Code: UKCAL-CWF-CON-EIA-RPT-00001-1003

Volume 1 Overview Chapters

Chapter 3 Proposed Development Description (Offshore)

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OCEAN WINDS

Volume 1 Chapter 3 Proposed Development Description (Offshore)

Code	UKCAL-CWF-CON-EIA-RPT-00001-1003
Revision	Issued
Date	18 October 2024

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Acronyms and Abbreviations

CAA	Civil Aviation Authority
CBRA	Cable Burial Risk Assessment
CLV	Cable Laying Vessel
CPS	Cable Protection System
DE	Design Envelope
DEA	Drag Embedment Anchor
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
FRP	Fully Restrained Platform
GW	Gigawatt
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
HTV	Heavy Transport Vessel
HVAC	High Voltage Alternating Current
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
JUV	Jack-up Vessels
kJ	kiloJoules
km	kilometres
km^2	Kilometres squared
kV	kiloVolt
LAT	Lowest Astronomical Tide
MCA	Maritime and Coastguard Agency

MD-LOT	Marine Directorate Licensing Operations Team
MLWS	Mean Low Water Springs
MHWS	Mean High Water Springs
mm	millimetre
MPA	Marine Protected Area
MS-LOT	Marine Scotland Licensing Operations Team
MSL	Mean Sea Level
NETS	National Electricity Transmission System
NLB	Northern Lighthouse Board
NOREL	Nautical and Offshore Renewable Energy Liaison
O&M	Operation and Maintenance
OECC	Offshore Export Cable Corridor
OnTI	Onshore Transmission Infrastructure
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
SAC	Special Area of Conservation
SPA	Special Protection Area
TP	Transition Piece
TSHD	Trailer Suction Hopper Dredger
UXO	Unexploded Ordinance
WTG	Wind Turbine Generator

3 Proposed Development Description (Offshore)

3.1 Introduction

3.1.1 Overview

3.1.1.1 This chapter describes the offshore design parameters of the Caledonia Offshore Wind Farm (OWF) (hereby known as the 'Proposed Development (Offshore)') that have been used to inform this Environmental Impact Assessment Report (EIAR). These design parameters cover all offshore and intertidal components of the Proposed Development (Offshore) located seaward of Mean High Water Springs (MHWS). These design elements are presented for all stages of the Proposed Development (Offshore), covering construction, operation and maintenance (O&M) and decommissioning. It also covers both temporary and permanent works/activities associated with the Proposed Development (Offshore).

3.1.1.2 The consenting strategy of the Proposed Development (Offshore) means that it will be delivered in two phases; Caledonia North (including Caledonia North Site and OECC) and Caledonia South (Caledonia South Site and OECC). More detail on the consenting strategy can be found in Section 3.1.4.

3.1.1.3 This chapter sets out the maximum design envelope (DE) that will apply to Caledonia North, Caledonia South and the overall Proposed Development (Offshore) including the project location, wind turbine generators (WTGs), foundations, offshore inter-array and interconnector cables, offshore substation platforms (OSPs), offshore export cables, landfall and other associated infrastructure. This chapter also includes details of the activities, approaches and timescales associated with construction, O&M and repowering/decommissioning that Caledonia North and Caledonia South will be expected to operate within.

3.1.1.4 The information presented in this chapter has been used to inform the technical assessments completed to assess the significance of effects upon key receptors, as included within Volumes 2, 3 and 4 of this EIAR.

3.1.1.5 An overview schematic of the Caledonia OWF as a whole, including both the main components of the Proposed Development (Onshore) and Proposed Development (Offshore) is shown below in Figure 3–1. Although Figure 3-1 shows a jacket foundation concept, other foundations are being considered for the Proposed Development (Offshore) as described in Section 3.2.2. For corresponding details regarding the Proposed Development (Onshore), refer to Volume 1, Chapter 4: Proposed Development Description (Onshore).

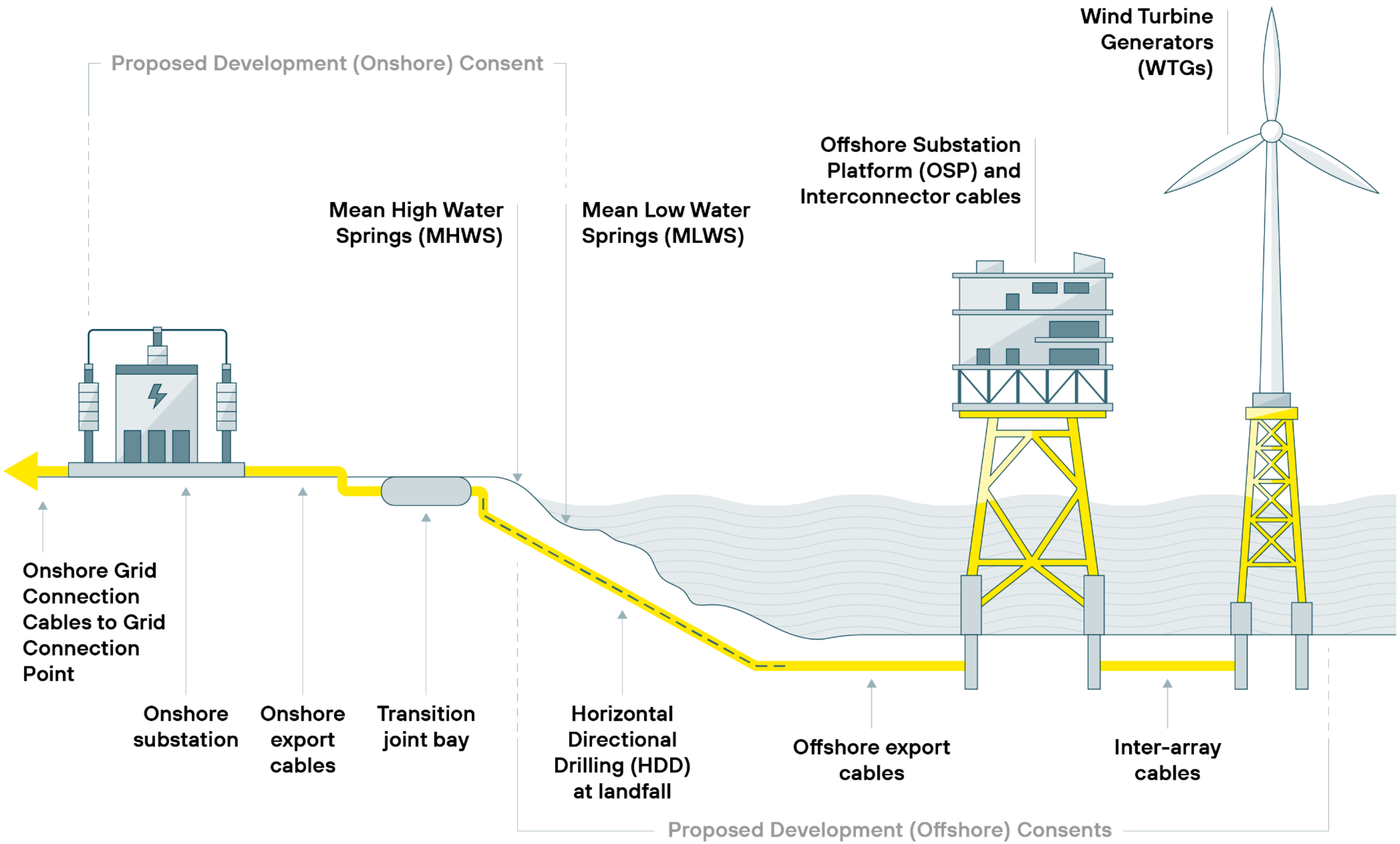


Figure 3–1: Proposed Development indicative schematic.

3.1.2 Design Envelope Approach

3.1.2.1 Caledonia Offshore Wind Farm Limited (the Applicant) has utilised a DE approach to inform this EIAR. The DE approach enables a range of parameters to be presented for each offshore aspect which provides the flexibility to allow for further refinement of the offshore design post-consent. The Environmental Impact Assessment (EIA) must, however, assess the maximum impact option(s) that could be constructed and operated to ensure that all potential environmental impacts have been assessed appropriately.

3.1.2.2 Where a DE approach is adopted through the need for flexibility, it is recommended that a formal Scoping Opinion is sought from the Scottish Ministers. The first version of the DE was set out to underpin the Offshore Scoping Report, which was submitted to Marine Directorate - Licensing Operations Team (MD-LOT)[i] in September 2022 (Volume 7, Appendix 2: Offshore Scoping Report). The resulting Scoping Opinion was received in January 2023 (Volume 7, Appendix 3: Offshore Scoping Opinion). The DE has since been reviewed, updated and further refined in accordance with the outcome of this Scoping Opinion, as well as taking into consideration more site-specific information that is now available from environmental, engineering and technical surveys, modelling outputs and subsequent project-level discussions with the relevant stakeholders.

3.1.2.3 According to the Scottish Government's Planning Advice Note on Environmental Impact Assessments (Scottish Government, 2013[1]), it is recognised that some aspects of a final project require a degree of flexibility to address uncertainties due to the changing nature of proposed developments and evolving technology (Scottish Government, 2013[11]). Reasons for the requirement for flexibility should be clearly explained and assessments should be undertaken on the parameters likely to result in the maximum adverse effect (i.e., the realistic worst-case scenario).

3.1.2.4 The key areas of the DE that require flexibility include:

- WTG technology - Having flexibility in certain WTG parameters, such as maximum blade tip height, means the project can benefit from the latest commercially viable technology at the time of construction, noting the extended period between submission of an application, receiving consent and commencing construction works;
- Foundation(s) - Similar to WTG technology, foundation technology is constantly evolving, and having flexibility in foundation choice gives the Applicant access to the most up-to-date technology at the time of construction. This includes the potential use of bottom-fixed and floating

[i] In 2023, Marine Scotland was renamed Marine Directorate, and thus the marine licensing and consents team is now referred to as Marine Directorate Licensing Operations Team (MD-LOT).

foundation types, for which final decisions will also be informed by site-specific surveys (e.g., geotechnical surveys and structural design);

- Array layout - Retaining flexibility with array layout is desirable, as certain aspects of the Proposed Development (Offshore), such as WTG rating, foundation type and spacing, will not be determined until post-consent following further project-specific surveys and detailed engineering. Where indicative (realistic) layouts have been required to inform assessments, these have been prepared to consider worst-case scenarios for specific impact pathways or receptors;
- Construction programme - Construction of the Proposed Development (Offshore) will be influenced by timings of consent award and final investment decision, availability of connection capacity to the National Electricity Transmission System (NETS), availability of supply chain, contractors and vessels, and subject to weather conditions, among other logistical factors;
- Site preparation - The requirement for site preparation works, such as debris and boulder removal, dredging and seabed levelling and unexploded ordnance (UXO) clearance, will be informed by detailed pre-construction site investigation which would be undertaken post-consent; and
- Vessel requirements - The vessel numbers and types required will be influenced by the final design of the Proposed Development (Offshore), and subject to availability. It is also noted that, at the time of writing, the Applicant has not determined the location of construction and O&M base(s) to support the Proposed Development (Offshore).

3.1.2.5 The DE approach has been adopted in accordance with the Scottish Government Guidance for applicants on using the design envelope for applications under Section 36 of the Electricity Act 1989, prepared by the Energy Consents Unit and Marine Scotland (Scottish Government, 2022a[2]).

3.1.3 Location, Site Information and Summary Details

3.1.3.1 The location of the Caledonia OWF (Caledonia North and Caledonia South) is shown in Figure 3–2 and Figure 3–3. The Array Area[ii] is located within the NE4 Option Agreement Area, approximately 429 kilometres squared (km^2) in size, identified in the Scottish Government's Sectoral Marine Plan for Offshore Wind Energy (Scottish Government, 2020[3]) and awarded to the Applicant through the ScotWind Leasing process.

3.1.3.2 The Proposed Development (Offshore) is located in the Moray Firth in the North Sea. The northern limit of the site is approximately 22km off the coast of Wick, Highland and the southern limit of the site is approximately 38km off

[ii] The area of the Proposed Development (Offshore) within the Moray Firth in which the Wind Turbine Generators (WTGs), inter-array/interconnector cables and Offshore Substation Platforms (OSPs) would be located.

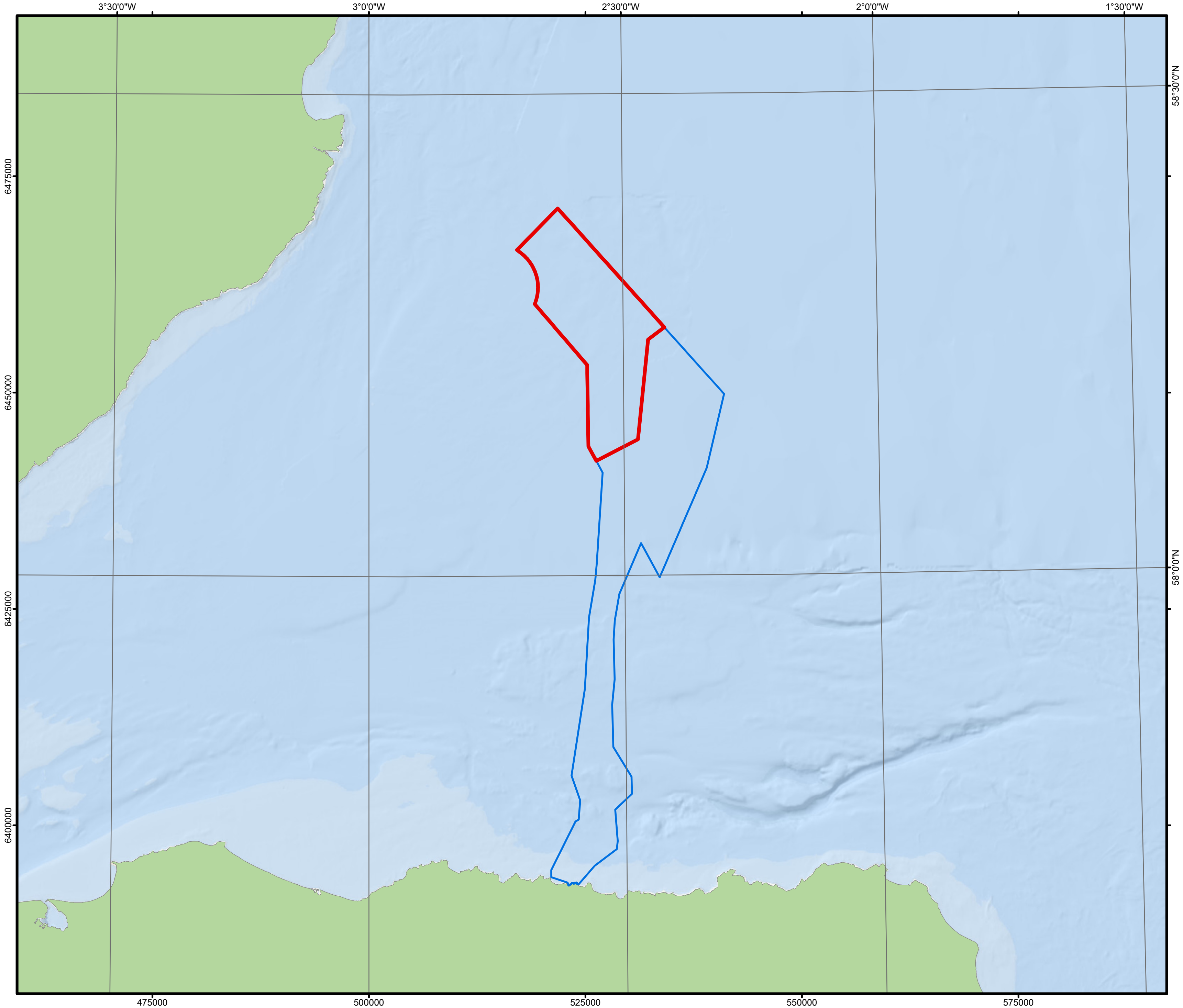
the coast of Banff, Aberdeenshire. The lifespan of the Proposed Development (Offshore) is anticipated to be 35 years. The depth range of the Array Area is approximately 39-88m relative to lowest astronomical tide (LAT).

