Neart na Gaoithe

Neart na Gaoithe Offshore Wind Farm

Cable Plan

July 2020

Rev 7.0

DOCUMENT REFERENCE: NNG-NNG-ECF-PLN-0007

Neart na Gaoithe Offshore Wind Farm

Cable Plan

Pursuant to Section 36 Consent Condition 19 and the Wind Farm Marine Licence Condition 3.2.2.9 and OfTW Marine Licence Conditions 3.2.2.8

For the approval of the Scottish Ministers

SIGN OFF		
Name (Role)	Signature	Date
David Sweenie Development Manager	[Redacted]	10/07/2020
Claire Gilchrist Offshore Consents Manager	[Redacted]	09/07/2020
Sarah MacNab Environmental Clerk of Works	[Redacted]	09/07/2020

Plan Overview

Purpose and Objectives of the Plan

This Cable Plan (CaP) has been prepared to address the specific requirements of the relevant conditions attached to the Section 36 (S36) Consent and Marine Licences (collectively referred to as the Offshore Consents) issued to Neart na Gaoithe Offshore Wind Limited (NnGOWL).

The CaP confirms the location of inter-array, interconnector and export cables, and their method of burial and protection. It explains how cable routing has been, and will be, informed by survey work that has identified constraints within the Project area. The CaP also confirms the technical specification of the cables to be installed.

All NnGOWL personnel and Contractors involved in the Project must comply with this CaP.

Scope of the Plan

The CaP covers, in line with the requirements of the consents conditions, and in line with industry standards and good practice, the following for the inter-array, interconnector and export cables:

- Installation methods;
- Routing;
- Technical specifications and an assessment of the attenuation of electro-magnetic fields;
- A summary of the cable burial risk assessments that have been undertaken to inform burial and protection plans; and
- Methodologies for surveys of the cables through the operational life of the Project.

Structure of the Plan

The CaP is structured as follows:

Sections 1 to 3 sets out the scope and objectives of the CaP, statements of compliance and provide an overview of the Project.

Section 4 confirms cable location and layout.

Section 5 details the technical specification of the cables and associated electromagnetic fields.

Sections 6 and 7 set out intended cable burial and protection, as informed by cable burial risk assessments.

Section 8 identifies cable inspection activities to be undertaken during the operational phase of the Project.

Section 9 confirms compliance with the Application.

Plan Audience

The CaP is intended to be referred to by personnel involved in the construction of the Project, including NnGOWL personnel and Contractors.

Compliance with this CaP will be monitored by the NnGOWL Consents team, NnGOWL's Environmental Clerk of Works (ECoW) and the Marine Scotland Licensing Operations Team (MS-LOT).

Plan Locations

Copies of this CaP are to be held in the following locations:

- NnGOWL Project Office;
- At the premises of the cable installation Contractors acting on behalf of NnGOWL;
- NnGOWL Marine Coordination Centre; and
- With NnGOWL's ECoW.

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Acronyms and Abbreviations

TERM	DESCRIPTION
AC	Alternating Current
AEZ	Archaeological Exclusion Zone
AGDS	Acoustic Ground Discrimination System
AHT	Anchor Handling Tug
ALARP	As Low As Reasonably Practical
CBRA	Cable Burial Risk Assessment
CLV	Cable Lay Vessel
CPS	Cable Protection System
CPT	Cone Penetration Test
CTV	Crew Transfer Vessels
DDM	Degrees Decimal Minutes
DoL	Depth of Lowering
DP	Dynamic Positioning
DSV	Dive Support Vessel
DTS	Distributed Temperature Sensing
EIA	Environmental Impact Assessment
EMF	Electromagnetic fields
ES	Environmental Statement
IEC	International Electrotechnical Commission
KP	Kilometre Point
GPS	Geographical Positioning System
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
MBES	Multi Beam Echosounder
MCA	Maritime and Coastguard Agency

TERM	DESCRIPTION
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MS-LOT	Marine Scotland Licensing Operations Team
OFGEM	Office of Gas and Electricity Markets
OSP	Offshore Substation Platforms
OSV	Offshore Support Vessel
O&M	Operation and Maintenance
PLGR	Pre-Lay Grapnel Run
ROV	Remote Operated Vehicle
SFF	Scottish Fishermen's Federation
SNH	Scottish Natural Heritage
SSS	Sidescan Sonar
TJB	Transition Joint Bay
WTW	Walk to Work
XLPE	Cross Linked Polyethylene

Defined Terms

TERM	DESCRIPTION
Addendum	The Addendum of Additional Information submitted to the Scottish Ministers by NnGOWL on 26 July 2018.
Application	The Environmental Impact Assessment Report, Habitats Regulations Appraisal Report and supporting documents submitted to the Scottish Ministers by NnGOWL on 16 March 2018; the Addendum of Additional Information submitted to the Scottish Ministers by NnGOWL on 26 July 2018 and the Section 36 Consent Variation Report dated 08 January 2019.
Company	Neart na Gaoithe Offshore Wind Limited (NnGOWL) (Company Number SC356223). NnGOWL has been established to develop, finance, construct, operate, maintain and decommission the Project.
Consent Conditions	The terms that are imposed on the Company under the Offshore Consents that must be complied with.

TERM	DESCRIPTION
Consent Plans	The plans, programmes or strategies required to be approved by the Scottish Ministers (in consultation with appropriate stakeholders) in order to discharge the Consent Conditions.
Contractors	Any Contractor/Supplier (individual or firm) working on the Project.
EIA Report	The Environmental Impact Assessment Report, dated March 2018, submitted to the Scottish Ministers by NnGOWL as part of the Application.
Inter-array Cables	The offshore cables connecting the wind turbines to one another and to the OSPs.
Interconnector Cables	The offshore cables connecting the OSPs to one another.
Marine Licences	The written consents granted by the Scottish Ministers under the Marine (Scotland) Act 2010, for construction works and deposits of substances or objects in the Scottish Marine Area in relation to the Wind Farm (Licence Number 06677/19/0) and the OfTW (Licence Number 06678/19/1), dated 4 June 2019 and 5 June 2019 respectively.
Offshore Consents	The Section 36 Consent and the Marine Licences.
Offshore Export Cable Corridor	The area within which the Offshore Export Cables are to be located.
Offshore Export Cables	The Offshore Export Cables connecting the OSPs to the landfall site.
OfTW	The Offshore Transmission Works comprising the OSPs, offshore interconnector cables and Offshore Export Cables required to connect the Wind Farm to the Onshore Transmission Works at the landfall.
OfTW Area	The area outlined in red and blue in Figure 1 attached to Part 4 of the OfTW Marine Licence.
OnTW	The onshore transmission works from landfall and above Mean High Water Springs, consisting of onshore export cables and the onshore substation.
Project	The Wind Farm and the OfTW.
Section 36 Consent	The written consent granted on 3 December 2018 by the Scottish Ministers under Section 36 of The Electricity Act 1989 to construct and operate the Wind Farm, as varied by the Scottish Ministers under section 36C of the Electricity Act 1989 on 4 June 2019.
Section 36 Consent Variation Report	The Section 36 Consent Variation Report submitted to the Scottish Ministers by NnGOWL as part of the Application as defined above on 08 January 2019.
Subcontractors	Any Contractor/Supplier (individual or firm) providing services to the Project, hired by the Contractors (not NnGOWL).
Wind Farm	The offshore array as assessed in the Application including wind turbines, their foundations and inter-array cabling.

TERM	DESCRIPTION
Wind Farm Area	The area outlined in black in Figure 1 attached to the Section 36 Consent Annex 1, and the area outlined in red in Figure 1 attached to Part 4 of the Wind Farm Marine Licence.

Consent Plans

CONSENT PLAN	ABBREVIATION	DOCUMENT REFERENCE NUMBER
Decommissioning Programme	DP	NNG-NNG-ECF-PLN-0016
Construction Programme and Construction Method Statement	CoP & CMS	NNG-NNG-ECF-PLN-0002
Piling Strategy	PS	NNG-NNG-ECF-PLN-0011
Development Specification and Layout Plan	DSLP	NNG-NNG-ECF-PLN-0003
Design Statement	DS	NNG-NNG-ECF-PLN-0004
Environmental Management Plan	EMP	NNG-NNG-ECF-PLN-0006
Operation and Maintenance Programme	OMP	NNG-NNG-ECF-PLN-0012
Navigational Safety and Vessel Management Plan	NSVMP	NNG-NNG-ECF-PLN-0010
Emergency Response Cooperation Plan	ERCoP	NNG-NNG-ECF-PLN-0015
Cable Plan	CaP	NNG-NNG-ECF-PLN-0007
Lighting and Marking Plan	LMP	NNG-NNG-ECF-PLN-0009
Project Environmental Monitoring Programme	PEMP	NNG-NNG-ECF-PLN-0013
Fisheries Management and Mitigation Strategy	FMMS	NNG-NNG-ECF-PLN-0008
Written Scheme of Investigation and Protocol for Archaeological Discoveries	WSI & PAD	NNG-NNG-ECF-PLN-0005
Construction Traffic Management Plan	CTMP	NNG-NNG-ECF-PLN-0014

1 Introduction

1.1 Background

1. The Neart na Gaoithe Offshore Wind Farm (Revised Design) received consent under Section 36 of the Electricity Act 1989 from the Scottish Ministers on 03 December 2018 and was granted two Marine Licences by the Scottish Ministers, for the Wind Farm and the associated Offshore Transmission Works (OfTW), on 03 December 2018. The S36 consent and Wind Farm Marine Licence were revised by issue of a variation to the S36 Consent and Marine Licence 06677/19/0 on 4 June 2019, and the OfTW Marine Licence by the issue of Marine Licence 06678/19/1 on the 5 June 2019. The revised S36 Consent and associated Marine Licences are collectively referred to as 'the Offshore Consents'.
2. The Project is being developed by Neart na Gaoithe Offshore Wind Limited (NnGOWL).

1.2 Objectives of this Document

3. The Offshore Consents contain a variety of conditions that must be discharged through approval by the Scottish Ministers prior to the commencement of any offshore construction works.
4. One such requirement is the approval of a Cable Plan (CaP). The relevant conditions setting out the requirement for a CaP for approval, and which are to be discharged by this CaP, are presented in full in Table 1-1.

Table 1-1 CaP consent conditions to be discharged by this Consent Plan

OFFSHORE CONSENTS REFERENCE	CONDITION	WHERE ADDRESSED
Section 36 Consent Condition 19	The Company must, no later than six months prior to the Commencement of the Development, submit a Cable Plan ("CaP"), in writing, to the Scottish Ministers for their written approval.	This document sets out the CaP for approval by the Scottish Ministers
	Such approval may only be granted following consultation by the Scottish Ministers with, [Scottish Natural Heritage]SNH, [Maritime and Coastguard Agency] MCA, [Scottish Fishermen's Federation]SFF and any such other advisors or organisations as may be required at the discretion of the Scottish Ministers.	Consultation to be undertaken by the Scottish Ministers.
	The CaP must be in accordance with the Application.	Section 9
	The CaP must include, but not be limited to, the following: a. The vessel types, location, duration and cable laying techniques for the inter array cables;	Section 4, 5 and 7
	b. The results of monitoring or data collection work (including geophysical, geotechnical and benthic surveys) which will help inform cable routing;	Section 4.2
	c. Technical specification of inter array cables, including a desk based assessment of attenuation of electro-magnetic field strengths and shielding;	Section 5

OFFSHORE CONSENTS REFERENCE	CONDITION	WHERE ADDRESSED
	d. A burial risk assessment to ascertain burial depths and where necessary alternative protection measures;	Section 6
	e. Methodologies for surveys (e.g. over trawl) of the inter array cables through the operational life of the wind farm where mechanical protection of cables laid on the sea bed is deployed; and	Section 8.1
	f. Methodologies for inter array cable inspection with measures to address and report to the Scottish Ministers any exposure of inter array cables.	Section 8.2
	Any consented cable protection works must ensure existing and future safe navigation is not compromised. The Scottish Ministers will accept a maximum of 5% reduction in surrounding depth referenced to Chart Datum. Any greater reduction in depth must be agreed in writing by the Scottish Ministers	Section 6.3
Wind Farm Marine Licence Condition 3.2.2.9; and **OfTW Marine Licence Condition 3.2.2.8**	The Licensee must, no later than six months prior to the Commencement of the Works, submit a CaP, in writing, to the Licensing Authority for its written approval.	This document sets out the CaP for approval by the Scottish Ministers
	Such approval may only be granted following consultation by the Licensing Authority with SNH, MCA, Scottish Fishermen's Federation ("SFF") and any such other advisors or organisations as may be required at the discretion of the Licensing Authority. Commencement of the Works may not take place until such approval is granted. The CaP must be in accordance with the Application.	Consultation to be undertaken by the Scottish Ministers.
	The CaP must include, but not be limited to, the following: a. The vessel types, location, duration and cable laying techniques for the inter array cables;	Section 4, 5 and 7
	b. The results of monitoring or data collection work (including geophysical, geotechnical and benthic surveys) which will help inform cable routing;	Section 4.2
	c. Technical specification of inter-array cables / [interconnector, export] cables, including a desk based assessment of attenuation of electro-magnetic field strengths and shielding;	Section 5.1
	d. A burial risk assessment to ascertain burial depths and where necessary alternative protection measures;	Section 6
	e. Methodologies for surveys (e.g. over trawl) of the inter array cables through the operational life of the wind farm where mechanical protection of cables laid on the seabed is deployed; and	Section 8.1
	f. Methodologies for inter array cable inspection with measures to address and report to the Licensing Authority any exposure of inter array cables.	Section 8.2

OFFSHORE CONSENTS REFERENCE	CONDITION	WHERE ADDRESSED
	Any licensed cable protection must ensure existing and future safe navigation is not compromised. The Licensing Authority will accept a maximum of 5% reduction in surrounding depth referenced to Chart Datum. Any greater reduction in depth must be agreed in writing by the Licensing Authority.	Section 6.3

1.3 Linkages with Other Consent Plans

5. This CaP sets out the inter-array, export and interconnector cable arrangements and the methods for installation. It forms part of a suite of approved documents that will provide the framework for the construction process – namely the other Consent Plans required under the Offshore Consents.

6. The consent conditions that require the development of a CaP do not explicitly identify linkages between this and other Consent Plans. However, other conditions require that several other Consent Plans be consistent with the CaP; these plans are identified in Table 1-2.

Table 1-2 CaP linkages with other Consent Plans

OFFSHORE CONSENT REFERENCE	CONSENT PLAN	CONSISTENCY WITH AND LINKAGE TO CAP
Section 36 Consent Condition 10; **Wind Farm Marine Licence Condition 3.2.2.8; and** **OfTW Marine Licence Condition 3.2.2.7**	**The Construction Method Statement (CMS)**	The purpose of the approved CMS is to detail the methods that will be implemented during the construction of the Project. The CaP must, so far as is reasonably practicable, be consistent with the CMS.
Section 36 Consent Condition 16; and **OfTW Marine Licence Condition 3.2.2.16**	**Operation and Maintenance Programme (OMP)**	The OMP will set out the procedures and good working practices for the operational and maintenance (O&M) phase of the Project. The OMP must be, so far as is reasonably practicable, consistent with the CaP.

1.4 CaP Document Structure

7. In response to the specific requirements of the Offshore Consents, this CaP has been structured so as to be clear that each part of the specific requirements have been met and that the relevant information to allow the Scottish Ministers to approve the CaP has been provided. The document structure is set out in Table 1-3.

Table 1-3: CaP document structure

SECTION	TITLE	OVERVIEW
1	Introduction	Background to consent requirements and overview of the CaP scope and structure; and Identifies those other Consent Plans with linkages to the CaP.
2	NnGOWL Statements of Compliance	Sets out the NnGOWL statements of compliance in relation to the CaP.
3	Project Overview	Provides an overview of the Project.
4	Location and Layout of Cables	Provides information on the cable routing and relevant key constraints considered.
5	Technical Specification of Cables	Sets out the technical specification of the cables.
6	Cable Burial	Summarises the Cable Burial Risk Assessments (CBRA) undertaken and confirms proposed burial depth of cables.
7	Cable Installation Method	Describes the method of cable installation.
8	Operation and Maintenance	Sets out the approach to cable inspections following installation.
9	Compliance with the Application	Confirms that the details set out in this CaP are in accordance with those assessed in the Application.

