Morven North Offshore Wind Array Project

Environmental Impact Assessment Report

Volume 1, Chapter 3: Project Description

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TTRPSEL	**Morven Offshore Wind Limited**

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3 Project Description

3.1 Introduction

3.1.1 Overview

3.1.1.1 This chapter of the Morven North Offshore Wind Array Project (hereafter “Morven North”) Environmental Impact Assessment (EIA) Report provides a description of the infrastructure, and encompasses activities related to the construction, operations and maintenance (O&M), and decommissioning of Morven North. This chapter is informed by design work undertaken to date and the current understanding of the environment associated with Morven North, derived from a desk-based review of available information and site specific surveys conducted by JERA Nex bp Limited (JNBP), together with German partner EnBW Energie Baden-Württemberg AG (EnBW) (hereafter referred to as “the Applicant”).

3.1.1.2 As detailed in Volume 1, Chapter 4: Site Selection and Consideration of Alternatives, the Applicant is seeking consent for offshore generation and transmission assets as part of four separate consent applications, which together comprise the Morven Programme (Morven North being one of the four consent applications of the Morven Programme). This EIA Report has been prepared for Morven North only as part of the consent application for Morven North.

3.1.1.3 The design and engineering options considered were informed by the specific conditions and environmental factors within the Morven North Boundary. The Applicant conducted various desk-based studies and site surveys in the early development stage to inform project design and refine project design parameters. Further studies are expected to be completed beyond the planning phase and into procurement and contracting to inform the final design of Morven North, including layout, numbers, types, sizes and foundation designs for wind turbines and Offshore Substation Platforms (OSPs).

3.1.1.4 The Applicant followed the Project Design Envelope (PDE) approach, meaning that the maximum design parameters for Morven North included in this chapter present the maximum design scenario (MDS), (i.e. the maximum extents of the design in order to assess the likely significant effects of Morven North). For some technical topics the MDS might be a combination of parameters, not just the maximum parameter, as explained and assessed in each topic chapter of the EIA Report (Volume 2, Chapters 7 to 21). The PDE presented in this chapter defines the maximum range of design parameters. Within the EIA, the Applicant has determined the maximum adverse effects (or minimum beneficial effects) that could occur for given receptor groups, selecting these from within the range in the PDE to define the MDS for that receptor group. As a result, for each topic-specific assessment, the predicted effects for any alternative parameter within the range will be no greater than those assessed.

3.1.1.5 The final detailed design will be further developed as additional information becomes available from site investigations and as the commercial availability of technologies changes. It should be noted that the final detailed design for Morven North will be within the PDE parameters presented in this chapter and across the EIA Report. This is a standard approach for large scale energy projects such as Morven North.

3.1.2 Purpose of chapter

3.1.2.1 The purpose of this Project Description chapter is to:

- provide the PDE for Morven North, including site information, size, design and other pertinent features of Morven North, based on preliminary conceptual design principles (Section 3.1.4) and current environmental understanding;
- set out the individual components of Morven North, along with the primary activities related to its construction, operation, maintenance, and decommissioning phases;

- provide the basis for the assessment of effects presented in each topic chapter of the Morven North EIA Report (Volume 2, Chapters 7 to 21).

3.1.3 Project Design Envelope approach

3.1.3.1 The Applicant has followed the PDE approach (also known as the “Rochdale Envelope”). The PDE approach aligns with Scottish Government (2013) guidance, where it is acknowledged that by applying the principles of the approach it is possible to undertake an environmental assessment that accounts for the need for flexibility in the future evolution of the detailed project proposal within clearly defined parameters. The level of detail must be sufficient to enable a robust assessment of the likely significant environmental effects and any necessary mitigation measures, considering a range of possibilities. The approach also complies with guidance from Marine Scotland and the Energy Consents Unit (June 2022) for applicants using the PDE approach for applications under Section 36 of the Electricity Act 1989. This approach allows for flexibility in the final Morven North design to account for supply chain constraints, and selection of the most appropriate technology for the site and conditions, while ensuring all likely significant effects (LSE[1]) (beneficial or adverse) are assessed and reported within the Morven North EIA Report. The PDE presents a range of potential parameters for Morven North including the maximum and minimum extents of the design. Further information on the PDE approach is presented in Volume 1, Chapter 6: EIA Methodology, of the Morven North EIA Report.

3.1.3.2 Offshore wind is a continually evolving industry with a constant focus on safety, increased efficiency and cost reduction, therefore improvements in technology and construction methodologies occur frequently and an unnecessarily prescriptive approach could preclude the adoption of new technology and methods. Consequently, this chapter sets out a series of maximum design parameters. This project description does not refer directly to the generation capacity of the wind turbines but rather their physical dimensions. Subsequently, the assessments are not linked directly to the overall capacity of Morven North or individual wind turbine capacity, but rather the physical dimensions of the wind turbines such as blade tip height and rotor diameter. The final design of Morven North will be informed by future site investigation work and the availability of technologies, taking into account commercial availability. The final design of Morven North will be within the PDE parameters assessed in the Morven North EIA Report and as presented in this chapter. This is considered to be an accepted/standard approach for large-scale infrastructure projects like Morven North.

3.1.3.3 The PDE describes a range of parameters that apply to a project technology design scenario (e.g. the largest wind turbine option). For example, wind turbine size and number are correlated, so selecting larger wind turbines likely means fewer wind turbines are required[1]. Therefore, each design parameter in this chapter is not considered independently. The PDE has been used to develop the MDS for each impact pathway to determine the parameters (or combination of parameters) likely to result in the maximum adverse effect (or minimum beneficial effect) on a particular receptor, while adhering to the project technology design scenarios. However, the maximum design parameters set out in this chapter will not necessarily comprise the MDS for any given impact on a receptor or receptor group assessed in the technical assessments (Volume 2, Chapters 7 to 21, of the Morven North EIA Report).

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[1] For example, if the MDS for a specific receptor related to the largest wind turbine design scenario, a smaller number of wind turbines would be noted within the chapter MDS table compared to the number of wind turbines stated as the maximum design parameter within this Project Description chapter.

3.1.4 Overview of Morven North

Morven North Boundary

3.1.4.1 The Applicant entered an Option Lease Agreement for the Morven Option Lease Agreement Site (hereafter 'Morven Site') in early 2022, covering approximately 860km^2.

3.1.4.2 Subsequent to the identification of the Morven Site, the Applicant has since defined the area for development, separating the Morven Site into Morven North and Morven South. This EIA Report will present the Morven North Boundary shown in Figure 3.1 and further details of the selection process are presented in Volume 1, Chapter 4: Site Selection and Consideration of Alternatives.

3.1.4.3 Morven North will be located approximately 61km from the Aberdeenshire coast as described in Volume 1, Chapter 1: Introduction.

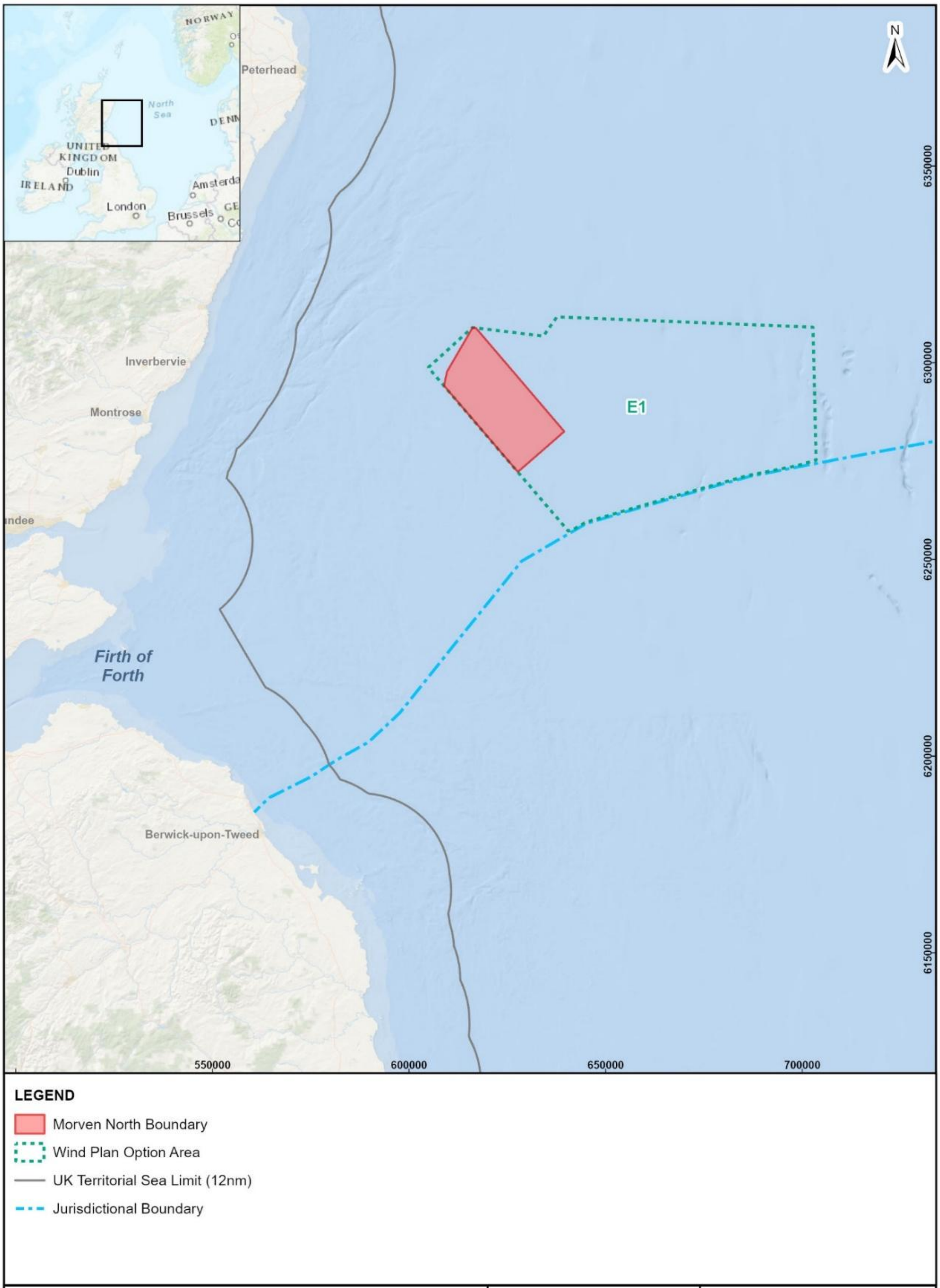
3.1.4.4 The Morven North Boundary is illustrated within Figure 3.1 and covers an area of 511.1km2. Morven North consists of the following infrastructure: wind turbines and foundations, OSPs and foundations, inter-array and interconnector cables and associated infrastructure, which are further detailed in Section 3.2 below.

Water depths and seabed composition within Morven North

3.1.4.5 A geophysical survey was conducted within the Morven Site from April 2022 to August 2022 to gather geophysical and bathymetric data. The maximum water depth recorded within the site boundary was at 75.28m at lowest astronomical tide (LAT), while the shallowest depth was 61.89m LAT.

3.1.4.6 A benthic survey was undertaken within the Morven Site from April 2022 to August 2022 to identify and characterise the benthic communities on the Morven Site. Seabed sediments within the Morven Site are predominantly composed of deep circalittoral sand and deep circalittoral coarse sediment, with an area of deep circalittoral mixed sediment in the western corner of the zone of influence (ZoI) (EUSeaMap, 2021). The benthic survey revealed that the seabed mainly consists of deep circalittoral sand, with a patchy distribution of deep circalittoral coarse sediment along the western edge of the Morven Site (Gardline, 2022), and therefore Morven North. The seabed is characterised by large generally flat areas with some shoals, and small channels (Gardline, 2022).

3.1.4.7 Additional details regarding the bathymetry and seabed composition can be found in Volume 3, Annex 7.1: Physical Processes Shared Technical Report and Volume 3, Annex 8.1: Benthic Subtidal Ecology Shared Technical Report.



0 2.5 5 10 15 20 25 30 nm

0 5 10 20 30 40 50 km

Geodetic Information:
Datum: European 1950
Projection: ED 1950 UTM Zone 30N

Morven North | TETRA TECH RPS ENERGY

Drawing Number: EOR0813A1-MVN-INT-E001-01

Data Sources: Client, Admiralty, Marine Scotland

Service Layer Credits: OceanWise, Esri, GEBCO, Garmin, NaturalVue, Esri, HERE, Garmin, FAO, NOAA

VER	DATE	DETAILS	BY	CHECK
00	17/04/25	First Issue	LM	TT
01	14/07/25	Revision	MJ	AP

Project Title: **The Morven North Offshore Wind Array Project**

Figure 3.1: Location of the Morven North Boundary in the context of Plan Option Area E1

3.2 Morven North infrastructure

3.2.1 Overview

3.2.1.1 The key components of Morven North are shown in Figure 3.2 and will include the following:

- up to 96 wind turbines (each comprising a tower section, nacelle, hub and three rotor blades) and associated support structures and foundations;
- up to five OSPs and associated support structures and foundations, including:
- up to four High Voltage Alternating Current (HVAC) collector substation platforms;
- up to one High Voltage Direct Current (HVDC) convertor substation (this could be a single platform or two platforms linked by a bridge);
- scour protection for wind turbine and OSP foundations;
- a network of inter-array cabling linking the individual wind turbines to each other and to the OSPs, plus interconnector cables connecting OSPs to each other (approximately 424km of inter-array cabling and 484km of interconnector cabling).

3.2.1.2 It should be noted that within the Morven Site Scoping Report submitted to the Marine Directorate – Licensing and Operations Team (MD-LOT) in July 2023, the maximum number of wind turbines proposed was 191 wind turbines. Following the decision to split the Morven Site, the maximum number of wind turbines remained the same across the Morven Site, with 96 wind turbines to be located within Morven North and 95 wind turbines to be located within Morven South. The minimum separation distance between wind turbines remains the same as outlined within the Morven Site Scoping Report (i.e. 1,000m between wind turbines within the Morven North Boundary). The final capacity of Morven North will be based on the available technology at the time of construction, within the bounds of the design envelope presented in this chapter.

