GREEN VOLT

Chapter 5

Project Description

Offshore EIA Report: Volume 1

Revision history

Revision	Date	Description	Prepared	Checked	Approved
1	31/03/2022	First draft	SF (Royal HaskoningDHV)	JM (Royal HaskoningDHV)	VC (Flotation Energy)
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3	09/01/2023	Final for submission	SF (Royal HaskoningDHV)	CM (Royal HaskoningDHV)	VC (Flotation Energy)

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Acronyms

Acronym	Description
AC	Alternating Current
ADD	Acoustic Deterrent Devices
AIS	Automatic Identification System
BEIS	Department for Business, Energy and Industrial Strategy
CAA	Civil Aviation Authority
CCTV	Closed Circuit Television
CfD	Contracts for Difference
CLV	Cable Lay Vessel
CNOOC	China National Offshore Oil Corporation
CO_2	Carbon Dioxide
CTV	Crew Transfer Vessel
DoB	Depth of Burial
EIA	Environmental Impact Assessment
ERCoP	Emergency Response Cooperation Plan
FID	Final Investment Decision
GPS	Global Positioning System
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
HLV	Heavy Lift Installation Vessel
HV	High Voltage

HVAC	High Voltage Alternating Current
IAC	Inter-Array Cable
INTOG	Innovation and Targeted Oil and Gas
KIS-ORCA	Kingfisher Information Service - Offshore Renewable & Cable Awareness
kJ	Kilojoule
kV	Kilovolt
LAT	Lowest Astronomical Tide
LV	Low Voltage
MCA	Maritime and Coastguard Agency
MGN	Marine Guidance Note
MHWS	Mean High Water Springs
MMMP	Marine Mammal Mitigation Plan
MPA	Marine Protected Atea
MW	Megawatt
MY	MingYang Wind Turbine Generator Manufacturer Option 3
NLB	Northern Lighthouse Board
NSTA	North Sea Transition Authority
NtM	Notice to Mariners
O&G	Oil and Gas
O&M	Operation and maintenance
OnTI	Onshore Transmission Infrastructure
OSP	Offshore Substation Platform

OWF	Offshore Wind Farm
PD	Pile Driving
Q1	Quarter 1
Q4	Quarter 4
ROV	Remotely Operated Vehicle
s.36	Section 36
SAC	Special Area of Conservation
SCADA	Supervisory Control And Data Acquisition
SP	Suction Piling
SPA	Special Protection Area
SSP	Semi-Submersible Platform
TLP	Tension Leg Platform
TPV	Third Party Verification
UK	United Kingdom
UV	Ultraviolet
UXO	Unexploded Ordinance
WTG	Wind Turbine Generator(s)

Glossary of Terms

Term	Description
Applicant	Green Volt Offshore Windfarm Ltd.
Buzzard	Buzzard Platform Complex.
Buzzard Export Cable Corridor	The area in which the export cables will be laid, from the perimeter of the Windfarm Site to Buzzard Platform Complex.
Green Volt Offshore Windfarm	Offshore windfarm including associated onshore and offshore infrastructure development (Combined On and Offshore Green Volt Projects).
Horizontal Directional Drilling	Mechanism for installation of export cable at landfall.
Inter-array cables	Cables which link the wind turbines to each other and the offshore substation platform.
Landfall Export Cable Corridor	The area in which the export cables will be laid, from the perimeter of the Windfarm Site to landfall.
Mean High Water Springs	At its highest and 'Neaps' or 'Neap tides' when the tidal range is at its lowest. The height of Mean High Water Springs (MHWS) is the average throughout the year, of two successive high waters, during a 24-hour period in each month when the range of the tide is at its greatest (Spring tides).
Moorings	Mechanism by which wind turbine generators are fixed to the seabed.
NorthConnect Parallel Export Cable Corridor Option	Landfall Export Cable Corridor between NorthConnect Parallel Landfall and point of separation from St Fergus South Export Cable Corridor Option.
NorthConnect Parallel Landfall	Southern landfall option where the offshore export cables come ashore.
Offshore Development Area	Encompasses i) Windfarm Site, including offshore substation platform ii) Offshore Export Cable Corridor to Landfall, iii) Export Cable Corridor to Buzzard Platform Complex.
Offshore export cables	The cables which would bring electricity from the offshore substation platform to the Landfall or to the Buzzard Platform Complex.
Offshore Export Cable Corridor	The proposed offshore area in which the export cables will be laid, from offshore substation to landfall or to the Buzzard Platform Complex.
Offshore infrastructure	All of the offshore infrastructure, including wind turbine generators, offshore substation platform and all inter-array and export cables.
Offshore substation platform	A fixed structure located within the Windfarm Site, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable form for export to shore.
Onshore Export Cable Corridor	The proposed onshore area in which the export cables will be laid, from landfall to the onshore substation.
Project	Green Volt Offshore Windfarm project as a whole, including associated onshore and offshore infrastructure development.

Safety zones	An area around a structure or vessel which must be avoided.
St Fergus South Export Cable Corridor Option	Landfall Export Cable Corridor between St Fergus South Landfall and point of separation from NorthConnect Parallel Export Cable Corridor Option.
St Fergus South Landfall	Northern landfall option where the offshore export cables come ashore.
Windfarm Site	The area within which the wind turbine generators, offshore substation platform and inter-array cables will be present.

CHAPTER 5:PROJECT DESCRIPTION

5.1 Introduction

1. This chapter of the **Offshore Environmental Impact Assessment (EIA) Report** provides a description of the key components of the Project (in this instance the Project refers to the offshore elements of the Green Volt Offshore Windfarm only, up to Mean High Water Springs (MHWS)), as well as details of how the windfarm will be constructed, operated, maintained and decommissioned. The details within this chapter inform and underpin the assessments undertaken for each technical chapter of the **Offshore EIA Report** (**Chapters 7 to 20**).

2. As outlined in **Chapter 1: Introduction**, the Project is being developed by Flotation Energy Ltd. Flotation Energy are leading the Project development and have formed the dedicated company, Green Volt Offshore Windfarm Limited (hereafter referred to as 'the Applicant'), to progress the development of the aim to complete construction of the Project and be operational by 2027.

3. The Project will provide oil & gas (O&G) platforms in the Outer Moray Firth with renewable electricity, harnessed from the proposed windfarm. The Project will provide electrification of the Buzzard O&G platform complex (herein called Buzzard), whilst various other Outer Moray Firth platforms will also have the potential to use electricity generated by the Project.

4. Buzzard is one of the UK's largest O&G assets and a relatively new facility with high power demand. Focusing our initial design around the decarbonisation of Buzzard provides an exciting opportunity to maximise potential emission savings, whilst offering a nearby connection point for other oil and gas installations looking to decarbonise their onboard power generation. The Project will also provide renewable energy to the Scottish mainland.

5. The Project enables 500,000 tonnes of carbon dioxide (CO_2) per year to be mitigated, including 300,000 tonnes of CO_2 from the electrification of oil and gas assets in the area.

6. The Offshore Development Area is anticipated to occupy an array area of 116 km^2, with a maximum export capacity of approximately 490 and 560 megawatts (MW) generated by up to 35 floating wind turbine generators (WTG) harnessing average wind speeds of 10.98 m/s. The Windfarm Site will be located on the Ettrick and Blackbird decommissioned O&G brownfield site at depths of 100 – 115 m (**Chapter 4: Site Selection and Assessment of Alternatives**).

7. The Project will have two Offshore Export Cables – the first to electrify Buzzard located approximately 20 km away, and the second to bring excess electricity to shore, reaching landfall around 80 km away near Peterhead, on the Aberdeenshire coast (**Figure 5.1**).

8. The key offshore components comprise:

   - wind turbine generators;
   - substructures and foundations;
   - mooring and anchoring;
   - offshore substation platform (OSP);
   - inter-array cables (IAC);
   - up to two export cables to Buzzard; and
   - up to two export cables to landfall.

5.2 Notable Design Considerations

9. This section details considerations factored into the refinement of the Project design.

5.2.1 Revised Windfarm Capacity

10. The base case proposal for a 30-turbine wind farm, as presented in the **Offshore Scoping Report** (Royal HaskoningDHV 2021) (**Appendix 1.2**), was designed to accommodate the delivery of renewable electricity to Buzzard. Buzzard is a major target for decarbonisation and provides an “anchor tenant” for the Project, with a baseload demand of 70 MW and CO_2 emissions of over 300,000 tonnes per year from its existing power generation. With the launch of the Innovation and Targeted Oil and Gas (INTOG) leasing round, alongside the North Sea Transition Deal and the increased focus on UK energy security (**Chapter 2: Need for the Project** and **Chapter 3: Policy and Legislative Context**), the capacity of the Project has been increased to a maximum of 35 turbines, to allow for the possibility of future connections to other O&G fields in the Outer Moray Firth.

11. The change in turbine numbers has been discussed with Marine Scotland Licensing Operations Team (MS-LOT) during the consultation process and upon advice received has been fully assessed as part of the **Offshore EIA Report**. MS-LOT confirmed no additional steps in the application process would be required. This change is not considered to alter the findings of the **Offshore Scoping Report** (**Appendix 1.2**) or the subsequent **Scoping Opinion** (MS-LOT, 2022) (**Appendix 1.1**). Furthermore, the change in turbine numbers has not affected any of the data gathering, methods of analysis or impact assessments conducted.

5.2.2 Wind Farm Site Boundary Adjustments.

12. At the time of scoping, the red line boundary encompassed a Windfarm Site of 144 km^2. This area been successfully refined by 20% to 115.98 km^2 despite the decision to scale the Project capacity by 17%.

13. Firstly, the southeast corner of the Windfarm Site was removed, reducing the site from 123.42 km^2 to 116.79 km^2. During stakeholder engagement and consultation with the local fisheries community, it was identified that the southeast portion of the red line boundary was of importance to the commercial fishing industry **(Chapter 4: Site Selection and Assessment of Alternatives** and **Chapter 13: Commercial Fisheries).** In response, the Applicant made the decision to completely remove this portion of the red line boundary of the site to minimise adverse effects on the fisheries community.

14. Secondly, an area to the northeast of the Windfarm Site was removed, reducing the site by 5.54 km^2. This reduction was the result of Crown Estate Scotland placing a buffer zone between the INTOG lease area Eb, and a carbon capture storage site licensed by the North Sea Transition Authority (NSTA) to Storegga Limited for their Acorn project. This 5.54 km^2 reduction ensures the Project is maintained within the boundary of the INTOG lease area and minimises adverse effects on other marine users.

15. To offset the reduction in Windfarm Site area due to the refinements discussed above, the Applicant has increased the Project’s western boundary by 4.73 km^2 to accommodate the new design envelope. The Applicant already had all necessary survey data for this area, and it remains within the INTOG lease area Eb.

5.2.3 Landfall Optioneering

16. The Applicant has undertaken landfall feasibility studies to refine landfall options down from five to the two presented later in this chapter (**Section 5.8.2.2**).

17. Other than the ‘NorthConnect Parallel’ option, the coastline South of Boddam has been removed from landfall considerations and not deemed suitable due to residential infrastructure.

18. There were no appropriate landfall options in the town of Peterhead because of existing land use and infeasible horizontal directional drilling (HDD) length.

19. St Fergus offers three landing point options, all favourable because of the topography, geological conditions and attainable HDD drill length. These options also permit a relatively direct route offshore towards the 12 nm boundary. NorthConnect Parallel Landfall is also feasible, with a shorter HDD drill length, but greater elevation difference to account for in HDD design.

20. St Fergus and NorthConnect Parallel (a total of four possible landing point options across two landfall locations) have been selected and taken forward as favoured options for landfall and will be described in more detail later in this chapter.

21. The Applicant has taken every opportunity to ensure that the most appropriate landfall option is selected with no significant effects to the environment.

LEGEND

🟥 Green Volt Offshore Wind Farm

🟦 Offshore Export Cable Corridor

0 20

Kilometres

Data:
Esri, HERE, Garmin
Esri, HERE
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Contains data from OS Zoomstack

PROJECT: GREEN VOLT

TITLE: Figure 5.1 Green Volt Offshore Windfarm development area including possible export cable to landfall route options

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GREEN VOLT

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5.3 Summary of the Offshore Development Area

22. **Table 5.1** outlines the key characteristics of the offshore elements of the Project. Onshore works are considered in a separate onshore EIA Report submitted separately (**Onshore EIA Report**).

Table 5.1 Summary of the Project Parameters for Assessment

Component	Parameter	Current assumed values for assessment
Site	Location	Decommissioned Ettrick and Blackbird O&G field (Brownfield Site)
	Windfarm Site Area	116 km^2
	Water depth	100 - 115 m
	Distance to shore from site boundary	80 km
	Mean Wind Speed	10.98 m/s
Turbines	Number of WTG within the array	Up to 35
	Single WTG capacity (MW)	Up to 16
	Rotor Hub Height (m)	132 – 143
	Rotor Tip Height (m above Lowest Astronomical Tide ;LAT)	242 - 264
	Rotor Diameter (m)	220 - 242
	Windfarm Total Rotor Swept Area (km^2)	1,330 – 1,610
	Spacing between WTG (m)	1,540 – 1.936
Substructure	Sub-Structure Type	Semi-submersible Platform (SSP) or Tension leg platform (TLP)
	Mooring Lines	Catenary (for SSP) or TLP tendons
	Minimum mooring radius (m)	100 - 650
	Anchor	Drag embedment anchors (for SSP) or Suction Piles (TLP)
	Maximum Number of Anchors (per turbine)	3-6 (SSP) or 6 (TLP)
	Elevation Above Waterline (m)	7 m (SSP) or 19 m (TLP)
	Colour	Yellow
	Navigation Lighting	As required by Civil Aviation Authority (CAA) and Maritime and Coastguard Agency (MCA)
Inter-Array Cables	Number of Inter-Array Cables	Up to 35 + 7 strings (42)
	Length of Inter-Array Cables (km)	3.2 per Inter-Array cable (IAC). In total 134
	Rated Capacity (kV)	66
	Installation	Surface laid on seabed with rock berm or trenched (trenching, jetting, ploughing, mechanical cutting and rock mattressing) to proposed trench depth
	Number of concrete mattresses per crossing	Up to 15
	Quantity of OSP	1
	Structure Type	4-legged jacket

Component	Parameter	Current assumed values for assessment
Offshore Substation Platform	Anchorage Technique	Pile Driving (PD), Suction Piling (SP)
Export Cables	Number	4 total, 2 cables to Buzzard, 2 cables to Landfall
	Cable Technology	Three-core armoured High voltage alternating current (HVAC)
	Rated Capacity (kV)	up to 66 (B), up to 275 to landfall
	Total Cable Length (km)	60, to Buzzard, 240 to landfall
	Installation Method Offshore	Trenching, jetting, ploughing and mechanical cutting
	Burial at Landfall	HDD
Landfall Works	Landfall Location	2 potential sites in the vicinity of Peterhead, Aberdeenshire, one of which will be chosen
	Number of Landfall Export Cables	2 cables maximum to one landfall site

5.4 Project Timeline

23. The overarching aim of the Project is to electrify the production of offshore O&G at Buzzard in the North Sea from the earliest possible time point, quarter 4 (Q4) of 2027. A high-level project schedule is shown in **Figure 5.2**.

