic Implementation and Monitoring Plan (approved by DESNZ), the Scour Protection and Cable Protection Plan (not yet submitted for approval to the MMO), and the Cable Specification, Installation and Monitoring Plan (not yet submitted for approval to the MMO). The approaches will be aligned in further iterations of the Decommissioning Programme.

As noted previously, prior to the deployment of cable protection associated with the export cable within the Haisborough, Hammond and Winterton SAC, information must be submitted to, and approved by, the Secretary of State (unless otherwise stated or unless otherwise agreed in writing by the Secretary of

State). Requirement 14 (2), (3) and (4) identifies the following documentation: '*(a) a decommissioning feasibility study on the proposed cable protection to be updated at intervals of not more than every ten years throughout the operational phase of the project; (b) a method statement for recovery of cable protection; and (c) a monitoring plan to include appropriate surveys following decommissioning to monitor the recovery of the area of the Haisborough, Hammond and Winterton Special Area of Conservation impacted by cable protection.*'

Under Section 108 of the Energy Act 2024, the Secretary of State must, from time to time, conduct such reviews of an approved decommissioning programme.

The BEIS Guidance (2019) notes that a comprehensive review 12-18 months before the first security provision is due to identify any changes in assumptions on costs and risks where these might affect the size or timings of financial securities.

It is important to note that the Decommissioning Programme will, notwithstanding approval under the aforementioned Requirements, remain a 'live' document which will be monitored and updated accordingly throughout the lifecycle of NVW, in order to reflect on changing circumstances, especially new regulatory requirements, and to give opportunity to incorporate improvements in knowledge and understanding of the marine environment and advancement in technology and working practices.

Under the Electricity Act 1989, the offshore transmission assets will be sold through the competitive tender process managed by ofgem and a licence granted for transmission of electricity generated by the offshore wind farm to the onshore grid. At the point of transfer, decommissioning of the transmission assets will become the responsibility of the appointed offshore transmission owner (OFTO) and notification will be submitted to DESNZ.

It is anticipated that the final Decommissioning Programme will be submitted approximately 1-2 years in advance of the proposed year of decommissioning such that consultation can be undertaken and approval obtained of the final version from the Secretary of State to support award of contracts for the removal works.

2.4 External Stakeholder Consultation

NVW regards effective and open communication and consultation as essential elements to the successful operation of the project. These principles have been adopted during the development of the project and are being applied during the life of NVW, including the decommissioning phase of the project.

In accordance with the Section 105 Notice, NVW is seeking the advice and opinions of the following parties and will continue to do this as part of the development of the approach to decommissioning that will be presented in the final Decommissioning Programme.

- Marine Management Organisation
- Natural England
- Chamber of Shipping
- Maritime and Coastguard Agency
- Royal Yachting Association
- Trinity House
- National Federation of Fishermen's Organisation

- Conservation Agency – assumed that this is the Eastern Inshore Fisheries Conservation Authority
- Relevant Harbour Authority/ies –assumed these to be Lowestoft and Great Yarmouth
- Relevant Inshore Fisheries: assumed these are Southwold Fishermen's Association; Lowestoft Fishermen; Great Yarmouth Fishermen and Sea Palling Fishermen; Caister Fishermen; Norfolk Fishermen's Society.
- Environment Agency
- National British Marine Aggregate Producers Association (BMAPA)

At the time of decommissioning, and in accordance with the Norfolk Vanguard Offshore Wind Farm Order 2022, NVW will issue timely and efficient Notices to Mariners and other navigational warnings of the position and nature of the decommissioning activities that will be taking place. Efforts will be made to ensure that this information reaches mariners in the shipping and fishing industry as well as recreational mariners.

The UK Hydrographic Office will be notified as appropriate on the progress and completion of the works.

3 Project Background Information

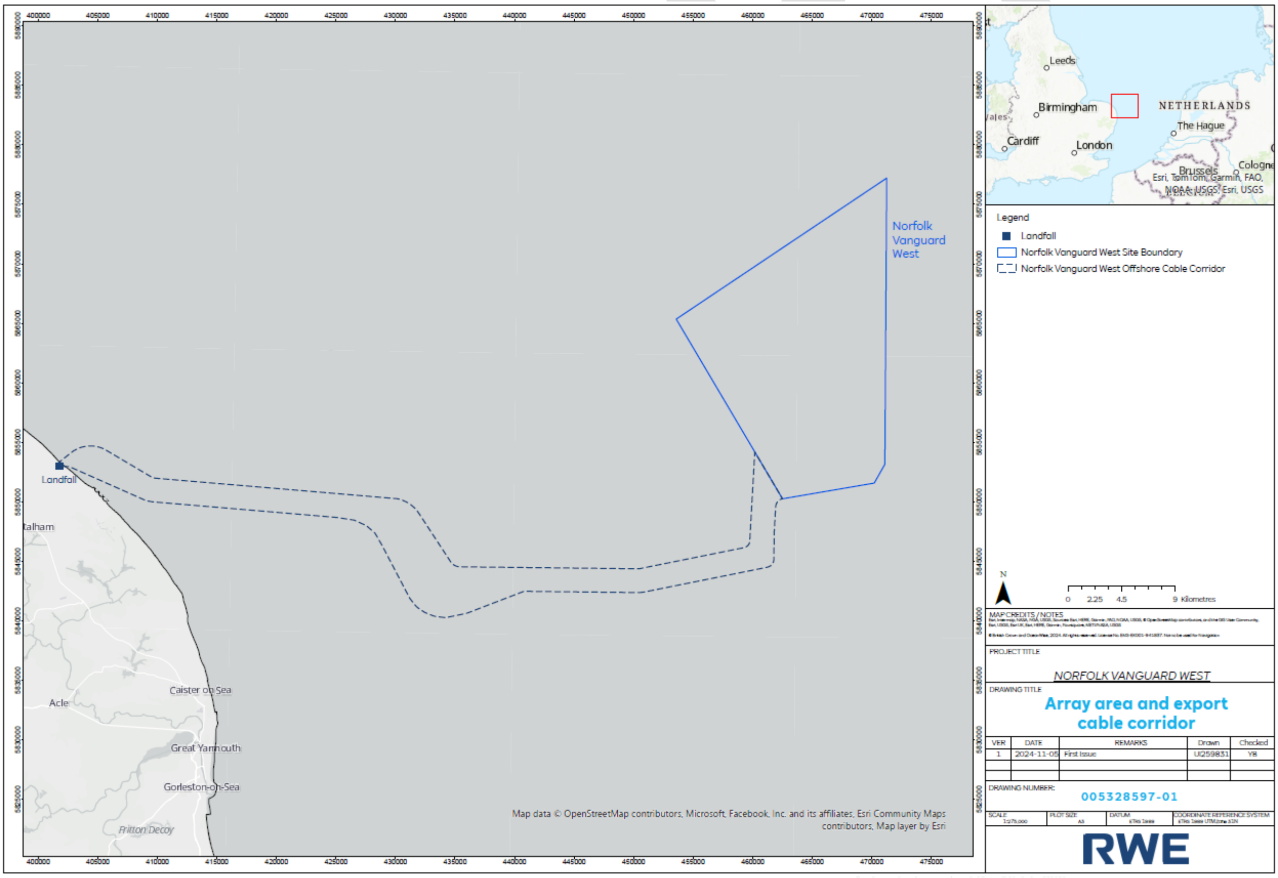
3.1 Introduction

To support the application for Development Consent for Norfolk Vanguard, an Environmental Statement (ES) [1] was produced for the Norfolk Vanguard DCO. As explained above, the Norfolk Vanguard DCO was later transferred to NVW and Norfolk Vanguard East (which is also partly authorised under the Norfolk Boreas DCO). Information from the ES, together with updated information prepared during the ongoing detailed design phase of NVW are presented in this section.

3.2 Site Location

The location of NVW is shown on Figure 3-1. The offshore array area is located in the southern North Sea, approximately 47km from the coast of Norfolk. The export cable crosses the Haisborough, Hammond and Winterton SAC and Marine Protected Area (MPA) for a distance of ~40 km before reaching landfall at Happisburgh. From there, onshore cables will transport power over approximately 60km to the onshore project substation at Necton, Norfolk.

Figure 3-1: NVW location plan with export cable route and site boundary



[1] Norfolk Vanguard Offshore Wind Farm Environmental Statement (June 2018) prepared by Royal Haskoning DHV on behalf of Norfolk Vanguard Ltd.

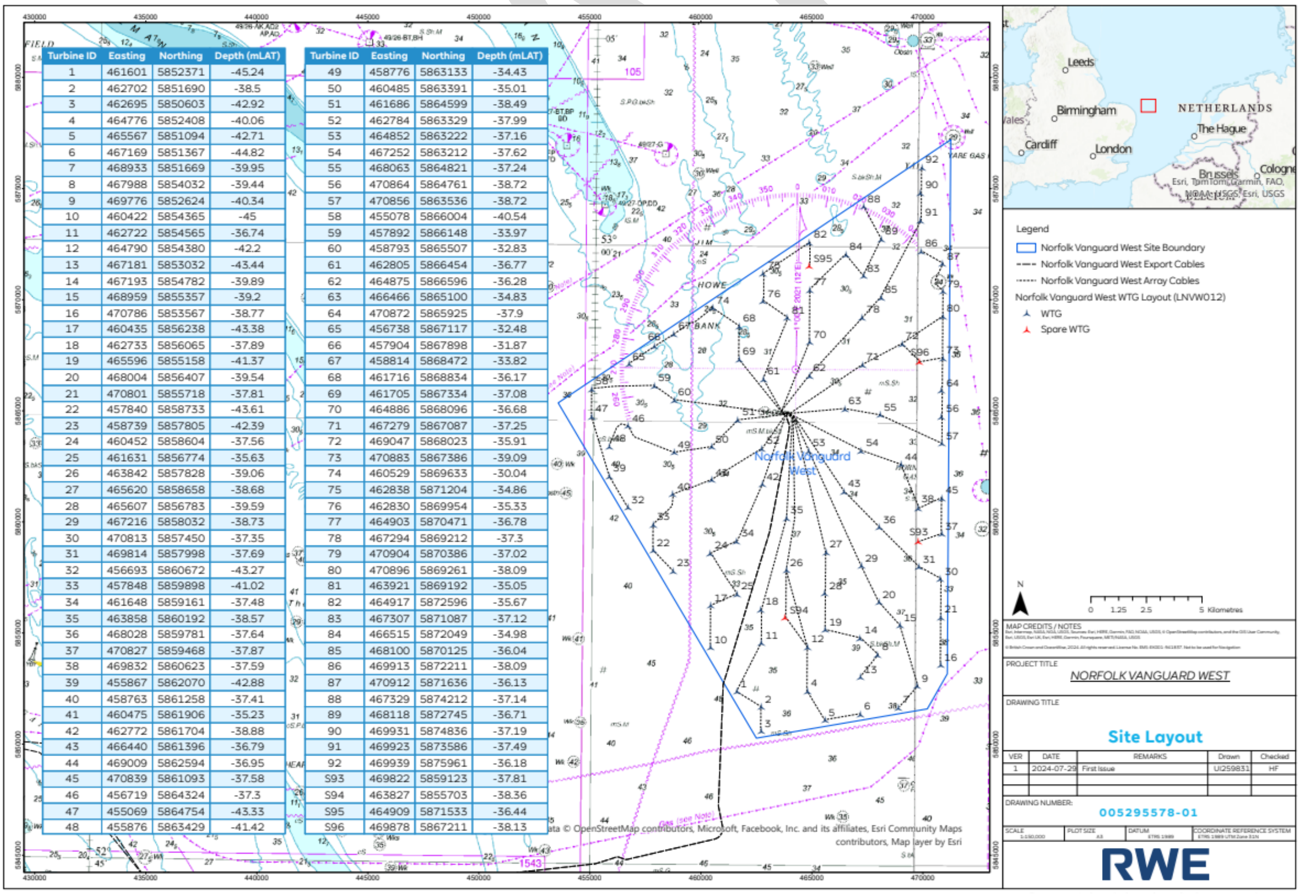
3.3 Site Layout

Based on the current design of the offshore infrastructure, NVW will comprise of 92 No. 15MW Vestas V236 turbines giving rise to a total site capacity of approximately 1380 MW. The capacity will be exported via one offshore converter station and an HVDC export cable back to shore in the vicinity of Happisburgh. The site boundary coordinates are provided in Table 3-1 and the array layout shown in Figure 3-2.

