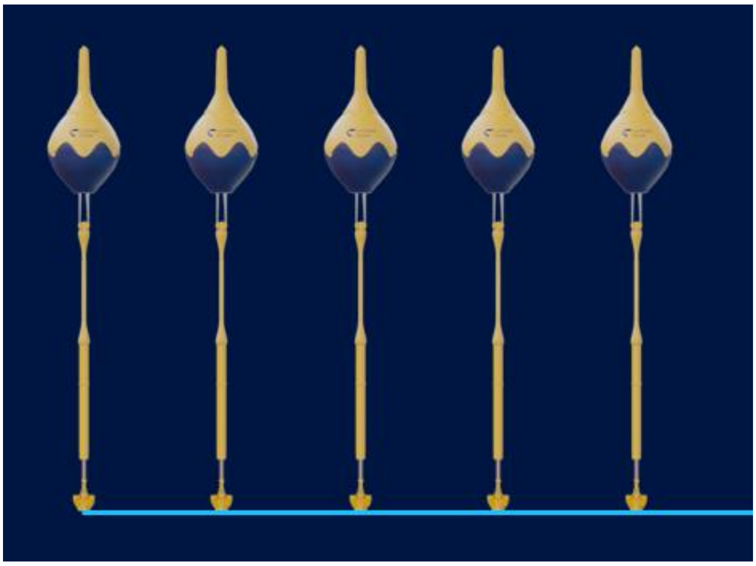
Endeavour Wave Limited | CorPack wave cluster

Project Information Summary

EMEC Billia Croo Wave Test Site

December 2024



Purpose

This Project Information Summary gives a high-level view of the company, the device, and the proposed project. This document is being submitted in lieu of a Construction Method Statement. This document is the foreword to the project's Marine Licence application, and will feed into the rest of the application supporting documentation, including but not limited to the following documents:

- Project Environmental Monitoring Plan
- Navigational Risk Assessment Addendum
- Decommissioning Program
- Third Party Verification

Document History

Revision	Date	Description	Originated by	Reviewed by	Approved by
001	10/12/2024	Draft	[Re		
002	18/12/2024	Reviewal	[Re (EMEC)		[Re (EWLtd)
003	20/12/2024	Final	[Re (EMEC)		[Re (EWLtd)

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1 Introduction

1.1 Company background

Endeavour Wave Limited is a subsidiary of CorPower Ocean AB, incorporated in December 2024 and was set up to develop wave energy project in the UK.

CorPower Ocean brings high-efficiency wave energy technology enabling reliable and cost-effective harvesting of electricity from ocean waves. With our research and development spanning decades, our innovations are inspired by the pumping principle of the human heart. Ocean energy brings stability to the clean energy mix, accelerating the transition to zero-carbon energy.

CorPower Ocean's turnkey offering includes state-of-the-art CorPack wave clusters, each providing 10-30MW of clean, sustainable wave power. We provide comprehensive support from project development to operations, including expert Farm Engineering services and reliable Operations and Maintenance contracts, ensuring seamless energy solutions for a sustainable future.

The project team includes expertise in marine energy, engineering, offshore operations and technology.

1.2 Technology background

The development of Corpower WEC technology was initiated in 2009. The development of the CorPower WEC technology was initiated in 2009 by inventor M.D. Stig Lundbäck, who was inspired by the pumping principles of the human heart. Two generations of scaled function demonstrators were built during 2009-2011, showing the viability of the mechanical and pneumatic aspects of the system. In 2012, Patrik Möller co-founded CorPower with Stig, following a techno-economic review before the project was accepted for the InnoEnergy incubator program.

The design principles behind a phase-controlled point absorber build upon more than 40 years of research conducted at NTNU in Trondheim. Phase controlled point absorbers were introduced by Kjell Budal and Johannes Falnes at NTNU in the 1980s, and the hydrodynamics and control principles have been continuously developed. The invention of the WaveSpring technology by Dr Todalshaug was a key step to bring phase control to a practical and industrially applicable technology. CPO has developed the WaveSpring technology since the start,and has an exclusive license to use the method from NTNU Technology Transfer Office.

1.3 Project background

The aim of the 1.8MW (5 individual devices) wave array at EMECs Billia Croo site is to actively demonstrate array scale WEC deployment. CorPower Ocean have worked extensively on deployment of their wave energy converter, HiWave 5 to be deployed at full scale in Acugadoura, Portugal in early 2023. This deployment of CorPowers C4 device, will provide certified and warrantied wave energy convertors, which will then be deployed in array format at EMEC.

Endeavour Wave Limited is seeking to deploy the first wave energy array of this scale in UK waters, utilising the existing infrastructure, knowledge and capacity at the European Marine Energy Centre. The project will prove the ability to deploy multiple devices, with the associated infrastructure and provide operational data from a relatively small, modular architecture for a 1.8MW project. This array will provide operational data to enable larger arrays to be deployed globally.

The project will not only provide technical information on the installation, operational and maintenance of an array of wave energy convertors but will provide financial and other information required to make wave energy projects bankable. This will increase the ability of wave energy projects, utilising the Corpower WEC to be deployable as part of a suite of marine renewable energy options. The project will also bring forward the position of wave power in UK waters, providing the first array scale, operational wave array in the UK. This is critical for both the technology and project, but also for the wider wave energy industry in the UK.

The project will be deployed within the Billia Croo grid connected, wave energy test site in Stromness, Orkney. It is anticipated that the project would be operational for a period of 15 years.

The project will be funded by Endeavour Wave Limited, utilising development fund directly and seeking financing support through existing relationship with Swedish Export Finance and other funders who are already engaged in discussions on the project. The project will also seek grant funding, preferably through access to CfDs through AR7.

2 Technology

2.1 Device Description

The CorPower WEC converts ocean waves into electricity through the rise and fall as well as the back-and-forth motion. A composite buoy, interacting with this wave motion, drives a Power Take Off (power train located inside the buoy) that converts the mechanical energy into electricity. The WEC consists of a lightweight buoy connected to the seabed through a power conversion module and a mooring system. By means of novel and patented technologies the CPO WEC moves in phase with incoming waves, amplifying the motion and power absorption, making it move in and out of the water surface.