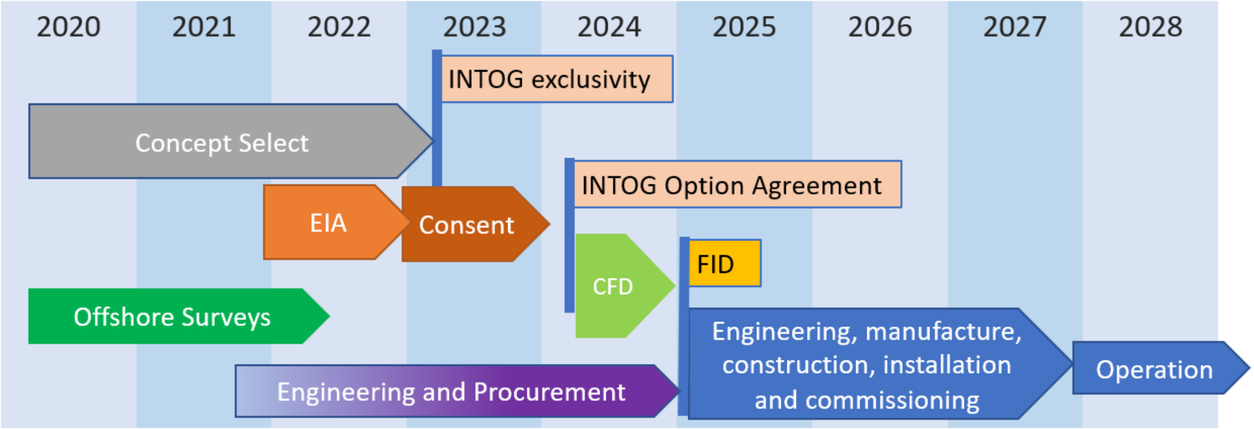

Figure 5.2 Green Volt Offshore Windfarm proposed timeline[1]

24. As addressed in **Chapter 2: Need for the Project,** the primary business case for the construction and operation of the Project rests upon its ability to remove CO_2 emissions produced by power generation for offshore O&G facilities, and to eliminate these emissions from the earliest possible time point. This will accelerate the UK's journey towards Net Zero emissions and the goals of the North Sea Transition Deal (**Chapter 3: Policy and Legislative Context)**.

25. O&G fields have a limited lifetime and any delay to project completion impacts both the ability to mitigate emissions and the business case for completion ahead of eventual O&G facilities decommissioning.

26. Floating wind has limited deployment but with huge potential for development of the offshore wind energy sector into deeper waters around the UK. The UK Government has announced a target for 1 GW offshore floating wind installation by 2030 and the Project provides a substantial contribution towards this target, building UK experience and driving down the cost of future offshore floating wind.

27. In order to meet the criteria for the Contracts for Difference (CfD) scheme in 2024, the Applicant requires prior consent for construction to be obtained from Scottish Ministers. the Applicant aims to begin construction in Quarter 4 (Q4) of 2025 and begin operation in Q4 of 2027.

5.5 Design Envelope Approach

28. The design envelope approach will be adopted for the **Offshore EIA Report**, in accordance with current best practice and Marine Scotland Advice on Electricity Act 1989 - Section 36 (s.36) applications (Marine Scotland 2022). This advice recognises that: "the nature of the proposed development and evolving technology mean that some aspects of the final project are yet to be settled in precise detail at the time that the application is submitted (such as the precise location of certain

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[1] CfD defines the Contracts for Difference (CfD) scheme, which is the government's main mechanism for supporting low-carbon electricity generation. Renewable generators in the UK that meet the eligibility requirements can apply in an auction round. Successful developers of renewable projects enter into a private law contract with the Low Carbon Contracts Company (LCCC), a government-owned company. Developers are paid a flat (indexed) rate for the electricity they produce over a 15-year period; the difference between the 'strike price' (a price for electricity reflecting the cost of investing in a particular low carbon technology) and the 'reference price' (a measure of the average market price for electricity in the GB market).

types of infrastructure, the foundation type, the size of certain structures or the turbine model). Where that is the case and some details are still the be finalised, the design envelope approach can be employed for such applications to enable a degree of flexibility and address these uncertainties."

29. The design envelope described in this chapter provides for a reasoned minimum and maximum extent for each parameter to establish the extent to which the project could impact on the environment. The final detailed design of the Project will be developed and refined within this consented envelope prior to construction, with the final design lying between the minimum and the maximum extent of the consent. This approach allows for detailed design work to be undertaken post-consent without rendering the assessment inadequate or falling outside the consented parameters. Furthermore, this approach allows for the relevant planning authority and regulator to confidently reach a decision based on an assessment of the worst-case scenario. This approach to the EIA, is further described in **Chapter 6: EIA Methodology.**

30. Therefore, the information presented in this chapter outlines the options required and the range of potential design and activity parameters upon which the subsequent impact assessment chapters are based. Where appropriate, each impact assessment chapter contains a section detailing the worst case scenario for specific receptors and impacts. These worst case scenario sections are derived from the information provided in this chapter.

5.5.1 Need for Flexibility

31. Detailed design work for the Project will occur post consent, when pre-construction site investigations will further inform the detailed design. The need for flexibility in the consent is a key aspect of any large development but is particularly significant for offshore wind projects where technology continues to evolve quickly. The design envelope must provide sufficient flexibility to enable the Applicant and its contractors to use the most up to date, efficient and cost-effective technology and techniques in the construction, operation, maintenance and decommissioning of the Project.

32. Key aspects for which flexibility is required include:

- turbine manufacturer, capacity and parameters due to the evolution of technology prior to offshore construction of the Project;
- number and capacity of offshore electrical platforms and export cables;
- build-out scenarios/ phasing options to enable the Applicant to construct the offshore wind farm in a way which produces power to the O&G platforms and/or the National Grid as early as possible whilst maximising efficiencies during construction; and
- construction and maintenance methodologies, as above, to enable competitive procurement and the most cost-effective option to be adopted.

33. This chapter outlines the range of parameters for the aspects of the project where flexibility is required, along with maximum and minimum values where relevant and appropriate.

5.6 Key Project Terminology

34. This project description uses specific terms for different elements of the offshore and onshore project areas and infrastructure. These terms are also used within the technical chapters (**Chapter 7 to Chapter 20**). For clarity, these terms are summarised in the **Glossary**.

5.7 Site Description

35. The proposed development area is located on the decommissioned Ettrick and Blackbird O&G fields, 80 km off the coast of Peterhead in the North Sea. Ettrick and Blackbird ceased oil and gas production in 2016 and are now brownfield sites with a well-developed data set from previous works.

Constructing the Project here provides proximity to the target consumers, as Buzzard is located 20 km away.

36. The bathymetry of the Windfarm Site is generally a flat seabed with no significant underwater slopes or features. The WTGs will float above waters 100 m - 115 m deep. The Landfall Export Cable Corridor extends back towards the Aberdeenshire coast along gently sloping seabed which gradually rises as it gets closer to the landfall, where a known underwater sharp rise is noted.

37. The geology of the seabed of the Windfarm Site is made up of Swatchway Formation with patches of Witch Ground Formation overlying. The Swatchway Formation is closely linked to the Coal Pit Formation and comprises disturbed sands, silts and muds. The Witch Ground Formation is generally formed of silty clays and sands and is characterised by ‘pockmarks’ which are likely formed by undersea gas escape. Infrastructure will not be situated in pockmarks (where there is the potential for submarine structures from leaking gases) due to the risk of shallow gas.

38. Along the Landfall Export Cable Corridor, the geology largely comprises of the Forth Formation, characterised by marine sands and soft muds ranging from 5-50 m thick, with the coastal area comprising more sand and gravel. Unconsolidated sediments in the vicinity of the development area are very unlikely to be mobilised.

39. The Windfarm Site has a mean annual wave height 2 - 2.25 m with semi-diurnal tides flowing from south to north. The highest astronomical tide (HAT) relative to the lowest astronomical tide (LAT) has been recorded at 3.26 m. As expected, due to the distance offshore, the tidal range is limited in comparison to more inshore locations.

40. The mean annual wind speed in the North Sea increases with distance from shore out to about 40 km, after which the impact of the land is significantly reduced. For the Windfarm Site, the average annual wind speed is recorded at 10.80 - 10.98 m/s, significantly higher than the inshore offshore wind farm sites in Scottish waters and will result in higher operational hours for the turbines.

41. The two proposed export cable corridor options (**Section 5.8.2.2**) pass through the Southern Trench Marine Protected Area (MPA) located on the east coast of Scotland.

42. The Southern Trench MPA has been designated to protect, amongst others, the following features:

- Minke whale (**Chapter 11: Marine Mammal Ecology**); and
- Burrowed mud (**Chapter 8: Marine Sediment and Water Quality, Chapter 9: Benthic Ecology**).

43. The Southern Trench MPA takes its name from a long deep trench which was carved out by glaciers. The trench feature functions as a nursery ground for juvenile fish and provides habitat for crustaceans including *Nephrops* and crabs.

44. If the NorthConnect Parallel Landfall option (**Section 5.8.2.2**) is chosen, then the Landfall Export Cable Corridor may lead to interaction with the Buchan to Collieston Cliffs Special Protection Area (SPA). The Buchan to Collieston Cliffs SPA protects the breeding site for the following bird species (See **Chapter 12: Offshore and Intertidal Ornithology):**

- Fulmar
- Guillemot
- Herring gull
- Kittiwake

45. The closest offshore developments to the Project’s Offshore Development Area (other than Buzzard) include the Hywind Scotland Pilot Park also located off the coast of Peterhead, and another China National Offshore Oil Corporation (CNOOC) installation, at the Golden Eagle O&G Field. The Hywind

Scotland Pilot Park lies approximately 52 km southwest from the Windfarm Site and the Landfall Export Cable Corridor will likely cross the Hywind export cable as it approaches Peterhead (**Chapter 17: Infrastructure and Other Marine Users**). Further to this, several ScotWind Planning Options are located to the north (NE7) and south (E2) of the Windfarm Site, which have been awarded to MarramWind and Vattenfall respectively in Q1 of 2022.

46. For further site details see the environmental baseline sections of technical chapters (**Chapter 7 – 20**).

5.8 Project Offshore Infrastructure

47. The technical details of the Project offshore infrastructure are presented within two broad categories:

- Windfarm Array: presents the specification of all infrastructure within the Windfarm Site; and
- Offshore Transmission Works: presents the specification of all offshore infrastructure outside of the Windfarm Site.

5.8.1 Windfarm Array

48. The Windfarm Array will comprise up to 35 WTGs, with a maximum overall capacity of 560 MW.

49. The array will occupy an area of 116 km^2 within the Windfarm Site. Power generated by these WTG will be collected via a series of IAC and transported to a single OSP. An indicative WTG array layout within the offshore consent boundary is shown below in Figure 5.3**.**

50. Key design considerations for the current layout have to date been influenced by geophysical and geotechnical seabed characteristics, stakeholder engagement (particularly with the commercial fisheries), and avoiding existing O&G infrastructure on the seabed (**Chapter 4: Site Selection and Assessment of Alternatives** and **Chapter 13: Commercial Fisheries**).

51. The final array layout will be determined when all statutory consents are in place and the Development has secured a CfD.

5.8.1.1 Wind Turbines

52. The selected WTG is expected to have a rated capacity of between 14 to 16 MW depending on the type of turbine selected. the Applicant is currently considering conventional three blade, horizontal axis WTG from three manufacturers, GE Halide X 14 MW, Vestas V236 15 MW, and MingYang MY-SE 16MW-242, however, no final decision has yet been made.

53. The maximum height of the WTG is to be up to 264 m from LAT to the blade tip in the vertical position. The minimum air draft above MHWS will be 22 m. The rotor diameter is based on two times the individual blade length, plus the diameter of the rotor hub. The rotor diameter is between 220 m and 242 m. The rotor hub height is determined from the blade length plus the blade tip clearance. For the WTG options considered, the rotor hub height is expected to be 132 m to 143 m. If tension leg substructures are used these rotor hub height values will vary with tidal range as well. The maximum and minimum rotor tip heights are based on the rotor diameter and the respective maximum or minimum blade clearance required above LAT. These WTG parameters among others are presented in **Table 5.2**.

54. To maximise the wind farm efficiency at harnessing energy, and to avoid excessive turbulent wake effects, the minimum spacing between structures under consideration (measured centre-to-centre) is 1,540 m and the layout is considered to be compliant with the requirements of Marine Guidance Note (MGN) 654 (MCA, 2021).

55. WTG operating wind speeds fall within the range of 3 metres per second (m/s) to 28 m/s. Above the cut-out speed of 28 m/s, the rotor is stopped to prevent damage to the WTG.

56. The nacelle will be mounted on top of a WTG tower which is a tubular steel column with typical base diameter of between 6.5 and 10 m. The transition piece connects the WTG tower to the substructure and can also house any communication equipment.

57. The WTG nacelle will house the power generation equipment, including the drive system, generator and brake.

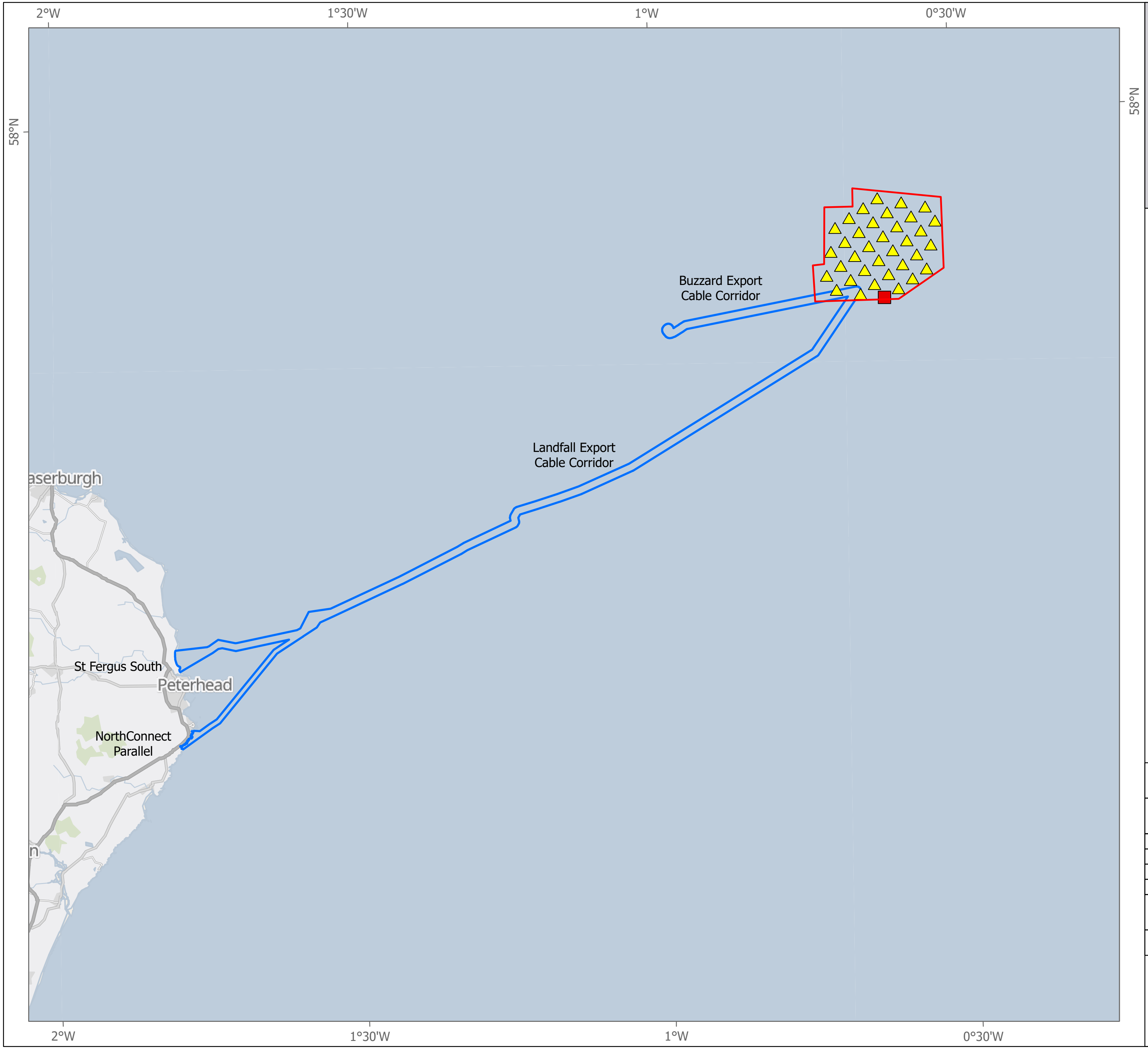
58. Each WTG will have its own control system to carry out functions like yaw control and ramp down in high wind speeds. The WTG monitoring and Supervisory Control And Data Acquisition (SCADA) control system will also be located in the nacelle.