Table 3-1: Site boundary coordinates

Point	Coordinates (ETRS 1989 UTM 31N)
1	471099 E, 5853163 N
2	470201 E, 5851581 N
3	462497 E, 5850264 N
4	453574 E, 5865359 N
5	471252 E, 5877202 N

Figure 3-2: NVW indicative site layout



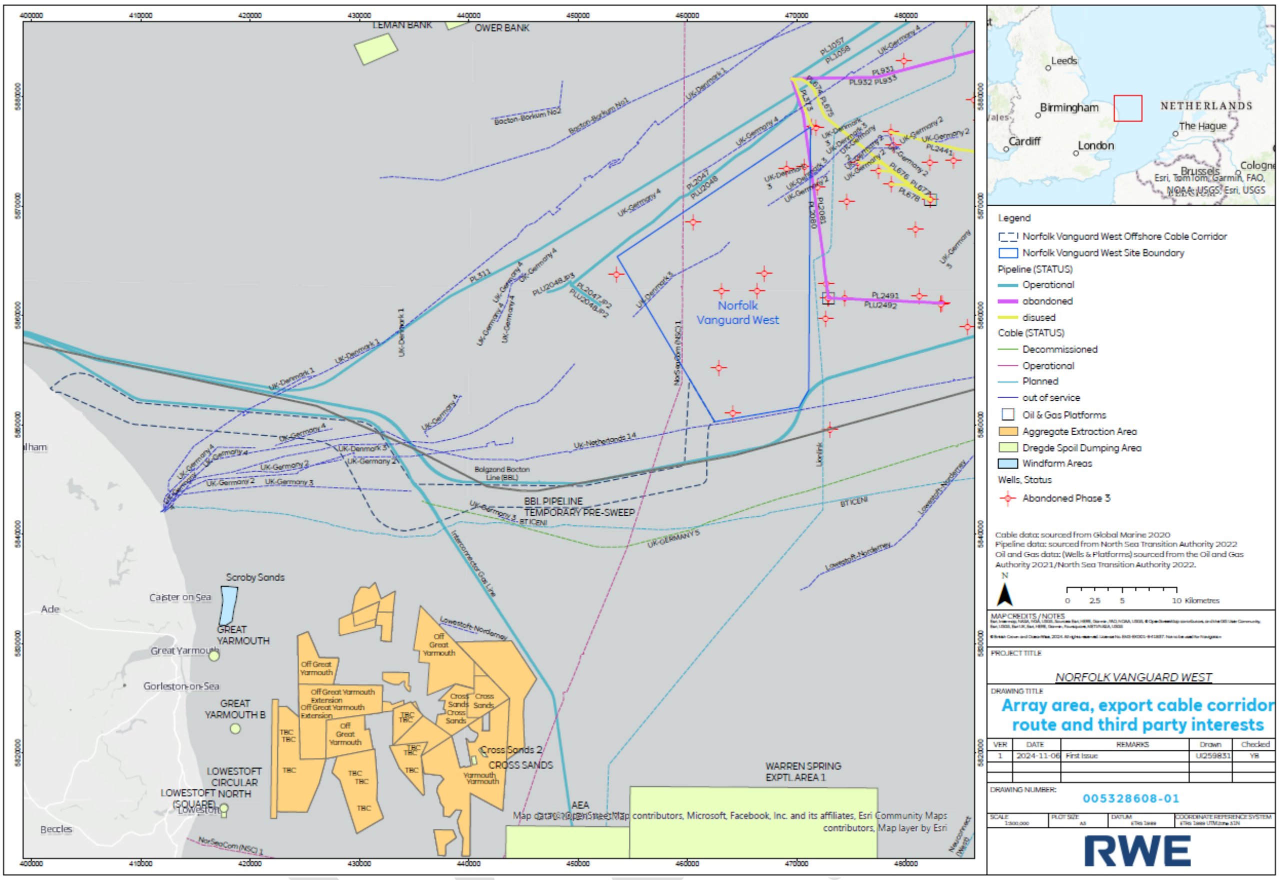
Turbine ID	Easting	Northing	Depth (mLAT)
1	461601	5852371	-45.24
2	462702	5851690	-38.5
3	462695	5850603	-42.92
4	464776	5852408	-40.06
5	465567	5851094	-42.71
6	467169	5851367	-44.82
7	468933	5851669	-39.95
8	467988	5854032	-39.44
9	469776	5852624	-40.34
10	460422	5854365	-45
11	462722	5854565	-36.74
12	464790	5854380	-42.2
13	467181	5853032	-43.44
14	467193	5854782	-39.89
15	468959	5855357	-39.2
16	470786	5853567	-38.77
17	460435	5856238	-43.38
18	462733	5856065	-37.89
19	465596	5855158	-41.37
20	468004	5856407	-39.54
21	470801	5855718	-37.81
22	457840	5858733	-43.61
23	458739	5857805	-42.39
24	460452	5858604	-37.56
25	461631	5856774	-35.63
26	463842	5857828	-39.06
27	465620	5858658	-38.68
28	465607	5856783	-39.59
29	467216	5858032	-38.73
30	470813	5857450	-37.35
31	469814	5857998	-37.69
32	456693	5860672	-43.27
33	457848	5859898	-41.02
34	461648	5859161	-37.48
35	463858	5860192	-38.57
36	468028	5859781	-37.64
37	470827	5859468	-37.87
38	469832	5860623	-37.59
39	455867	5862070	-42.88
40	458763	5861258	-37.41
41	460475	5861906	-35.23
42	462772	5861704	-38.88
43	466440	5861396	-36.79
44	469009	5862594	-36.95
45	470839	5861093	-37.58
46	456719	5864324	-37.3
47	455069	5864754	-43.33
48	455876	5863429	-41.42
49	458776	5863133	-34.43
50	460485	5863391	-35.01
51	461686	5864599	-38.49
52	462784	5863329	-37.99
53	464852	5863222	-37.16
54	467252	5863212	-37.62
55	468063	5864821	-37.24
56	470864	5864761	-38.72
57	470856	5863536	-38.72
58	455078	5866004	-40.54
59	457892	5866148	-33.97
60	458793	5865507	-32.83
61	462805	5866454	-36.77
62	464875	5866596	-36.28
63	466466	5865100	-34.83
64	470872	5865925	-37.9
65	456738	5867117	-32.48
66	457904	5867898	-31.87
67	458814	5868472	-33.82
68	461716	5868834	-36.17
69	461705	5867334	-37.08
70	464886	5868096	-36.68
71	467279	5867087	-37.25
72	469047	5868023	-35.91
73	470883	5867386	-39.09
74	460529	5869633	-30.04
75	462838	5871204	-34.86
76	462830	5869954	-35.33
77	464903	5870471	-36.78
78	467294	5869212	-37.3
79	470904	5870386	-37.02
80	470896	5869261	-38.09
81	463921	5869192	-35.05
82	464917	5872596	-35.67
83	467307	5871087	-37.12
84	466515	5872049	-34.98
85	468100	5870125	-36.04
86	469913	5872211	-38.09
87	470912	5871636	-36.13
88	467329	5874212	-37.14
89	468118	5872745	-36.71
90	469931	5874836	-37.19
91	469923	5873586	-37.49
92	469939	5875961	-36.18
S93	469822	5859123	-37.81
S94	463827	5855703	-38.36
S95	464909	5871533	-36.44
S96	469878	5867211	-38.13

3.4 Third Party Infrastructure

This section details any third party infrastructure existing or proposed within the vicinity of NVW.

- The closest existing OWF is Scroby Sands Offshore Wind Farm, a Round 1 project of 60MW is situated 45km away from NVW. Dudgeon and Sheringham Shoal are the next closest UK wind farm developments, at over 66km and 75km distance from NVW.I In terms of proposed OWF, the closest ones include Norfolk Vanguard East, Norfolk Boreas and East Anglia Three.
- There are nine oil and gas wells or platforms situated within 5km of NVW array (the closest being Yare 0.1km and Horne and Wren Platform 1.8km) although the majority of the infrastructure has been decommissioned / removed.
- The following oil and gas licencing blocks overlap with NVW: 49/28a, licenced to Centrica 10% Perenco 23.3% Tullow and 53/2a, licenced to Perenco 35. There are also licence blocks undergoing consultation for development, 41km north of the offshore cable corridor and 49km north west of NVW. These blocks are licensed to Independent Oil and Gas Limited (IOG).
- The Tampnet (formerly known as North Sea Com 1 fibre optic) cable runs from Lowestoft north through the offshore cable corridor and NVW.. There is a BT ICENI telecoms cable along the Southern edge of the export cable route but is outside of the red line boundary. All other cables intersecting the Norfolk Vanguard offshore project area are inactive.
- The offshore cable corridor will intersect the Interconnector Bacton-Zeebrugge gas pipeline and the BBL Balgzand-Bacton gas pipeline.
- There is a proposed National Grid Interconnector cable that may be laid in proximity to the wind farm.
- There are no aggregate dredging licenced or application areas within the Norfolk Vanguard offshore project area. There are aggregate dredging licences and exploration agreements approximately 27km south west of NVW.
- There is one disused marine disposal site HU202 (BBL Pipeline disposal site) that runs through the offshore cable corridor. There are two closed marine disposal sites, HU146 and HU148 within 2km of the landfall site and two closed marine disposal sites approximately 25km north of NVW. The largest marine disposal site in the surrounding area is TH075 (Warren Springs). This site is located 26km south of NVW and has been closed since 1995. The closest open marine disposal site is HU176, located 38km south west of NVW.
- The offshore cable corridor overlaps with a Coal and Brine Consultation Area (also known as a Coal Mining Reporting Area)
- No military practice and exercise areas (PEXAs) overlap with NVW. The closest PEXA is the Southern Military Defence Area (MDA); 49km from NV West, and the distance to the closest point of the offshore cable corridor is 71km.

Figure 3-3: NVW third party infrastructure



3.5 Seabed and Physical Conditions

Water depths across the array area of NVW vary between approximately 20 and 50m below LAT. The minimum water depth is along the north-central edge of the site and the maximum water depth is within the south-west corner of the site. The primary bathymetric features are broad (2.5 to 3.0km apart) but low (typically 5m high) sandbanks which trend north-south through the site and represent the south-east limit of the Norfolk Bank System. The westernmost sandbank is slightly higher (up to 7m), broader (up to 4km wide) and continues past the southern boundary of NVW. At a more local scale the seabed is uneven due to the presence of bedforms of various sizes. Sand waves within NVW are up to 6m high with crests oriented approximately east-west, indicative of north-south tidal currents. The majority of the sand waves are asymmetric with their steeper sides facing north, indicating migration towards the north. The sand waves are overlain by megaripples which also blanket the site where sand waves are not present. Where megaripples are present on a relatively smooth or only mildly undulating seabed, such as the centre of the site, their crests are linear with a consistent spacing of about 8 to 10m, and typical heights of 0.5m.