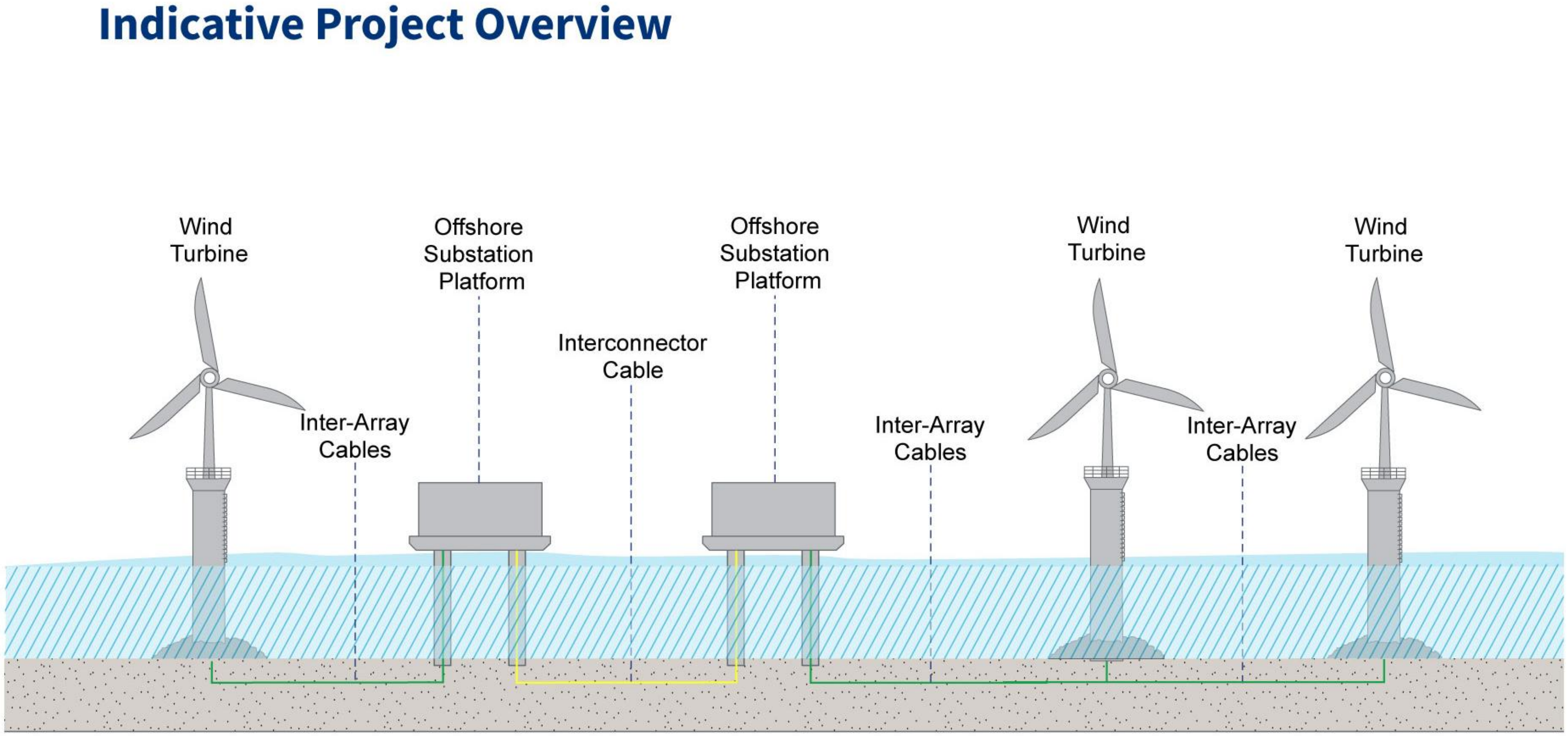


Figure 3.2: Indicative project overview of the Morven North Offshore Wind Array Project[2] (not to scale)

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[2] Note that this indicative figure does not show all possible foundation options for wind turbines and OSPs. Foundation options are further described, accompanied by indicative figures, in proceeding sections of this chapter.

3.2.2 Wind turbines

3.2.2.1 Morven North will consist of up to 96 wind turbines. The final number of wind turbines will be determined during the detailed design phase of Morven North ahead of construction.

3.2.2.2 A range of wind turbine parameters are included which reflect the varying generating capacities of wind turbines considered in the PDE. This allows for a degree of flexibility to account for any anticipated developments in wind turbine technology while still allowing each technical topic to undertake a robust assessment of the MDS for each potential impact pathway. Consent is therefore sought for the physical parameters of the wind turbines which form the basis of the MDS, and is not specific to the indicative installed capacity of turbine options considered within the Morven North PDE.

3.2.2.3 A range of wind turbine options have been considered. The parameters in Table 3.1 provide both the maximum number of wind turbines, as well as the largest wind turbine within the PDE. Therefore, the combination of these parameters does not represent a realistic design scenario, however, they represent the most adverse parameters of a range of wind turbines which may be available at the time of construction.

Table 3.1: Maximum design parameters: wind turbines

Parameter	Maximum design parameter
Maximum number of wind turbines	96
Maximum blade tip height (m) above Lowest Astronomical Tide (LAT)	363
Minimum blade tip clearance above LAT (m)	34
Maximum hub height above LAT (m)	203
Maximum rotor diameter for wind turbine option with smallest height in PDE (m)	250
Maximum rotor diameter for wind turbine option with largest height in PDE (m)	320
Maximum number of blades	3
Minimum turbine spacing (m)	1,000

3.2.2.4 The wind turbines will follow the traditional wind turbine design with a horizontal rotor axis with three blades connected to the hub of the wind turbine nacelle. The nacelle will be supported by a tower structure which is fixed to the Transition Piece (TP) and foundation. Section 3.2.4 provides details of wind turbine foundations.

3.2.2.5 The maximum blade tip height (metres (m) above LAT) is expected to be no greater than 363m, with a maximum rotor diameter (m) of 320m and a minimum blade tip clearance (m above LAT) of 34m. The maximum design parameters for the wind turbines are presented in Table 3.1 and a schematic of a typical offshore wind turbine is illustrated in Figure 3.3.

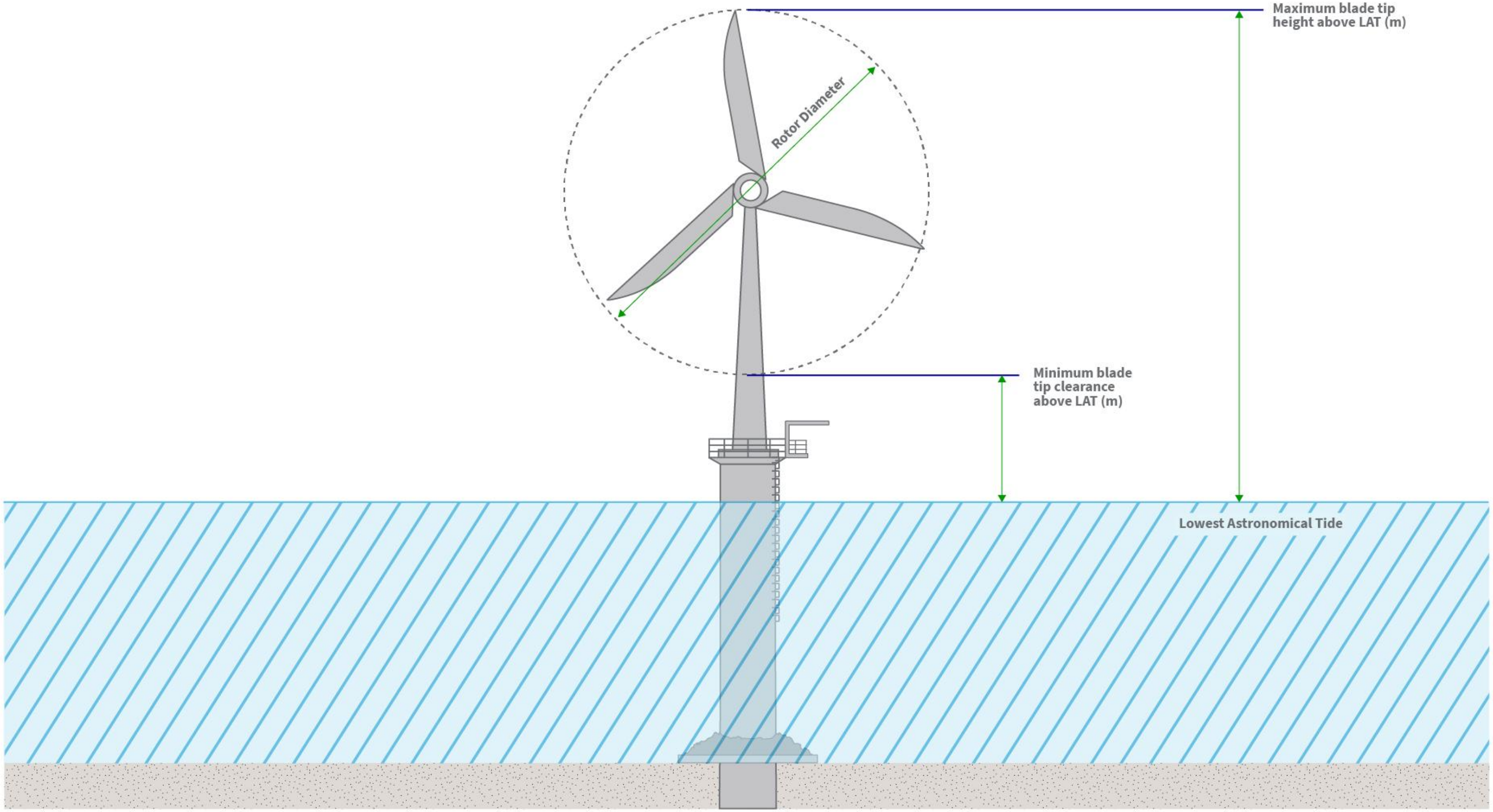

Figure 3.3: Illustration of a typical offshore wind turbine (not to scale)

3.2.2.6 The Morven North layout will be designed to optimise the use of available wind resource and suitable seabed conditions, while minimising environmental effects and potential impacts on other marine users. The final layout will be confirmed following detailed design (post-consent) in consultation with relevant stakeholders and submitted to the MD-LOT for approval.

3.2.2.7 Throughout the Morven North lifecycle, various consumables may be required to enhance operation, productivity, and reduce wear on wind turbine components. These consumables may include:

- grease;
- synthetic oil;
- hydraulic oil;
- gear oil;
- lubricants;
- nitrogen;
- water/glycerol;
- transformer silicon/ester oil;
- diesel fuel;
- sulphur hexafluoride;
- glycol/coolants.

3.2.2.8 The quantities needed for each consumable will depend on the final design of the selected wind turbine. To minimise the potential release of any chemicals into the marine environment during construction, O&M, and decommissioning phases, appropriate controls and mitigation measures will be implemented as outlined in the Environmental Management Plan (EMP) and Marine Pollution Contingency Plan (MPCP). Outlines of these documents are provided in Volume 4, Annex 1: Environmental Management Plan (EMP) (Version 1) and Volume 4, Annex 1, Appendix 1: Marine Pollution Contingency Plan (MPCP) (Version 1).

3.2.3 Offshore Substation Platform topsides

3.2.3.1 The following OSP arrangement scenarios have been considered within this Morven North EIA Report:

- OSP Option 1: up to five OSPs, comprising:
  - up to four High Voltage Alternating Current (HVAC) collector substation platforms;
  - up to one High Voltage Direct Current (HVDC) converter substation platform.
- OSP Option 2: up to five OSPs, comprising:
  - up to four HVAC collector substation platforms;
  - up to one bridge-linked HVDC converter substation, which consists of two HVDC converter substation platforms (including foundations) linked via a steel bridge to accommodate cabling between the platforms[3].

3.2.3.2 The final number and specifications of each OSP will depend on the final electrical set up for Morven North. Figure 3.4 illustrates a typical design of an OSP with the topside placed on a piled jacket foundation. Figure 3.5 illustrates a typical bridge-linked HVDC OSP.

3.2.3.3 The exact locations of the OSPs will be determined following the detailed design phase ahead of construction. The maximum design parameters for the OSP options are presented in Table 3.2 and Table 3.3, respectively.

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[3] For the purposes of assessment in the Morven North EIA Report the bridge-linked HVDC OSP has been treated as a single structure. Note, in the case where a bridge-linked HVDC OSP is included in Morven North, there will be no HVDC OSP required in Morven South.