2 NnGOWL Statements of Compliance

8. NnGOWL (including NnGOWL's relevant Contractors/Subcontractors) in undertaking the construction and operation of the Project will comply with this CaP as approved by the Scottish Ministers.

9. Where updates or amendments are required to this CaP, NnGOWL will ensure the Scottish Ministers are informed as soon as reasonably practicable and where necessary the CaP will be resubmitted for approval.

10. NnGOWL will comply with the limits defined by the Application and supporting documentation (referred to in Annex 1 of the S36 Consent and Part 2 of the Wind Farm and OfTW Marine Licence in so far as they apply to this CaP (unless otherwise approved in advance by the Scottish Ministers)).

3 Project Overview

11. The Wind Farm Area is located to the northeast of the Firth of Forth, 15.5 km directly east of Fife Ness on the east coast of Scotland (See Figure 3-1). The Wind Farm Area covers approximately 105 km^2. Offshore Export Cables will be located within the 300 m wide Offshore Export Cable Corridor, running in an approximately southwest direction from the Wind Farm Area, making landfall at Thorntonloch beach to the south of Torness Power Station in East Lothian. Figure 3-1 shows the Wind Farm Area and Offshore Export Cable Corridor.

12. The Offshore Consents allow for the construction and operation of the following main components, which together comprise the Project:

- 54 wind turbines generating a maximum total output of around 450 MW;
- 54 jacket substructures installed on pre-piled foundations, to support the wind turbines;
- Two alternating current (AC) substation platforms, referred to as Offshore Substation Platforms (OSPs), to collect the generated electricity and transform the electricity from 66 kV to 220 kV for transmission to shore;
- Two jacket substructures installed on piled foundations, to support the OSPs;
- A network of inter-array subsea cables, buried and/or mechanically protected, to connect strings of turbines together and to connect the turbines to the OSPs;
- One interconnector cable connecting the OSPs to each other;
- Two buried and/or mechanically protected subsea export cables to transmit the electricity from the OSPs to the landfall at Thorntonloch and connecting to the onshore buried export cables for transmission to the onshore substation and connection to the National Grid network; and
- Minor ancillary works such as the deployment of metocean buoys and permanent navigational marks.

13. It is currently anticipated that offshore construction will commence in Summer 2020. Details of the construction programme are provided in the Construction Programme and Construction Method Statement (CoP and CMS).

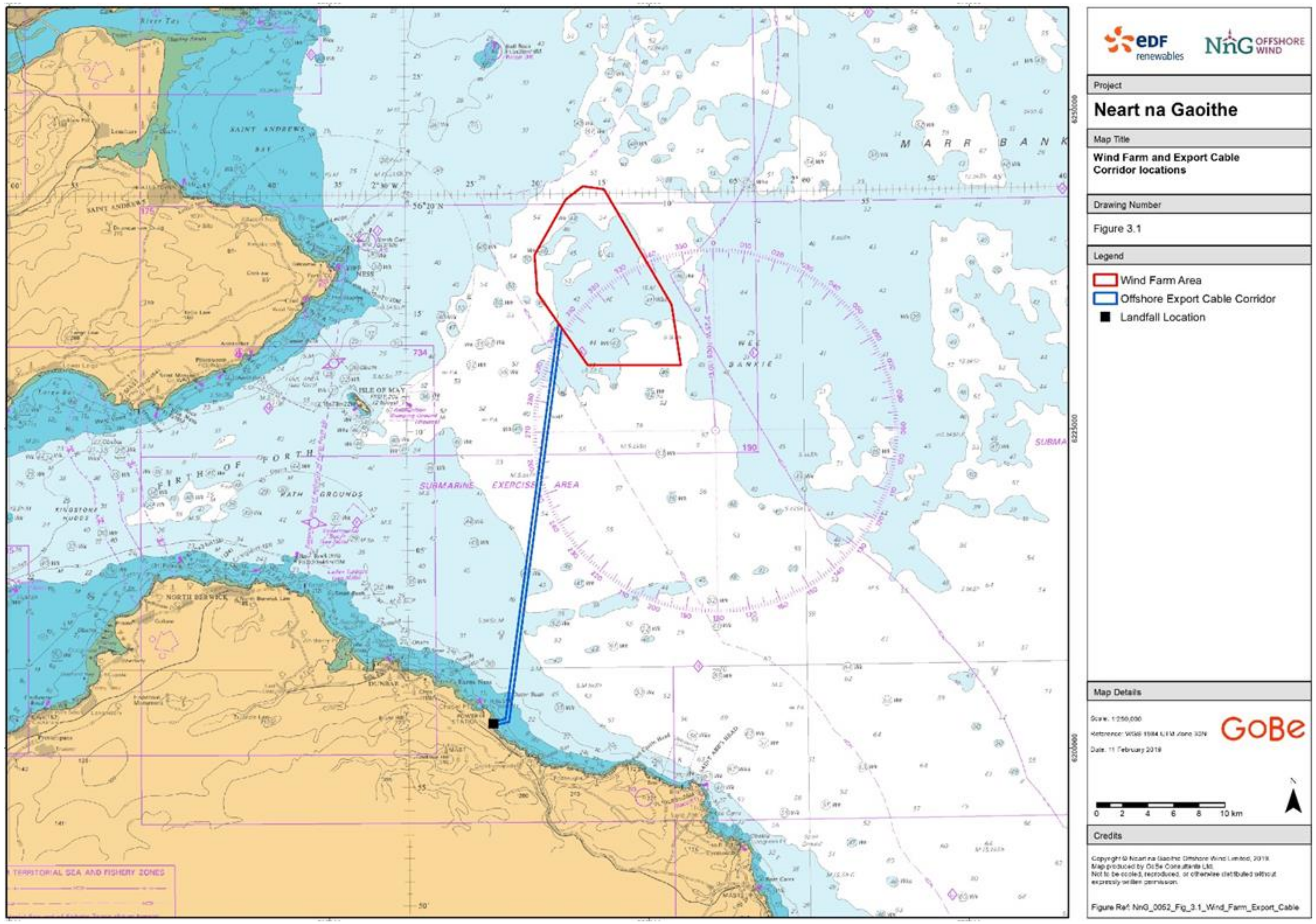


Figure 3-1: Wind Farm Area and Offshore Export Cable Corridor locations

4 Location and Layout of Cables

4.1 Introduction

14. This section describes the layout and location of the inter-array, interconnector and export cables, and the information that has been used to inform routing.

4.2 Site Investigations

15. A series of geotechnical, geophysical and benthic surveys have been commissioned by NnGOWL to understand seabed conditions across the Wind Farm Area. The results of these surveys have been considered in defining the inter-array, interconnector and export cable routing (primarily driven by the array layout and landfall location) and installation methods. A summary of the pre-construction surveys conducted is provided in Table 4-1.

Table 4-1: Surveys relevant to this CaP

DATA SOURCE	COVERAGE	DATA USE	DATE
Geophysical surveys	Within and around the Wind Farm Area and Offshore Export Cable Corridor	Side Scan Sonar (SSS), Acoustic Ground Discrimination System (AGDS) and swath bathymetry used to inform site development (e.g. identification of a likely layout) and Environmental Impact Assessment.	2009
Geotechnical surveys	Within and around the Wind Farm Area	Cone Penetration Tests (CPTs), vibrocores and borehole sampling. Data used to inform site development and Environmental Impact Assessment.	2010
Sub-tidal benthic survey	Within and around the Offshore Wind Farm Area and Export Cable Route Corridor.	Sub tidal sampling comprising of 0.1 m^2 Hamon grab for quantitative faunal and sediment analysis, seabed digital images collected using drop down video, 2 m epibenthic beam trawls and 0.04 m^2 Shipek grab for contaminant analysis. Data used to inform Environmental Impact Assessment.	2009
Intertidal biotope mapping survey	500 m cable corridor at the landfall location at Thorntonloch	Intertidal Global Positioning System (GPS) biotope mapping survey, core sampling and dig over survey to identify habitat distribution. Data used to inform Environmental Impact Assessment.	2009
Habitat mapping	Within and around the Offshore Wind Farm Area, Export Cable Route Corridor and landfall location.	Interpretation of sub-tidal and intertidal benthic datasets for biotope classification and mapping. Data used to inform Environmental Impact Assessment.	2009
Preliminary assessment of coarse sediment benthic habitats	Within and around the Offshore Wind Farm area.	Data interpretation to determine potential presence of geogenic stony reef used to inform Environmental Impact Assessment.	2011
Geotechnical surveys	Offshore Wind Farm Area and Offshore Export Cable Corridor	CPTs within the Wind Farm Area and CPTs and vibrocores along the Offshore Export Cable corridor.	2012

DATA SOURCE	COVERAGE	DATA USE	DATE
		Data used to inform site development (e.g. refinement of layout).	
Geotechnical Survey	Offshore Wind Farm Area	Boreholes to inform site development and cable installation and protection methods and design.	2014
Geophysical Survey	Offshore Wind Farm Area focusing on lines orientated along rows of turbines following a north west to south east orientation.	Multibeam echosounder (MBES) and SSS. Data used to inform site development (e.g. refinement of layout), pile installation and design.	2015
Geotechnical Survey	Offshore Wind Farm Area	Boreholes and CPTs. Data used to inform site development (e.g. refinement of layout), pile installation and design.	2018/19
Geophysical Survey	Offshore Wind Farm Area focused on intended works/infrastructure locations, and the Offshore Export Cable Corridor.	MBES, SSS, magnetometer and sparker. Data used to inform pile design and installation and identify seabed preparation requirements. Data also analysed to refine Archaeological Exclusion Zones.	2019/20
Nearshore Geophysical and Geotechnical Survey	Offshore Export Cable Corridor within the nearshore area from the landfall location to approximately 2 km offshore.	MBES, SSS and sub-bottom profilers. Borehole sampling has been completed along a centreline within the Offshore Export Cable Corridor. Data used to inform nearshore and landfall Offshore Export Cable installation methodology. Data also analysed to refine Archaeological Exclusion Zones. Data analysis and reporting will conclude in March 2020.	2019/20
Geotechnical Survey	Offshore Wind Farm Area	Boreholes. Data used to inform detailed pile design and installation (e.g. pile drivability assessment). Data analysis and reporting will conclude in March 2020.	2020

16. Any additional constraints identified following review of survey data gathered in 2020 that results in a significant change to cable routing or installation, will be addressed through an update to this CaP.

4.3 Survey Outputs

4.3.1 Geophysical and Geotechnical Surveys

17. Bathymetry across the Wind Farm Area ranges from approximately 43 m to 58 m below Lowest Astronomical Tide (LAT). The shallowest water is located in the southern half of the Area, along a linear ridge orientated northwest to southeast, which rises 2 m above seabed level to 40.5 m. The deepest water, at approximately 58 m, occurs in the west of the Wind Farm Area close to the boundary within a channel orientated northwest-southeast.

18. Initial studies conducted to inform the Original Application for the Project (NnGOWL, 2012) and more recent survey work conducted in 2019 (Fugro, 2019) (See Table 4-1) both report that sediments within the Wind Farm Area mainly comprise muddy sand, fine to very fine sand and

gravelly sand. These are underlain by varying depths of clay associated with the Wee Bankie formation and sediments associated with Forth and St Abbs formation. At the thickest point underlying sediment reach up to 73 m thick in two palaeochannels that cross the Wind Farm Area. The bedrock beneath this consists of Carboniferous limestones in the east and sandstones in the west.

19. Water depths in the Offshore Export Cable Corridor reach 58 m LAT adjacent to the Wind Farm Area boundary (NnGOWL, 2012). Depths in the nearshore section of the Corridor out to approximately 2 km from the shoreline are highly variable due to the presence of exposed folded bedrock that comprises the seabed here. Further offshore, out to approximately 7 km, the seabed gradient decreases and is generally flat and featureless, especially where soft-sediment makes up the seabed surface. Along the Offshore Export Cable Corridor recent survey work generally corroborates the findings of earlier surveys (Fugro, 2019; 2020). Within the nearshore area the Offshore Export Cable Corridor comprises of bedrock with veneers of sands and gravels, and areas of deeper mixed sediments generally dominated by sand and gravel components (Fugro, 2020). Further offshore the Export Cable Corridor varies between areas of muddy sand with high clay and silt components and areas of coarser sand with gravel (Fugro, 2019). This is interrupted by a series of igneous dykes around 9 km offshore from the landfall.

20. The results of all surveys undertaken to date have been issued to the cable installation Contractor, who has used the data to undertake route engineering and identify the most appropriate cable burial tools and techniques.

4.3.2 Benthic Surveys

21. The dominant sediment type found in the Wind Farm Area is slightly gravelly muddy sand, although patches of coarser sediment (e.g., sandy gravel and gravelly sand) were also recorded within the Wind Farm Area. Offshore characterisation surveys identified the presence of the biotope complex SS.SMu.CSaMu (circalittoral sandy mud) with epifaunal species present including seapens (e.g., *Virgularia mirabilis*) and brittlestars (e.g., *Amphiura* spp.). Infaunal species include polychaetes (e.g., Spiophanes bombyx) and bivalves (e.g., *Mysella bidentata*, *Abra* spp. and *Nuculoma* spp.) across the Wind Farm Area (NnGOWL, 2018).

22. Video analysis indicated biotopes more typical of soft sediments with polychaete tubes, megafauna burrows, seapens (e.g., *Pennatula phosphoracea* and *V. mirabilis*) and Chaetopterus tubes. These features suggest the presence of the Priority Marine Feature 'burrowed mud' and the component biotope SS.SMu.CFiMu.SpnMeg (Seapens and burrowing megafauna in circalittoral fine mud), covering a proportion of the Wind Farm Area.

23. A series of rocky substrates corresponding to the exposure of the Wee Bankie Formation were also observed during video analysis with areas of a highly variable seabed comprising a mix of substrate habitat types. These included large boulders and cobbles supporting a mosaic of the biotopes CR.MCR.EcCr.FaAlCr.Pom (faunal and algal crusts with *Pomatoceros triqueter* and sparse *Alcyonium digitatum* on exposed to moderately wave-exposed circalittoral rock) and CR.MCR.EcCr.FaAlCr.Adig (*A. digitatum*, *P. triqueter*, algal and bryozoan crusts on wave-exposed circalittoral rock).

24. The Offshore Export Cable Corridor is characterised by deep circalittoral mud and gravelly muddy sand, typical of the outer Firth of Forth. Further inshore, the cable route is characterised by deep circalittoral coarse sediment and low energy rock habitats.

25. The habitat complexes along the Offshore Export Cable Corridor closer to the Wind Farm Area comprised muddy sand biotope complexes. Further inshore, the area is characterised by coarse sediment (e.g, SS.SCS.CCS) comprising cobbles, pebbles, gravel and coarse sand. Conspicuous

fauna identified from the video images comprised keel worms *Pomatoceros* spp. and crustaceans such as *Munida rugosa*.

26. Discrete areas of both the Wind Farm Area and the Offshore Export Cable Corridor supported dense areas of the brittlestar *Ophiothrix fragilis* which fitted the biotope SS.SMx.CMx.OphMx.

27. Benthic surveys have not identified any habitats that have influenced cable routing or installation methods.

4.4 Key Constraints

4.4.1 Wind Farm Area

28. The Development Specification and Layout Plan (DSLP) identifies those constraints present within the Wind Farm Area that have influenced the final layout of the Wind Farm array; this layout has driven the layout and location of the inter-array and interconnector cables as shown on Figure 4-1. The inter-array and interconnector cables typically travel in straight lines between structures, though do deviate to avoid Archaeological Exclusion Zones (AEZs), which are mapped on Figure 4-1 below.

4.4.2 Offshore Export Cable Corridor

29. The constraints detailed within the DSLP and presented on Figure 4-1 have been considered in routing the export cable from the edge of the Wind Farm Area boundary to the OSPs. Along the Offshore Export Cable Corridor, the following physical constraints have also been identified:

- An AEZ; and
- Challenging ground conditions in the nearshore area (from landfall to approximately 1.25 km offshore), steep protruding bedrock at Kilometre Point (KP) 9 offshore from landfall and extended areas of uneven bedrock from landfall out to approximately KP3. Survey work is ongoing to further investigate these features and inform cable routing and installation in these locations.

