Environmental Impact Assessment Report

NISA

North Irish Sea Array

Volume 2: Introductory Chapters

Chapter 8

Construction Strategy - Offshore

Statkraft

CIP Copenhagen Infrastructure Partners

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Contents

Tables

Images

8. Construction Strategy – Offshore

8.1 Introduction

8.1.1 Introduction

The North Irish Sea Array (NISA) Offshore Wind Farm, hereafter referred to as the proposed development, is the subject of this Environmental Impact Assessment Report (EIAR) and is a combination of offshore infrastructure and onshore infrastructure. The proposed development boundary is shown in Figure 1.1 of Volume 7. The proposed development is being developed by North Irish Sea Array Windfarm Limited (the Developer).

A detailed description of the offshore and onshore elements of the proposed development is provided in Volume 2, Chapter 6: Description of the Proposed Development- Offshore (hereafter referred to as the Offshore Description chapter) and Chapter 7: Description of the Proposed Development – Onshore (hereafter referred to as the Onshore Description chapter).

For clarity, while the proposed development is assessed as a whole in this EIAR, the boundary between onshore and offshore infrastructure is the high-water mark (HWM) as defined by Ordnance Survey Ireland mapping. Image 6.1 of the Onshore Description chapter illustrates the offshore and onshore infrastructure of the proposed development and the interface between each.

For the purposes of the EIAR, the construction strategy of the proposed development below the HWM (i.e., offshore infrastructure) is described in this chapter. The construction strategy of the proposed development above the HWM (i.e., onshore infrastructure) is described in Volume2, Chapter 9: Construction Strategy – Onshore (hereafter referred to as the Onshore Construction chapter).

This chapter, which has been prepared in accordance with Part 1 of Annex IV of the EIA Directive, describes the strategy to construct the offshore elements and associated infrastructure of the proposed development. The offshore infrastructure is located within the proposed development boundary below the HWM, from the landfall to the furthest extent of the array covering an area of approximately 125km^2 referred to as the ‘offshore development area’ and will comprise the following:

Array area – where the following infrastructure will be located:

- Offshore Wind Turbine Generators (WTGs).
- Offshore Substation Platform (OSP).
- Seabed foundations (for WTGs and OSP).
- Inter-array cables.

Offshore Export Cable Corridor (ECC) - where the offshore electrical infrastructure, consisting of two export cables, will be routed from the OSP to landfall.

Landfall site – the proposed development at the landfall site traverses the HWM and consists of both onshore and offshore infrastructure. The offshore infrastructure consists of the transition of the two offshore export cables coming ashore to the onshore export cables at the transition joint bays (TJB). This chapter describes the offshore infrastructure at landfall. Refer also to the Onshore Description chapter which describes the onshore infrastructure at landfall. Both chapters should be read together for full details on infrastructure at landfall.

8.1.2 Design Flexibility

As noted in Section 6.2.2 of the Offshore Description chapter, An Bord Pleanála issued its opinion on design flexibility, signed 30 January 2024 (the ‘DF Opinion’) to be used throughout the offshore development area. Further information on the requirement for flexibility throughout the proposed development is included in Volume 2, Chapter 2: EIA Methodology.

The proposed development is therefore submitting two project options for consideration within the planning application and in this EIAR, with only one project option selected for construction following detailed design post-consent. The construction strategy for each of the two project options have been described per project option where they differ from each other. Further information on the project options is provided in Section 6.2.3 of the Offshore Description Chapter.

8.2 Construction Programme

The following section describes the current construction programme assumptions for the offshore aspects of relevance for the EIAR. It is assumed that the proposed development will be built out in a single construction campaign and the construction programme illustrates the likely duration of major installation elements and how they relate to one another.

8.2.1 Construction Programme

Subject to obtaining statutory consent (i.e., planning approval) and the relevant permits and licences, construction of the offshore elements of the proposed development is expected to commence in 2027, with completion expected in 2029, as demonstrated in Table 8.1 below. The contracting and delivery of specific work packages as outlined in Table 8.1 may differ between the two project options however, the overall programme of construction will remain the same

Table 8.1 Construction Timeline

Activity Name	Year 1 – 2027				Year 2 – 2028				Year 3 - 2029			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Pre construction activities												
Landfall												
Offshore Export Cables Installation Period												
Foundation Piling (WTG and OSP) (monopile)												
Foundation pre-piling (WTG and OSP) (jackets) Substructure Installation (WTG and OSP) (jackets)												
Offshore Substation Topside Installation												
Array Cable Installation Period												
WTG Installation period												

Section 6.5 of the Offshore Description Chapter describes two potential substructure/foundation options: monopiles or jackets on pin piles.

It should be noted that only one of the two foundation options will be installed, either jackets or monopiles as per Table 8.1. As indicated, in the programme irrespective of the foundation option used, the overall programme duration is not expected to differ.

Construction offshore will take place up to 24 hours per day, 365 days per year. Commissioning (see Section 8.8) and pre-commissioning may also take place 24 hours per day, seven days per week. The overall duration of construction is dependent on factors such as supply chain, including fabricators and component suppliers, port and vessel availability, weather conditions and progress made throughout.

8.2.2 Construction Sequencing

Subject to obtaining planning approval and the relevant permits and licences, onshore and offshore infrastructure may be constructed in parallel, or construction activities may be undertaken in a phased, sequential approach.

Offshore construction is assumed to be undertaken following the indicative sequence below, although it should be noted that some activities may be undertaken simultaneously. The sequence is as follows:

- Detailed site investigations
- Pre-construction surveys
- Seabed preparation
- Landfall Horizontal Direction Drilling (HDD) for export cable
- Offshore export cable installation and cable protection installation
- Foundation installation and scour protection installation
- Inter-array cable installation and cable protection installation
- OSP installation; and
- WTG installation.

8.3 Offshore Wind Farm Construction

8.3.1 Pre-Construction Surveys

Several preliminary offshore surveys were undertaken to inform the initial design of the offshore elements of the proposed development. To confirm these findings and inform the detailed design and construction strategy, a series of detailed site investigation surveys will be undertaken in the array area and along the ECC. A Maritime Usage Licence is being obtained for these surveys. The information obtained from these surveys will be used to inform the final siting of infrastructure and detailed design of the proposed development.

Additional surveys will be required immediately prior to construction, as part of the seabed preparation phase, which are included as part of this planning application. These surveys will be required to further characterise the seabed conditions and morphology and identify any potential obstructions or hazards to the construction works.

The additional pre-construction surveys include geophysical surveys that are non-intrusive and will utilize towed equipment such as side scan sonar, sub bottom profiler, multibeam echosounder and magnetometer to gather detailed information on the bathymetry, seabed sediments, geology, and anthropogenic features (e.g., existing seabed infrastructure, unexploded ordnance (UXO) that exist across the offshore development area. Remotely Operated Vehicles (ROV) may also be used for further identification of findings from the geophysical surveys.

8.3.2 Seabed Preparation

Seabed preparation will be carried out in advance of foundation construction and cable laying as required.

This would involve levelling and dredging of the surficial sediments as well as the removal of any boulders and obstructions. The various methods of seabed preparation to be employed are described in the following sections.

If dredging is required, it would be carried out by dredging vessels using suction hoppers or similar. The material generated during dredging will overspill from the hopper locally and be discharged nearby in a suitable location of similar sediment type within the array area.

8.3.2.1 Unexploded Ordnance (UXO) Clearance

During the construction of offshore wind farms in Europe, there is potential to encounter UXO originating from historical military action or modern munitions. This poses a health and safety risk where it may be located at or near the planned location of infrastructure and associated vessel activity, and therefore it is necessary to survey for and manage this risk.