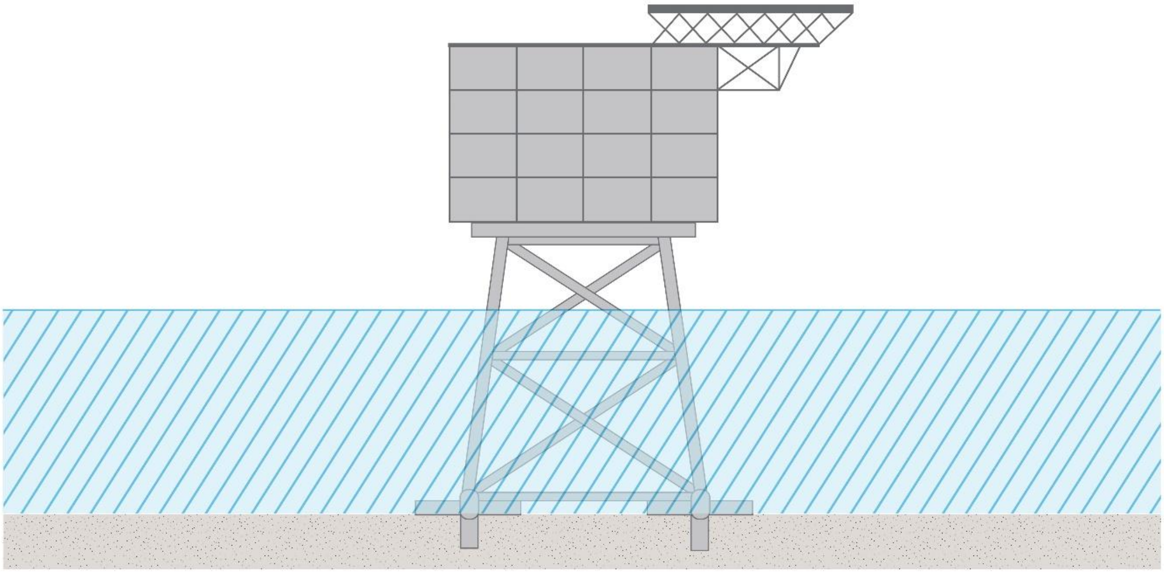

Figure 3.4: Illustration of a typical Offshore Substation Platform on a piled jacket foundation (not to scale)

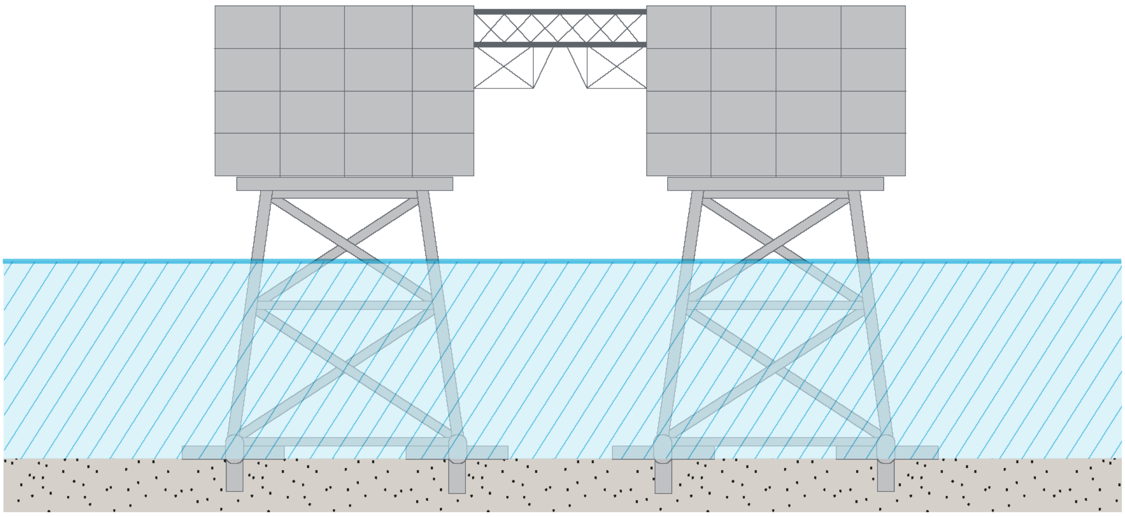

Figure 3.5: Illustration of typical Offshore Substation Platforms on piled jacket foundations connected by a bridge link (referred to as the bridge-linked High Voltage Direct Current Offshore Substation Platform and considered as a single structure) (not to scale)

Table 3.2: Maximum design parameters for the Offshore Substation Platform Option 1

Parameter	Maximum design parameter	
	HVAC Collector Substation	HVDC Convertor Substation
Maximum number of OSPs	4	1
Maximum length of topside (m)	80	240
Maximum width of topside (m)	60	180
Maximum height of topside above LAT (excluding helideck, crane, lightning protection or antenna structure) (m)	70	100
Maximum height of lightning protection above LAT (m)	90	120
Maximum height of helideck above LAT (m)	90	120
Maximum height of crane above LAT (m)	90	120
Maximum height of top of antenna structure above LAT (m)	90	120
Maximum weight of topside (t)	15,000	30,000
Topside – maximum area (m^2) (length x width)	4,800 (80 x 60)	43,200 (240 x 180)

Table 3.3: Maximum design parameters for the Offshore Substation Platform Option 2

Parameter	Maximum design parameter	
	HVAC Collector Substation	Bridge-linked HVDC OSP
Maximum number of OSPs	4	1[4]
Maximum length of topside (m)	80	580[5]
Maximum width of topside (m)	60	180
Maximum height of topside above LAT (excluding helideck, crane, lightning protection or antenna structure) (m)	70	100
Maximum height of lightning protection above LAT (m)	90	120
Maximum height of helideck above LAT (m)	90	120
Maximum height of crane above LAT (m)	90	120

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[4] It should be noted that this comprises two HVDC converter substations, however, as they are bridge linked, they are classed as one structure.

[5] Note that this value comprises the length of the two HVDC converter substations (2 x 240m) making up this single bridge-linked structure plus the bridge link (100m).

Parameter	Maximum design parameter	
	HVAC Collector Substation	Bridge-linked HVDC OSP
Maximum height of top of antenna structure above LAT (m)	90	120
Maximum weight of topside (t)	15,000	60,000 (2 x 30,000)[6]
Topside – maximum area (m^2) (length x width)	4,800 (80 x 60)	104,400 (580 x 180)
Bridge link details (applicable to bridge-linked HVDC OSP only)		
Maximum distance between OSP edges (bridge length) (m)	N/A	100
Minimum distance between OSP edges (bridge length) (m)	N/A	10
Minimum clearance height (m) (Highest Astronomical Tide (HAT))	N/A	14

3.2.4 Foundations and support structures

3.2.4.1 The wind turbines and OSPs will be attached to the seabed by foundation structures. With only preliminary geophysical and geotechnical surveys undertaken to date, the Applicant requires flexibility in foundation choice to accommodate ground condition unknowns within the Morven North Boundary.

3.2.4.2 To allow for flexibility in final foundation design, four foundation types have been considered for Morven North, of which three are proposed for both wind turbines and OSPs, and one is considered for OSPs only:

- foundation options considered for wind turbines and OSPs:
- monopile foundations (Foundation Option 1);
- piled jacket foundations (for wind turbines – up to four legs per jacket; for OSPs – up to six legs per jacket) (Foundation Option 2);
- suction bucket jacket foundations (for wind turbines – up to four legs per jacket; for OSPs – up to six legs per jacket) (Foundation Option 3).

3.2.4.3 foundation options considered for OSPs only:

- gravity base foundations (Foundation Option 4).

3.2.4.4 The foundation type will be selected during detailed design and following detailed pre-construction site investigation surveys. The foundations will be fabricated offsite, stored at a port facility and transported to Morven North for installation. This section provides an overview of the design parameters associated with each proposed foundation type for both wind turbines and OSPs.

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[6] Note that this value refers to two HVDC converter substation topsides with maximum weight of 30,000t each.

Foundation Option 1: monopile foundations (wind turbine and High Voltage Alternating Current Offshore Substation Platforms)

3.2.4.5 Monopile foundations consist of a single steel tubular section with or without a TP (see example schematic in Figure 3.6). There may be ladders, a crane, and other components to facilitate boat landings, or connection to the tower. The TP or upper part of the monopile is typically painted yellow and marked according to relevant regulatory guidance. Monopiles are proposed as a foundation option for wind turbines and HVAC OSPs (included in OSP Options 1 and 2, as described above in section 3.2.2.8); HVDC OSPs would not be installed with monopile foundations. Table 3.4 outlines the maximum design parameters for monopile foundations for wind turbines and HVAC OSPs.

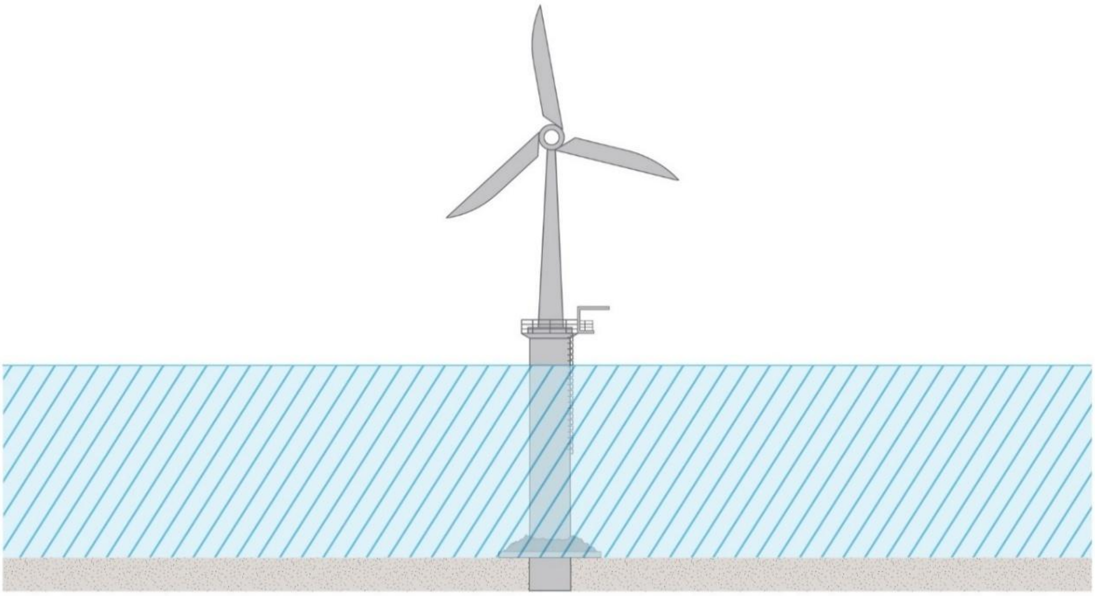

Figure 3.6: Schematic of a typical monopile foundation (wind turbine) (not to scale)

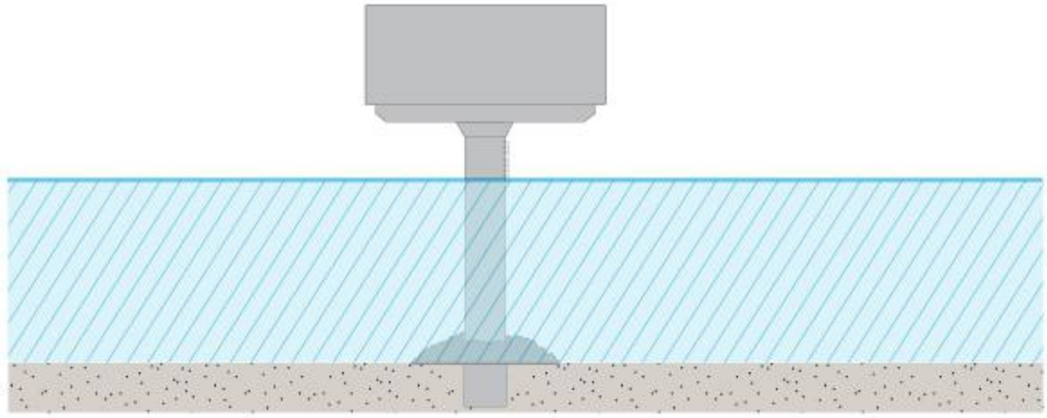

Figure 3.7: Schematic of a typical monopile foundation (High Voltage Alternating Current Offshore Substation Platform) (not to scale)

Table 3.4: Maximum design parameters for foundation option 1 (monopiles)

Parameter	Maximum design parameter		
	Wind turbines	OSP Option 1[7]	OSP Option 2[8]
Maximum number of monopile foundations	96	4	4
Maximum pile diameter (m)	16	16	16
Maximum TP diameter (m)	13	13	13
Maximum pile penetration depth (m)	64	64	64
Maximum pile length (m)	150	167.50	167.50
Maximum seabed footprint per pile (m^2)	201	201	201
Maximum total seabed footprint for Morven North (m^2)	16,965 [9]	804.20	804.20
Maximum hammer energy (kJ)	6,600	6,600	6,600

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[7] It should be noted that monopile foundations will only be used for the HVAC collector substations included in OSP Option 1

[8] It should be noted that monopile foundations will only be used for the HVAC collector substations included in OSP Option 2

[9] Note: this value is based on 96 monopiles with 15m diameter

Foundation Option 2: piled jacket foundations (wind turbines and High Voltage Alternating Current/ High Voltage Direct Current Offshore Substation Platforms)

3.2.4.6 Piled jacket foundations are steel lattice structures (comprising steel tubular members and welded joints) which support wind turbines or OSPs and are secured to the seabed by pin piles. The steel tubular pin piles are typically narrower than monopiles and will most likely be piled by hydraulic hammers, vibration installation, or drilled into the seabed. The TP and foundation structure are fabricated as an integrated part of the jacket. Morven North may use either six-legged (for OSPs only), four-legged or three-legged piled jacket foundations. An example of a pin piled jacket is shown in Figure 3.8.