4.5 Location and Layout

4.5.1 Inter-Array Cables and Interconnector Cable

30. The wind turbines will be connected by inter-array cabling arranged in circuits ('loops'). There will be 6 loops with 8 - 10 turbines on each. The first and last wind turbine in a loop is connected by an inter-array cable to an OSP. The OSPs will be connected to one another by a single interconnector cable. The arrangement of the cables is set out in Figure 4-1.

31. The lengths of each of the inter-array and interconnector cables between the bellmouths of the turbines and OSP locations are presented in Table 4-2. The length of the inter-array cabling and interconnector cabling to be installed in contact with the seabed will be approximately 94 km and 4 km (subject to any micro-siting).

32. The total amount of cabling required also includes the vertical lengths, which are encased within the J-tubing from the bellmouth up to the full height of the WTG or OSP. This totals 106 km and 4 km for the inter-array cables and interconnector cable, respectively. This additional 10 km of cabling is not in direct contact with the seabed but is included here for completeness.

4.5.1.1 Route Refinement and Micro-siting

33. The final location and layout of the inter-array cables and the interconnector cable presented in Figure 4-1 remains subject to possible further minor route refinement ('micro-siting') following analysis of the data being collected as part of the recent survey campaign detailed in Table 4-1. Micro-siting would be undertaken to route around any newly identified constraints and would not constitute significant changes to this CaP.

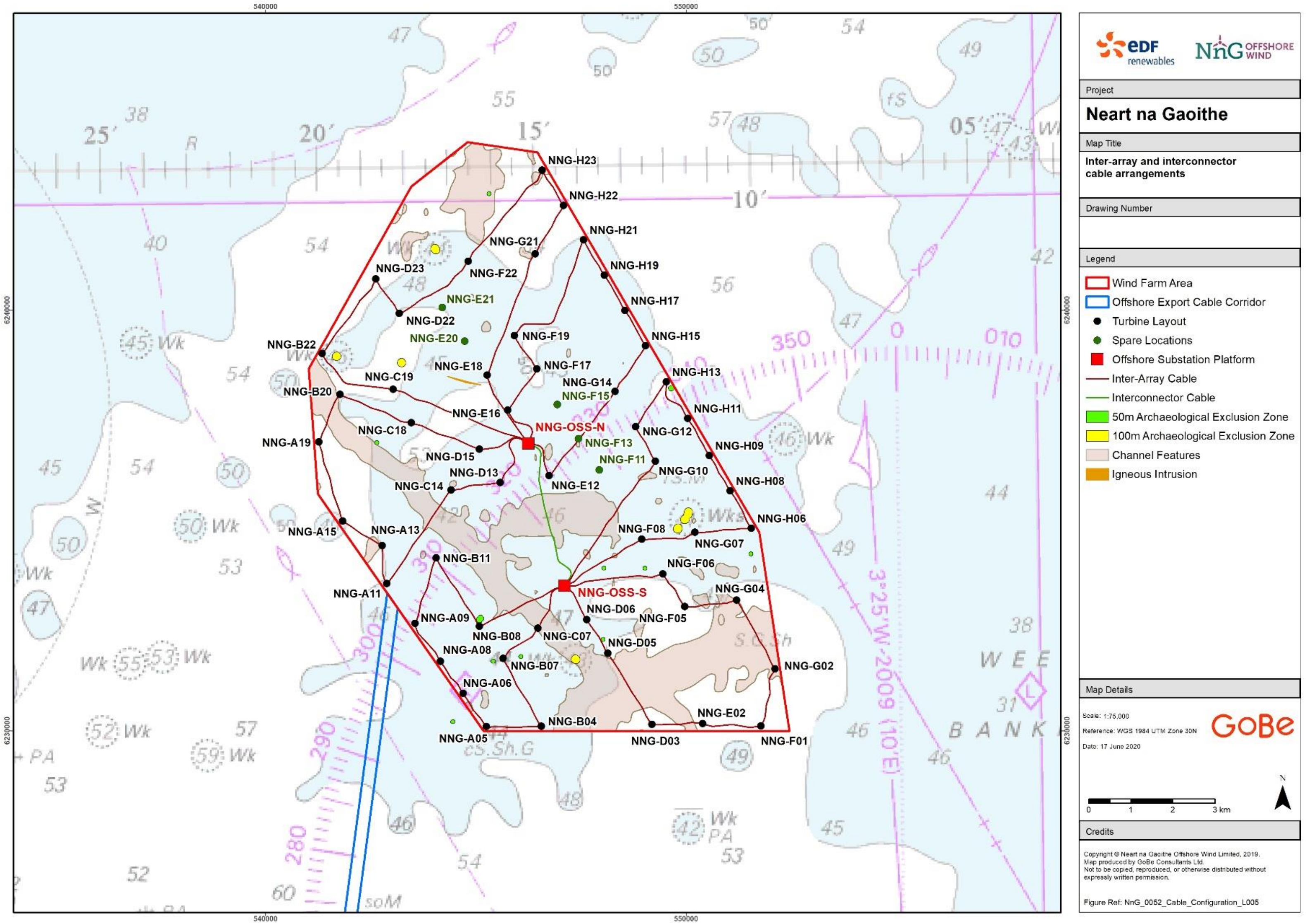


Figure 4-1: Inter-array and interconnector cable configuration, showing 66kV cable connectivity between turbines and OSPs

Table 4-2: Inter-array and interconnector cable arrangements and cable lengths

ARRAY LAYOUT		START POINT			END POINT			ROUTE LENGTH FROM J TUBE TO J TUBE (M)
START	END	LATITUDE (DDM WGS84)	LONGITUDE (DDM) WGS84	WATER DEPTH (M)	LATITUDE (DDM) WGS84	LONGITUDE (DDM) WGS84	WATER DEPTH (M)	
Inter-array cables								
NNG-OSS-N	NNG-D13	56° 16.446' N	2° 15.193' W	52.0	56° 15.946' N	2° 15.848' W	50.2	1609.8
NNG-D13	NNG-C14	56° 15.946' N	2° 15.848' W	50.2	56° 15.858' N	2° 16.984' W	50.0	1171.8
NNG-C14	NNG-A11	56° 15.858' N	2° 16.984' W	50.0	56° 14.668' N	2° 18.489' W	48.5	2705.9
NNG-A11	NNG-A13	56° 14.668' N	2° 18.489' W	48.5	56° 15.153' N	2° 18.580' W	52.1	899.2
NNG-A13	NNG-A15	56° 15.153' N	2° 18.580' W	52.1	56° 15.474' N	2° 19.485' W	53.2	1082.6
NNG-A15	NNG-A19	56° 15.474' N	2° 19.485' W	53.2	56° 16.490' N	2° 20.015' W	53.2	1969
NNG-A19	NNG-B20	56° 16.490' N	2° 20.015' W	53.2	56° 17.097' N	2° 19.521' W	51.5	1245.6
NNG-B20	NNG-C18	56° 17.097' N	2° 19.521' W	51.5	56° 16.725' N	2° 17.882' W	50.3	1821.2
NNG-C18	NNG-D15	56° 16.725' N	2° 17.882' W	50.3	56° 16.377' N	2° 16.321' W	46.4	1718.9
NNG-D15	NNG-OSS-N	56° 16.377' N	2° 16.321' W	46.4	56° 16.446' N	2° 15.193' W	52.0	1253.1
NNG-OSS-N	NNG-C19	56° 16.446' N	2° 15.193' W	52.0	56° 17.156' N	2° 18.293' W	52.1	3472.4
NNG-C19	NNG-B22	56° 17.156' N	2° 18.293' W	52.1	56° 17.623' N	2° 19.921' W	54.0	2049.4
NNG-B22	NNG-D23	56° 17.623' N	2° 19.921' W	54.0	56° 18.572' N	2° 18.667' W	54.1	2205
NNG-D23	NNG-D22	56° 18.572' N	2° 18.667' W	54.1	56° 18.128' N	2° 18.135' W	51.1	972.5
NNG-D22	NNG-F22	56° 18.128' N	2° 18.135' W	51.1	56° 18.785' N	2° 16.536' W	49.6	2085.4
NNG-F22	NNG-H23	56° 18.785' N	2° 16.536' W	49.6	56° 19.943' N	2° 14.806' W	53.9	2839.1
NNG-H23	NNG-H22	56° 19.943' N	2° 14.806' W	53.9	56° 19.488' N	2° 14.322' W	53.7	962.4
NNG-H22	NNG-G21	56° 19.488' N	2° 14.322' W	53.7	56° 18.873' N	2° 14.988' W	54.2	1340.8
NNG-G21	NNG-E18	56° 18.873' N	2° 14.988' W	54.2	56° 17.324' N	2° 16.122' W	50.8	3127.8
NNG-E18	NNG-OSS-N	56° 17.324' N	2° 16.122' W	50.8	56° 16.446' N	2° 15.193' W	52.0	1902.9
NNG-OSS-N	NNG-E16	56° 16.446' N	2° 15.193' W	52.0	56° 16.874' N	2° 15.658' W	52.3	1128.5
NNG-E16	NNG-F17	56° 16.874' N	2° 15.658' W	52.3	56° 17.394' N	2° 14.978' W	51.4	1198.1

ARRAY LAYOUT		START POINT			END POINT			ROUTE LENGTH FROM J TUBE TO J TUBE (M)
START	END	LATITUDE (DDM WGS84)	LONGITUDE (DDM) WGS84	WATER DEPTH (M)	LATITUDE (DDM) WGS84	LONGITUDE (DDM) WGS84	WATER DEPTH (M)	
NNG-F17	NNG-F19	56° 17.394' N	2° 14.978' W	51.4	56° 17.828' N	2° 15.487' W	47.9	964
NNG-F19	NNG-H21	56° 17.828' N	2° 15.487' W	47.9	56° 19.043' N	2° 13.865' W	51.1	3147.7
NNG-H21	NNG-H19	56° 19.043' N	2° 13.865' W	51.1	56° 18.588' N	2° 13.397' W	50.8	952.1
NNG-H19	NNG-H17	56° 18.588' N	2° 13.397' W	50.8	56° 18.134' N	2° 12.932' W	50.4	949.5
NNG-H17	NNG-H15	56° 18.134' N	2° 12.932' W	50.4	56° 17.677' N	2° 12.466' W	51.1	953.9
NNG-H15	NNG-G14	56° 17.677' N	2° 12.466' W	51.1	56° 17.095' N	2° 13.181' W	51.1	1317.4
NNG-G14	NNG-E12	56° 17.095' N	2° 13.181' W	51.1	56° 16.029' N	2° 14.720' W	50.3	2548
NNG-E12	NNG-OSS-N	56° 16.029' N	2° 14.720' W	50.3	56° 16.446' N	2° 15.193' W	52.0	1021.2
NNG-OSS-S	NNG-G10	56° 14.615' N	2° 14.395' W	48.0	56° 16.197' N	2° 12.270' W	52.0	3697.5
NNG-G10	NNG-G12	56° 16.197' N	2° 12.270' W	52.0	56° 16.640' N	2° 12.715' W	48.9	943.7
NNG-G12	NNG-H13	56° 16.640' N	2° 12.715' W	48.9	56° 17.214' N	2° 11.997' W	53.3	1297.9
NNG-H13	NNG-H11	56° 17.214' N	2° 11.997' W	53.3	56° 16.740' N	2° 11.513' W	49.5	1098.1
NNG-H11	NNG-H09	56° 16.740' N	2° 11.513' W	49.5	56° 16.263' N	2° 11.027' W	51.0	999.5
NNG-H09	NNG-H08	56° 16.263' N	2° 11.027' W	51.0	56° 15.808' N	2° 10.556' W	50.2	957.8
NNG-H08	NNG-H06	56° 15.808' N	2° 10.556' W	50.2	56° 15.324' N	2° 10.079' W	49.7	1005.5
NNG-H06	NNG-G07	56° 15.324' N	2° 10.079' W	49.7	56° 15.279' N	2° 11.379' W	50.1	1348.5
NNG-G07	NNG-F08	56° 15.279' N	2° 11.379' W	50.1	56° 15.198' N	2° 12.603' W	49.7	1284.1
NNG-F08	NNG-OSS-S	56° 15.198' N	2° 12.603' W	49.7	56° 14.615' N	2° 14.395' W	48.0	2148.9
NNG-OSS-S	NNG-F06	56° 14.615' N	2° 14.395' W	48.0	56° 14.751' N	2° 12.129' W	50.5	2369.8
NNG-F06	NNG-F05	56° 14.751' N	2° 12.129' W	50.5	56° 14.330' N	2° 11.632' W	45.6	924.1
NNG-F05	NNG-G04	56° 14.330' N	2° 11.632' W	45.6	56° 14.405' N	2° 10.436' W	49.1	1237.2
NNG-G04	NNG-G02	56° 14.405' N	2° 10.436' W	49.1	56° 13.520' N	2° 9.572' W	53.2	1867.1
NNG-G02	NNG-F01	56° 13.520' N	2° 9.572' W	53.2	56° 12.790' N	2° 9.915' W	50.5	1437.9
NNG-F01	NNG-E02	56° 12.790' N	2° 9.915' W	50.5	56° 12.829' N	2° 11.251' W	49.9	1386.8

ARRAY LAYOUT		START POINT			END POINT			ROUTE LENGTH FROM J TUBE TO J TUBE (M)
START	END	LATITUDE (DDM WGS84)	LONGITUDE (DDM) WGS84	WATER DEPTH (M)	LATITUDE (DDM) WGS84	LONGITUDE (DDM) WGS84	WATER DEPTH (M)	
NNG-E02	NNG-D03	56° 12.829' N	2° 11.251' W	49.9	56° 12.828' N	2° 12.421' W	50.8	1205.9
NNG-D03	NNG-D05	56° 12.828' N	2° 12.421' W	50.8	56° 13.744' N	2° 13.417' W	49.6	1974.5
NNG-D05	NNG-D06	56° 13.744' N	2° 13.417' W	49.6	56° 14.179' N	2° 13.894' W	49.2	930.1
NNG-D06	NNG-OSS-S	56° 14.179' N	2° 13.894' W	49.2	56° 14.615' N	2° 14.395' W	48.0	957.2
NNG-OSS-S	NNG-C07	56° 14.615' N	2° 14.395' W	48.0	56° 14.076' N	2° 15.018' W	47.9	1278.3
NNG-C07	NNG-B07	56° 14.076' N	2° 15.018' W	47.9	56° 13.695' N	2° 15.822' W	45.1	1125.6
NNG-B07	NNG-B04	56° 13.695' N	2° 15.822' W	45.1	56° 12.818' N	2° 14.965' W	49.8	1867.2
NNG-B04	NNG-A05	56° 12.818' N	2° 14.965' W	49.8	56° 12.822' N	2° 16.231' W	45.4	1321.7
NNG-A05	NNG-A06	56° 12.822' N	2° 16.231' W	45.4	56° 13.249' N	2° 16.755' W	50.4	942.3
NNG-A06	NNG-A08	56° 13.249' N	2° 16.755' W	50.4	56° 13.665' N	2° 17.267' W	46.6	923.9
NNG-A08	NNG-A09	56° 13.665' N	2° 17.267' W	46.6	56° 14.153' N	2° 17.845' W	47.9	1099.8
NNG-A09	NNG-B11	56° 14.153' N	2° 17.845' W	47.9	56° 14.989' N	2° 17.341' W	49.6	1662.4
NNG-B11	NNG-B08	56° 14.989' N	2° 17.341' W	49.6	56° 14.109' N	2° 16.365' W	48.5	1908.8
NNG-B08	NNG-OSS-S	56° 14.109' N	2° 16.365' W	48.5	56° 14.615' N	2° 14.395' W	48.0	2255.6
Interconnector Cable								
NNG-OSS-N	NNG-OSS-S	56° 16.446' N	2° 15.193' W	52.0	56° 14.615' N	2° 14.395' W	48.0	3,820.50

4.5.2 Export Cables

34. The Wind Farm and OSPs will be connected to the onshore transmission works (OnTW) by two High Voltage Alternating Current (HVAC) cables. The two offshore export cables will be located within the Offshore Export Cable Corridor shown in Figure 4-2. The corridor is 300 m wide and approximately 33 km long from the landfall location to the Wind Farm Area boundary.