CorPower's technology addresses the key challenges of efficient wave energy harvesting in a unique way. It tunes and detunes the devices to the sea conditions, by such introducing a function to wave energy similar to wind turbines pitching the blades to control the driving force of the device.

Inspired by the pumping principle of the human heart, CorPower uses stored pressure to convert energy from waves in both stroke directions. The human heart uses stored hydraulic pressure to provide force for the return stroke, thereby only requiring the muscles of the heart to pump in one direction. In a similar way, CorPower WEC uses pneumatic pressure to push the buoy downwards. It mimics the energy storage aspect of the human heart whereby the upward force of a wave swell pushes the buoy upwards while the stored pneumatic pressure provides the restoring force driving the buoy downwards. This results in an equal energy production in both directions and a light-weight design with high natural frequency.

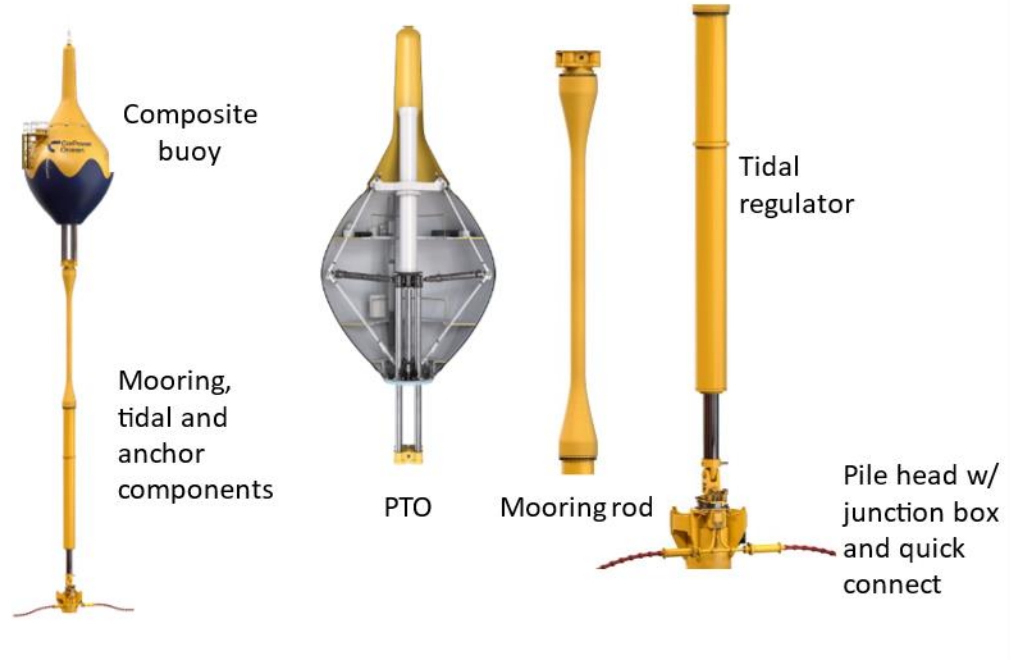


Figure 1. WEC system overview with sub-systems

The CorPower WEC (Figure 1) is a Point Absorber type of WEC rated at 350kW, with a heaving composite buoy on the ocean surface that absorbs the wave energy. The buoy is connected to the seabed using an UMACK anchor & mooring system. The WEC uses a unique phase control technology that allows the WEC to be tuned and detuned, altering the system's response to ocean conditions. In operational tuned mode, phase control makes the device oscillate in phase with incoming waves, strongly amplifying the WEC's motion and thereby the power capture. In storms, the detuned state makes the WEC transparent to incoming waves for enhanced survivability.

This combination allows for a large amount of energy to be harvested using a relatively small and low-cost device. Compact and lightweight devices are efficient to produce in volumes, install, operate, and maintain in modular multi-device arrays using low-cost vessels, which improves uptime, increases availability for a higher annual energy production (AEP), and significantly reduces operational costs (OPEX). Moreover, the WEC composite hulls can be produced in large numbers locally at customers' sites with a unique mobile factory concept developed and operated by CorPower, with low cost and minimum GHG emissions from transport and logistic.

The array ready device will have an industrial design and build quality of a production machine, based on cycles of learning from the previous generation devices. The machine architecture is generally maintained from current technology generation, with innovation on sub-systems designed for reliability and optimised for volume manufacturing. It will have less parts, less complexity and deliver higher performance, reliability, and maintainability.

An overview of the WEC layout is shown in Figure 2, Figure 3 and Figure 4.