59. The rotor, nacelle and upper tower sections will be painted in semi-matt pale grey colour. The lower tower section or substructure of each WTG, from approximately 15 m above HAT to 2 m below LAT, will be painted with a high visibility yellow colour to satisfy the requirements of the CAA, MCA and Northern Lighthouse Board (NLB). (**Figure 5.4**).

60. The range of all WTG dimensions within the Design Envelope, are given in Table 5.2**.**

Table 5.2 WTG Parameters for Assessment

Parameter	Parameter Limit	
	Min	Max
Number of WTG within the array	35	
Single WTG capacity (MW)	14	16
Number of Blades	3	
Axis	Horizontal	
Blade Tip Clearance (m above MHWS)	22	22
Rotor Hub Height (m)	132	143
Rotor Tip Height (m above LAT)	242	264
Rotor Diameter (m)	220	242
Operating Wind Speed Range (m/s)	Cut in: 3 – 5; Cut out: 28	
Windfarm Total Rotor Swept Area (km^2)	1,330	1,610
Rotor Swept Area per turbine (km^2)	38	45.9
Spacing between WTG (m)	1,540	1,936
Colour	Matt light grey/off white, with yellow substructure	
Navigation Lighting	As required by CAA, MCA, etc	



LEGEND

- ▭ Green Volt Offshore Wind Farm
- ▭ Offshore Export Cable Corridor
- △ Indicative turbine locations
- ■ Offshore Substation Platform

0 20
Kilometres

Data:
Esri, HERE, Garmin, USGS
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Contains data from OS Zoomstack

PROJECT: GREEN VOLT

TITLE: Figure 5.3 Preliminary arrangement of turbines and substructure at Green Volt Project Area

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Figure 5.4 A 9.5 MW turbine supported by a semi-submersible substructure as used on the Kincardine floating windfarm

5.8.1.1.1 Substructures and Anchorage

61. Floating wind farm technology requires substructures to position and stabilise the WTG for operation. Floating substructures, require mooring to anchors on the seabed in order to maintain position the WTG throughout the lifetime of the development. For the Project, there are currently three floating substructure options being considered:

Option 1 – Semi Submersible Platform

62. The first substructure option is a SSP, secured to the seabed using an asymmetric catenary mooring system. The semi-submersible floating platform will provide buoyancy to support the floating WTG and counteract the overturning momentum from the high wind speeds.

63. The mooring system will attach to drag embedment anchors weighing approximately 10 to 35 tonnes. Due to seabed sediment conditions at the site, this type of anchorage is assessed as the most effective. The catenary mooring system was previously successfully employed for the floating installation at the Ettrick and Blackbird O&G field. Expected mooring line radius is 650 m in length, equating to a total seabed footprint of 1,950 m^2 per turbine.

64. No driven pin piling anchorage methods are being considered.

65. An example image of this substructure option is provided in **Figure 5.5**.

66. The semi-submersible floating platform comprises three or four vertical columns of 14 m diameter, inter-connected with a truss structure composed of main beams, connecting columns and bracings. Secondary structures include two boat landings, deck space and railings (for personnel access) and associated equipment including two J or I tubes for the IAC access. The platform is expected to have

a width of 110 m, a depth of 125 m with an operational draught of 13 m with six mooring points (Table 5.3).

Option 2 – Semi Submersible Barge

67. A similar substructure to the semi submersible platform in option 1.

68. The mooring system will also attach to drag embedment anchors weighing 10 to 35 tonnes, with no driven pin piles.

69. A damping barge consists of is a square ring-shaped hull fitted with a large central opening called a damping pool. The dampening effect of the oscillating water column in the damping pool allows for a relatively compact design with a shallower draught. The mooring arrangement is as per the semi-submersible using either a catenary or semi-taught system with 3 - 6 mooring lines connected to drag embedment anchors or suction pile anchors.

70. An example image of this substructure option is provided in **Figure 5.5**.

Option 3 - Tension Leg Platform

71. The third foundation option is a TLP, which is secured using vertically moored tendons, attached to the seabed using a suction piled anchor system.

72. No driven pin piling anchorage methods are being considered.

73. An example image of this substructure option is provided in **Figure 5.5**.

74. A typical sketch of the two different mooring and anchorage methods are presented in Figure 5.6 and **Figure 5.7.**

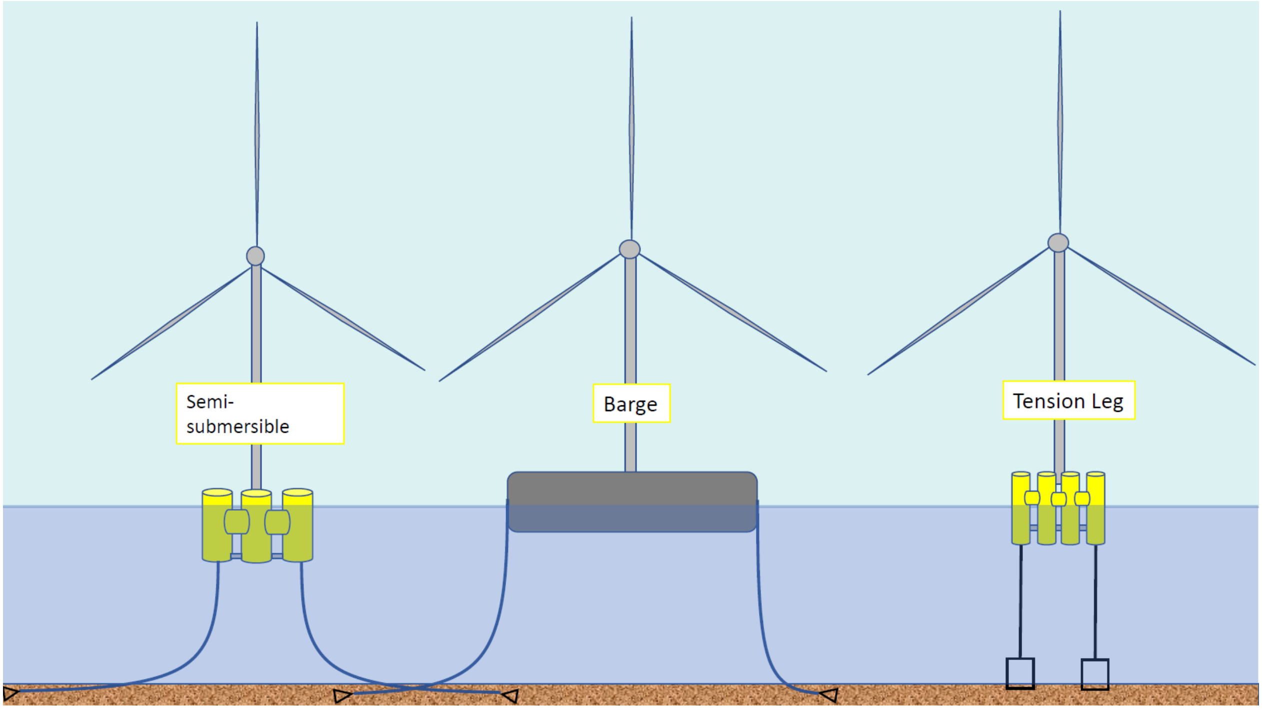
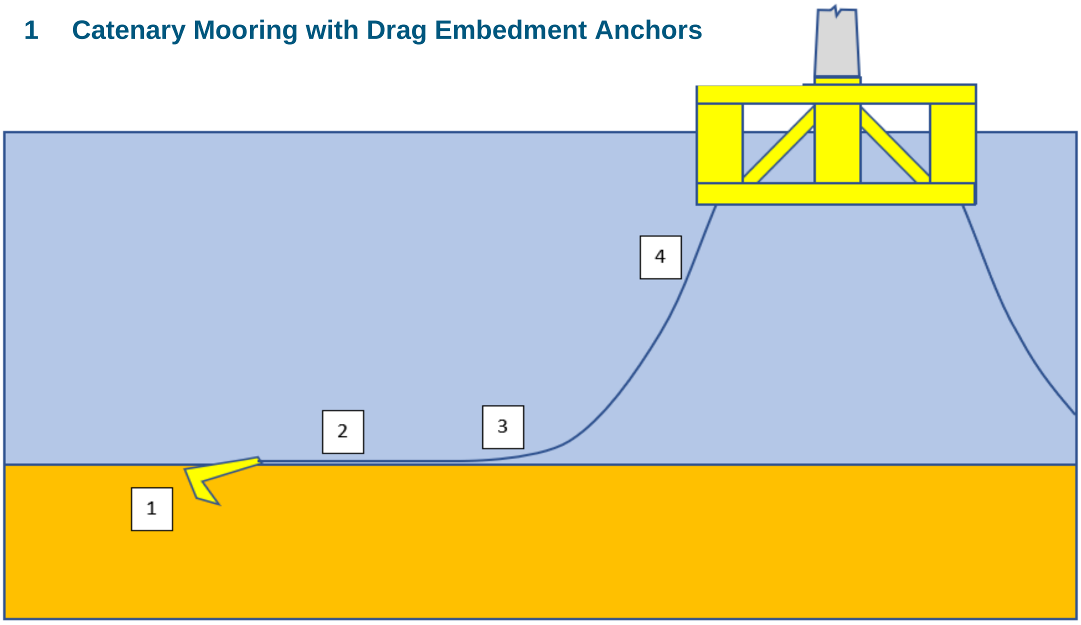
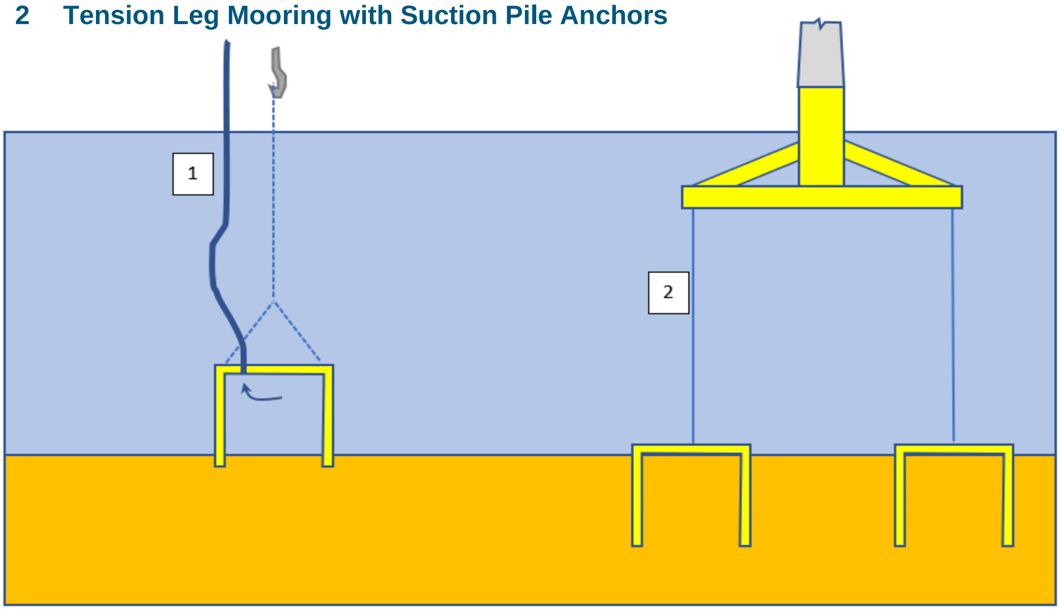


Figure 5.5 Figure showing three different substructure options. Option 1: Semi-Submersible Platform, option 2: Semi-Submersible Barge and option 3 – Tension Leg Platform



1 Catenary Mooring with Drag Embedment Anchors

Figure 5.6 An overview sketch of the Catenary mooring system with Drag Embedment anchors. ***1 =*** *Drag embedment anchor pre-installed by a vessel by placing on seabed and applying line tension to become embedded.* ***2 =*** *Fore-runner chain section remains stationary on seabed.* ***3 =*** *Touchdown chain section that accommodates floater motion.* ***4 =*** *Top chain self-weight generates tension to keep the floater on-station.*



2 Tension Leg Mooring with Suction Pile Anchors

Figure 5.7 An overview sketch of the Tension Leg Mooring system with Suction Pile anchors. ***1 =*** *Suction pile is lowered to the seabed, then seawater is pumped out of the inner volume to draw the suction pile into the seabed using the natural hydrostatic effect.****2 =*** *Once all suction piles are installed, the Tension Leg Platform is connected to suction piles via tendons.*

Scour Protection

75. Marine structures such as fixed turbine foundations, and cables, can be susceptible to erosion, or scouring of the bed sediment in the vicinity of their foundations due to the action of waves, currents and tides. If necessary, scour protection can be installed to ensure that erosion of the seabed around the foundation does not affect the stability, or integrity of the structure.

76. Scour protection is provided by rock placement around the foundation. Floating substructures, reliant upon a catenary mooring or TLP systems, reduce interaction with the seabed significantly and reduce potential for scour.

77. Further to this there is already estimated to be low rates of sediment scour around the anchors for the floating turbines at the Windfarm Site (**Chapter 7: Marine Geology, Oceanography & Physical Processes**). This is supported by the 2021 geophysical decommissioning survey data of the Ettrick and Blackbird O&G installations, and the clear visibility of the placement of previous anchor systems on the seabed in this zone.

78. Therefore, for option 1 and 2, scour protection will not be required at the Windfarm Site. As a conservative assumption, for substructure option 3 the suction pile anchors are expected to require scour protection at an estimated total area of 1,414 m^2 for the Windfarm Site.