35. The export cables will run from the OSPs and converge approximately 2 km inside of the boundary of the Wind Farm Area and will then run broadly in parallel to the landfall location. Within the Offshore Export Cable Corridor, the cables will be routed to avoid engineering and environmental constraints. The cables will converge in the nearshore area at the landfall location. The cables will make landfall on Thorntonloch beach on the East Lothian coast.

4.5.2.1 Route refinement

36. The final location of the offshore export cables presented in Figure 4-2 remains subject to possible minor route refinement following analysis of the data being collected as part of the recently completed and planned survey campaigns detailed in Table 4-1. Minor refinements to the location of the offshore export cables may be required.

Table 4-3: Export cable arrangement and lengths

ARRAY LAYOUT		START POINT			END POINT		APPROXIMATE LENGTH (KM)
START	END	LATITUDE (DDM WGS84)	LONGITUDE (DDM) WGS84	WATER DEPTH (M) LAT	LATITUDE (DDM) WGS84	LONGITUDE (DDM) WGS84	
NNG-OSS-N	Landfall	56° 16.446' N	2° 15.193' W	52.0	55° 57.599' N	2° 23.813' W	37.7
NNG-OSS-S	Landfall	56° 14.615' N	2° 14.395' W	48.0	55° 57.594' N	2° 23.809' W	37.4

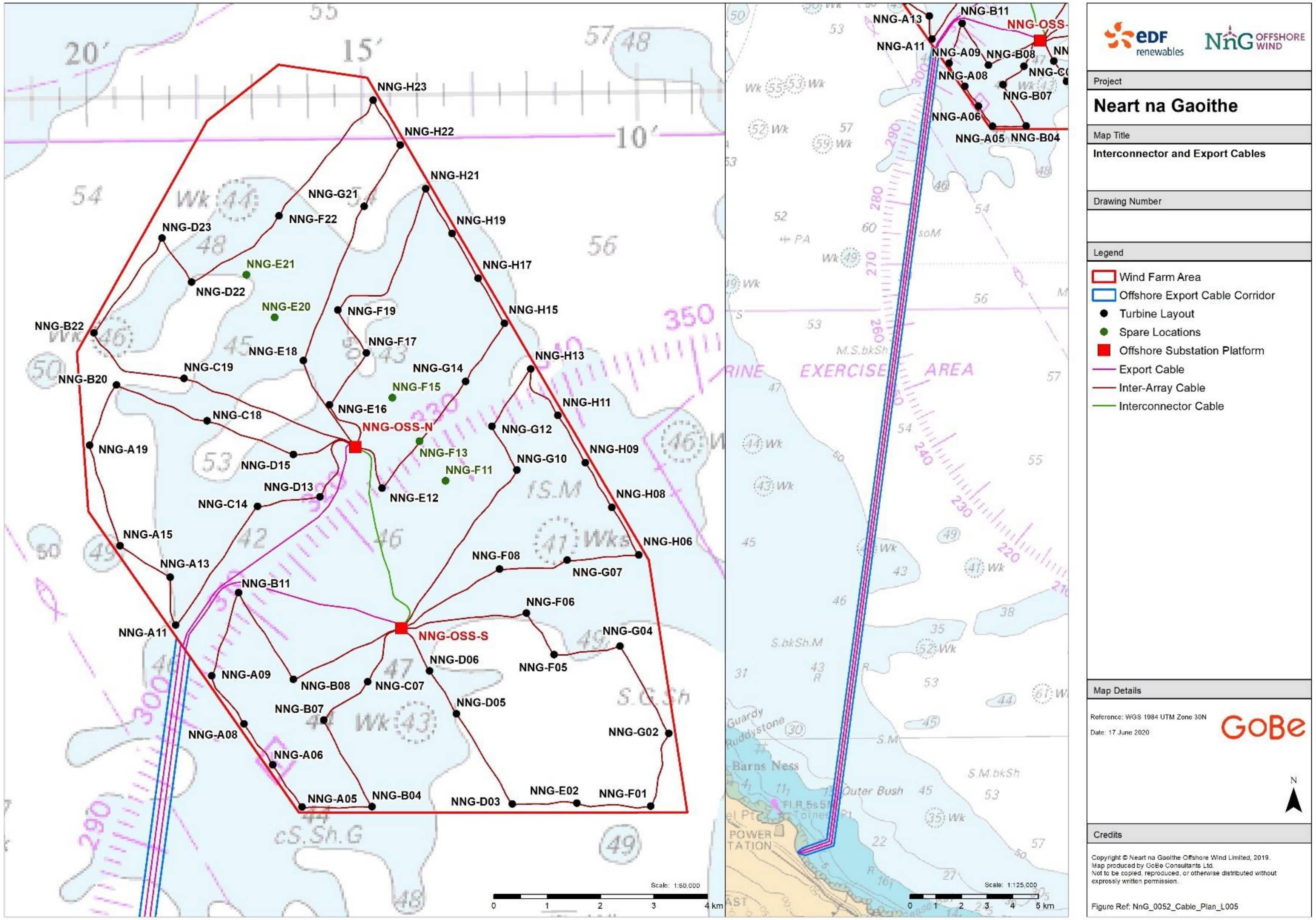


Figure 4-2: OSP locations and the interconnector and export cable arrangements and key constraints within the Offshore Export Cable Corridor

5 Technical Specification of Cables

5.1 Inter-Array Cables and Interconnector Cable

37. The inter-array cables and the interconnector cable will comprise 3 core 66 kilo Volt (kV) armoured submarine power cables of a type typically used to support medium voltage connections between offshore installations.

5.1.1 Cable Components

38. The main components of the inter-array cables are shown in Figure 5-1 and are described briefly below. The interconnector cable will follow a similar design but will utilise copper conductors instead of aluminium. The inter-array and interconnector cables will be designed in accordance with industry standards as set out in the relevant International Electrotechnical Commission (IEC) and DNV-GL guidance.

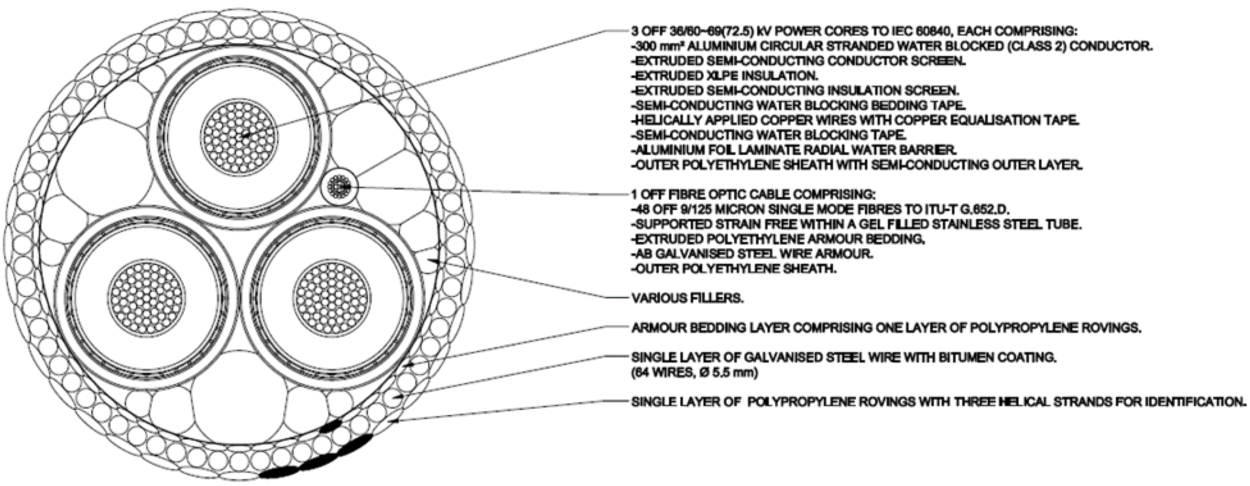


Figure 5-1: Inter-array and interconnector cable design

5.1.1.1 Power Cores

39. The cables will be comprised of three aluminium power cores each with a cross-sectional area of approximately 300 mm^2. The aluminium power cores are of flexible design and suitable for installation and use in a sub-sea environment. The cores will be insulated with cross-linked polyethylene (XLPE). For waterproofing each core will be surrounded with a semi conducting water blocking tape suitable for subsea use.

5.1.1.2 Integrated Data Cable

40. The inter-array and interconnector cable will be bundled with a fibre optic sub-cable which will provide the necessary functionality for turbine control and instrumentation systems and will also provide internet connectivity and communications on each turbine and OSP. The cables will be supported in a water repellent gel within a stainless steel tube, protected by inner polyethylene sheath, galvanised steel wire armour and an outer polyethylene sheath.

5.1.1.3 Cable Armouring

41. Appropriate filler materials (e.g. ropes or extruded polymeric profiles) will be included within the cable interstices.

42. The inter-array and interconnector cables will then be protected by one layer of galvanised steel wire.

43. Bitumen and polypropylene rovings (bundles of fibre wrapped around the cable) are applied over the armour wires for outer protection of the cable.

5.1.2 Electromagnetic Fields

44. This section summarises the results of a desk based assessment carried out by the cable manufacturer on behalf of NnGOWL on the attenuation of electromagnetic fields associated with the inter-array cables and interconnector cable.

45. The study calculated the magnetic field magnitudes at a given distance from the inter-array and interconnector cable at a burial depth of 1.0 m. The magnitudes were calculated using the Finite Element Method with the analysis software package Comsol. The study confirmed that the electromagnetic field (EMF) generated by the cables decreases rapidly with distance from them.

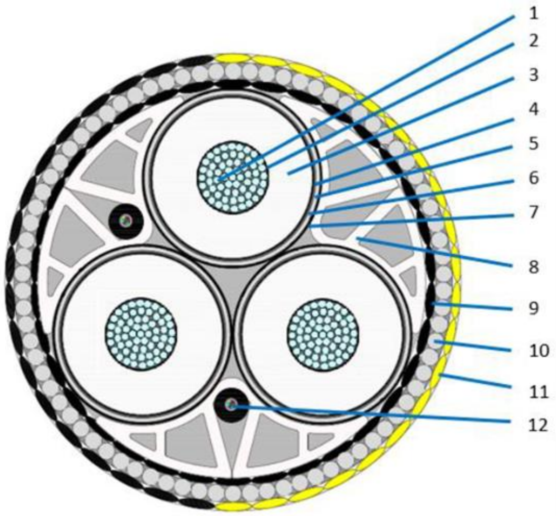
46. The modelling outputs predict that the EMF generated by the inter-array cables and interconnector cable will reduce to zero within 0.25 m of the cable when it is carrying the maximum current of 459 Amp (A) and 923 A respectively. The maximum generated EMF identified is 1.3 millitesla (mT) and 2.1 mT at the surface of the inter-array cable and interconnector cable respectively. In both cases the EMF reduces down to 0 mT before it reaches the seabed surface. Therefore, the predicted maximum magnetic field strength of the inter-array cables and interconnector cable at the seabed is expected to be lower than the earth's magnetic field (~0.05 mT).

5.2 Offshore Export Cables

47. The offshore export cables will comprise two 3 core 220 kV armoured submarine power cables. The offshore export cables will be designed in accordance with industry standards as set out in the relevant International Electrotechnical Commission (IEC) and DNV-GL guidance.

5.2.1 Cable Components

48. The main components of the offshore export cables are shown in Figure 5-2 and are described briefly below.



Item	Description	Details
1	Conductor	Aluminium stranded power core covered with water blocked tape
2	Conductor Screen	Extruded semi-conducting compound
3	Insulation	Cross-linked polyethylene (XLPE)
4	Insulation Screen	Extruded semi-conducting compound
5	Water Barrier	Water blocking tapes
6	Metallic Sheath	Lead alloy sheath
7	Core Outer Sheath	Semi-conducting extruded polyethylene
8	Layup	Power core interstices filled with extruded shaped fillers
9	Bedding	Synthetic tape
10	Armour	90 galvanised steel wires flushed with bitumen
11	Serving	Polypropylene strings
12	Cables	48 single fibres supported in a water repellent gel within a stainless steel tube

Figure 5-2: Offshore Export Cable design

5.2.1.1 Power Cores

49. Each offshore export cables for the Project, will comprise three power cores each with a cross-sectional area of approximately 630 mm^2. The conductors will be formed mainly of aluminium conductors as shown in Figure 5-2. Copper conductors may be used within the horizontal ducts at the landfall location and within the OSP j-tubes.

50. The cores will be insulated with XLPE. For waterproofing each core will be surrounded with a semi conducting water blocking tape suitable for subsea use.

5.2.1.2 Fibre Optic Data Cable

51. The offshore export cables will be bundled with two fibre optic sub-cables supported in a water repellent gel within a stainless steel tube, protected by inner polyethylene sheath, galvanised steel wire armour and an outer polyethylene sheath.

5.2.1.3 Cable Armouring and outer sheathing

52. Appropriate filler materials (e.g. ropes or extruded polymeric profiles) will be included within the cable interstices to provide a robust and stable base for the application of armouring.

53. The offshore export cables will then be protected by one layer of galvanised steel wire flushed with bitumen for corrosion protection. The armouring provides external mechanical protection, weight and strength. Polypropylene rovings are applied over the armour wires for outer protection of the cable. The outer serving is black with a helical stripe for identification.

5.2.2 Electromagnetic Fields

54. This section summarises the results of a desk based assessment carried out by the cable manufacturer on behalf of NnGOWL on the attenuation of electromagnetic fields associated with the offshore export cables.

55. The study calculated the magnetic field magnitudes at seabed level and 1 m above seabed level generated from the offshore export cables at a burial depth of 1.0 m. The magnitudes were calculated using the Finite Element Method. The study confirmed that EMF decreases rapidly with distance from the cables.

56. The modelling outputs predict that the EMF generated by the export cables will reduce to zero within 5 m of the cables when it is carrying the maximum current of 599 A. The maximum generated EMF identified is 0.014 mT at the surface of the seabed directly above the cable. Therefore, the predicted maximum magnetic field strength of the export cables at the seabed is expected to be lower than the earth's magnetic field (~0.05 mT).

6 Cable Burial

6.1 Introduction

57. Section 6.2 below provides a summary of the Cable Burial Risk Assessments (CBRAs) undertaken to identify potential threats to the cables and proposes burial depths to minimize risk from these threats. Section 6.3 then sets out proposed cable burial and protection, which has been informed by the CBRA findings.

6.2 Cable Burial Risk Assessment

58. CBRA is a risk-based assessment undertaken to help determine an optimized Depth of Lowering (DoL) for subsea cables, such that threats to the cable and to other marine users (e.g. interactions between anchors or fishing gear with cables) can be avoided.

59. For the purpose of this CaP, cable burial depth will be described as the DoL. The DoL is the depth measured from the top of the cable to the surrounding mean seabed level (Figure 6-1).

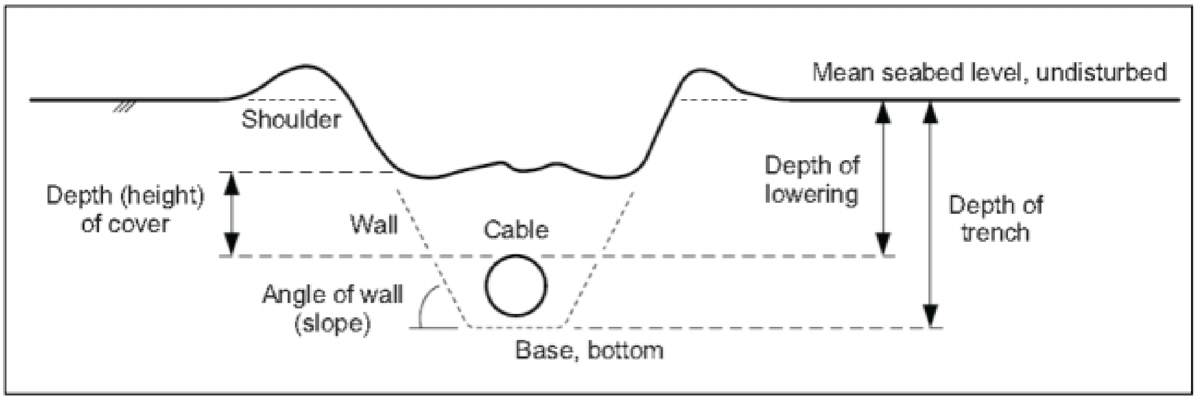


Figure 6-1: Cable Depth of Lowering (DoL) relative to Mean Seabed Level (MSBL).