3.1.3.3 The Proposed Development (Offshore) will incorporate various offshore infrastructure within the Array Area and Offshore Export Cable Corridor (OECC) between the Array Area and preferred Landfall Site. The boundary of the Proposed Development (Offshore) is presented within Figure 3–2 and includes the Array Area, OECC and Landfall Site. The Proposed Development also comprises the onshore component above Mean Low Water Spring (MLWS), referred to as the Proposed Development (Onshore), which includes the onshore transmission infrastructure (OnTI) that facilitates connection of the Caledonia OWF to the National Electricity Transmission System (NETS). Details relating to the OnTI and connection to the NETS are provided in Volume 1, Chapter 4: Proposed Development Description (Onshore).

3.1.3.4 The Caledonia Site has been divided into two development sites: Caledonia North and Caledonia South. These sites will be the location for the Caledonia North and Caledonia South developments. The shallower Caledonia North is proposed to contain bottom-fixed WTG technology only, while the relatively deeper Caledonia South is proposed to contain either bottom-fixed WTG technology only, or a combination of bottom-fixed and floating WTG technology. The total Array Area footprint is approximately 423km^2, which comprises Caledonia North with a footprint of approximately 218.5km^2 and Caledonia South with a footprint of approximately 204.5km^2 (Figure 3–2). It is noted that this reflects a slight reduction in total size of the Array Area compared to the original NE4 Plan Option; refer to Volume 1, Chapter 6: Site Selection and Alternatives for further information.

3.1.3.5 The Caledonia North OECC covers the area within which the Caledonia North Offshore Export Cables are installed, extending southward from the Caledonia North Site, through the Caledonia Site and to the Landfall Site at Stake Ness, with a total footprint of approximately of 390.8km^2 (Figure 3–2). The Caledonia South OECC covers the area within which the Caledonia South Offshore Export Cables are installed, extending southward from the Caledonia South Site to the Landfall Site at Stake Ness, with a total footprint of approximately 221.3km^2 (Figure 3–3). The exact route of the offshore export cables within the OECCs will be determined at a later stage through a route optioneering appraisal once a full post-consent site investigation campaign has been completed. This will determine the preferred route in terms of environmental and technical considerations, alongside consideration of consultation feedback.

3.1.3.6 There are a number of protected areas in the vicinity of the Proposed Development (Offshore). There is a direct overlap between the OECC and the Southern Trench nature conservation Marine Protected Area (MPA), which has been designated for the protection of minke whales, a number of habitats including burrowed mud, fronts and shelf deeps, and several geological features such as moraines and sub-glacial tunnel valleys. The Proposed Development (Offshore) is also located in the vicinity of the Moray Firth Special Area of Conservation (SAC) (approximately 55km), the Moray Firth Special Protection Area (SPA) (approximately 30 kilometres (km)), the East Caithness Cliffs SPA (approximately 20km), the Troup, Pennan and Lion's Head SPA (approximately 30km) and the North Caithness Cliffs SPA (approximately 30km). Further details about designed sites of relevance to the Proposed Development (Offshore) is available within Application Document 13: Habitat's Regulations Appraisal: Report to Inform Appropriate Assessment.



Caledonia North Site

Caledonia North Offshore Export Cable Corridor

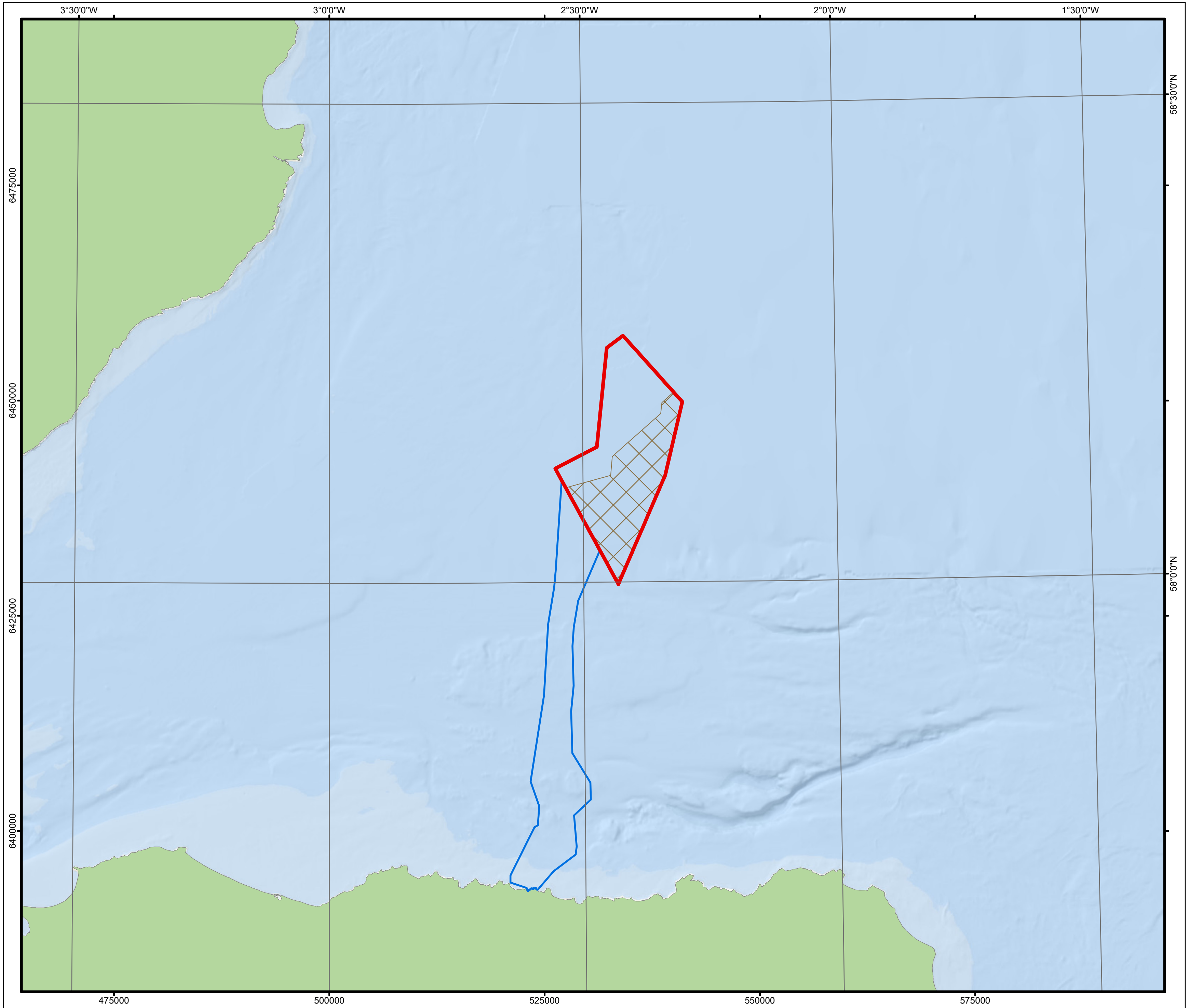
0 5 10 15 20 km

REV	DATE	DOC STATUS	ORIGIN	REVIEW	APP
01	09/09/2024	Approved	EV	BB	DH

CALEDONIA Offshore Wind Farm

GoBe APEM Group

CONTRACTOR DRAWING NO UKCAL1_GO_WNF_GEN_MAP_00324	CONTRACTOR REV 01
GEODETIC PARAMETERS WGS 84 / UTM zone 30N (EPSG: 32630)	
DRAWING TITLE Figure 3-2: Location of Caledonia North, including the Caledonia North Site and the Caledonia North Offshore Export Cable Corridor (OECC)	
STATUS Approved	SCALE 1:600,000
DRAWING NUMBER N/A	SHEET NO 01 of 01 / REV N/A



Caledonia South Site

Caledonia South Offshore Export Cable Corridor

Area suitable for Floating WTG

0 5 10 15 20 km

REV	DATE	DOC STATUS	ORIGIN	REVIEW	APP
01	09/09/2024	Approved	EV	BB	DH

CALEDONIA Offshore Wind Farm

GoBe APEM Group

CONTRACTOR DRAWING NO: UKCAL1_GO_WNF_GEN_MAP_00325	CONTRACTOR REV: 01
GEODETIC PARAMETERS: WGS 84 / UTM zone 30N (EPSG: 32630)	

DRAWING TITLE

Figure 3-3: Location of Caledonia South, including the Caledonia South Site and the Caledonia South Offshore Export Cable Corridor (OECC)

STATUS: Approved	SCALE: 1:600,000	
DRAWING NUMBER: N/A	SHEET NO: 01 of 01	REV: N/A

3.1.4 Phased Approach

3.1.4.1 The Applicant is seeking to deliver electricity to the NETS from 2030. Due to the volume of NETS reinforcement works required to connect offshore wind projects, the Applicant is expecting the Proposed Development to be connected to the NETS in phases. To support with the deliverability of these phases, the Applicant is submitting two offshore consent applications (Section 36 and associated Marine Licences) for the Proposed Development (Offshore) and two Marine Licences for the OfTI assets.

3.1.4.2 The division of the Caledonia Site into two discrete application areas allows for flexibility to phase the build out of the application areas in either order. The DE and EIA consider concurrent and sequential/phased build scenarios, such that Caledonia North or Caledonia South may be constructed and connected to the NETS in either order. Therefore, this EIAR considers the scenarios within Volume 1, Chapter 5: Proposed Development Phasing. The numbers of WTGs in Caledonia North and Caledonia South are dependent on which phase will be constructed first. If constructed first, the number of WTGs in Caledonia North will not exceed 77. If Caledonia South is constructed first, the number of WTGs in Caledonia South will not exceed 78. In all instances, the number of WTGs in the following phase will be such that the total number of WTGs across the Proposed Development (Offshore) will not exceed 140. Within the Caledonia OWF assessment, the split (of infrastructure between Caledonia North and Caledonia South) is assessed on a chapter-by-chapter basis to ensure the realistic worst-case assessment assumes highest magnitude of impact from offshore wind infrastructure is located in the area of the site that is most sensitive for that receptor. Within individual assessments (Caledonia North and Caledonia South) the same approach is followed to ensure the worst-case assessment is considered for each of the chapters. This includes consideration of whether potentially fewer, but larger WTGs are installed, or a greater number of smaller WTGs are installed, which could vary between assessments.

3.1.4.3 The uncertainty around timing of the phases for connecting the Proposed Development to the NETS has implications on the assessment of impacts from construction. Within the assessment, it has been necessary to account for the following scenarios and assumptions in relation to phasing:

- Sequential Construction – Phases 1 and 2 would be built one after another. Construction of phase 2 could commence immediately after phase 1 or later, subject to the dates confirmed for connection to the NETS. This would create a ‘gap’ in construction which could extend up to five years following the completion of Phase 1 construction; and
- Concurrent Construction – Both phases constructed at the same time, for example due to circumstances where there was a delay in delivery to grid infrastructure pre-2030.

3.1.4.4 Further details about the potential phased approach to construction of the Proposed Development (Offshore) are provided in Volume 1, Chapter 5: Proposed Development Phasing.

3.1.5 Summary of Key Components and Design Parameters

3.1.5.1 The Proposed Development (Offshore) is comprised of the Array Area, the OECC and the Landfall Site (Figure 3–2). This chapter will further discuss these components and their design parameters, with an outline description provided in Table 3–1. This includes information specific to the Caledonia North and Caledonia South application areas, as well as the overall Caledonia Project.

Table 3–1: Outline description of the Proposed Development (Offshore).

Design Parameters	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
WTG foundation type	-	Bottom-fixed	Bottom-fixed; Bottom-fixed and floating	Bottom-fixed; Bottom-fixed and Floating
Maximum number of WTGs)	-	77	78	140*
WTG foundation technology composition – Bottom-fixed	-	Up to 77	Up to 78 (bottom-fixed only; assumes no floating component)	Up to 140 (bottom-fixed only; assumes no floating component)
WTG foundation technology composition – Floating		Not applicable (no floating component)	Up to 39 (assumes remaining composition bottom-fixed up to a combined total of 78)	Up to 39 (assumes remaining composition bottom-fixed up to a combined total of 140)
Number of OSPs	-	2	2	4
OSP foundation type	-	Bottom-fixed	Bottom-fixed	Bottom-fixed
Transmission system	-	High Voltage Alternating Current (HVAC)	HVAC	HVAC
Number of interconnector cables	-	1	1	2
Maximum length of interconnector cables	km	30	30	60

Design Parameters	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum number of inter-array cables	-	77	78	140
Maximum length of inter-array cables (total)	km	360	365 for bottom-fixed foundations; up to 182.5 for floating foundations (assumes combined with bottom-fixed foundations up to a total of 365)	655 for bottom-fixed foundations; up to 182.5 for floating foundations (assumes combined with bottom-fixed foundations up to a total of 655)
Number of export cables	-	2	2	4
Maximum length of export cables (total)	km	180	150	330
Refer to paragraph 3.1.4.2 for further details explaining the maximum number of WTGs for Caledonia North and Caledonia South, as well as maximum number of WTGs for the Proposed Development (Offshore) noting this is less than the sum of the maximum number of WTGs for Caledonia North and Caledonia South.				