79. Installation methods are outlined below in **Section 5.9.**

Table 5.3 Floating Substructure Parameters for Assessment

Parameter	Min/Max Parameter Limit		
	Option 1: Semi-Submersible Platform	**Option 2: Semi-Submersible Barge**	**Option 2: Tension Leg Platform**
Mooring Lines	Catenary		TLP Tendons
Mooring Line Radius (m)	650		100
Diameter Around Each Turbine (m)	1694		
Anchor	Drag embedment anchors		Suction Pile
Maximum Number of Anchors (per turbine)	3-6		6
Anchor Weight (tonnes)	10 – 35		100
Anchor Seabed Displacement (per turbine; m^2)	10 m x 10 m (per anchor) 600 (per turbine)		
Seabed Footprint (per turbine; m^2)	1,950		471
Active Benthic Footprint (per turbine; m^2)	1,950		1,885
Active Benthic Footprint (per turbine; m^2)	1,950		1,885
Elevation Above Waterline (m)	7 m		19 m
Geometry	Equilateral 3 or 4 sided		3 sided
Platform Width (m)	110		86
Platform Depth (m)	125		98

Parameter	Min/Max Parameter Limit		
	Option 1: Semi-Submersible Platform	**Option 2: Semi-Submersible Barge**	**Option 2: Tension Leg Platform**
Operational Draught (m)	13		19
Maximum Horizontal Face Length (m)	125		100
Diameter of Vertical Columns (m)	14		9
Access Points	2 x boat-landings		
Electrical Cable Access	2 x J or I-tubes		
Mooring Points	6		
Colour	Yellow		
Navigation Lighting	As required by CAA, MCA, etc		

5.8.1.2 Inter-Array Cables

80. The IAC network of the Windfarm Site collects the electrical power generated at the WTG and connects to an OSP, where the combined generated power can be converted to a higher voltage for transmission to Buzzard, other O&G platforms in the Outer Moray Firth and connection to the UK national grid onshore.

81. The IAC will consist of a three-core dynamic HVAC subsea cable rated up to 66 kilovolts (kV) and fibre optic system, which will be installed in a “free hanging” or “lazy wave” configuration to decouple the floater induced motion from the catenary, achieving a mid-water arch by means of distributed buoyancy modules.

82. The preferred option for IAC laying technique is still to be confirmed however the Project is considering trenching, jetting, ploughing and mechanical cutting. and surface laid with protection overlain.

83. For all trenching techniques, burial depth is expected between minimum 0.6 to 1.5 m, with expected trench width of 3 m. Jetting and ploughing options would result in a seabed disturbance width of 10 m, and a total area of disturbance of 1.34 km^2. Where possible, the Project will aim to actively backfill the cable trench to achieve the required cable burial depth.

84. The alternative non-buried installation technique being considered is a surface laid cable with external protection achieved by means of rock berm or ‘mattressing’. The average width of rock berm for this IAC laying option is expected to be 10 m with a height of 1.5 m. The volume of rock berm protection required per km of IAC would be 8,250 m^3 /km.

85. It is anticipated that a small 20 m portion of IAC approaching the turbine foundation will need to be surface laid with rock berm protection. Rock berm for this section is expected to have a width of 5 m and have a seabed coverage of 100 m^2.

86. The cables will connect the WTG together into 7 ‘strings’ of 5 units (Figure 5.8). To retain project design flexibility, the total array cable length of 134 km is based on an estimate for regular array layouts with a range of WTG spacing, with an additional factor to allow for the potential adoption of irregular array layouts. The WTG array strings will then be connected to the OSP.

87. Within the Windfarm Site there are three cables and six pipelines which could result in the need for cable crossing works (**Chapter 17: Infrastructure and Other Marine Users).**

88. The design and methodology of these crossings will be confirmed in agreement with the asset owners; however, it is expected that a small layer of rock berm will be placed over the existing asset for protection. The IAC will then be laid perpendicularly (or as close to that as possible) across this and covered by a second post-lay layer of rock/mattresses to ensure that the IAC remain protected and in place. The estimated footprint of external cable protection at the cables and pipeline crossings is 2,100 m^2.

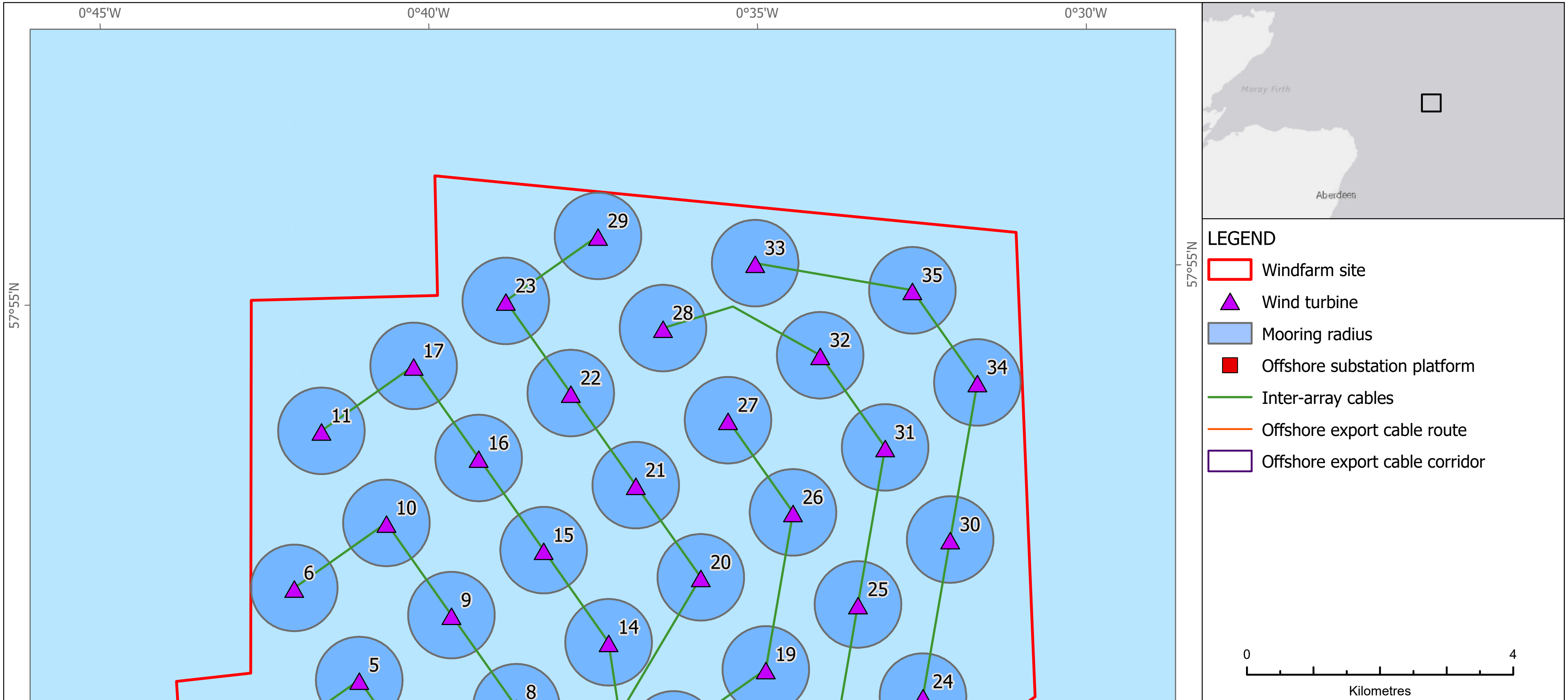
89. The precise array cable layout will be confirmed by the final WTG mooring design and layout configuration, optimised for production of power given the prevailing wind direction on site and features on the seabed. IAC layout will also be influenced by ground conditions, electrical losses, installation limitations, environmental constraints and economic factors.

90. Installation methods are outlined below in **Section 5.9**.

91. The key parameters of the IAC, including cable protection, are set out in **Table 5.4.** An example of the IAC configuration for the full Windfarm Site is presented in **Figure 5.8**.

Table 5.4 Inter-Array Cable Parameters for Assessment

Parameter	Min/Max Parameter Limit
Number of Inter-Array Cables	Up to 35 + 7 strings (42)
Length of Inter-Array Cables (km)	3.2 per IAC. In total 134
Cable Outer Diameter (mm)	220
Rated Capacity (kV)	66
Installation	Surface laid on seabed with rock berm or trenched (trenching, jetting, ploughing, and mechanical cutting) to proposed trench depth
Burial	Extent of burial to be confirmed
Proposed Trench Depth (m)	1.5
Proposed Trench Width (m)	3
Proposed Rock Berm Protection Volume (m^3)	8,250
Proposed Height of Rock Berm (m)	1.5
Proposed Width of Rock Berm (m)	10
Number of Cable Crossings	3 (umbilicals)
Number of Pipeline Crossings	6
Crossing Technique	Rock Berm/Concrete Mattressing'
Number of concrete mattresses per crossing	15
Total Volume of Rock Berm per Crossing (m^3)	3,150
Total Area of Rock Berm protection per Crossing (m^2)	2,100
Total Length of Crossings (m)	300
Height of Crossing (m)	1
Width of Crossing (m)	7



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TITLE: Fig 5.8 Indicative Windfarm Layout

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5.8.1.3 Offshore Substation Platform

92. The Applicant plans for power generated by each string of WTG to be brought to a single OSP, located to optimise the IAC and export cable lengths. At the OSP, the generated power will be transformed to a higher Alternating Current (AC) voltage of up to 66 kV for export to Buzzard, and up to 275 kV for export to Onshore Transmission Infrastructure (OnTI). The OSP will also provide relevant metering of power to Buzzard and to the onshore grid connection point.

93. The Applicant expect this OSP to be supported on a jacket substructure likely similar in scale and size as the standard offshore transmission substation, such as those used by the other offshore wind farms in the Moray Firth (Figure 5.9). However, the Applicant recognises the Windfarm Site is in deeper waters further away from the shore than other Moray Firth OWFs.

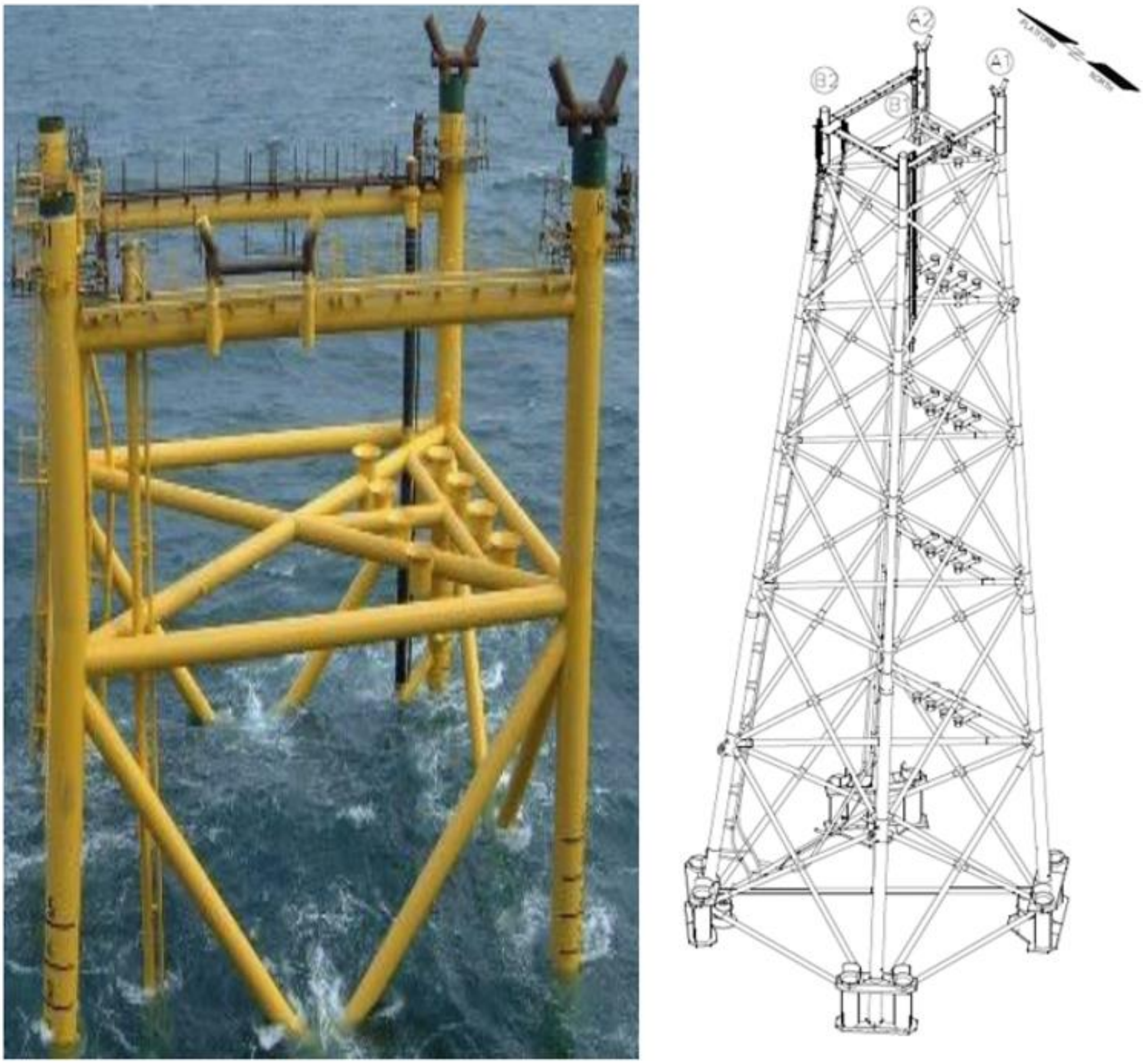


Figure 5.9 A 4-legged Jacket option used for the Goldeneye O&G Field Platform located in North Sea block 14/29, adjacent to block 20/3 where the Offshore Development Area will be located.

Figure 5.10 Siemens Offshore Transmission Module solution utilised on the Moray East Offshore Windfarm. The Green Volt OSP will be similar. Figures obtained from https://news.siemens.co.uk/news/siemens-wins-order-for-its-largest-offshore-grid-connection-in-the-uk-to-date

94. **Table 5.5** presents the design parameters under consideration for the Project’s OSP.

95. The maximum footprint plan for the OSP will be 43 m x 33.5 m with the topsides comprised of several decks stacked on top of another as required (**Figure 5.10**).

96. The OSP jacket substructure options include a 4-legged jacket secured to the seabed by either pile driving (PD) or suction piling (SP).

97. The piles for the PD design option would have a maximum diameter of 3 m and will be driven down into the seabed to a maximum penetration depth of 50 m. The maximum hammer driving energy is 2300 kJ. The piles for the suction pile design option would have a larger maximum diameter of 14 m and will be driven down into the seabed to a maximum penetration depth of 20 m.

98. The PD installation method is discussed in **Section 5.9.1.4.**

99. Equipment and facilities may consist of:

- high voltage (HV) power transformers;
- HV switchgear and busbars;
- substation auxiliary systems and Low Voltage (LV) distribution;
- instrumentation, metering equipment and control systems;
- standby generators;
- shunt reactor(s);
- auxiliary and uninterruptible power supply systems;
- navigation, aviation and safety marking and lighting;
- systems for vessel access and/or retrieval;
- potable water supply;
- black water separation;
- storage (including stores, fuel, and spares); and
- communication systems and control hub facilities.