60. CBRAs have been undertaken by external technical consultants Cathie in accordance with the following industry guidance documents:

- Carbon Trust (2015) Cable Burial Risk Assessment Methodology, Guidance for the Preparation of Cable Burial Depth of Lowering Specification, CTC835, February 2015;
- Carbon Trust (2015) Application Guide for the Specification of the Depth of Lowering using the Cable Burial Risk Assessment (CBRA) methodology, Dec 2015; and,
- DNV-GL (2016) Subsea Power Cables in Shallow Water, DNV-GL-RP-0360, 2016.

61. The CBRA method reviews threats based on their anticipated frequency (e.g. how often anchor strike can be expected to occur in the area) and consequence (e.g. to what depth anchors may penetrate the seabed). Once the frequency and consequence of the identified threats is understood, the CBRA investigates how the risk associated with that threat can be mitigated to an acceptable level (as determined by DNV-GL standards) by cable burial, based on known ground conditions (as informed by site survey data; see Sections 4.3.1 and 6.2.1) and prevailing hydrodynamic conditions (i.e. sediment mobility).

62. The CBRAs considered the following main threats:

- Anchor strike: Vessel data was analysed to understand vessel activity in the Project area based on site-specific AIS and radar data and coastal AIS data, and the anchor types and sizes associated with this activity were identified, allowing an understanding of likely depths of anchor penetration.
- Fishing gear interactions: Fisheries data was analysed to understand fishing activity in the Project area, the types of gear in use and the likely depths of gear penetration based on the most recent data collated by the Marine Management Organization (MMO) and the International Council for the Exploration of the Sea (ICES). See Section 6.2.3 for more detail.
- Sediment mobility (considered a secondary threat): Existing seabed data were analysed to understand the potential for mobile bedforms and their thickness. The results of assessment remain indicative pending the analysis of recently gathered additional seabed survey data. The potential for mobile bedforms of 0.2 – 0.3 m thickness in some locations was identified.

6.2.1 Ground Conditions

63. Geotechnical and geophysical site investigations have identified several 'soil' types present across the Wind Farm Area, as summarized in Section 4.3.1. These include sand (with varying silt and gravel content), clay (of various strengths) and rock (dolomite, sandstone and siltstone, close to/at the seabed surface in places). Sands are widespread across the Wind Farm Area; low strength to medium strength clays are also relatively widespread; medium to high strength clays are found on seabed mounds; and rock is encountered at/near the seabed surface in some locations.

64. Soil conditions encountered along the Offshore Export Cable Corridor comprise loose to medium dense mud / sand overlying glaciomarine clays and bedrock. The sand cover is generally limited in thickness (< 1m thick) and almost absent in some areas nearshore, where the underlying bedrock is sub/outcropping. Older muddy / clayey layers are dominant in the central stretch of the Corridor, where the bedrock deepens before re-emerging in close proximity to the Wind Farm boundary. Soils in the intertidal zone comprise sand with gravel and cobbles (indicated as 'firm sand') over stiff to very stiff, locally firm, silt and bedrock. The beach is widely covered by shingle, boulders and rocks.

6.2.2 Anchor Strike

65. A risk assessment of anchor strike was undertaken using Project-specific marine traffic survey data gathered during both winter and summer months across several years. Data included marine traffic information gathered using Automatic Information System (AIS) and radar during offshore survey work and shore based AIS information on marine traffic. The maximum anchor penetration depth based on the vessel types present within the Wind Farm Area and the seabed conditions was considered to be 2.44 m; along the Offshore Export Cable Corridor the maximum penetration depth was estimated to be up to 6.64 m where there are thicker layers of soft clay. This is considered to be a conservative worst-case scenario as much of the Wind Farm Area and Offshore Export Cable Corridor are comprised of stiffer sands and gravels and areas of rock.

66. Assuming unburied (surface-laid) cables, the risk return period from emergency anchoring to a single array cable is over 100,000 years, with the cumulative risk of anchoring to all 61 infield cables being once every 9,725 years. The corresponding values for the export cables were > 26,000 years for one cable and 1 in 9,326 years for both Offshore Export Cables.

6.2.3 Fishing Gear Interaction

67. A risk assessment of fishing gear interaction was undertaken based on MMO fisheries data and other data sets and the outcomes of consultation as detailed within the Application (NnGOWL, 2018).

68. These data sets include a detailed profile of the vessels operating from key fishing ports for vessels operating within the local and regional study areas, including number of vessels, length and age profiles, as well as descriptions of the fishing methods deployed. In addition, consultation with Scottish and Anglo-Scottish inshore and offshore fisheries stakeholders was undertaken to both ground-truth data and to understand temporal and spatial patterns of fishing activity (NnGOWL, 2018). Furthermore, these data sets were updated specifically for the CBRA, to ensure a recent overview of the baseline.

69. The probability of fishing gear and cables interacting is dependent upon gear type and dimensions; for the purposes of the precautionary assessment, trawling using otter boards was assumed as this is considered the worst case.

70. To mitigate the risk of interactions with fishing gear and based on a probabilistic assessment considering the type and frequency of fishing activity a recommended DoL of 0.2 m was determined in areas of sand, with 0.3 m DoL determined in areas of soft clay.

6.2.4 Sediment Mobility

71. The CBRAs undertaken for both the export cable and inter-array and interconnector cables also consider secondary hazards that may result in cable fatigue or abrasion. For example, surface laid cables would be subject to loading from waves and currents and this could result in cable migration across the seabed. Excessive movement on the seabed could cause abrasion and / or fatigue issues. Buried cables may be subject to exposure where there is a high degree of seabed mobility.

72. An assessment of bathymetry data and physical processes in the Wind Farm Area have not identified large mobile bedforms. Analysis of seabed conditions and local hydrodynamics indicate a maximum thickness of potentially mobile bedforms within the Wind Farm Area of up to 0.2 to 0.3 m. Within the Wind Farm Area effects of local tides and currents and sediment processes are not anticipated to be significant due to the depth and relatively low current speeds recorded.

73. Data along the Offshore Export Cable Corridor is limited however, sediment thickness along the cable route has been considered and no thick layers of mobile sediment have been identified. Sediment mobility along the Offshore Export Cable Corridor will be reviewed on receipt of the results of the ongoing geophysical surveys to identify any significant mobile bedform features.

74. Along the Export Cable Corridor, coastal processes may result in exposure of near shore cables, which could increase risk to cables from external threats and within the intertidal zones, dedicated cable installation and protection methods have been developed for cable protection at the landfall location comprising a mixture of Horizontal Directional Drilling (HDD), burial and mechanical protection as detailed in Section 7.2.2.1.

6.2.5 CBRA Findings

75. Table 6-1 below summarises the findings of the CBRAs.

Table 6-1: CBRA findings summary

THREAT	DOL AT WHICH RISK IS DEEMED ACCEPTABLE IN LINE WITH DNV-GL STANDARDS
Inter-array and interconnector cables	
Commercial shipping	0.5 m
Commercial fisheries	0.2 m in areas of sand/harder ground 0.3 m in areas of soft clay
Final recommended DoL (taking account of above threats and seabed mobility)	0.7 – 0.8 m
Export cables	
Commercial shipping	1.0 m offshore 0.5 m nearshore (landfall to approximately 4 km offshore)
Commercial fisheries	0.2 m in areas of sand/harder ground 0.3 m in areas of soft clay
Final recommended DoL (taking account of above threats and seabed mobility)	1.0 m offshore 0.5 m nearshore (landfall to approximately 4 km offshore)

6.2.5.1 CBRA Summary

76. The CBRAs identify that the best means of mitigating against any potential threats to cables is cable burial, noting that routing cannot avoid the widespread nature of the threats considered.

77. The Application assumed a target burial depth of 1.0 m along the inter-array cable, interconnector and export cables. The CBRAs demonstrate that this DoL is sufficient to adequately mitigate the risk of cable strikes from anchors or fishing gear.

6.3 Cable Burial and Protection

78. The CBRAs identified the DoL at which threats to the cables are mitigated to an acceptable risk level. The results of the CBRAs have been used to inform intended cable burial and protection, as set out below.

79. It is anticipated that burial of cables to a target DoL of 1.0 m will be achieved along the majority of cable routes. In locations where DoL is either anticipated to be unfeasible during detailed design, or is not achieved during installation, there will be a potential requirement for localised additional protection along sections of cables. It should be noted that any requirement for additional cable protection will be within the consented limits, as follows;

- up to 20% of the total consented length of inter-array and interconnector cables (24 km); and
- up to 15% of the total consented length of the export cable (12.8 km).

80. NnGOWL will ensure that any consented cable protection works will not compromise safe navigation and, as such, do not currently anticipate exceeding a maximum of 5% reduction in

surrounding water depth. Any greater reduction in depth, relative to chart datum, would be discussed with the MCA and agreed in writing by the Scottish Ministers.

81. On the basis of currently available information, there is anticipated to be potential for rock protection on some sections of the export cables, where burial to target DoL is not technically feasible. This is described below in Section 6.3.2.

6.3.1 Inter-array and Interconnector Cables

82. All inter-array and inter-connector cables will be buried beneath the seabed to a minimum target DoL of 1.0 m wherever possible and installation methods and tools have been selected to maximise the likelihood achieving DoL. If the DoL cannot be achieved during installation, means of additional protection, such as rock placement or concrete mattressing, will be employed to safeguard the cables from threats.

83. Exposed cables adjacent to the turbines and OSPs (where cables emerge from burial beneath the seabed to connect with turbines or OSPs) will be protected using a Cable Protection System (CPS).

84. Final route engineering is ongoing for inter-array and interconnector cables; however, all currently available information indicates that burial to anticipated DoL will be achieved. If areas requiring rock placement are identified prior to commencement of cable installation these will be notified to MS-LOT in advance. The final achieved (i.e. as-built) burial profile for inter-array and interconnector cables will be provided by the cable installation Contractor once cable installation and the post-lay survey has been completed.

6.3.2 Offshore Export Cables

85. Target DoL will vary along the export cable routes, as suggested in Table 6.1 above. The offshore export cables will be buried beneath the seabed to a minimum target DoL of 1.0 m wherever possible along the majority of the route. As above, installation methods and tools have been selected to maximise the likelihood achieving DoL.

86. At the landfall site, the export cables will be routed through two pre-installed horizontal ducts beneath the seabed and under Thorntonloch beach. The CBRA has indicated that out to approximately 4 km offshore from the landfall location, the risk of cable strikes is mitigated to an acceptable level with a DoL of 0.5 m, reflecting reduced vessel activity.

87. If the DoL cannot be achieved during installation, means of additional protection, such as rock dumping or concrete mattressing, will be employed to safeguard the cables from threats. The final achieved (i.e. as-built) burial profile for export cables will be provided by the cable installation Contractor once cable installation and the post-lay survey has been completed.

88. Final route engineering is ongoing for the offshore export cables, however, latest survey data indicates potential requirement for rock protection on some sections of the cables, where achieving target DoL is not technically feasible due to the presence of hard ground. Table 6-2 below summarises the currently anticipated target DoL and installation solutions along the export cable routes.

89. Currently available information indicates that KP 0 (landfall) to KP 4 (i.e. approximately 4 km offshore) is predominantly rock that could prevent target DoL being achieved; where this is the case there may be a requirement for deployment of rock protection in discrete areas.

90. From KP 4 to the Wind Farm Area the seabed is comprised of predominantly sand or clay overlying bedrock, with soft ground of sufficient depth to allow for a jetting cable burial solution. Currently available information indicates that burial to anticipated DoL will be achieved along the majority of this route. One discrete area has been identified where it may not be possible to reach the

target DoL. The latest survey information indicates the presence of an outcrop of bedrock and highly variable bathymetry in the vicinity of KP 9 (i.e. approximately 9 km offshore). At this location, cable burial to target DoL may not be achieved and alternative solutions to the deployment of rock protection are currently being explored by NnGOWL and their Contractors. One such solution may involve a minor re-routing of the export cables to the West of the rock outcrop, as shown by the 'Extension Area' Figure 6-2 below, to enable their burial in adjacent soft ground and to minimise any requirement for cable protection. Any re-routing out with the consented boundaries of the export cable corridor would be subject to the necessary consents and the CaP would be revised as required.

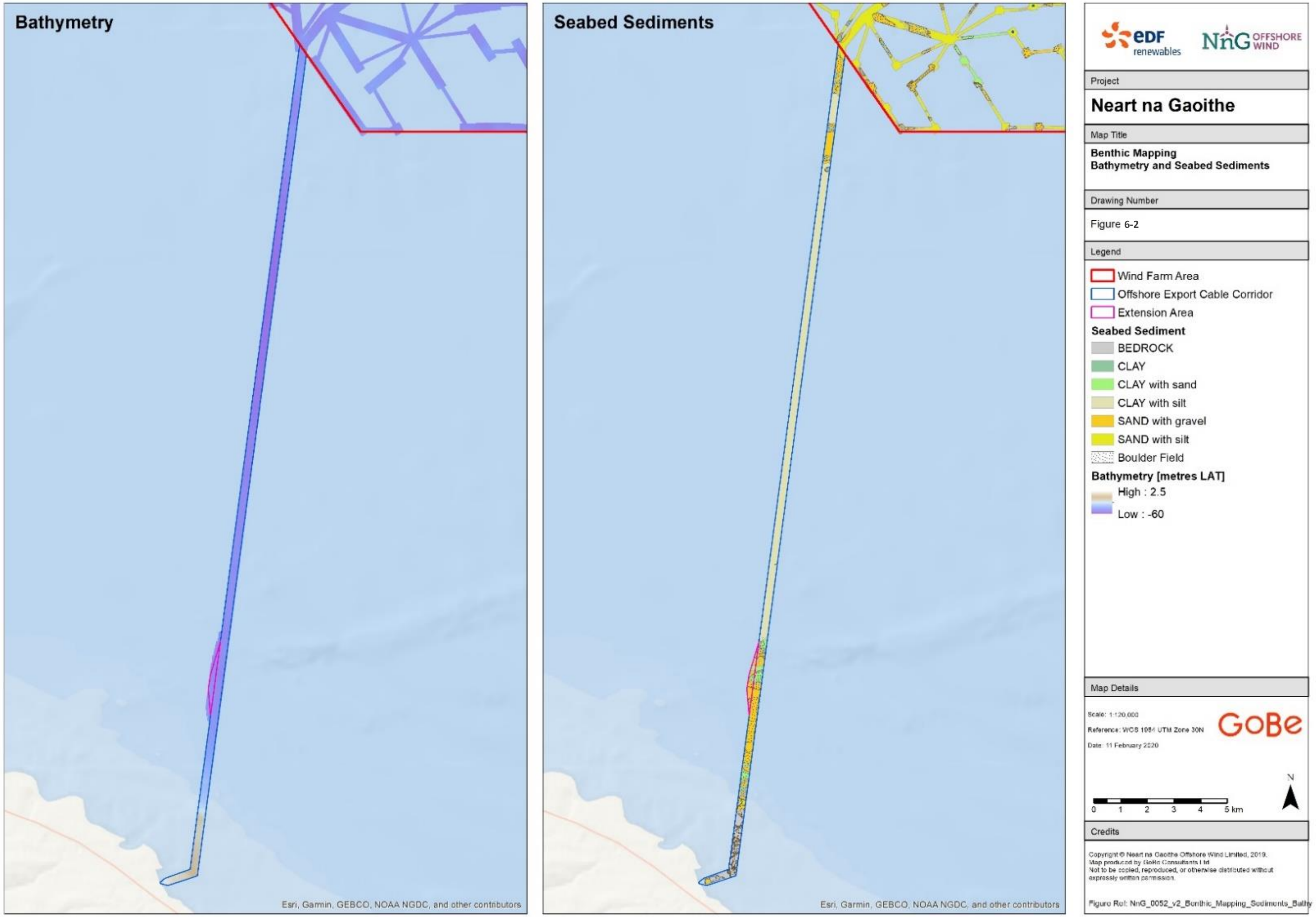


Figure 6-2: Potential re-route of export cables at KP 9

Table 6-2: Export cable protection options

LOCATION	KP	TARGET DOL IN COMPLIANCE WITH THE CBRA	BURIAL TOOL OPTIONS THAT COMPLY WITH THE CBRA
Nearshore	KP 0 to KP 0.9		Horizontal directional drilling
	KP0.9 to KP1.25	0.5m	Mechanical cutting tool Barge mounted rock breaker
Offshore	KP 1.25 to KP 4 (where soft soils)	0.5m	Jetting tool
	KP 1.25 to KP 4 (where hard ground)	1.0m	Mechanical cutting tool
	KP 4 to KP 38.05 (where soft soils)	1.0m	Jetting tool
	KP 4 to KP 38.05 (where hard ground)	1.0m	Mechanical cutting tool

7 Cable Installation Method

7.1 Inter-Array and Interconnector Cables

7.1.1 Installation Vessels

92. Table 7-1 details the main construction vessel types and their role in the inter-array and interconnector cable installation campaign.