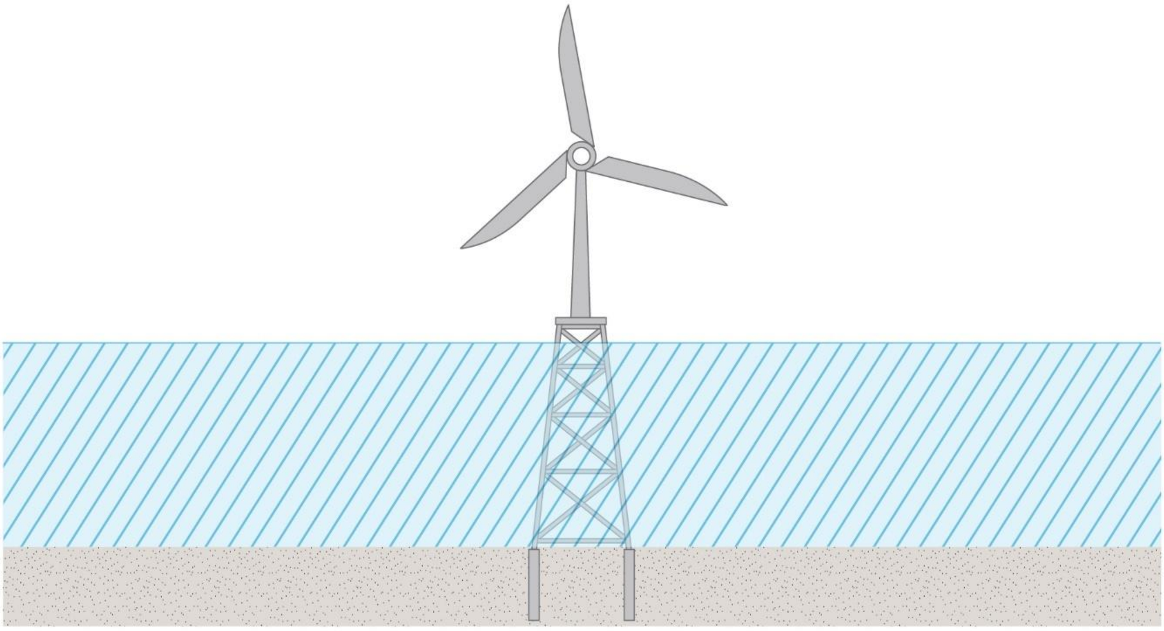

Figure 3.8: Schematic of a typical pin pile jacket foundation (not to scale)

3.2.4.7 The piled jacket foundations will be transported to site by sea. Once at site, the jacket foundation will be lifted by the installation vessel using a crane and lowered towards the seabed in a controlled manner. The hollow steel pin piles are typically driven or drilled into the seabed, relying on the frictional and end bearing properties of the seabed for support. The maximum design parameters for jacket foundations with pin piles for wind turbines and for OSPs are provided in Table 3.5 and Table 3.6, respectively.

Table 3.5: Maximum design parameters for foundation option 2 (jacket foundations with pin piles) - wind turbines

Parameter	Maximum design parameter
Maximum number of jacket foundations	96
Maximum number of legs per foundation	4
Maximum leg diameter (m)	5
Maximum number of pin piles per leg	1
Maximum pin pile diameter (m)	5.3

Parameter	Maximum design parameter
Maximum embedment depth (below seabed) (m)	83
Maximum pile length (m)	93
Maximum hammer energy (kJ)	4,500
Maximum seabed footprint per foundation (m^2)	66
Maximum seabed footprint for Morven North (m^2)	4,129 [10]
Maximum separation of adjacent legs at seabed level (m)	64
Maximum separation of adjacent legs at LAT (m)	54

Table 3.6: Maximum design parameters for foundation Option 2 (jacket foundations with pin piles) – Offshore Substation Platforms

Parameter	Maximum design parameter			
	OSP Option 1		OSP Option 2	
	HVAC	HVDC	HVAC	Bridge-linked HVDC
Maximum number of OSP jacket foundations	4	1	4	2
Maximum number of legs per foundation	6	6	6	6
Maximum leg diameter (m)	5	5.3	5	5.3
Maximum number of pin piles per leg	4	4	4	4
Maximum pin pile diameter (m)	4.5	5	4.5	5
Maximum pile penetration depth (m)	65	80	65	80
Maximum pile length (m)	90	105	90	105
Maximum dimensions of mud mats per jacket foundation (m^2)	576	576	576	576
Maximum hammer energy (kJ)	4,000	4,000	4,000	4,000
Maximum seabed footprint per foundation (m^2)	703	733	703	733
Maximum seabed footprint for Morven North (m^2)	2,813	733	2,813	1,466
Maximum separation of adjacent legs at seabed level (m)	60	160	60	160
Maximum separation of adjacent legs at LAT (m)	50	135	50	135

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[10] Note: this value is based on 96 jacket foundations with 3.7m diameter pin piles.

Foundation Option 3: suction bucket jacket foundations (wind turbines and High Voltage Alternating Current/ High Voltage Direct Current Offshore Substation Platforms)

3.2.4.8 Jacket foundations with suction buckets are steel lattice structures (comprising tubular steel members and welded joints) fixed to the seabed by suction buckets installed below each leg of the jacket structure. The suction buckets are typically hollow steel cylinders, capped at the upper end and do not require a hammer or drill for installation (see example schematic in Figure 3.9).

3.2.4.9 The maximum design parameters are provided in Table 3.7 and Table 3.8. Wind turbines could have three or four legged jackets whereas OSPs could have three, four or six legged jackets.

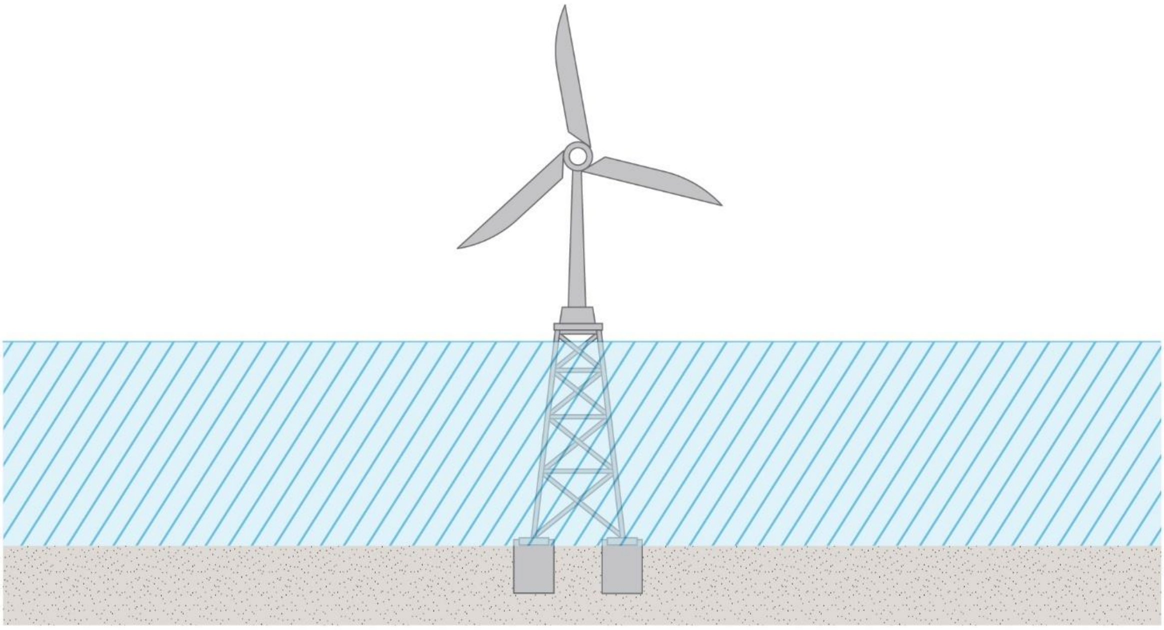

Figure 3.9: Schematic of a typical suction bucket jacket foundation (wind turbines) (not to scale)

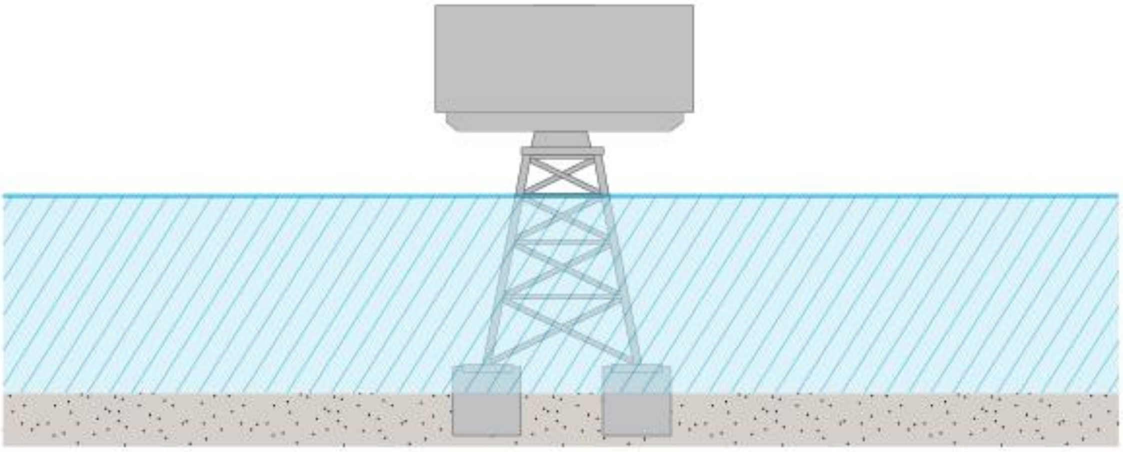

Figure 3.10: Schematic of a typical suction bucket jacket foundation (Offshore Substation Platform) (not to scale)

Table 3.7: Maximum design parameters for foundation Option 3 (jacket foundations with suction buckets) – wind turbines

Parameter	Maximum design parameter
Maximum number of jacket foundations	96
Maximum number of legs per jacket with suction bucket	4
Maximum leg diameter (m)	5
Maximum seabed footprint per foundation (m^2)	1,018
Maximum seabed footprint for Morven North (m^2)	59,112
Maximum diameter of suction bucket (m)	20
Maximum expected penetration depth (m)	23
Maximum separation of adjacent legs at seabed level (m)	40
Maximum separation of adjacent legs at LAT (m)	40

Table 3.8: Maximum design parameters for foundation Option 3 (jacket foundations with suction buckets) – Offshore Substation Platforms

Parameter	Maximum design parameter			
	OSP Option 1		OSP Option 2	
	HVAC	HVDC	HVAC	Bridge-Linked HVDC
Maximum number of jacket foundations	4	1	4	2
Maximum number of legs per jacket with suction bucket	6	6	6	6
Maximum leg diameter (m)	5	5.3	5	5.3
Maximum seabed footprint per foundation (m^2)	1,527	1,527	1,527	1,527
Maximum seabed footprint for Morven North (m^2)	6,107	1,527	6,107	3,054
Maximum diameter of suction bucket (m)	20	20	20	20
Maximum expected penetration depth (m)	25	25	25	25
Maximum separation of adjacent legs at seabed level (m)	60	160	60	160
Maximum separation of adjacent legs at LAT (m)	50	135	50	135

Foundation Option 4: gravity base foundations (High Voltage Alternating Current/ High Voltage Direct Current Offshore Substation Platforms)

3.2.4.10 Gravity base foundations are generally made of concrete with steel reinforcements, or steel alone, and consist of a base, a conical structure and a smaller cylindrical top (generally called the shaft) which can be made of steel and connected to the lower concrete conical structure. This shape provides support and stability to the wind turbine or OSP. Note, HVDC converter substations will not be developed via a gravity base with conical caisson and instead may be developed with gravity foundations built around a rectangular support structure.

3.2.4.11 For large OSPs such as the HVDC converter substations, gravity base foundations may be ballast weighted and built around a rectangular support structure with up to six legs (see example schematic in Figure 3.11). This eliminates the requirement for drilling or piling, unless ground reinforcements with piles or suction buckets are required to stabilise the seabed. In case of the latter, the numbers and dimensions of piles or suction buckets will not exceed the values given for piled jacket foundations or suction bucket jacket foundations. The seabed is dredged and primed with bedding material (e.g. crushed rock) to stabilise the foundation prior to installation, with excavated material disposed of on site within the Morven North Boundary.

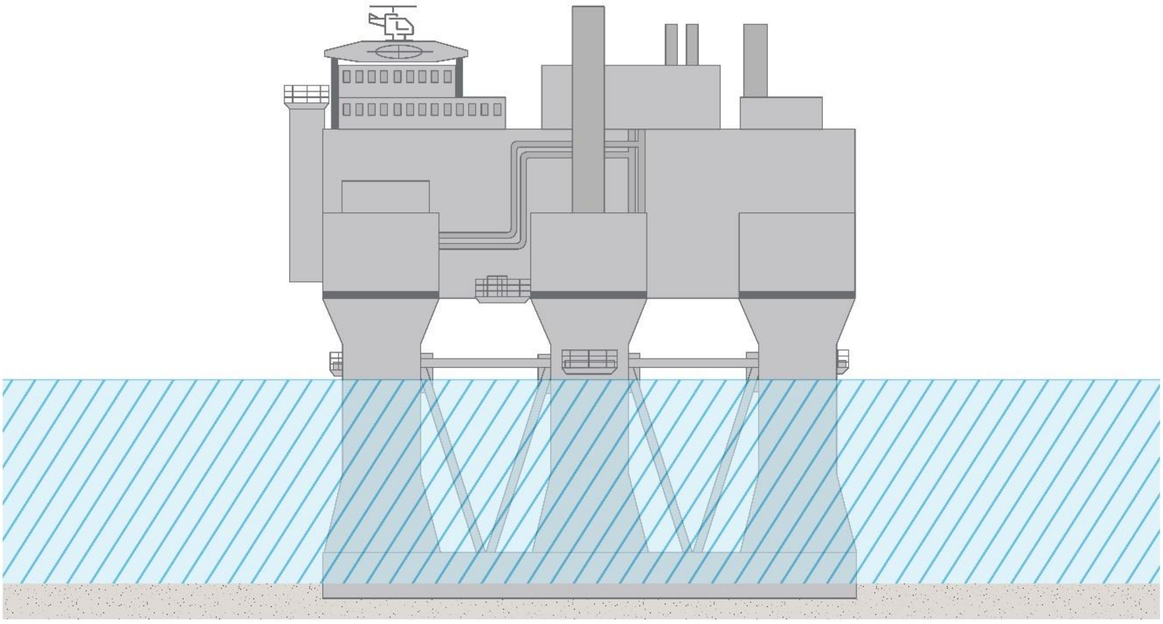

Figure 3.11: Schematic of a typical rectangular gravity base foundation with six legs (not to scale)

3.2.4.12 The maximum design parameters for gravity base foundations for OSPs is provided in Table 3.9.

Table 3.9: Maximum design parameters for foundation Option 4 (gravity base foundations)

Parameter	Maximum design parameter			
	OSP Option 1		OSP Option 2	
	HVAC	HVDC	HVAC	Bridge-Linked HVDC
Maximum number of gravity base foundations	4	1	4	2
Foundation shape	Conical	Rectangular	Conical	Rectangular
Maximum diameter/size (width x length) of gravity base foundation at seabed (m)	67	195 W x 255 L	67	195 W x 255 L
Maximum diameter/size (width x length) of gravity base foundation at sea surface (m)	17	180 W x 240 L	17	180 W x 240 L
Maximum caisson diameter (m)	51	N/A	51	N/A
Maximum foundation penetration depth (m)	10	10	10	10
Maximum seabed footprint per foundation (m^2)	3,526	49,725	3,526	49,725
Maximum seabed footprint for Morven North (m^2)	14,103	49,725	14,103	99,450
Maximum total height below sea surface (m)	75	75	75	75

3.2.5 Scour protection for foundations

3.2.5.1 Foundation structures for wind turbines and OSPs are at risk of seabed erosion and scour pit formation due to natural hydrodynamic and sedimentary processes. The development of scour pits is influenced by the shape of the foundation structure, seabed sedimentology and site specific metocean conditions such as waves, currents and storms. Scour protection may be employed to mitigate scour around foundations. There are several commonly used scour protection types (presented in Figure 3.12), including:

- concrete mattresses;
- rock placement;
- rock bags;
- frond mattresses.