Studies to date indicate the array area to be low risk and one area within the ECC near the coast in the southwest is considered medium risk of encountering UXOs. (Alpha Associates, 2021)

If UXOs are found, depending on their nature, they can be avoided by rerouting / relocating cables or foundations. If that is not technically feasible, high-order detonation; low-order deflagration; removal/ relocation; and other less intrusive means of neutralising the UXO may be employed. A case-by-case risk assessment will be undertaken following dedicated geophysical surveys. These will employ magnetometers which allow ferrous objects to be detected and potential UXO targets discerned from the data. When a target has been identified as a potential UXO, it will be examined further using an ROV where possible. It is proposed that any UXO with potential to contain live ammunition may be detonated in situ and any remaining debris removed. Until detailed surveys have been completed and the final location of cables and foundations have been determined it is not possible to determine what, if any, UXOs will require detonation. For the preparation of this EIAR and design development, a desk based UXO study (Ref. 6 Alpha Associates, 2021) has been completed to manage the risk of UXO being located. The results of this desk study will inform the design of any post-consent geotechnical / geophysical surveys.

Where a target is confirmed as non-UXO the device may be recovered for onshore disposal where practicable.

8.3.2.2 Pre-Lay Grapnel Runs

A Pre-Lay Grapnel Run (PLGR) is a seabed clearance operation that takes place before the installation of a cable. The PLGR is carried out following the pre-construction cable route surveys and immediately prior to cable installation. The PLGR will be undertaken by a multi-purpose vessel and will involve the towing of an array of grapnels along the seabed of cable route such that any obstacles or debris (e.g. rocks) that could obstruct cable installation are removed.

8.3.2.3 Boulder Clearance

Until detailed surveys have been completed it is not possible to determine the extent of boulder presence across the offshore development area. The geophysical survey data available presently indicates a high incidence of boulders.

Relocation of foundations and rerouting of cables will be considered, however where this is not technically feasible, then boulder clearance will be required in order to avoid obstructions or damage to foundations, cables and cable protection measures and to reduce potential delays to the construction programme. Based on industry experience it is currently assumed that boulders greater than 0.5m diameter may need to be cleared. For the inter-array cables, it is anticipated that a 40m wide corridor will typically be cleared per cable. For the offshore export cables, two individual clearance corridors, each with a width of 40m will be cleared.

Boulder clearance is a common feature of offshore wind farm route clearance. In the event of a high density of boulders, a displacement plough is a common method to employ.

The displacement plough is a simple and robust Y-shaped design with a boulder board attached to the plough which scrapes along the seabed surface. The plough will be pulled along the seabed by a vessel and will typically clear a 15m wide path.

If the boulder density is low or the seabed slope exceeds 5 degrees and the plough cannot operate, it will be more convenient to use a grab which is guided and monitored by an ROV. This will also be the preferred method if any boulders present are too large for the plough. More information on boulder clearance activities is provided in the Offshore Environmental Management Plan (EMP) (Appendix 6.1 of Volume 9).

8.3.2.4 Seabed Profiling

The geophysical survey data available presently suggests a relatively featureless seabed across the offshore development area. Therefore, activities such as sand wave (large-scale, transverse ridges of sand that form on the seabed) clearance is not considered part of the construction strategy.

Notwithstanding, pre-construction surveys may still identify sediment bedforms (geological features that develop on the seabed). There are also technical requirements associated with the performance of cable installation and burial tools that will mean a relatively level seabed is required. Sediment bedforms may therefore have to be levelled prior to cable installation.

Controlled / Mass flow excavation is a process used for seabed preparation and profiling, bulk removal of sediment, rock dispersal, cable trenching and reburial. Deployed from a near-stationary vessel, a mass flow excavation device is lowered to a controlled position just above the seabed. The tool uses counter-rotating impellers to generate a large volume column of water, propagating towards the seabed at a velocity of up to 10m/s. This high-volume, low-pressure column of water fluidises and disperses the seabed material. This technique is generally suitable for a range of soil types, including sand and gravel, loose rock, silt and soft clays.

Seabed profiling is expected to be required as part of the installation process for jacket foundations. In order to give a level and stable platform for the jacket structure prior to placement of seabed frame and piling, a preparatory step of seabed levelling is expected to be required. This would involve the use of a trailing-suction hopper dredger (TSHD). For the water depths across the array area, it is expected that a large sized TSHD would be necessary. A TSHD removes material from the seabed via a draghead close to the seabed which collects material which is then connected to a suction pipe which deposits the material into a hopper on board. Once the hopper capacity has been reached, the on-board material would be discharged to the seabed through bottom doors at a designated location on the site. This technique is generally suitable for loose rock, silt and soft clays. This preparatory dredging will only be required for Project Option 2, where it is expected that up to 50% of WTG locations will require dredging (18 No. locations) at a diameter of 87m, and to a depth of 1m into the seabed. This would equate to in-situ removal volume of 107,400m^3.

8.3.3 Substructures and Foundations

Foundations are designed to support WTGs and the OSP. These structures are typically fixed to the seabed and are required to withstand wind forces and a wide range of meteorological conditions in the offshore environment.

As noted previously, two potential foundation/substructure options – monopiles or jackets on pin piles are being considered and both are assessed in this EIAR. For Project Option 1 and 2, monopiles are considered. For Project Option 2, there is the possibility of monopiles, or jackets considered; however, only one of the two foundation options will be installed. The WTGs will be installed on either a single monopile or jacket while the OSP may be installed on either of one monopile, two monopiles or a jacket.

The following sections describe the construction strategy for the proposed foundations.

Various vessels are referred to within the following subsections. For further detail on these vessels refer to Section 8.4.

8.3.3.1 Monopile Foundation

A monopile foundation comprises a single tubular steel section which is typically driven into the seabed via a hammer or drilling or a combination of both.

A monopile comprises of a series of rolled steel sections that are circumferentially welded together to form a tubular steel pile. They are the predominant foundation type for offshore wind farms and can be installed by either of driving into the seabed or drilling. In the case of driving, monopiles are typically driven into the seabed such that they are founded on a suitable bearing stratum of soil and/or weak rock.

The sub-seabed geological conditions and the findings of detailed design (particularly driveability assessments) may require that a monopile be installed with the use of a drilling technique. To mitigate against the possibility that the monopile would encounter premature refusal during a driving operation, drilling before installation or as part of Drive-Drill-Drive (DDD) would be required. Detailed designs of the foundations are not known, as is the detailed geotechnical conditions at each prospective WTG location. As a result, it is not known which technique would be required to install the foundation. As a precautionary approach, it has been assumed that 100% of monopiles will be installed by impact driving for the underwater noise modelling, detailed in the Underwater Noise Technical Note (see Appendix 14.1 of Volume 9). More detailed explanation between pile driving and drilling is given in Section **Error! Reference source not found.**.

If drilling is required, the proposed approach for disposal of drill cuttings is to discharge it to the sea. A pipe directs the discharge to approximately 100m away of the operation where sufficiently fine material would be discharged to the water column while coarse material will settle down to the seabed. Due to the subsurface geological conditions at the site, it is expected that up to 75% of the monopiles could need to be drilled. A precautionary approach has been taken for modelling of drilling in the marine physical processes model detailed in Volume 3, Chapter 10: Marine Geology, Oceanography and Physical Processes and the Marine Process Modelling Report (Appendix 10.2 of Volume 9) on the numbers of foundations assumed to be drilled. The expected average drilling rate can be assumed to advance within a range of between 0.5 m/h and 0.75 m/h.

If drilling for the foundation is required, it is anticipated to take up to 2 days to complete per pile. Any drilling event required for each pile will be separated by less than 12 hours. Dispersal assessments have been carried out as part of the marine physical process modelling, which is described in Volume 3, Chapter 10: Marine Geology and Physical Processes and Appendix 10.2: Marine Process Modelling Report of Volume 9.