Table 7-1: Main inter-array and interconnector cable installation vessels

VESSEL TYPE	ROLE
Anchor Handling Tug (AHT)	Pre-lay Grapnel Run (PLGR)
Dynamic Positioning (DP) 3 Cable Installation Vessel (CLV)	Cable delivery from port of manufacture; Cable laying; and Cable trenching and burial.
Offshore Support Vessel (OSV)*	Pre- and Post- lay surveys;
Crew Transfer Vessel (CTV)	Transfer of personnel to and from turbine and OSP structures to assist with site preparations, cable pull-in, cable termination and testing.
Walk to Work (WTW) Vessel	Transfer of personnel to turbine and OSP structure for site preparations, pull-in operations as well as termination and testing. May be used as an alternative or in addition to CTVs.
Fall Pipe Vessel	Will be used as required to deploy rock placement around J-tubes and or where burial depth is insufficient for cable protection.

*Two OSV support vessels may be used to support the CLV.

93. Ancillary vessels such as guard vessels may be required during construction. The number of guard vessels will be dependent on the active construction activities being undertaken at the time.

7.1.2 Method and Process of Installation

94. An indicative installation process for the inter-array cable and interconnector cables is presented in Figure 7-1 below. Greater detail on each of the stages in the installation process (IAC-1 – IAC4) is then provided in the subsequent sections.

95. It is currently anticipated that a single CLV will lay and bury the cable. The CLV will lay the cable on the seabed with burial taking place following first and second end pull-in operations.

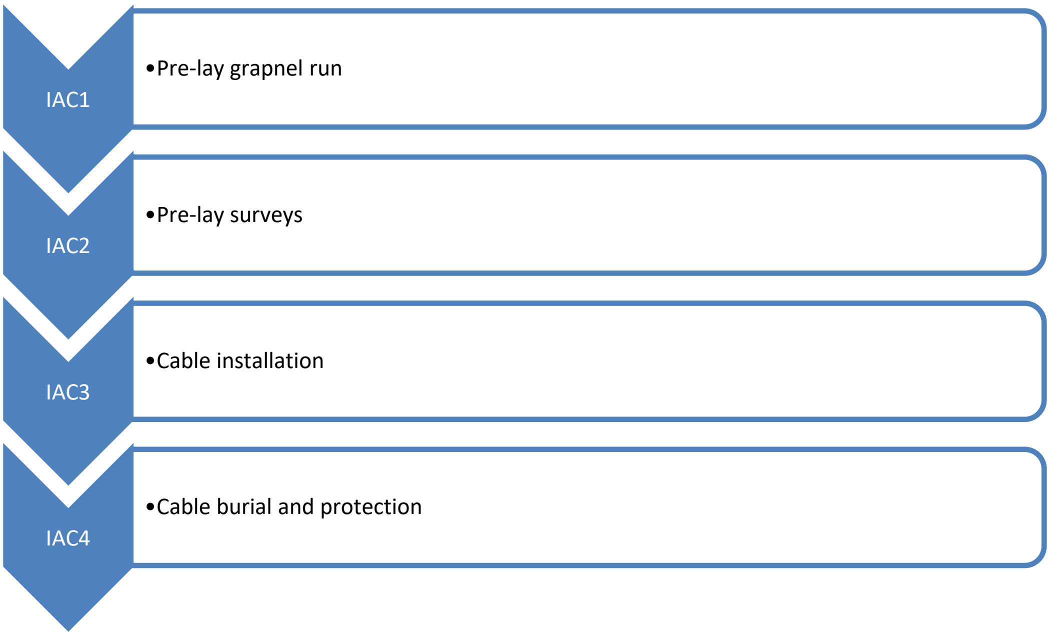


Figure 7-1: Inter-array and interconnector cable installation sequence

7.1.2.1 Inter-Array and Interconnector Cable Installation Stage IAC1 – Pre-lay grapnel run

96. Seabed debris or features (for example scrap trawler warps or ships' crane wires that may have been jettisoned by vessels onto the seabed) can be detrimental to the trenching or burial tool. Therefore, after boulder clearance and before the start of cable laying operations the cable route will be cleared of any remaining obstructions by undertaking a pre-lay grapnel run (PLGR).

97. An anchor handling tug will be mobilised with a towed grapnel rig. All intended cable routes will be subject to PLGR.

98. Any debris recovered to the deck will be retained on board the vessel for disposal onshore.

7.1.2.2 Inter-Array and Interconnector Cable Installation Stage IAC2 – Pre-lay Surveys

99. An OSV will perform a pre-lay survey as part of the cable installations, this will be done after the vessel is loaded and has arrived at site to ensure no changes that will affect the cable installation have occurred since the previous surveys. A Remote Operated Vehicle (ROV) will be used to carry out the pre-lay survey. The vessel will also be equipped with geophysical survey equipment (e.g. a multi-beam echosounder) should it be required.

7.1.2.3 Inter-Array and Interconnector Cable Installation Stage IAC3 – Cable Installation

100. In the event that the cable installation Contractor proposes an installation procedure involving a burial tool that has not previously been proven in similar ground conditions, it will be necessary to carry out a trial to test the capability of the burial tool to achieve the required burial depth. The results of the trial will be used to confirm the adequacy of the tool or to inform minor adjustments to the tool, to be made whilst offshore, to ensure its adequacy. This approach will assist in minimising the risk of ineffective cable burial and thus of the deployment of rock protection. If trenching trials are required, these would involve the installation of up to three test cables each approximately 1 km in length within the Wind Farm Area; the test cables would then be removed and returned to the vessel deck. The trials would take place prior to cable installation commencing. It is not yet confirmed that such trials will be required. Should it be deemed that

amendments to the Offshore Consents are required to cover this activity, a variation would be sought by NnGOWL.

101. Cable installation will be undertaken by the CLV which has been pre-loaded with the subsea cable lengths stored on cable carousels. The cables are installed between the turbines and between the turbines and OSPs to form the 'strings' of turbines. The installation methodology from OSP to turbine is very similar to that of the turbine to turbine.

102. Prior to first end pull-in operations preparation teams will be deployed to rig the turbine jackets and/or OSP jackets with all the required pull-in equipment and material. Preparation teams will be transferred using the walk to work vessel and / or by CTV. Sets of pull-in equipment will be available to allow the preparation teams to prepare sufficient pull-in locations simultaneously.

103. The following steps describe the key stages in the first end cable pull-in process:

- The pull-in hoisting equipment will be lifted onto and set up on the turbine or OSP foundation.
- The assembled CPS will be arranged on the deck of the CLV and the sealed end of the cable will be pulled from the carousel and through the CPS on the back deck of the CLV.
- The messenger wire is pre-installed in the foundation J Tubes prior to load out. It will be recovered from the foundation J-tube to the CLV by means of an ROV. It will then be connected to the front of the cable on the CLV.
- The cable will then be pulled off the CLV and into the J tube by the messenger wire. This will be controlled by a team on the foundation controller a winch and a team monitoring the cable on the CLV. An ROV will also monitor entry of the cable into the J Tube.
- The cable will be secured in the foundation by means of a hang off clamp to ensure it does not slip back down the J Tube.

104. A typical cable 1st End Pull-in operation is illustrated Figure 7-2 and described below.

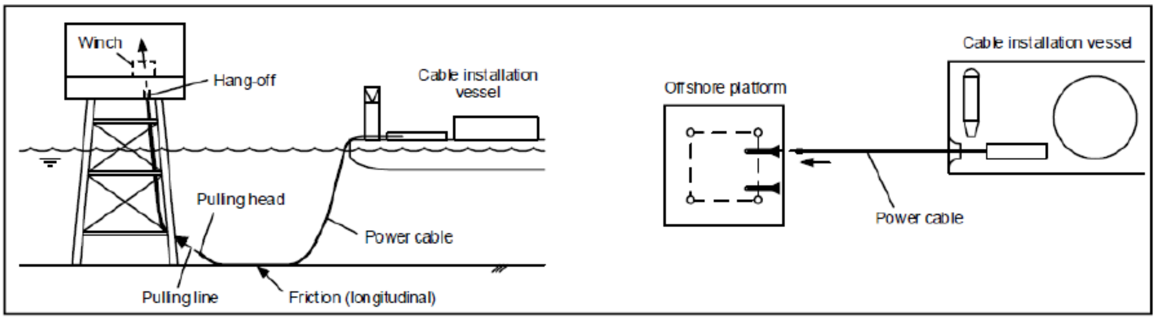


Figure 7-2 Typical 1st end pull-in operation

105. Following 1st end pull-in of the cable the CLV will commence laying along the planned cable route towards the second turbine or OSP pull-in location.

106. Personnel will undertake preparatory work on the turbine or OSP foundation prior to arrival of the CLV as detailed prior to first end cable pull-in.

107. The CPS will be prepared on the deck of the CLV during transit towards the turbine or OSP. The CLV will stop cable laying at a pre-determined distance from the second end pull in location and cut and seal the inter-array cable. The cut and sealed end of the cable will then be routed round a cable quadrant and through the CPS.

108. The messenger wire will again be recovered onto the CLV and attached to the cable. The quadrant is then moved towards the stern of the CLV and lifted by the vessel winch located on an A-frame. The quadrant is then lowered to the seabed as the second end of the cable is pulled in through the J-tube of the turbine or OSP foundation and terminated in the same way as first end pull in operations.

109. A typical 2nd end pull-in operation is illustrated in Figure 7-3.

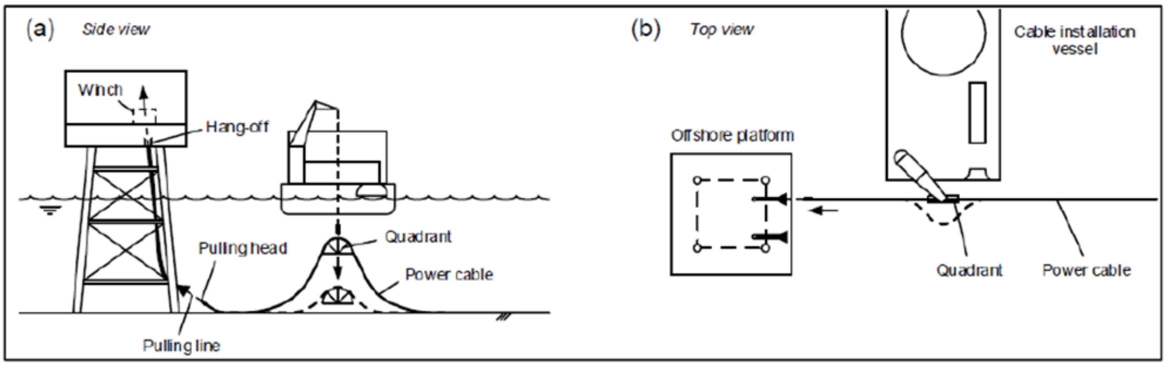


Figure 7-3: Typical 2nd end pull-in operations

110. When the quadrant reaches the seabed, it will be tripped to offload the cable.

111. Following installation testing and termination of the cables will be conducted by personnel transferred onto the jackets from the walk to work vessel or CTVs.

7.1.2.4 Inter-Array and Interconnector Cable Installation Stage IAC4 – Cable burial and protection

112. There may be a need for close-fitting cable protection at the cables ends between the J- or I-tubes and where the cables are buried. Rock placement or graded rock may also be required to support any free span sections of cables in these locations.

113. Once cables are installed on the seabed, cable burial will be conducted by a hybrid trenching tool that can be set to use water jetting and / or mechanical cutting to achieve required burial depths. The trenching tool can use jetting or mechanical cutting modes simultaneously to account for highly variable seabed conditions.

Figure 7-4: Deployment of a hybrid cable trenching tool

114. The trencher is equipped with a variety of survey and positioning equipment which are used for trencher positioning and monitoring of the cable along the route during the trenching operations. This equipment allows an assessment of depth of lowering to determine whether a second pass of the trenching tool is required.

115. The trencher will be deployed from the CLV and using cameras will be lowered over the surface laid cable. The trenching tool will then move along the seabed to the required starting location. The cable will then be positioned between jetting arms or loaded into a cable trough for mechanical cutting depending on the seabed conditions. The cable trenching tool will follow the path of the cable lowering the cable into the seabed using the jetting arm, cutting swords or a combination of both. If required a second pass of the trenching tool will be completed.

116. The trenching tool has been selected taking into account seabed conditions to maximise success in reaching target DoL. At present it is anticipated that minimal additional cable protection will be required across the inter-array cable routes. Analysis of geophysical survey data will be used to review this position.

117. Following cable burial, a post-lay survey of the cables will be completed to determine the depth of lowering. If depth of lowering has not been achieved alternative burial tools will be considered. If practicable in certain sections, to minimise cable protection, use of an alternative mass flow/jetting/plough tool deployed from an OSV or CLV may be used. If an alternative burial tool cannot reach the target depth of lowering additional cable protection measures will be considered. The following list details additional cable protection measures that will be considered in the event that adequate depth of lowering is not achieved:

- Durable crushed or original rock of defined size range;
- Concrete 'mattresses'; and
- Bags (high strength nylon fibre) of gravel, hardened sand-cement grout, or concrete (grout/concrete pre-filled and hardened onshore). The bag option may include a technique where the grout is introduced to the nylon fibre bag offshore through proprietary pipes (the bags being permeable to water but not to grout).

118. NnGOWL may consider alternative cable protection systems. Where an alternative cable protection solution is used that is not covered by the licensed deposits on the Wind Farm Marine

Licence these will be subject to approval of an additional marine licence or variation to the existing Offshore Consents.

119. Ongoing engagement with fisheries organisations will be undertaken in accordance with the Fisheries Liaison Strategy, outlined within Section 5 of the Fisheries Management and Mitigation Strategy (FMMS), in accordance with FLOWW (Fishing Liaison with Offshore Wind and Wet Renewables Group) (2014) Best Practice Guidance. NnGOWL confirm that where it is identified that rock placement is required, NnGOWL will issue a Notice to Mariners containing the justification of the requirement for cable protection in that location. A clear chart and coordinates illustrating the location of the cable protection would be included within the Notice.

120. Within the Application (NnGOWL, 2018), NnGOWL committed to undertake over trawls on export, inter-array and interconnector cables in locations where protection has been installed, in order to ensure that the protection scheme has been successful. Where it is confirmed that cable burial to DoL has been achieved by post-lay survey (see para 113), NnGOWL will not undertake over trawl investigations. Where target DoL is not achieved and additional cable protection is deployed, over trawl investigations will be undertaken by NnGOWL.

121. NnGOWL propose to undertake over trawl investigations utilising the most appropriate methodology available at the time of cable installation, in agreement with MS-LOT and following engagement with stakeholders including fisheries organisations, in accordance with the Fisheries Liaison Strategy outlined within Section 5 of the FMMS. It is currently envisaged that over trawl investigations could take the form of three-dimensional modelling (based on geophysical survey data collected for each location) and will take account of:

- The extent and location of the cable protection material;
- The design of the cable protection material (noting that these can be designed to minimise effects on towed fishing gear); and
- The amount and type of fishing activity observed along the cable routes.