100. Scour protection will be installed around the base of the jacket substructure to ensure that erosion of the seabed around the foundation does not affect the stability, or integrity of the structure. Further details of the expected scour protection are provided in **Section 5.9.1.4.**

Table 5.5 Offshore Substation Parameters for Assessment

Parameter	Min/Max Parameter Limit	
Quantity of OSP	1	
Structure Type	4-legged jacket	
Height of OSP (above LAT, m)	70	
Weight (tonnes)	2,600 (jacket); 3,074 (topside)	
Maximum Topside length (m)	43	
Maximum Topside width (m)	33.5	
OSP Footprint Area Per Foundation (m^2)	452	
Anchoring Technique	**Pile Driving**	**Suction Piling**
Maximum hammer driving energy (kJ)	2300	N/A
OSP Footprint Area Per Foundation (m^2)	452	982.5
Number of piles per foundation	4	4

Parameter	Min/Max Parameter Limit	
Pile Diameter (m)	3	14
Seabed Penetration Depth (m)	50	20
Pile Footprint (m^2)	7.1	154
Scour Protection Material	Rock (gravel and cobble)	
Scour Protection Area Per Foundation (m^2)	1,781	3,314.1
Scour Protection Volume Per Foundation (m^3)	2,672	4,971
Scour Protection Depth (m)	1.5	
Scour Protection Diameter (m)	24	35.4

5.8.2 Offshore Transmission Works

5.8.2.1 Export Cables

101. The Project will export directly to Buzzard and to the Scottish mainland via export cables from the OSP. See **Figure 5.1** for an overview of the proposed export cable works.

5.8.2.1.1 To Buzzard

102. Two three-core armoured HVAC cables with a voltage of either 33 or 66 kV are proposed to export electricity to Buzzard, 20 km away from the indicative location of the OSP. A maximum cable length of 30 km per export cable is expected.

5.8.2.1.2 To Landfall

103. The Project will utilise the same cable technology for the export cables for the cables from the OSP to landfall. Two three core armoured HVAC cables are proposed, but to reduce transmission losses and minimise the number of export cables required to landfall, the voltage carried (up to 275 kV) will be higher than that to Buzzard. The offshore export cables will carry electricity approximately 80 km to the landfall location. A maximum cable length of 120 km per export cable is expected to reach the OnTI.

104. Two potential landfall options are under consideration and landfall is anticipated to be installed through HDD.

105. **Table 5.6** provides a summary of the expected design envelope for export cables. Installation methods are outlined below in **Section 5.9.2.**

Table 5.6 Export Cable Parameters for Assessment

Parameter	Design Envelope	
	To Buzzard	To Landfall
Number of Cables	2	
Cable Technology	Three-core armoured HVAC	
Rated Capacity (kV)	Up to 66 kV	Up to 275
External Cable diameter (mm)	215	300
Cable Length from OSP (km)	60	240
Installation Method Offshore	Trenching, jetting, ploughing and mechanical cutting	
Trench Width Per Cable (m)	3	

Parameter	Design Envelope	
	To Buzzard	To Landfall
Trench Depth (m)	0.6 - 1.5	
Indicative width of disturbance from Jetting or Ploughing Options (m)	10	
Indicative area of disturbance from Jetting or Ploughing Options (km^2)	0.60	2.40
Separation Distance Between Cables (if unbundled, m)	50	
Burial at Landfall	HDD	
Burial Offshore if Depth of Lowering not achieved	Rock deposits in trench to bury cable if the sediment removed from trench does not provide sufficient material to bury cable.	
Scour Protection	None considered – to be monitored during operational phase	

106. Cable burial/armouring requirements will be assessed following the completion of side scan and sub bottom profiling surveys. Should any sections of the marine cable require additional protection following combined lay/burial operation, then this will be provided by post lay jet burial, engineered, localised rock deposits or mattressing. All additional protection works would aim to keep with the profile of the seabed.

107. Sections of cable may also be fitted with additional cast iron or synthetic external cladding to provide localised protection in certain areas. It is expected that this additional protection would only be needed for the inshore portion of the export cables (within approximately 15 km of shore).

5.8.2.2 Landfall Works

108. As outlined in **Chapter 4: Site Selection and Assessment of Alternatives**, the landfall location for the export cable has not yet been determined; however, two principal options are under consideration (**Figure 5.11**):

- option 1: **St Fergus South** Located north of Peterhead with three possible landing points for an onshore / offshore jointing pit and onward cable to New Deer. Locations to the north allow the project to avoid the Buchan Ness to Collieston SPA and Special Area of Conservation (SAC) but provide a more complex path onshore with a number of river crossings on route to the project substation at New Deer.
- option 2: **NorthConnect Parallel** located south of Peterhead with one landing point for an onshore / offshore jointing pit and onward cable to New Deer. Locations to the south may require crossing the Buchan Ness to Collieston SPA and SAC via HDD and is co-locating with the NorthConnect HVDC Link cable.

109. The final decision on landfall location will be determined following a detailed evaluation of the potential routes from the landfall options and New Deer, which will be presented within the **Onshore EIA Report**.

110. It is expected that for both options 1 and 2 the cable will be landed via a conduit drilled by HDD. Due to cable lay vessel draft limitations, the HDD punch-out location will be at least -5m LAT, but could be as much as -10m LAT. With respect to -5m to -10m LAT, the distance will likely be between 400m and 1000m from shore for the St Fergus options, and the North Connect Parallel option south of Boddam will be between 500m and 700m from shore.

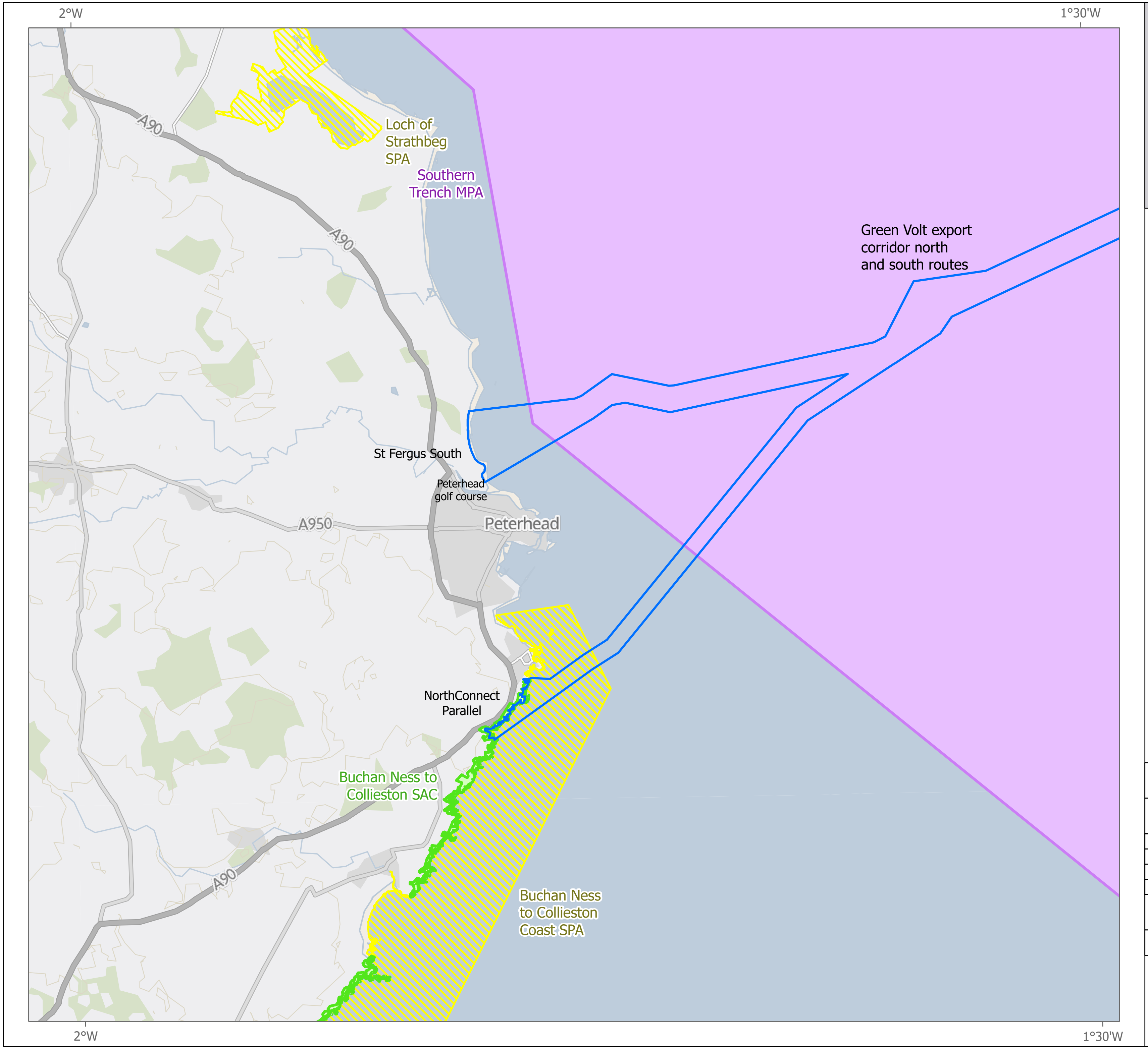
111. A single jointing pit will be used to provide the connection point between the two offshore export cables and onshore export cable. Phase compensation reactor(s) will be permanently installed above

the jointing pit. The final size of the site will be 20 by 8 m. The jointing pit and onshore infrastructure will be located outside the Buchan Ness to Collieston SPA.

112. For an overview of the works at Landfall, see **Table 5.7**. Installation methods are outlined below in **Section 5.9,** and detailed in the **Onshore EIA Report.**

Table 5.7 Landfall Parameters for Assessment

Parameter	Min/Max Parameter Limit
Landfall Location	2 sites being considered in the vicinity of Peterhead, Aberdeen. St Fergus South option or the NorthConnect Parallel option.
Number of Landfall Export Cables at decided option	2
Number of Bores	2, one for each export cable
Bore Diameter (mm)	750 - 900



LEGEND

- 🟦 Offshore Export Cable Corridor
- 🟩 Special Area of Conservation (SAC)
- 🟪 Marine Protected Area (MPA)
- ▨ Special Protection Area (SPA)

0 4
Kilometres

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TITLE: Figure 5.11 Landfalls Options 1 NorthConnect Parallel and Option 2 St Fergus South.

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5.9 Construction

113. One of the main advantages of floating offshore wind substructures is that a considerable amount of the offshore site construction activity can take place onshore in port construction zones before the fully assembled units are towed out to site for mooring and electrical cable connection. This not only substantially reduces the extent of marine operations associated with the project construction; therefore, significantly reducing vessel presence and underwater marine noise against a fixed offshore wind farm installation, but also the requirement for very large specialist construction vessels during installation operations. The duration of floating offshore wind turbine construction activities is significantly shorter than that of traditional fixed foundation wind turbines. The WTG are expected to be operational in 2027 with the assumption that one substructure and corresponding floating turbine can be assembled and towed out to site each week.

114. The aim is to design out the scenario where an emergency tow is required by following appropriate design codes and draw on experience gained by the oil and gas industry. The number of mooring lines per floating substructure allows for some failure (in relation to metocean conditions or vessel allision, for example) whilst maintaining integrity of the mooring system. The materials for each mooring line are selected to ensure stability and wear resistance, whilst the attachment points are designed for fatigue.

115. During construction, all aspects of the mooring system and the attachment points will be subject to thorough scrutiny. As the floating substructures are classed as ships, there will be compliance with flag state rules and a class surveyor will be present throughout. Third party verification (TPV) of the mooring systems will be undertaken by an independent and competent body to ensure they meet the required standards. Once at the Windfarm Site, a programme of inspection of the floating substructures and mooring systems will be in place on a pre-determined cycle.

116. Each unit will have a Global Positioning System (GPS) system which sets off an alarm if movement starts goes beyond a pre-set limit, for example from a ship allision. It should be noted that this limit is less than what would be expected from a mooring failure and would trigger a response to check the moorings. The alerts will be provided to the Marine Coordination Centre.

117. The floating substructures will probably have mooring bollards that could take tow lines. However, onboard access would be required to attach tow lines, which may be challenging in adverse weather conditions. In such an event, warning mechanisms will be used to give adequate notification to ensure the safety of other sea users until weather conditions are suitable for a towing connection to be made. The procedures for emergency situations will all be detailed in an Emergency Response Cooperation Plan (ERCoP) that will be approved by the MCA and the NLB.

118. When the units are under tow to or from the wind farm site there will be emergency tow bridles in place, in addition to the tow lines. The bridles float on the surface with a buoy at the free end, but these are not permanent features as the floating lines can be degraded by ultraviolet (UV) and marine growth and potentially fail at the critical moment.

119. Initial onshore fabrication and offshore construction is planned to start in Q4 of 2025 following the project Final Investment Decision (FID) process. Construction is scheduled to take three years, with the aim of connecting Buzzard to the UK grid by Q4 2027 and thus beginning the Project’s operational phase.

120. There are uncertainties remaining in the current construction methodology for the Project. However, an overview of the anticipated construction methodology has been summarised below.

121. Project construction will be completed in a number of stages as follows:

- pre-construction surveys and seabed preparation activities;

- WTG assemble and pre-commissioning;
- WTG integration;
- mooring installation;
- export cable installation;
- substructure integrated with WTG tow–out;
- mooring hook up;
- array cable installation;
- OSP jacket installation and piling;
- array cable connection;
- OSP topside installation; and
- final WTG commissioning.

122. See **Figure 5.12** for an indicative outline of the construction programme.

		2023				2024				2025				2026				2027			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Site investigation Pre-Construction	**Engineering Surveys**		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩										
Offshore Substructure Installation (incl. moorings)	**Offshore Substructure Installation and Commissioning**												🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	
Offshore Construction	**WTG Assembly and Pre-Commissioning**																🟩	🟩	🟩		
	WTG Commissioning																		🟩	🟩	
	HDD																🟩	🟩			
	Substation Piles Jacket & Topside Installation																	🟩	🟩		
	Export Cables Installation																	🟩	🟩		
	Array Cables Installation and Pull in																	🟩	🟩	🟩	

Figure 5.12 The Project programme for offshore construction

5.9.1 Windfarm Array

5.9.1.1 Assembly of WTG Units and Substructures (at Port)

123. It is proposed that the WTG will be assembled and commissioned on the semi-submersible floating platform at a port facility in the sheltered waters of a port/harbour along the east coast. It is also anticipated that the final stages assembly of the semi-submersible floating platform, prior to WTG integration, are also undertaken at the same local port, if facilities are determined sufficient to support this work. However, this will be confirmed following submission of the consent application.

124. The assembly of the WTG units involves the mounting of the assembled WTG and tower onto the upended and ballasted WTG platform (**Figure 5.13**).

125. Prefabricated primary sub-components of the substructure will be moved into position using Self Propelled Modular Transporters or crawler cranes for welding or bolting activities. Fabrication aids such as grillages or bespoke cradles may be utilised to optimise crane operations and access towers or working platforms will be used to ensure safe access.

126. To optimise assembly time, the majority of secondary structures will have been pre-installed prior to final assembly. Depending on the yard facilities, a dry dock, semi-submersible barge or ring crane could be employed to launch the assembled the substructure (**Figure 5.13**).

127. Once launched, the substructure will be ballasted and trimmed for WTG integration. To minimise WTG assembly time, the tower may be pre-assembled and pre-commissioned prior to installation. A ring crane will be required to lift the WTG component parts with lifting aids used to reduce risks associated with working under suspended loads. Once assembled, the WTG commissioning team will perform all necessary bolting activities. The substructure will then be towed to a holding location away from the assembly line for all remaining commissioning and testing activities.