3.2 Offshore Infrastructure

3.2.1 Wind Turbine Generators (WTGs)

3.2.1.1 The Proposed Development (Offshore) will comprise up to 140 WTGs, each converting wind energy to electricity. A range of WTG models will be considered for the Proposed Development (Offshore); however, they are all likely to follow the traditional WTG design with three blades and a horizontal rotor axis (Figure 3–4). The blades are connected to a central hub, forming a rotor which turns a shaft connected to a generator. The generator is located atop the WTG tower within a containing structure known as the nacelle. The nacelle is supported by the tower structure which is affixed to the foundation structure at its base (either bottom-fixed or floating; see Section 3.2.3). Each WTG will have a minimum clearance ("air gap") between sea level and the blade tip at the lowest point of the blade swept area.

3.2.1.2 As WTG technology is constantly evolving, the final model(s) of WTG to be used for the Proposed Development (Offshore) will be selected post-consent. The model selected will influence the number of WTG required, which will not exceed the maximum number included in the DE. Therefore, a range of WTG options and associated dimensions are being considered against which the environmental impacts have been assessed. The anticipated DE for WTGs, including relevant dimensions, is provided in Table 3–2. Details referring to bottom-fixed WTGs relates to Caledonia North and Caledonia South, while floating parameters are only applicable to Caledonia South (should this technology be used).

3.2.1.3 The WTG layout for the Proposed Development (Offshore) will be finalised post-consent, based on the minimum and maximum downwind and crosswind spacing set out in Table 3–2, while ensuring compliance with the requirements of Marine Guidance Note 654 (Maritime and Coastguard Agency (MCA), 2021). Where a layout is required to assess specific impact pathways for EIA topics, indicative worst-case layouts have been developed. The assumptions upon which these indicative worst-case layouts have been based are described in the respective EIAR chapters.

3.2.1.4 Typically, the WTG tower sections are pre-assembled onshore including any internal components. For bottom-fixed WTG installations, the completed tower structure is then transported vertically to the offshore site for installation onto the foundation (see Section 3.2.3). Offshore turbine installation is typically undertaken by jack-up vessels due to the need for a stable platform to perform offshore lifting operations and mating of components at height.

3.2.1.5 Three variations in the tower-nacelle-rotor installation process are considered:

- Tower installed onto foundation, followed by placement of the nacelle on the tower and lifting blades to mate with the hub, turning the rotor each time to repeat the same lift three times;
- Tower installed onto foundation, followed by placement of the nacelle on the tower and then pre-assembled rotor with blades (prepared in port) lifted in one piece to mate with the nacelle (single rotor lift); and
- Mounting the hub and two blades on the nacelle at port, before mounting the nacelle on the tower at the installation site and then lifting the final blade.

3.2.1.6 The first method is the industry preferred method and most likely scenario. The installation of a single turbine, including vessel positioning, is typically expected to take around 24 hours, depending on the location and weather conditions. It is anticipated that WTG installation (following foundation installation) will take 8-12 months each to complete for Caledonia North and Caledonia South.

3.2.1.7 For floating WTGs and substructures, these require pre-assembly at a construction marshalling port. The major turbine components are moved to the quayside and some pre-assembly work within the WTG is typically performed at this stage (e.g. installation of electrical equipment in the base of the turbine tower). The floating substructure is brought from wet storage to the quayside using harbour tugs. The major WTG components (i.e., tower, nacelle and blades) are then assembled onto the floating substructure in a process known as final assembly or WTG integration. The assembled floating

WTG is pre-commissioned at port to the greatest possible extent to reduce offshore commissioning work. This involves mechanical and electrical testing of the various subsystems. Typically, wet storage for the fully integrated WTG and substructure is then required prior to tow-out. This is in addition to the wet storage required for inbound floating substructures.

3.2.1.8 It should be noted that the assessment of wet storage has not been included within the scope of the EIAR and, therefore, the Applicant is not seeking consent for wet storage of WTGs as part of this application. However, it is recognised that such consent is likely to be necessary in the event that wet storage is required as part of the Proposed Development (Offshore), specifically in relation to Caledonia South. The Applicant will continue to liaise with MD-LOT on the assessment requirements and consenting regime for wet storage.

3.2.1.9 Once there is a suitable weather window, the fully integrated floating WTG and substructure assembly is towed from the construction port to the offshore site. The floating offshore wind turbine is hooked-up to a pre-installed mooring spread.

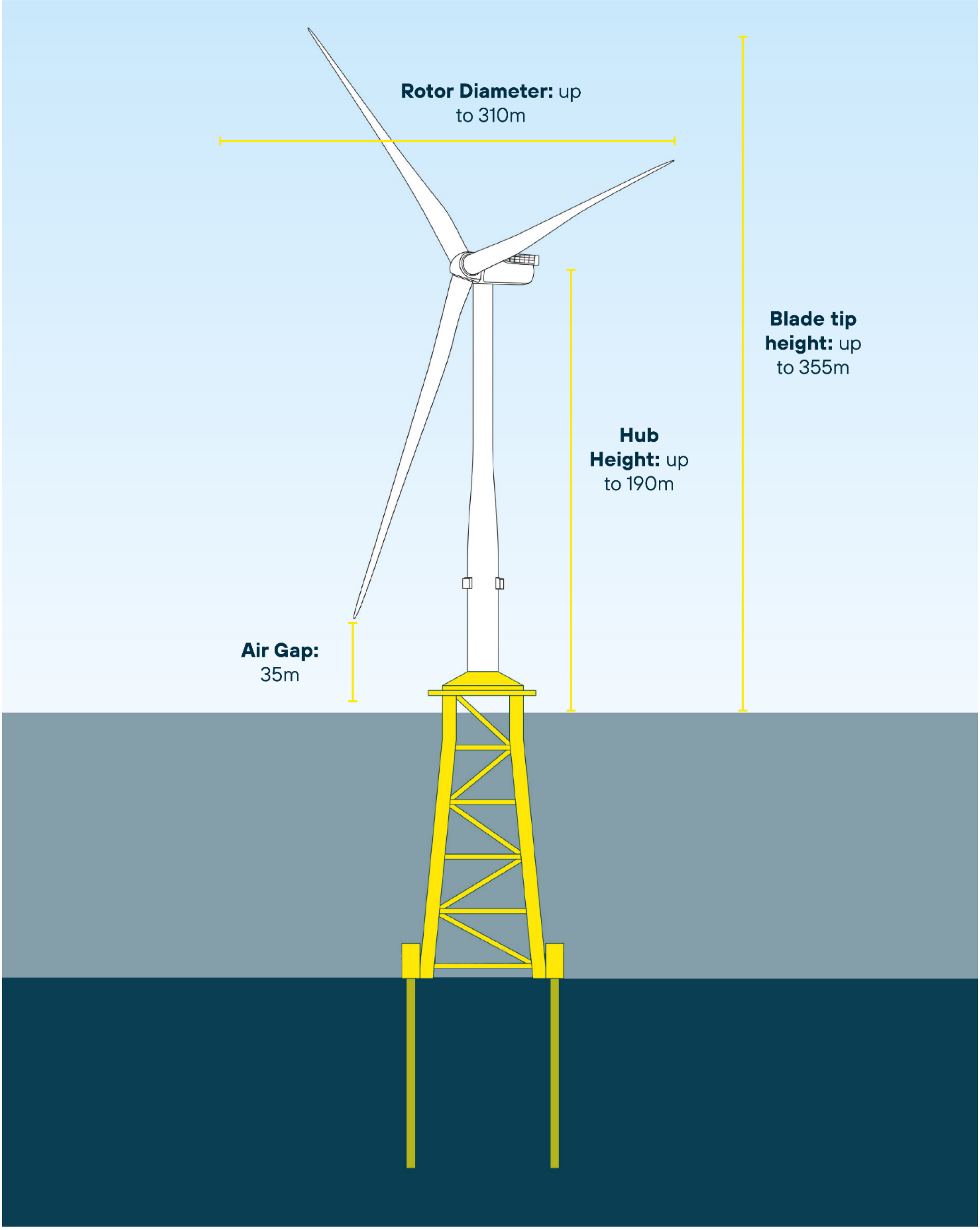


Figure 3–4: Indicative design of a WTG.

Table 3–2: WTG design envelope.

Design Parameters	Units	Design Envelope		
		Caledonia North	Caledonia South	
Foundation type	-	Bottom-fixed	Bottom-fixed	Floating
Maximum number of WTGs (note, up to 140 WTGs in total*; see Table 3–1)	-	77	78	39
Minimum blade tip height (air gap)	m above Mean Sea Level (MSL)	35	35	35
Maximum blade tip height	m above MSL	355	355	325
Maximum hub height	m above MSL	190	190	170
Maximum rotor diameter	m	310	310	290
Maximum blade length	m	151	151	140
Maximum swept area per turbine	m^2	75,500	75,500	66,000
Minimum downwind and crosswind spacing	m	944	944	944
Maximum downwind and crosswind spacing	m	1,860	1,860	1,740
Anticipated operational life	Years	35	35	35
Markings and lighting	The Proposed Development (Offshore) will be constructed to satisfy the requirements of the Civil Aviation Authority (CAA), MCA, and the Northern Lighthouse Board (NLB) in respect of marking and lighting specifications. Maritime navigational marking and lighting for the final layout design will be agreed post-consent with the NLB. As a minimum, lighting will comply with requirements of the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation O-117 or similar, and during operations will take into account any new guidance from the Navigation and Offshore Renewable Energy Liaison (NOREL) group.			

Design Parameters	Units	Design Envelope	
		Caledonia North	Caledonia South
Colour	The colour scheme for nacelles, blades and towers is generally RAL 7035 (light grey). Foundation steelwork is generally RAL 1023 (traffic light yellow) up to Highest Astronomical Tide (HAT) plus 15m or to Aids to Navigations, whichever is higher.		
* Refer to paragraph 3.1.4.2 for further details explaining the maximum number of WTGs for Caledonia North and Caledonia South, as well as maximum number of WTGs for the Proposed Development (Offshore) noting this is less than the sum of the maximum number of WTGs for Caledonia North and Caledonia South.			

3.2.2 Offshore Substation Platforms (OSPs)

3.2.2.1 A maximum of four HVAC OSPs will be required for the Proposed Development (Offshore). The OSPs will house electrical transmission equipment which transform electricity generated by the WTGs to a higher voltage and thereby allowing the power to be efficiently exported to the onshore NETS. The location of the OSPs is not yet determined, but consent is being sought for two of the OSPs to be located within Caledonia North and two within Caledonia South. The OSP consists of a ‘topside’ platform supported by a bottom-fixed foundation structure (see Section 3.2.3). The anticipated DE for the OSPs, including relevant dimensions, is provided in Table 3–3, with an indicative design shown in Figure 3–5.

Figure 3–5: Indicative design of an OSP (taken from Moray West OWF).

Table 3–3: OSP design envelope.

Design Parameters	Units	Design Envelope	
		Caledonia North	Caledonia South
Number of OSPs	-	2	2
Maximum length of topside	m	55	55
Maximum width of topside	m	45	45
Maximum height of topside	m	25	25
Maximum height at bottom of lower deck	m above MSL	30	30
Maximum height of OSP (highest point)	m above MSL	55	55

3.2.3 Foundations

Overview

3.2.3.1 The DE for WTG foundations includes bottom-fixed and floating technologies, while OSP foundations include bottom-fixed technologies only. The specific technology and makeup of the WTG and OSP foundations has not yet been selected, and the final technology selection will be driven by a series of environmental, technical and commercial variables, as technologies and methodologies continue to evolve. The design options being considered for the Proposed Development (Offshore) are provided in Table 3–4, with each foundation type discussed in terms of design and installation in the following sections.

Table 3–4: WTG foundation options.

Foundation		Design Envelope			
		WTG	OSP	Caledonia North	Caledonia South
Bottom-fixed	Jackets with pin piles	✓	✓	✓	✓
Bottom-fixed	Jackets with suction caissons	✓	✓	✓	✓
Bottom-fixed	Monopiles	✓	✓	✓	✓
Bottom-fixed	Fully-restrained platforms	✓	x	x	✓
Floating	Semi-submersible platforms	✓	x	x	✓
Floating	Tension leg platforms	✓	x	x	✓

Jacket with Pin Piles

3.2.3.2 Jacket with pin pile foundations are formed of a steel lattice construction comprising tubular steel members and welded joints, secured to the seabed by hollow steel pin piles connected to the jacket feet (Figure 3–6). There is typically no separate transition piece (TP) for WTGs, as the TP and ancillary structure are fabricated as an integral part of the jacket. The DE includes jackets with up to four legs, each with a single pin pile securing the foundation to the seabed, thus up to four pin piles per foundation.

3.2.3.3 A summary of the DE for jackets with pin piles is presented in Table 3–5, noting these details are applicable to the use of this foundation type within Caledonia North and Caledonia South.