Installation of monopiles via drilling will require a drilling spread to be available on the pile installation vessel. Drilling fluids or 'flush' are expected to be used, both to lubricate the drill bit, aid with the removal of drill arisings from the drill face and to stabilise the face of the borehole during drilling. Non-toxic and inert drilling fluids such as Bentonite or Xanthum gum are typically used for offshore drilling operations. Intermittent flushing out of the drill bit will be required, resulting in a slurry type discharge into the water column along with the cuttings mentioned above.

A transition piece (TP) may be required for the monopile, but it is possible to design the foundation-tower interface with a direct connection (i.e. 'TP-less' connection), whereby the flange of the foundation is bolted directly to the tower flange. A TP is typically fitted over the monopile and secured via bolts or grout. Grouting would be done with an ultra-high strength certified cement-based grout.

When grouting is required, it will be done with the use of an ultra-high strength cement-based grout, undertaken from the installation vessel or with the support of a grout vessel. The total installation duration is expected to be six months and will require up to two installation vessels and three support vessels. Crew change helicopter trips may be scheduled during the installation.

The total installation duration will be approximately eight months and will require up to two installation vessels and three support vessels. Crew change helicopter trips may be scheduled during the installation.

8.3.3.2 Jacket Foundation

Jacket foundations are an option for Project Option 2 only. Jacket foundations typically consist of three or four main legs which are linked by a lattice of cross-braces. Each leg is secured to the sea floor using a driven or drilled pin-pile.

Piles can be installed either before or after the jacket is lowered to the seabed. If before, a temporary piling template will be placed on the seabed to guide the pile locations. This is usually a welded steel installation frame.

The piles will then be installed through the template, which is subsequently removed, and the jacket affixed to the piles after it has been lowered into position, either welded or swaged.

If piles are installed after the jacket is lowered to the seabed, the piles will be installed through the jacket feet at the seabed, or through the legs of the jacket from the top of the structure. As there is no separate TP, there is no requirement for installing an additional structure offshore.

If drilling is required to achieve the required pile penetration, the preferred approach for the drill arisings is to discharge it to the sea. All recovered material would be dispersed within the offshore development area. To model the construction scenario with the greatest potential for likely significant effects within the EIAR, the marine physical processes model provided in Appendix 10.2 considers that drilling is expected to be required for 100% of the piled jacket foundations. The expected average drilling rate can be assumed to advance within a range of between 0.5 m/h and 0.75 m/h. It is anticipated drilling will take up to two days to complete per jacket, and each piling event will be separated by less than 12 hours. A drilling spread will be available on the pile installation vessel.

A Heavy Lift Vessel (HLV) will install the jacket onto the seabed or onto the piles, depending on the construction sequence. This may take up to one day.

When grouting is required, it will be done with an ultra-high strength cement-based grout from the installation vessel or with the support of a grout vessel. The installation is expected to take place across two seasons with the pile installation taking six months across the first season and the jacket installation taking six months across the second season. The works will require two installation vessels, one support vessel and three transport vessels. Crew change helicopter trips may be scheduled during the installation.

8.3.4 Foundation Installation

Both the monopile and piled jacket foundations will require installation of piles into the seabed. The options for installing the piles are either driven piles or drilled piles as described in Section 8.3.4.1 and 8.3.4.2 below.

Drilling is typically required where shallow bedrock is present or rock strengths are high, and as a result driving is not expected to achieve the required penetration depth.

The following foundation installation options have been considered within the EIAR for the two project options:

Table 8.2 Foundation installation options for Project Option 1 and Project Option 2

Project Option and Foundation Type	Options for installation
Project Option 1 (monopiles)	• All monopiles at all locations are fully driven (Section 8.3.4.1); • 25% of monopiles are fully driven and 75% of monopiles are a) fully drilled or b) driven until refusal then drilled and driven (i.e., relief drilling) (Section 8.3.4.2).
Project Option 2 (monopiles)	• All monopiles at all locations are fully driven (Section 8.3.4.1); • 100% of monopiles are a) fully drilled or b) driven until refusal then drilled and driven (i.e., relief drilling) (Section 8.3.4.2).
Project Option 2 (jacket foundations	• All jackets at all locations are fully driven (Section 8.3.4.1) • All jackets at all locations are fully drilled (Section 8.3.4.2)

Both monopiles and pin piles can be subject to refusal during driving operations. However, pin piles are potentially more susceptible to refusal and/or buckling in bedrock and boulders due to the thin wall thickness of the pile, hence as a precautionary approach a higher percentage of drilling has been assumed for jacket foundations in the marine physical processes modelling as presented in Appendix 10.2.

8.3.4.1 Driven Piles

Pile driving also known as piling or impact piling is a construction technique in which a large hammer is dropped or typically driven onto the top of the foundation pile which drives the pile into the seabed. During the pile driving, the pile is held in place by the support structure or by piling frames mounted on a vessel.

This helps to ensure that the pile is driven vertically and does not become misaligned during the driving process. The piling frames maintain the pile orientation until it has been installed to a sufficient depth to maintain its stability without any further support. Table 8.3 provides indicative values for the 100% driven pile scenario.

Table 8.3 Piling Parameters for Driven Piles.

Parameter	Monopile foundations (100% Driven)	Jacket foundations (100% Driven)
Piles per WTG foundation	1	3-4
Number of piled foundations (WTG) Project Option 1	49	0
Number of piled foundations (WTG) Project Option 2	35	35
Number of piled foundations (OSP) Project Option 1 and 2	1-2	4
Pile diameter (m)	12.5	6
Maximum hammer energy (kJ)	5,500	3,000
Maximum number of blows per pile	10,548	5103
Number simultaneous piling events within the Site	0	0

Each piling event would commence with a soft-start at a lower hammer energy, followed by a gradual ramp-up to the maximum hammer energy required.

The key impact piling parameters are described in Table 8.3. Further information describing the detailed piling parameters used to inform the assessment, including the underwater noise modelling, are provided in Volume 3, Chapter 13: Fish and Shellfish Ecology and Volume 3, Chapter 14: Marine Mammal Ecology.

8.3.4.2 Drilled Piles

For drilled piles two techniques will be considered – drilling & grouting and drive-drill-drive (DDD). The choice of which technique to deploy will depend on the characteristics of the rock (including rock type, rock mass strength, fracture condition, extent of weathering). Drilling rate can be assumed to advance within a range of between 0.5 m/h and 0.75 m/h.

Drilled and grouted piles have been used on several projects offshore (e.g. Saint Nazaire and Saint Brieuc offshore wind farms) and are the most common form of pile construction where bedrock is close to surface. There are two main types of drilled and grouted piles:

- Single stage piles: A socket hole is drilled to the required penetration depth into the bedrock, after which the pile is placed in and grouted.
- Two stage piles: A primary casing is either a) initially driven into the soil or b) used conjunction with the drilling tool to advance a hole down into the bedrock. The casing may be required as it ensures that the hole remains stable and provides support to the bottom hole assembly (BHA) of the drill . Once the casing and drill has reached the required penetration depth, the drill is retracted, and pile is inserted in the open hole. The final step of grouting the external annulus between pile and soil/rock can then be completed.

In Drive-Drill- Drive (DDD) Piles (Relief Drilling), the below steps are followed:

1. Drive pile with hammer through overburden to refusal.
2. Relief drill through centre of refused pile, drilling through overburden.
3. Continue drilling below pile toe level. Drill diameter is typically ~60 – 90% of pile diameter. A thin ‘ledge’ may be left beneath the pile wall.
4. Continue to drive the pile, breaking off the ‘ledge’.
5. Drive pile to target penetration depth to complete installation, then remove hammer.