3.2.5.2 These are described in the subsections below.

Concrete mattress placement

3.2.5.3 Concrete mattresses are constructed using high strength concrete blocks and ultraviolet (UV) stabilised polypropylene rope. The mattresses are lowered to the seabed from an installation vessel and once the correct position is confirmed, a frame release mechanism is triggered and the mattress is deployed on the seabed. This single mattress installation is repeated to cover the area around the foundation that requires protection. The mattresses may be gradually layered in a stepped formation on top of each other dependant on expected scour. Mattresses with sloped edges would be deployed to reduce the potential for fishing gear to snag the edges of the mattresses.

Rock placement

3.2.5.4 Initially gravel is placed around the foundation as a filter layer. This provides protection from any impact from the larger size rocks that make up the armour layer. The larger size rocks are then placed on top of the filter layer, preventing the winnowing of sediment through the armour layer. Rock placement is often achieved using a vessel with equipment such as a “fall pipe”, which allows precise installation of rock close to the seabed. For rock protection, the Applicant will explore the use of rock that is as similar as possible to the rock that occurs naturally in the area.

Rock bags

3.2.5.5 Prefilled rock bags consist of various sized rocks constrained within a rope or wire netting container and can be placed around the foundations with specialist installation beams.

Frond mattress placement

3.2.5.6 Frond mattresses (mats) are typically several metres wide and long, composed of continuous lines of overlapping buoyant polypropylene fronds that create a drag barrier which prevents sediment in their vicinity being transported away. The frond lines are secured to a polyester webbing mesh base that is itself secured to the seabed by a weighted perimeter or anchors pre-attached to the mesh base[11]. Frond mattresses are installed following the same procedure as concrete mattresses. The fronds floating in the water column, however, can impede the correct placement of additional mattresses. The fronds are designed to catch and trap sediment to form protective, localised sand berms.

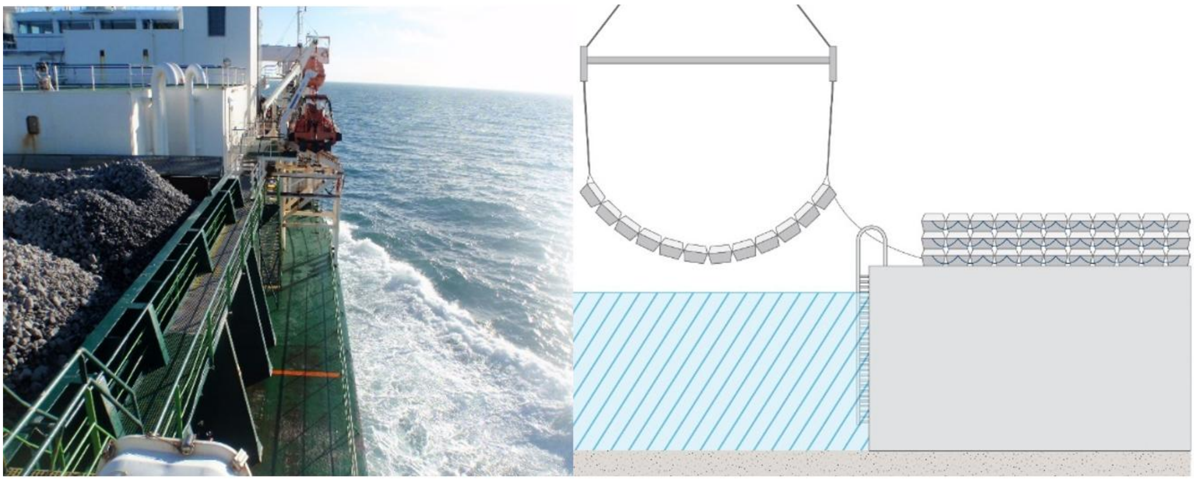

Figure 3.12: Illustrative scour protection types (Left: delivery of rock to EnBW’s Hohe See Offshore Wind Farm; Right: concrete mattresses)

3.2.5.7 The amount of scour protection required would vary depending on the size and shape of the four foundation options being considered for Morven North. The final choice of scour protection will be made after design of the foundation structure is confirmed, taking into account a range of aspects including geotechnical data, meteorological and oceanographical data, water depth, foundation type, maintenance strategy and cost.

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[11] Seabed Scour Control Systems (SSCS) Frond Mats installed in the North Sea in 1984 remain in place today and have required no maintenance since being deployed, as the mats are designed not to degrade with time (SSCS, 2022).

3.2.5.8 Scour protection parameters for the different foundations being considered are presented in Table 3.10 and Table 3.11.

Table 3.10: Maximum design parameters: Scour protection for foundation options - wind turbines

Parameter	Maximum design parameter
Scour protection type	Layers of graded rock, rock filled mesh fibre bags, pre-cast concrete block mattresses, polypropylene fronds mattresses secured by weighted perimeter or anchors
Foundation Option 1 - monopiles	
Maximum height of scour protection (m)	2.5
Maximum area of scour protection per foundation (excluding pile area) (m^2)	3,870
Maximum volume of scour protection per foundation (m^3)	10,179
Maximum volume of scour protection for Morven North (m^3)	858,833
Foundation Option 2 – jacket foundations with pin piles	
Maximum height of scour protection (m)	2.5
Maximum area of scour protection per foundation (excluding pile area) (m^2)	7,607
Maximum volume of scour protection per foundation (m^3)	19,184
Maximum volume of scour protection for Morven North (m^3)	1,251,082
Foundation Option 3 – jacket foundations with suction buckets	
Maximum height of scour protection (m)	2.5
Maximum area of scour protection per foundation (excluding pile area) (m^2)	11,053
Maximum volume of scour protection per foundation (m^3)	29,988
Maximum volume of scour protection for Morven North / South (m^3)	2,012,284

Table 3.11: Maximum design parameters: Scour protection for foundation options – Offshore Substation Platforms

Parameter	Maximum design parameter			
	OSP Option 1		OSP Option 2	
	HVAC	HVDC	HVAC	Bridge-Linked HVDC
Scour protection type	Layers of graded rock, rock filled mesh fibre bags, pre-cast concrete block mattresses, polypropylene fronds mattresses secured by weighted perimeter or anchors			
Foundation Option 1 - monopiles[12]				
Maximum height of scour protection (m)	2.5	N/A	2.5	N/A
Maximum area of scour protection per foundation (excluding pile area) (m^2)	3,871	N/A	3,871	N/A
Maximum volume of scour protection per foundation (m^3)	10,179	N/A	10,179	N/A
Maximum volume of scour protection for Morven North (m^3)	40,715	N/A	40,715	N/A
Foundation Option 2 – jacket foundations with pin piles				
Maximum height of scour protection (m)	2.5	2.5	2.5	2.5
Maximum area of scour protection per foundation (excluding pile area) (m^2)	13,467	50,049	13,467	50,049
Maximum volume of scour protection per foundation (m^3)	33,666	125,123	33,666	125,123
Maximum volume of scour protection for Morven North (m^3)	134,663	125,123	134,663	250,245
Foundation Option 3 – jacket foundations with suction buckets				
Maximum height of scour protection (m)	2.5	2.5	2.5	2.5
Maximum area of scour protection per foundation (excluding pile area) (m^2)	16,432	53,032	16,432	53,032
Maximum volume of scour protection per foundation (m^3)	41,081	132,581	41,081	132,581
Maximum volume of scour protection for Morven North (m^3)	164,324	132,581	164,324	265,162
Foundation Option 4 – gravity base foundations				

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[12] Note that monopiles are not proposed for HVDC OSPs (including the bridge-linked HVDC OSP), therefore, maximum design parameters for these are listed as 'N/A'.

Parameter	Maximum design parameter			
	OSP Option 1		OSP Option 2	
	HVAC	HVDC	HVAC	Bridge-Linked HVDC
Maximum height of scour protection (m)	4	4	4	4
Maximum area of scour protection per foundation (excluding pile area) (m^2)	36,945	74,725	36,945	74,725
Maximum volume of scour protection per foundation (m^3)	147,781	100,000	147,781	100,000
Maximum volume of scour protection for Morven North (m^3)	591,122	100,000	591,122	200,000

3.2.6 Subsea cables

Inter-array cables

3.2.6.1 Inter-array cables will carry electrical current produced by the wind turbines to the OSPs. Several wind turbines are typically grouped on the same cable 'string' to connect the wind turbines to an OSP, with multiple cable 'strings' connecting back to each OSP.

3.2.6.2 The maximum design parameters for inter-array cables are presented in Table 3.12 below.

Table 3.12: Maximum design parameters for inter-array cables

Parameter	Maximum design parameter
Maximum external cable diameter (mm)	260
Maximum total length of cable (km)	424
Maximum voltage (kV)	132
Cable installation methodology	Prelay plough, plough, trenching, cutting and jetting.
Cable burial technique	Jet trenching, mechanical trenching, dredging, ploughing, controlled flow excavation, rock cutting, backfilling or other burial techniques.
Minimum cable burial depth (m)	0.5
Target cable burial depth (m)	1
Maximum cable burial depth (m)	3
Maximum width of cable trench (m)	3
Maximum width of seabed affected by installation per cable (m)	20
Total area of seabed disturbance for inter-array cables (km^2)	8.48

Interconnector cables

3.2.6.3 Interconnector cables will be required to connect the OSPs to each other in order to provide redundancy in the case of failures within the electrical transmission system.

3.2.6.4 Interconnector cables will be installed by the same methods proposed for inter-array cables in Section 3.2.6.

3.2.6.5 The maximum design parameters for the interconnector cables are presented in Table 3.13.

Table 3.13: Maximum design parameters for interconnector cables

Parameter	Maximum design parameter
HVAC/HVDC	HVAC
Maximum voltage (kV)	275
Maximum number of cables	10
Maximum total cable length (km)	484
Maximum external cable diameter (mm)	322
Cable installation methodology	Prelay plough, plough, trenching, cutting and jetting.
Cable burial technique	Jet trenching, mechanical trenching, dredging, ploughing, controlled flow excavation, rock cutting, backfilling or other burial techniques.
Minimum cable burial depth (m)	0.5
Target cable burial depth (m)	1
Maximum cable burial depth (m)	3
Maximum width of cable trench (m)	3
Maximum width of seabed affected by installation per cable (m)	20
Total area of seabed disturbance for inter-array cables (km^2)	9.68

External cable protection

3.2.6.6 The inter-array and interconnector cables will be buried where possible. Where minimum burial depth is not achievable, for example where crossing pre-existing cables, pipelines or exposed bedrock, external cable protection will be employed (such as rock or concrete mattresses), providing a hard protective layer to restrict movement and prevent exposure of cables over the lifetime of Morven North.

3.2.6.7 The maximum design parameters for external cable protection are presented in Table 3.14.

Table 3.14: Maximum design parameters for external cable protection

Parameter	Maximum design parameter	
	Inter-array cables	Interconnector cables
Type	Concrete mattresses, rock placement, rock bags, grout bags, cement bags, sandbags, articulated pipes, cast iron shells, bend restrictors/stiffeners, cable protection systems, frond mats.	
Maximum height of cable protection (m)	3	3
Maximum width of cable protection (m)	10	10
Maximum percentage of cable length which may require cable protection (%)	10	10
Maximum length of cables which may require cable protection (m)	42,375	48,400
Maximum total cable protection footprint area (m^2)	423,750	484,000
Maximum total cable protection volume (m^3)	1,271,250	1,452,000

Cable crossings

3.2.6.8 Up to five cable crossings may be installed across Morven North using one or more of the methods listed in Table 3.15.

Table 3.15: Maximum design parameters for cable crossings

Parameter	Maximum design parameter	
	Inter-array cables	Interconnector cables
Maximum number of crossings	5	5
Crossing material/method	Concrete mattresses, rock placement, rock bags, grout bags, cement bags, sandbags.	
Maximum height of crossing (m)	4	4
Maximum width of crossing (m)	36	36
Maximum length of each crossing (m)	80	80
Maximum length of crossings across Morven North	400	400
Maximum area of protection material per crossing (m^2)	2,880	2,880
Maximum total area of crossing protection across Morven North (m^2)	14,400	14,400
Maximum volume of protection material per crossing (m^3)	11,520	11,520
Maximum volume of crossing protection across Morven North (m^3)	57,600	57,600

3.3 Site preparation activities

3.3.1.1 Several site preparation activities may be required in the Morven North Boundary. Site preparatory works are assumed to begin prior to the first activities within the Morven North Boundary and continue as required throughout construction. As such, site preparation activities may happen at any point during the construction phase (see Section 3.4.7).

3.3.1.2 An overview of these activities is provided below.

3.3.2 Pre-construction site investigation surveys

3.3.2.1 A number of pre-construction site investigation surveys may be undertaken to inform detailed project design work and to identify in detail:

- seabed conditions and morphology;
- presence/absence of any potential obstructions or hazards.