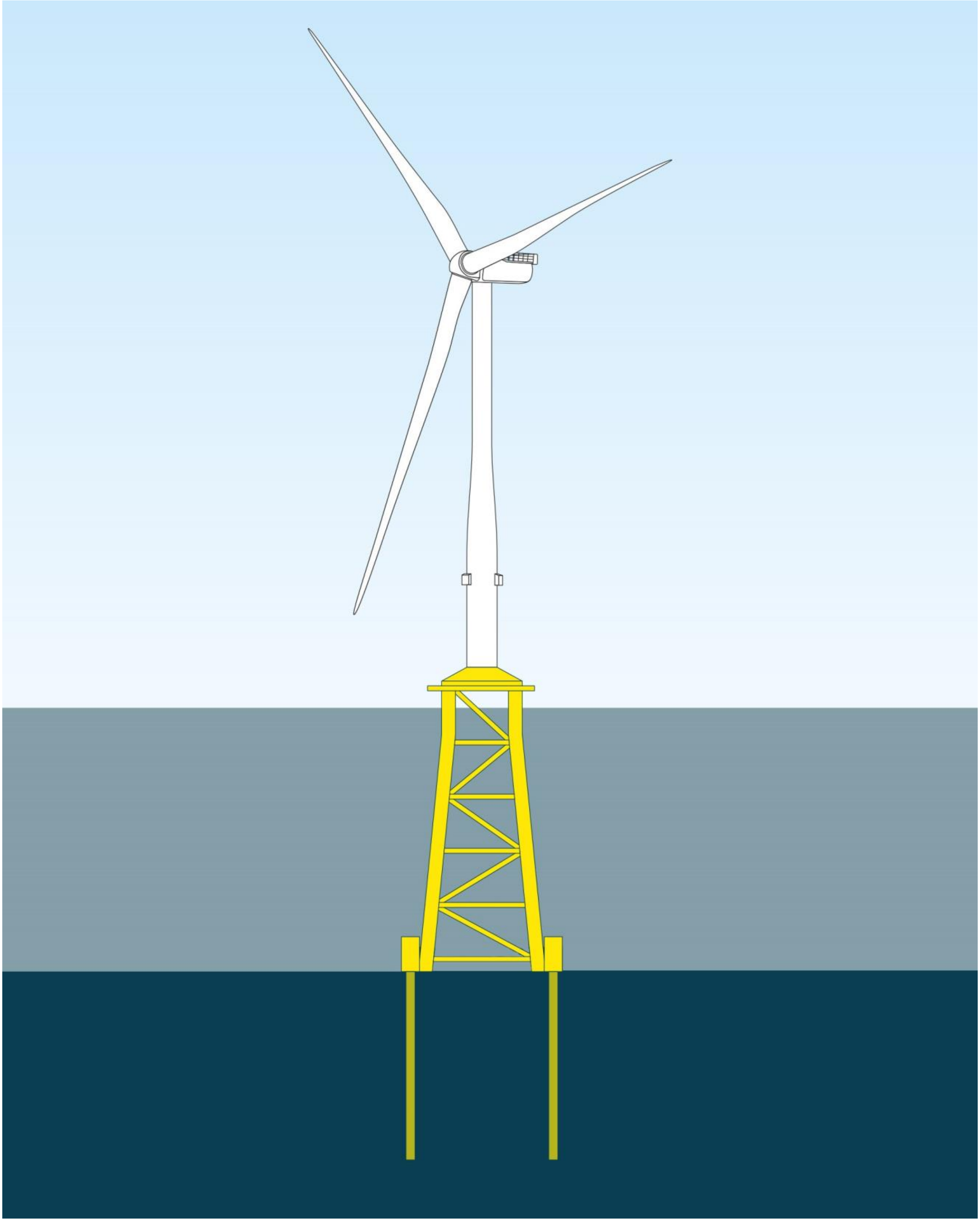


Figure 3–6: Indicative design of a jacket with pin piles WTG foundation.

Table 3–5: Jacket with pin piles design envelope.

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum number of jacket with pin piles foundations	-	77 (WTG), 2 (OSP)	78 (WTG), 2 (OSP)	140 (WTG)*, 4 (OSP)
Maximum number of legs per jacket	-	4	4	4
Maximum diameter of jacket legs	Metre (m)	4	4	4
Maximum number of pin piles per jacket	-	4	4	4
Maximum diameter of pin piles per jacket	m	4	4	4
Maximum jacket leg spacing at the seabed	m	40 at centre line; 44 including pin piles	40 at centre line; 44 including pin piles	40 at centre line; 44 including pin piles
Maximum seabed footprint (shadow) per jacket	Metre squared (m^2)	1,936	1,936	1,936
Maximum seabed footprint per jacket including scour protection	m^2	4,500	4,500	4,500
Maximum seabed footprint for all jacket foundations (including scour protection)	m^2	346,500 (WTG), 9,000 (OSP)	351,000 (WTG), 9,000 (OSP)	630,000 (WTG), 18,000 (OSP)
Maximum jacket leg spacing at surface	m	24 (LAT); 22.8 (HAT)	24 (LAT); 22.8 (HAT)	24 (LAT); 22.8 (HAT)
Maximum penetration depth per pin pile	m	80	80	80
Maximum hammer energy for pin piles	Kilojoules (kJ)	4,400	4,400	4,400
Maximum number of pin piles requiring drilling per jacket	-	4	4	4

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum spoil/drilled volume per jacket (assumes four pin piles)	Metre cubed (m^3)	6,032	6,032	6,032
Maximum spoil/drilled volume for all jacket foundations	m^3	464,464 (WTG), 12,064 (OSP)	470,496 (WTG), 12,064 (OSP)	844,480 (WTG), 24,128 (OSP)
* Refer to paragraph 3.1.4.2 for further details explaining the maximum number of WTGs for Caledonia North and Caledonia South, as well as maximum number of WTGs for the Proposed Development (Offshore) noting this is less than the sum of the maximum number of WTGs for Caledonia North and Caledonia South.				

Jacket with Suction Caissons

3.2.3.4 Jacket with suction caissons foundations are formed of a steel lattice construction comprising tubular steel members and welded joints, secured to the seabed by suction caissons (Figure 3–7). Suction caissons are steel cylindrical skirts which penetrate into the seabed and are held in place under the weight of the jacket and hydrostatic forces created as a result of hydraulically excavating the internal cavity of the steel cylindrical skirt.

3.2.3.5 There is typically no separate TP for WTGs, as the TP and ancillary structure are fabricated as an integral part of the jacket. The DE includes jackets with up to four legs, each with a single suction caisson securing the foundation to the seabed, thus up to four suction caissons per foundation.

3.2.3.6 A summary of the DE for jackets with suction caissons is presented in Table 3–6, noting these details are applicable to the use of this foundation type within Caledonia North and Caledonia South.

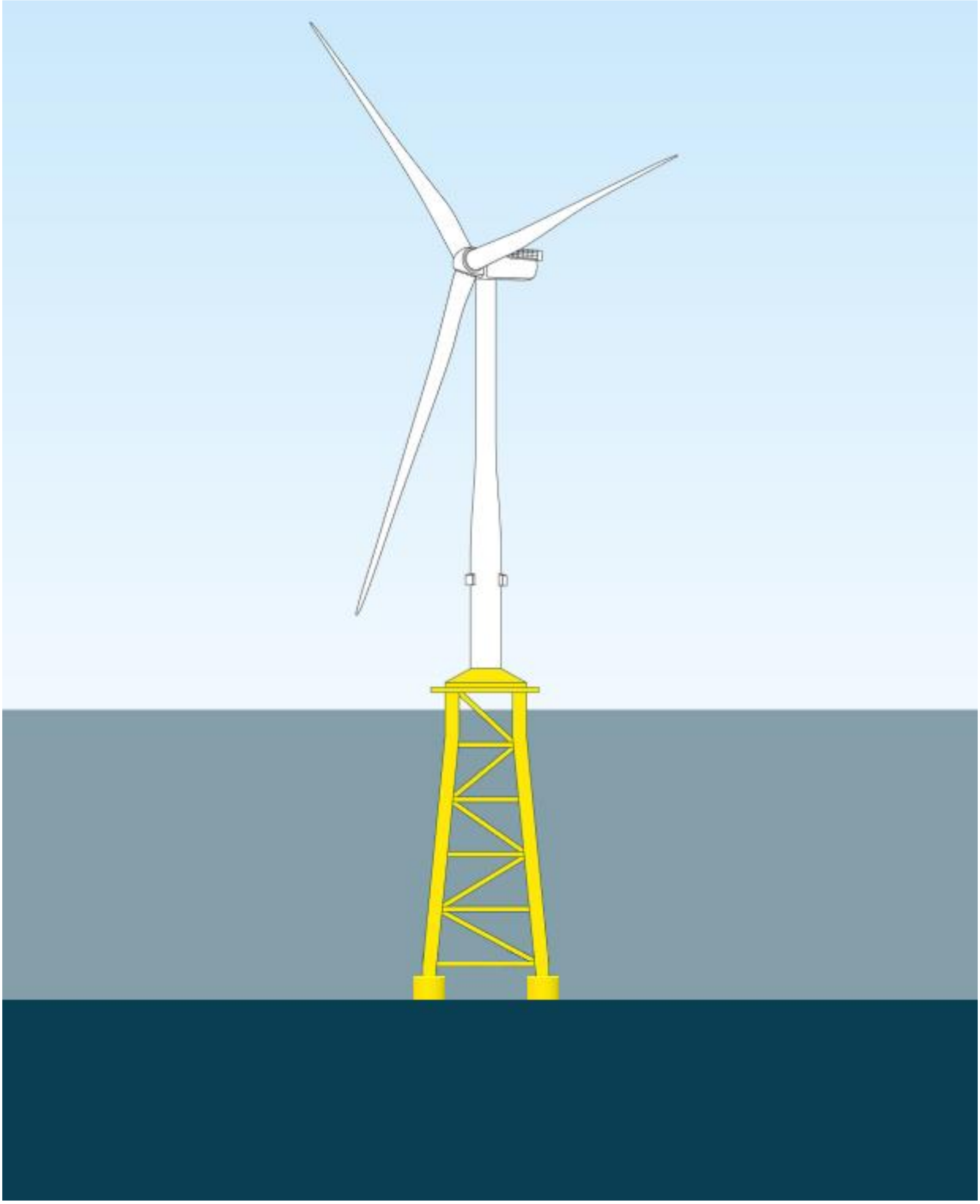


Figure 3–7: Indicative design of a jacket with suction caissons WTG foundation.

Table 3–6: Jacket with suction caissons design envelope.

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum number of jacket with suction caissons foundations	-	77 (WTG), 2 (OSP)	78 (WTG), 2 (OSP)	140 (WTG)*, 4 (OSP)
Maximum number of legs per jacket	-	4	4	4
Maximum diameter of jacket legs	m	5	5	5
Maximum number of suction caissons per jacket	-	4	4	4
Maximum diameter of suction caissons per jacket	m	15	15	15
Maximum jacket leg spacing at the seabed	m	40 at centre line; 55 including suction caissons	40 at centre line; 55 including suction caissons	40 at centre line; 55 including suction caissons
Maximum seabed footprint (shadow) per jacket	m^2	3,025	3,025	3,025
Maximum seabed footprint per jacket including scour protection	m^2	11,500	11,500	11,500
Maximum seabed footprint for all jacket foundations (including scour protection)	m^2	885,500 (WTG), 23,000 (OSP)	897,000 (WTG), 23,000 (OSP)	1,610,000 (WTG), 46,000 (OSP)
Maximum jacket leg spacing at surface	m	24 (LAT); 22.8 (HAT)	24 (LAT); 22.8 (HAT)	24 (LAT); 22.8 (HAT)
Maximum penetration depth of suction caissons	m	30	30	30

* Refer to paragraph 3.1.4.2 for further details explaining the maximum number of WTGs for Caledonia North and Caledonia South, as well as maximum number of WTGs for the Proposed Development (Offshore) noting this is less than the sum of the maximum number of WTGs for Caledonia North and Caledonia South.

Monopile

3.2.3.7 Monopiles are single tubular/cylindrical steel columns which penetrate the seabed (Figure 3–8). For WTGs, a tubular steel TP of similar diameter to the monopile is secured mechanically (e.g., bolted flange connection) or by a grouted interface (comprising an inert cement mix that is pumped into the anulus between the TP and the monopile), or by a hybrid connection. The TP typically includes integrated ancillary components, as well as providing the connection to the WTG tower.

3.2.3.8 A summary of the DE for monopiles is presented in Table 3–7, noting these details are applicable to the use of this foundation type within Caledonia North and Caledonia South.

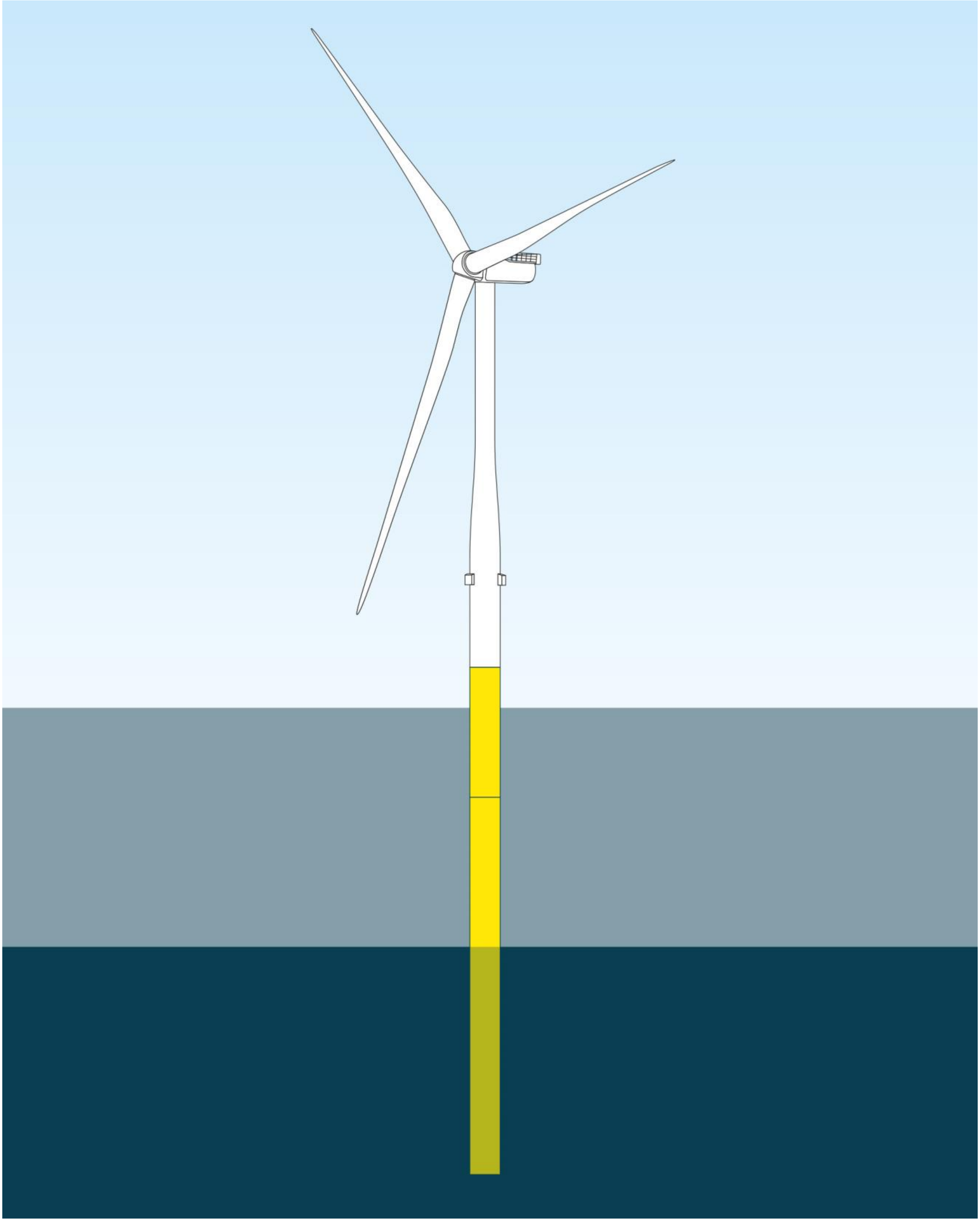


Figure 3–8: Indicative design of a monopile WTG foundation.