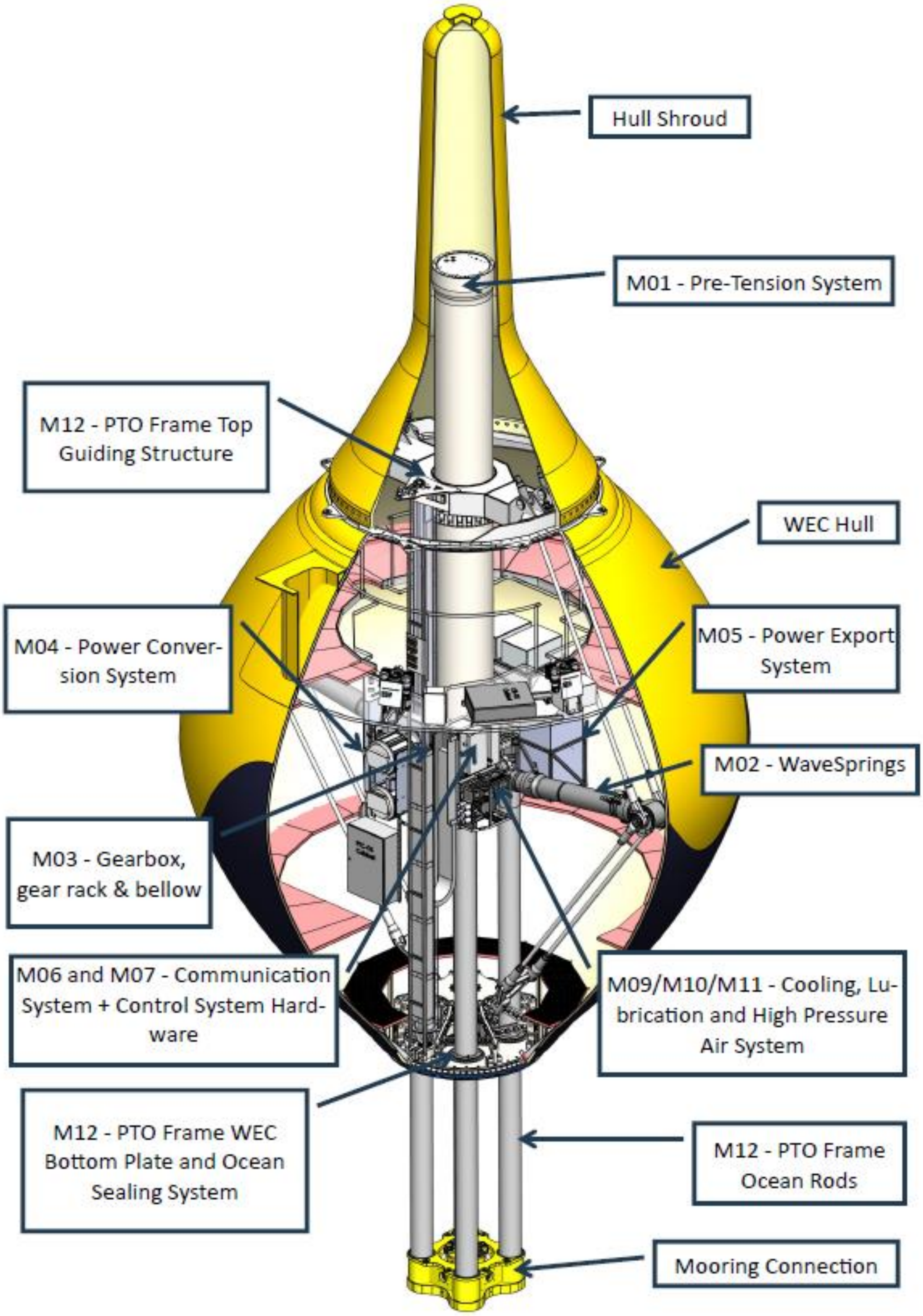


Figure 2. WEC Overview – PTO modules

Figure 3. Corpower WEC with PTO mated in the composite hull, top shroud, and mooring rod in foreground

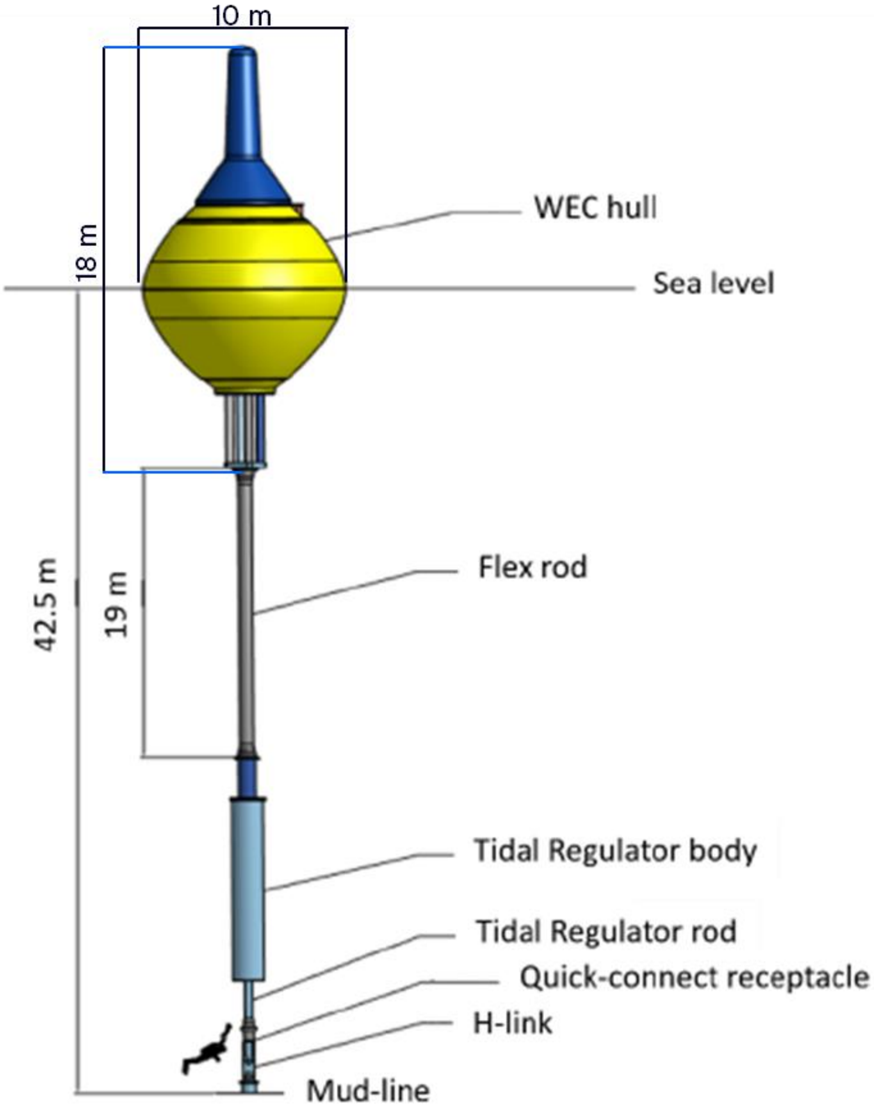


Figure 4. WEC overview - deployment

2.2 Mooring system

Position keeping of the WEC is achieved through a mooring system as illustrated in section 3.4 and the figures above. The WEC is connected to the anchor through a quick-connect system consisting of a remote mechanical, electrical and data connection. The mooring system is then made up of a flexible rod, tidal regulation linear actuator, and crossed H-link universal joint, that all combined are the UMACK Anchor (Figure 5). Other anchor types are considered as alternatives, such as rock anchor (drilled) and monopile (vibrated). The UMACK anchor will be vibrated 18m into the seabed, weighs 37 tonnes and has a circumference of 3.7m. The UMACK is an anchoring system that:

- Can resist vertical loads in excess of 15MN
- Can resist over a hundred million load cycles
- Is suitable for sand and sand/clay seabed types
- Mitigates disturbance to marine life with use of Vibratory install methodology

- Can be 100% decommissioned at the end of project, by reversing the vibration installation process
- Eliminates slack-snatch loading events
- Monopile geometry, eliminates the need for a subsea foundation structure
- Reduces deployment and retrieval time to 30-60min. (pull-down + connect)

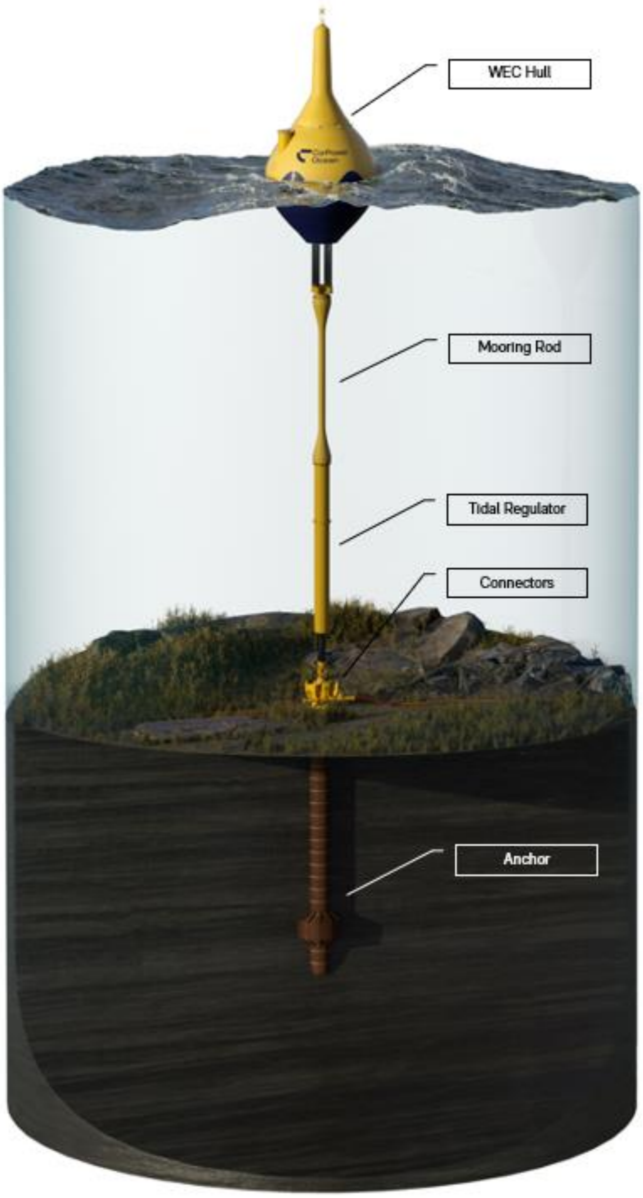


Figure 5. Outline of the Mooring & Anchoring System to the Seabed (UMACK)

2.3 Materials used

Table 1. Proposed list of materials to be used

Components	Type of Deposit*	Nature of Deposit (P = Permanent, T = Temporary)	Deposit Quantity (tonnes, m^3, etc.)	Contingency Allowance
Anchor	Steel	P	215 t	20%
Hull	Composite	P	120 t	20%
Power take off	Steel	P	285 t	20%
	Aluminium	P	6 t	20%
	Copper	P	6,5 t	20%

*Types of deposits to consider: Steel/Iron; Timber; Plastic/Synthetic; Composite; GRP; Concrete; Silt; Sand; Stone/Rock/Gravel; Concrete Bags/Mattresses; and Cable.

2.4 Third Party Verification (TPV)

Either Tension Technology International Ltd or Orcades Marine Ltd will perform TPV.

3 Project Description

The CorPack wave cluster project is a first of its kind for wave energy in Scotland. The 1.8MW project is seen as a stepping-stone moving from R&D towards commercial projects as well as the first project developer-built wave energy array. The project is aimed to prove the commercial feasibility of involving OEM capabilities with a scalable supply chain, EPCI applications as well as the ability to build bankable wave energy farms by a project developer.

3.1 Onshore Assets

No additional onshore assets are required for this project.

3.2 Site Location

EMEC's grid-connected test site, Billia Croo, is ideally located on the western coast of Mainland Orkney, outside Stromness. The test site's location subjects it to the powerful forces of the North Atlantic Ocean, giving it one of the highest wave energy potentials in Europe with an average wave height of 2-3 m and extremes of up to 17 m. The site is located approximately 2 km offshore with each test berth roughly 0.5 km apart. Similar to its description within its project envelope: a visual of Billia Croo which highlights its updated boundaries – split into two sections (offshore test site plus a shallower inshore area) – following ongoing extension is shown below (Figure 7). Section 36 consent for the extension has been granted but it will not be used until all subjected conditions are met. The coordinates for the site's outermost points on the perimeter are provided in Table 2.