3.3.2.2 Pre-construction site investigation surveys are likely to include geophysical and geotechnical surveys which would be conducted within, and in the vicinity of, the footprint of the foundations for wind turbines and OSPs and along the inter-array and interconnector cable routes. Geophysical survey works may be carried out to provide more detail on potential for UXO and associated requirement for clearance, bedform and boulder mapping, bathymetry, topographical overview of the seabed and an indication of subsoil-layers. Geotechnical surveys would be conducted at specific locations within the Morven North Boundary.

3.3.2.3 Geophysical surveys are likely to include techniques as follows:

- Side Scan Sonar (SSS);
- Sub-bottom Profiling (SBP);
- Multibeam Echo-Sounder (MBES);
- Single Beam Echo-Sounder (SBES);
- high-density magnetometer (MAG) and/or Gradiometer (GRAD) surveys;
- Ultra High Resolution Seismic (UHRS) 2D and/or 3D.

3.3.2.4 Geotechnical Investigations are likely to include techniques as follows:

- Boreholes;
- Cone Penetration Tests (CPTs); - (Seabed and downhole techniques);
- Seismic Cone Penetration Tests (SCPTs) - (Seabed and downhole techniques);
- Downhole Geophysical Logging and in situ testing (e.g. High pressure dilatometer (HPD) or Pressuremeter);
- Vibrocores.

3.3.2.5 To assist in the design development and selection of foundation options, there may also be the performance of seabed trials of potential foundation options, for example a suction bucket (SBJ) trial. The purpose of this would be to trial potential foundation solutions to test trial installation and capacity to identify in-situ conditions to inform foundation selection.

3.3.3 Unexploded Ordnance clearance

3.3.3.1 It is possible that UXO may be encountered during the construction or installation of offshore infrastructure. This poses a potential health and safety risk where it coincides with the planned location of infrastructure and associated vessel activity, and therefore it is necessary to survey for and carefully manage clearance of UXO.

3.3.3.2 In order to identify UXO, detailed surveys of the location where infrastructure will be located are required. This work cannot be conducted before a consent application is submitted because the detailed design work needed to confirm the location of infrastructure is reliant upon the pre-construction site investigation surveys outlined in Section 3.3.2. In addition, the survey for identification of potential UXO must be undertaken within approximately one year ahead of the start of construction as UXO surveys are only valid for one year due to the potential for hydrodynamics to uncover UXO that may not be detected in pre-application surveys.

3.3.3.3 The following methodologies and order in which steps will be taken are considered for UXO avoidance/clearance:

- Step 1 - avoid/microsite or leave in situ;
- Step 2 - relocation of UXO to avoid detonation;
- Step 3 - low order clearance method (e.g. deflagration);
- Step 4 - high order clearance method (e.g. detonation, with associated mitigation measures).

3.3.3.4 Given the health and safety risks posed by UXOs, the Applicant aims to avoid UXOs through micrositing or relocating them where feasible. If avoidance methods are not viable, a specialist contractor will clear UXOs before further site preparation and construction commence. The preferred clearance method involves using a low order technique (subsonic combustion) with a single donor charge of 0.25kg net explosive quantity for each clearance event. The maximum parameters for UXO clearance are provided in Table 3.16. As detailed in paragraph 3.3.3.3, high order clearance methods may be utilised if avoidance, relocation and low order techniques were not viable. High order techniques would be utilised as a last resort, as per the UXO Clearance Joint Position Statement (UK Government, 2025).

3.3.3.5 Detailed design work is necessary to confirm planned infrastructure locations before conducting any UXO surveys. Based on a desk-based study (Ordtek, 2022) and experiences from other offshore wind farms in the region, such as the Seagreen 1 Offshore Wind Farm, the Applicant estimates that up to 15 UXOs may require clearance.

Table 3.16: Maximum unexploded ordnance parameters across Morven North

Parameter	Maximum design parameter
Maximum weight (munition; explosive + casing) expected to be encountered (kg)	986
Maximum charge weight (modelled explosive mass) (kg equivalent TNT)	554
Maximum realistic number of UXO to be cleared	15
Maximum duration of UXO clearance activities (days)	15
Maximum number of detonation activities occurring in 24hrs	1

3.3.4 Boulder clearance

3.3.4.1 Boulder clearance is commonly required during offshore wind farm site preparation. A boulder is typically defined as being over 200mm in diameter/length. Boulder clearance may be required along the inter-array cable and interconnector cable routes but may also be required in the vicinity of the wind turbine and OSP foundations. Boulder clearance is required to reduce the risk of shallow cable burial resulting in the need for further cable burial works and/or cable protection, as well minimising risk of damage to cables during installation. Boulders would pose the risk of damage and exposure to the cable as well as an obstruction risk to the foundation and cable installation equipment. Therefore, boulders may be moved to the side of the construction area within the Morven North Boundary. All boulders will remain in the marine environment, likely within the Morven North

Boundary. Boulders may be cleared using a boulder grab and/or plough, however, the methodology to be used will be informed by the pre-construction geophysical and geotechnical surveys.

3.3.4.2 Table 3.17 provides the maximum design parameters for boulder clearance in the Morven North Boundary. With respect to inter-array and interconnector cables, boulder clearance will occur within the footprint of cable installation activities therefore the footprint is not presented to prevent double counting of the seabed footprint parameters. The total area of seabed disturbance for inter-array and interconnector cables (i.e. footprint in which boulder clearance will occur) is presented previously in Table 3.12 and Table 3.13, respectively.

Table 3.17: Maximum design parameters for boulder clearance in the Morven North Boundary

Parameter	Maximum design parameter
Maximum width of boulder clearance along inter-array and interconnector cables (m) (per cable)	20
Maximum proportion of inter-array and interconnector cables requiring boulder clearance (%)	100
Maximum total area of boulder clearance for wind turbines and OSPs (m^2)	4,839,300

3.3.5 Sandwave clearance

3.3.5.1 In some areas within the Morven North Boundary, existing sandwaves and similar bedforms may need to be removed prior to the installation of cables. This is carried out mainly for two reasons:

- Many of the cable installation tools require a relatively flat seabed surface in order to work effectively. Installing cables on a slope over a certain angle, or where the installation tool is working on a camber, may reduce the ability to meet target burial depths.
- Cables must be installed to a depth where it may be expected to stay buried for the duration of the Morven North operational lifetime. Sandwaves are generally mobile in nature therefore the cable must be buried beneath the level where natural sandwave movement could result in the cable becoming un-covered. Sometimes this can only be achieved by removing the mobile sediments before installation takes place.

3.3.5.2 Sandwave clearance may take place throughout the construction phase (see Section 3.4.7). If required, sandwave clearance will be completed in areas within the Morven North Boundary along the inter-array cable and interconnector cable routes. Seabed features clearance will involve removal of the peaks of the seabed features by dredging, with material replaced in the troughs, thereby levelling the seabed. A specialist dredging vessel may be required to complete the seabed features clearance.

3.3.5.3 Site specific geophysical and bathymetry data from the Morven North Boundary were utilised to identify sandwaves, revealing that up to 15% of inter-array cables and up to 15% of interconnector cables may require sandwave clearance. Additionally, based on the preliminary site investigation data, it was determined that up to 80% of foundation locations may require sandwave clearance. UXO and boulder clearance may also be necessary, as discussed in Section 3.3.4.

3.3.5.4 Sandwave clearance methods may involve pre-installation ploughing, which smooths out sandwaves by redistributing sediment from the crests into nearby troughs to create a level seabed. Other methods for consideration would include Controlled Flow Excavation (CFE) or jet trenching. Large-scale dredging is not expected to be necessary within the Morven North Boundary.

3.3.5.5 The maximum design parameters for sandwave clearance in the Morven North Boundary is summarised in Table 3.18. The final values required for sandwave clearance will be confirmed following completion of a detailed geophysical survey campaign ahead of construction to inform detailed design.

3.3.5.6 Similar to boulder clearance and as noted in paragraph 3.3.4.2, sandwave clearance will occur within the footprint of cable installation activities therefore the footprint is not presented to prevent double counting of the seabed footprint parameters. The total area of seabed disturbance for inter-array and interconnector cables (i.e. footprint in which sandwave clearance will occur) is presented previously in Table 1.14 and Table 1.15, respectively.

Table 3.18: Maximum design parameters for sandwave clearance in the Morven North Boundary

Parameter	Maximum design parameter
Inter-array and interconnector cables	
Maximum sandwave clearance width along inter-array and interconnector cables (m)	20
Maximum proportion of inter-array and interconnector cables requiring sandwave clearance (%)	15
Maximum sandwave clearance volume for inter-array and interconnector cables collectively (m^3)	13,071,600
Wind turbine and OSP foundations	
Maximum total area of sandwave clearance for wind turbine foundations (for scour protection) (m^2)	4,455,300
Maximum total volume of sandwave clearance for wind turbine foundations (including scour protection) (m^3)	13,365,900

3.3.6 Removal of disused and out of service cables

3.3.6.1 If the final location of Morven North infrastructure crosses any out of service cables, these will be removed where feasible. Any cable removal will be undertaken in consultation with the asset owner and in accordance with the International Cable Protection Committee (ICPC) guidelines (2011). Where feasible, cables will be retrieved to a vessel deck, where one end will be cut, the cable will be pulled past the crossing point, and then cut again before being pulled to the surface where it will be removed from site by the vessel. Up to 5km of disused/out of service cables are expected to be removed within the Morven North Boundary.

3.4 Construction phase

3.4.1.1 The construction of Morven North is estimated to occur over a duration of up to five years. Table 3.19 provides an indication of the expected major construction activities provided as a stepped series of activities. It should be noted that these activities may not run consecutively one after another throughout the construction phase of Morven North, rather, different activities may occur concurrently in different areas of the Morven North Boundary (e.g. foundation installation (step 3) may commence in the western portion of the Morven North Boundary, whilst OSP installation is ongoing in the eastern portion of the Morven North Boundary). Further details of construction phase activities will be provided in a Construction Method Statement which will be developed post-consent.

Table 3.19: Indicative construction activities for Morven North

Activity	Description
Step 1 - Pre-construction surveys (see Section 3.3.2)	Geotechnical and geophysical surveys, boulder and UXO surveys.
Step 2 - Seabed preparation activities (see Sections 3.3.3 to 3.3.6)	Seabed preparation activities (e.g. rock picking, sandwave leveling and clearance (pre-lay plough/dredging), pre-lay grapnel run (PLGR), UXO clearance, and removal of third party or out of service cables) to aid installation of wind turbine and OSP foundations, inter-array cables and interconnector cables.
Step 3 - Foundations installation (see Section 3.4.2)	Installation of wind turbine and OSP foundations.
Step 4 - OSP installation and commissioning (see Section 3.4.3)	Installation of OSPs and associated equipment required for this infrastructure, including commissioning.
Step 5 - Interconnector cables installation (Section 3.4.4)	Installation of interconnector cables, connecting OSPs.
Step 6 - Inter-array cables installation (Section 3.4.4)	Installation of inter-array cables, connecting wind turbines to other wind turbines or to OSPs.
Step 7 - Wind turbine installation and commissioning (Section 3.4.5)	Installation of the wind turbines onto the previously installed wind turbine foundations, including commissioning.
Step 8 - Post-construction as-built surveys	Surveys to document what has been constructed.

3.4.2 Foundations installation

Installation of monopile foundations (foundation Option 1)

3.4.2.1 Depending on soil conditions and monopile size, monopile foundations are most likely to be piled by hydraulic hammers or blue piling hammer. In areas of rough seabed, drilling may aid the piling process, with drilling spoil disposed of at the drill site. The installation will be carried out from jack-up or floating vessels/barges with the required equipment.

3.4.2.2 Up to two monopiles may be installed in a 24-hour period, assuming concurrent piling operations. A "soft start" procedure will be employed whereby the hammer strikes will commence at 15% of the maximum hammer energy up to 100% of the maximum hammer energy (if required). Concurrent piling may involve the piling for wind turbine monopile foundations and/or HVAC OSP monopile foundations, but no more than two concurrent piling events will occur at any one time. The maximum design parameters for monopile foundations is shown in Table 3.20 and an illustrative monopile foundation is shown above in Figure 3.6.

Table 3.20: Maximum design parameters for foundation Option 1 piling characteristics (wind turbines and High Voltage Alternating Current Offshore Substation Platforms)

Parameter	Maximum design parameter for wind turbines	Maximum design parameter for HVAC OSPs
Maximum number of piles requiring piling	96	4

Parameter	Maximum design parameter for wind turbines	Maximum design parameter for HVAC OSPs
Maximum hammer energy (kJ)	6,600	
Soft Start Energy (% of Maximum Hammer Energy)	15	
Duration		
Maximum soft start duration (minutes)	20	
Maximum duration of piling (per pile) (hours)	24	
Minimum number of piles installed over 24 hours	1	
Maximum total number of days when piling may occur over construction phase	96	4
Concurrent piling		
Maximum number of concurrent piling events	2	
Minimum distance between concurrent piling events (m)	1,000	
Maximum distance between concurrent piling events (km)	37.10	

3.4.2.3 Pile driving is unsuitable in areas where hard ground is encountered. In these instances, drilling may be required, which initially involves the installation of a sacrificial caisson to support surficial soils during the drilling activities. The pile would then be lowered into the drilled bore and grouted in place. The voids (annuli) between the pile and the rock, and between the pile and the caisson are filled with inert grout, which is pumped from a vessel into the bottom of the drilled hole. Control measures and monitoring would be in place during this process to ensure minimal spillage to the marine environment. Drilling characteristics are presented in Table 3.21.

3.4.2.4 Drilling activities will result in release of seabed material (drill arisings) which will be deposited adjacent to each drilled foundation location within the Morven North Boundary.