Table 3–7: Monopile design envelope.

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum number of monopile foundations	-	77 (WTG), 2 (OSP)	78 (WTG), 2 (OSP)	140 (WTG)*, 4 (OSP)
Maximum diameter of monopile foundations	m	14	14	14
Maximum seabed footprint per monopile	m^2	154	154	154
Maximum seabed footprint per monopile including scour protection	m^2	3,632	3,632	3,632
Maximum seabed footprint for all monopile foundations (including scour protection)	m^2	279,664 (WTG), 7,264 (OSP)	283,296 (WTG), 7,264 (OSP)	508,480 (WTG), 14,528 (OSP)
Maximum penetration depth per monopile	m	50	50	50
Maximum hammer energy for pin piles	kJ	6,600	6,600	6,600
Maximum spoil/drilled volume per monopile	m^3	11,546	11,546	11,546
Maximum spoil/drilled volume for all monopile foundations	m^3	889,042 (WTG), 23,092 (OSP)	900,588 (WTG), 23,092 (OSP)	1,616,440 (WTG), 46,184 (OSP)

* Refer to paragraph 3.1.4.2 for further details explaining the maximum number of WTGs for Caledonia North and Caledonia South, as well as maximum number of WTGs for the Proposed Development (Offshore) noting this is less than the sum of the maximum number of WTGs for Caledonia North and Caledonia South.

Fully Restrained Platform (FRP)

3.2.3.9 FRPs provide an innovative bottom-fixed foundation, summarised as a monopile with mooring lines and piled anchors, and a transition piece. A single tubular steel column penetrates the seabed and is secured to the WTG tower using either a mechanical steel transition piece or a grouted interface connection. As these monopiles would likely to be installed in deeper waters (compared to a traditional monopile), a taut mooring system is implemented using either piled anchors or suction piles in order to provide additional stability (Figure 3–9).

3.2.3.10 The Caledonia South application area includes areas of greater water depth (particularly towards the south/southeast) compared to Caledonia North, which could present constraints on traditional bottom-fixed WTG technology. As a result, FRPs are being considered as an additional type of bottom-fixed WTG foundation for the Proposed Development (Offshore), but only for installation within Caledonia South. It is noted that the concept combines characteristics of bottom-fixed and floating technologies. The mooring system consists of three driven piles as anchor, with two lines per anchor for redundancy, connected to a TP that could maintain the same design and connection method as for the classic monopile in shallower waters.

3.2.3.11 A summary of the DE for FRPs is presented in Table 3–8, noting these details are applicable to the use of this foundation type within Caledonia South only. It should also be noted that this foundation type would only be used for WTGs, and thus it would not be used to support OSPs.

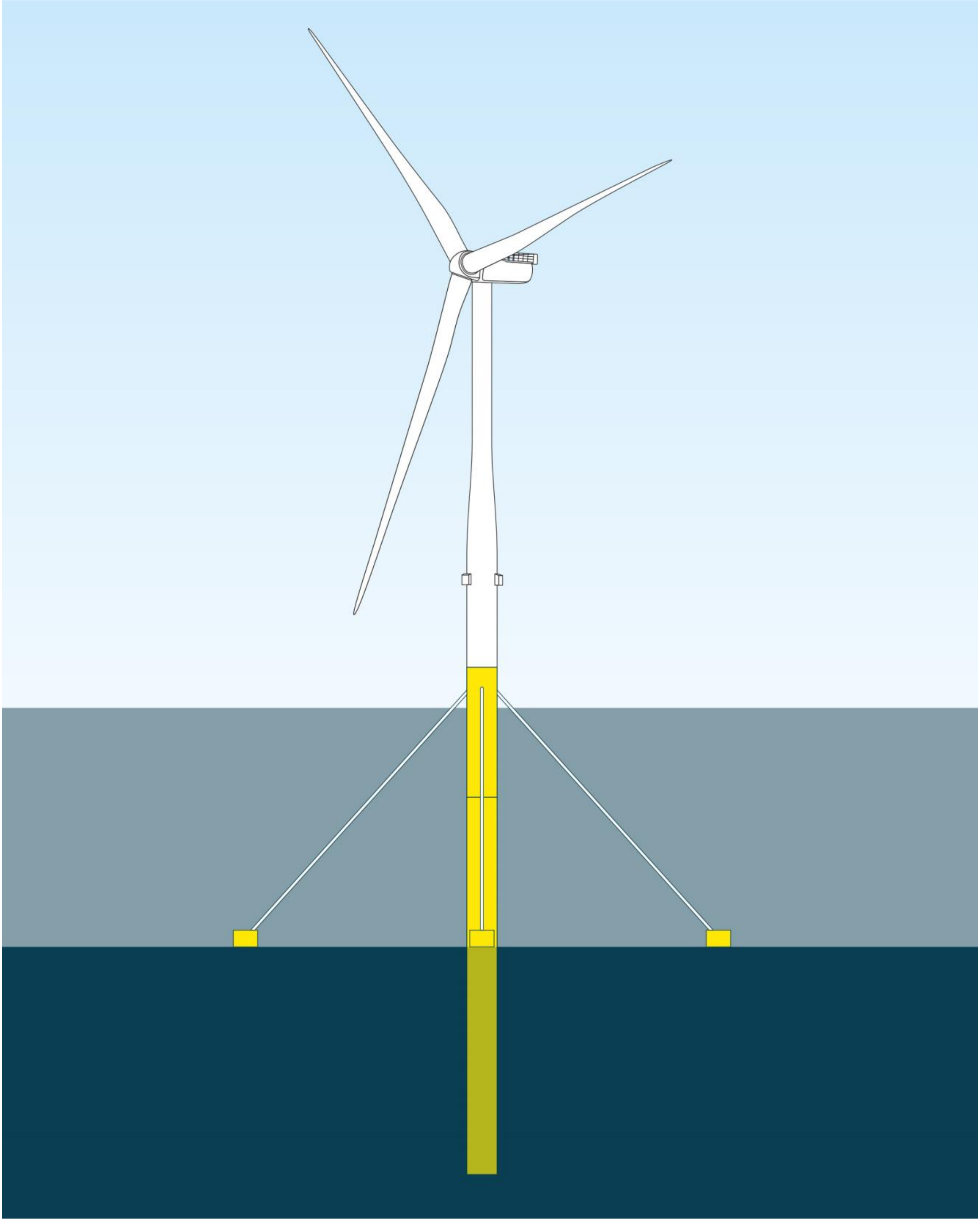


Figure 3–9: Indicative design of a fully restrained platform (FRP) WTG foundation.

Table 3–8: Fully restrained platform (FRP) design envelope.

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum number of FRP foundations	-	N/A	39 (WTG only)	39 (WTG only; used as part of Caledonia South)
Maximum diameter of FRP monopile foundations	m	N/A	14	14
Maximum seabed footprint per FRP monopile	m^2	N/A	154	154
Maximum penetration depth per FRP monopile	m	N/A	50	50
Maximum number of anchors per FRP	-	N/A	3	3
Maximum diameter of FRP anchor piles	m	N/A	4	4
Maximum anchor spread diameter per FRP	m	N/A	100	100
Anchor spread angle	°	N/A	45	45
Maximum seabed footprint per FRP monopile and anchors including scour protection	m^2	N/A	4,989	4,989
Maximum seabed footprint for all FRP monopile foundations and anchors (including scour protection)	m^2	N/A	194,571 (WTG only)	194,571 (WTG only; used as part of Caledonia South)
Maximum hammer energy for FRP monopiles	kJ	N/A	6,600	6,600
Maximum spoil/drilled volume per FRP monopile	m^3	N/A	9,237	9,237

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum spoil/drilled volume for all FRP monopile foundations	m^3	N/A	360,243 (WTG only)	360,243 (WTG only; used as part of Caledonia South)

Semi-submersible

3.2.3.12 The semi-submersible foundation is a potential floating concept for use for WTGs within Caledonia South. It is a three-column, steel semi-submersible with an eccentric tower arranged on one of the columns. The columns are interconnected at the lower end via pontoons and at the upper end via truss elements (Figure 3–10). The semi-submersible foundation retains its stability through buoyancy force, which is achieved through its large footprint and its geometric design, which assures the weight of the WTG is counter-balanced by an equivalent buoyancy force on opposite sides of the structure. The design considers a passive ballast (seawater) and station-keeping mooring system.

3.2.3.13 The anchor types that are being considered for the semi-submersible foundations include drag embedment anchors (DEAs) and piled anchors (noting piled anchors may be driven or drilled based on soil conditions). Generally, for semi-taut station keeping systems, DEAs are the preferred option when the soil profile allows. DEAs are suitable for the deep/intermediate rock profiles where full penetration is expected. In the shallow rock profile, DEAs are not possible; hence, driven piles are considered the most suitable option. In cases of upper bound (hard) chalk, drilled anchors with grouting may be used to install the mooring line anchors.

3.2.3.14 A summary of the DE for semi-submersibles is presented in Table 3–9, noting these details are applicable to the use of this foundation type within Caledonia South only. It should also be noted that this foundation type would only be used for WTGs, and it would not be used to support OSPs.

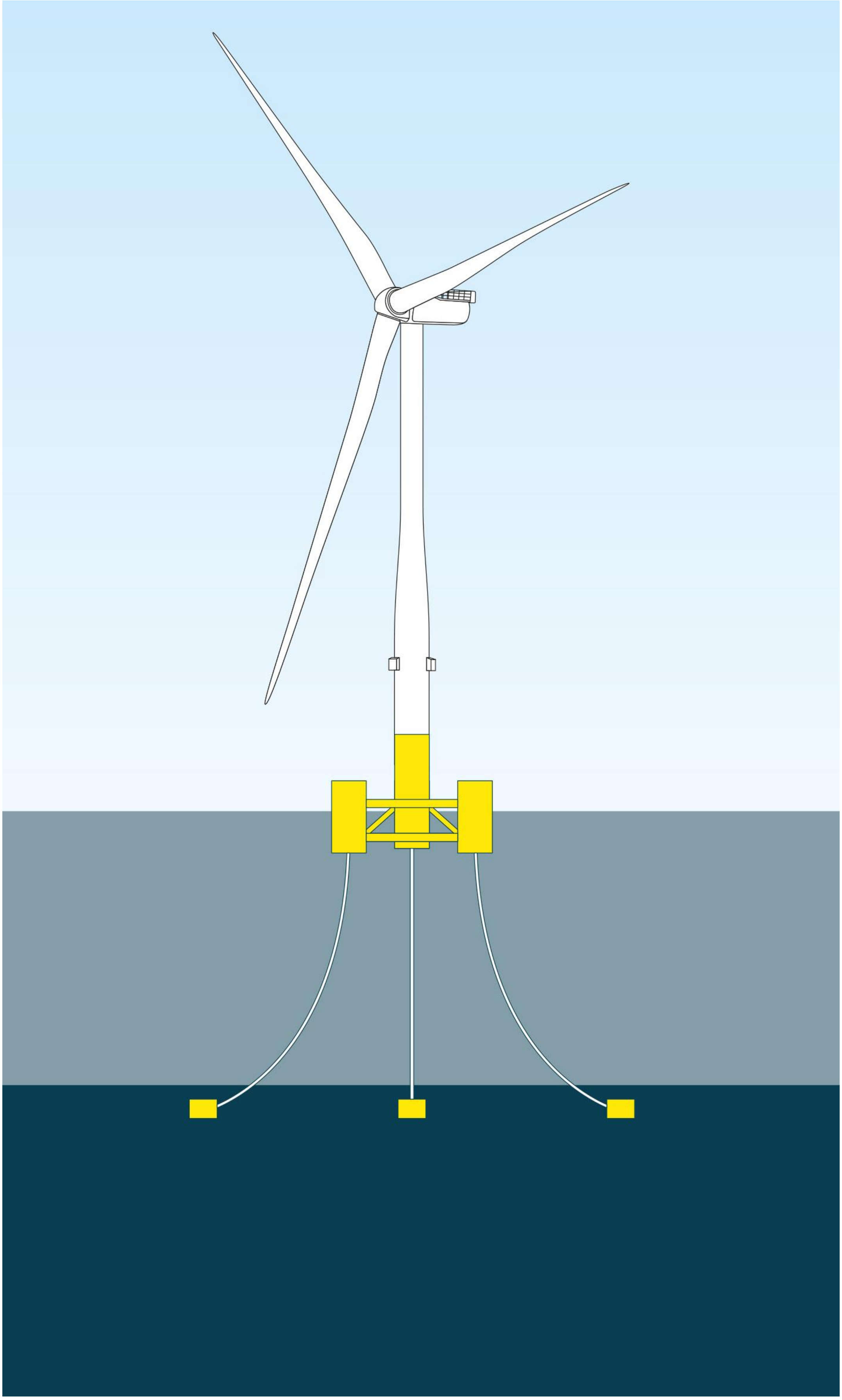


Figure 3–10: Indicative design of a semi-submersible WTG foundation.

Table 3–9: Semi-submersible design envelope.

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum number of semi-submersible foundations	-	N/A	39 (WTG only)	39 (WTG only; used as part of Caledonia South)
Maximum dimensions of floating semi-submersible structure per foundation	m	N/A	102 x 96.7m	102 x 96.7m
Maximum draught of floating semi-submersible foundation in water column	m	N/A	20	20
Number of legs per semi-submersible foundation	-	N/A	3	3
Maximum number of mooring lines per leg	-	N/A	2	2
Maximum number of mooring lines per semi-submersible foundation	-	N/A	6	6
Maximum number of anchors per semi-submersible foundation	-	N/A	6	6
Type of mooring spread	-	N/A	Semi-taut, catenary	Semi-taut, catenary
Maximum mooring radius per semi-submersible foundation	m	N/A	1,000	1,000
Maximum mooring line sweep area (catenary configuration)	m^2	N/A	45,000	45,000
Maximum seabed footprint per semi-	m^2	N/A	76	76

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
submersible foundation (anchors)				
Maximum seabed footprint per semi-submersible foundation and anchors including scour protection	m^2	N/A	679	679
Maximum seabed footprint for all semi-submersible foundations and anchors (including scour protection)	m^2	N/A	26,566 (WTG only)	26,566 (WTG only; used as part of Caledonia South)
Maximum penetration depth per anchor	m	N/A	40	40
Maximum diameter of anchor piles	m	N/A	4.8	4.8
Maximum hammer energy for anchor piles	kJ	N/A	2,000	2,000
Maximum spoil/drilled volume per anchor	m^3	N/A	214	214
Maximum spoil/drilled volume for all anchors	m^3	N/A	49,983 (WTG only)	49,983 (WTG only; used as part of Caledonia South)

Tension Leg Platform

3.2.3.15 The tension leg platform foundation is a potential floating concept for use for WTGs within Caledonia South. It is a three-armed, rectangular cross-section tension leg platform with a concentric tower on top of the central shaft. The central column with a conical section will be above the waterline. Vertical tendons (steel wire) will be connected on the sides of the arms securing the structure to the seabed (Figure 3–11). The tension leg platform is not self-stable, and thus no ballast involved, with the stability deriving from the tendons (mooring lines). Several anchor types are being considered for the tension leg platform foundations, including driven piles, drive-drill-drive, suction and drilled/grouted piles.

