Q-Connect

WES Quick Connection Systems Stage 2 Public Report

Quoceant

This project has been supported by Wave Energy Scotland

Project Introduction

The Q-Connect system is a modular and adaptable Quick Connection System (QCS) for rapid and safe connection of moorings and electrical cables. It is being developed to serve a wide range of WEC types and has the potential for wider application in the marine industry. Stage 2 of this project focused on numerical modelling of key operations, extended design development, and furthered commercial understanding.

Stage 2 of the project has been delivered by a team including project lead Quoceant and five sub-contractors, Inyanga Maritime, the European Marine Energy Centre (EMEC), Mocean Energy, AWS Ocean Energy and SMD. The project team and their roles in stage 2 is 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.

Inyanga Maritime, Marine Operations – 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.

EMEC, Commercial Strategy - 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.

Mocean Energy, Developer Test Case – 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, Developer Test Case – 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.

SMD, Advisory Role – 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.

1 Description of Project Technology

The Q-Connect is a modular and adaptable Quick Connection System (QCS) being developed to provide mechanical and electrical connection in a single operation. The Q-Connect system provides 'hands free' remote connection and disconnection of 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. This allows WECs to be installed in short weather windows and in conditions available year-round at typical exposed wave energy sites. The WEC can also be removed in conditions up to the WEC towing limits. Crucially for both early demonstration and long-term economics, small and relatively inexpensive vessels may be used to carry out installation and removal operations with minimal crew.

A single compact package combines mechanical latching and release with well-proven wet-mate power and data connection in a robust staged and self-aligning mating arrangement. The system will achieve high reliability by building on proven design elements from previous quick connect systems. The Q-Connect's wet mate connector carriage maintains reliable electrical connection under this highly dynamic application, and over many expected install/removal cycles.

The design comprises a set of modular subsystems and components that may be combined in different configurations to provide quick, safe, and low-cost connection for a wide range of WEC types and applications. This modular approach allows a common framework of equipment and operational procedures to be made available to the whole sector, with associated benefits in reliability, shared equipment and skills, and reduced costs. Feedback from different operations using common equipment then provides for ongoing iterative improvements in reliability and function for all applications, and improvements may be rolled out to serve the sector. The male (mooring) side of the Q-Connect for one configuration is shown in Figure 1.

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.

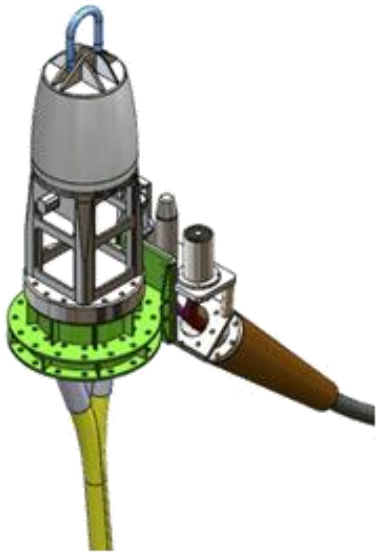

Figure 1: The male (mooring) side of the Q-connect in 'pull-up configuration with a single mooring tether. (latching mechanism not shown)

2 Scope of Work

Stage 2 built on the successful completion of Stage 1 which demonstrated the feasibility of the Q-Connect concept. Stage 2 of this project focused on numerical modelling of key operations, extended design development and furthering commercial understanding and development strategies.

Modelling – Extensive dynamic modelling was undertaken in OrcaFlex, Proteus DS and Abaqus. The numerical modelling considered two test case devices: Mocean Energy's Blue Horizon and AWS Ocean Energy's Waveswing™. Simulations focused on understanding of weather limits, loading and motions during the key marine operations of machine installation, onsite operation, and machine disconnection. The numerical modelling was complimented with production of a small-scale 3D printed model giving a feel for design tolerances and component interactions.