To the north of NVW are a series of sandbanks collectively called the Norfolk Bank System. They represent the most extensive example of offshore linear ridge type sandbanks in UK waters. The proposed offshore cable corridor has a route through the banks within the south-west part of the system. Water depths within the offshore portion of the cable corridor, in the region of the array area, are typically 40 to 50m below LAT. Progressing towards the coast, water depths decrease progressively from around 50m below

LAT to 10m below LAT about 500 to 1000m from the coast. The 2m below LAT contour is typically 200m to 30m from the coast. Along the offshore export cable route are a number of sandbanks, shoals, sand waves, megaripples and sand ridges. The offshore cable corridor passes through the southern end of the Annex I sandbank system located within the Haisborough, Hammond and Winterton SAC.

The ground conditions across the site are generally comprised of different types of soils as outlined in Table 3-2.

Table 3-2: Soil unit summary

Soil Unit		Characteristics	Occurrence
1	Holocene	Upper Clean to Silty SAND, dense to very dense. Lower Silty SAND to Sandy SILT, medium dense to dense.	Found at seabed, in variable thickness
2	Twente	Fine SAND with laminae of clay and peat.	May be found below a cover of Holocene sand, not identified in the baseline SI positions.
3	Brown Bank	Upper high to extremely high strength silty CLAY. Intermediate silty SAND to sandy SILT of varying density. Lower low to high strength silty CLAY to clayey SILT. Occasionally more SAND to Silty Sand layers below the lower CLAY.	Found below a cover of Holocene or at seabed, in variable thickness.
4	Swarte Bank	Mixed sediments from clay and silt to gravelly sand, infilling large channels eroded into the Yarmouth Roads Formation.	Not identified in the baseline SI positions.
5	Yarmouth Roads	Clean medium dense to very dense SAND to Silty SAND, heavily stratified sands with laminations of clay and silt, and occasional high to very high strength CLAY/SILT layers.	Found below Brown Bank, present in all baseline SI positions.
as identified in the boreholes at 2020 survey			

3.6 Metocean Conditions

All metocean information presented in this section is gathered from the project Marine Assessment[2].

3.6.1 Wind measurements

Nominal wind conditions are presented in Table 3-3 and

Table 3-4.

Table 3-3: Nominal wind conditions

Nominal wind conditions (annual)	
Annual 10-minute mean wind speed	a) 10.21m/s (at EAZE Metmast at 149.74m HH above MSL)
Weibull scale parameter	b) 10.17m/s (NVW Farm average at 149.74m HH above MSL)
Weibull shape parameter	11.48 (NVW average at HH)
Wind speed measurement height	2.19 (NVW average at HH)
Mean air density	10.00m/s at EAZE metmast; 102m top elevation MSL
Mean exponential wind shear coefficient	1.228 Kg/m^3 at HH

Table 3-4: Extreme wind conditions (return period 50 years)

Extreme wind conditions	
Maximum 10-minute mean wind speed	41.2m/s
Maximum 3-second gust wind speed	47.1m/s (based on GF of 1.14 approx.)
Wind speed measurement height	102m MSL (85m top height + 17m platform)

3.6.2 Tide levels

The tide levels are presented in Table 3-5. NVW array area is located within an area of seabed that is subject to a micro-tidal regime, with an average spring tidal range of up to 1.5m.

[2] Design Report Norfolk Vanguard West Offshore Wind Farm Marine Assessment (Document Number:P NVW-REP-DSM-00-Marine Assessment-01, Revision 01.

Table 3-5: Tide levels

Tidal levels	From LAT
Highest Astronomical Tide	2.4m
Mean High Water Springs	2.0m
Mean High Water Neaps	1.6m
Mean Sea Level	1.3m
Mean Low Water Neaps	0.9m
Mean Low Water Springs	0.5m
Lowest Astronomical tide (LAT)	0.0

3.6.3 Currents

The typical currents across the site are detailed in Table 3-6. Currents typically run north/south through the field depending on the tide cycle.

Table 3-6: Currents at NVW

Extreme Current Speed	1 year return	50 year return
Depth Averaged	1.2m/s	1.4m/s
Surface	1.7m/s	1.8m/s

3.6.4 Wave climate

The regional wave climate is composed of a combination of swell waves generated offshore and locally-generated wind-waves. Data from observation campaigns shows that the predominant waves close to NVW arrive from the south-southwest with subordinate waves from the north. The 1 in 50 year return period significant wave height is 7m in NVW. Across the majority of NVW, water depths are likely to be sufficient to limit the effect of wave action on seabed sediments, apart from during exceptionally stormy seas or over shallower areas.

The extreme wave conditions based on a return period of 50 years are shown in Table 3-7.

Table 3-7: Extreme wave conditions

Extreme wave conditions	
Maximum wave height	13.8m
Corresponding design wave period	11.0s
3-hour significant wave height	7.3m

3.7 Environmental Considerations

An ES for the Norfolk Vanguard Offshore Wind Farm project which included NVW was produced in June 2018. Volume 1 of the ES assessed the offshore works[3].

As detailed previously as part of the marine licence application process required for decommissioning, an Environmental Impact Assessment and Habitats Regulation Assessment will be undertaken to fully assess the environmental effects of the final decommissioning approach, in line with relevant legislation at the time

Table 3-8 outlines key environmental considerations for decommissioning based on the information presented in ES.

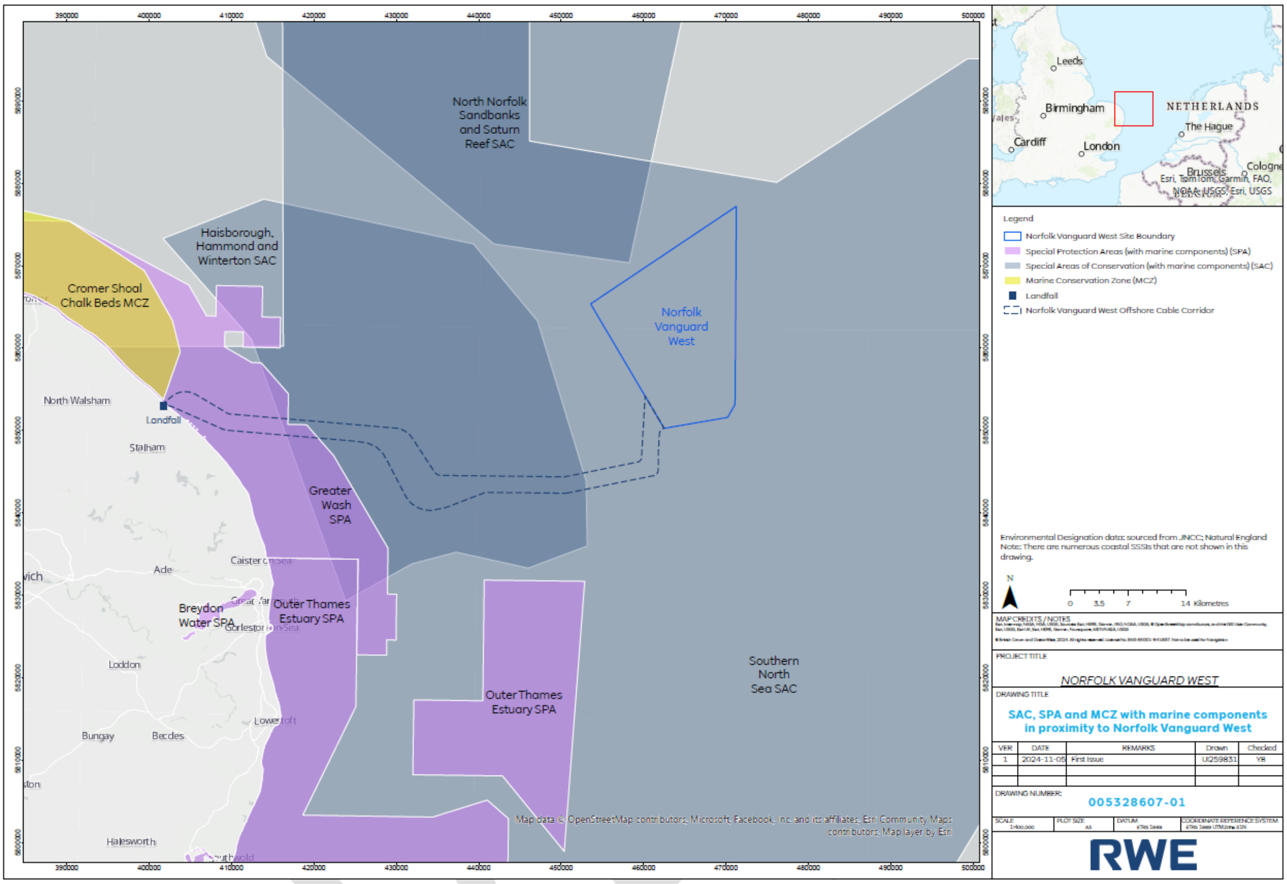
Table 3-8: Environmental Considerations

Topic	Environmental Consideration
Designated sites	There are a number of sites that are designated as being important for nature conservation located in the vicinity of the project. The location of these sites relative to the Project are shown on Figure 3-. The potential effects of decommissioning on the protected features of the designated sites were not considered to be significant. However, the ES notes that a further assessment will be undertaken in advance of any decommissioning works taking account of known information at the time, including relevant guidelines and requirements. Greater Wash Special Protection Area (SPA) (intersected by export cable, 36km from array) was classified in 2018. The Greater Wash SPA is classified for the protection of red-throated diver (*Gavia stellata*), common scoter (*Melanitta nigra*), and little gull (*Hydrocoloeus minutus*) during the non-breeding season, and for breeding Sandwich tern (*Sterna sandvicensis*), common tern (*Sterna hirundo*) and little tern (*Sternula albifrons*). Haisborough, Hammond and Winterton SAC (intersected by export cable) was designated in September 2017. Located off of the north-east coast of Norfolk, the Haisborough, Hammond and Winterton SAC contains the protected features 'Sandbanks slightly covered by sea water all the time' and 'Reefs'. Fisheries management measures came into force within the SAC from 22 March 2022 through the Marine Protected Areas Bottom Towed Fishing Gear Byelaw 2023. Southern North Sea SAC (intersected by the array area) was designated in 2019. The Annex II species, Harbour porpoise (*Phocoena phocoena*) is the primary reason for site selection.
Commercial fisheries	Fisheries activities broadly fall into two categories: Dutch vessels undertaking trawling (including UK flagged but Dutch owned beam trawlers) and seine netting; and local UK static gear fisheries. The key species for the trawlers include plaice and Dover sole, whilst the local fishermen target lobster, edible crab and whelks.
Marine and coastal archaeology	The known offshore archaeological baseline offshore comprises charted wrecks and obstructions and previously unidentified anomalies of possible

[3] RPS (June 2005) Environmental Statement: Volume 1: Offshore Works London Array Limited

Topic	Environmental Consideration
	maritime or aviation origin. Archaeological Exclusion Zones (28) have been recommended and a protocol for archaeological discoveries will be implemented.
Marine and coastal ornithology	A number of bird species were recorded during the offshore surveys, with species of particular interest including red throated diver, kittiwake, gannet, puffins, guillemot and razorbill.
Marine and intertidal ecology	The main species were found to be marine worms, brittle stars, sea urchins and starfish, typical of the southern North Sea. Two protected habitats (sandbanks and reefs formed by marine worms) are present in the area. The offshore cable corridor runs through the Haisborough, Hammond and Winterton Special Area of Conservation (SAC), and to the south of the Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ).
Fish and shellfish ecology	A variety of species (including commercial fish and shellfish species and species of conservation importance) were found to be present during the site specific surveys and nursery and spawning grounds were also identified within the offshore project area.
Marine mammals	Site surveys and other data indicated low numbers of marine mammals, with only three species, harbour porpoise, grey seal and harbour seal, using the NVW site in sufficient numbers to enable them to be analysed. The project is not predicted to have a significant impact on any other species which visit the area infrequently.
Shipping and navigation	The key shipping and navigation features are the International Maritime Organisation (IMO) Routeing Measures, namely the DR1 Lightbuoy Deep Water Route (DWR) and the West Friesland DWR. These form part of the wider IMO Routeing Measure network within the North Sea, which has been established to promote safe navigation by all vessels. The majority of marine traffic in the vicinity of NVW is from cargo vessels and tankers, largely utilising the routeing measures, however established commercial traffic routes also currently cross the site.
Marine water and sediment quality	Water quality within the offshore study area is good, and seabed sediments do not contain levels of pollution that would be of concern. Additionally, natural levels of sediment in the water vary depending on season and during stormy weather.