6. This process may need to be repeated if driving refusal is again encountered.

This method is used in soils that are too hard or the frictional resistance of the soil/rock along the walls of the pile would cause the pile to refuse. Drilling is employed to reduce this resistance, be it at the pile toe or along the pile walls. The relief hole allows the pile to displace the soil more easily, and it also reduces the stress on the pile. This ensures that the pile is not unnecessarily exposed to excess hammering that would otherwise cause it to fatigue.

Table 8.4 provides indicative drill cutting volumes anticipated for the various foundation types.

Table 8.4 Indicative Drill Cutting Volumes

	WTG			OSP (Project Option 1 and 2)		
	Monopile (Project Option 1)	Monopile (Project Option 2)	Jacket on pin piles (Project Option 2)	Jacket on pin piles	One monopile (assuming OSP monopile is 100% drilled)	Two monopiles (assuming OSP monopiles are 100% drilled)
Drill cutting volume across site (m^3)	338,243	332,136	356,257	10,179	11,045	22,089

8.3.5 Scour Protection

Scour protection may be required to prevent erosion of the seabed around foundations. The requirement for scour protection will be determined prior to the construction of the foundations and the appraisal of the shallow geological conditions and geo-morphological regime on the site.

If required, the preferred solution will comprise a rock armour layer laid on a filter layer of smaller graded rocks. The filter layer can be installed before or after the foundation is installed. Alternatively, a single layer of scour protection may be used comprising of heavier rock material with larger individual rock size.

In the case of jacket solutions, the seabed may require dredging. This is to ensure that a level area is created for the placement of the seabed template that guides the pin piles and to allow placement of a uniform and level scour protection layer. The scour protection mat will be circular in footprint with the substructure centrally located within it. The diameter of the scour protection at WTG locations will be approximately 77m, irrespective of a three or four legs jacket solution. The diameter of the scour protection at the OSP location will be 78 m. For both, the depth of the scour protection is expected to be approximately 1.75 m in thickness.

8.3.6 Corrosion Protection

As noted in Section 6.3.5 of the Offshore Description Chapter, corrosion protection is required to reduce corrosion in the steel foundations. Steelwork in the splash zone requires coating due to the high corrosion rate in that zone. Permanently submerged steelwork can also be coated to reduce the amount of additional protection required.

Cathodic Protection (CP) in the form of sacrificial anodes or impressed current cathodic protection (ICCP) prevention systems are added to the foundation to minimise corrosion caused by sea water and oxygen. Sacrificial anodes are made of zinc or aluminium and are placed around the submerged part of the foundation. The size and requirement to replenish the sacrificial anodes varies depending on manufacturer and design of the CP system. ICCP are increasingly used in the marine environment below the water line of each foundation.

Above the waterline WTGs, foundations, transition pieces and towers will be coated to restrict corrosion and marine growth. The foundation and transition piece will be coated yellow whereas the tower, blades and nacelle are coloured light grey.

8.3.7 Wind Turbine Generators (WTGs)

WTGs comprise a tower, nacelle, and rotor, supported and fixed to the seabed by means of a foundation. A TP may be used, which acts as the interface between the tower and the foundation.

The WTG components will be transported from a port by a special purpose Jack-Up Vessel (JUV) or a Heavy Lift Vessel (HLV). JUVs have up to six legs. The loaded vessel will transit to the location of the first WTG to be installed. Upon arriving at the WTG location, the JUV will lower its legs and jack up until the entire hull has a sufficiently safe air gap between the water level and hull.

Once in a stable position it will lift the tower, nacelle, and blades in sequential order and secure to the foundation. In the case of a HLV, it will operate in floating condition. Alternatively, the WTG components may be loaded onto barges or feeder vessels in port and installed as described above by the JUV or HLV which will remain on site throughout the installation campaign. The exact methodology for the assembly is dependent on WTG type and installation contractor preference which will be determined following detailed design development and site investigation.

The total duration for the WTG installation campaign is expected to be approximately 180 days.

Each installation vessel or barge may be supported by smaller vessels such as tugs, guard vessels, anchor handling vessels (AHV) and crew transfer vessels (CTV).

8.3.8 Offshore Substation Platform (OSP)

The topside structure of the OSP, which includes all the electrical and mechanical equipment, will be constructed onshore. This approach allows for the installation and pre-commissioning of the equipment to be carried out in a controlled environment before it is transported to the offshore location.

When transporting the topside to the offshore development area, there are two main options. One option is to use a barge, which does not have the capability to directly install the topside. Alternatively, a HLV, which has the necessary installation capability, can be used for transportation.

If a barge is chosen for transport, a separate HLV or a JUV will be employed to lift the topside from the barge and place it onto the pre-installed foundation at the offshore location. This lifting operation is crucial for securely positioning the topside onto the foundation. To support the installation vessel during this process, additional vessels such as tugs, and fast response vessels may be utilized.

The OSP may be installed on either of one monopile, two monopiles or jackets on pin piles foundation options. The construction of these foundation types will be like that of the WTG foundations as described above. After the OSP is successfully installed, the next step is to connect the inter-array and offshore export cables. These cables are essential for connecting the substation to the WTG, and the onshore grid. Once the cables are brought into the topside, the commissioning work for the OSP will commence. This commissioning process involves a series of tests, inspections, and adjustments to ensure that all systems and components of the OSP are functioning as intended and are ready for operation.

The total duration for the installation of the OSP is estimated to be approximately 90 days.

During the installation period, a team of personnel will be involved in managing the interconnection of cables, conducting thorough checks on electrical systems, verifying communication networks, and performing other necessary tasks to ensure the overall functionality and reliability of the substation. The completion of the OSP installation signifies the readiness of the substation to receive and distribute electricity generated by the WTGs.

8.3.9 Subsea Inter-Array and Export Cables Installation

Cable installation methodology, as well as the burial depth and any requirement for protection measures, will be defined by a detailed cable burial risk assessment (CBRA). Typically, cable burial depth is between 1 and 3m but can vary depending on the seabed conditions. As the cables will be laid in varying water depths and ground conditions along their length, the CBRA will inform cable burial depth. The installation techniques will consist of one or a combination of trenching, dredging, jetting, ploughing, vertical injection, and rock cutting.

The cables will be installed using a dedicated cable installation vessel (CIV) with dynamic positioning (DP) capability (a computer-controlled system which automatically maintains a vessel's position using onboard technologies), which will spool the cable from the rear of the vessel whilst the cable tension, lay angle and landing location are monitored using on vessel and ROV equipment.

Further details on vessel types can be found in Section 8.4. The cable installation rates is assumed to be 300 m/hr with up to 3 cable laying vessels involved across trenching, laying and post-lay burial processes. The inter-array cable installation will take place in deep water, while the export cable installation will cover both deep and the shallower water of the export cable corridor.

Deep water cable laying and trenching refers to the installation of submarine cables in areas with significant water depths, typically exceeding 10m and extending to several kilometres. Intermediate shallow water cable laying and trenching occurs in relatively shallower areas ranging from a few meters to approximately 10m. The depth of the trench in deep water installations is generally shallower than in shallow water installations.

Export and inter-array cables are likely to be buried using a combination of techniques including trenching, jetting, and ploughing. The burial depth will ensure that the cable is adequately protected against scour and damage from activities such as trawling, anchoring etc. There are no volumes of spoil anticipated with the installation methods, the arisings are expected to be side cast or lost due to dispersal.

In areas of harder ground conditions (e.g. hard lenses of dense sands or compacted gravels), where the required trench depths cannot be achieved, there is potential for placing the cable on top of the seabed or at shallow depth. This would require the use of additional protection measures such as rock placement, or mattresses to provide adequate overlying protection and cover to the cables. Cable protection measures are described in more detail in Section 8.3.10.

