



## **Q-Connect**

# ***WES Quick Connection Systems Stage 3 Public Report***

**Quoceant**



The Q-Connect project has been supported by Wave Energy Scotland



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## Project Introduction

The Q-Connect system is a modular and adaptable Quick Connection System (QCS) for rapid and safe simultaneous connection of moorings and electrical cables. It is being developed to serve a wide range of Wave Energy Converter (WEC) types and has the potential for wider application in the marine industry. Stage 3 of this project focused detailed design and qualification testing of a full-scale prototype system.

Stage 3 of the project has been delivered by a team including project lead Quoceant and five sub-contractors, the European Marine Energy Centre (EMEC), SMD, Mocean Energy, AWS Ocean Energy, and Inyanga Maritime. The project team and their roles in stage 3 are briefly outlined below:

**Quoceant**, Project Lead – A Scottish based engineering consultancy specialising in marine energy and technology, its staff have a wealth of experience the wave energy sector. Quoceant’s independent consultancy has benefitted a wide range of companies in the wave, tidal, offshore wind, and maritime sectors. The company also seeks to directly innovate enabling technology for the blue economy.



**EMEC**, Test Witnessing and Commercial input - EMEC is the first and only centre of its kind in the world to provide developers of both wave and tidal energy converters with purpose-built, accredited open-sea testing facilities. With 13 grid-connected test berths, there have been more marine energy converters deployed at EMEC than at any other single site in the world.

**SMD**, Actuation Systems – SMD are an advanced global designer and manufacturer of remotely operated and autonomous power and control solutions. SMD has a passion for excellence, backed by proven engineering expertise and outstanding global service over the last 50 years.



**Mocean Energy**, Technology Steering Group Member – Mocean Energy are developers of the Blue Horizon and Blue Star wave energy converters. Both technologies are based on the same concept – a hinged, surface floating raft with a unique geometry designed to improve performances compared to traditional hinged rafts and increase survivability by diving through the largest waves.

**AWS Ocean Energy**, Technology Steering Group Member – AWS Ocean Energy is the developer of the Archimedes Waveswing™. The Waveswing™ is a submerged wave power buoy - a unique device designed to provide reliable and affordable power for maritime communities and offshore applications.



**Inyanga Maritime**, Marine Operations Expertise – Inyanga Marine provide cost-effective and reliable offshore operations and engineering consultancy for developers specialised in the marine renewables sector. The team have contributed to almost every marine renewable device installation in the UK over the past 5 years, including over 50 connection / release operations, 28 of which used quick connect systems.

## ***1 Description of Project Technology***

Wave and tidal technologies remain diverse in their design, but typically share the need for a connection system between the subsea infrastructure (both moorings and electrical cabling) and the device. This connection system should be fast, safe, and weather tolerant over repeated connection and disconnection cycles. Such a system enables maintenance off site, reduces installation and decommissioning costs, and allows a staged and controlled approach to early testing.

The Q-Connect is a modular and adaptable Quick Connection System (QCS) developed by Quoceant with support from project sub-contractors. The Q-Connect system provides quick, 'hands free' remote connection and disconnection for a wide range of different WEC types, to both moorings and electrical systems, with no person access to the WEC and no taut lines on deck. It therefore offers important safety advantages for offshore marine operations. Additionally, the 'hands free' approach increases the weather tolerance of installation and removal operations and reduces their duration. The effect of this is to significantly reduce the cost of marine operations both by reducing the time they take and, more impactfully to reduce weather waiting.

The Q-Connect is a single compact package combining mechanical latching and release with well-proven wet-mate power and data connection in a robust staged and self-aligning mating arrangement. The system is targeting high reliability by building on proven design elements from previous quick connect systems in combination with novel design elements with reliability at their core.

The system is shown below in Figure 1. It consists of a male and female half. In the configuration shown the male is pulled up to meet the female half by a remotely controlled winch which would be located inside or on-top of the WEC (or other type of marine structure). The male half is pre-installed with the mooring and subsea electrical cable and, when disconnected is supported subsea by built in buoyancy.

The Q-Connect has been designed to be flexibly used to suit application and alternative configurations can orientate the female on the seabed and the male lowered in for connection, or both halves can be located midwater. Furthermore, the design is readily adaptable to a range of load requirements, mooring configurations and wave or tidal energy structures. In this manner, Quoceant have designed a system with wide applicability to developers and marine test centres.