7.2 Offshore Export Cables

7.2.1 Installation Vessels

122. Table 7-2 details the main types of construction vessels and their role in the export cable installation campaign.

Table 7-2: Main export cable installation vessels

VESSEL TYPE	ROLE
Anchor Handling Tug (AHT)	Undertaking PLGR operations.
Dive Support Vessel (DSV)	May be required to assist with cable pull-in at the landfall location.
Jack-Up Barge	To assist with cable burial in the near shore area, if required.
Backhoe Dredge Barge	To assist with cable burial / protection in the near shore area as required.
DP2 CLV	Cable delivery from port of manufacture; Pre- and Post- lay surveys;

	Cable lying Cable trenching and burial
Offshore Support Vessel (OSV)	Deployment of burial and trenching tools.

123. Ancillary vessels such as guard vessels may be required during construction.

7.2.2 Method and Process of Installation

124. An indicative export cable installation sequence is presented in Figure 7-5 below. Greater detail on each of the stages in the installation process (EC1 – EC4) is then provided in the subsequent sections.

125. It is currently anticipated that export cable installation will be completed by a CLV. A second vessel will be used to complete the burial of the cable once it has been laid on the seabed by the CLV.

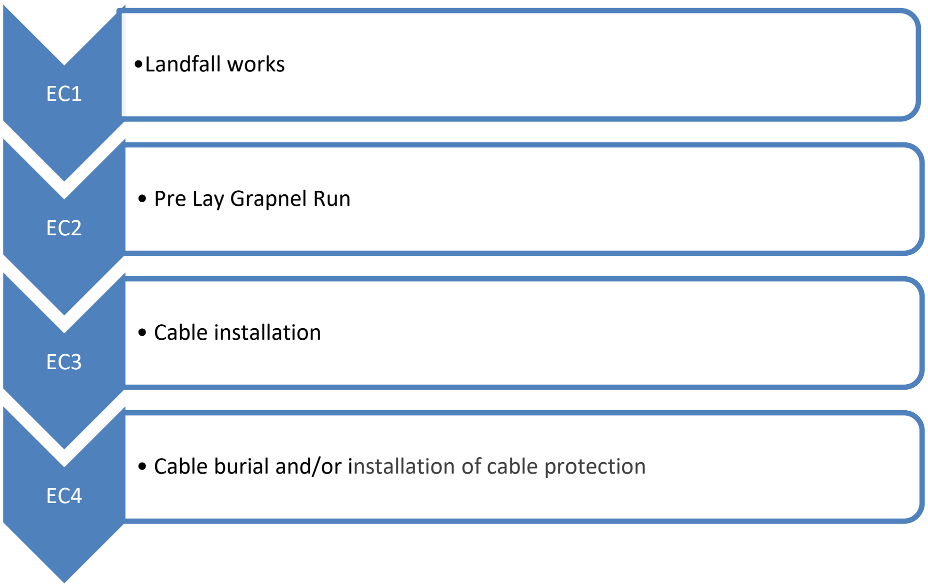


Figure 7-5: Export Cable installation sequence

7.2.2.1 Export Cable Installation Stage EC1 – Landfall works

126. Ducts through which the export cables will be pulled will be installed underneath Thorntonloch beach using a Horizontal Directional Drilling (HDD) technique.

127. HDD involves drilling a bore underground between two points, into which ducting to carry electrical cable can be installed. To achieve this, an onshore drill rig will commence drilling at the onshore end of the underground channel, above MHWS landward of the beach at Thorntonloch.

128. The HDD drilling process will comprise the following stages:

- A small diameter pilot hole will be drilled from the onshore drill site, for the purpose of defining the path of the channel into which the ducts and later the cable is to be installed;
- The pilot hole will be enlarged using a steel reamer to accommodate a duct larger than the diameter of the export cable;

- The ducting will be floated offshore and then attached to the reamer and pulled through the channel from the seaward entry point to the onshore drill site, at which point it will be sealed and protected in preparation for cable pull in at a later date.

129. The final landfall installation process will be subject to review following analysis of the ongoing nearshore geophysical and geotechnical survey data. Open cut trenching may be used at the landfall locations if ground conditions prove not to be conducive to HDD techniques.

130. In the event that HDD is not possible, an excavator or rock breaker will be used to dig the necessary trenches. Seawards of Mean Low Water Spring (MLWS) the excavator or rock breaker will be mounted on a barge to excavate trenches for cable duct installation. Should the sediment depth be insufficient, rock breakers or other mechanical cutting methods may be required to achieve the required burial depth. Cable ducts would be installed in the trenches and backfilled with cable pull-in operations being conducted in the same manner under both circumstances.

131. The length of the ducting is subject to further engineering analysis following survey. It is expected that the ducting, from onshore entry above MHWS to offshore exit below MHWS, will be between 150m and 800m long. The export cables will converge at the HDD exit ducts which will be approximately 10 – 20 m apart.

7.2.2.2 Export Cable Installation Stage EC2 – Pre-Lay Grapnel Run

132. The PLGR will follow the same procedure as for the inter-array cable and interconnector cable routes as set out in Section 7.1.2.1.

7.2.2.3 Export Cable Installation Stage EC3 – Cable installation

133. In the event that the cable installation Contractor proposes an installation procedure involving a burial tool that has not previously been proven in similar ground conditions, it will be necessary to carry out a trial to test the capability of the burial tool to achieve the required burial depth. The results of the trial will be used to confirm the adequacy of the tool or to inform minor adjustments to the tool, to be made whilst offshore, to ensure its adequacy. This approach will assist in minimising the risk of ineffective cable burial and thus of the deployment of rock protection. If trenching trials are required, these would involve the installation of up to three test cables each approximately 1 km in length within the Export Cable Corridor; the test cables would then be removed and returned to the vessel deck. The trials would take place prior to cable installation commencing. It is not yet confirmed that such trials will be required. Should it be deemed that amendments to the Offshore Consents are required to cover this activity, a variation would be sought by NnGOWL.

134. The export cable will be loaded onto the CLV turntable at the cable manufacturing facility. There will be one load out per export cable.

135. Cable installation will commence at the landfall with cable pull in through the installed ducts. The shore end site area will be prepared, including rigging safety barriers, excavating the onshore trench, exposure of the ends of the HDD, the installation and testing of the winch(s) and liaison with the offshore teams.

136. The ducts will be exposed, having been left shallow buried, and the exit flange will be removed. The HDD will be flushed with a suitable amount of water to displace any debris that may be present and cleaned using a mandrill guided by ROV or a dive team, if required.

137. On approaching the landing point, the CLV will position itself as close to the exit of the cable ducts as possible but at a safe working water depth. It is anticipated that this position will be at approximately the 10m depth contour.

138. The nearshore support team will then pass the messenger wire to the CLV waiting offshore. The cable head will be attached to the messenger wire which will be hauled back through the pre-installed ducts as the CLV is paid out from the CLV (Figure 7-6).

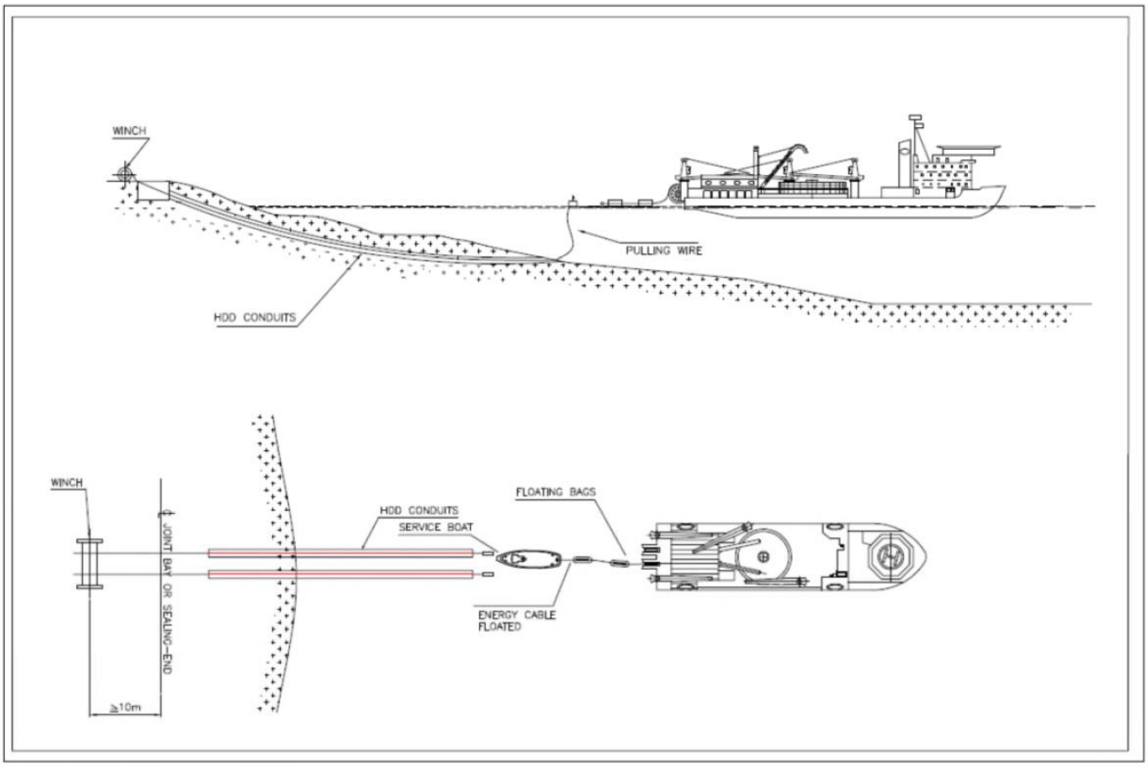


Figure 7-6: Illustration of landfall cable pull-in operations

139. A pull-in winch located onshore will draw the cable through the ducts. The cable will be paid out by the CLV. Floats will be attached to the cable as it is paid out at intervals up to the position of duct. The cable pull in will be monitored by ROV, or by a dive team.

140. Once the cable has been pulled into the ducts and secured onshore, the support team will ensure the cable is located over the proposed cable route and then will commence removing floats between the duct and the cable vessel. The final position of the cable will be recorded by ROV or divers.

141. Once all floats have been removed the CLV will progress along the route laying the cable on the seabed.

142. The CLV will continue to lay the cable and monitor the touch down location along the export cable route in the direction of the OSP. The OSP preparation team will begin on site checking and setting up the equipment for the installation of the export cable to the platform. The messenger wire will have been pre-installed in the J-tube at the fabrication yard and will be suitable for recovery on site by a ROV. On site the wire will be replaced with a pulling line of a suitable length and strength for the cable pull in operation.

143. Once at the OSP the CLV will stop approximately 100 m from the platform. The export cable will be cut and sealed at the appropriate length and routed around a quadrant and through the CPS for second end pull-in operations. A ROV will recover a messenger wire that is pre-installed inside the j-tubes during OSP foundation fabrication. The cable pull-in operations, managed from the OSP, will then follow the same procedures as detailed under Section 7.1.2.3 in relation to the inter-array cable pull-in.

7.2.2.4 Export Cable Installation Stage EC4 – Cable burial and protection

144. The surface laid cable will then be buried into the seabed to the target DoL. A jetting tool will be used in softer ground conditions and a mechanical cutting tool over harder ground; slightly different tools may be used to support the same process in the nearshore area between the 10 m depth contour and the cable duct exits. Burial will be completed from an OSV equipped for trenching or burial, and in the nearshore area a backhoe dredge barge may assist.

145. Following cable burial, a post-lay survey of the cables will be completed to determine the depth of lowering. Where the target DoL is not achieved alternative protection methods will be considered. The following materials will be considered for cable protection:

- Durable crushed or original rock of defined size range;
- Concrete 'mattresses'; and
- Bags (high strength nylon fibre) of gravel, hardened sand-cement grout, or concrete (grout/concrete pre-filled and hardened onshore). The bag option may include a technique where the grout is introduced to the nylon fibre bag offshore through proprietary pipes (the bags being permeable to water but not to grout).

146. NnGOWL may consider alternative cable protection systems. Where an alternative cable protection solution is used that is not covered by the licensed deposits on the OfTW Marine Licence these will be subject to approval of an additional marine licence or variation to the existing Offshore Consents.

147. Ongoing engagement with fisheries organisations will be undertaken in accordance with the Fisheries Liaison Strategy, outlined within Section 5 of the FMMS, in accordance with FLOWW (2014) Best Practice Guidance. NnGOWL confirm that where it is identified that rock placement is required, NnGOWL will issue a Notice to Mariners containing the justification of the requirement for cable protection in that location. A clear chart and coordinates illustrating the location of the cable protection would be included within the Notice.

148. Within the Application (NnGOWL, 2018), NnGOWL committed to undertake over trawls on export, inter-array and interconnector cables in locations where protection has been installed, in order to ensure that the protection scheme has been successful. Where it is confirmed that cable burial to DoL has been achieved by post-lay survey (see para 140), NnGOWL will not undertake over trawl investigations. Where target DoL is not achieved and additional cable protection is deployed, over trawl investigations will be undertaken by NnGOWL.

149. NnGOWL propose to undertake over trawl investigations utilising the most appropriate methodology available at the time of cable installation, in agreement with MS-LOT and following engagement with stakeholders including fisheries organisations, in accordance with the Fisheries Liaison Strategy outlined within Section 5 of the FMMS. It is currently envisaged that over trawl investigations could take the form of three-dimensional modelling (based on geophysical survey data collected for each location) and will take account of:

- The extent and location of the cable protection material;
- The design of the cable protection material (noting that these can be designed to minimise effects on towed fishing gear); and
- The amount and type of fishing activity observed along the cable routes.

7.3 Seabed Deposits

150. Seabed deposits will be recorded and reported to MS-LOT on a Transportation Audit Report (TAR) to be submitted monthly throughout construction in accordance with Condition 3.2.3.1 of the Wind Farm and OfTW Marine Licences. Within one month of completion of construction a final audit report will be issued to MS-LOT detailing the full deposits deployed as required by Condition 3.2.4.2 of the Wind Farm and OfTW Marine Licences.

151. Within one month of completion of Construction NnGOWL will provide the "as-built" positions of all structures and any sub-sea infrastructure associated with the Project to MS-LOT. This information will also be forwarded to the UK Hydrographic Office (UKHO) and Defence Geographic Centre (DGC) for aviation and nautical charting purposes as required by Condition 3.2.4.4 of the Wind Farm and OfTW Marine Licence.

8 Operation and Maintenance

8.1 Introduction

152. This section sets out the anticipated O&M activities associated with the inter-array cables, interconnector cables and the offshore export cables. NnGOWL is required to sell and subsequently transfer ownership of the Transmission Assets (comprising the offshore export cables, and the OSPs[1]) to an Offshore Transmission Operator (OFTO). After the transfer of ownership, the OFTO will take on responsibility for the O&M measures associated with the Transmission Assets.

153. This section sets out indicative O&M procedures, which will be fully described in the Operation and Maintenance Programme (OMP).

8.2 Ongoing cable inspections

154. When the Project is operational, further cable or seabed surveys will be undertaken to confirm that cables remain buried.

155. A survey will be undertaken approximately 1-year post-installation to confirm the cables remain buried. The frequency and scope of further monitoring will be proportionate to the risk of future cable exposure and determined based on comparisons with the initial post-installation survey results. The following surveys or inspections may be considered as part of ongoing O&M activities:

- Geophysical surveys along all routes or those routes which are considered at risk of exposure based on initial post-installation survey findings;
- Surveys at approaches to structure j-tubes where there may be greater risk of scour/ erosion; and
- A Distributed Temperature Sensing (DTS) system or similar will be installed to remotely and continuously monitor cable health from the O&M base.

8.3 Cable exposure

156. In the event of cable exposure, cable sections will be inspected to determine the full extent of exposure. An assessment will be undertaken to determine the risk posed by the exposed cables to other sea users and to the Project. Where the risk is unacceptable, remedial action will be undertaken to ensure the cable is adequately protected. The following measures will be considered:

- Reasonable endeavours will be made to re-bury the cable to a safe DoL taking into account the risk of exposure re-occurring;
- Placement of rock bags or rock armour or suitable alternatives such as frond mats, tyre mats etc[2]., at the cable ends to mitigate cable movement / migration; or
- Placement of additional rock armouring along the length of exposed cable. This approach is considered a last resort and would be agreed in advance of deployment with MS-LOT.