8.3.9.1 Trenching

Mechanical trenching consists of using trenchers to cut the soil and lay the cable in the trench, see Image 8.2. Trenching consists of three consecutive operations. First a trench is excavated or cut while placing the sediment next to the trench. The cable is subsequently laid in the trench and lastly the sediment is returned to the trench, or the trench is left to infill naturally.

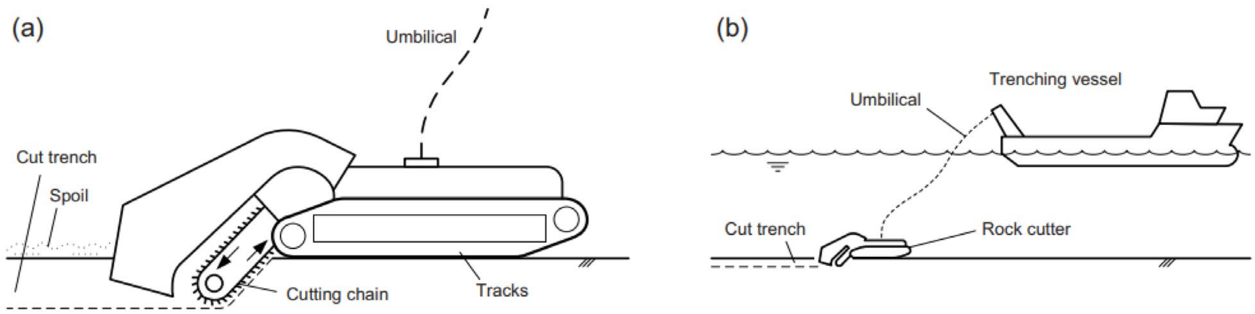

Image 8.1 Mechanical Trenchers. (a) Principal components, (b) Under operation (Source: DNVGL-RP-0360)

Pre-lay cutting of trenches (or 'pre-trenching') allows for two distinct operations. Where the ground conditions are suitable; a large trench is cut in one or multiple passes to the correct depth before the cable is laid back in the trench at a later date. The trench can be backfilled naturally or if required with a backfill plough or other method of material replacement.

8.3.9.2 Ploughing

Ploughing consists of lifting a small wedge of seabed material, placing the cable beneath, and placing the sediment back in place over the cable. Ploughing causes minimal disturbance of the seabed by minimising the amount of sediment displaced and ensuring the reinstatement of the seabed. Ploughing is suitable for a large range of seabed conditions; however, its potential is limited to weak soils and potentially weak or weathered rock.

Ploughing tools include any equipment that can be pulled by a surface vessel or mounted on autonomous caterpillar-tracked vehicles that can go around the ocean floor while receiving power from a surface vessel.

As the plough wedge passes through the ground, cables are inserted as part of the installation process. The condition of the seabed and the designated towing tension are two factors that affect how quickly the cables are buried using the ploughing method.

8.3.9.3 Jetting

Jetting involves the injection of pressurised water jets into the seabed to fluidise the sediment to form a trench, enabling the cables to sink into the seabed. The fluidised material subsequently resettles, giving a degree of backfill.

Two methods of water jetting are typically available:

- Lay the cable and jet at a later date: In this method, the cable is first placed onto the seafloor, and subsequently, a jetting apparatus is positioned above the cable's location. Under the cable, water jets are launched, forcing the sediment to become fluidized. This method causes the cable to fall to the predetermined depth, either due to self-weight or with the assistance of a weight attached to it. The jetting device can be attached to self-propelled caterpillar-tracked vehicles that are specifically made to navigate the seabed or it can be directly towed by a surface vessel. These vehicles draw power from a surface vessel while moving along the ocean floor.
- Lay the cable and jet simultaneously: In this method, high-pressure water jets are used to create a trench for the cable. The cable is then laid into the trench behind the jetting lance. The jetting tool can either be installed on a ROV or towed directly by a surface vessel.

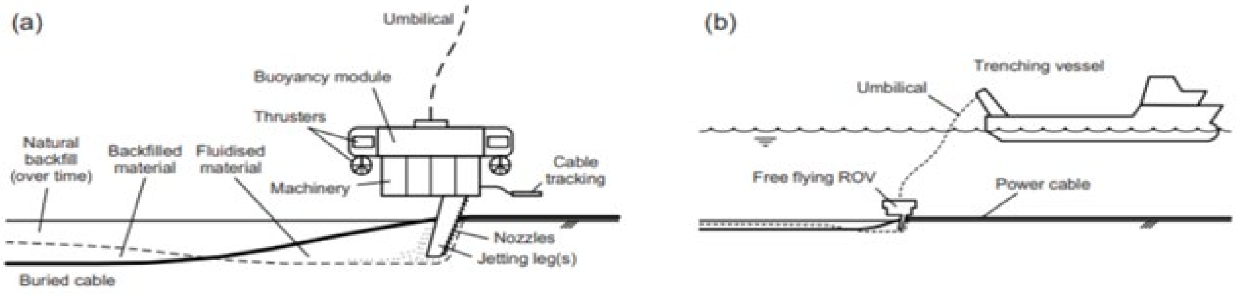

Image 8.2 ROV jet trencher. (a) Principal components, (b) Under operation (Source: DNVGL-RP-0360)

8.3.9.4 Controlled / Mass Flow Excavation

Controlled or Mass Flow Excavation process as described in Section 8.3.2.4 can be used for cable trenching and reburial within the seabed. It can also be used as a dredging technique for bulk excavation of material.

8.3.9.5 Cable Crossings

No third-party cabling or pipelines have been identified within the offshore development area. Inter-array cable layout will be designed to avoid cable crossing where practicable However, if inter-array cable crossing is unavoidable, cable crossing protection measures will be implemented as described in the following sections.

8.3.10 Cable Protection

As stated in the Offshore Description Chapter, cables will be buried where practicable to provide appropriate protection. When burial is not possible, additional cable protection techniques will be used such as mattressing and or rock placement. These may be used to protect the cable from direct damage or to provide stabilisation to minimise abrasion damage over time caused by cable movement. It is expected that 20% of cable length is will require protection either during initial installation, or throughout the operational phase of the proposed development. Final design of the cable protection will be subject to the cable routing, hydrodynamics and the ground conditions.

8.3.10.1 Rock Placement

In the event that cables cannot be installed to be required burial depth, such that they are adequately protected within the seabed, an additional overlying rock berm can be installed over the cables. Rock will be installed using specialist ships and barges via fall pipes. Indicative rock size of 450mm is anticipated and rocks will be placed in a sloped profile across the seabed with a height of 2m and width of 5m.

8.3.10.2 Mattress Placement

Concrete mattresses consist of several concrete blocks linked together by means of elastic cables as shown in Image 8.4. Concrete mattresses are lifted by cranes and placed on top of the cables following a pre-determined geometry specified in the design criteria.

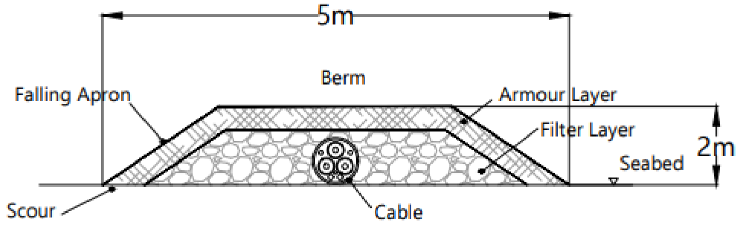

Image 8.3 Typical Mattress Cable Protection – not to scale (Source: NISA)

8.3.10.3 Offshore Cable Joint

Offshore cable joints are used when two sections of offshore cable are required to be jointed offshore, typically due to the shallow water installation methodology used or to join to smaller sections of cable together to achieve the required distance. Following jointing of the cable cores onboard the cable laying vessel, joint housing and cable resistors are added to the joint to mechanically protect the jointed section during over-boarding for the vessel and installation onto the seabed. Following this the joint will be protected by burial or secondary protection as described in previous sections.