Figure 3-4: Environmental Designations in proximity to NVW



4 Description of Project Components to be Decommissioned

4.1 Introduction

This section provides a description of the components of NVW that will be decommissioned. At the time of writing, some design details such as final size of the WTGs and exact locations of the infrastructure are not finalised. These details will be updated in future revisions of this Decommissioning Programme.

This section has been divided into two sections: generation assets and transmission assets.

The separation point of the transmission and generation assets is typically at the switchgear on the incoming array cables, however this will be fully defined in the OFTO agreement.

4.2 Generation Assets

4.2.1 Wind Turbine Generator

Outline details of the WTG can be seen below in Table 4-1.

Table 4-1: WTG Component Details

WTG Details	
Model	Vestas V236
Capacity	Approx. 15MW
Rotor Diameter	236m
Hub Height	Approximately 149.74m above MSL
Nacelle & Hub Mass	632t
Nacelle & Hub Dimensions *[l x b x h]*	27.5m x 14.05m x 10.7m
Blade Mass *[each]*	63.53t
Blade Dimensions *[l x root diameter]*	115.4m x 5.1m
Tower Mass	870.5t
Tower Top Diameter	5616mm (OD)
Tower Bottom Diameter	8000mm (OD)
Tower Length	128.25m
Tower MP Connection Type	Bolted

4.2.2 WTG Foundations

Each WTG will be installed on top of a monopile (MP) foundation, outline details of which are provided in Table 4-2. A clustering approach was taken for the monopile design, consequently there is a range of sizes.

Table 4-2: Foundation Details

Foundation Details	
Foundation Type	Monopile with Transition Piece
Transition Piece Length	23m
Transition Piece Diameter (skirt)	8m (8.38m)

Foundation Details	
Transition Piece Weight	360-410t
Monopile length	78.4 – 87.3m
Monopile Diameter *(top x bottom)*	8m x 9.7-10.3m
Monopile Mass	1446-2074t
Monopile Penetration	33.8 - 40.4 m

The final locations of installed WTG foundations will be provided in a subsequent version of the Decommissioning Programme.

4.2.3 WTG Scour Protection

Scour protection is proposed for the WTG foundations. The current design indicates approximately 72,097 m^3 of scour protection per monopile foundation. This scour protection is anticipated to involve a double layer comprising of filter and armour layers. The first layer (filter layer) will be installed prior to foundation installation and the second layer (armour layer) will be installed after foundation installation. This means that the filter layer of the scour protection will be present within the monopile foundation.

4.2.4 Inter Array Cables

There will be approximately 226km of array cables to link the WTGs and provide a connection to the offshore substation.

The cables between adjacent wind turbines will be relatively short with an average length of 2.4km. However, some of the cables between the offshore substation(s) and the 16 wind turbine strings will be longer, and could be up to 15km in length.

The nominal operating voltage of the array cables will be less than 100kV (Root Mean Square, phase-to-phase). The nominal voltage is likely to be 66kV. Two or three different conductor sizes will be used in the array network. The size of each individual cable will be chosen according to the electrical load that the cable is required to carry. The array cables would be approximately 100-150mm in diameter, with three conductor packages enclosed in a protective sheath. The conductors are expected to be aluminium, and would be encased in solid polymeric insulation with metallic screens. The insulation would be XLPE (cross linked polyethylene) or Ethylene Propylene Rubber (EPR). All cables will contain optical fibres embedded between the cores for communication purposes.

4.2.5 Inter Array Cable Protection

There may be some locations where cable protection may be required for the array cables due to ground conditions or presence of third party infrastructure. Options could include rock placement, concrete mattresses, grout or sand bags, frond mattresses or uraduct (or similar).

4.3 Transmission Assets

4.3.1 Offshore Substation

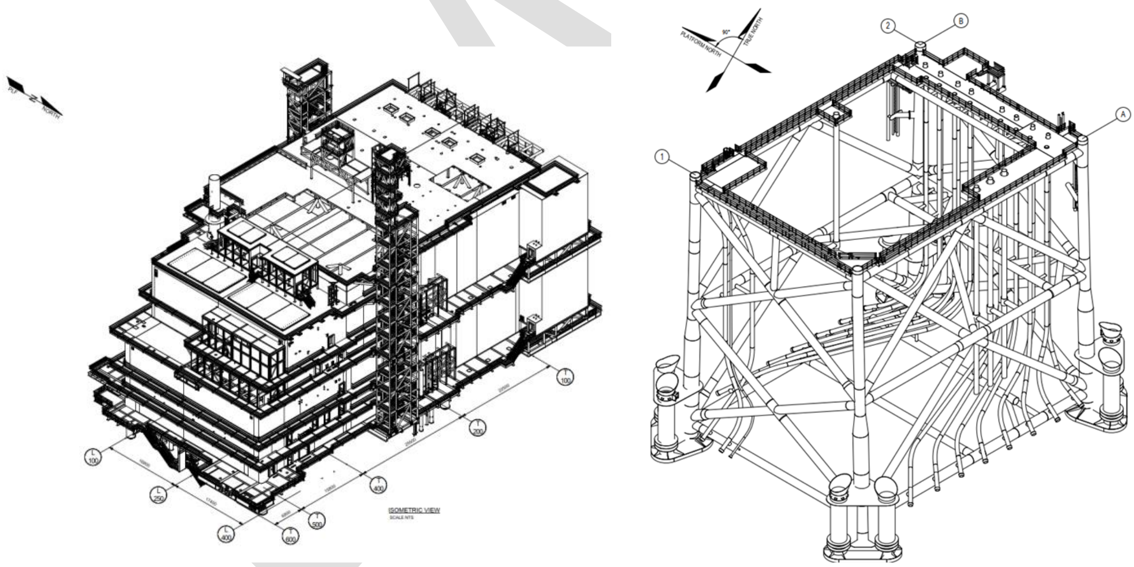
The electricity generated by the WTGs will be transformed at the High-Voltage Direct-Current (HVDC) OSS. The OSS will consist of a topside and jacket foundation with details outlined in

Table 4-3. Images of the structures are provided in Figure 4-1

Table 4-3: Offshore Substation Details

Offshore Substation Details	
Foundation Type	Jacket
Jacket weight (NTE)	3026t (3500t)
Jacket dimensions top	33.8m x 46.9m
Jacket dimensions bottom	49m x 60.9m
Jacket height	47.25m
Jacket Piles	4 No. 84" Dia x 66.2m 4 No. 84" Dia x 67.1m
Pile weight	2290t
Pile Penetration	53.5m
Topsides dimensions *(l x w x h)*	70x34.2x41 m
Topside weight (Target)	12,750t

Figure 4-1: Offshore Substation Structures



4.3.2 Scour Protection OSS

It is expected that circa 13,300m³ of rock will be required at the offshore substation to protect against scour.

4.3.3 Export Cable

With a cable mass of 2 x 51 t/km (plus Fibre Optic Cable (FOC)) the 82 km long double string export cable will transport the transformed electrical energy from the OSS to the onshore landfall. For one string of the cable bundle the conductor mass is ~38 t/km. Approximately 40 km of the export cable will run through the SAC and MPA.

4.3.4 Export Cable Protection

The export cable will require at least three crossings along its route which will require cable protection, There may be additional areas where protection may be required for the export cable due to ground conditions or presence of third party infrastructure. Options for all aspects could include rock placement, concrete mattresses, grout or sand bags, frond mattresses or uraduct (or similar).

5 Decommissioning Approach Guiding Principles

5.1 Introduction

This section sets out the guiding principles for decommissioning including overarching principles, together with those within the Agreements for Lease and legislative requirements for waste.

5.2 Overarching Principles for Decommissioning

NVW is committed to upholding the highest standards as far as is reasonably practicable for Health, Safety, Security and Environment (HSSE). During the development of the decommissioning approach, NVW has sought to adhere to the following key principles:

- **No harm to people.** NVW are committed to adhering to the highest standards for health and safety throughout the whole lifecycle of their offshore wind assets. NVW seeks to promote safe best practice in order to minimise risk during the development and implementation of decommissioning solutions.
- **Minimise environmental impact.** NVW will utilise the Best Practicable Environmental Option [BPEO] concept when developing the precise decommissioning methodology. The selected methodology will be that which has the minimum impact on the environment at an acceptable cost.
- **Consideration of the rights and needs of legitimate users of the sea.** NVW will respect the rights and needs of other users of the seabed. NVW will seek to ensure that decommissioning activities will minimise impact on external stakeholders and an emphasis will be placed on transparent and clear communication between all parties.
- **Promotion of sustainability.** NVW will seek to ensure that, as far as is reasonably practicable, future generations do not suffer from a diminished environment or from a compromised ability to make use of marine resources as a result of decommissioning activities.
- **Adherence to the Polluter Pays Principle.** NVW's decommissioning and waste management provisions acknowledge our responsibility to incur the costs associated with our impact on the environment.
- **Maximise the re-use, recycling and/or repurposing of materials.** NVW is committed to maximising the reuse, repurposing and/or recycling of waste materials and pays full regard to the 'waste hierarchy'.
- **Commercial viability.** In order that commercial viability is maintained for NVW's offshore wind portfolio; Best Available Technique not Entailing Excessive Cost [BATNEEC] decommissioning solutions will be sought.
- **Practical integrity.** Solutions that are necessary to achieve one or more of the above objectives must be practicable.

5.3 The Crown Estate Lease and Legislative Requirements

Clause 3.17 of the Agreement for Lease for the transmission assets and Clause 3.16 of the Agreement for Lease for the generation assets require that the wind farm is decommissioned in accordance with the Decommissioning Programme which, as defined in the Definitions is the Decommissioning Programme required under the Energy Act 2004. Under the Energy Act 2004, the international conventions of UNCLOS and OSPAR are considered.

The BEIS Guidance [2019] states that the standards for the removal of offshore installations should not fall below those set by the International Maritime Organisation [IMO] in 1989 [or successor standards] [IMO, 1989][4].

Exceptions from full removal of all infrastructure will be considered in line with these standards, on provision of compelling evidence that removal would:

- create unacceptable risks to personnel or the marine environment;
- be technically unfeasible; or
- involve extreme costs.

Exceptions will be considered on a case by case basis prior to decommissioning, taking on board environmental conditions, the balance of risk, cost and technological capabilities at that time. The use of a 'comparative assessment framework', such as that set out in the decommissioning guidance for the oil and gas sector has been proposed as a means of determining and settling out the position on infrastructure removal within the BEIS Guidance [2019].

Consultation will be undertaken with relevant regulators, The Crown Estate and external stakeholders on the acceptability of the final proposals.

It is anticipated that an application for a marine licence will be submitted to authorise the decommissioning of NVW. The requirements for environmental assessments supporting the marine licence application will be reviewed when the final decommissioning schedule is known.

As the offshore elements of NVW are located within marine protected areas, the requirements of the Conservation of Habitats and Species Regulations (as amended)) will be addressed as part of the approval process for the final preferred decommissioning approach.