Table 3.21: Maximum design parameters for foundation Option 1 drilling characteristics (wind turbines and Offshore Substation Platforms)

Parameter	Maximum design parameter for wind turbines	Maximum design parameter for OSPs
Maximum number of piles requiring drilling over Morven North	48	4
Maximum proportion (%) of all piles requiring drilling over Morven North	50	100
Minimum drilling rate (m/hour)	0.2	0.2
Maximum drilling rate (m/hour)	1.5	1.5
Maximum drilling depth (per pile) (m)	64	64

Parameter	Maximum design parameter for wind turbines	Maximum design parameter for OSPs
Maximum drilling duration (per pile) (hours)	320	320
Maximum drilling duration for Morven North (days)	600	54
Maximum volume of drill arisings per pile (m^3)	14,358 [13]	14,357
Maximum volume of drill arisings for Morven North (m^3)	571,894 [14]	57,428
Maximum number of concurrent drilling events	3	2

Installation of piled jacket foundations (foundation Option 2)

3.4.2.5 Pin piles are driven and/or drilled into the seabed relying on the frictional and end bearing properties of the seabed for support. Up to two vessels may be piling simultaneously, with concurrent piling being undertaken at a minimum distance of 1km between locations, and maximum distance of 37.10km. Concurrent piling may involve the piling for wind turbine jacket foundations and/or OSP jacket foundations, but no more than two concurrent piling events will occur at any one time. If hard ground is encountered, drilling will be required. The piling and drilling characteristics for pin piled jacket foundations are presented below in Table 3.22 to Table 3.25 for wind turbines and OSP Options 1 and 2.

Table 3.22: Maximum design parameters for foundation Option 2 piling characteristics (wind turbines)

Parameter	Maximum design parameter for wind turbines
Maximum number of piles requiring piling	384
Maximum hammer energy (kJ)	4,500
Soft Start Energy (% of Maximum Hammer Energy)	15
Duration	
Maximum soft start duration (minutes)	20
Maximum duration of piling (per pile) (hours)	9
Minimum average number of piles installed over 24 hours	2
Average number of piles installed over 24 hours	4
Maximum number of days when piling may occur	96
Concurrent piling	

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[13] Note that this value is based on a pile diameter of up to 16m drilled to a depth of up to 64m.

[14] Note that this value is based upon a scenario where up to 96 monopile foundations are installed with pile diameter of up to 15m, of which 50% require drilling to a depth of up to 60m

Parameter	**Maximum design parameter for wind turbines**
Maximum number of concurrent piling events	2
Minimum distance between concurrent piling events (m)	1,000
Maximum distance between concurrent piling events (km)	37.10

Table 3.23: Maximum design parameters for foundation Option 2 piling characteristics (Offshore Substation Platforms)

Parameter	**Maximum design parameter**			
	OSP Option 1		**OSP Option 2**	
	HVAC	**HVDC**	**HVAC**	**Bridge-Linked HVDC**
Maximum number of piles requiring piling	96	24	96	48
Maximum hammer energy (kJ)	4,000		4,000	
Soft Start Energy (% of Maximum Hammer Energy)	15		15	
Duration				
Maximum soft start duration (minutes)	20		20	
Maximum duration of piling (per pile) (hours)	9		9	
Minimum average number of piles installed over 24 hours	2		2	
Average number of piles installed over 24 hours	4		4	
Maximum number of days when piling may occur	24	6	24	12
Concurrent Piling				
Maximum number of concurrent piling events	2		2	
Minimum distance between concurrent piling events (m)	1,000		1,000	
Maximum distance between concurrent piling events (km)	37.10		37.10	

Table 3.24: Maximum design parameters for foundation Option 2 drilling characteristics (wind turbines)

Parameter	Maximum design parameter
Maximum number of piles requiring drilling over Morven North	192
Maximum proportion (%) of all piles requiring drilling over Morven North	50
Minimum drilling rate (m/hour)	0.39
Maximum drilling rate (m/hour)	1.6
Maximum drilling depth (per pile) (m)	83
Maximum drilling duration (per pile) (hours)	190.24
Maximum drilling duration for Morven North (days)	1,452
Maximum volume of drill arisings per pile (m^3)	2,178
Maximum volume of drill arisings for Morven North (m^3)	189,448
Maximum number of concurrent drilling events	3

Table 3.25: Maximum design parameters for foundation Option 2 drilling characteristics (Offshore Substation Platforms)

Parameter	Maximum design parameter			
	OSP Option 1		OSP Option 2	
	HVAC	HVDC	HVAC	Bridge-Linked HVDC
Maximum number of piles requiring drilling over Morven North	96	24	96	48
Maximum proportion (%) of all piles requiring drilling over Morven North	100	100	100	100
Minimum drilling rate (m/hour)	0.41	0.39	0.41	0.39
Maximum drilling rate (m/hour)	1.54	1.45	1.54	1.45
Maximum drilling depth (per pile) (m)	65	80	65	80
Maximum drilling duration (per pile) (hours)	190.24	246.15	190.24	246.15
Maximum drilling duration for Morven North (days)	761	247	761	493
Maximum volume of drill arisings per pile (m^3)	1,266	1,888	1,266	1,888

Parameter	Maximum design parameter			
	OSP Option 1		OSP Option 2	
	HVAC	HVDC	HVAC	Bridge-Linked HVDC
Maximum volume of drill arisings for Morven North (m^3)	121,558	45,306	121,558	90,611
Maximum number of concurrent drilling events	3	3	3	3

Installation of suction bucket jacket foundations (foundation Option 3)

3.4.2.6 The installation of a suction bucket jacket foundation will likely follow the steps set out below:

- At the installation site, the jacket foundations would be lowered by crane to the seabed.
- Water is pumped out of the bucket to suction it to the seabed.
- Once the bucket has penetrated the seabed to the expected depth of 25m, the pump is turned off.
- A thin layer of grout is then injected under the top side of the bucket to fill the void and ensure contact between the soil within the bucket, and the top of the bucket itself.

3.4.2.7 The TP and foundation structure is fabricated as an integrated part of the jacket structure and are not installed separately offshore. It should be noted that piling and drilling techniques are not required for installation of suction bucket jacket foundations, therefore, parameters have not been provided for these.

Installation of gravity base foundations (foundation Option 4 – Offshore Substation Platforms only)

3.4.2.8 Gravity base foundations can be either transported by a vessel or barge to site or self-floated and pulled by tugs. Lowering at location will be supported by self-flooding of the gravity base foundation with seawater, for some designs assisted by a suitable crane from a heavy lift vessel to the seabed.

3.4.2.9 After the gravity base foundation is installed, it will be ballasted with a suitable material such as gravel, rock, crushed concrete, aggregate, high density rocks (such as olivine or iron ore), or dredged sand (from site preparation works) before the TP is installed.

3.4.2.10 It should be noted that piling and drilling techniques are not required for installation of gravity base foundations, therefore, parameters have not been provided for these.

3.4.3 Offshore Substation Platform topside installation and commissioning

3.4.3.1 The OSP topsides will be transported to Morven North via vessel from the fabrication yard or pre-assembly harbour, following installation of foundations for OSPs. It is assumed that the OSP topsides will be transported by the installation vessel or on a barge towed by a tug. Once on site, the OSP topside will be rigged up, seafastening cut, lifted and installed onto the foundation. The topside and foundation will then be welded or bolted together. Rigging, welding and bolting equipment will be available on board the installation vessel.

3.4.4 Inter-array and interconnector cable installation

3.4.4.1 Installation (or lay) of inter-array cables and interconnector cables will be undertaken using a cable lay vessel, using various equipment such as a carousel or reels, tensioners and cable lay spread.

Inter-array cables and interconnector cables are typically surface laid prior to cable burial or installation of external cable protection post lay. Cable lay and cable burial can also be performed simultaneously.

3.4.4.2 Possible installation methods for inter-array and interconnector cables include ploughing, trenching and jetting whereby the seabed is opened and the cable laid within the trench (see Table 3.12 and Table 3.13 for all potential installation methods proposed as part of the PDE). The installation method will be defined post-consent with a detailed Cable Plan (CaP) incorporating a Cable Burial Risk Assessment (CBRA) which will take into account environmental and human considerations that could affect cable burial such as trawling and vessel anchors. The installation method chosen may be any or a combination of the techniques outlined in Table 3.12 and Table 3.13.

3.4.4.3 The inter-array cables will be buried where possible and protected with a hard protective layer (such as rock or concrete mattresses) where minimum burial depth is not achievable. Section 3.2.6 outlines external cable protection which may be employed and cable crossings which may be required.

3.4.5 Offshore wind turbines installation and commissioning

3.4.5.1 Wind turbines are typically installed using the following process:

- Step 1: Wind turbine components collected from a port in the UK, Europe or elsewhere and loaded onto barges or dedicated transport vessels at port and transported to the array area. Generally, blades, nacelles, and towers for a number of wind turbines are loaded separately onto the vessel.
- Step 2: Wind turbine components will be installed onto the existing foundations by an installation vessel. Each wind turbine will be assembled on site. The exact methodology for the assembly is dependent on the wind turbine type and installation contractor and will be defined in the pre-construction phase. Jack-Up Vessels (JUVs) are often used to ensure a stable platform for installing the wind turbine components.

3.4.5.2 Following installation, commissioning activities will then take place.

3.4.6 Installation vessel and helicopters

3.4.6.1 The details of vessel and helicopter movements with numbers of trips required for the construction phase are presented in Table 3.26. A number of vessel types will be used during the construction phase including Heavy Lift Vessels (HLVs), Cable Lay Vessels (CLVs), JUVs and support vessels. Support vessels are typically smaller than the main installation vessels and may comprise tugs, guard vessels, anchor handling vessels, or similar. These vessels will primarily shadow the same movements as the installation vessels they are supporting.

3.4.6.2 JUVs or barges touch down on the seabed when their jack-up spud cans (base structure of each leg) are lowered into place. Jack-up vessel parameters are presented in Table 3.27.

Table 3.26: Maximum design parameters for vessel and helicopter requirements during the construction phase

Vessel type	Maximum number of vessels on site at any one time	Maximum number of return trips over the construction period
Installation and support vessels	15	488
Tug/anchor handler	8	416
Cable lay installation and support vessels	4	162
Guard vessels	2	172

Vessel type	Maximum number of vessels on site at any one time	Maximum number of return trips over the construction period
Survey vessels	2	156
Seabed preparation vessels	3	50
Crew Transfer Vessels (CTVs)	6	1,460
Scour protection installation vessels	1	156
Helicopters	2	1,826
Total	43	4,886
Total (excluding helicopters)	41	3,060

Table 3.27: Maximum design parameters for jack up vessels

Parameter	Maximum design parameter
Maximum number of legs per vessel	4
Maximum area of spud cans (m^2)	1,600
Maximum number of jack-up positions per wind turbine	3
Maximum number of jack-up positions per OSP	3

3.4.7 Construction programme

3.4.7.1 A high-level indicative construction programme is presented in Table 3.28. The programme illustrates the likely window in which the construction of the major project components will occur. Note, for the purposes of assessment, where required a date of 2033 has been assumed as an indicative date for the commencement of construction, with the construction window being up to five years. The final construction commencement date and construction duration will become clearer as the project continues to mature, with confirmation of key factors such as agreement of grid connection dates, project financing/route to market etc.

Table 3.28: Indicative construction programme for Morven North

Activity (Time in brackets is time taken for completion, green colouring denotes window)	Year 1 construction				Year 2 construction				Year 3 construction				Year 4 construction				Year 5 construction			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Pre-construction UXO and boulder identification and removal (16 months)			🟩	🟩	🟩	🟩	🟩													
Foundation installation - piles (12 months)								🟩	🟩	🟩	🟩									
Foundation installation - jackets (18 months)									🟩	🟩	🟩	🟩	🟩	🟩						
Foundation installation - scour protection (9 months)									🟩	🟩	🟩									
Inter-array and interconnector cables - seabed preparation (15 months)							🟩	🟩	🟩	🟩	🟩									
Inter-array and interconnector cables - installation and test (12 months)											🟩	🟩	🟩	🟩						
Inter-array cables and interconnector - cable protection (6 months)														🟩	🟩					
Wind turbine installation and commissioning (21 months)														🟩	🟩	🟩	🟩	🟩	🟩	🟩
Topside installation and commissioning (18 months)														🟩	🟩	🟩	🟩	🟩	🟩	

3.4.8 Recommended safe passing distances and aids to navigation

Recommended safe passing distances and Notice to Mariners

3.4.8.1 The Applicant will ensure that other mariners are informed of safe clearance distances around construction, installation, maintenance, and decommissioning activities during the construction and operation of the Morven North, following standard practices and guidelines. Further details are provided in the Volume 2, Chapter 13: Shipping and Navigation.

Statutory safety zones

3.4.8.2 Volume 1, Chapter 2: Policy and Legislation outlines the legislation for establishing statutory safety zones. The Applicant plans to apply for the following safety zones for Morven North:

- temporary (or rolling) 500m safety zones around all surface-piercing structures where construction work is being carried out by a construction vessel;
- 50m safety zones around all partially completed or completed surface-piercing structures that are not yet fully commissioned during the construction phase;
- 500m safety zones around any structure undergoing major maintenance, as defined by the Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007.

Recommended safe passing distances

3.4.8.3 For the safety of third-party vessels, the Applicant may implement recommended safe passing distances during the construction, operation, maintenance, and decommissioning phases of Morven North. these distances will be communicated to other sea users through Notices to Mariners (NtMs).

Aids to navigation

3.4.8.4 A scheme for wind turbine lighting and navigation marking will be submitted to Scottish Ministers for approval following consultation with relevant consultees post consent. Outline plans have been provided in Volume 4 of the Morven North EIA Report and include the following:

- Volume 4, Annex 4: Lighting and Marking Plan (LMP) (Version 1);
- Volume 4, Annex 5: Navigation Safety Plan and Vessel Management Plan (NSPVMP) (Version 1).

3.4.8.5 The specifics of the lighting and navigation markings on the wind turbines will be discussed with consultees post-application.

3.5 Operations and maintenance phase

3.5.1.1 The overall operation and maintenance (O&M) strategy will be confirmed once the final design and technical specifications of Morven North are known. Note, for the purposes of assessment, where required an indicative date for the commencement of O&M activities has been assumed as 2038. This is consistent with current assumptions around construction commencement in 2033 with a duration of up to five years. This is considered a realistic assumption at this stage, however depending on the final construction dates, duration and sequencing of the Morven Programme, this date may differ.