Figure 5.13 Example of WTG assembly onto a semi-submersible platform at quay side. (Source: Kincardine)

5.9.1.2 Installation of WTG Units and Substructures (Offshore)

128. Substructures will be towed to site using Anchor Handling Tugs (**Figure 5.14**) following analysis of the weather forecast over the towing route and installation window. Project vessels will utilise dynamic positioning to hold station; anchors will only be dropped in an emergency. Once held in the correct position, the substructure will be secured to pre-laid mooring lines. Automatic connection systems such as ball grab connectors may be installed to reduce weather downtime, potentially shorten deployment of installation vessels, and decrease exposure of personnel on deck.

129. Each substructure is connected to a dynamic array cable. Once the cable is pulled into the substructure through an I-tube, the cable lay vessel (CLV) will unspool the cable whilst moving to the next substructure. Once the cable is terminated, electrical hook up will be performed with oversight from a Senior Authorised Person. Commissioning teams will then perform WTG final verification tests.

Figure 5.14 Tug vessel towing the Kincardine's integrated WTG and semi-submersible substructure unit out to windfarm site.

5.9.1.2.1 Drag Embedment Anchors

130. Installation method for drag embedment anchors will be:

- A pre-lay survey will be performed to identify and remove any debris along the route of the mooring lines.
- The mooring lines may be entirely chain, or a combination of chain and synthetic rope sections.
- The mooring lines will be deployed by connecting the anchor on the back deck of an Anchor Handling Tug. The anchor will be lowered to the seabed into a pre-determined target box and orientated to face the WTG location. The location of the anchor on the seabed will be recorded for comparison with the post embedment location. The chain will then be deployed and laid along the survey corridor. Upon completion of the laying operation the chain end will be transferred onto the main winch wire for the load test procedure.

- The embedment of the anchor involves the anchor handling tug applying a large horizontal thrust to the mooring line to pull the anchor down into the seabed. The load applied will be least equal to the maximum design tension. Whilst the load is gradually applied, the tension is monitored using a load cell on the main winch. Once the target tension is reached, the load will be maintained for a period of time to ensure the anchor has reached its final location. The anchor will usually embed to a depth well below the seabed level. The final position determined accurately by measuring the movement of a pre-defined point on the mooring line. The length of the chain can then be adjusted to compensate for the drag distance of the anchor.

5.9.1.2.2 Suction Pile Anchors

131. Installation method for drag embedment anchors will be:

- A pre-lay survey will be performed to identify and remove any debris at the target pile locations.
- The suction pile anchors may be deployed by crane or winch from the back deck of tailored Offshore Construction Vessel or Anchor Handling Tug.
- The embedment of the anchor involves pumping water out of the suction piles. The internal pressure of the suction pile will therefore be less than the external pressure of the sea. This pressure differential will push the suction piles into the seabed.
- Connecting the mooring lines or tendons will be performed using Remotely Operated Vehicle (ROV) anchor chain connectors. For the semi-submersible or barge the mooring lines may be entirely chain, entirely synthetic rope, or a combination of chain and synthetic rope sections. For the TLP, pre-tensioned steel tendons will be used.

5.9.1.3 Installation of Inter-Array Cables

5.9.1.3.1 Pre-Installation

132. The routing of the IAC will be determined through a combination of desktop studies using existing survey data and offshore surveys. Prior to IAC installation, geophysical and ground-truthing surveys will be performed to confirm there are no obstacles such as rocks, wrecks, metal objects, debris, or unexploded ordinance (UXO). If an obstruction is identified an appropriate strategy will be developed to remove or route around the obstruction.

133. Immediately prior to cable installation a survey will be performed to confirm mooring line and anchor locations. Should any hazards be identified, minor modifications to the location or protection of IAC may be required.

5.9.1.3.2 Installation

134. Each WTG will be connected via a 66 kV dynamic IAC. The cable installed between each WTG may include buoyancy modules to prevent the cable overstretching, dynamic bend stiffeners and touchdown protection (**Figure 5.15**).

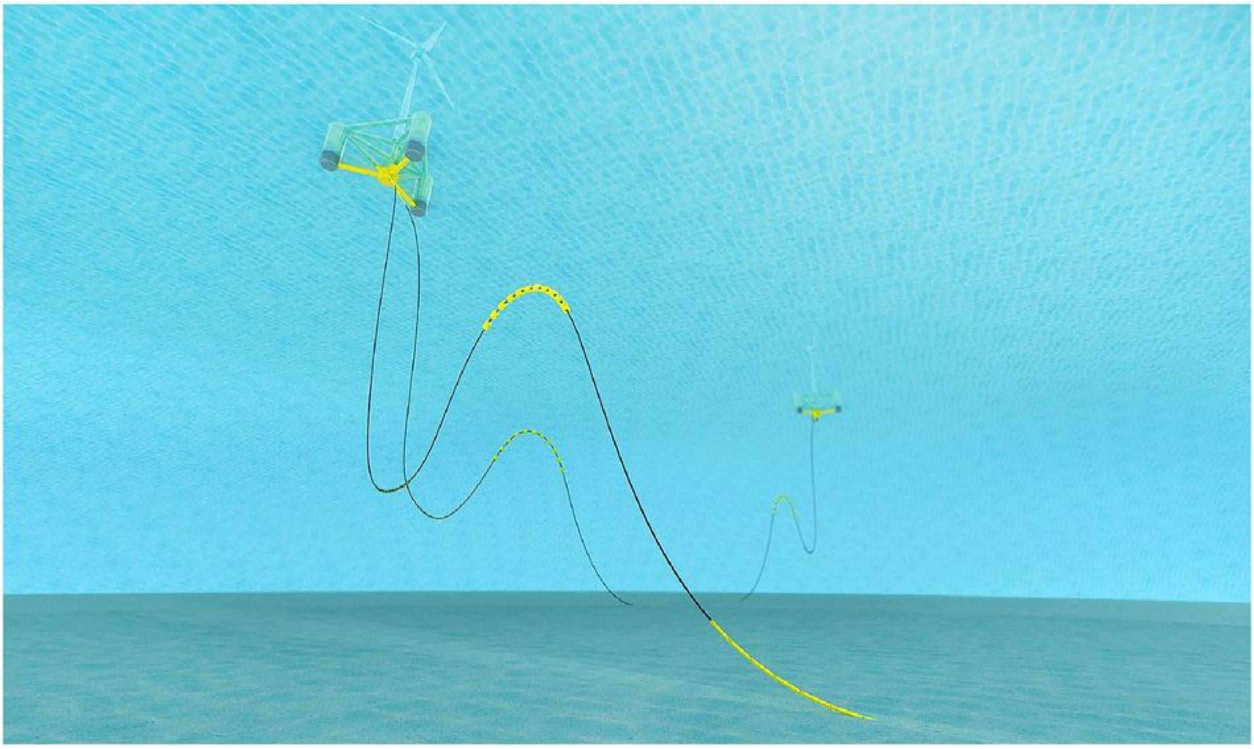

Figure 5.15 Inter-array cables in lazy wave shape (Rentschler et al. 2019)

135. Where required, the IAC will be trenched to a minimum depth of burial (DoB) of 0.6 m using either simultaneous lay and burial, or post-lay burial via jetting or trenching, in line with guidance, as appropriate (DECC, 2011). Where possible, the Project will aim to actively backfill the cable trench to achieve the required cable burial depth

136. If the minimum depth of burial of the cable is not achieved consideration will be given to protection in the form of rock dumping or concrete mattresses in the localised areas. A cable burial risk assessment will be carried out prior to the remedial work.

137. IAC installation will be undertaken by a CLV like that pictured in **Figure 5.16**.

138. The final decision on the method of IAC installation will be made at the detailed design phase which will occur after the consent application submission.

Figure 5.16 A Normand Clipper Cable Lay vessel involved in IAC cable installation at the Kincardine windfarm.

5.9.1.4 Installation of Offshore Substation Platform

139. As described in **Section 5.8.1.3**, the jacket foundation legs may be fixed to the seabed either with pin piles or suction piles.

5.9.1.4.1 Pin Piled Jacket Option

140. The piles, the OSP and jacket will be collected and transported to site by a combination of heavy lift installation vessel (HLV), transportation vessels, or barges.

141. Following pre-installation surveys and seabed preparation to remove any obstacles such as boulders, the HLV lift will place the jacket into position on the seabed.

142. The use of acoustic deterrent devices (ADD) to deter marine mammals from the area will be discussed with the relevant stakeholders and will be implemented through the Marine Mammal Mitigation Plan (MMMP).

143. The piles will be upended into vertical orientation and lowered to the seabed for installation. Using pile sleeves at the base of the jacket legs as a template, the piles will be installed using a hydraulic hammer.

144. Soft start procedures will be employed using energy as low as practicable to check hammer operation, initially embed the pile and to allow marine mammals to leave the area. Hammer energy will then remain below 500 kilojoule (kJ) for a minimum of 20 minutes in line with JNCC (2010) guidelines.

145. Hammer energies will then be minimised at levels sufficient for pile installation, resulting in energy ramp-up throughout the piling operation with a hammer blow rate of 40-45 strikes per minute maintained throughout. The complete piling operation of a four-leg jacket is expected to take approximately 2 days.

146. The HLV will be used to lift and install the OSP onto the jacket. Pile grippers may be employed to level the jacket into the correct position and create a secure connection whilst the pile grout is curing.

147. See **Table 5.8** for an overview of the expected approach to the installation of the pin piles. This process is illustrated in Figure 5.17.

Table 5.8 Pin Piling Installation Regime

Parameter	Min/Max Parameter Limit
Maximum hammer driving energy (kJ)	2,300
Soft start assumed starting hammer energy (kJ)	300 - 500
Soft start assumed duration (hr)	0.33
Soft start assumed blows per minute	6
Blows per minute	40 -45
Maximum number of blows per pile	10,406
Maximum pile time for the OSP foundation (hr)	10
Number of piles installed in same 24-hour period	4

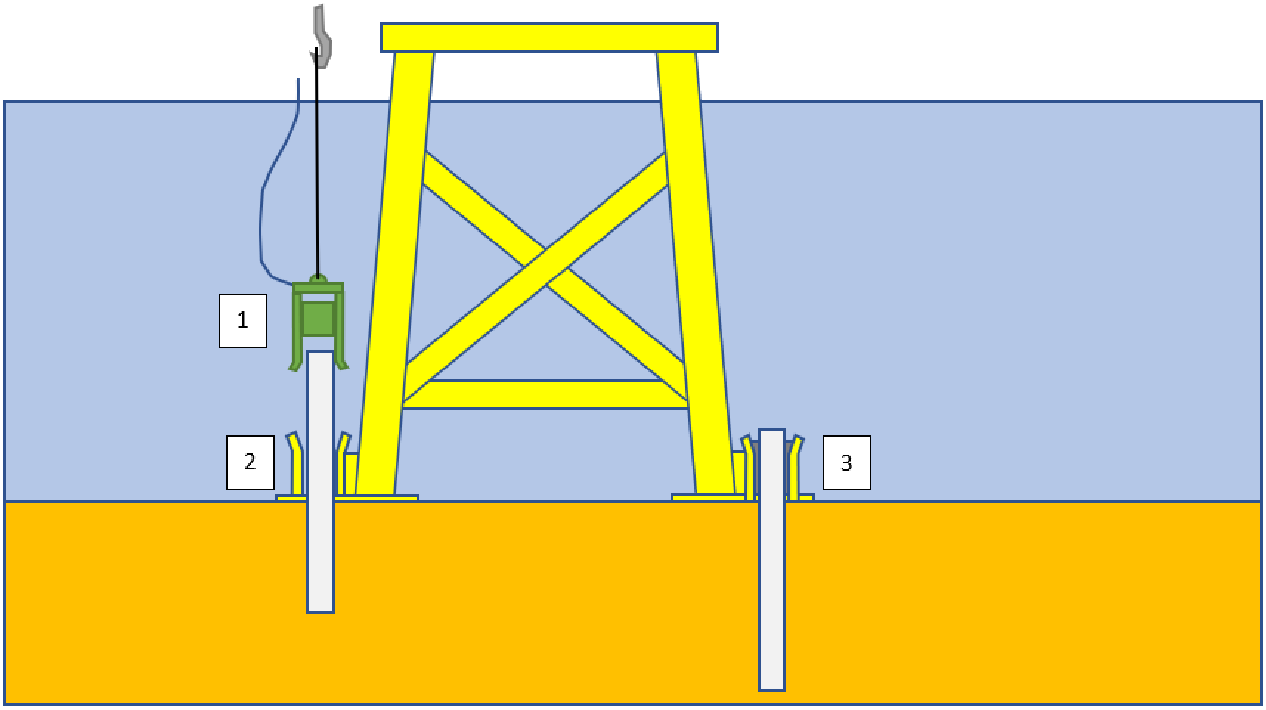

*Figure 5.17 An overview of pin pile jacket installation method. **1 =** Pile installation tool uses a controlled hammer device supported on a crane to drive the pile into the seabed. **2 =**The pin pile passed through a guide that is a structural part of the jacket base. **3 =** The pin pile is grouted within the guide that bonds the jacket to the pins, forming a connected foundation.*

5.9.1.4.2 Suction Piled Jacket Option

148. In areas like the Ettrick and Blackbird brownfield site, where the seabed is level, the suction pile foundation may not require significant seabed preparation. However, measures may be required in areas where sand waves are present to provide a level formation for the installation and to allow scour protection to be later placed around the foundation.

149. The suction pile parameters for assessment are provided in **Table 5.5.** It is proposed the spoil will be disposed of within the Windfarm Site.

150. The jacket and OSP will be collected and transported to site by a combination of the HLV, transportation vessels, or barges. At the base of the jacket, suction piles will have been pre-installed into the legs during fabrication.

151. Following pre-installation surveys and seabed preparation to remove any obstacles such as boulders, the HLV lift will place the jacket into position on the seabed. Once placed on the seabed and settled under its own weight, water will be pumped out of the suction piles (**Figure 5.18**). The internal pressure of the suction pile will therefore be less than the external pressure of the sea. This pressure differential will push the suction piles into the seabed. Suction pile penetration is expected to take up to 8 hours but the whole operation may take approximately 1 day.

152. Scour protection will be installed by placing an initial scour protection filter layer on the seabed at each foundation location. Following the installation of the suction piles further erosion protection will be installed by placing larger rocks/armour layer around the foundations above the seabed. The rock placement will be installed using a fall pipe vessel or a vessel with a side tipping system. On a fall pipe vessel, the rock is installed through a chain-mail pipe with an ROV positioned at the end of the pipe to adjust the delivery point. Alternatively, a grabbing device may be used to place the rock directly.