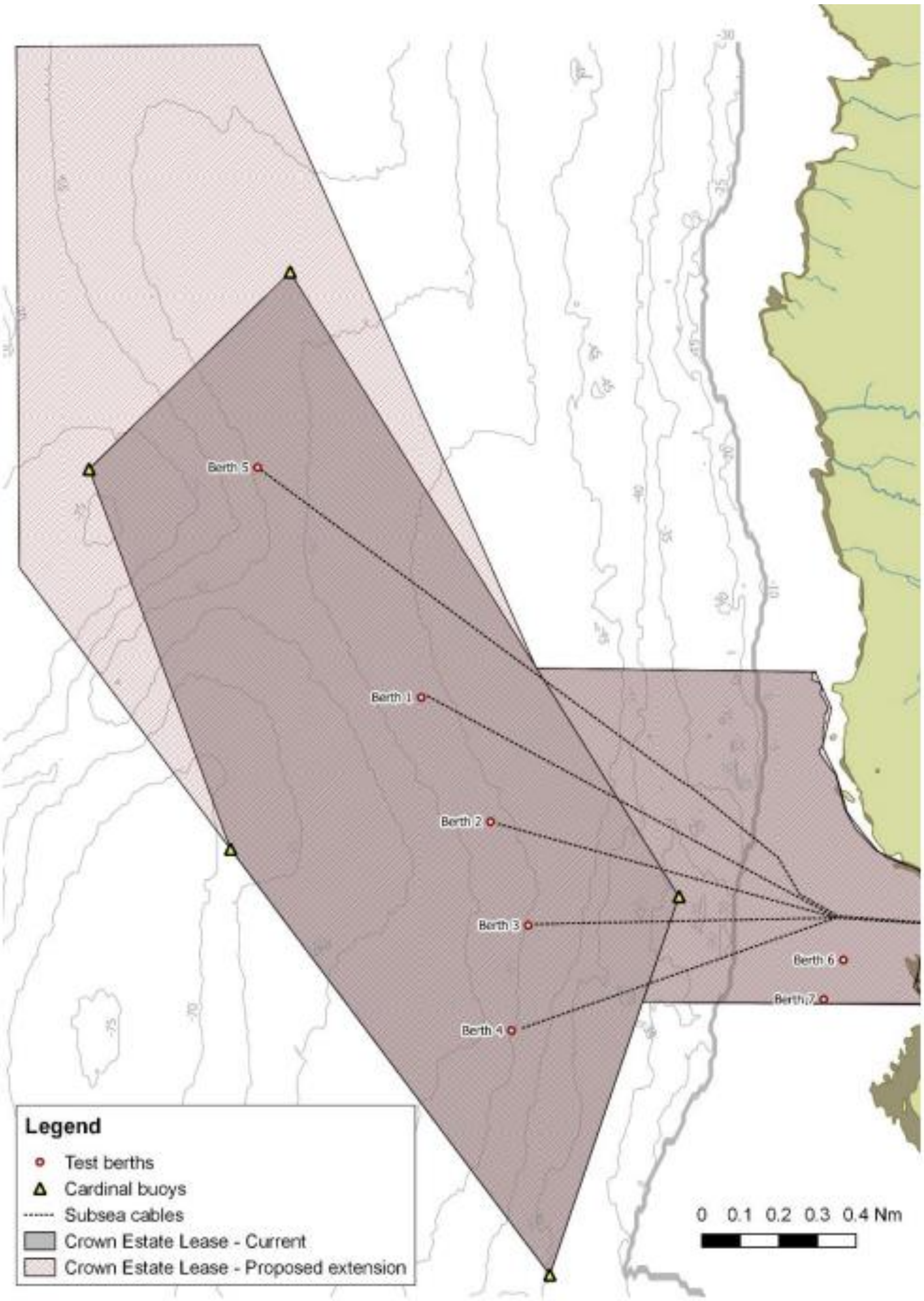


Figure 6. EMEC's Billia Croo wave test site including upcoming extension area

Table 2. Billia Croo test site perimeter

Extended boundary perimeter	WGS84/ ETRS 89	
	Latitude	Longitude
W	58°59.240’ N	003°25.694’W
NW	59°00.587’ N	003°25.711’W
NE	59°00.587’ N	003°24.491’W
E	58°58.393’ N	003°22.391’W
S	58° 57.418’ N	003° 23.038’ W

3.3 Device Location

The CorPack wave cluster will be deployed within the area indicated for Billia Croo (Figure 7), with Table 3 indicating the marine license location of the CorPack wave cluster within its perimeters – including its upcoming extension.

Table 3. Location of CorPack wave cluster

Location Description	Latitude and longitude (WGS 84)
Test site outermost boundary points (on thin red line)	58°59.240’ N 003°25.694’W
	59°00.587’ N 003°25.711’W
	59°00.587’ N 003°24.491’W
	58°58.393’ N 003°22.391’W
	58°57.418’ N 003°23.038’W
CorPack site points (bold red line)	58° 58.271' N 003° 24.240' W
	58° 58.569' N 003° 23.617' W
	58° 58.242' N 003° 23.029' W
	58° 57.944' N 003° 23.652' W