3.2.3.16 A summary of the DE for tension leg platforms is presented in Table 3–10 noting these details are applicable to the use of this foundation type within Caledonia South only. It should also be noted that this foundation type would only be used for WTGs, and it would not be used to support OSPs.

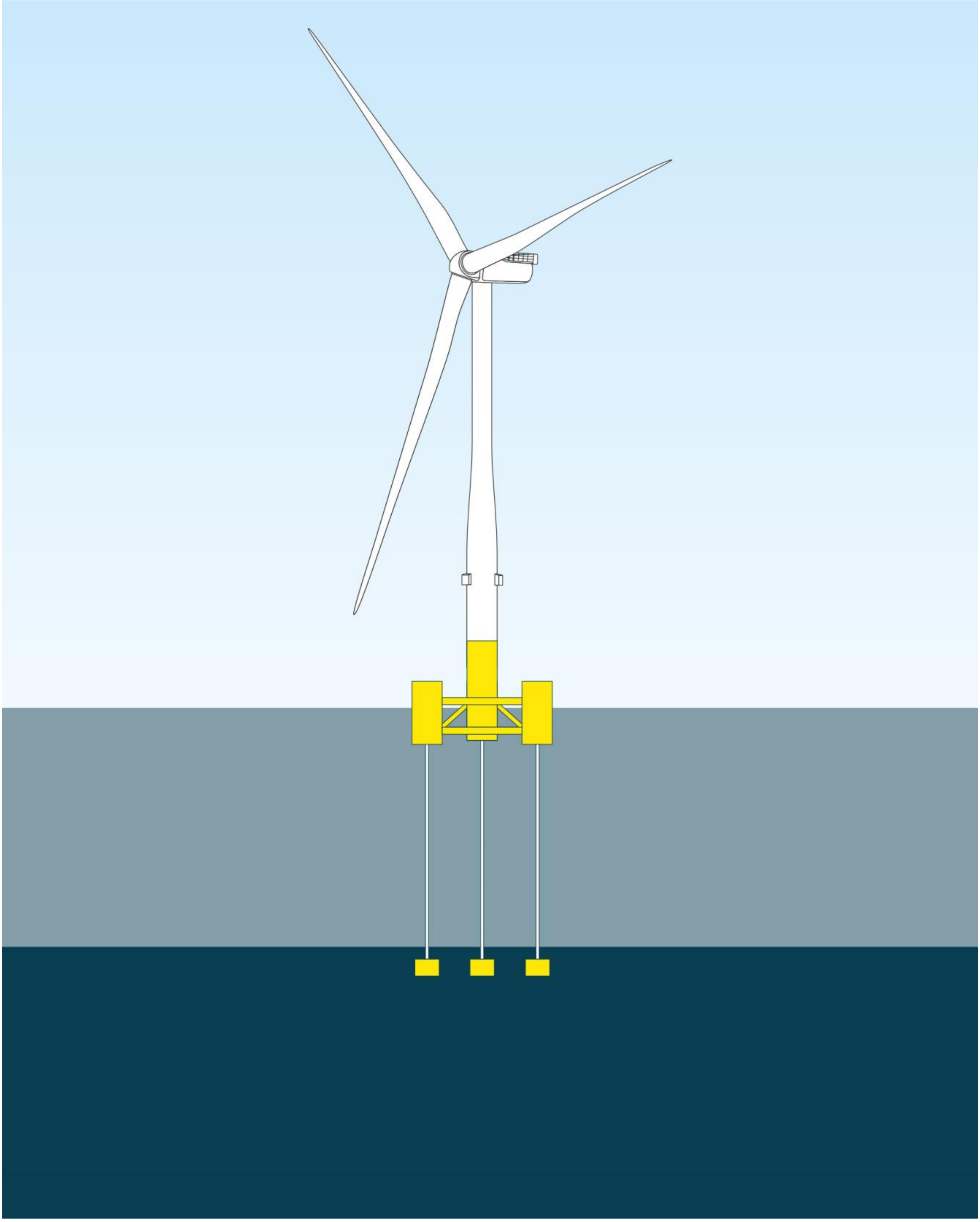


Figure 3–11: Indicative design of a tension leg platform WTG foundation.

Table 3–10: Tension leg platform design envelope.

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum number of tension leg platform foundations	-	N/A	39 (WTG only)	39 (WTG only; used as part of Caledonia South)
Maximum dimensions of floating tension leg platform structure per foundation	m	N/A	103 x 89	103 x 89
Maximum draught of floating tension leg platform foundation in water column	m	N/A	30	30
Number of arms per tension leg platform foundation	-	N/A	3	3
Maximum number of mooring lines (tendons) per arm	-	N/A	6	6
Maximum number of mooring lines per tension leg platform foundation	-	N/A	18	18
Maximum number of anchors per tension leg platform foundation	-	N/A	18	18
Type of mooring spread	-	N/A	Mooring tendons, taut system	Mooring tendons, taut system
Maximum mooring radius per tension leg platform foundation	m	N/A	56	56
Maximum seabed footprint per tension leg platform foundation (anchors)	m^2	N/A	326	326
Maximum seabed footprint per tension leg platform foundation and	m^2	N/A	2,933	2,933

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
anchors including scour protection				
Maximum seabed footprint for all tension leg platform foundations and anchors (including scour protection)	m^2	N/A	114,491 (WTG only)	114,491 (WTG only; used as part of Caledonia South)
Maximum penetration depth per anchor	m	N/A	55	55
Maximum diameter of anchor piles	m	N/A	4.8	4.8
Maximum hammer energy for anchor piles	kJ	N/A	2,000	2,000
Maximum spoil/drilled volume per anchor	m^3	N/A	339	339
Maximum spoil/drilled volume for all anchors	m^3	N/A	237,978 (WTG only)	237,978 (WTG only; used as part of Caledonia South)

3.2.4 Inter-array and Interconnector Cables

Inter-array Cables

3.2.4.1 Inter-array cables connect WTGs together, as well as strings of WTGs to OSPs. The inter-array cables will be multi-core HVAC cables, up to 230mm diameter (may vary depending on the voltage or material of the cable itself), with a maximum voltage of 132 kiloVolt (kV), and a fibre optic system (up to 48 fibres). The total length of inter-array cables will be up to a maximum of 360km for Caledonia North and 365km for Caledonia South.

3.2.4.2 A summary of the DE for inter-array cables is presented in Table 3–11, noting these details are applicable to the inter-array cables within Caledonia North and Caledonia South.

Table 3–11: Inter-array cable design envelope.

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum number of inter-array cables	-	77	78 (bottom-fixed foundations) 39 (floating foundation)	140 (up to 39 floating, assumes remaining composition bottom-fixed up to a combined total of 140*)
Maximum inter-array cable diameter	mm	230	230	230
Maximum voltage	kV	132	132	132
Inter-array cable arrangement/ specification and form	-	3 phase, HVAC, multi-core	3 phase, HVAC, multi-core	3 phase, HVAC, multi-core
Maximum inter-array cable length (total)	km	360	365 (bottom-fixed foundations); up to 182.5 (floating foundations; assumes remaining composition bottom-fixed up to a combined total of 365)	655 (bottom-fixed foundations); up to 182.5 (floating foundations; assumes remaining composition bottom-fixed up to a combined total of 655)
Inter-array cable installation methods	-	Jet trencher, mechanic trencher, cable plough	Jet trencher, mechanic trencher, cable plough	Jet trencher, mechanic trencher, cable plough
Maximum trench width (seabed)	m	2	2	2
Maximum affected width (seabed) from cable installation	m	15	15	15
Maximum total area of seabed	m^2	5,400,000	5,475,000	9,825,000

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
disturbance during installation per cable				
Target burial depth	m	1	1	1
Maximum burial depth	m	3	3	3
Cable protection methods	-	Rock placement, grout bags, iron cast, engineered Cable Protection System (CPS), concrete mattresses	Rock placement, grout bags, iron cast, engineered CPS, concrete mattresses	Rock placement, grout bags, iron cast, engineered CPS, concrete mattresses
Maximum length of cable where cable protection may be required	m	108,000	109,500	196,500
Maximum cable protection width per cable	m	20	20	20
Maximum inter-array cable protection footprint (total)	m^2	2,160,000	2,190,000	3,930,000
Maximum cable protection height per cable	m	1.5	1.5	1.5
Anticipated number of cable crossings	-	Anticipated up to ten per application area; to be determined following further site investigations and detailed design work. The final layout will seek to minimise cable lengths and the number of cable crossings		
Maximum cable crossing height	m	1.5	1.5	1.5
Maximum cable crossing length	m	150	150	150

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum cable crossing width	m	20	20	20
Cable touchdown radius for floating WTGs	m	N/A	200	200
Maximum length of floating cable per WTG	m	N/A	4,000	4,000
* Refer to paragraph 3.1.4.2 for further details explaining the maximum number of WTGs (and inter-array cables) for Caledonia North and Caledonia South, as well as maximum number of WTGs (and inter-array cables) for the Proposed Development (Offshore) noting this is less than the sum of the maximum number of WTGs (and inter-array cables) for Caledonia North and Caledonia South.				

Interconnector Cables

3.2.4.3 Interconnector cables may be installed to connect OSPs within the respective application areas to each other in order to improve the reliability of the electrical system (i.e., a single interconnector cable connecting the two OSPs within Caledonia North, and similarly for Caledonia South). The interconnector cables will be multi-core HVAC cables, up to 290mm diameter (may vary depending on the voltage or material of the cable itself), with a maximum voltage of 275kV, and a fibre optic system (up to 48 fibres). The length of each interconnector cable will be a minimum of 10km and a maximum of 30km. The length of interconnector cables required and routing will be dependent on the final OSPs locations and consideration of engineering and environmental factors following detailed site investigations. A summary of the DE for interconnector cables is presented inTable 3–12, noting these details are applicable to the interconnector cables within Caledonia North and Caledonia South.

Table 3–12: Interconnector cable design envelope.

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum number of interconnector cables	-	1	1	2
Maximum interconnector cable diameter	millimetre (mm)	290	290	290
Maximum voltage	kV	275	275	275
Interconnector cable arrangement/ specification and form	-	3 phase, HVAC, multi-core	3 phase, HVAC, multi-core	3 phase, HVAC, multi-core
Maximum interconnector cable length (total)	km	30	30	60
Interconnector cable installation methods	-	Jet trencher, mechanic trencher, cable plough	Jet trencher, mechanic trencher, cable plough	Jet trencher, mechanic trencher, cable plough
Maximum trench width (seabed)	m	2	2	2
Maximum affected width (seabed) from cable installation	m	15	15	15
Maximum total area of seabed disturbance during installation per cable	m^2	450,000	450,000	450,000
Target burial depth	m	1	1	1
Maximum burial depth	m	3	3	3
Cable protection methods	-	Rock placement, grout bags, iron cast, engineered CPS, concrete mattresses	Rock placement, grout bags, iron cast, engineered CPS, concrete mattresses	Rock placement, grout bags, iron cast, engineered CPS, concrete mattresses
Maximum length of cable where cable	m	9,000	9,000	18,000

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
protection may be required				
Maximum cable protection width per cable	m	20	20	20
Maximum interconnector cable protection footprint (total)	m^2	180,000	180,000	360,000
Maximum cable protection height per cable	m	1.5	1.5	1.5
Anticipated number of cable crossings	-	Anticipated up to two per application area; to be determined following further site investigations and detailed design work. The final layout will seek to minimise cable lengths and the number of cable crossings.		
Maximum cable crossing height	m	1.5	1.5	1.5
Maximum cable crossing length	m	150	150	150
Maximum cable crossing width	m	20	20	20

3.2.5 Offshore Export Cables

3.2.5.1 The offshore export cables will export energy from the OSPs to the interface with the onshore export cables at the transition joint bay at the Landfall Site. There will be up to four offshore export cables required for the Proposed Development (Offshore), with two connecting Caledonia North and two connecting Caledonia South. All offshore export cables will be located in separate trenches within the OECC, making landfall at Stake Ness on the Aberdeenshire coast via horizontal direction drilling (HDD; see Section 3.2.6).

3.2.5.2 The offshore export cables will be multi-core HVAC cables, up to 290mm diameter (may vary depending on the voltage or material of the cable itself), with a maximum voltage of 275kV, and a fibre optic system (up to 48 fibres). The length of individual offshore export cables required will be dependent on the final OSP locations and consideration of engineering and environmental factors following detailed site investigations. However, the total length of offshore export cables will be up to a maximum of 180km for Caledonia North and up to a maximum of 150km for Caledonia South.

3.2.5.3 The wet storage of export cables may be required during periods within the construction phase. The export cable will be laid from shore towards the Array Area where the OSP cable end will be left on the seabed within the vicinity of the OSP and protected until it can be collected by the Cable Lay Vessel (CLV) and pull-in to the OSP can take place.

3.2.5.4 The location of the wet-stored cable end will be agreed with MD-LOT in advance.

3.2.5.5 A summary of the DE for offshore export cables is presented in Table 3–13 noting these details are applicable to the offshore export cables from Caledonia North and Caledonia South. See Figure 3–2 and Figure 3–3 for spatial extents of the Caledonia North OECC and Caledonia South OECC, respectively.