The Q-Connect provides a solution that is technically and operationally sound, built on the experience of creating and operating the previous state of the art WEC quick connection systems. Quoceant are now working to modify the Q-Connect for the floating wind market by increasing the size of the mechanical connector and adapting the system to operate with high voltage wet mate connectors.

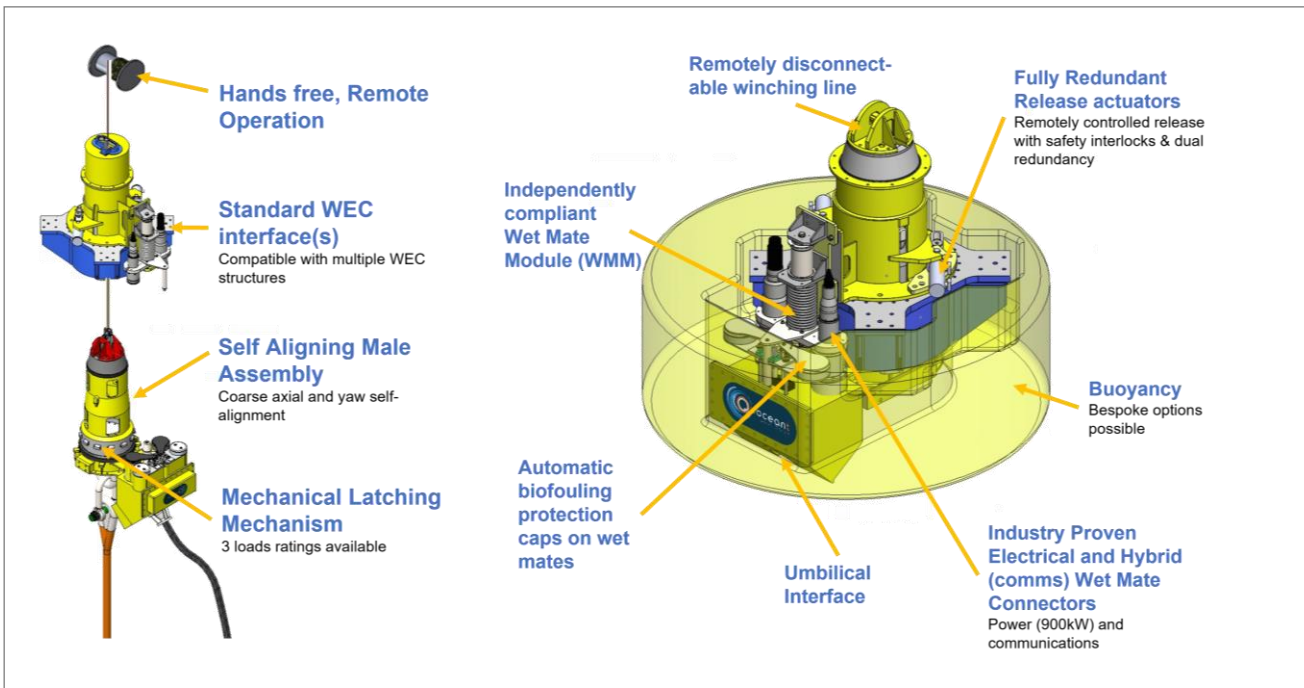


Figure 1: Key features of the Q-Connect.

## 2 Scope of Work

The Stage 3 project built on the successful completion of Stage 1, which demonstrated feasibility, and Stage 2, which focused on numerical modelling of key marine operations and extended the design detail. The work packages in Stage 3 were:

**Design and Procurement** – Quoceant finalised the detailed design of the Q-Connect ahead of qualification testing in subsequent work packages. Finite element analysis undertaken in Stage 2 was extended to look at finer details of the design. Quoceant produced fabrication drawings for all systems and designed the required test rigs for sub-system and full-system testing. Quoceant then managed the procurement of all parts and oversaw the fabrication of key elements.

**Sub-System Testing** – The qualification testing began with a focus on key sub-systems to prove out reliability and function of the more novel elements of the design. This programme of activity included three test rigs and four test set-ups and saw dedicated testing on the wet mate capping system and mechanical latching system. The programme of tests included strength testing of the latching system.