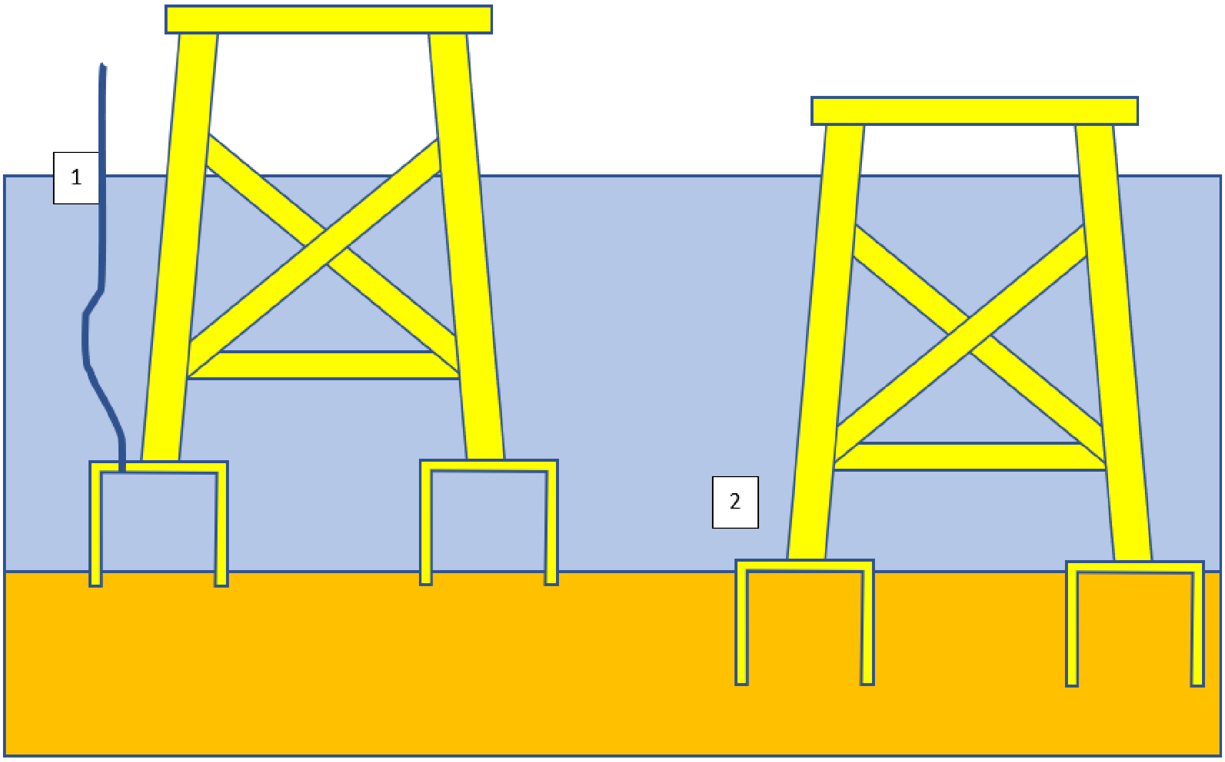

Figure 5.18 An overview of suction pile jacket installation method. ***1 =*** *As the jacket is lifted on the sea-bed, water is pumped out of all suction cans at the same time, effectively drawing the cans into the seabed.* ***2 =*** *Once the jacket is in final position, the hoses are removed and the suction cans are sealed to maintain the foundation.*

5.9.2 Offshore Transmission Works

5.9.2.1 Export Cable

153. A significant amount of work has been undertaken to select an export cable route that avoids a number of constraints and seabed features (**Chapter 4: Site Selection and Assessment of Alternatives**). The following sections outline the range of activities that will need to be undertaken to install the offshore export cable.

5.9.2.1.1 Pre-Installation Surveys

154. Pre-installation surveys and activities (e.g. UXO, Boulder Clearance, works which will be undertaken under separate marine licences) will be performed in the same manner as described for inter-array cables (**Section 5.9.1.3**). In addition, cable installation activities will be preceded with a pre-lay grapnel run to clear debris from the cable route or an alternative method to check for debris.

155. A Hazard Assessment, which will utilise the findings of the pre-installation survey, will identify whether there is a requirement for a pre-sweep of the seabed ahead of cable installation. Up to 0.1 km^2 seabed may require pre-sweeping operations.

5.9.2.1.2 Export Cable Installation

156. The export cables will be collected from the load-out port or the cable manufacturer and transported to landfall location by the CLV (**Figure 5.16**). A shore pull will be performed to take the cable to the onshore transition joint pit via the HDD ducts. Following the shore pull the cable will be laid along the predetermined route. Pipeline and cable crossings will require rock placement or mattressing.

157. Cable burial may be achieved by simultaneous lay and burial or post-lay burial to a minimum DoB of 1.5 m.

158. The preferred method of cable installation would involve the simultaneous lay and burial of the cable from a dedicated cable installation vessel; this will be reviewed following the completion of the engineering work and export cable survey.

159. Where possible, to minimise the extent of any unnecessary habitat disturbance, the Project will aim to actively backfill material displaced as a result of cable burial activities, in order to promote recovery.

160. Cable burial depth will be monitored in the midzone, where the seabed is active with mega-ripples.

5.9.2.2 Cable Landfall

161. Onshore works and impacts associated with the HDD are considered in the **Onshore EIA Report** and not in this report (**Figure 5.19)**.

162. The cable landfall will be located near Peterhead and there are currently two options for the location with the same method of the installation of the cable landfall (**Figure 5.11**):

- option 1: St Fergus South; and
- option 2: NorthConnect Parallel

163. Although the majority of the activities associated with each of these options will take place onshore, both options include some activities which take place below MHWS mark and therefore need to be licenced under the Marine (Scotland) Act 2010 (**Chapter 3: Policy and Legislative Context**).

164. HDD is a trenchless technology widely used in cable landing applications offering several benefits compared to the traditional open-cut method. HDD works will involve:

- A shallow draft CLV with a flat keel will be deployed to install the export cable nearest the shore from the HDD exit point in the sub-tidal area. Some flat-bottomed barges can ground out, therefore an adequate survey will be undertaken, for assessment of local conditions. They can be either self-propelled or rely on support vessels to provide towage and assistance. They also tend to operate with an anchor spread, requiring working space which is dependent on water depth but can be in the range of 200-300 m either side of the cable route.
- HDD boreholes will be required to install the conduits through which the offshore export cable will be pulled in. The bore diameter is expected to be between 750 – 900 mm. The depth and the length of each individual HDD borehole will be determined as part of the HDD feasibility study.

- The offshore and onshore cable circuits will be jointed at landfall in a transition jointing pit. When landing a cable via HDD, the jointing of the onshore and offshore sections of the export circuit typically takes place in proximity of the HDD entry point onshore.
- Following the cable pull-in operations and the completion of the jointing activities, the transition joint pit will be backfilled and then the ground re-instated.
- The HDD bore path design and alignment require thorough considerations to account for any information on cable mechanical properties, local geology, nearshore physical processes, bathymetry and tides, and electrical constraints such as cable separation requirements.

165. An illustration of this method is presented in **Figure 5.19.**

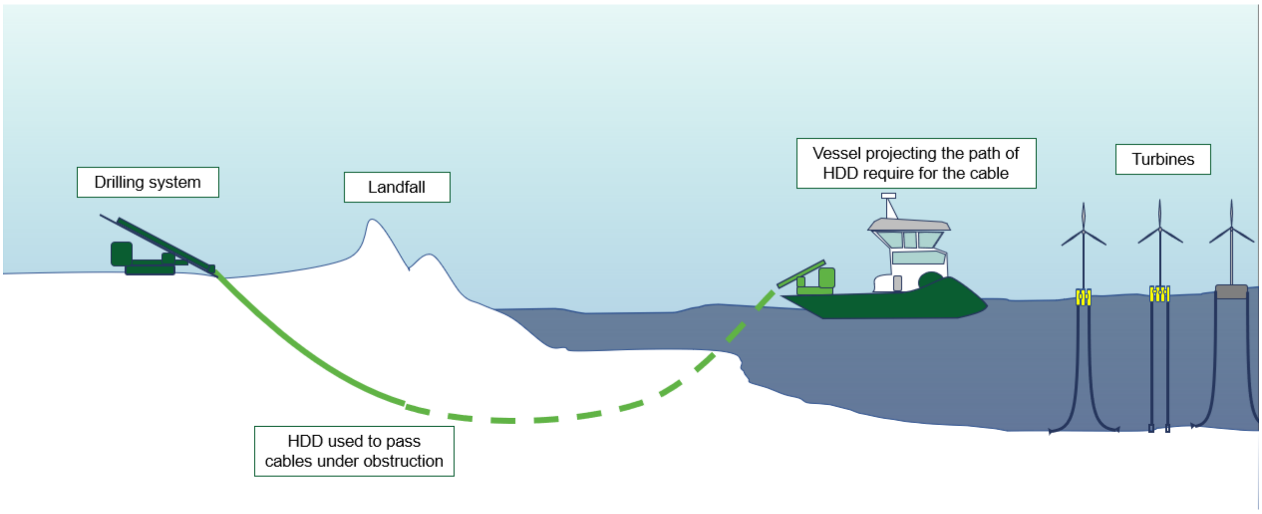

Figure 5.19 Overview of export cable installation method

5.9.3 Navigational Safety, Lighting Requirements and Colour Scheme

166. Throughout the construction phase and, subject to discussions with the MCA and other stakeholders, navigational marker buoys may be required to identify the location of the site boundaries or to provide warnings regarding the existence of temporary facilities on the seabed. These temporary measures may be replaced by permanent markings in accordance with agreed requirements, for the lifetime of the project.

167. During the operational phase of the Project, the offshore array will be marked with appropriate navigational marker buoys to provide the necessary warning to mariners of the presence of the site. The exact type and configuration of any navigational markers will be determined via consultation with the MCA and NLB and will also be informed by the outputs of the project-specific Navigation Risk Assessment.

168. Consideration will be given to use of virtual aids to navigation as well as buoyage. The site will be marked on the UK hydrographic charts and through Kingfisher Information Service - Offshore Renewable & Cable Awareness (KIS-ORCA) to manage fisheries awareness. The actual WTG will also be marked in accordance with relevant aviation requirements and via consultation with key organisations (MCA, CAA). CAA Policy and Guidelines on Wind Turbines CAP 764 (CAA, 2016) will be followed (**Chapter 14: Shipping and Navigation** and **Chapter 16: Aviation and Radar**).

169. It should be noted there a no helicopter platforms within 6 nm of the Windfarm Site, with the nearest helideck being located on Buzzard.

170. The colour scheme for nacelles, blades and towers is generally RAL 7035 (light grey). Foundation steelwork is generally in RAL 1023 (traffic yellow) from HAT up to a minimum of 15m.

5.9.4 Safety Zones

171. During the construction phase it is proposed that there is a 500 m radius safety zone around each turbine/OSP location, in line with the Energy Act 2004 (Chapter 2 Offshore production of energy – safety zones for installation) and The Electricity (Offshore Generating Stations) (safety zones) (Application Procedures and Control of Access) Regulations 2007. During the operational and maintenance phase it is proposed that there is a 50 m radius safety zone around each turbine/OSP location.

172. Through the application for consent, the Applicant will seek to omit rights of navigation within the scope of these distances around each structure, to establish the desired safety zones. Once the Project is operational, an Automatic Identification System (AIS) and closed-circuit television (CCTV) from an onshore operation and maintenance (O&M) Control Centre(s) will be in place to monitor vessel movements within the Windfarm Site. These safety zones will make clear to passing third party traffic the areas which should be avoided to minimise collision risk with the construction vessels undertaking these works, noting such vessels may be Restricted in Ability to Manoeuvre . The Project may also utilise and promulgate advisory safe passing distances around ongoing works where identified as necessary via risk assessment. Details and locations of any safety zones and advisory safe passing distances will be promulgated including via Notices to Mariners (NtMs) and the Kingfisher Bulletin.

5.9.4.1 O&G Infrastructure Exclusion Zones

173. There is no agreed legal or regulator position regarding the need to apply defined exclusion zones between the decommissioned O&G infrastructure on the seabed of the Windfarm Site and newly installed project infrastructure (Flotation Energy, 2022).

174. The WTG array position (**Figure 5.3**) will deliberately avoid placing turbines and substructures directly above pipelines, umbilicals remaining in-situ, and abandoned well-centres at the seabed. The final offsets applied will be determined by collaboration with the O&G operator via a structured risk assessment approach.

175. Positioning of Wind Farm equipment on the seabed such as moorings and inter-array cables will also avoid interaction where possible, however, there is a strong likelihood that crossings will be necessary. Such crossings will be finalised with the input and agreement with the O&G operator since they will be legally responsible for the notification process and the ongoing liability associated with the decommissioned equipment affected by the crossing (Flotation Energy 2022).

5.9.5 Underwater Noise

176. Several activities during the construction, operation and decommissioning of the Project will result in generation of underwater noise. The most significant noise sources are likely to be piling driving of the foundations of the OSP and clearance of UXO (under separate marine licence). An underwater noise modelling study has been undertaken in support of the assessment and is detailed in **Chapter 10: Fish and Shellfish Ecology, Chapter 11: Marine Mammal Ecology**.

5.9.6 Wind Farm Commissioning

177. The commissioning of the Project will be in accordance with approved commissioning procedures. Commissioning will generally comprise the following process, with procedures formalising the different, individual stages:

- a mechanical, visual and electrical continuity assessment;

- an energisation programme;
- testing mechanical, electrical and control functions;
- identification of faults;
- rectification of faults;
- re-testing; and
- certification.

5.9.7 Environmental Management Plan

178. Upon consent award, the Applicant will formulate a specific environmental policy which will set out environmental targets for the construction phase of the Project. The policy will be included in tender documents as a requirement on contractors who should be able to demonstrate a track record and proven ability to meet the necessary environmental standards.

179. An Environmental Management Plan, amongst others, will be developed to provide a framework to protect the environment before, during and after installation to ensure that all legislative and regulatory requirements are met. This will include details of environmental monitoring, auditing and reporting systems to be employed during installation.

5.10 Operation and Maintenance

180. This section describes the O&M activities anticipated throughout the 35-year design life of the Project.

181. During the operational phase of the project, scheduled and unscheduled monitoring and maintenance of offshore infrastructure will be required including refurbishment and replacement. All offshore infrastructure, including WTG, floating substructures, cables and offshore platforms will be included in monitoring and maintenance programmes.

182. The O&M information presented here is based on best available information at the time of writing. This is drawn from current operational knowledge in addition to reflecting regulatory requirements and industry best practice. The information provided covers:

- Base of operations;
- Maintenance activities;
- WTG access facilities;
- Weather monitoring facilities;
- O&M vessel movements; and
- Waste management plan.

5.10.1 Base of Operations

183. A purpose-built onshore O&M Marine Control Centre facility is expected to be located on the quayside at an east coast Harbour. All O&M activities will be managed and ran from here.

5.10.1.1 Marine Control Centre

184. The Marine Control Centre for the Project will have AIS, video surveillance and radar coverage which will identify vessels with AIS facilities entering into the safety zone during O&M activities (**Section 5.9.3**). Any vessel identified or observed to stray into the safety zone will be contacted by a designated member of the crew of the O&M vessels or guard vessels or from the Marine Control via multi-channel Very High Frequency radio and warned that they have encroached the safety zone. They will be

instructed to divert their course out of the safety zone. Vessels which ignore this warning are considered a potential danger. These vessels will be notified again before vessel details are reported to the MCA enforcement unit.

185. As mentioned in **Section 5.8.1.1,** the WTG will be connected to a central SCADA system for the remote control of the wind farm. The SCADA system will communicate with the wind farm via fibre optic cables, microwave, or satellite links.

5.10.2 Safety Zones

186. During normal operation, a 50 m safety zone will be in place around each wind turbine.

187. In the event of the requirement for major maintenance it is proposed that the area around the affected turbine has a safety zone extending to a 500 m radius.

5.10.3 Weather and Sea Conditions Monitoring

188. Data from the on-site weather and sea conditions monitoring equipment will be used to support operations throughout the life of the Project. Aside from the normal requirement for wind and wave measurement devices, consideration will also be given to measuring tidal flow and direction and water temperature.