3.5.1.2 Throughout the lifetime of Morven North, routine and non-routine O&M works will be undertaken. Routine maintenance activities may include inspections, removal of marine growth build up, minor repairs, cleaning activities, and the replacement of consumables and corrosion protection systems. Non-routine major maintenance activities may include but are not limited to component exchanges and replacement of infrastructure and equipment (e.g. wind turbine blades, gearboxes and interconnector and inter-array cables), scour protection and cable protection replenishment or replacement, cable reburial and cable repair activities, painting and other coating works, replacement of access ladders, and geophysical surveys.

3.5.1.3 Table 3.29 provides a list of O&M activities planned for Morven North.

Table 3.29: Maximum design parameters: operation and maintenance activities

Maximum design parameters	Description
Foundations (wind turbines and OSPs)	
Routine inspections	Inspections of foundations, including TPs and ancillary structures (e.g. J-tubes, scour protection), above and below sea level.
Geophysical and geotechnical surveys	Geophysical survey of seabed and assets which may include: • Multi-beam Echo-sounder (MBES); • Sidescan Sonar (SSS); • Single Beam Echosounder (SBES); • Sub-Bottom Profilers (SBP); • Ultra High Resolution Seismic (UHRS); • magnetometers and gradiometers; • It is possible that these surveys could be performed with Unmanned Survey Vessels (USVs) Geotechnical survey of seabed and assets which may include: • boreholes; • cone penetration tests (CPTs) and Seismic Cone Penetration Tests (SCPTs); • vibrocores; • downhole (DH) (Geophysical Equipment (Acoustic Televiewer, Natural Gamma, Caliper, PS Logger)); • ROVs.
Repairs and replacements of navigational equipment	Repair and replacement of electrical equipment such as lighting, fog horns, navigation lights and transponders.
Removal of marine growth	Removal of marine growth from foundations, transition pieces, or access ladders.
Replacement of corrosion protection anodes	Removal and replacement of anodes required for corrosion protection.
Painting	Application of paint or other coatings to protect the foundations from corrosion (internal or external), including surface preparation.
Replacement of access ladders and boat landings	Removal and replacement of ancillary structures (e.g. access ladders and boat landings).
Modifications to or replacement of J-tubes	Modifications to or replacement of J-tubes during foundation maintenance or repair works.
Wind turbines	
Routine inspections	Inspections within the wind turbine or on the exterior of the wind turbine, (e.g. blade inspections).

Maximum design parameters	Description
Replacement of consumables	Replacement of consumables within the wind turbine (e.g. filters, oils, lubricants).
Minor repairs and replacements within the wind turbine	Minor repairs and replacements (like-for-like) within the turbine (e.g. motors, pumps, small electric equipment, circuit breakers, fuses).
Major component replacement	Replacement of blades, gearboxes, transformers or generators.
Painting or other coatings	Paint or other coatings applied (internal/external). Coatings on the blades and minor paint repairs to tower and nacelle.
OSPs	
Routine inspections	Inspections within the OSP or on the exterior of the OSP.
Replacement of consumables and minor components.	Replacement of consumables (e.g. oils, lubricants) and minor components within the OSP.
Major component replacement	Replacement of transformers, switchgear etc.
Painting or other coatings	Paint or other coatings applied (internal/external).
Inter-array and interconnector cables	
Routine inspections	Inspections of the cable and any cable protection, including at their entry into J-tubes on offshore structures.
Geophysical surveys	Survey of seabed and assets: • Vessel with Side Sonar Scan (SSS); • Multibeam-echo sounder (MBES); • Sub-bottom profiler (SBP); • magnetometer (MAG); • no seabed interaction and subsea ROV with SOV. It is possible that these surveys could be performed with USVs.
Inter-array and interconnector cable repair	Repair and replacement of inter array and interconnector cable sections or whole inter array/interconnector cable.
Inter-array or interconnector cable reburial, mattressing and placement of rock bags	Reburial of exposed inter array and interconnector cable sections.
Modifications to or replacement of J-tubes	Modifications to or replacement of J-tubes (e.g. during inter array/interconnector cable repair works).

3.5.2 Operation and maintenance vessels

3.5.2.1 The general O&M strategy may rely on CTVs, service operation vessels, supply vessels, cable and remedial protection vessels, plus helicopters for the operations and maintenance services that will be performed at Morven North. The likely maximum number of O&M vessels on site at any one time, and per year, are presented in Table 3.30.

Table 3.30: Maximum design parameters for vessels and helicopters required during operation and maintenance phase

Parameter	Maximum number of vessels or helicopters on site at any one time North	Maximum number of return trips per year North
CTVs	8	219
Jack-up vessels	2	13
Cable repair vessels	2	3
SOVs and other vessels	3	59
USVs	4	60
Helicopters	2	1,660
Total	21	2,013
Total (excluding helicopters)	19	353

3.6 Decommissioning phase

3.6.1.1 Under Section 105 of the Energy Act 2004 (as amended), developers of offshore renewable energy projects are required to prepare a decommissioning programme for approval by Scottish Ministers. A Section 105 notice is issued to developers by the regulator after consent or marine licence has been issued for the given development. Developers are then required to submit a detailed plan for the decommissioning works, including anticipated costs and financial securities. The plan will consider industry practice, guidance and legislation relating to decommissioning at that time. The plan will be consulted on with relevant stakeholders and will be made publicly available. MD-LOT will further consult on the plan, the costs and financial securities prior to seeking ministerial approval. The decommissioning plan and programme will be updated during Morven North’s lifespan to take account of changing practice and new technologies.

3.6.1.2 At the end of the operational lifetime of Morven North, it is currently anticipated that all structures above the seabed or ground level (with the exception of monopiles/pin-piles (depending on foundation option chosen for wind turbines and OSPs), scour protection and cable protection) will be completely removed where this be feasible and practicable. Monopiles/pin-piles, scour protection and cable protection are either expected to remain fully or partly in situ depending on the most up to date legislation and guidance, best practice, and consideration of environmental conditions and sensitivities at the time of decommissioning.

3.6.1.3 The decommissioning sequence will generally be the reverse of the construction sequence and involve similar types and numbers of vessels and equipment. The Crown Estate Scotland Option Lease Agreement for Morven North requires decommissioning at the end of its lifetime.

3.6.2 Wind turbines and Offshore Substation Platforms

3.6.2.1 Wind turbines would be removed by reversing the methods used to install them, as described in Section 3.4.5.

3.6.2.2 OSPs may be decommissioned using the following procedure, which is the reverse of the installation method:

- assess the structural integrity and the weight of the topside;
- empty all tanks, remove all liquid and hazardous materials;
- terminate cable connections between the topside and the foundations;
- cut the steel connections between the topside and the foundation;

- lift the topside off the substructure and place on a barge/transport vessel for transportation to onshore;
- complete decommissioning onshore. Demobilise used equipment, recycle and dispose of all components.

3.6.3 Foundations

3.6.3.1 If Foundation Options 1 or 2 are selected, these would likely be cut below the seabed level and the foundation will be removed in a single lift including the transition piece. This means they would not create a hazard for fishing or shipping. The portion of the monopile/pin-pile foundation below seabed level will be left in situ to reduce seabed disruption, however, this will be reviewed throughout the lifetime of Morven North. Suction bucket foundations can be removed in entirety using the overpressure to release them from the seabed, reversing the method of installation. Jackets will be fully removed from site.

3.6.3.2 As the decommissioning programme will be updated during the lifespan of Morven North, it may be decided, closer to the time of decommissioning, that removal will result in greater environmental impacts than leaving components in situ. The Applicant's position is that scour protection will preferably be left in situ, but removal has been assessed as the MDS.

3.6.3.3 In the case of gravity base foundations which may be selected as an option for the OSPs only, it is expected that following removal of the topsides and ballast, the foundation may be removed using a single lift from the transition piece. With this method, the suction at seabed may cause the base slab to detach from the foundation. In this case, the foundation should be cut above the base slab before removal, this would leave the base slab on the seabed. It is also possible that, depending on the weight of the foundation, it may be re-floated using buoyancy tanks and towed back to shore. In either case, this should be in reverse of the installation procedure.

3.6.4 Inter-array cables and interconnector cables

3.6.4.1 It is proposed that cables will be removed where possible and appropriate to do so. This approach will be reviewed at the time of decommissioning following the most up to date and best available guidance. There is potential that where cables are buried, these may be cut and left in situ. Therefore, for the purpose of the Morven North EIA Report, each topic has assessed the scenario deemed to be most adverse with respect to topic receptors, meaning that the most adverse scenario may be cable removal or to leave in situ. The Applicant's position is that cable protection (including cable ducting, rock dumping, etc) will preferably be left in situ, however removal has been assessed as the MDS.

3.7 Quality, health, safety, security and environment

3.7.1.1 The Applicant has a strong focus on Quality, Health, Safety, Security and Environment with the associated company policy, together with processes and procedures, ensuring that Morven North will be safe by design and that this is verified.

3.7.1.2 Morven North will be risk assessed according to the relevant government guidance as well as the Applicant's internal best practice. These risk assessments will then form the basis of the methods and safety mitigations put in place across the life of Morven North.

3.7.1.3 The Applicant has a focus on employee safety with the policy ensuring that their wind farms and places of work are safe by design and that the processes and procedures are adhered to. There is a clearly defined safety culture in place in order to avoid incidents and accidents.

3.7.1.4 There will be constant controls to ensure that the safety measures are observed and followed, and the Applicant has built a safe workplace for its employees and contractors.

3.8 Waste management

3.8.1.1 Waste will be generated as a result of Morven North, with most of the waste expected to be generated during the construction and decommissioning phases.

3.8.1.2 Procedures for handling waste materials will be described in a Site Waste Management Plan (SWMP), which will be part of the final EMP. The SWMP will describe and quantify the waste types arising from Morven North activities and how these will be managed (dispose, reuse, recycle or recover). The SWMP is detailed within Volume 4, Annex 1: Environmental Management Plan (EMP) (Version 1).

3.8.1.3 The SWMP will be developed once further detailed design information is available, prior to construction.

3.9 Repowering

3.9.1.1 In sectors where non-renewable resources like oil and gas are being extracted, it is standard practice to remove all structures from the seabed during offshore decommissioning. However, for offshore renewable energy projects, repowering may be considered as an alternative, especially since the demand for the generated power will likely persist at the time of decommissioning.

3.9.1.2 Morven North is expected to have an operational lifespan of 35 years, during which regular upkeep and maintenance will be necessary, as detailed in Section 3.5. Near the end of its design life, repowering Morven North might be appropriate, particularly if new technology becomes available. This could involve reconstructing and replacing wind turbines and/or foundations with those of different specifications or designs. If the new specifications and designs fall outside the parameters of the MDS or if the impacts associated with construction, operation, maintenance, and/or decommissioning exceed those considered in Morven North EIA Report, additional consent(s) and potentially a new EIA Report may be required for repowering. Consequently, this falls outside the scope of the current Morven North EIA Report.

3.10 Designed-in measures

3.10.1.1 The Applicant has committed to implementing a number of designed-in measures as part of the development of Morven North. Since these measures are integrated into the project design of Morven North, they have been considered in the topic-specific assessments found in Volume 2, Chapters 7 to 21, of the Morven North EIA Report. Additional information on the designed-in measures, secondary mitigation, and monitoring commitments can be found in Volume 3, Annex 6.3: EIA Commitment Register, of the Morven North EIA Report.

3.11 Residues, emissions and waste

3.11.1.1 As required by the EIA Regulations, a description of the expected residues, emissions, and wastes generated by Morven North, along with the resulting LSE[1] from pollutants, sound, vibration, light, heat, radiation, nuisances, and waste disposal and recovery, must be provided. These requirements, along with their corresponding sections in Morven North EIA Report, are detailed in Table 3.31.

Table 3.31: Residues and emissions

Morven North EIA report requirement	How and where considered within the Morven North EIA report
A description of the expected residues, emissions, and waste production, where relevant, is required. Additionally, a description of the project's LSE[1] on the environment due	The following chapters assess the LSE[1] associated with the emission of sound and vibration and associated nuisances:

Morven North EIA report requirement	How and where considered within the Morven North EIA report
to the emission of pollutants, sound, vibration, light, heat, radiation, the creation of nuisances, and the disposal and recovery of waste must be provided	- Volume 2, Chapter 8: Benthic Subtidal Ecology; - Volume 2, Chapter 9: Fish and Shellfish Ecology; - Volume 2, Chapter 10: Marine Mammals; - Volume 2, Chapter 21: Inter-related and Ecosystem Effects; - Volume 3, Annex 10.1: Marine Mammals Shared Baseline Technical Report. The following chapters assess LSE[1] associated with electromagnetic fields: - Volume 2, Chapter 8: Benthic Subtidal Ecology; - Volume 2, Chapter 9 Fish and Shellfish Ecology; - Volume 2, Chapter 10: Marine Mammals. Disposal and recovery of waste is addressed in: - Volume 4, Annex 1: Environmental Management Plan (EMP) (Version 1).

3.12 Natural resources

3.12.1.1 The EIA Regulations also require a description of the anticipated LSE[1] resulting from the use of natural resources. These requirements, along with their corresponding sections in the Morven North EIA Report, are detailed in Table 3.32.

Table 3.32: Natural resources

Morven North EIA report requirement	How and where considered within the Morven North EIA report
A description of the project's LSE[1] on the environment resulting from the use of natural resources, particularly land, soil, water, and biodiversity, considering the sustainable availability of these resources as much as possible.	This chapter describes the use of natural resources. The following chapters assess seabed disturbance (land and soil): - Volume 2, Chapter 7: Physical Processes; - Volume 2, Chapter 8: Benthic Subtidal Ecology; - Volume 2, Chapter 9: Fish and Shellfish Ecology.

Morven North EIA report requirement	How and where considered within the Morven North EIA report
	The following chapters assess the use of rocks: - Volume 2, Chapter 8: Benthic Subtidal Ecology; - Volume 2, Chapter 12: Commercial Fisheries; - Volume 2, Chapter 13: Shipping and Navigation.

3.13 References

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