8.3.11 Landfall site

The landfall is where the two offshore export cables from the OSP come ashore. As outlined in Section 8.1, the interface between the offshore and onshore infrastructure of the proposed development is the HWM.

The proposed construction method for connecting the two 220kV offshore export cables to the two onshore Transition Joint Bays (TJBs) will be via HDD. As the offshore export cable HDD process spans both seaward and landward of the HWM, for clarity, it is described in its entirety below. Construction of the TJBs is described in the Onshore Construction chapter.

8.3.11.1 HDD

HDD Set-up

The principle of HDD is to drill a bore underground between two points, into which an electrical cable can be installed, without needing to excavate an open trench along the route. To achieve this, an onshore drill rig drills from an entry pit, toward the exit site (reception pit) of the HDD.

At the landfall site, an HDD compound will be located within an agricultural field landward of the HWM, at least 50m from the edge of the coastal hills and cliffs and approximately 75m x 75m in size. Further information on the HDD set up and layout of the landfall HDD is provided in the Onshore Construction Chapter.

The HDD operation will comprise of two separate bore operations – one for each of the offshore export cables. Each HDD bore will have its an exit pit, and the two exit pits will be separated by a minimum distance of 20 m. The HDD exit pit will be located at a point seaward of the Low Water Mark i.e. the subtidal zone. The exit pits will be at least 20m wide and 30m long, orientated perpendicular to the adjacent coastline. Each exit pit will be 2.5m deep at the seaward end reducing to 1.5m at the landward end. In addition to exit pits, there will be a transition zone which is at least 6m wide and 50m long, excavated to a depth of 1.5m.

It is envisaged that the HDD bore would extend to a point at a suitable distance offshore, usually several hundred metres considering geological features, water depths, mechanical properties of cables and ducts. Confirmation of the precise location of the HDD exit requires the completion of a planned geotechnical survey of the landfall site, and subsequent design. Thus, the distance of the bore and the HDD exit location will be confirmed prior to the commencement of works.

HDD Works

The HDD works comprise the following main stages:

A. A pilot hole of approximately 300mm diameter will be drilled from onshore to offshore.

B. A reaming process will increase the diameter of the pilot hole to accommodate the safe installation of the HDD duct. This will require a number of passes to gradually increase the diameter of the HDD bore. At the HDD exit pit, an approximate 30m x 20m pit between 1.5m and 2.5m deep will be created in the seabed. This will be achieved using mass flow excavation or long reach excavators or a combination of both.

C. The HDD reamer head will punch through the seabed at the exit.

D. A high-density Polyethylene (HDPE) liner pipe (duct) will be pre-assembled offsite and then floated in, connected to the drill pipe, and pulled onshore from the offshore end through the pre-drilled bore.

E. Steps A – D are then repeated for the second 220kV offshore export cable.

F. The ducts will then be checked to make sure they are clear for cable pull-in and messenger wires will be installed.

G. Cables will then be installed in the ducts by pulling onshore through the ducts from the offshore delivery vessel.

H. Following the completion of the cable pull-in, external cable protection (e.g. rock armour) will be placed in the exit pit to protect the ducting and cable contained within (see Section 8.3.10).

I. Reinstatement works will comprise of either of:

   a. Where a long reach excavator has been used, any material side cast will be used for infill; or

   b. In the instance of mass flow excavation being used, an element of dredged material will pile to the side for infill after works.

Once commenced, the HDD drilling activities are expected to operate continuously over a 24-hour period until each bore is complete. Consequently, lighting will be provided to provide a safe working area. Directional lighting will be employed to minimise light spill onto adjacent areas and the lighting will be configured to meet health and safety requirements. The overall duration of the landfall works will take 10 months to complete, with the HDD bore works comprising 4 months and the cable pulling 2 months. Drilling of both bores may be carried out simultaneously to accelerate the works programme.

The HDD will require a drilling fluid or ‘mud’, to cool and lubricate the drill head. Drilling muds are typically bentonite based, and generally comprise of 92% water and 8% bentonite powder. Bentonite drilling muds are non-toxic, inert substances, with widespread use across drilling operations in the marine environment.

The bentonite effectively seals the bore maintaining a self-supporting system throughout the drill. The bentonite drilling fluid is circulated down through the drill rods and back up outside the rods in the annulus of the borehole.

While the bentonite drilling fluid is non-toxic, if enough enters a waterbody, it can potentially settle on the bottom, smothering benthic flora and affecting faunal feeding and breeding sites. In saltwater environments, the smothering effect is less problematic because seawater degrades the bentonite fluid, causing it to flocculate and allowing faster dispersal. However, as the HDD exit pit is seaward of the intertidal zone and is wave driven, the bentonite is unlikely to settle as it would be dispersed into the water column by the wave processes.

An HDD frac-out contingency plan, detailing measures to be taken to reduce the risk of bentonite breakout (loss of drilling fluid to the surface) and measures to be taken for the protection of sensitive ecological receptors, should a breakout occur has been included in the Offshore Environmental Management Plan (Offshore EMP) (Ref to Volume 8, Appendix 6.1: Offshore Environmental Management Plan).

On completion of each HDD process the drill will emerge in the exit pit with the potential to release around 30 tonnes of drilling muds (e.g. Bentonite slurry) as a near-bed discharge, as well as coarser drill cuttings. There is expected to be an initial near-instantaneous release of up to 10 tonnes of drilling muds at punch-out (estimated to last for around 100 seconds), followed by a longer period of around 24 hours during reaming and pull-back with a release of up to 20 tonnes of drilling muds.

During the HDD boring, the drilling fluid will be 'self-contained' with all fluid returned onshore to a recycling pit or tank, where it can be filtered and re-used for drilling purposes. Upon completion of the HDD works, the majority of the drilling fluid can be reused post-treatment, with any waste drilling fluid taken offsite by tanker for treatment and licensed disposal.

Water will be brought to site in tankers (to make up drilling fluid) for lubrication of the bore and to provide the requisite volumes of water to the compound. The water used will be non-saline and non-potable water.

8.3.11.2 Cable Installation

Following the completion of the HDD duct installation, the cable for each circuit will be pulled through the ducts. A ground level platform will be constructed for the cable pull-in winch. The winch will be anchored using kentledge blocks, sheet piles or rock anchors.

Prior to pulling, the cable ducts will be tested to ensure the cable can be pulled through without any obstructions.

8.3.11.3 Commissioning, site management and landfall reinstatement

Refer to the Onshore Construction chapter for overall description of commissioning activities, delivery routes, site management (such as employment, security, hoarding fencing, community liaison etc), materials management, safety management and environmental management at the landfall site.

8.4 Offshore Construction Vessels

This section gives an overview of the types of vessels currently used for installing wind farms. Construction will require a variety of different vessel dependent on the final WTG, foundation, construction port, and construction strategy adopted. Except where noted, the vessels use DP to maintain their location, thus avoiding any disturbance of the seabed.

8.4.1 Jack up vessels

JUV can be used to install the foundations, transition pieces, tower, nacelle and blades. JUV are around 200m in length with up to 8 legs and can carry up to 200 passengers. Mounted at the base of each leg is a spud can which is circular in-plan with a shallow conical underside and a sharp protruding spigot. When deployed on the seabed, this allows penetration of the legs and the vessel to jack up. The total area of seabed area penetrated by the spun cans is approx. 1800m^2.