Figure 2: Subsystem tests (left) of the mechanical latching system and (right) of the wet mate capping system.

**Full-System Testing** – Following successful sub-system tests, the full Q-Connect system, at full scale, was assembled for demonstration. This programme of testing took place in Hydrus’s fabrication and assembly facility and included dry and wet demonstration. The test campaign demonstrated the self-alignment and self-latching functions of the Q-Connect over a range of entry angles and offsets. EMEC provided independent witnessing of the test activities.

**Impact assessment** – Throughout the development programme, the impact of the Q-Connect on key metrics has been quantified and described against a base case. Stage 3, saw these assumptions refined and updated using the results of the build and qualification test programme. The Q-Connect was shown to have major advantages over the baseline cases on all key WEC success metrics, namely, affordability, installability, availability, survivability, performance, and compliance.

**Commercial Engagement** – Quoceant worked with project partners EMEC to increase sector awareness of the Q-Connect technology and engage with wave, tidal and floating wind developers.

### ***3 Project Achievements***

The project delivered against its stated objectives, significantly advancing the Q-Connect technology through demonstration and qualification testing, taking the system to TRL6+.

The first stage of the project completed the detailed design of the prototype unit, including updating key design documents such as the Basis of Design and Functional Specifications. Throughout design development Quoceant have adopted a risk managed approach in-line with the DNV qualification for new technology. This informed the structure of the test programme undertaken in stage 3 with focus initially on novel and critical sub-systems.

Sub-system testing addressed several of the remaining risks identified in Stage 2 of the project. The first of these was achieved with demonstration of the manufacturing and assembly techniques required to make the sub-systems, and confirmation of assumed costs for these. The test programme tested three sub-systems using three test rigs in four different test configurations. The latching mechanism and the novel wet mate capping system were among the sub-systems tested. Tests successfully demonstrated functionality of all sub-systems examined. The latching mechanism underwent 100 test cycles, demonstrated repeated release under load capability and was proof load tested.

The full-system Q-Connect qualification programme, first proved out assembly and commissioning processes. This was carried out at Hydrus’s fabrication and assembly facility in Brechin. The demonstration, also in Brechin, successfully showed the self-alignment and self-latching functions of the Q-Connect over a range of entry angles and offsets. Finally, the demonstration in the wet, showed functionality within a representative environment including wetted surface effects.

In summary the project successfully demonstrated:

- The hands-free, rapid, and remotely controllable nature of the Q-Connect engagement and disengagement operations,
- Repeated and reliable engagement, automatic alignment, and latching function.

- Repeated and reliable release functionality, including durable release under load capability, reliable release in simulated fault conditions, and mechanical-only back up release functionality,
- The proof and minimum breaking strength of the latching system,
- The reliability of the novel capping system for protection of the wet mate connectors,
- The manufacture, assembly, and commissioning procedures,
- The full system functionality and operation in the dry and in the wet, the latter being demonstrated with the system in an inverted configuration with the female becoming the lower half.



**Figure 2: Quoceant, WES and Hydrus team representatives at the full-system demonstration of Q-Connect.**

#### ***4 Recommendations for Further Work***



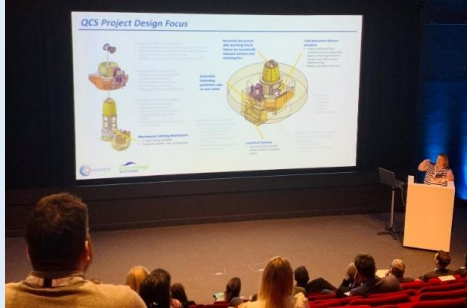
Quoceant are already under way with further work focused on adapting the Q-Connect technology for use in floating wind applications and the wider marine industry. This work will consider the scale up of the mechanical connection system and how to accommodate the higher voltage requirements of the wind sector. Engagement with the floating wind sector confirms there is a high desire for a quick connection solution both for mooring lines and for cable connections.

In parallel work has begun to progress along the certification route and this will be an area of further work which extends into the first at sea demonstrations.





Quoceant continue engagement with the wave and tidal sector, and with funding bodies, in order to find a route to allow the demonstration of the technology at sea. Quoceant would welcome contact from any technology developers, test sites or equipment manufacturers interested in learning more about Q-Connect.