189. A summary of the expected weather and sea monitoring equipment for the Project is provided in **Table 5.9**

Table 5.9 Details of expected Met Masts and Wave Buoys Associated with the Project

	Floating LiDAR	**Fixed LiDAR**	**Wave Buoys**
Maximum Number of Installations	1	1	2
Foundation Type	Buoy	Buzzard Platform	Buoy
Max Elevation (HAT, m)	5	50	2
Max Width at Sea Surface (m)	5	N/A	1
Max Footprint at Seabed Including Scour Protection (m^2)	5	N/A	5
Hazardous Materials (litres)	1,000 litres diesel / 250 litres methanol / batteries (lead-acid / lithium)	N/A (mains power from Buzzard)	Batteries (lead-acid / lithium)
Indicative Number of Yearly O&M Visits	2	2	2
Indicative Instruments Required	'Lidar, wave sensor, acoustic Doppler current profiler, water temperature, air temperature, atmospheric pressure and relative humidity.	'Lidar, air temperature, atmospheric pressure and relative humidity.	'Wave sensor, acoustic Doppler current profiler and water temperature.
Possible navigational buoy required	Unlikely. Floating lidar buoy would have navigational lantern, radar reflector and AIS.	No	No
Anchorage	Catenary mooring, with gravity anchor (concrete or steel).	N/A	Catenary mooring, with gravity anchor (concrete or steel).

5.10.4 Maintenance Activities

190. O&M of the Project after commissioning will comprise of both scheduled and unscheduled events. Scheduled works on the WTG and offshore electrical infrastructure will include annual or bi-annual maintenance, statutory inspection and routine inspection, visits. When necessary, retrofitting and upgrading works may also take place. The scheduled works will normally be timetabled for the summer months, given the typically more settled weather and longer day light hours, but some unscheduled work may be required out of season.

191. Twenty-four-hour working will be considered, as this type of solution could be delivered from a mothership stationed near the Windfarm Site. Exact maintenance requirements for the different WTG options from the three manufacturers are not known at this stage. There will also be a core operations team at the onshore O&M Control Centre to manage and support all aspects of the Project's operation.

192. The accessibility criteria for the floating substructures are expected to be the same as that of fixed foundation wind farm installations. The primary means of access will be from vessels whereby the floating structure will host access systems (typically ladders).

193. Helicopter access is not being considered.

194. For repairs that cannot reasonably be completed on site, towing to port may be required. The floating substructure, moorings and IAC arrangements are designed to enable safe and efficient disconnection of the WTG from its moored position. The structure will also be designed to allow for towing with conventional tugs between the offshore site and port.

5.10.4.1 WTG and floating substructures

195. The following sequence is envisaged for a major WTG maintenance scope:

- The turbine is shut down and is isolated from the array cable;
- The power cable is disconnected from the turbine; the cable end is suitably stored;
- The mooring system is disconnected from the turbine;
- The complete wind turbine and structure assembly is towed to the O&M port for repair; and
- Following quayside repair a repeat of the relevant steps of the installation sequence will be completed to bring the turbine back into operation.

196. If significant advances in dynamic positioning of offshore vessel and crane technologies are made it may become possible to complete major component changeouts in-situ.

197. The frequency of these corrective services will vary over the lifetime of the Project. The current technology of WTG requires an annual major service every 12 months; they will also require periodic visits in the event the WTG experiences a fault which cannot be remotely addressed. In addition, some models of WTGs will require gearbox oil changes every five years.

198. Unscheduled repair activities will range from, attendance on location to deal with the resetting of false alarms, to major repairs. The frequency of unscheduled activities is expected to be highest in the early years of operation, when WTG are first commissioned and require servicing.

199. Maintenance and inspection activities will be performed after the WTG in question has been shut down. Boarding of the units will most likely be undertaken by Crew Transfer Vessel (CTV). Helicopters are currently not being considered as an option. The CTV will dock, and access will be via ladders on the substructure.

5.10.4.2 Moorings and Anchors

200. Monitoring and maintaining moorings and anchors, will take place in line with the industry guidelines underpinned by a risk-based approach. These works will include periodic visual inspections (using ROV) of the entire mooring system, checking the condition of:

- anchor (drag embedment or suction piles) condition for evidence of displacement and scour (specific inspection requirements TBC based on chosen technology);
- mooring line (catenary or tension leg tendons) condition including corrosion (particularly at the point of the seabed) and biofoul; and
- connection points for corrosion, functionality. The Project will seek to maintain budget flexibility to capitalise on maintenance innovations such as sensor technologies and autonomous underwater vehicles, for example.

5.10.4.3 Cable Works

201. Maintenance activities expected to take place on the cables during the operational phase include but are not limited to:

- cable repair by recovering the cable from its trench/water column and making the necessary repairs i.e. splicing in a new section etc;
- cable route inspection, both seabed and water column;
- reburial of sections of cable which have become exposed; and
- placement of scour protection over sections of the cable identified as in need of protection.

202. Recovery of the cable will be performed by means of a suitable dynamically positioned vessel. A suitable dive platform may also be needed dependent upon depth of the operation. All recovered and redundant cable will be disposed of and recycled as appropriate onshore.

203. Cut and exposed cable ends will be sheathed and buoyed to the surface in preparation for the repair operation. The buoyed end will then be recovered onto the cable handling vessel and cable jointing will proceed.

204. Any new section of cable will be jointed aboard a cable-handling vessel before being re-laid back to the seabed. The resting cable will be assessed to ensure it is in the correct position and sufficient slack is available. The newly repaired export cable will be placed on, or as close to the original cable/trench as practicably possible.

5.10.5 Pollution Prevention and Waste Management

205. Pollution prevention across the Project will be controlled and mitigated from the design stage onwards.

206. For example, the WTG nacelle frame will typically be designed and manufactured with an incorporated bund which can hold the full oil content of the gearbox in the event of a catastrophic failure. Additionally, if any oil filled transformers are used, the area will be bunded to contain any oil leaks.

207. The WTG maintenance personnel and any maintenance support vessel crew would be trained and equipped to use spill kits in the event of a break in containment occurring. This will be closely supported by a safe system of work which will be governed by a full risk assessment and method statement process. In the event of the safe system of work failing, or a catastrophic incident occurring, it is assumed that a spill response contract will be in place to control, manage, recover and dispose of any contaminants and dropped objects.

208. During construction and decommissioning, the use of fuels will be required, and some chemicals may be required on board vessels involved in the marine installation of HDD works. Accidental spill of these substances has the potential to occur in the Windfarm Site, Buzzard Export and the Landfall Export Cable Corridors. Impacts from spills associated with the land-based HDD works will be covered in the **Onshore EIA Report**.

5.10.6 Major Accidents and Disasters

209. The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 require the Applicant to consider significant risks to the receiving communities and environment, for example through major accidents or disasters. Similarly, significant effects arising from the vulnerability of the proposed development to major accidents or disasters should be considered.

210. Relevant risks are covered in the topic chapters within this **Offshore EIA Report** (**Chapters 7 to 20**), and a screening of major accidents and disasters relevant to the Project is provided in **Appendix 5.1: Major Accidents and Disasters Screening**. The appendix presents the methodology and findings of the screening of major accidents and disasters. This has been informed by Project-specific UXO Survey Acquisition, Processing and Survey Verification Test Procedures (**Appendix 5.2**), a UXO Threat and Risk Assessment (**Appendix 5.3**) and a Risk Mitigation Strategy (**Appendix 5.4**).

211. Offshore wind developments have an intrinsically low risk of major accidents and disasters. The turbines, blades, towers and mooring systems of offshore wind farms have an excellent safety record with a very low failure rate and are positioned many kilometres offshore away from populated areas and the public.

212. The risk of substation fires is historically low. The lubricants, fuel and cleaning equipment required within the project will be stored in suitable facilities designed to the relevant regulations and policy design guidance.

213. The Applicant recognise the importance of the highest performance levels of health and safety to be incorporated into the project. There is a commitment to adhere to a high level of process safety, from design to operations and for all staff, contractors and suppliers to have a high level of safety awareness/knowledge of safety. The Applicant will ensure that all employees have undergone necessary health and safety training.

214. Mitigation measures embedded into the construction, operation, maintenance and decommissioning phases of the Project, alongside use of industry safety standards, minimise the impacts on the relevant receptors identified during the assessment. The residual risk of major accidents and disasters associated with any aspect of the project, during the construction, operation and decommissioning phases is for hazards with the potential to occur in the Project area is considered to be low.

5.11 Decommissioning

5.11.1 Background

215. Decommissioning requirements are set out in the Energy Act 2004 (as amended) and current Offshore renewable energy: decommissioning guidance (Scottish Government, 2022). This will be a key requirement under Crown Estate Scotland lease agreement. The Applicant will be required to prepare detailed, costed decommissioning plans for approval by Scottish Ministers and to set aside funds for the purposes of decommissioning.

216. It is likely that decommissioning will be subject to separate consenting process.

5.11.2 Decommissioning Approach

217. The overarching principles that will be followed when developing an appropriate Decommissioning Programme are derived from the Department for Business, Energy and Industrial Strategy (BEIS) Guidance Note (BEIS 2019) and Marine Scotland's Draft Guidance Note (Scottish Government 2022).

218. The Applicant will consider:

- The Best Practicable Environmental Option, which is the option that delivers the most benefit or least damage to the environment at an acceptable cost, both in the short and long terms. This involves balancing the reduction in environmental risk with practicability and cost of reducing the risk;
- Safety of surface and subsurface navigation;
- Other uses of the sea; and
- Health and safety considerations.

219. In addition, the Project will adhere to the principles of:

- Sustainable development, and will seek to ensure that, as far as reasonably practicable, future generations do not suffer from a diminished environment or from a compromised ability to make use of marine resources; and
- Polluter pays principle, which acknowledge the Project's responsibility to incur the costs associated with our impact on the environment.

220. In developing a Decommissioning Programme, the company will seek to maximise the re-use of materials and will pay full regard to the 'waste-hierarchy'. In order to ensure that commercial viability is maintained, the BATNEEC (Best Available Technique Not Entailing Excessive Cost) decommissioning solutions will be sought.

221. In achieving the above objectives, the Project will ensure practical integrity. When decommissioning the wind farm, The Applicant will seek to minimise influence on land transportation and where practicable, will plan transportation between the coast and respective waste management facilities in order to reduce safety issues and disturbance to traffic (**Onshore EIA Report**).

222. Throughout the Project lifespan the Decommissioning Programme will be reviewed and updated every 5 years. Consultee bodies listed in the S105 Notices, and any additional consultees identified by MS-LOT or the Applicant, will be provided with the opportunity to comment on the final decommissioning strategy prior to it being finalised. It is anticipated that the final revision process will commence two years prior to the initiation of decommissioning activities.

223. Due to the floating wind farm technology utilised on the Project, and the low seabed footprint it is anticipated that decommissioning will be straightforward process.

5.11.3 Removal of WTG

224. The removal of turbine components including blades, nacelle, and tower will largely be a reversal of the installation process (**Sections 5.9.1)** and will mostly be undertaken in a sheltered near-shore location where better controlled operations are possible.

225. The general methodology for carrying out wind turbine decommissioning will likely be:

- to de-energise wind turbines and isolate them from the grid;
- conduct assessment on potential hazards during the decommissioning work and pollutants to the environment that may result from the decommissioning work;
- mobilise suitable vessels to site;

- reposition the WTGs to a sheltered near-shore location;
- remove turbine blades;
- removal of all tower/nacelle internal cables that connect the generator and transformer as well as related control and communication cables;
- remove nacelle including the gearbox and generator;
- dismantle and remove turbine tower; and
- to transport of all components to an onshore facility where they will be processed for reuse/recycling/disposal.

5.11.4 Removal of Substructures and Foundations

226. The removal and dismantling of the floating substructures will largely be a reversal of the installation process. Decommissioning will be undertaken in the same controlled manner as the installation process and in accordance with a risk management plan to ensure the same level of safety and pollution control measures.

227. Whichever anchoring system (drag embedment or suction piles) is deployed the post decommissioning state will be the same in terms of leaving the site with a clear seabed surface free from obstruction to other seabed traffic such as fishing gear.

228. Components will be re-used or recycled, where possible.

5.11.5 Removal of Offshore Cabling including Export Cabling

229. Relevant stakeholders and regulators will be consulted to establish which sections of the offshore cables will require removal.

230. It is anticipated that the dynamic sections of the IACs will require removal and potentially cut at the static transition.

231. If there are no issues with stakeholders/regulators and the risk of the cables becoming exposed is minimal, then the cables (and relevant scour protection) may be left in-situ to avoid disturbing the seabed unnecessarily.

232. The ends of the cables will be cut as close to the seabed and weighted down for burial to ensure they no interference with trawling and other users of the sea. A decision to decommission infrastructure in situ will be supported by a comparative assessment process (in line with the BEIS and Scottish Government guidance).

233. The sequence for removal of the cables is anticipated to be:

    - to locate the cable using a grapnel and lift it from the water column or seabed. It may be necessary to use an ROV to cut and/or attach a lifting attachment to the cable so that it can be safely recovered to the vessel;
    - for dynamic cable removal the buoyancy modules will be removed as the cable is recovered to deck;
    - Seabed material may need to be removed to locate the static cable on the seabed. This is likely to be carried out using a water jetting tool;
    - the recovery vessel will either 'peel out' the cable as it moves backwards along the cable route whilst picking it up on the winch. If the seabed is very stiff/hard it may first under-run the cable with a suspended sheave block to lift the cable from the seabed. The use of a suspended sheave block could be carried out before by a separate vessel such as a tug prior to the recovery vessel ‘peeling out’ the cable; and

- the recovery vessel will either spool the recovered cable into a carousel or cut into lengths as it is brought aboard before transport to shore.

234. Where possible IAC and export cables materials will be processed for reuse/recycling/disposal.

5.11.6 Removal of Scour Protection

235. It may be preferable to leave the scour protection in-situ to preserve the marine habitat that may have developed over the life of the Project. Relevant stakeholders and regulators will be consulted to establish what the best approach is.

236. If removal is deemed necessary, the removal sequence is anticipated to be:

- for rock armour, the individual boulders are likely to be recovered using a grab vessel, and transferred to a suitable barge for transport to an approved onshore site for appropriate re-use or disposal; or
- the filter layer is likely to be dredged and transported to be reused or disposed of at a licensed disposal area (this could be offshore or onshore).

5.11.7 Safety Zones

237. During decommissioning it is proposed that there is a 500 m safety zone around each turbine/OSP location.

5.11.8 Seabed Clearance and Restoration of the Site

238. The Applicant is committed to restoring the habitat across the Offshore Development Area to the condition that it was in before Project construction.

239. Consistent with the decommissioning provisions detailed above, the key restoration work will relate to:

- ensuring that anchors (e.g. if suction anchors are deployed) are cut below seabed and are made safe and adequately covered; and
- ensuring that cables and cable ends are adequately buried, or otherwise protected.

240. In line with the details provided above, the Applicant are committed to ensuring the Project is safely and effectively decommissioned.

241. Where necessary, upon completion of the decommissioning works a survey will be undertaken to ensure that all debris has been removed. The survey will enable identification and recovery of any debris located on the seabed which may have arisen from activities related to the decommissioning process which may pose a risk to navigation or other users of the sea (e.g. fishermen).

242. The process of collecting and presenting evidence that the site is cleared is required to be independent of the Project. An independent survey company would complete such surveys and issue survey results to MS-LOT for review.

243. The required survey area would be determined during the decommissioning phase of the Project, taking into account good practice at the time and the views of stakeholders.

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