JUV work in water depths of around 80m and have a lifting capacity of around 3,500 tonnes. The size of vessel used tends to increase as the size of the proposed WTG increases. Refer to Image 8.5.

Image 8.4 Jack-up Crane Vessel (Source: CIP)

8.4.2 Heavy lift vessels

HLVs are typically used for transportation and installation of jackets and monopiles for offshore wind turbines. HLVs are equipped with floating crane and are suitable for any seabed. HLVs have relatively fast transit speed and can be positioned quickly for installation. HLVs are around 200m in length and can carry up to 250 passengers. HLVs have typical lifting capacity of around 3,000 -5,000 tonnes. HLVs are also deployed for the decommissioning of foundations. Refer to Image 8.6.

Image 8.5 Heavy Lift Vessels (HLVs) (Source: CIP)

8.4.3 Service operational vessels

Service operational vessels (SOVs) are used for crew transfers, offshore accommodation, commissioning and safety monitoring. SOVs are around 80m in length and can carry up to 70 passengers, if needed, at a speed of up to 15kn. The deck area can be up to 900m². SOVs can be used when wave heights are below 2.5m.

They often have a walk to work system onboard which provides a motion compensated walkway from the vessel to the turbine access platform. Refer to Image 8.7.

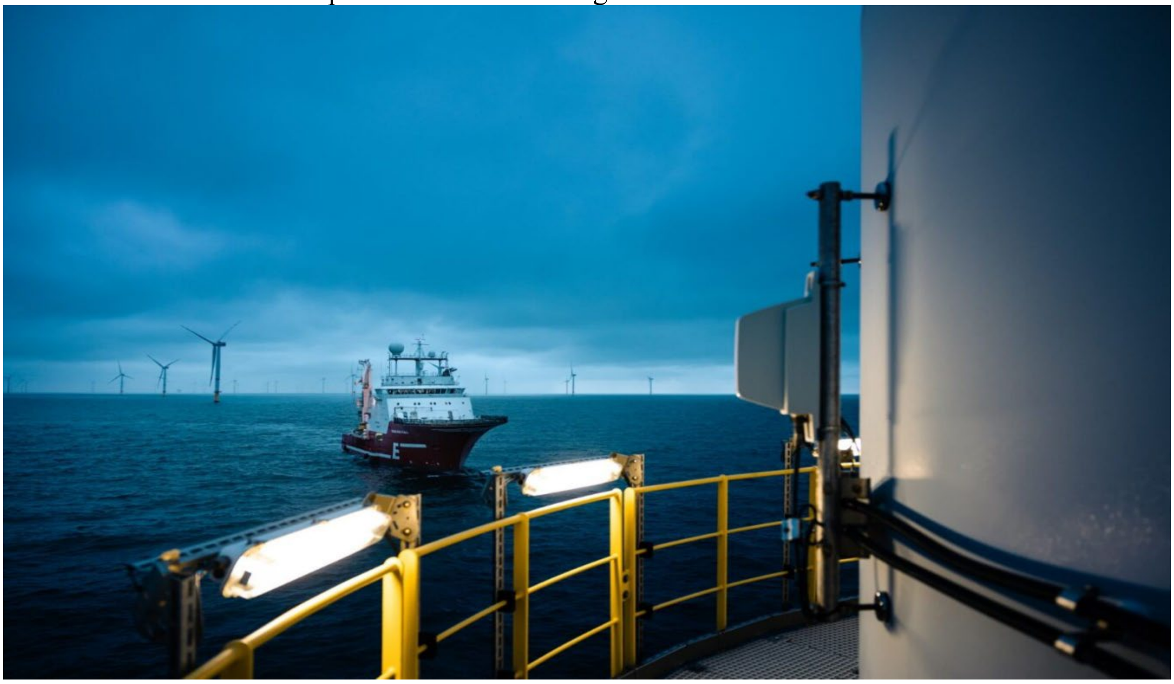

Image 8.6 Service Offshore Vessels (SOVs) (Source: Veja Mate - CIP)

8.4.4 Crew transfer vessels

CTVs are a quick and agile vessel used to transfer the crew from shore to wind turbine or between vessels. CTVs are around 25m in length and can carry around 12 passengers at a speed of up to 25kn. CTVs can be used to complete offshore transfers when wave heights are typically below 1.5m. Refer to Image 8.8.

Image 8.7 Crew Transfer Vessels (CTVs) within the array (Source: Veja Mate - CIP)

8.4.5 Barges and towing vessels

Transportation barges and towing vessels can be used to transport foundations, transition pieces, tower, nacelle, and blades to site. Towing vessels can be up to 80m long and barges are around 150m long. If more economical, work could be done with the JUV alone. Refer to Image 8.9.

Image 8.8 Towing Barge (Sound Castor) (Source: Wikimedia Commons)

8.4.6 Dredging vessels

Dredging vessels are used to excavate or move sediments like silt, sand, rocks, dirt, and other debris from the seabed with a dredger. Dredging vessels are also used for flattening of sand waves and levelling of seabed. Dredging vessels are typically equipped with advanced navigation systems, surveying equipment, and monitoring technologies to ensure precise dredging operations and minimize environmental impacts. Dredging vessels can be up to 165m in length with dredging depths of up to 45m achievable, but for the purposes of the assessment, a dredging vessel has been assumed to be 159m in length with a sediment holding capacity of around 15,000 m3. Refer to Image 8.10.

Image 8.9 Dredging Vessel (ORANJE Dredger) (Source: Wikimedia Commons)

8.4.7 Fall pipe vessels

Fall pipe vessels (FPV) are used for installing scour protection and other rock armour protection (e.g cable protection). Provided water depths allow, FPVs are equipped for rock installation in both deep and shallow water. FPVs have a capacity of several tens of thousands of tonnes of rock. A fall pipe is used to carefully position rock on the seabed around the foundations.

8.4.8 Cable installation vessels

Cable installation vessels (CIV) are used for inter-array and export cable installation. The vessels are optimised for the cable lay operation as well as the burial of the cable in the seabed. They consist of a carousel for cable storage, crane for lifting and over boarding chute to guide cable into the water. They also have ROV capability for monitoring and burying the cable. Refer to Image 8.11.

Image 8.10 Cable Installation Barge (Source: CIP)

8.4.9 Offshore supply vessels

Offshore supply vessels (OSV) are be used for grouting, towing and equipment transfer. OSVs typically range from 50 to 80m in length. OSVs can be fitted out with additional equipment depending on their specific purpose. Depending on the amount of grouting required, larger vessels of 150m length can be used, which have a larger storage capacity.

8.4.10 Support Vessels

To aid the offshore construction vessels, additional support vessels may be required to support a range of other activities, including surveys using ROV and geophysical equipment, diving activities, PLGR, tugs, anchor handling vessels (AHV) and guard vessels.

Guard vessels may be required to maintain surveillance around the installation vessels with restricted manoeuvrability, as it is necessary to ensure other vessels keep clear of the installation activity to avoid the risk of collision. Additionally, they may be required to protect the cable prior to trenching/burial, or placement of cable protection.

8.4.11 Construction Vessel Traffic

8.4.11.1 WTG Installation Vessels

For the EIAR, the following assumptions have been made on the maximum number of vessels and return trips to the proposed development from the construction port throughout the turbine installation campaign. Refer to Table 8.5.