Design – The basis of design, functional requirements, specifications, and standards against which design is being conducted and assessed were updated at the start of the project and incorporated the learning from the stage 1 project. The Q-Connect system design was significantly progressed with work including detailed finite element analysis, sizing and material selection, design life calculation and build assessment. Supplier engagement was undertaken for the key components and fabrications and information used to refine the bill of materials and costing.

Marine operations assessment and storyboarding – Quoceant led an exercise to develop storyboards of the main operational steps in using the Q-Connect for the two-test case WEC devices. The storyboards were peer reviewed by project partners Inyanga Maritime and EMEC. These Q-connect operations were compared against the 'baseline' connection and disconnection process carried out using conventional technology. This allowed the reduction in marine operations time and complexity to be described and quantified.

Impact assessment – The impact of the Q-Connect on key metrics was quantified and described against base case assumptions. 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 Strategy: EMEC led a work-package to set-out the commercial and technical development strategy. This including engagement with potential customers, assessment of funding opportunities, short- and long-term market assessment and a manufacturing assessment.

3 Project Achievements

The project delivered against its stated objectives, significantly advancing the design of the Q-Connect and providing further operational and commercial understanding. The extensive numerical modelling programme gave valuable insight into the interfacing of the Q-Connect with test case machines and provided further confidence in weather limit assumptions around key marine operations. The design analysis work and supplier engagement has significantly progressed the Q-Connect design, increasing confidence in strength and life calculations. Components with the highest risk due to novelty or design criticality have been identified and the Stage 3 test plan drawn up to focus on the qualification and testing of these.

The impact assessment drew together conclusions from across the work-packages to quantity the impact of using a Q-Connect system over a comparative baseline. The Q-Connect technology has been shown to deliver significant OPEX cost savings and as a result has been shown to have a payback period of less that one WEC install and remove cycle, with further OPEX savings over each WEC's life amounting to millions of pounds. This demonstrates the massive value for money that the Q-Connect technology can offer. Additionally, O&M

modelling work has shown that the Q-Connect technology can enable double digit WEC availability and power production percentage improvements for well-developed commercial WECs; for prototype and First-of-a-Kind WECs the impact is multiples of this. These availability and performance improvements are enabled because a move to the use of the Q-Connect technology results in onsite installation operation times being reduced by >80%, and onsite removal times being reduced by >85% over the baseline cases. These improvements in installability also enable robust work-up programmes to be delivered that are the cornerstone of risk-mitigated qualification programs for early stage WECs.

The project took place under the shadow of the coronavirus pandemic and a second nationwide lockdown, this posed challenges with communication and resourcing as team members juggled work, home-schooling and childcare. Despite this the project delivered with only a slight delay in timelines with contingency plans working well to ensure continued progress. We thank WES for their understanding and allowance for extra time to deliver some aspects of the project.

4 Recommendations for Further Work

A Stage 3 work plan is well advanced and focuses effort on testing and qualification of key components and sub-assemblies. The work will form an important step on the route to technology certification with tests focused on key areas of novelty and those items with the highest identified risks. Tests will be robustly documented, and results fed into the ongoing design development process. Further important learning will be made from observing the fabrication and assembly of components allowing the design for manufacture to be iterated and cost saving areas identified.

In parallel the commercial development of the Q-Connect system will be progressed through continued engagement with the market, and through developing onward funding opportunities.

5 Communications and Publicity Activity

The Q-Connect project is described on the Quoceant website. On award of Stage 2 a blog release was made with accompanying social media posts. Quoceant submitted an abstract, “Get Connected! A Quick Connection System for Marine Renewables” for presentation at All Energy in 2020 but this has been delayed due to the coronavirus pandemic – hopefully, an opportunity will arise later in the year.

The Q-connect team are planning additional publicity around the completion of stage 2.

https://www.quoceant.com/post/getting-connected

Getting Connected (quoceant.com)

6 Useful References and Additional Data

https://www.quoceant.com/projects Quoceant projects website including short article on this project

Publicity Material

Filename	Media Type	Description
Quoceant-logo	.png	Quoceant's company logo
Q-Connect general image	.png	Public image of the Q-Connect concept