Table 3–13: Offshore export cable design envelope

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum number of offshore export cables	-	2	2	4
Maximum offshore export cable diameter	mm	330	330	330
Maximum voltage	kV	275	275	275
Offshore export cable arrangement/ specification and form	-	3 phase, HVAC, multi-core	3 phase, HVAC, multi-core	3 phase, HVAC, multi-core
Maximum offshore export cable length (total)	km	180	150	330
Offshore export cable installation methods	-	Jet trencher, mechanic trencher, cable plough	Jet trencher, mechanic trencher, cable plough	Jet trencher, mechanic trencher, cable plough
Maximum trench width (seabed)	m	2	2	2
Maximum affected width (seabed) from cable installation	m	15	15	15

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Maximum total area of seabed disturbance during installation	m^2	2,700,000	2,250,000	4,950,000
Target burial depth	m	1	1	1
Maximum burial depth	m	3	3	3
Cable protection methods	-	Rock placement, grout bags, iron cast, engineered CPS, concrete mattresses	Rock placement, grout bags, iron cast, engineered CPS, concrete mattresses	Rock placement, grout bags, iron cast, engineered CPS, concrete mattresses
Maximum length of cable where cable protection may be required	km	90	75	165
Maximum cable protection width per cable	m	20	20	20
Maximum offshore export cable protection footprint (total)	m^2	1,800,000	1,500,000	3,300,000
Maximum cable protection height per cable	m	1.5	1.5	1.5
Anticipated number of cable crossings	-	Anticipated up to eight per application area; to be determined following further site investigations and detailed design work. The final layout will seek to minimise cable lengths and the number of cable crossings		
Maximum cable crossing height	m	1.5	1.5	1.5
Maximum cable crossing length	m	150	150	150
Maximum cable crossing width	m	20	20	20

3.2.7 Landfall Site

3.2.7.1 The offshore export cables will make landfall at Stake Ness on the Aberdeenshire coast, located to the west of Whitehills. The Landfall Site provides an interface between the offshore and onshore aspects of the Proposed Development. Refer to Volume 1, Chapter 4: Proposed Development Description (Onshore) for details pertaining to the onshore components and associated activities of the Proposed Development situated above MLWS.

3.2.7.2 It is anticipated that the four offshore export cables will be pulled-in through a conduit prepared by Horizontal Directional Drilling (HDD). This trenchless technique avoids interaction with surface features and is used to install ducts through which cables can be pulled. HDD involves drilling through the ground from an onshore HDD site compound to a point offshore beyond the intertidal area, ideally with sufficient water depth for the cable laying vessel (CLV) to access.

3.2.7.3 Given the extensive rocky habitat and exposed bedrock features at Stake Ness (see Volume 2, Chapter 4: Benthic Subtidal and Intertidal Ecology and Volume 7B Appendix 4-5: Caledonia Offshore Wind Farm Intertidal Survey Report), it was not considered feasible or realistic to include trenching techniques at landfall within the DE. Instead, it is anticipated that the HDD punch-out location will be situated within the shallow subtidal area (likely between 10m and 40m water depths). The DE includes up to four HDD pits, which will need to be excavated/dredged. It is not envisaged that cofferdams will be required at the HDD punch-out locations, and it is considered unlikely that access to the foreshore at Stake Ness will be required. This installation technique therefore presents the least disturbance in terms of public access / use as well as reducing any environmental impact (particularly to intertidal and subtidal habitats).

3.2.7.4 The HDD process uses a drilling head controlled from the rig to drill a pilot hole along a pre-determined profile to the HDD exit point. The pilot hole is then widened using sequentially larger drilling heads until the hole is wide enough to accommodate the cable ducts. Drilling mud, typically including a lubricant such as bentonite (a non-toxic, inert natural clay material), is pumped to the drilling head to stabilise the borehole, recover drill cuttings and ensure the borehole does not collapse. Once the drilling operation has taken place, the ducts are pulled through the drilled holes. Once the offshore export cables have been pulled through the ducts, the HDD exit pits will either be backfilled using side-cast material or left to naturally backfill.

3.2.7.5 A summary of the DE for Landfall Site is presented in Table 3–14, noting these details are applicable to the offshore export cables within Caledonia North and Caledonia South.

Table 3–14: Summary of the Landfall Site infrastructure design envelope

Design Parameter	Units	Design Envelope		
		Caledonia North	Caledonia South	Proposed Development (Offshore)
Landfall Site location	-	Stake Ness	Stake Ness	Stake Ness
Offshore export cable installation method at landfall	-	HDD	HDD	HDD
Number of HDD pits	-	2	2	4
Maximum HDD pit dimensions	m	15 x 6 x 1.2	15 x 6 x 1.2	15 x 6 x 1.2
Diameter of each HDD bore	mm	860 (for 630mm duct)	860 (for 630mm duct)	860 (for 630mm duct)
Maximum HDD length per offshore export cable	km	1.2	1.2	1.2
Volume of sediment released per HDD pit	m^3	47	47	47
Volume of drilling fluid released per HDD pit	m^3	450	450	450

3.3 Construction

3.3.1 Construction Activities and Programme

3.3.1.1 Indicative construction programmes summarising typical construction activities and their durations, for both Caledonia North and Caledonia South, is outlined in Figure 3–12 and Figure 3–13. This construction programme is a representation of works required to deliver Caledonia North or Caledonia South and is presented irrespective of anticipated grid connection dates. It is noted that this indicative construction programme includes the installation of floating foundations, but if this technology is not deployed, the construction programme may be slightly shorter.

Indicative Construction Activities for Caledonia North works	Estimated Duration (Months)	Year 1 Q1	Year 1 Q2	Year 1 Q3	Year 1 Q4	Year 2 Q1	Year 2 Q2	Year 2 Q3	Year 2 Q4	Year 3 Q1	Year 3 Q2	Year 3 Q3	Year 3 Q4
Seabed Preparation (boulders, UXO, PLGR, etc.)	12												
Install piling/anchors (e.g., monopiles or jacket pin piles)	9-18												
Install foundation substructures (bottom-fixed)	7-9												
Install OSPs	4-5												
Install inter-array cables	8												
Inter-array cable termination and testing	8-9												
Lay offshore export cables	6												
Install WTGs (bottom-fixed)	8-12												
Offshore export cable termination and testing	3												
Commission OSPs	6												
Commission WTGs	7-9												

Figure 3–12: Indicative programme for the construction of Caledonia North[iii].

[iii] Programme presents indicative durations and do not tie Applicant to a start date of the beginning of the calendar year.

		Year 1				Year 2				Year 3			
Indicative Construction Activities for Caledonia South works	**Estimated Duration (Months)**	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Seabed Preparation (boulders, UXO, PLGR, etc.)	12												
Install piling/anchors (e.g., monopiles, jacket pin piles or fully-restrained platforms)	9-18												
Install foundation substructures (bottom-fixed)	7-9												
Install foundation anchor (floating)	22												
Install OSPs	4-5												
Install inter-array cables	8												
Inter-array cable termination and testing	8-9												
Lay offshore export cables	6												
Install WTGs (bottom-fixed)	8-12												
Tow floating WTGs to offshore site and hook-up installation	10												
Offshore export cable termination and testing	3												
Commission OSPs	6												
Commission WTGs	7-9												

Figure 3–13: Indicative programme for the construction of Caledonia South[iv].

[iv] Programme presents indicative durations and do not tie Applicant to a start date of the beginning of the calendar year.

3.3.1.2 The key sequencing and approximate durations (per application area) of construction and commissioning activities for elements of Caledonia North and Caledonia South are provided in Table 3–15 and Table 3-16, respectively. It should be noted that some activities will temporally overlap, thus reducing the overall duration of the works. It is anticipated that construction works associated with the Proposed Development (Offshore) will take approximately 3-4 years to complete per application area. Given the uncertainty around grid availability, a potential gap between construction phases of up to five years has also been accounted for in the construction programmes.

3.3.1.3 Full details of potential scenarios and the anticipated timings of construction and commissioning activities of the Proposed Development (Offshore) are provided in Volume 1, Chapter 5: Proposed Development Phasing.

Table 3–15: Summary of key sequencing and approximate durations of construction and commissioning activities of Caledonia North.

Activity	Estimated Duration (Months)
Seabed preparation (e.g., boulder clearance, UXO, PLGR, etc.)	12
Install piling/anchors (e.g., monopiles or jacket pin piles)	9-18
Install foundation substructures (bottom-fixed)	7-9
Install OSPs	4-5
Install inter-array cables	8
Inter-array cable termination and testing	8-9
Lay offshore export cables	6
Install WTGs (bottom-fixed)	8-12
Offshore export cable termination and testing	3
Commission OSPs	6
Commission WTGs	7-9

Table 3-16: Summary of key sequencing and approximate durations of construction and commissioning activities of Caledonia South.

Activity	Estimated Duration (Months)
Seabed preparation (e.g., boulder clearance, UXO, PLGR, etc.)	12
Install piling/anchors (e.g., monopiles, jacket pin piles, or fully-restrained platforms)	9-18
Install foundation substructures (bottom-fixed)	7-9
Install foundation anchor (floating)	22
Install OSPs	4-5
Install inter-array cables	8-9

Activity	Estimated Duration (Months)
Inter-array cable termination and testing	8-9
Lay offshore export cables	6
Install WTGs (bottom-fixed)	8-12
Tow floating WTGs to offshore site and hook-up installation	10
Offshore export cable termination and testing	3
Commission OSPs	6
Commission WTGs	7-9

3.3.2 Site Preparation

3.3.2.1 A full post-consent survey campaign comprising detailed geophysical and geotechnical surveying will be commissioned in order to further inform the final project design. Following Final Investment Decision, the site will then be prepared for construction and the installation of WTGs, OSPs and cables. These site preparation works are expected to include the following:

- Dredging and seabed levelling (e.g., sandwave flattening using trailer suction hopper dredger (TSHD));
- Rock bag installation activities in case of opting for jack-up vessels (JUVs);
- Debris and boulder removal;
- UXO survey/intervention;
- Pre-installation surveys;
- Pre-lay grapnel run to remove out of use cabling, fishing nets, etc.; and
- Crossing preparations by laying rocks or concrete mats on top of third-party cables.

3.3.2.2 Specific studies will be completed to understand the risk of UXO across the Caledonia Site that shall determine if a specific survey is required to identify and remove any confirmed UXO targets. The method for removal/clearance shall be reviewed based on the type of target found and in consultation with a UXO disposal expert as to the safest method for reducing UXO risk to as low as reasonably practicable. Consent to undertake UXO survey and clearance activities will be sought via a separate Marine Licence application.

3.3.2.3 Remote operated vessels (ROVs) may be used to assist in the carrying out of seabed surveys prior to installation.

3.3.3 Installation

3.3.3.1 This section provides a brief summary of anticipated methodologies for the installation of foundations (bottom-fixed and floating) and offshore cables (inter-array, interconnector and export cables).

Bottom-fixed Foundations

Jacket with Pin Piles

3.3.3.2 Cylindrical steel pin piles are typically installed prior to the jacket structure. A piling template will be placed on the seabed to guide the pile locations. Drilling may be required where soil conditions do not allow for pile driving/vibro piling, and to ensure the required penetration depths are achieved. The jacket foundation will then be transported to the installation location and will be lifted with a crane by an installation vessel. The crane will then lower the foundation into the pin pile sockets. Where required, a high strength grout will be used to provide a strong connection between the pin piles and jacket structure. Drilling spoil is expected to be left *in-situ* adjacent to the foundation location. Post piling/drilling of pin piles once the jacket structure is in place at the installation location is also retained as an option within the DE. Post piling/drilling of pin piles once the jacket structure is in place at the installation location is also retained as an option within the DE.

Jacket with Suction Caissons

3.3.3.3 The foundation is transported to the installation location and lowered to the seafloor. When the caisson has reached the seafloor, a pipe running out of the caisson and up each leg pumps the water out of the steel cylindrical skirt. This creates a suction force that presses the caisson into the seabed. Once the required depth has been achieved, the pump is turned off and a high strength grout, concrete and/or appropriate filler is injected under the caisson to fill in the air gap, ensuring there is contact between the soil and the top of the caisson. Pile driving or drilling activities are not required for the installation of jackets with suction caissons; however, it should be noted that the selection of this type of foundations is highly dependent on suitable ground conditions.

Monopile

3.3.3.4 The monopile foundation is transported to the installation location, where it is lifted into a vertical position, lowered to the seabed and driven to the required depth. Drilling may be required where soil conditions do not allow for driving/vibro piling only, and to ensure the required penetration depths are achieved. If required, drilling is carried out before the monopile is lowered into the socket and a high-strength grout may be required to secure the monopile into the drilled socket. Drilling spoil is expected to be left *in-situ* adjacent to the foundation location.

Fully Restrained Platform (FRP)

3.3.3.5 The FRP concept is a novel approach to support the installation of bottom-fixed foundations in deeper water than traditional technologies. It is anticipated that the three anchor piles would first be installed and mooring lines pre-laid, followed by installation of the monopile and hook-up to moorings to complete the mooring arrangement. Anchoring methods could include piled anchors or suction piles. Drilling may be required where soil conditions do not allow for pile driving/vibro piling (not applicable to suction piles), and to ensure the required penetration depths are achieved. Mooring lines are then attached to the anchors, and pre-laid on the seabed. The monopile foundation will then be transported to the installation location, where it is lifted into a vertical position, lowered to the seabed and driven to the required depth (drilling may be required to ensure the required penetration depths of the monopile are achieved). A high-strength grout may be required to secure the monopile into the drilled socket. The pre-laid mooring lines will then be connected to the monopile to create taut mooring system. Drilling spoil is expected to be left *in-situ* adjacent to the foundation location.

Floating Foundations

Semi-submersible and Tension Leg Platform

3.3.3.6 In the case that the chosen WTG foundation includes floating technology within Caledonia South (i.e., semi-submersible or tension leg platform), the chosen anchors will be installed and mooring lines will be laid at the unit location, awaiting the arrival of the floating WTG structure. Depending on the soil condition and strength, drilling and grouting may be required. The mooring lines will be laid back on themselves to allow the platform to be positioned and secured prior to hook-up. The WTG units will be wet towed to the installation location from either the assembly port or a wet storage location by offshore tugs or anchor handling tugs, with the turbine already installed. Upon arrival of the platform on site, specialised vessels will perform the mooring hook-up procedure.

3.3.3.7 Anchoring methods for semi-submersible foundations could include DEAs, driven anchor piles or drilled/grouted piles, while for tension leg platform foundations this could include driven anchor piles, suction anchors or drilled/grouted piles. A piling template will be placed on the seabed to guide the anchor pile locations. DEAs are the preferred option for semi-taut station-keeping systems. Drilling may be required where soil conditions do not allow for pile driving (not applicable to suction piles), and to ensure the required penetration depths are achieved. Drilling spoil is expected to be left *in-situ* adjacent to the foundation location.