[1] Some elements of the OSPs will be retained as part of the Wind Farm Assets.

[2] Alternative cable protection solutions not covered by the licensed deposits on the Wind Farm or OfTW Marine Licence will be subject to approval of an additional marine licence or variation to the existing Offshore Consents.

8.4 Cable failure

157. The following sections outline procedures to repair or replace damaged or faulty subsea cables.

158. Repairs will be conducted by a CLV or suitable alternative vessel such as a jack-up vessel. Depending on the location of the fault the following cable repair options will be considered. The following lists set out indicative procedures associated with potential cable repair scenarios.

8.4.1 Replacement of a full inter-array cable length

159. The following steps provide an indicative overview of the procedure to replace a full length of a single inter-array cable (i.e. a length between two structures):

i. The repair vessel will de-bury the damaged section. It is likely that the cable will be exposed using a jetting tool and/or mass flow excavation;
ii. The cable will be cut at the damage location subsea using an ROV and the first end of the cable disconnected at the turbine or OSP;
iii. The first end of the cable and the CPS will be recovered to the repair vessel;
iv. The second end of the cable will then be disconnected from the turbine or OSP;
v. The second end cable and CPS will be recovered to the repair vessel;
vi. A new section of cable will be installed following the procedures detailed under 7.1.2.3.
vii. The cable will then be protected using the most appropriate burial tool or protection options, following the same procedure detailed under 7.1.2.4.

8.4.2 Replacement of a section of subsea cable

160. The following steps provide an indicative overview of the procedure to cut out a section of cable in the middle of a length and insert a new piece of cable using two cable joints;

i. The repair vessel will de-bury the damaged section. It is likely that the cable will be exposed using a jetting tool and/or mass flow excavation;
ii. The cable will be cut either side of the damaged location subsea using an ROV;
iii. The cable repair vessel will then recover the first end of the inter-array cable or export cable to be repaired.
iv. A cable joint will be used to connect a repair section of cable to the cut end of the recovered cable;
v. The second end of the cable to be repaired will then be recovered. This end of the cable will be connected to the other side of the cable repair section using a second cable joint;
vi. The repaired cable will then be lowered to the seabed. The cable repair section will result in a bight (loop) at the repair location.
vii. The cable will then be re-buried using the most appropriate burial tool or protected using rock protection or following the same procedure detailed under 7.1.2.4.

8.4.3 Replacement of a section of cable adjacent to a turbine or OSP

161. The following steps provide an indicative overview of the procedure to replace a section of cable close to a structure:

a. The repair vessel will de-bury the damaged section. It is likely that the cable will be exposed using a jetting tool and/or mass flow excavation;

i. Once the location of the damage is identified the cable end closest to a structure will be identified for recovery;

ii. The cable will be cut at the location of the damage either subsea using an ROV or recovered and cut on the deck of the CLV;

iii. The cable end identified for recovery will then be disconnected from the turbine or OSP and recovered to the CLV;

iv. The CPS will be recovered to the cable repair vessel;

v. The CLV will then return to the location of the cut cable and recover the second end of the cable;

vi. A cable joint will be used to connect a repair section of cable to the cut end of cable still connected to the turbine or OSP;

vii. The cable will then be returned to the seabed and cable lay will commence towards the disconnected turbine or OSP. Once at the turbine or OSP location second end-pull-in will be completed. It is anticipated that cable lay and second pull-in will be completed using the same procedure detailed under section 7.1.2.3.

viii. The cable will then be re-buried using the most appropriate burial tool following the same procedure detailed under 7.1.2.4.

8.4.4 Replacement of a section of cable at the Landfall

162. The following steps provide an indicative overview of the procedure to replace a section of cable close to the landfall Transition Joint Bay (TJB) (Export Cable Only):

i. The repair vessel will de-bury the cable around the HDD exit point using a jetting tool, mass flow excavation, or using a backhoe dredge or grab if required.

ii. The cable will be disconnected at the onshore TJB and the repair vessel will recover the redundant cable from the horizontal duct at the landfall location;

iii. A new length of cable will then be installed through the horizontal ducts following the same procedures set out in Section 7.2.2.1.

iv. Cable installation will then commence until it reaches the cut end of the export cable, as described under Section 7.2.2.3;

v. The cut end of the export cable will then be recovered to the repair vessel and connected to the newly installed cable using a cable joint;

vi. The cable will then be re-buried using the most appropriate burial tool following the same procedure detailed under Section 7.2.2.4.

9 Compliance with the Application

9.1 Introduction

163. Sections 9.2 and 9.3 sets out information from the Application with regard to:

- Compliance with the cable installation details as assessed in the Application; and
- Cable installation-related mitigation measures detailed in the Application.

9.2 Compliance with Installation Details Assessed in the Application

164. The EIA Report described a range of specification and layout options that could be applied during the construction of the Project.

165. Since the Offshore Consents were awarded, the design of the Project and approach to installation has been refined to that described in this CaP (and in other relevant Consent Plans). In order to demonstrate compliance of this refined design, the installation methods and cable specifications described in the EIA Report are compared to the installation methods and specifications detailed within this CaP.

9.2.1 Inter-Array Cable Installation

166. Figure 9-1 summarises the inter-array cable options and assumed installation methods presented within the Application. It also summarises the selected options and confirmed installation methods described in this CaP.

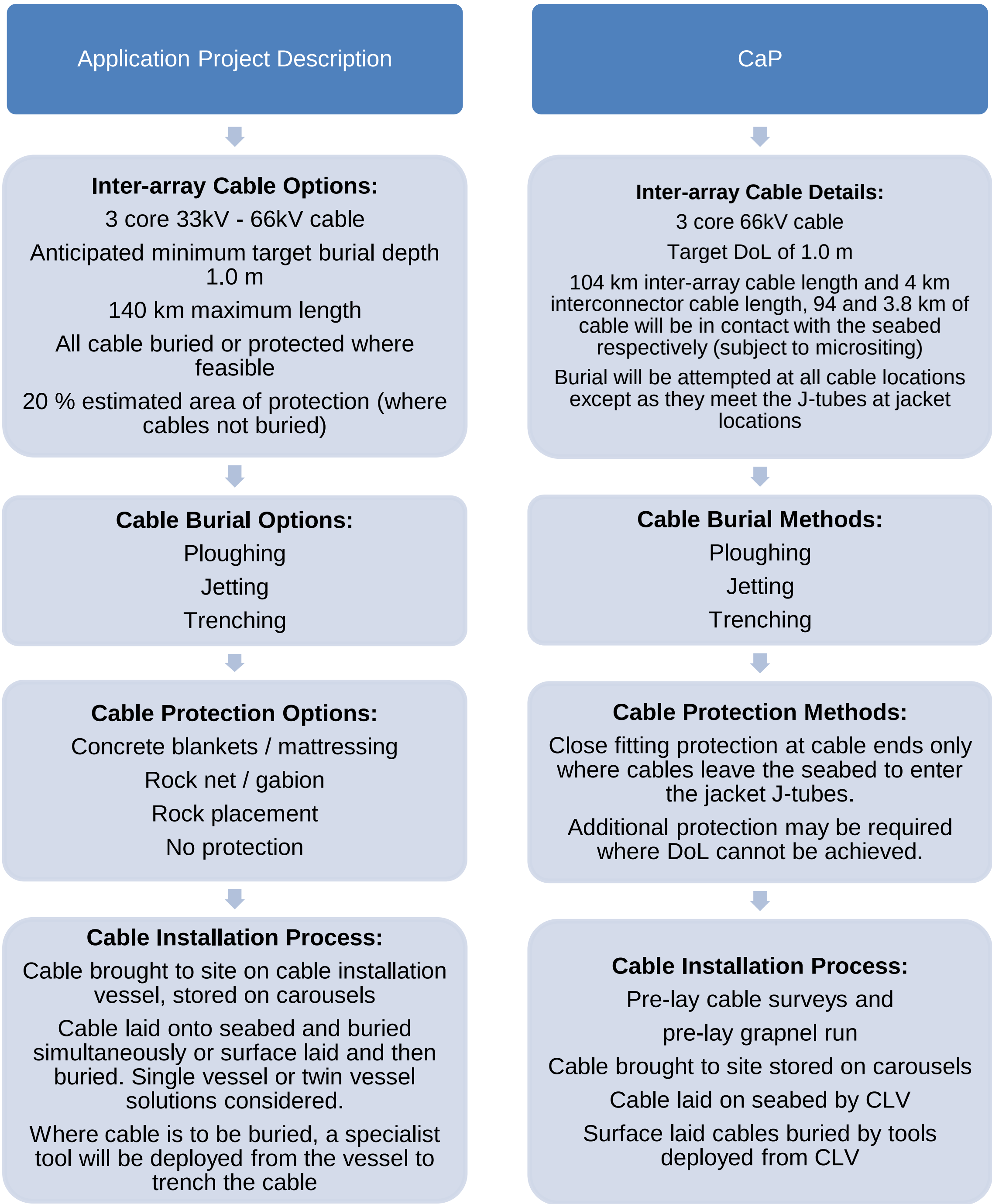


Figure 9-1: Comparison of inter-array and interconnector cable installation methods described in the Application and CaP

9.2.2 Offshore Export Cable Installation

167. Figure 9-2 summarises the Offshore Export Cable options and assumed installation methods presented within the Application. It also summarises the selected options and confirmed installation methods described in this CaP.

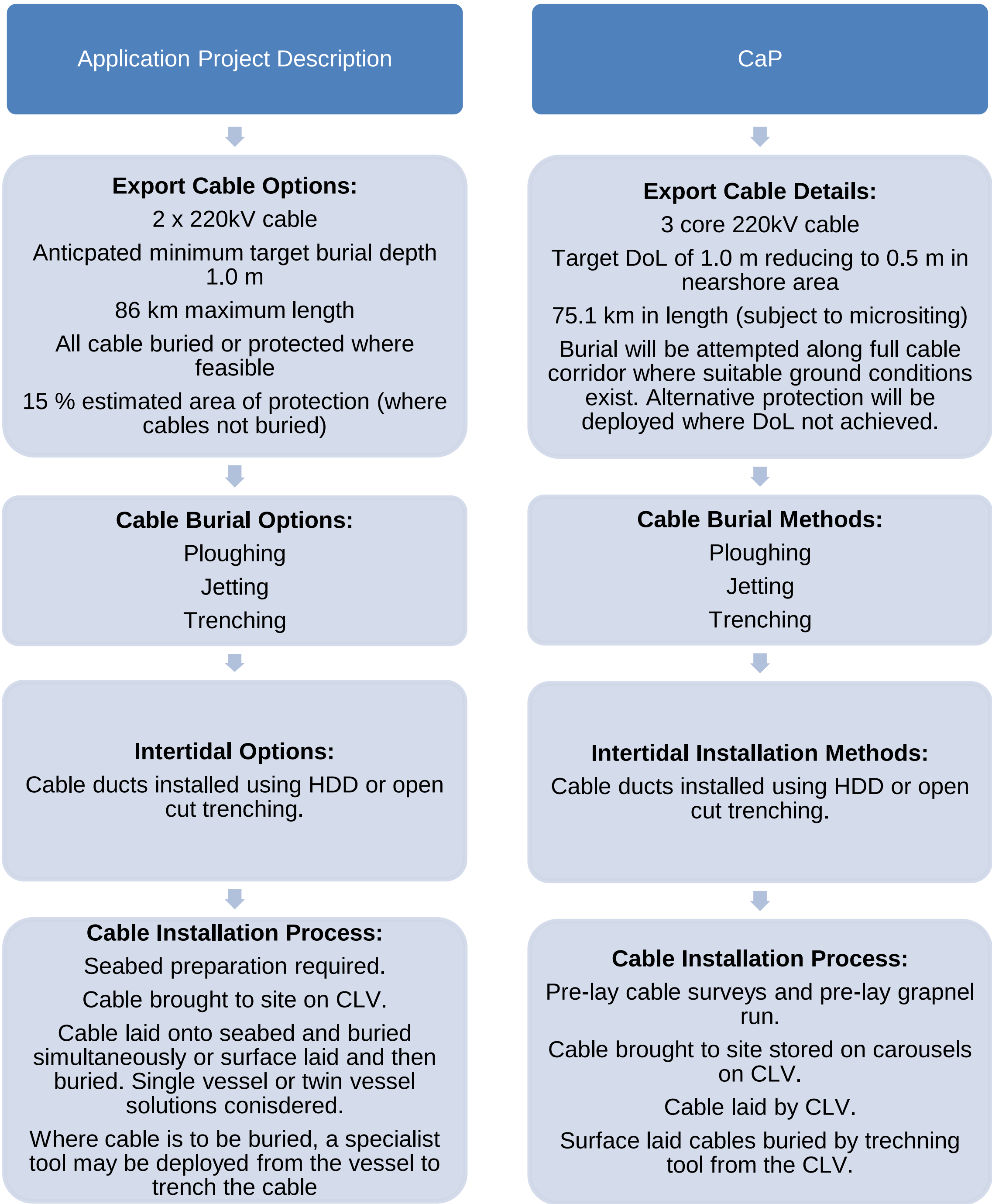


Figure 9-2: Comparison of Offshore Export Cable installation methods described in the Application and CaP

9.3 Delivery of Mitigation Proposed in the Application

168. The EIA Report detailed mitigation measures of relevance to the inter-array, interconnector and export cable installation activities. The relevant mitigation measures are detailed in Table 9-1, which identifies where each commitment has been addressed within this CaP or within other NnGOWL Consent Plans where appropriate.

Table 9-1: Construction related mitigation measures relevant to the CaP

CONSTRUCTION PROCESS	MITIGATION MEASURE	WHERE ADDRESSED
Cable Installation		
Cable protection	Cable will be buried where possible to mitigate impacts on physical processes, benthic habitats and other sea users. Cables, where techniques allow, should be back filled to increase recovery rates.	Described in Section 7. Where ground conditions permit jetting, sediment will settle back into the cable trench.
Cable Specifications	Cable specifications will be compliant with industry standards and best practice such as the relevant International Electrotechnical Commission (IEC) specifications to minimise risk of effects resulting from EMF to benthic and fish communities.	See Section 5
Pre-construction cable route survey	Conduct a pre-construction cable route survey to identify any sensitive seabed habitats. Should such habitats be recorded, the Offshore Export Cable Corridor will be micro-sited, in consultation with Scottish Natural Heritage (SNH) and other stakeholders via submission, for approval, to MS-LOT of a Cable Plan (CaP).	See Section 9.3.1

9.3.1 Pre-Construction Cable Route Surveys

169. Previous baseline habitat surveys conducted to inform the Original Environmental Statement (ES) did not identify any areas of habitat with a high conservation value, such as reef or shellfish beds, within the Offshore Export Cable Corridor. The ES prepared in support of the Originally Consented Project (NnGOWL, 2012) concluded that there would be no significant impacts on benthic communities. These conclusions were validated in the Scoping Report (NnGOWL, 2017) for the Project and subsequently scoped out of further assessment in the Application (NnGOWL, 2018).

170. Recent high resolution geophysical surveys have been completed along the length of the offshore Export Cable Corridor (See Section 4.2 for details). The aim of the survey work was to confirm seabed conditions to inform cable routing and installation methods. The Offshore Export Cable Corridor is 300 m wide, which constrains micro-siting options. Given the low risk to benthic communities, the limited spatial extent of any impact and the limited scope for micro-siting within the Offshore Export Cable Corridor, NnGOWL do not see the value in undertaking further benthic habitat surveys and do not plan to undertake further benthic habitat surveys along cable routes prior to cable installation.

10 References

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Carbon Trust (2015) Application Guide for the Specification of the Depth of Lowering using the Cable Burial Risk Assessment (CBRA) methodology, Dec 2015; and,

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FLOWW (2014) Best Practice Guidance for Offshore Renewable Developments: Recommendations for Fisheries Liaison. Fisheries Liaison with Offshore Wind and Wet Renewables Group (FLOWW). Available online: https://www.thecrownestate.co.uk/media/1775/ei-km-in-pc-fishing-012014-floww-best-practice-guidance-for-offshore-renewables-developments-recommendations-for-fisheries-liaison.pdf [Accessed on 26 March 2019]

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