Other permissions may be required for specific activities, e.g. European Protected Species licences may be required for potential effects on European Protected Species. Additional marine licences may be required, supported by relevant studies for certain decommissioning activities (e.g. a disposal marine licence supported by a site characterisation for any marine dredging and disposal; Unexploded Ordnance site investigations and clearance).

[4] IMO [19 October 1989] Guidelines And Standards For The Removal Of Offshore Installations And Structures On The Continental Shelf And In The Exclusive Economic Zone

5.4 Waste Management

NVW is committed to maximising the re-use of waste materials and will utilise the 'waste hierarchy' (Figure 5-1) which suggests that reuse should be considered first, followed by recycling, incineration with energy recovery and, lastly, disposal. In any event, waste management will be carried out in accordance with all relevant legislation and with any necessary disposal taking place at appropriately licensed facilities.

The proposed approach to disposal of the main components of the project is set out in Table 5-1 but is subject to evolution of technology, change in regulations and demand for materials over the lifetime of the project.

Figure 5-1: Waste hierarchy

Table 5-1: Proposed Development waste types and their place in the waste hierarchy

Material	Pre-treatment	Reuse / Recycle / Disposal
Wind turbine support structures [monopile foundation]	Establish available design life at end of project life, and/or break down into transportable size.	As part of the end of life assessment process options related to reuse of the MP foundation for further power generation will be investigated. Should no further use be identified the recovered MP foundation steel will be recycled.
Steel from wind turbine tower and nacelle removed to shore	Establish available design life at end of project life, and/or break down into transportable size.	As part of the end of life assessment process options related to reuse of the WTG tower and nacelle will be investigated. Should no further use be identified the recovered turbine tower steel will be recycled.

Material	Pre-treatment	Reuse / Recycle / Disposal
Copper or aluminium from power cables and electrical systems	Strip cable from power cables and electrical systems	Recycle
Composite materials from wind turbine blades and other WTG components	Break down into transportable size	Follow waste hierarchy and seek to recycle where possible (acknowledging challenges in the recycling industry), recover energy where not and if other opportunities are not possible then dispose.
Used lubricants from wind turbines	Filter	Recycle
Non-recyclable materials and fluids	None	Dispose of in line with all local regulations and legislation.

6 Proposed Decommissioning Methodology

6.1 Introduction

This section outlines proposed decommissioning methodologies for the generation and transmission assets. It should be noted that once operational, the offshore transmission assets will be transferred to the Offshore Transmission Owner (OFTO) along with the responsibility for decommissioning. This will be reflected in updated decommissioning programmes submitted following the transfer.

6.2 Selection of Decommissioning Strategy

The BEIS Guidance (2019) notes that the following points should be taken into account when developing the final decommissioning approach:

- *"arguments should be tailored to the individual site and should set out whether the risks of buried cables etc are equal across all parts of the site (for example, are some areas of the site more prone to sediment shift?);*
- *arguments should be relative to the effect of conducting the activity during construction;*
- *the IMO exception for 'extreme cost' is not normally expected to be accepted where it is the sole reason being cited for partial decommissioning;*
- *where safety concerns are being cited, this is likely to be given greater weight if written evidence from a third party (such as the Health and Safety Executive or a known decommissioning contractor) can be provided;*
- *the developer/owner is encouraged to consider using the 'Comparative Assessment Framework' set out in decommissioning guidance for the Oil and Gas sector when determining and setting out their position*[5]*.'*

All work will follow the recommendations and requirements of the Construction (Design and Management) (CDM) Regulations 2015 (or applicable regulations at the time the work starts).

The decommissioning strategy assumes that the wind farm is dismantled in the reverse sequence of installation.

It should be noted that close coordination and collaboration between the OFTO owner and the generation asset owner will be required in order to ensure an optimised end of life process.

6.3 Pre-Decommissioning Works and Predicted Degradation, Movement and Stability of Remains

Surveys will be designed to provide an assessment of the condition of the infrastructure, the state of the environment and any safety considerations to inform decisions on the best practicable environmental option [BPEO].

[5] Reference:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760560/Decom_Guidance_Notes_November_2018.pdf

The use of a 'comparative assessment framework', such as that set out in the decommissioning guidance for the oil and gas sector has been proposed as a means of determining and setting out the position on infrastructure removal within the BEIS Guidance [2019].

It is proposed that surveys proportionate to the scale of the decommissioning operations and the potential risks to the environment are completed in order to inform the development of a 'comparative assessment framework'.

The suggested surveys and inspections are, but are not limited to:

- Bathymetric surveys
- Asset integrity surveys
- Environmental surveys – scope to be confirmed [e.g. benthic ecology]

These surveys, inspections and assessments will include a review of any assets remaining in situ upon completion of the decommissioning activities. The selected methodology will then be submitted as the final version of the Decommissioning Programme.

The final Decommissioning Programme will be prepared in advance of offshore decommissioning commencing in accordance with relevant legislation and take into account best practice, technological capabilities and costs at that time.

As-built documents and ongoing operational assessments will be reviewed and compared to the findings of the surveys. Any deviation/modification from the as-built documentation that was made during the operational life of the site will be highlighted and notified to the contractors by the operations team of the site to ensure proper knowledge transfer and thereby fulfilling the Construction [Design and Management] Regulations 2015 requirements.

Assessments will evaluate the structural integrity of the lifting points and other critical load bearing areas of the different components that are to be decommissioned. Inspection and certification of the site equipment like ladders, work at height equipment, nacelle crane, lifting gears will be carried out to ensure they are safe to use while completing the decommissioning works offshore.

Tools for general lifting and handling of the different WTG components will be selected as per the Original Equipment Manufacturers [OEM] recommendations and through close engagement with the selected offshore works contractors.

Assessments will be carried out to optimise the vessel and equipment spread that will be used for decommissioning.

6.4 Future Technology Adoption

Continuous evaluation and tracking of technology, equipment and decommissioning methodologies that are assessed to have a potential positive impact on the decommissioning activities is ongoing, and this will continue for the life of the windfarm.

This continuous evaluation will ensure that the final decommissioning methodology proposed utilises the most suitable technology or methodology to ensure minimum impact as a result of the offshore decommissioning campaign.

Further details of vessels, equipment and tooling can be found in Section 7.

6.5 WTG Decommissioning

Decommissioning of the WTGs will be the first activity completed in the decommissioning campaign. Close alignment with the OFTO operator will be required in order to ensure compliance with the HV Safety Rules during the necessary de-energisation and isolation process.

It is expected, due to the scale of the NVW site, that the decommissioning will be carried out in a phased manner enabling / allowing for the continued generation of power whilst decommissioning activities are completed. This will require close collaboration with the OFTO owner and an alignment of generator and OFTO decommissioning programmes. This shall be managed during the development of the final decommissioning programme.

The decommissioning of the WTGs will be in accordance with the following procedure:

Item	Description
1	Mobilisation of a suitable decommissioning vessel and onshore port facility. It is expected that a JUV will be utilised for the decommissioning of the WTG components due to the sensitivity of the lifts being conducted.
2	Transit of the vessel to the wind farm site.
3	Ensure electrical and mechanical isolation of the WTG.
4	Position the vessel at [next] WTG location.
5	Conduct the safe removal of any hazardous fluids [if identified as necessary during the detailed engineering phase] from the WTG. Process for safe and legal transport to shore and subsequent disposal.
6	Unbolt and remove 3no. blades from WTG in individual lifts returning to vessel for seafastening for transport to shore.
7	Cut the cable connections where required to enable lift off of the components.
8	Unbolt and remove nacelle and hub assembly in single lift returning to vessel to be seafastened for return to shore.
9	Unbolt and remove tower. The number of lifts taken to complete this activity will be dependent on the final vessel selection, seafastening design and onshore disposal facility capabilities.
10	Install temporary aids to navigation and any required temporary guides or equipment that may be required to facilitate the foundation removal.
11	Repeat steps 4 through 9 until vessel capacity is reached.
12	Transit vessel from wind farm site to selected port for offloading and processing of WTG components.
13	WTG components to be processed onshore.

Item	Description
13	Vessel returns to site for next cycle. Vessel continues to cycle between port and wind farm site until all WTGs have been decommissioned.

It should be noted that the sequence of decommissioning activities may vary depending on the capabilities and characteristics of the chosen decommissioning vessel. Further assessments will be conducted as part of the final decommissioning programme. Further it should be noted that many offshore optimisations may have a direct impact on the onshore requirements and as such a holistic assessment of the operations will need to be completed to ensure that an optimised solution is identified and implemented during the offshore execution.

Potential optimisations for the decommissioning of the WTGs include, but are not limited to:

- Removal of the 3 blades and the hub in a rotor start configuration – reducing the number of offshore lifts.
- Removal of a single blade and then the removal of the nacelle and remaining 2 blades in a 'bunny-ears' configuration – reducing the number of offshore lifts.
- The use of a transportation barge to transport decommissioned components from the NVW site to the selected port facility – increasing 'up-time' of the vessel on site.

6.6 Wind Turbine Generator Foundation Decommissioning

The WTG monopile foundations will be removed after the decommissioning of the WTG and the inter array cables.

It is proposed that the monopile foundations will be decommissioned by cutting the monopile [usually 1-2 metres] below the seabed. Currently there is no commercially proven, technically feasible, proven safe methodology for full monopile removal. Potential future technologies or methodologies are discussed in Section 6.6.1.

The cutting operations associated with the decommissioning of the monopile foundation can be undertaken internally or externally. Factors influencing the decision include:

- The amount of internal steel work within the monopile,
- If the array cables have been installed inside or outside the monopile,
- The amount of dredging that will be needed inside or outside the monopile to provide access for the cutting tool.

Internal cutting has so far been typical. The soil plug and the extent of dredging that would be required inside each monopile to carry out internal cutting will be evaluated and suitable tools selected for the works.

In order to provide access for dredging and cutting operations first the internal platform of the monopiles will be removed. This can be achieved either through removal of the transition piece fully or by removing the internal platforms of the transition piece whilst leaving the primary steel in place. This will be dependent on the final design of the structure.

Once internal dredging has been completed to a suitable depth, technologies such as ultra high pressure abrasive water jet cutting, gas cutting or diamond wire solutions can be utilised to cut the monopile to the required depth below the sea bed/mudline.

Further details regarding potential equipment and tooling for monopile removal is included in Section 7.

It is assumed that the following process will be followed for the decommissioning of all foundations.

Item	Description
1	Mobilisation of a suitable decommissioning vessel and onshore port facility. It is expected that a floating heavy lift vessel may be utilised for the decommissioning of the foundations.
2	Transit of the vessel to the wind farm site.
3	Position the vessel at [next] foundation location.
4	Remove any temporary aids to navigation.
5	Install additional connection between the monopile and the transition piece. In order to prevent dropped objects and to ensure the integrity of the foundation structure during lifting operations it is expected that installation of a fixed connection between the MP and TP will be required. The design and installation of this step will be dependent on the selected contractor's vessel capability, preferred equipment and decommissioning methodology, and will be fully detailed during the detailed design phase ahead of offshore execution.
6	Prepare the TP for cutting and lifting operations.
7	Cut the MP foundation below the TP level and lift the TP to the vessel for transport to shore for processing. The methodology and exact location of the cut will be dependent on the selected contractor's vessel, equipment, and preferred methodology, and will be detailed during the design phase ahead of offshore execution. Further details on potential cutting tool options are included in Section 7.
8	After removal of the TP the next step will be to dredge the internal annulus of the MP to facilitate an internal cut below seabed level. Further details on potential dredging tools are included in Section 7.
9	After confirmation of successful dredging of the internal annulus of the MP, an internal cut of the MP will be made. Note: Specific attention shall be paid to the lifting arrangement of the MP, structural integrity of the foundation during the cutting operations, required weather windows, and environmental conditions for the operation during the detailed design of the decommissioning methodology.
10	After the cut of the MP below seabed has been confirmed the MP will be lifted to the installation vessel and seafastened for transport back to the selected port.
11	Repeat steps 3 through 10 until vessel capacity is reached.