Scour Protection

3.3.3.8 Scour protection may be required to avoid the erosion (scour) of seabed around foundations due to the action of currents and waves. This could include the use of rock placement, concrete mattresses or frond mats. The spatial extent of scour protection is likely to vary per foundation type, as follows (with a height of up to 2m):

- Jacket with pin piles: up to 28m in diameter per isolated pin pile;
- Jacket with suction caissons: up to 72m in diameter per isolated suction caisson;
- Monopile: up to 68m in diameter per monopile;
- FRP: up to 68m in diameter per monopile and 12m in diameter per anchor pile;
- Semi-submersible: up to 12m in diameter per anchor pile; and
- Tension leg platform: one scour protection 'pancake' with an area of up to 600m^2 per set of anchors (6).

Inter-array, Interconnector and Offshore Export Cables

3.3.3.9 The installation methods for cables included within the DE are jet trenching, mechanic trenching and cable ploughing. The expected minimum target burial depth is 1m, with a maximum target burial depth of 3m; this will also be informed by a cable burial risk assessment (CBRA).

3.3.3.10 In instances where adequate burial cannot be achieved, an alternative cable protection will be deployed. The maximum volume of cable protection within the DE is conservative and will be refined following detailed surveys and a CBRA. The cable protection methods being considered include rock placement, grout bags, concrete mattresses, iron cast and an engineered Cable Protection System (CPS). It is noted that CPS is also typically installed at the end of the cables to protect them where they are in a free span zone between the substructure cable entry point and into burial. In this zone, the cables are affected by dynamic environmental loads (waves and current), and the CPS protects the cables from these loads and provides impact protection. It is also possible that cables will need to cross other infrastructure, including third parties (e.g., other subsea cables from operators such as telecommunications).

3.3.3.11 Given the potential deployment of floating WTG foundations within Caledonia South, further consideration has been included within the DE regarding the cable touchdown point on the seabed. There is estimated to be a 200m touchdown radius from the centre of the floating structure, where it is anticipated that inter-array cables will be buried between WTGs and OSPs. It is noted that inter-array cables connecting floating WTGs may also be suspended in intervals in the water column in a "wave-like" formation by buoyancy modules to reduce tension and to dissociate the motion of the WTG with the static section of the inter-array cable.

3.3.4 Construction Vessels

3.3.4.1 The number and type of vessels supporting offshore construction will be determined post-consent and will be informed by the final design of the Proposed Development (Offshore), Transport and Installation Strategies and the availability of vessels. The typical vessel types required for construction works associated with the installation of foundations, WTGs, OSPs and cables are set out in Table 3–17.

Table 3–17: Indicative vessel types to be used during the construction phase.

Vessel Type	Foundation (Bottom-fixed)				Foundation (Floating)		Topside		Offshore Cables		
	Jacket with Pin Piles	Jacket with Suction Caissons	Monopile	Fully Restrained Platform (FRP)	Semi-submersible	Tension Leg Platform	WTG	OSP	Inter-array Cables	Interconnector Cables	Offshore Export Cables
JUVs	x	x	x	x			x	x			x
Impact hammer and drilling rigs	x		x	x	x	x					
Heavy lift vessels (HLVs) or sheerleg	x	x	x	x							
Heavy transport vessels (HTVs), crane transport vessels and barges/tugs	x	x	x	x	x	x	x	x			
Feeder vessels depending on distance between marshalling port and site (includes transport of goods)	x	x	x	x	x	x					
Construction support vessels (CSVs)	x	x	x	x	x	x					

Vessel Type	Foundation (Bottom-fixed)				Foundation (Floating)		Topside		Offshore Cables		
	Jacket with Pin Piles	Jacket with Suction Caissons	Monopile	Fully Restrained Platform (FRP)	Semi-submersible	Tension Leg Platform	WTG	OSP	Inter-array Cables	Interconnector Cables	Offshore Export Cables
Boulder removal vessel	x	x	x	x	x	x	x	x	x	x	x
Survey vessels	x	x	x	x	x	x			x	x	x
Guard vessels	x	x	x	x	x	x	x	x	x	x	x
Crew transfer vessels (CTVs)	x	x	x	x	x	x	x	x	x	x	x
Scour protection installation vessels	x	x	x	x	x	x					
Platform supply vessels (PSVs)			x	x							
Vessels for anchor/mooring line installation				x	x	x					
ROVs	x	x	x	x	x	x	x	x	x	x	x
Vessel for hook-up between monopile and mooring lines					x	x					
Cable laying vessels (CLVs)									x	x	x
Trenching support vessels (TSVs)									x	x	x
Pre-lay grapnel run (PLGR) vessels									x	x	x
TSHD for sand dune clearance									x	x	x
UXO clearance vessels	x	x	x	x	x	x	x	x	x	x	x

Vessel Type	Foundation (Bottom-fixed)				Foundation (Floating)		Topside		Offshore Cables		
	Jacket with Pin Piles	Jacket with Suction Caissons	Monopile	Fully Restrained Platform (FRP)	Semi-submersible	Tension Leg Platform	WTG	OSP	Inter-array Cables	Interconnector Cables	Offshore Export Cables
Crossing preparation fall pipe vessels (FPVs)									x	x	x
Remedial protection vessels post laying FPV									x	x	x
Workboats to support shore pull-in											x
Small vessels to support short pull-in and HDD exit protection											x

3.3.4.2 A summary of indicative vessel movements over the total construction phase is presented in Table 3–18. Movements refer to the transit to and from the construction port and site (centre). A single vessel movement would equate to the transit between the construction port and site, and/or transits between asset locations in the Array Areas. These figures are indicative only and will vary dependant on the construction vessel utilised and the mobilisation strategy. Port area assumed to be within the Moray Firth.

3.3.4.3 It is not anticipated that there will be the need for helicopters to be used during the construction phase of the Proposed Development (Offshore).

Table 3–18: Indicative vessel movements over the duration of the construction phase.

Activity	Indicative Vessel Movements		
	Caledonia North	Caledonia South	Proposed Development (Offshore)
Foundation piling	154	156	280
Substructure	308	312	560
WTG installation	219	221	397
WTG commissioning	437	442	793
Array Area cables installation and hook up	798	807	1450
OSP installation (foundation, substructure and topside)	219	222	396
Export cables	65	65	116
Total	2200	2225	3992

3.3.5 Safety Zones

3.3.5.1 During the construction of the Proposed Development (Offshore), it is anticipated that 500m safety zones will be implemented around wind farm structures and/or OfTI during construction of the Proposed Development (Offshore). 50m safety zones will also apply to any partially constructed wind farm structures and/or OfTI up until the point of commissioning. A separate application for safety zones will be submitted prior to construction when further details are available on the construction strategy.

3.3.5.2 Marine control and vessel management will be provided by a dedicated marine coordination centre. Guard vessels will be deployed to monitor safety zones, in addition to overall marine traffic and inform vessels of construction activities within the Array Areas and OECC.

3.3.6 Waste Management

3.3.6.1 The types and volume of the waste materials associated with the Proposed Development (Offshore) are unknown at this stage; however, the Applicant accepts the responsibility of dealing with waste material from the moment it is produced until it is received by a business that is authorised to deal with it, through construction, O&M and decommissioning stages of the Proposed Development (Offshore).

3.3.6.2 Post-consent and prior to construction, the Applicant will produce a Waste Management Plan which will define waste management measures for the Proposed Development (Offshore) to minimise, recycle, reuse and dispose of waste material through various waste streams in compliance with relevant environmental and waste legislation. Waste management measures will be aligned with Ocean Winds UK and global waste management policies.

3.4 Operation and Maintenance (O&M)

3.4.1.1 The final O&M strategy will be finalised post-consent and will be informed by the location of the O&M base(s) and the final design parameters of the Proposed Development (Offshore). The final O&M strategy will be implemented throughout the anticipated 35 years operational lifespan of the Proposed Development (Offshore).

3.4.1.2 A summary of the expected O&M activities is presented in Table 3–19 noting the frequency should be considered applicable to both application areas (i.e., Caledonia North and Caledonia South), with the exception of floating WTG foundations which would only apply to Caledonia South if this technology is used. O&M activities are likely to be completed by CTVs, Service Operation Vessels and, for major repairs/replacements, JUVs.

3.4.1.3 As per the construction phase (Section 3.3.5), it may be necessary for safety zones to be implemented around wind farm structures and/or OfTI involved in major O&M activities (e.g., major overhauls, cable repairs/replacement). Marine control and vessel management will be provided by a dedicated marine coordination centre. Guard vessels will be deployed in the Array Areas and OECC to monitor safety zones, overall marine traffic and inform vessels of O&M activities.

3.4.1.4 It is not anticipated that there will be the need for helicopters to be used during the O&M phase of the Proposed Development (Offshore).

Table 3–19: The expected frequency of operation and maintenance (O&M) activities.

Component	Activity	Frequency	Comments
WTG	Routine servicing	Daily	Routine servicing is weather dependant.
WTG	Safety checks	6-12 months	This will be informed by the supplier and certification documents.
WTG	Oil and High Voltage	Annually	-
WTG	Blade inspections	Annually	-
WTG	Major overhauls	Rarely	This will be informed by the component or activity.
WTG	Scheduled maintenance	6-12 months	This will be informed by the component or activity.
WTG	Fault rectification	Monthly	The frequency of fault rectification can vary dependent on the component or type of intervention maintenance required.
WTG	Major component replacement	Reactive	Assumed 1-2 major component failures per asset during operational lifetime. Assumed 0-3 individual major component interventions per year.
OSP	Preventative maintenance	3 months	General visual inspection and digital virtual interface of equipment
OSP	Corrective maintenance	Reactive	Main transformer and switchgear replacement/repair. Unlikely. Major component replacement is not anticipated during Design lifetime.
Foundations - bottom-fixed	Preventative maintenance	Annually	General and detailed visual inspection of primary steel (TP, jacket, jacket/pile connection) and secondary steel (J-tubes, boat landing, rest platform, ladders, access platforms, scour protection, cathodic protection system)
Foundations - bottom-fixed	Corrective maintenance	Reactive	No specific failures anticipated, only resulting from accidents/incidents damaging the asset (i.e., vessel collision, dropped objects)

Component	Activity	Frequency	Comments
Foundations - floating	Preventative maintenance	Annually	Platform, dynamic cable, stationkeeping
Foundations - floating	Corrective maintenance	Reactive	Platform, dynamic cable, stationkeeping
Cables – interconnector, inter-array and offshore export	Preventative maintenance	Annually	Above Sea Level: Inspection of cable hang-offs, terminations, fibres and earthing cables, distributed temperature sensing system including replacement of worn components. Below Sea Level: survey of landfall HDD exit/protection, crossings, cable seabed transitions at OSPs J-tube exit.
Cables – interconnector, inter-array and offshore export	Corrective maintenance	Reactive	Replacement of cable section. Unlikely. Major component replacement is not anticipated during Design lifetime.

3.5 Decommissioning

3.5.1.1 At the end of the operational lifetime of the Proposed Development (Offshore), it is anticipated that all structures above the seabed level will be completely removed. The decommissioning of Caledonia North and Caledonia South may or may not be carried out at the same time. The decommissioning sequence and method is anticipated to generally be the reverse of the construction sequence and involve similar types and numbers of vessels and equipment. Closer to the time of decommissioning, it may be decided that removal would lead to greater environmental impacts than leaving components *in situ*, in which case certain components may be cut at or below the seabed (e.g., piles) or left buried (e.g., inter-array, interconnector and offshore export cables).

3.5.1.2 A draft Offshore Decommissioning Plan has been prepared as part of this EIAR (Volume 7, Appendix 15: Caledonia North Outline Offshore Decommissioning Plan and Volume 7, Appendix 16: Caledonia South Outline Offshore Decommissioning Plan). It is noted that the decommissioning strategy will be confirmed in line with relevant guidance at a later stage of the Proposed Development (Offshore). The selected approach will acknowledge the preferences stated in the most recent guidance at the time of writing, such as the Scottish Government's Guidance for the Decommissioning of Offshore

Renewable Energy Installations in Scottish Waters (Scottish Government, 2022b[4])

3.5.1.3 Upon commencing the decommissioning phase, the WTGs will be de-energised and isolated from the NETS. Suitable HLVs will be mobilised to the site and will begin removing key components of the WTGs including blades, all tower/nacelle internal cables, control and communication cables, the nacelle and generator, and finally dismantle the tower. These components will be transported to an onshore facility for processing.

3.5.1.4 All hazardous substances and fluids will be removed from the WTGs (such as oil reservoirs and any hazardous materials or components). These hazardous substances and fluids will be disposed of in accordance with the relevant regulations in force at the time of disposal. All components with hazardous fluids will be treated with care to minimise risk of spillage. All steel components will be sold for scrap to be recycled, noting these forms the bulk of the WTG structures. The WTG blades, made predominantly of fibreglass, will be disposed of in accordance with the relevant regulations in force at the time of decommissioning.

3.5.1.5 Pile foundations would likely be cut approximately 2m below the seabed, with due consideration made of likely changes in seabed level and removed. This could be achieved by inserting pile cutting devices. Once the piles are cut, the substructures would be lifted and removed from the site. At this time, it is not thought to be reasonably practicable to remove entire piles from the seabed, but endeavours will be made to ensure that the sections of pile that remain in the seabed are fully buried.

3.5.1.6 The Applicant will endeavour to remove all subsea infrastructure, including scour and cable protection, at the point of decommissioning. All materials recovered would be treated according to the waste hierarchy and regulations at this time. Where marine habitat has established on this infrastructure then the Applicant may, in agreement with the relevant authorities, decide to leave *in situ*.

3.5.1.7 It is unknown at this time what types of decommissioning techniques and vessels will be available on the market at the point of decommissioning. A worst-case assumption would be the same number of vessel movements/trips as during the construction/installation phase. However, it is expected that many more efficiencies would be achievable in over 30 years' time.

3.6 Life Extension and Repowering

3.6.1.1 The DE includes an anticipated operational lifespan of the Proposed Development (Offshore) of up to 35 years. At the end of the Proposed Development's lifespan, there will be an assessment of the viability for project life extension or repowering versus decommissioning. If life extension or repowering was deemed feasible, an assessment process would be completed at a later stage seeking relevant consents (not included as part of the current

EIA/application process), this would include consideration of extending the operational lifespan of the Proposed Development (Offshore) or partial decommissioning and repowering. The life extension or repowering of Caledonia North and Caledonia South may occur at different times.

3.7 References

[1] Scottish Government (2013) 'Planning Advice Note 1/2013: Environmental Impact Assessment'. Available at: https://www.gov.scot/publications/planning-advice-note-1-2013-environmental-impact-assessment/ (Accessed 01/03/2024).

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