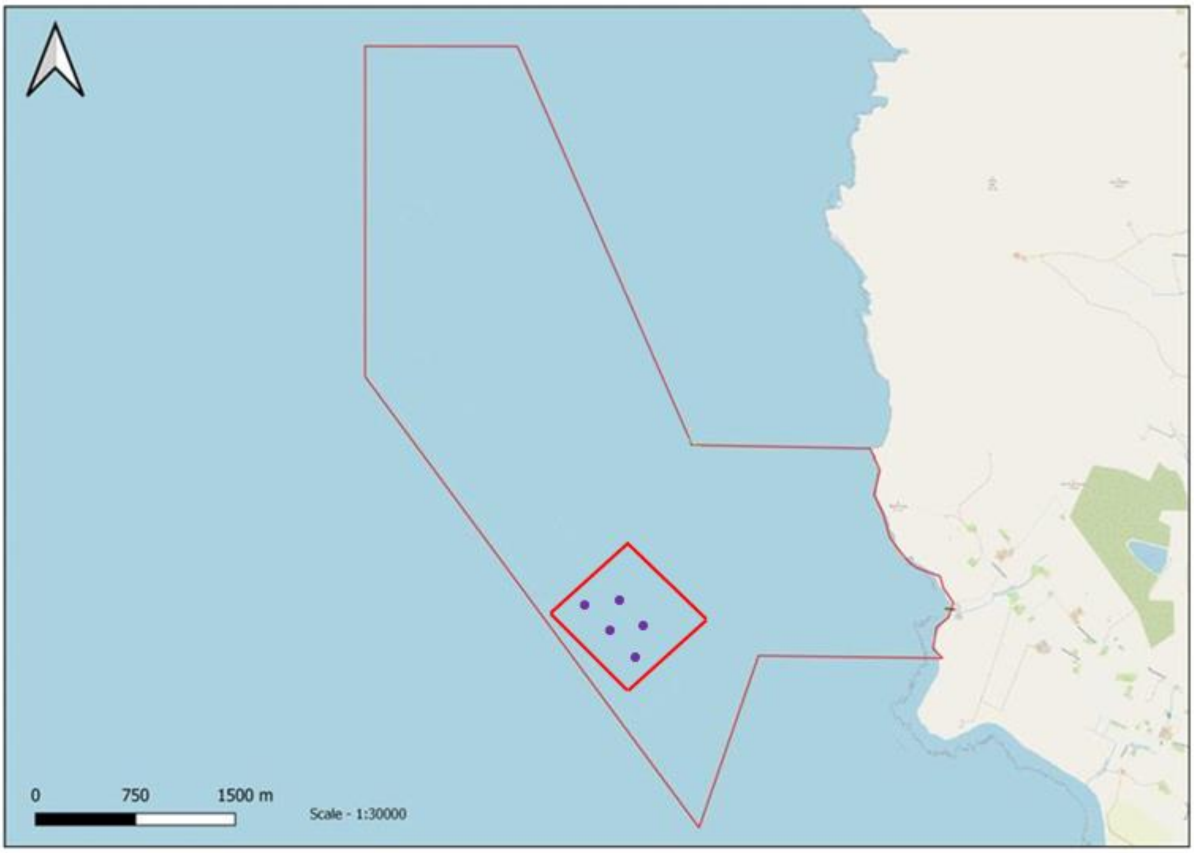


Figure 7. Billia Croo site and proposed CorPack wave cluster array location and configuration

3.4 Installation method

The installation sequences are detailed below that provide the overview of the steps of:

A. WEC loadout, lifting the WEC system from quay into water.
B. WEC Pull-down and mechanical connection sequence to the UMACK anchor head
C. Subsea connection of power and fibre communication to shore.

Step 1: Loadout of WEC from quayside into harbor in Stromness

- Figure 8 illustrates the WEC Load-Out into the water (Hull, PTO and UMACK System integrated) ready for Offshore Installation. WEC systems are preferably handled with slipway and trailer system for transfer from quay into the water, avoiding the need of cranes. Should slipway access be limited, the WEC systems can be lifted with two cranes as per below.

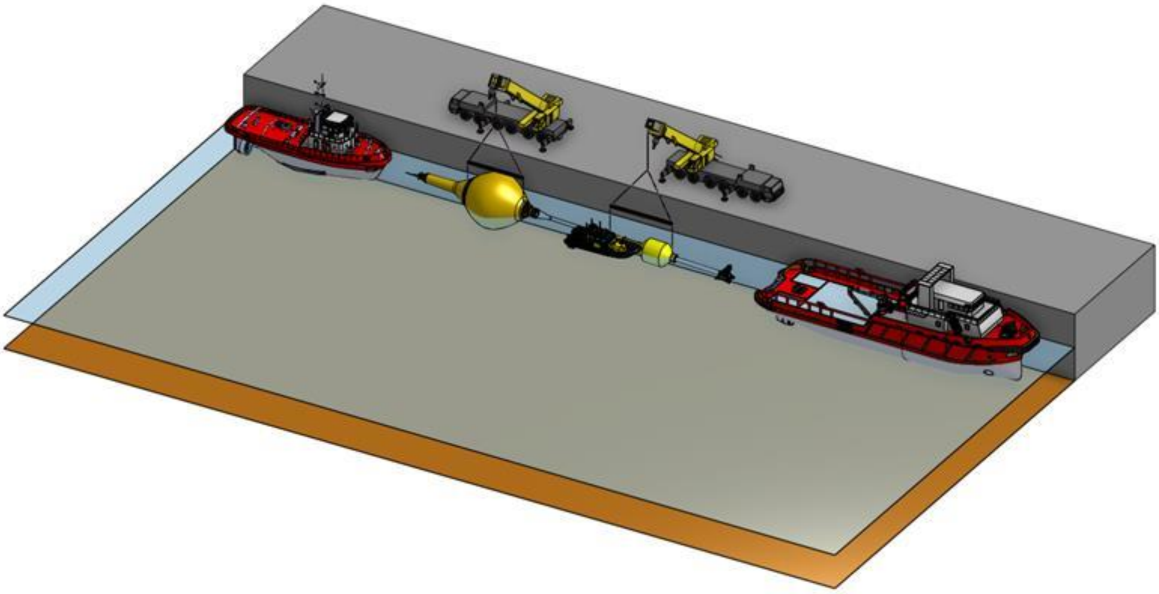


Figure 8. WEC load-out ready for offshore

Step 2: Tow WEC to wave energy site

- Tow-out distance ~ 28 km
- Lead tow vessel with 2nd vessel to provide back-tension and heading control. (may not be required)

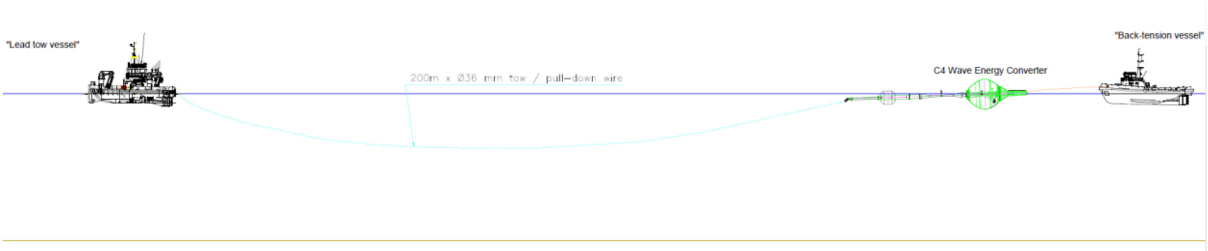


Figure 9. Tow WEC to site

Step 3: Recover and connect the previously installed messenger line from the anchor

- The messenger wire was pre-threaded through the pile-head up-turn sheave
- The messenger wire is connected to the tow-in/ pull-down wire

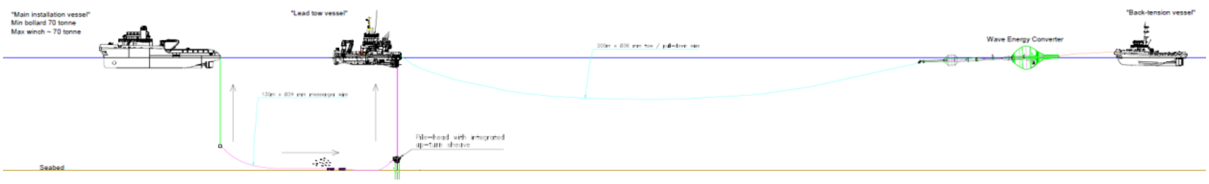


Figure 10. Recover and connect the messenger line from the anchor

Step 4: Begin pulling the WEC towards the pile head

- The WEC is pulled towards the pile head by the main installation vessel
- The lead-tow vessel controls the off-lead angle to the pile head.