Table 8.5 Vessel / Helicopter Requirements for WTG Installation

Vessel / Helicopter type	Number of vessels / helicopters	Number of return trips per vessel / helicopter type (Project Option 1)	Number of return trips per vessel / helicopter type (Project Option 2)
Installation vessel (e.g. JUV, HLV)	2	15	10
Personnel support vessels (e.g. CTV)	6	90	70
Component transport vessels (e.g. barges, towing vessel)	2	45	30
Helicopter support	1	10	7

8.4.11.2 Foundation Installation Vessels

The required number of vessels and return trips for foundation installation can be seen in Table 8.6.

Table 8.6 Vessel / Helicopter Requirements for Foundation Installation

Vessel Type	Number of vessels	Number of return trips per vessel (Project Option 1)	Number of return trips per vessel (Project Option 2)
Installation vessels (e.g. JUV, HLV)	2	8	6
Personnel support vessels (e.g. CTV, SOV)	3	49	35
Component transport vessels (e.g. barges, towing vessel)	3	8	6
Scour protection vessels	2	75	50
Dredging vessels (Project Option 2 only)	1	0	9

8.4.11.3 OSP installation vessels

The required number of vessels and return trips for OSP installation is provided in Table 8.7.

Table 8.7 OSP installation vessel requirements

Vessel Type	Number of vessels	Number of return trips per vessel (Project Option 1)	Number of return trips per vessel (Project Option 2)
Installation vessels (e.g. JUV, HLV)	1	2	2
Component transport vessels (e.g. barges, towing vessel)	2	2	2
Personnel support vessels (e.g. CTV, SOV)	2	250	250
Transport vessel	1	50	50

8.4.11.4 Cable Installation Vessels

The required number of vessels and return trips for inter array and export cable installation can be seen in Table 8.8 and Table 8.9, respectively.

Table 8.8 Vessel Requirements for Inter-Array Cable Installation

Vessel Type	Number of vessels	Number of return trips per vessel (Project Option 1)	Number of return trips per vessel (Project Option 2)
Main laying vessels	1	4	3
Main burial vessels	1	7	6
Personnel support vessels (e.g. CTV, SOV)	1	120	100
Component transport vessels	1	5	5

Table 8.9 Vessel Requirements for Export Cable Installation

Vessel Type	Number of vessels	Number of return trips per vessel (Project Option 1)	Number of return trips per vessel (Project Option 2)
Main laying vessels	1	2	2
Main burial vessels	1	3	3
Support vessels (e.g. CTV, SOV)	1	2	2
Work boats/ rigid inflatable boats for pull in operation - 24h	12	2	2
Work boats for landfall HDD installation	1	30	30
Small JUV for landfall HDD installation	1	2	2
Guard vessels for HDD and Cable installation	1	20	20

8.4.11.5 Guard Vessels

The required number of guard vessels and return trips for the construction phase of the proposed development is provided in Table 8.10.

Table 8.10 Guard vessel requirements for the construction phase of the proposed development

Vessel Type	Number of vessels	Number of return trips per vessel (Project Option 1)	Number of return trips per vessel (Project Option 2)
Guard vessel	4	64	52
Observation vessel	5	64	52
Personnel Transport vessels (CTVs)	2	45	45

8.5 Construction Ports

The WTG and foundation components described above will be brought to site via a construction port. All components are anticipated to be transported via sea transport and delivered to the construction port.

Transportation and delivery of large components (e.g. WTG blades) to the construction port via roads is not anticipated. At the construction port, the components will be stored and, in some instances, assembled before being transferred to the offshore development area using the vessels described above.

There are a number of suitable ports under consideration by the proposed development, both on the island of Ireland, Great Britain and France. A multi-port approach may be taken to remove the risk of a single point of failure to the proposed development. An Irish port would be the preference of the project, to support the development of the offshore industry in Ireland. However, this will depend on the rate of the required development being undertaken, to enable the relevant ports to cater for the construction and maintenance of offshore wind farms. All feasible locations will be considered when making the final decision.

8.6 Workforce/Employment

The offshore element of the proposed development is expected to create employment opportunities for approximately 850 individuals. These employment opportunities are crucial for supporting and ensuring the successful completion of the proposed development.

8.7 Advisory Safety Zones

During construction and decommissioning, the proposed development will deploy advisory safety zones around individual structures undergoing installation/decommissioning. Due to a lack of Irish guidance, the safety zones are advisory only and will be based on the relevant UK guidance, MGN 654 (Maritime and Coastguard Agency, 2021). Advisory safety zones will be employed via Notice to Mariners.

Advisory safety zones of up to 500m in radius around individual structures undergoing installation will be established. Advisory safety zones of 50m will be sought for incomplete structures where construction activity may be temporarily paused (and therefore the 500m advisory safety zone has lapsed) such as installed foundations or where construction works are completed but the WTGs have not yet been commissioned. The proposed development will also recommend that advisory clearance distances of up to 500m in radius are observed around installation vessels.

Where deemed appropriate by risk assessment and in consultation with the relevant statutory authorities, guard vessels may be deployed.

8.8 Offshore Wind Farm Commissioning

After the installation of WTGs and the OSP and following completion of the cabling connections, a planned process of testing and commissioning is conducted to ensure the optimal functioning of all mechanical and electrical components before the wind farm becomes operational. This is a necessary quality assurance step before handover of the proposed development from the respective contractors to the Developer. This essential phase typically spans a duration of around 10 to 12 days. During the testing and commissioning phase, various comprehensive tests are performed to evaluate performance, safety features, and overall reliability. Skilled technicians and engineers meticulously inspect and validate each aspect of the WTGs and OSP operation, including its mechanical components, electrical systems, and control mechanisms.

The process of testing the turbine encompasses an examination of various control systems present in the turbine, including those related to the generator, switchgear, transformer, gearbox (if applicable), yaw control, and meteorological measurement functions. During the testing phase, all interlocks and safety systems are inspected for their effectiveness in both static and running modes. This ensures that the WTGs safety mechanisms are in place and capable of responding appropriately to any potential issues or emergencies. Additionally, ancillary systems such as hydraulics undergo a pre-testing regime to ensure their readiness before the rotation of the turbine.

The final stage of the commissioning process involves energising the WTG through the inter-array cables. Both inter-array cables and export cables are subject to final commissioning and acceptance to ensure that all terminations and cables are functioning as intended. This process involves the connection of specialist equipment at the termination points (e.g. OSP or WTG) to ensure that the cables are performing as per the electrical design requirements. If the grid connection is not available at the time of commissioning, and the WTGs do not have an external power supply, an alternative method would be provided which gives a temporary power supply to the WTGs. The temporary power supply allows the WTGs to be powered which allows moving components to run, initiation of testing processes, and assessment of the WTG performance and functionality even in the absence of a permanent grid connection.

8.9 Decommissioning

It is anticipated that any offshore decommissioning process will involve similar activities to the construction process but that these will be undertaken in reverse, with removal of above surface structures initially (blades, nacelle, turbine, towers, and transition piece) followed by removal of foundations and associated subsurface infrastructure. It may be determined that the removal of foundations, pilings, scour protection and inter-array / offshore export cabling may cause greater environmental impacts than leaving in-situ and that if safe to do so, then certain infrastructure may be cut at or just below the seabed at an assumed depth of 1m – 2m below seabed level with cabling left buried.

Further detail on decommissioning activities can be found in the Offshore Description chapter.

8.10 References

- 6 Alpha Associates, 2021. Unexploded Ordnance Threat and Risk Assessment with Risk Mitigation Strategy - North Irish Sea Array.
- DNVGL-ST-0126 Support Structures for Wind Turbines
- DNVGL-ST-0145 Offshore Substations
- DNVGL-RP-0360 Subsea Power Cables in Shallow Water
- DNVGL-ST-0054 Transportation and installation of offshore wind turbines
- DNVGL-RP-0416 Corrosion protection of offshore wind turbines
- Wikimedia Commons