Item	Description
12	Transit vessel from wind farm site to selected port for offloading and processing of foundation sections.
13	Foundation sections to be processed onshore.
14	Vessel returns to site for next cycle. Vessel continues to cycle between port and wind farm site until all foundations and any other associated infrastructure (e.g. permanent or temporary Aids to Navigation) have been decommissioned.

It is proposed that the scour pit left behind after the decommissioning works will be left to infill naturally given the site conditions. Successful infilling of the pits will be confirmed with the post decommissioning bathymetry survey.

A post decommissioning monitoring program will be agreed with relevant parties to assess the site ensuring no risk to other maritime users.

6.6.1 Discussion on Full Monopile Removal

Vibratory extraction or vibro lifting is a potential technology that could be further developed in order to facilitate full monopile extraction. This technology uses vertical movement or oscillation of the vibro hammer that is connected to the pile head with a vibration frequency that is usually between 10-40Hz but dependent on the soil condition[6]. By continuous agitation of the soil around the pile the soil loses its particle structure and a state of liquefaction is reached creating low soil resistance. This enables the main crane to lift the weight of the complete monopile and the vibro hammer.

In 2016, the PVE 500M vibro lifting tool was used by the Dieseko Group for the decommissioning of the Nuon Lely offshore windfarm foundations in the Netherlands[7]. The wind farm was constructed in 1992 and was decommissioned after 24 years of operation. Four piles each 26m long with diameters ranging between 3.2 - 3.7m were decommissioned using this technology.

The CAPE VLT 320 Tandem was used by Cape Holland in 2021 to demonstrate vibro extraction by lifting a 4m diameter with a length of 56.6m monopile on Amalia offshore windfarm off the Dutch coast[8]. The monopile had been installed in 2018 and the extraction trial was performed as a part of Slip Joint Offshore Research [SJOR] project. During this project, the extracted pile was installed again and extracted whilst performing a series of tests to gather data on aspects such as soil response and controlling verticality during the extraction process within the required tolerances. Figure 6-1 illustrates the CAPE VLT 320 Tandem vibro lifting tool.

[6]Nils Hinzmann, Philipp Stein, Dr. Jörg Gattermann, Decommissioning of offshore monopiles, occurring problems and alternative solutions, Technische Universität Braunschweig, 2018.
[7]https://www.diesekogroup.com/project/decommissioning-lely-offshore-wind-farm/ accessed 30th October 2023
[8]https://capeholland.com/news/monopile-decommissioning-on-amalia-offshore-wind-farm/ accessed 30 October 2023

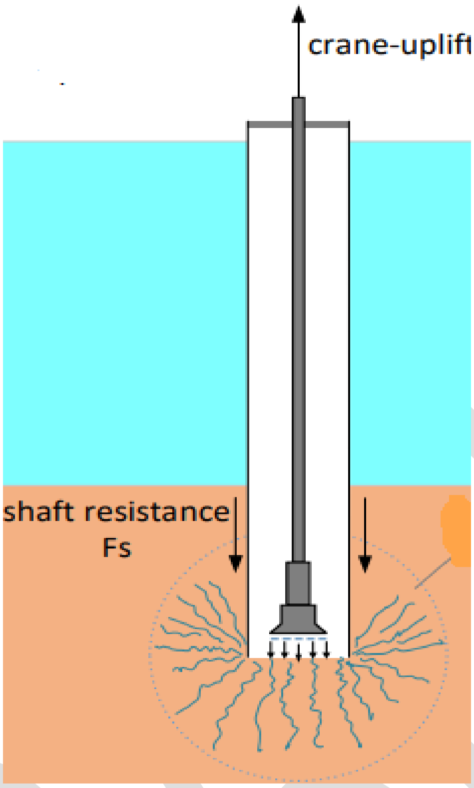
Figure 6-1: Vibro extraction carried out by CAPE HOLLAND[9]

There is further potential to use internal dredging solution to reduce the internal shaft resistance in combination with a vibro lifting tool. This could be examined if the vibro lifting tool alone is incapable of overcoming the soil friction of the monopiles.

Another option for full decommissioning is internal dredging of the monopile as shown in Figure 6-2. Internal dredging is undertaken to remove sea bed material from the soil plug to the toe of the monopile to reduce the internal shaft resistance/friction and to loosen the pile tow area. Once dredging has been completed, the crane is then able to lift-off the foundation as the resistance forces are reduced. However, this technology has not been successfully demonstrated on a commercial scale WTG foundation yet and would require more studies and evaluations before deployment.

[9] Reference: Offshore Wind monopile decommissioning - CAPE Holland

Figure 6-2: Internal dredging concept



Further developments are also being studied as part of joint industry projects including for example hydraulic pile extraction by capping each pile and pressuring the space between the soil and cap thereby extracting the pile in principle.

It must be recognised that none of these methods are yet to be commercially proven and in particular with the pile diameter deployed at NVW and are thus not currently considered viable alternatives, these will however be monitored for developments and incorporated into this plan if the suitability changes.

6.7 Inter Array Cable Decommissioning

To determine the approach to array cable decommissioning, the first step will be to undertake a survey of the inter array cable routes to confirm the location of the cables, the depth of burial and the location and type of any cable protection.

Further studies, including but not limited to; sediment morphology studies, environmental studies and cable burial risk assessment studies will be completed in order to provide guidance on the best practice methodology for the inter array cable removal.

These surveys and studies will inform the works associated with the 'comparative assessment framework' in order to determine either the preferred removal methodology, or the evidence to leave the inter array cables in situ.

Ahead of the offshore execution of the works detailed engineering will be completed in order to optimise the removal methodology. However, it is expected that the following high level process will be followed.

Item	Description
1	Mobilisation of a suitable decommissioning vessel and onshore port facility.
2	Transit of the vessel to the wind farm site.
3	Position the vessel at [next] WTG location.
4	Using remote [ROV] systems cut the inter array cable as close to the foundation structure as possible. ***Note:*** *location and form of 'disconnection' between the inter array cable and the foundation will be dependent on the methodology, vessel and equipment available at the time of decommissioning.*
5	Dependent on the confirmed burial depth of the inter array cables a number of methods may be employed to remove the cable. 1. Direct mechanical extraction using equipment on the decommissioning vessel to 'pull' the cables from the seabed. 2. De-burial of the cable by means of Mass Flow Excavator, plough, jet trencher, etc followed by recovery of the cable onto the decommissioning vessel.
6	Recover the inter array cable end onto the decommissioning vessel.
7	Either coil the inter array cable onto a carousel for transport to shore, or recovery of the cable onto the deck of the vessel and subsequently cut into specific lengths for transport to shore.
8	When the decommissioning vessel is at capacity return to port for offloading of inter array cable.
9	If required, vessel returns to site for next cycle. Vessel continues to cycle between port and wind farm site until all inter array cables have been decommissioned.
10	Inter array cable will be processed onshore for recycling and/or disposal.

The current assumption is that all inter array cables are required to be removed during the decommissioning. However, the exact requirement will be informed by means of a 'comparative assessment framework' and subsequent discussion with relevant stakeholders. A post decommissioning monitoring programme will be developed in consultation with relevant parties should any inter array cables be left in situ.

6.8 Foundation Scour and Inter Array Cable Protection Decommissioning

Extraction of the scour protection would typically be aggressive to the benthic environment and likely to cause damage. The current industry standard method to remove the scour protection would be via dredging vessel, for example a trailing suction hopper vessel which would recover materials onboard for repurposing or disposal elsewhere.

The scour protection is expected to have developed into a habitat for local species, this will be monitored but it is likely that it will be preferred to leave the scour protection in place for this reason. This would be subject to a comparative assessment, or as otherwise agreed depending on the development of renewables regulations. Developments in technology for scour protection removal will be monitored and will be considered as part of the ongoing comparative assessment and evaluated as such.

6.9 Offshore Substation Decommissioning (Transmission Asset)

It should be noted that close coordination and collaboration between the OFTO owner and the generation asset owner will be required in order to ensure an optimised end of life process.

Substation decommissioning will typically require large lifting assets due to the size of the installed structures. Experience from the oil and gas industry shows it is generally safest to recover large topsides structures to shore in one lift for safe dismantling and recycling. Typically this method requires a large SSCV to lift the structure onto a cargo barge for safe transportation to shore. The same vessel would then move to remove the supporting jacket. The piles would be pinned to the jacket prior to lifting to avoid the grouted connection taking load and then they would be internally cut below the seabed. The entire structure would then be recovered, taken ashore for recycling either directly or by being placed on a cargo barge.

In a similar manner to the monopile full foundation removal, discussed in Section 6.6, the removal of the pile remnants in the seabed would be comparatively assessed based on the prevailing technology at the time of decommissioning. Developments in methods and equipment will be continuously monitored through the life of the site.

6.10 Export Cable Decommissioning (Transmission Asset)

The current design indicates that approximately 40km of the export cable runs through the SAC and MPA. For this section of the export cable, it is proposed that only the cable protection will be removed (if installed). Given the presence of protected features that the site is designated for biogenic reef and sandbanks partially covered by seawater all of the time, in this area of the cable route, the most practical environmental option could be to leave the cables in situ where they have remained buried. This is considered to be the option of the least environmental impact as this will minimise disturbance to the seabed.

For protection at cable crossings within SACs it is expected the protection will be recovered where possible. The rock protection will be recovered through the use of dredgers and other protection measures will be recovered through lifting to the vessel deck during the cable de-burial activities. As stated in Section 2.3.3, this document and the approach and commitments made within it may be affected by commitments made in other DCO discharge documents. The approaches agreed in these documents will be aligned in further iterations of the Decommissioning Programme.

7 Proposed Decommissioning Vessels & Equipment

This section discusses specialist vessels and equipment that could be employed to undertake the decommissioning works.

7.1 Removal Vessels

7.1.1 Jack-up Vessel

Depending on the size of the turbine then a medium/large JUV could be used to undertake the WTG and potentially foundation decommissioning activities. For access to the site and to each location, specific navigation and access studies will need to be performed.

The choice of jack up vessel will be based on the following criteria:

- Crane lifting capacity of circa 900t tonnes suitable to lift the heaviest WTG component or circa 1800t for the heaviest foundation component.
- Crane minimum under hook height of circa 165m [hub height plus an allowance for rigging] making it capable of lifting the full tower in single lift and vertically sea fasten on the deck.
- Enough deck space to carry multiple WTGs, foundations and other required equipment like lifting tools, internal dredging and cutting equipment etc.

Jack up vessels are preferred over heavy lift vessels as they minimise the use of dynamic positioning system, they simplify lifts requiring high accuracy such as blade removal and because they would be capable of lifting and handling the type and size of WTGs installed. The Jan de Nul vessel Voltaire is an example of a typical jack-up vessel that could be used to remove the WTGs, there are other alternatives in the market.

Figure 7-1: Jan de Nul's Voltaire jack-up vessel[10]

[10] Reference: https://www.jandenul.com/sites/default/files/2022-10/Voltaire%20%28EN%29.pdf

The Voltaire is 169m long and 60m wide with a 3,200t capacity crane and a maximum hook height above the deck of 162.5m

7.1.2 Floating lift vessels

Floating lift vessels may also be used to remove the foundations and potentially the WTGs if deemed safe and viable to do so. Typically floating lift vessels have higher crane capacities and also more flexibility in positioning since they avoid the need to jack-up and down. Considering the capacities identified in Section 7.1.1 then the Jan de Nul vessel Les Alize would be suitable for a foundation removal vessel. The vessel is 237m long and 52m wide with a 5000t capacity crane, the vessel is shown in Figure 7-2. It should be noted there are other similar vessels available in the market.