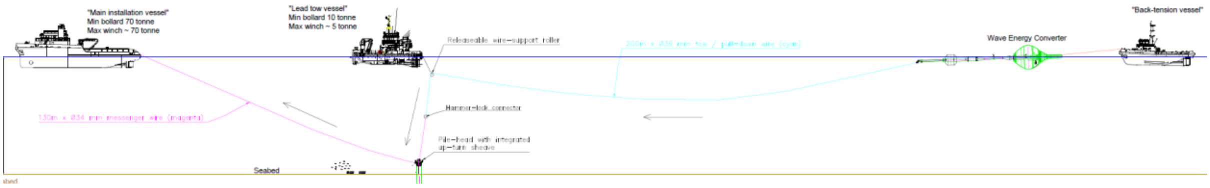


Figure 11. Pull WEC towards pile head

Step 5: The end of the WEC is above the pile head

- The tow / pull-down wire is threaded through the pile-head up-turn sheave.
- The end of the WEC (the mooring quick connector) is ~ above the pile head

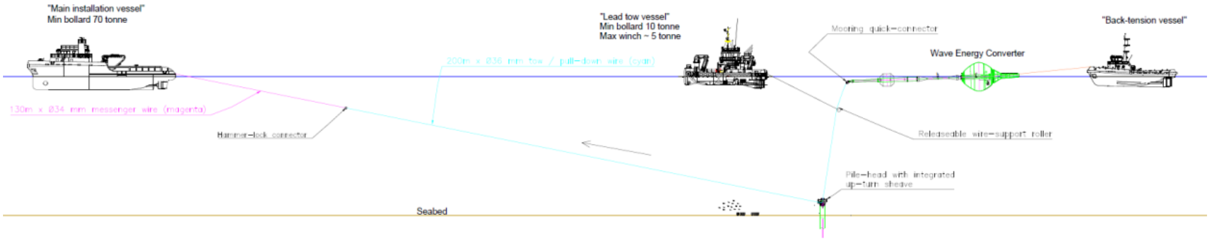


Figure 12. WEC above pile head

Step 6: Disconnect the wire support roller and lead-tow vessel

- The wire support roller and lead-tow vessel are disconnected.
- WEC is ready for pull-down installation

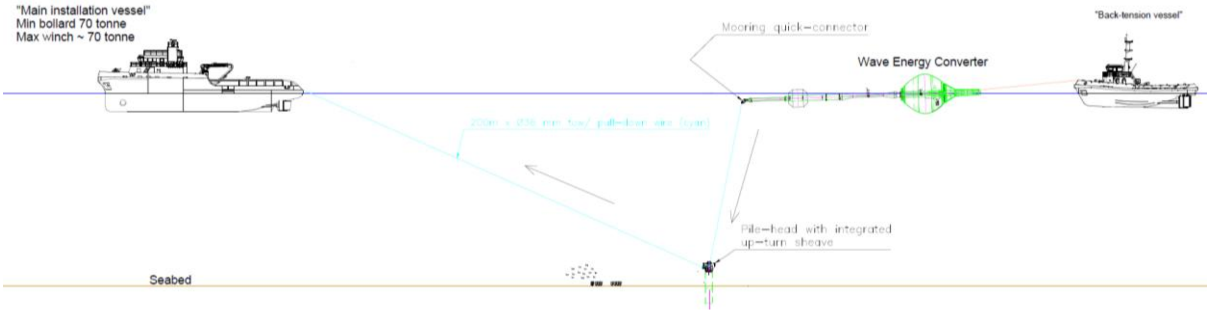


Figure 13. Disconnect wire support and tow vessel

Step 7: The WEC is party installed

- The main installation vessel moves ahead, pulling the WEC down to the pile head

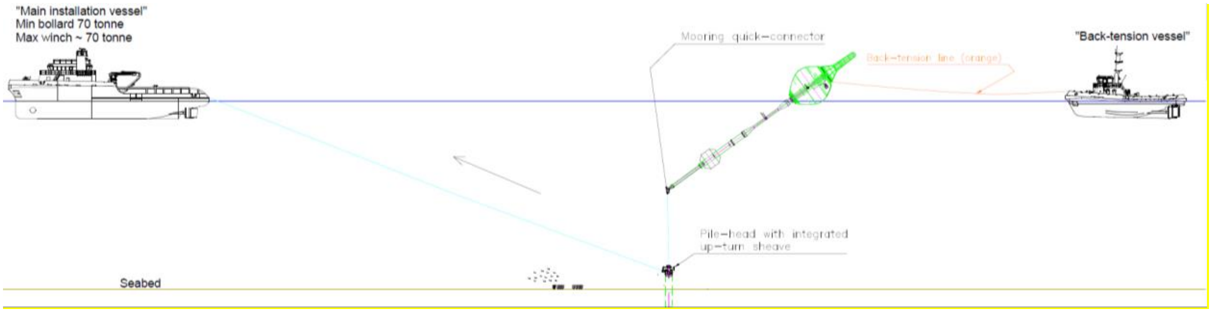


Figure 14. Partly installed WEC

Step 8: The WEC is fully installed

- When the mooring quick connector is engaged in the pile-head receptacle, the connector is hydraulically locked using on-board power