## 5 Communications and Publicity Activity

The Q-Connect project has engaged in several conferences and events and have provided regular project statements through website and social media channels. In addition, the project held a highly successful technology showcase webinar. Communications and public activity are summarised below:

Date	Publication/Event
July 2021	<p>Project award announced.</p> <p><a href="#">Key projects secure £1.8m of Wave Energy Scotland funding in push to net zero   The Scotsman</a></p> <p>Stage 3 award announcement: <a href="#">Q-Connect Wins Stage 3 Funding (quoceant.com)</a></p>  <p>Key projects secure £1.8m of Wave Energy Scotland funding in push t... Three key projects are to share in £1.8 million of funding in a bid to bring down the cost of wave energy. scotsman.com</p>
March 2022	<p>Quoceant news story: Qualification of Quoceant’s Marine Quick Connection System gets Underway at Hydrus in Brechin.</p> <p><a href="#">Qualification of Quoceant's Marine Quick Connection System gets Underway at Hydrus in Brechin</a></p>  <p>quoceant.com Qualification of Quoceant’s Marine Quick Connection System gets Un... Quoceant have started testing their novel marine quick connection system – the Q-connect. The tests will be carried out at Hydrus’s stat...</p>
May 2022	<p>Presentation at Wave Energy Scotland Annual Conference. Attendance advertised on Quoceant social media and website.</p> 



<p>May 2022</p>	<p>Presentation and exhibition at All-Energy event. Attendance advertised on Quoceant social media and website. Quoceant exhibited the wet mate module from the demonstration Q-Connect.</p>	
<p>Sept 2022</p>	<p>Blog on benefits of QCS to early testing. <a href="https://www.queocean.com/blog/manage-risks-how-quick-connection-systems-can-enable-controlled-at-sea-testing">Manage Risks: How Quick Connection Systems Can Enable Controlled at Sea Testing. (queocean.com)</a></p>	 <p>Manage Risks: How Quick Connection Systems can Enable Controlled at Sea Testing. queocean.com • 1 min read</p>
<p>Sept. 2022</p>	<p>Printed a 3D model of marketing purposes. This included a representative wet mate module with springs. The model was demonstrated at ICOE/OEE in San Sebastian and at FOW in Aberdeen.</p>	
<p>3<sup>rd</sup> Oct 2022</p>	<p>Held a showcase webinar. The webinar was chaired by EMEC with Quoceant speaking and answering questions. It is available to view <a href="#">here</a></p>	 <p>EMEC @EMEC_Ltd · Sep 23 Join us on 3 October to hear about @Quoceant's quick connection system for #waveenergy, #tidalenergy and floating offshore wind. Register here <a href="https://us02web.zoom.us/webinar/regist...">us02web.zoom.us/webinar/regist...</a></p> <p><b>Q-CONNECT WEBINAR</b> A QUICK CONNECTION SYSTEM FOR MARINE ENERGY</p> <p>3 OCTOBER 2022 12:00 - 13:15 BST WAVE, TIDAL &amp; FLOATING WIND</p> <p>EMEC wave energy SCOTLAND</p>

Jan 2023	Blog and press release on the demonstration: <a href="#">Quoceant Demonstrate their Q-Connect Technology</a>	 A group of seven people, including men and women, are standing in an industrial or workshop environment. They are wearing safety gear, including white hard hats and high-visibility orange and yellow vests. They are gathered around a large piece of equipment, which appears to be a submersible or a specialized vessel. A white banner with the Quoceant logo and the text "Innovation. Offshore." is prominently displayed in front of them. The background shows industrial structures and equipment.
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## 6 Useful References and Additional Data

The Q-Connect showcase webinar is available to view at EMEC's YouTube Channel - [here](#).

**Publicity Material**

<b>Filename</b>	<b>Media Type</b>	<b>Description</b>
Quoceant-logo	.png	Quoceant’s company logo
Q-Connect-WES at Hydrus	.jpeg	Photo of the Q-Connect demonstration at Hydrus’s facility. WES, Hydrus and Quoceant team members.
Q-Connect-CAD-Latched	.jpeg	CAD model of the Q-Connect latched and shown without buoyancy.
Q-Connect-CAD-Unlatched	.jpeg	CAD model of the Q-Connect prior to latching. Male is shown without buoyancy.