Figure 7-2: Jan de Nul's Les Alize heavy lift vessel[11]

For the 12,500t substation topsides a larger capacity lift vessel will be required, typically the preferred removal method is a single lift to move the deconstruction onshore. With this in mind then a large semi-submersible crane vessel will typically be required. A vessel such as Heerema Marine Contractor's Sleipnir has the capacity to remove the substation topsides. The vessel is 220m long and 102m wide with dual cranes meaning it has a maximum lift capacity of 20,000t. This same vessel could also be used to remove the substation foundation. There are a very limited number of SSCVs available on the market and the ultimate selection will be very dependent on the final lift weight of the topsides.

[11] Reference: https://www.jandenul.com/sites/default/files/public/Les%20Aliz%C3%A9s%20%28EN%29.pdf

Figure 7-3: Heerema Marine Contractor's SSCV Sleipnir[12]

7.1.3 Cable removal vessel/ barge

The final decommissioning strategy for cables will influence the vessels selected. The strategy will be influenced in part, by any requirements for dredging and or cable de-burial activities.

For partial or full cable removal, the current assumption would be to utilise a suitable cable de-burial vessel to carry out the de-burial, cutting and winching of the cable to the main deck. The main criteria for selecting an appropriate vessel/barge would be sufficient deck space and characteristics to work safely offshore. The vessel would be expected to operate on DP when the water depths allow for the safe use of Dynamic Positioning [DP] operations and potentially anchors elsewhere. It should be noted that shallow water areas such as the export cable shore approach would likely necessitate and additional, shallow water vessel. Figure 7-4 shows a typical cable installation vessel that could be utilised and support vessel that could be employed.

Figure 7-4: Cable lay vessel and support boat

Optimisation of the selected vessels will be evaluated based on their specific characteristics and ability to perform the required operations.

[12] Reference: https://www.heerema.com/heerema-marine-contractors/fleet/sleipnir]

Supporting vessels, such as tow boats and anchor handlers, would depend on the selected cable de-burial vessel and the depth and width of the dredged navigational channel.

7.1.4 Support vessels

The decommissioning operations will need to be supported by the following vessels:

- **Crew transfer vessels [CTVs]** - to transfer personnel and equipment to the site to carry out the decommissioning works.
- **Cargo Barges** – Barges may be used to transport recovered structures back to shore. They will be delivered offshore with grillage and seafastening pre-installed to allow for safe operations offshore. Their size will be dependent on the operation and optimised to suit the planned activities.
- **Tow boats** – Towing and anchor handling vessels and multi-cat boats would be utilised especially if the selected decommissioning strategy uses barges that are not self-propelled. The number and the specification of these vessels will vary depending on the final decommissioning plan. Tow boats will also be required if it is found that floating and tugging the extracted monopile by plugging both of its ends is technically feasible.
- **Dive boat** - A dive boat may be required for surveying subsea cable positions and burial depths prior to decommissioning in areas of shallow water depth where ROV operations may be limited.
- **Guard vessel** – dependent on the decommissioning methodology it may be a requirement to have a guard vessel to patrol the boundary of the site and to police any applied Safety Zones[13] while decommissioning works are ongoing.

7.2 Specialist Equipment

All the following sections contain illustrations of the current technology for decommissioning, and consequently illustrate the principles for the systems rather than the specific equipment that would be deployed. The equipment shown would need to be scaled up for the size of the NVW structures.

7.2.1 Dredging tool for internal dredging of monopiles

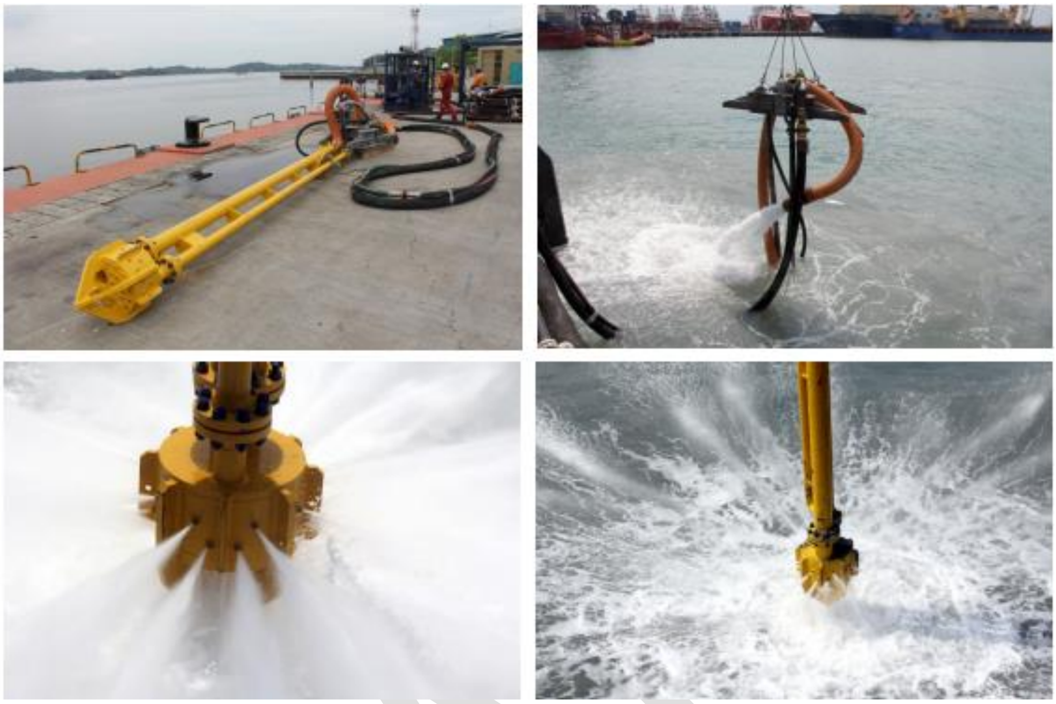
Internal dredging of the monopile may be necessary if it is decided to partially remove the monopile by internal cutting or to reduce the shaft friction and loosen the pile toe when doing full removal using vibro extraction.

An internal dredging tool like the airlift tool which is commonly utilised for the monopile decommissioning activities completed to date This tool uses high pressure water to break the hard sediments inside the pile, and compressed air is pumped subsea within the tool creating a venturi which allows the sediment to flow up through the airlift tool to pump the sediments out of the pile.

The tool is deployed using the vessel main or auxiliary crane and Figure 7-5 shows an example of an airlift internal pile dredger.

[13] Electricity (Offshore Generating Stations) (Safety Zones) (Applications Procedures and Control of Access) Regulations 2007 (SI No 2007/1948) introduced in August 2007

Figure 7-5: Airlift pile dredger[14]



7.2.2 *Crane grabs for dredging the outside of monopile*

Grab cranes may be required to carry out external dredging around the monopile if external cutting is chosen for foundation decommissioning. These are typically hydraulically operated and can be deployed by either a main vessel or support vessel depending on the overall programme requirements. They are available in a variety of sizes, an example is shown in Figure 7-6.

Figure 7-6: CY hydraulic clamp bucket[15]

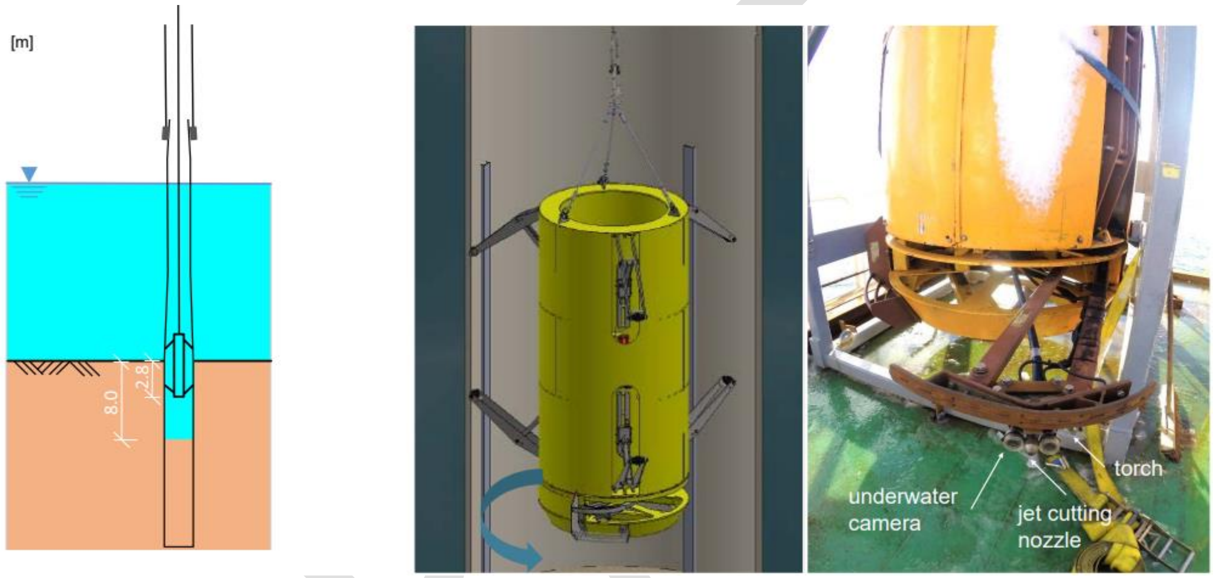
[14] reference: https://www.oceaneering.com/datasheets/ST&R-Air-Lift-Pile-Dredges.pdf
[15] reference: Long Reach High Reach Construction Equipment Attachments - LRHR, LLC

7.2.3 Internal water-jet cutting spread

An internal ultra high pressure abrasive water jet cutting tool may be used if it is decided to partially remove the pile. This technology uses water sprayed at very high pressure through multiple nozzles to form a fine cutting jet. The water jet is mixed with abrasive material like garnet or flint, enabling the jet to cut through concrete and steel plates.

The cutting tool is lifted using the crane and inserted inside the monopile once internal dredging is carried out to the required depth and the dredging tool is recovered. Figure 7-7 shows the general arrangement and picture of an internal water cutting tool.

Figure 7-7: Internal water jet cutting[16]



7.2.4 Internal gas cutting spread

Automatic under water pipe cutting ROVs can be utilised for internal gas cutting of the monopile if it is later deemed as the suitable tool for partial removal of monopiles. The gas cutting technology could also be potentially used as a back-up in case the internal water cutting fails to successfully cut the monopile.

The gas cutter is deployed inside the monopile using the crane once internal dredging is done to the required depth and the internal dredger spread is recovered to the main deck and the cutting tool is operated remotely.

The TMS internal pile cutter has a spread that includes gas/oxygen bottles, a control cabin, a lifting frame and an umbilical on a 40ft flat track. A picture of the TMS internal pile cutting tool is shown in Figure 7-8.

[16] Reference: [1] [PDF] Offshore monopile decommissioning on a scaled basis [researchgate.net]

Figure 7-8: TMS internal pile cutting tool[17]

7.2.5 External water jet cutting tool

External water cutting tool works on the same principle as internal water cutting as explained in the above section 7.2.2, with the only difference being the cutting is done externally which will require full circumferential access of the monopile.

External dredging has to be done around the monopile to the required depth for the enabling full circumferential access to the cutting tool, and the cutting tool is deployed on completion of the dredging. Figure 7-9 shows an example of abrasive external water cutting tool.

Figure 7-9: External water jet cutting tool[18]

7.2.6 External diamond wire cutting tool

The diamond wire cutting is another technology that can be employed for external cutting of the monopiles or inter array cables.