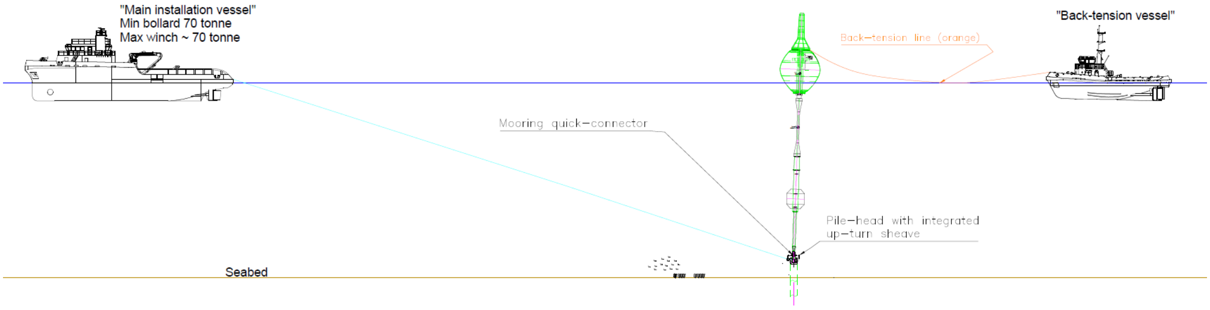


Figure 15. WEC fully installed

Step 9: The pull-down wire is laid down and abandoned

- The pull-down wire is abandoned to the seabed, in readiness for WEC recovery.
- The tidal regulator length is adjusted by onboard systems to its operational position.
- WEC installation is complete, and the WEC is ready to power-up
- The vessels return to port.

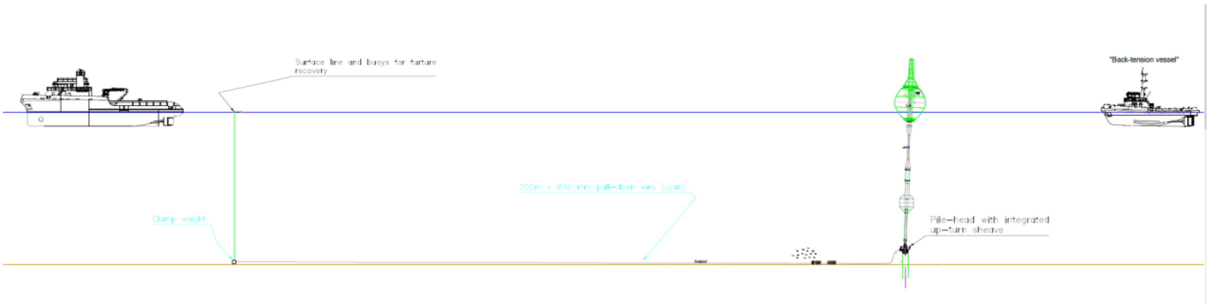


Figure 16. Pull-down wire is laid down

3.5 Removal method

The removal method is a reverse activity of the installation method. At the end of the project, the site will be cleared of the equipment installed by the project, unless otherwise agreed with the site owner and relevant authorities.

3.6 Anticipated vessel traffic to site

As mentioned above, this project is expected to run for 15 years. The table below shows the anticipated vessel traffic to site over that period.

Table 4. Anticipated vessel traffic to site

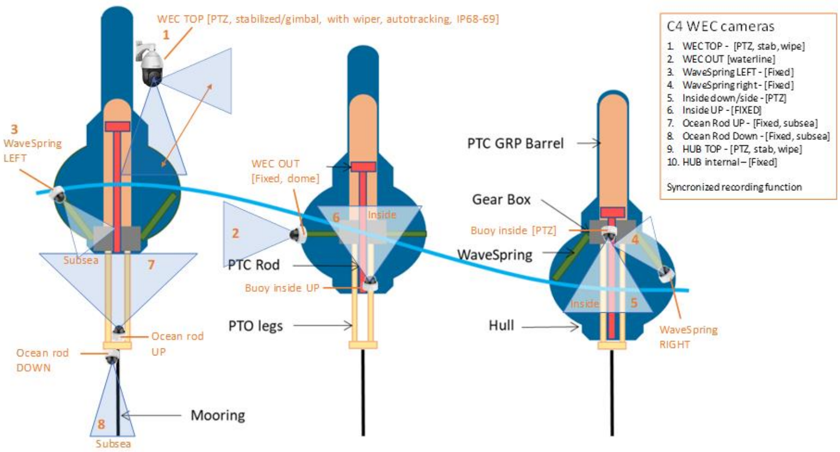
Vessel Type	Vessels number required	Number of transits per year
Installation		
Construction vessel	2	3
Support multicat vessels	1	3

Bollard pull vessel	1	3
Operations & Maintenance		
RIB / CTV	2	10
Bollard pull vessel	2	10
Decommissioning		
Construction vessel	1	3
Bollard pull vessel	1	3

3.7 Device monitoring systems

WEC Inspections. The WECs will be monitored and inspected on site, both remotely and by onsite technicians with the following methods:

- The onshore SCADA (Supervisory control and data acquisition) system incorporates continuous monitoring and control functions of the hub and the WEC, showing their location in real time via GPS tracker. Radio and/or 4G link, with its respective antenna and mast, could be provided as a backup solution for remote control and monitoring system with onshore SCADA system.
- As shown in the figure below, there will be multiple cameras assembled on the WECs, monitoring in real time both the inside, the surface and the subsurface components. This allows for fast reaction times in case of unplanned maintenance.



CAMERA VIEW

- Inspection ROVs will also be used for additional inspection below water of the WEC hull subsurface, the mooring, and the anchoring, especially for the purpose of corrosion and biofouling monitoring. As an example, the ROV we are currently using is the BlueROV2 below:

4 Proposed Schedule

The 5 devices CorPack wave cluster is able to be installed and decommissioned in a short space of time (3 months) which, compared to other array projects, reduces the impacts associated with installation and decommissioning in terms of disturbance to receptors

Table 5. Project Schedule

Stage	Month						
	1	2	3	3-180	181	182	183
Installation	■	■	■				
Operation				■			
Decommission					■	■	■

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