In this method a diamond wire is physically passed through the monopile or cable with the cut being completed by means of friction.

[17] Reference: Cutting ROV's – TMS
[18] Reference: Abrasive water jet cutting [fisheroffshore.com]

Diamond wire cutting is usually deployed with support from a working class ROV which is also able to verify the cutting line to ensure a complete cut.

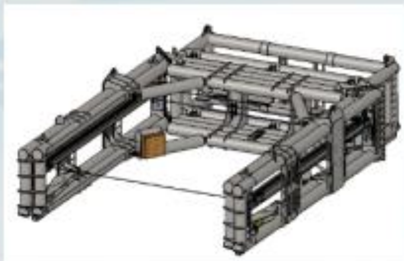
It should be noted that if diamond wire cutting is utilised for the below seabed MP cut that external dredging will need to be completed to ensure full circumferential access of the monopile for the cutting tool.

An example of a subsea diamond wire cutter for array cable cutting deployed from an ROV is shown in Figure 7-10 with a diamond wire cutting tool suitable for MP cutting shown in Figure 7-15.

Figure 7-10: Diamond wire cutting tool deployed from an ROV[19]

Figure 7-11: Dimond Wire Cutting Machine from CUT[20]

240" DWCM		
Performance	240" OD tubular cutting capacity	
Power Requirement	Hydraulic Power 200 l/min @ 300 bar	
Weight (kg)	Air	Water
	42,978	11531
Dimensions (mm) – any clamp position		
Length	13,277	
Width	8,758	
Height	2,696	



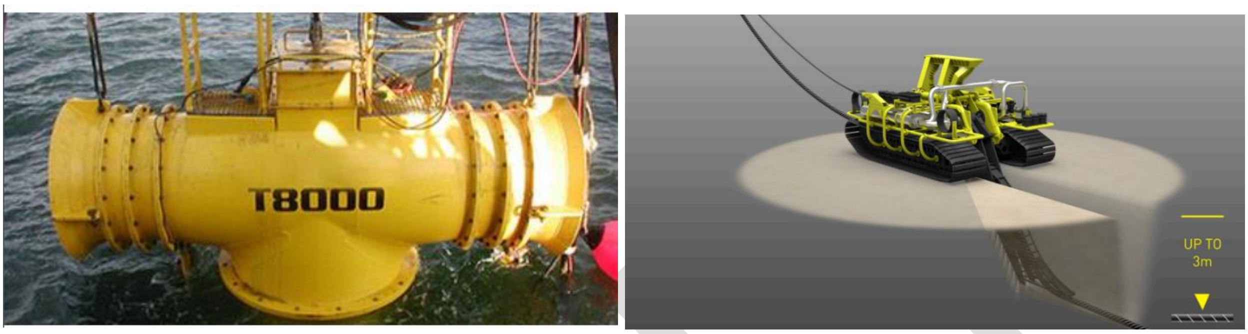
[19] reference: Subsea Cutting - Cutting Underwater Technologies Ltd [cut-group.com]
[20] Reference: https://www.cut-group.com/datasheets/240inchDataSheet.pdf

7.2.7 Cable de-burial tool

Cable de-burial tools may be assessed as being required to support the partial or full decommissioning of the inter array cables.

Commonly used cable de-burial tools include Mass Flow Excavators [MFE] and ploughs combined with jetting or trenching tooling. Examples of currently available de-burial tools are shown in below.

Figure 7-12: Controlled flow excavator [Left], Boskalis trenchformer [right][21]



7.3 Ports

The main criteria for selecting ports to support decommissioning of windfarms are:

- Port specifications suitable to berth and support installation vessels / barges
- Proximity to the windfarm
- Ground bearing capacity [t/m^2] of quayside and laydown area [for mobile cranes, self propelled modular transporters, storage of WTG and foundation components]
- Storage area [for storing components until transportation to recycling facility/ scrap yard]
- Ability to support logistics of offloading and movement of large components.
- Availability of recycling sites nearby.

Potential candidates for decommissioning ports are listed below in Table 7-1.

Table 7-1: Decommissioning port options

Port	Distance to site [Nm]	Advantages	Disadvantages
Great Yarmouth	34	Large outer harbour for construction management and support Existing supply chains for offshore operation support	Insufficient space for setdown of assets Outer port not large enough to accept main decommissioning vessels.

[21] reference: James Fisher Subsea Excavation | T8000 excavation tool [jfsubseaexcavation.com], trenchformer.pdf [boskalis.com]

Port	Distance to site [Nm]	Advantages	Disadvantages
Able Seaton	173	Existing decommissioning infrastructure in place	Long distance from site Competition from oil and gas
Hull/Grimsby	106	Large number of site options for setdown of recovered materials.	Lack of pre-existing major disposal supply chain

8 Decommissioning Offshore Schedule

It is desirable to complete offshore decommissioning activities during the summer weather window where there is less probability of weather downtime. However, due to the size and scale of the wind farm this may not be not possible, with year round working likely required in order to complete the project in a reasonable timeframe.

8.1 Generation Assets

The pre decommissioning works will be completed ahead of the commencement of the main works to provide sufficient information to the main decommissioning contractors on the condition of the site.

Where possible the summer months will be utilised to conduct the work with reduced weather downtime; with the WTG decommissioning taking place in year 1 with cables and foundations following on in year 2.

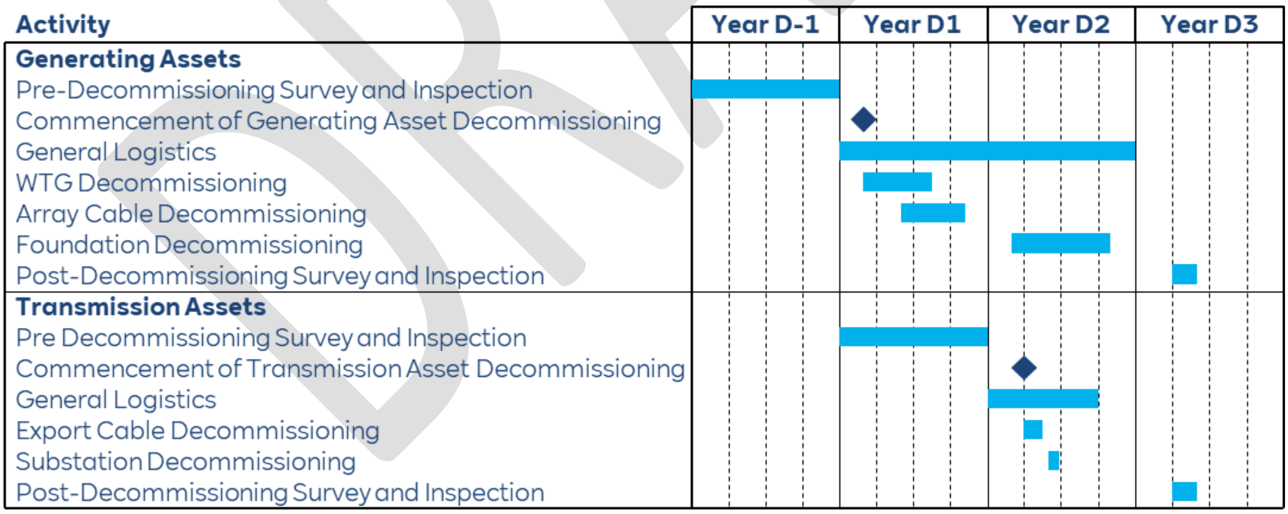
8.2 Transmission Assets

It is expected that the OFTO decommissioning will be completed during year 2 after the generation assets. However, alignment with the OFTO will be required in order to ensure an optimised schedule is developed in detail.

8.3 Decommissioning Programme

An illustrative decommissioning programme is provided in Figure 8-1. It is currently expected that the decommissioning operations would span two years.

Figure 8-1: Decommissioning programme overview



9 Decommissioning Costs

Decommissioning costs will be developed and submitted in accordance with the DCO requirements as a separate annex to this Decommissioning Programme.

10 Project Management and Verification

This version of the Decommissioning Programme will be submitted to DESNZ for approval prior to the commencement of offshore construction as required under the DCO.

Following approval, it will be used as the basis for updated versions of the Decommissioning Programme that will be submitted to DESNZ through the life of the site. It is noted that for transmission assets, the format may be amended following transfer of assets to the OFTO and agreement with DESNZ on the approach for final decommissioning will be the responsibility of the OFTO. Consultation on the proposals set out within a draft document will be undertaken with DESNZ and any other relevant authorities prior to submission of the final version. The proposals within the final Decommissioning Programme will be used as the basis for the Marine Licence application that will be submitted to the Marine Management Organisation to consent the removal activities under the Marine and Coastal Access Act 2009.

Post completion of decommissioning, the Decommissioning Report will be submitted to DESNZ. The Decommissioning Report will provide a description of how the decommissioning was undertaken and full details of any assets left in situ.

11 Seabed Clearance and Restoration of the Site

The Crown Estate Agreements for Lease for the transmission (Clause 3.17) and generation (Clause 3.16) assets require that the generation and transmission assets are removed in accordance with the approved Decommissioning Programme and relevant Legal Obligations and that the site is restored to a good and safe order and condition in accordance with the Project Company's covenants in this Lease.

The Energy Act 2004 requires that NVW is removed in accordance with the final Decommissioning Programme approved by the Secretary of State and that if the relevant object will be wholly or partly removed, the final Decommissioning Programme 'must include provision about restoring that place to the condition that it was in prior to the construction of the object'.

Site clearance and restoration of the project will be undertaken according to the requirements set out within the final approved Decommissioning Programme agreed prior to the commencement of offshore decommissioning. The approach will be determined based on the final strategies proposed and approved for decommissioning. Active restoration relying on intervention with equipment is not currently envisaged as it is considered that such works present unnecessary and unacceptable risk to personnel and increased environmental impact. Rather, it is considered that allowing the seabed to 'self-settle' is sufficient and in proportion to the anticipated limited environmental impact of the proposed decommissioning.

12 Post Decommissioning Monitoring

The Crown Estate Agreements for Lease, the Energy Act 2004 and the BEIS Guidance (2019] requires ongoing monitoring maintenance and management of the site for as long as the approved Decommissioning Programme or legal obligations apply. Post-decommissioning monitoring surveys of the site will be carried out as required under the approved Decommissioning Programme, the marine licence for decommissioning and also the Maritime and Coastguard Agency (2021] 'MGN 654'[22] [or successive document].

Immediately after the decommissioning activities, appropriate surveys will be undertaken to confirm that decommissioning activities have been completed in accordance with the approved Decommissioning Programme. Further surveys will then be undertaken at appropriate intervals after the decommissioning works are complete. The timetable and scope of which will be agreed and presented in the final version of the Decommissioning Programme and marine licence application supporting information.

Where partial decommissioning is carried out due to technical unfeasibility or other approved reasons (e.g. environmental, risk to navigation etc.), a site monitoring plan will be agreed upon between The Crown Estate and Norfolk Vanguard West Offshore Wind Farm Ltd. to monitor the sea bed for potential exposure of the buried components. Remedial plans and actions may also be agreed upon between Norfolk Vanguard West Offshore Wind Farm Ltd. and The Crown Estate (in consultation with further relevant parties) to respond to any exposure of buried components to ensure navigational safety and to minimise risk to marine users. These remedial plans and actions would include processes for the notification of the identification of any hazards to navigation to the United Kingdom Hydrographic Office and other relevant parties.

All post decommissioning survey reports will be provided to the relevant authorities as required.

[22] Maritime and Coastguard Agency (2021) MGN 654 Safety of navigation: OREIs - Guidance on UK navigational practice, safety and emergency response